

## Article

# Asteroid Mining and Capital Markets: A Long-Term Analysis of Economic Viability and Commodity Market Implications

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## Abstract

Asteroid mining has increasingly attracted attention as a potential future source of critical minerals, particularly platinum-group metals (PGMs), due to advances in commercial spaceflight and declining launch costs. Despite growing interest, the long-term economic feasibility of asteroid mining remains uncertain because of high capital requirements, technological limitations, and regulatory ambiguity.

This paper evaluates the financial viability of asteroid mining using a discounted cash flow (DCF) framework under a moderate long-term scenario. The analysis incorporates assumptions regarding launch cost reductions, extraction efficiency improvements, commodity price trends, and investment risk over the period 2035–2100. In addition to modeling mission-level cash flows and net present value (NPV), the study examines broader implications for commodity markets and capital allocation.

The findings suggest that asteroid mining is unlikely to be economically viable within conventional capital market frameworks in the near or medium term. Although operational profitability may emerge in the latter half of the century, extended investment horizons and high discount rates significantly reduce present value. The analysis also highlights a potential structural paradox in which large-scale extraction could increase the supply of platinum-group metals and exert downward pressure on commodity prices, thereby reducing future profitability.

The paper concludes that asteroid mining may require alternative financing structures and long-horizon investment frameworks rather than traditional project finance models. More broadly, the study contributes to the emerging discussion surrounding space resource economics and the financial valuation of frontier technological industries.

**Keywords:** *Asteroid Mining Capital Markets, Discounted Cash Flow, Space Economics, Platinum Group Metals, Space Finance, Commodity Markets, Resource Economics*

# 1. Introduction

Over the past decade, interest in commercial exploitation of extraterrestrial resources has increased significantly. Advances in launch technology, declining costs of access to orbit, and the emergence of private space companies have shifted asteroid mining from a purely speculative concept toward a topic of serious economic and technological discussion. Companies and space agencies are increasingly exploring the possibility that near-Earth asteroids (NEOs) could serve as future sources of valuable minerals and industrial materials (OECD, 2023).

One of the most frequently cited economic motivations for asteroid mining is the potential abundance of high-value metals contained within certain classes of asteroids. In particular, some metallic asteroids may contain significant quantities of PGMs, including platinum, palladium, rhodium, and iridium (Sanchez et al., 2021). These metals are widely used in catalytic converters, electronics manufacturing, and emerging technologies such as hydrogen fuel cells (USGS, 2023). Because global terrestrial production of PGMs remains relatively limited and geographically concentrated, the possibility of accessing extraterrestrial sources has attracted attention from both policymakers and private investors (USGS, 2023). However, the presence of valuable resources does not by itself establish commercial viability. The economic value of an asteroid also depends on its accessibility, recoverable resource concentration, extraction efficiency, transportation requirements, and the future market price of the extracted material (Hein, Matheson and Fries, 2020).

The broader space industry has changed, potentially improving long-term prospects for space resource use. Growth in commercial launch providers and reusable rocket tech has lowered space access costs. While cheaper launches are crucial for future resource extraction, other costs like spacecraft development, extraction, processing, operations, and funding still make up a large part of total project expenditure (Adilov, Alexander & Cunningham, 2026).

Despite these developments, asteroid mining remains highly speculative from both a technological and financial perspective. Several critical technical capabilities must be developed before economically viable asteroid resource extraction can occur. These include advanced propulsion systems capable of both high-thrust maneuvers and efficient low-thrust deep-space travel, reliable methods for resource extraction in microgravity environments, and technologies for in-situ resource utilization (ISRU) that allow materials to be processed directly in space (Sarkar, 2024). Research on near-Earth asteroid resources has also demonstrated that the distinction between the physical presence of a resource and its economic accessibility is important when assessing potential mining targets (Hein, Matheson and Fries, 2020).

Over the last two decades, space access economics has shifted fundamentally. Launch costs have fallen significantly from the Space Shuttle era due to reusable commercial launch technologies (Adilov, Alexander & Cunningham, 2026). While lower transportation costs reduce the capital required for asteroid mining, these cost declines must be evaluated alongside long development horizons and technical uncertainties.

Financial viability remains uncertain due to high upfront capital expenditures, long timelines, and technical risk. Additionally, ambiguous regulatory frameworks regarding space resource ownership under international treaties like the Outer Space Treaty may complicate capital formation and private investment (United Nations, 1967; U.S. Congress, 2015; Luxembourg Government, 2017).

Consequently, early initiatives may rely on alternative financing like government grants, venture capital, research partnerships, or public-private collaborations. Long-term success will hinge on falling launch costs, technological maturity, resource accessibility, commodity prices, and capital availability (McKinsey & Company, 2023).

This paper evaluates asteroid mining from a financial perspective, assessing whether projects can achieve economic viability under plausible market and technological conditions using discounted cash flow (DCF) analysis, cost estimation models, and commodity-price scenarios.

The analysis also considers the broader implications that extraterrestrial resource extraction could have for commodity markets and capital markets if large quantities of rare metals were introduced into global supply chains. In particular, increased extraterrestrial supply could affect the future prices of PGMs while simultaneously creating new investment opportunities in space infrastructure, resource extraction, transportation, and related industries (Hein, Matheson and Fries, 2020; Morgan

Stanley, 2022). This creates an important economic tension: the successful expansion of asteroid mining could increase the availability of valuable resources while potentially reducing the commodity prices that underpin the industry's revenues.

The paper proceeds by first examining the existing literature and technological development surrounding asteroid-resource extraction, followed by consideration of the resource accessibility, legal, and environmental conditions that may influence future commercial activity. The analysis then develops the cost structure and assumptions required to evaluate a potential asteroid-mining mission before applying discounted cash flow and net present value techniques to assess its long-term financial viability. Subsequent sections examine the model results and sensitivity analysis before considering the implications of asteroid-derived resources for commodity markets, financing, and capital formation. The paper concludes by discussing the principal limitations of the analysis and the conditions that could influence the development of the industry over the long term.

## 2. Literature Review

The concept of asteroid mining has been explored across multiple disciplines, including planetary science and resource characterization (Gaffey, Helin & O'Leary, 1979; Lewis, 1992), techno-economic analysis (Hein, Matheson and Fries, 2020), and space law and resource governance (United Nations, 1967; U.S. Congress, 2015; Luxembourg Government, 2017). Existing literature generally focuses on three primary dimensions: technical feasibility, resource potential, and legal frameworks. However, comparatively less attention has been paid to integrating these factors within a financial modelling framework.

Early research on near-Earth asteroid resources established that the potential resource base extends beyond a purely theoretical inventory of metals. Gaffey, Helin and O'Leary (1979) used remote-sensing observations and meteorite evidence to argue that a substantial fraction of small near-Earth asteroids could contain volatile materials and free metals, while emphasizing the importance of improved spectral characterization in determining the composition of individual objects. Lewis (1992) subsequently distinguished between volatiles, free metals, and bulk material as potentially exploitable asteroid resources and noted that some near-Earth asteroids can be energetically more accessible than the Moon. These studies provide an important physical basis for considering asteroids as potential resource sources, but they do not establish commercial viability. The economic value of a resource depends additionally on accessibility, extraction efficiency, transportation requirements, development expenditure, and the market value of the recovered material (Hein, Matheson and Fries, 2020).

From a scientific perspective, there is evidence that NEOs contain potentially valuable materials, with metallic (M-type) asteroids containing iron, nickel, and trace amounts of platinum-group metals (PGMs) (Sanchez et al., 2021). However, only a small subset of known asteroids may be both compositionally valuable and dynamically accessible (Elvis, 2014; Lewis, 1992). Engineering literature highlights challenges in deep-space propulsion, autonomous extraction in microgravity, and in-situ resource utilization (ISRU), while noting that fully operational asteroid-mining systems remain at an early stage of development (Hein, Matheson and Fries, 2020; Sarkar, 2024).

Legal and policy research has highlighted uncertainty surrounding property rights and resource governance in space. The Outer Space Treaty prohibits national appropriation of outer space but does not explicitly establish ownership rights over extracted resources. National legislation, including frameworks developed by the United States and Luxembourg, has sought to clarify these rights, although a universally accepted international framework has yet to emerge (United Nations, 1967; U.S. Congress, 2015; Luxembourg Government, 2017).

Economic studies have examined the potential effects of asteroid mining on commodity markets, particularly the supply and pricing of PGMs. Hein, Matheson and Fries (2020) examine the techno-economic conditions underlying asteroid mining, while Yarlagadda (2022) considers the broader economic implications of asteroid-resource extraction. While extraterrestrial resources could introduce substantial additional supply, large-scale extraction could also place downward pressure on prices and reduce the profitability of mining activities.

Across these strands of literature, an important distinction emerges between the physical availability and economic accessibility of extraterrestrial resources. Resource abundance alone does not establish commercial viability, which also depends on accessibility, transportation, extraction and processing efficiency, mission duration, development expenditure, and future commodity prices. Despite substantial research on these individual dimensions, relatively limited attention has been given to integrating technical feasibility, market dynamics, and capital-market valuation within a single framework, particularly through long-horizon DCF analysis (Hein, Matheson and Fries, 2020).

This study addresses this gap by linking these factors through a long-horizon DCF and Net Present Value (NPV) framework. It therefore examines asteroid mining not only as a technological possibility, but also as a potential future investment project subject to capital requirements, uncertain returns, commodity-market conditions, and the cost of capital.

### **3. Resource Potential of Metallic Asteroids**

One of the primary economic motivations behind asteroid mining is the potential availability of high-value metals in NEOs, particularly PGMs. PGMs include platinum, palladium, rhodium, ruthenium, iridium, and osmium—metals that are both rare and industrially critical. These elements are widely used in catalytic converters, electronics manufacturing, medical devices, and emerging technologies such as hydrogen fuel cells and advanced semiconductors (USGS, 2023).

Recent surveys have identified over 30,000 near-Earth asteroids, though only a small fraction are considered economically viable targets (ESA, 2022). Estimates suggest that approximately 1 per cent of near-Earth objects may contain meaningful concentrations of PGMs, and an even smaller subset meets the orbital accessibility constraints required for cost-effective missions (Elvis, 2014). This highlights that resource abundance alone does not translate directly into economic feasibility.

Asteroids, particularly metallic or M-type asteroids, are believed to contain relatively high concentrations of these elements compared with the Earth's crust (Sanchez et al., 2021). PGMs are highly siderophile elements; much of the Earth's accessible crust contains relatively low concentrations of these metals compared with their abundance in some metal-rich asteroids (Elvis, 2014).

More recent observational work provides evidence that at least some near-Earth asteroids are substantially metal-rich. Sanchez et al. (2021), using near-infrared spectroscopy of the near-Earth asteroids 6178 (1986 DA) and 2016 ED85, estimated that the bodies contained approximately 85% metal and 15% pyroxene by mineral abundance. Their analysis further suggested that the quantities of iron, nickel, cobalt, and PGMs present in 1986 DA could exceed currently estimated terrestrial reserves. However, these results concern specific objects and should not be generalized to the entire near-Earth asteroid population. For financial modelling, this distinction is important because the presence of unusually metal-rich bodies does not establish that comparable concentrations will be found in economically accessible targets.

Economically, these metals are highly attractive due to their market value and supply chain importance. Rhodium, for instance, has exceeded hundreds of thousands of dollars per kilogram, driven by its rarity and emissions-control applications. Acquiring large volumes from space raises key questions regarding financial feasibility and global commodity market impacts.

However, the existence of metal-rich asteroids does not automatically imply that they are economically viable mining targets. Previous research suggests that only a small fraction of known near-Earth asteroids may contain concentrations of metals high enough to be considered economically valuable.

This scarcity of economically viable targets highlights the importance of asteroid characterization and surveying missions. Identifying suitable asteroid bodies—those that combine high metal concentrations with relatively low orbital energy requirements—will likely be a key step in the development of the future asteroid mining industry (Hein et al., 2020).

## 4. Emerging Commercial Efforts in Asteroid Resource Extraction

While asteroid mining has long been discussed in theoretical and scientific literature, the past decade has seen the emergence of several private companies attempting to explore the commercial feasibility of extraterrestrial resource extraction. Among these companies is AstroForge, a U.S.-based aerospace company founded in 2022 to extract PGMs from metallic asteroids (AstroForge, 2025).

AstroForge represents a new generation of space startups seeking to apply commercial spaceflight capabilities toward deep-space resource extraction. The company's strategy focuses on targeting relatively small metallic asteroids that may contain concentrated deposits of PGMs. These missions are intended not only to identify promising resource targets but also to develop technologies for processing and refining asteroid material in space (AstroForge, 2025).

One of the company's early missions involved the launch of a small satellite designed to test technologies for refining metals in space. Although the mission experienced technical difficulties, it served as an early attempt to demonstrate the feasibility of space-based mineral processing. The company has since continued to develop additional missions aimed at characterizing asteroids and eventually extracting materials from them (AstroForge, 2025).

The broader strategy behind such missions reflects an incremental development pathway common in the commercial space industry. Initial missions focus on technology demonstration and asteroid reconnaissance, followed by later missions that may attempt to extract and return materials to Earth. This staged development model mirrors the approach used in other emerging space sectors, such as reusable launch vehicles and satellite constellations (Morgan Stanley, 2022).

Private efforts such as AstroForge highlight a broader shift in the economics of space exploration. Historically, deep-space missions were almost exclusively conducted by government space agencies due to their enormous cost and technological complexity. However, declining launch costs and increasing private investment in the space industry have opened the possibility that commercial actors may play a larger role in future space resource development (Adilov et al., 2026; Morgan Stanley, 2022).

Nevertheless, despite growing private interest, asteroid mining remains in an early experimental stage. No commercial mission has yet successfully returned mined material from an asteroid for economic purposes (AstroForge, 2025). The current generation of missions, therefore, represents an exploratory phase aimed at validating both the technological feasibility and economic rationale for future resource extraction activities.

## 5. Legal and Regulatory Framework of Asteroid Mining

A critical constraint on the development of asteroid mining is the absence of a comprehensive and clearly defined legal framework governing extraterrestrial resource extraction. While technological and economic feasibility are often discussed as primary barriers, legal uncertainty represents an equally significant challenge, particularly in the context of capital formation and long-term investment decisions.

The current legal foundation for space activities is largely derived from the Outer Space Treaty of 1967, which establishes that outer space is the "province of all mankind" and prohibits national appropriation of celestial bodies. However, the treaty does not explicitly address the ownership of resources extracted from those bodies. This ambiguity has created what is often described as a "legal vacuum," in which key questions regarding asteroid mining remain unresolved (United Nations, 1967).

One of the most fundamental issues concerns resource ownership. While some national frameworks—such as legislation introduced by the United States and Luxembourg—have recognized the right of private entities to own extracted space resources, these interpretations are not universally accepted. As a result, there remains no globally agreed-upon standard determining whether extracted materials can be treated as private property or whether they fall under some form of collective ownership regime (United Nations, 1967; U.S. Congress, 2015; Luxembourg Government, 2017).

Closely related to this issue is the lack of clarity surrounding licensing and authorization mechanisms. Under existing international law, space activities are conducted under the supervision of nation-states, which are responsible for authorizing

and continuously supervising private actors. However, there is no standardized international process for granting licenses specifically for asteroid mining operations. This creates uncertainty for firms seeking to undertake such missions, particularly in terms of regulatory compliance and long-term operational approval (U.S. Congress, 2015).

Furthermore, space activities lack a standardized international licensing system for asteroid mining, creating regulatory compliance uncertainties for private entities operating under state supervision. Environmental protection also remains under-regulated; potential externalities like orbital debris, contamination, and mission interference face minimal guidance under existing treaties (Luxembourg Government, 2017).

Additionally, ethical and legal debates persist over benefit-sharing for outer space as a global commons, yet no enforceable redistribution framework or specialized extraterrestrial dispute resolution system exists. Consequently, these legal ambiguities increase risk premiums and hinder capital access, making clear property rights and stable regulations essential to attracting necessary private investment.

## **6. Environmental and Sustainability Considerations of Asteroid Mining**

One of the most significant arguments for asteroid mining is its potential to alleviate the depletion of terrestrial resources. Many critical elements used in modern industry—including silver, gold, copper, and rare metals—are finite and are being consumed at increasing rates due to industrialization and technological demand. Some estimates suggest that reserves of key elements are being depleted at varying rates, raising long-term concerns about the sustainability of current extraction practices. While such estimates vary depending on methodology, the broader trend indicates increasing pressure on Earth's mineral reserves (World Bank, 2020).

Some metallic asteroids may contain metal concentrations substantially higher than those found in economically viable terrestrial deposits (Sanchez et al., 2021). As a result, asteroid mining has been proposed as a potential alternative source of critical minerals, which could reduce dependence on Earth-based extraction.

A reduction in terrestrial mining activity could generate meaningful environmental benefits. Traditional mining operations are associated with deforestation, habitat destruction, water contamination, and soil degradation. These impacts are often concentrated in ecologically sensitive regions and may have long-lasting or irreversible consequences. If asteroid mining were able to supply even a portion of global demand for high-value metals, it could reduce the need for environmentally intensive mining practices on Earth. This aligns with broader sustainability goals aimed at minimizing the ecological footprint of resource extraction (Hein, Saidani and Tollu, 2018).

However, this potential benefit must be evaluated alongside the environmental implications of space-based operations. The asteroid mining industry remains in its early stages, with ongoing research and development focused on propulsion systems, extraction methods, and in-situ resource utilization (ISRU). These technological developments are energy-intensive and may involve frequent launch activity, which carries its own environmental footprint. Although advances in launch technology have reduced launch costs, launch activity itself has environmental impacts, and the cumulative effects of increased launch frequency remain uncertain (Dallas et al., 2021).

Asteroid mining poses space-specific sustainability risks, including orbital debris, particulate matter, and the contamination of celestial environments. These environmental effects are not yet addressed through a comprehensive and established environmental-assessment framework for commercial space-resource extraction (Dallas et al., 2021).

Asteroid-derived water (H<sub>2</sub>O) could become important for a self-sustaining space economy. It could be processed into hydrogen and oxygen propellant, potentially reducing the amount of propellant that must be launched from Earth and supporting deep-space logistics. Its value remains in-situ utilization rather than terrestrial consumption due to transport costs (Hein, Saidani and Tollu, 2018).

Additionally, asteroid mining could disrupt terrestrial commodity markets. Increasing the supply of metals like platinum or nickel might reduce harmful terrestrial extraction but could negatively impact economies reliant on traditional mining. Ultimately, asteroid mining offers a dual sustainability narrative: it potentially mitigates terrestrial environmental degradation while introducing novel risks and governance challenges in space. Long-term sustainability will depend on effectively balancing these trade-offs.

## **7. Financial Modeling of Asteroid Mining Viability**

This study addresses this gap by linking these factors through a long-horizon DCF and Net Present Value (NPV) framework. It therefore examines asteroid mining not only as a technological possibility, but also as a potential future investment project subject to capital requirements, uncertain returns, commodity-market conditions, and the cost of capital. This study employs a discounted cash flow (DCF) framework to evaluate the long-term financial viability of asteroid mining. DCF analysis is a standard tool in capital markets used to assess the present value of future cash flows under uncertainty.

The analysis spans the period 2035–2100, reflecting the long development timelines associated with deep-space infrastructure projects. While simplified, this framework provides a structured approach to evaluating the economic feasibility of asteroid mining under plausible future conditions.

### **7.1. Key Assumptions and Formulas**

The assumptions used in this model are grounded in current trends in the space and commodities sectors. The 2.5 per cent annual decline in mission expenditure is a modelling assumption informed in part by observed reductions in commercial launch costs and potential operational improvements. It is not intended as a forecast of total mission costs. Yield growth of 3 per cent annually represents gradual improvements in extraction technology, rather than speculative breakthroughs. The 25 per cent discount rate is intentionally high to account for the extreme uncertainty and long investment horizon associated with asteroid mining projects.

The model incorporates several core assumptions:

- Initial mission cost: approximately US\$500 million
- Annual cost decline: 2.5%, reflecting incremental technological improvements and reduced launch costs
- Initial extraction yield: 1,000 kg of platinum
- Yield growth: 3% annually due to improvements in extraction efficiency
- Initial platinum price: US\$30,000 per kg (World Platinum Investment Council, 2023)
- Price growth: 1.5% annually
- Discount rate: 25%, reflecting extreme technological, regulatory, and execution risk

These assumptions are designed to represent a moderate scenario, avoiding both overly optimistic projections and excessively conservative estimates. Existing trends in the space and commodities sectors inform the assumptions used in this model. Launch cost reductions are based on observed declines in commercial spaceflight costs associated with reusable launch systems (Adilov, Alexander and Cunningham, 2026).

Commodity pricing assumptions are derived from recent market data on PGMs (World Platinum Investment Council, 2023; USGS, 2023).

Table 1: Variables

| Variable                               | Value | Notes                         |
|----------------------------------------|-------|-------------------------------|
| Start Year                             | 2035  | Illustrative model start year |
| Discount Rate                          | 25%   | High-risk weight              |
| Initial Mission Cost (US\$M)           | 500   | Model assumption              |
| Cost Decline Rate                      | 2.5%  | Annual decline                |
| Initial Platinum Price (US\$/kg)       | 30000 | Realistic Platinum price      |
| Price Growth Assumption                | 1.5%  | Inflation + Scarcity          |
| Initial Annual Recovered Quantity (Kg) | 1000  | Model assumption              |
| Recovered-Quantity Growth Rate         | 3%    | Tech improvements             |

The selection of a 25 per cent discount rate reflects the high-risk nature of emerging space industries, consistent with venture-style investment frameworks for technologically uncertain projects. Yield growth and efficiency improvements are modeled conservatively to reflect incremental technological progress rather than speculative breakthroughs.

### 7.1.1. Financial Model and Valuation Methodology

#### 1. Recoverable Resources

Recoverable Resource Formula:

$$Q(\text{recoverable}) = Q(\text{in situ}) \times C \times E$$

Where:

$Q(\text{in situ})$  = estimated quantity of the resource present in the asteroid

$C$  = concentration of the target resource

$E$  = extraction/recovery efficiency

This formulation distinguishes between the theoretical quantity of a resource present within an asteroid and the quantity that could realistically be recovered. A large estimated resource base therefore does not necessarily translate into an equivalent quantity of commercially usable material.

#### 2. Revenue

Revenue Formula:

$$\text{Revenue}(t) = Q(t) \times P(t)$$

Where:

$Q(t)$  = quantity of recovered material sold in year  $t$

$P(t)$  = realized market price per unit in year  $t$

For PGMs, this can be expressed as:

$$\text{Revenue}(PGM, t) = Q(PGM, t) \times P(PGM, t)$$

This relationship links the physical quantity of recoverable resources to their potential economic value and allows changes in commodity prices to be incorporated into the financial model.

### 3. Net Cash Flow

Net Cash Flow Formula:

$$\text{Net Project Cash Flow}(t) = \text{Revenue}(t) - \text{Mission Expenditure}(t)$$

Simplified project cash flow after accounting for the principal expenditures required to operate and develop the project. In the asteroid-mining context, this includes expenditures associated with spacecraft development, launch, extraction, processing, operations, and other mission-related costs.

### 4. Present Value

Present Value Formula:

$$PV(t) = CF(t) / (1 + r)^t$$

Where:

$PV(t)$  = present value of the cash flow in year  $t$

$CF(t)$  = cash flow in year  $t$

$r$  = discount rate

$t$  = number of years from 2035, with 2035 treated as  $t = 0$

Because asteroid-mining projects may require substantial expenditure many years before generating significant revenues, discounting is particularly important when evaluating their present economic value.

### 5. Net Present Value

Net Present Value Formula:

$$NPV = \sum_{t=0} CF(t)/(1 + r)^t$$

Where:

$CF(t)$  = cash flow in year  $t$

$r$  = discount rate

$t$  = number of years from 2035, with 2035 treated as  $t = 0$

$n$  = total project period

NPV represents the present value of expected future cash flows after accounting for the initial expenditure. A positive NPV indicates that the project's discounted cash inflows exceed its initial expenditure under the assumptions used in the model.

## 7.2. Cost and Revenue Dynamics

The model demonstrates a gradual convergence between mission costs and revenue generation over time.

In the early years (2035–2050), mission costs significantly exceed potential revenue. For example:

- In 2035, the estimated revenue is approximately US\$30 million compared to an initial mission expenditure of US\$500 million
- This results in a substantial negative cash flow of approximately –US\$470 million

Table 2: Illustrative decomposition of the initial US\$500 million modelling assumption. [Percentages are not empirical cost estimates]

| Component         | %  | Example (\$M) |
|-------------------|----|---------------|
| Launch            | 30 | 150           |
| Spacecraft        | 25 | 125           |
| Mining Equipment  | 20 | 100           |
| Processing (ISRU) | 15 | 75            |
| Operations        | 10 | 50            |

Even by 2050, despite improvements in yield and pricing, revenue remains insufficient to offset costs.

However, over longer time horizons, two key trends emerge:

1. Declining costs due to improved launch systems and operational efficiency
2. Increasing revenue driven by higher yields and gradual commodity price growth

By approximately 2076, these trends begin to converge.

### 7.3. Risk and Model Uncertainty

The model is sensitive to several key variables, although the magnitude of the effect differs across assumptions:

#### *1. Launch Cost Reduction*

A faster decline in launch costs would significantly accelerate viability.

#### *2. Extraction Yield*

Higher-than-expected yields could dramatically improve revenue projections.

#### *3. Commodity Prices*

A decline in platinum prices (e.g., due to supply shocks) could undermine profitability.

#### *4. Discount Rate*

The model quantitatively examines discount rate changes, where cash flow timing creates a non-standard sensitivity pattern. Due to long-term project uncertainty, baseline NPV is not a fixed estimate and remains highly sensitive to transportation costs, commodity prices, extraction performance, and the discount rate. Sensitivity analysis is thus applied to assess how parameter shifts impact NPV and highlight key sources of financial risk.

### 7.4. Visual Representation of Results

Table A / Appendix A: Appendix A presents the detailed discounted cash flow (DCF) model and annual financial projections. The table provides the underlying values for mission expenditure, extraction yield, platinum price, revenue, annual project cash flow, discount factor, and discounted cash flow used in the analysis.

For modelling purposes, each year represents a stylised mission cycle within a developing asteroid-mining programme. Mission expenditure declines over time, while recovered output and commodity prices increase according to the specified assumptions. Figure 1 illustrates the gradual convergence of mission expenditure and revenue, with annual revenue eventually exceeding mission expenditure from 2076 onward. Figure 2 shows the gradual improvement in annual project cash flow, which becomes positive in 2076.

Figure 1: Mission Expenditure and Revenue Under the Moderate Scenario, 2035–2100

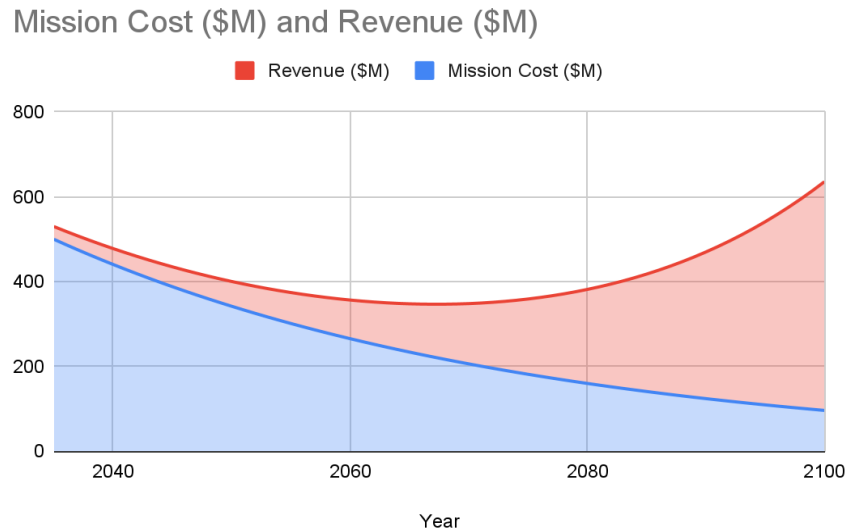
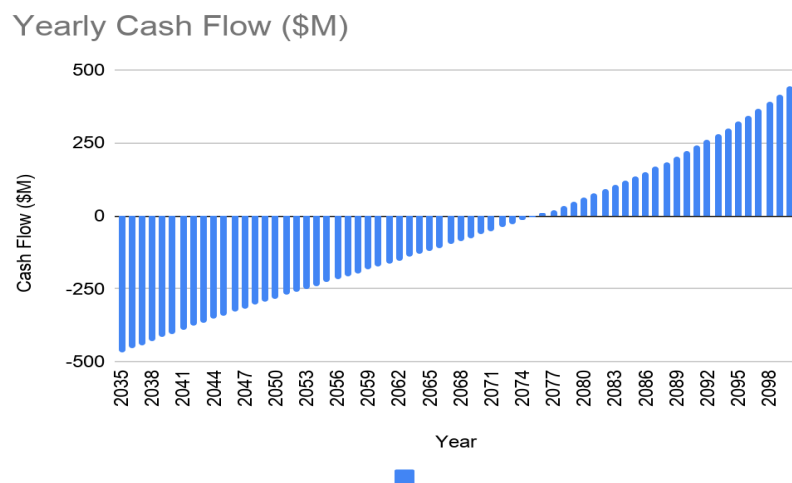


Figure 2: Annual Project Cash Flow under the Moderate Scenario, 2035–2100



## 7.5. Sensitivity Analysis

These assumptions are designed to represent a moderate scenario, avoiding both overly optimistic projections and excessively conservative estimates. Existing trends in the space and commodities sectors inform the assumptions used in this model. Launch cost reductions are based on observed declines in commercial spaceflight costs associated with reusable launch systems (Adilov, Alexander and Cunningham, 2026).

Commodity pricing assumptions are derived from recent market data on PGMs (World Platinum Investment Council, 2023; USGS, 2023). In this study, Sensitivity analysis evaluates how changes in individual model assumptions affect the project's calculated NPV. Initial mission expenditure, platinum price, discount rate, and annual mission-cost decline are varied while other baseline assumptions are held constant.

1. NPV Sensitivity to Initial Annual Mission Expenditure

| Initial Mission Cost | NPV (\$M) |
|----------------------|-----------|
| \$400M               | -1,634.9  |
| \$450M               | -1,862.1  |
| \$500M — Base        | -2,089.4  |
| \$550M               | -2,316.7  |
| \$600M               | -2,543.9  |

Interpretation: A \$100M reduction in the initial mission-cost assumption improves NPV by approximately \$455M

2. NPV vs. Platinum Price

| Initial Platinum Price | NPV (\$M) |
|------------------------|-----------|
| \$24,000/kg            | -2,126.1  |
| \$27,000/kg            | -2,107.7  |
| \$30,000/kg — Base     | -2,089.4  |
| \$33,000/kg            | -2,071.1  |
| \$36,000/kg            | -2,052.7  |

Interpretation: The relatively small change in NPV across the tested platinum-price scenarios indicates that commodity price alone has limited influence on project value under the model assumptions. This reflects the long time horizon and substantial discounting of future revenues.

3. NPV vs. Discount Rate

| Discount Rate | NPV (\$M) |
|---------------|-----------|
| 15%           | -2,956.3  |
| 20%           | -2,433.8  |
| 25% — Base    | -2,089.4  |
| 30%           | -1,846.8  |
| 35%           | -1,667.0  |

Interpretation: The sensitivity results stem from the project's cash-flow timing, characterized by large early negative flows preceding later positive ones, underscoring the role of timing in DCF valuations for uncertain, long-duration projects. Raising the discount rate discounts distant positive cash flows more heavily than earlier negative ones, yielding a less negative NPV. This improvement reflects model timing dynamics rather than enhanced project economics.

#### 4. NPV Sensitivity to Annual Mission-Cost Decline

| Annual Mission-Cost Decline | NPV              |
|-----------------------------|------------------|
| 1.5%                        | -\$2.175B        |
| 2.0%                        | -\$2.132B        |
| <b>2.5% Base</b>            | <b>-\$2.089B</b> |
| 3.0%                        | -\$2.049B        |
| 3.5%                        | -\$2.010B        |

Interpretation: Faster reductions in mission costs improve NPV, demonstrating the importance of technological and transportation-cost improvements to long-term viability. However, the project remains NPV-negative across the tested range, indicating that cost reductions alone may not be sufficient under the baseline assumptions.

Taken together, the sensitivity analysis reinforces the conclusion that the financial viability of asteroid mining depends less on a single optimistic assumption than on the interaction between capital expenditure, the timing of revenue generation, technological improvement, commodity prices, and the required return on capital.

Under all tested one-at-a-time sensitivity ranges, the project's NPV remains negative. The result therefore remains unchanged within the parameter ranges examined, although this does not establish robustness to simultaneous changes in multiple assumptions.

## 7.6. Interpretation of Results

The results suggest that asteroid mining is not financially viable in the near or medium term under the moderate assumptions used in the model. High upfront capital requirements, gradual revenue growth, and the long investment horizon constrain financial value.

At the 25 per cent discount rate, the present value of later positive cash flows is insufficient to offset the discounted value of the earlier negative cash flows. This highlights the distinction between annual operational profitability and overall investment viability.

## 8. Limitations

This study uses a simplified discounted cash flow (DCF) framework to establish a transparent baseline for assessing the potential financial viability of asteroid mining. DCF is useful in this context because it provides a structured and widely understood method of relating projected future cash flows to present value, while allowing individual assumptions such as mission expenditure, extraction yield, commodity prices, and the discount rate to be examined directly (Damodaran, 2012). However, the model should be viewed as a baseline financial framework rather than a representation of a fully operational asteroid-mining project.

Several assumptions introduce uncertainty into outcomes. The model focuses on platinum as a single commodity and assumes gradual improvements in mission costs and extraction efficiency, while actual missions may involve multiple resources and substantially different technological development paths. In addition, limited empirical data from commercial asteroid-mining

missions means that resource composition, accessibility, and recoverable yield remain uncertain (Hein et al., 2020). The model also does not fully incorporate potential commodity-price feedback, whereby large-scale extraterrestrial supply could reduce platinum prices and consequently project revenues.

The model represents a simplified annualized mission-cycle framework and does not capture potential economies of scale, learning effects, reusable infrastructure, or changing risk levels over the 2035–2100 horizon. Similarly, applying a constant discount rate does not reflect the possibility that project risk could decline as technologies mature and operational experience develops.

The model also aggregates spacecraft development, launch, extraction, processing, and operating expenditures into a simplified mission-cost series and does not separately model taxes, working capital, financing structure, residual value, or other corporate-level cash flows.

The sensitivity analysis provides some indication of how changes in key assumptions affect the results but cannot capture every possible technological or market outcome. Accordingly, the estimated NPV should be interpreted as a **scenario-based assessment of financial conditions**, rather than a precise forecast of the future value or commercial timing of asteroid mining.

## 9. Implications for Capital Markets

The findings suggest that asteroid mining presents a challenge to conventional capital-market valuation because of substantial upfront expenditure, delayed cash-flow realization, and extreme technological and regulatory uncertainty. A project may therefore be technically achievable while remaining difficult to finance under conventional capital-allocation frameworks (OECD, 2023).

As a result, asteroid mining may not fit neatly into traditional project finance models. Instead, the sector may require hybrid financing mechanisms combining public funding, strategic state support, venture-style capital, and long-horizon institutional investment. Government participation may be especially important during early development phases due to the strategic and technological externalities associated with space infrastructure (Rao and Park, 2026; McKinsey & Company, 2023).

The evolution of the broader space economy also suggests that capital markets are beginning to develop mechanisms capable of supporting long-horizon space businesses. Morgan Stanley Research identifies increased private investment, infrastructure development, strategic partnerships between established aerospace firms and commercial entrants, and alternative financing structures such as special purpose acquisition companies (SPACs) as important features of the emerging space economy (Morgan Stanley, 2022). These developments are relevant to asteroid mining because the industry's unusually long development periods and high technological risks may require financing structures that differ from those traditionally used for conventional mining projects. Rather than relying solely on conventional project finance, future asteroid-mining ventures could potentially combine strategic corporate investment, venture capital, government participation, and public-market financing as technological and commercial uncertainty declines.

The study also raises important questions regarding the evolution of financial markets in response to long-duration technological projects. Existing valuation methods are generally optimized for investments with relatively predictable cash flows and shorter time horizons. However, asteroid mining represents a category of investment where uncertainty itself becomes a defining characteristic of the asset class.

This suggests that future “space finance” frameworks may require alternative valuation approaches capable of incorporating:

- Strategic resource optionality,
- Technological learning curves,
- Geopolitical considerations,
- Infrastructure network effects,
- Long-term scarcity dynamics.

Another major implication concerns commodity market stability. If asteroid mining succeeds at scale, the resulting increase in the supply of PGMs could materially alter global commodity pricing structures. Under such conditions, the industry may encounter a self-limiting dynamic in which increased production suppresses prices and reduces the profitability of future extraction (OECD, 2023).

The potential effects of asteroid-derived resources may extend beyond the profitability of individual mining companies to the structure of commodity markets and resource-dependent economies. Yarlagadda (2022) argues that large-scale asteroid mining could generate substantial increases in the supply of certain raw materials and potentially place downward pressure on terrestrial commodity prices. The distributional effects could also be significant for economies that rely heavily on mineral exports, particularly if firms operating in space acquire the ability to supply commodities at a scale that materially changes global markets. These possibilities reinforce the importance of incorporating commodity-market responses into long-term financial assessments rather than treating future resource prices as independent of the development of asteroid mining.

This dynamic resembles historical commodity cycles in terrestrial resource industries, where supply expansion frequently leads to price compression and declining returns on capital. However, asteroid mining introduces this challenge on a potentially unprecedented scale due to the theoretically vast quantity of extraterrestrial resources.

Consequently, the long-term economic value of asteroid mining may not lie primarily in transporting metals back to Earth, but rather in enabling a self-sustaining space economy. Resources such as water, nickel, and construction materials could become economically valuable within space itself, supporting orbital manufacturing, refueling infrastructure, and deep-space logistics networks.

Under this framework, asteroid mining could become an enabling component of future space infrastructure. This distinction is critical from a capital markets perspective, as infrastructure assets are often valued differently from commodity extraction projects due to their strategic and network-based characteristics.

Ultimately, asteroid mining may require not only technological breakthroughs but also the emergence of new financial paradigms capable of allocating capital across extremely long time horizons and uncertain technological frontiers. In this sense, the development of asteroid mining may represent not only an engineering challenge but also a transformation in how future capital markets evaluate risk, scarcity, and interplanetary economic activity (Rao and Park, 2026; McKinsey & Company, 2023).

## 10. Conclusion

This study evaluated the long-term financial viability of asteroid mining using a discounted cash flow (DCF) framework spanning 2035 to 2100. Combining qualitative analysis with quantitative modeling, the paper assesses whether space resource extraction can achieve economic feasibility under realistic capital market assumptions used in this study.

Under the moderate assumptions used in the model, asteroid mining does not appear financially viable in the near or medium term. The model begins in 2035 with an initial mission expenditure of approximately US\$500 million and an estimated first-year revenue of US\$30 million, resulting in a substantial initial cash-flow deficit. As mission costs decline by 2.5 per cent annually while extraction yield and platinum prices increase, annual cash flow gradually improves and becomes positive in 2076. However, the project's total NPV remains approximately -US\$2.09 billion over the 2035–2100 modelling horizon. This demonstrates the distinction between operational profitability and financial viability: a project may eventually generate positive annual cash flow while remaining unattractive to investors when distant returns are heavily discounted.

The results suggest that the principal challenge is therefore not simply whether asteroid resources can eventually be extracted, but whether the expected future revenues can justify the substantial capital requirements and uncertainty associated with reaching that stage. Under the assumptions adopted in this study, conventional investment frameworks would therefore face difficulty supporting asteroid-mining projects without substantial changes in the underlying economics. Long-horizon institutional capital, strategic investment, public-sector support, or alternative financing structures may become more relevant during the industry's early development (Damodaran, 2012; Rao and Park, 2026).

The analysis also highlights an important market-level consideration. If asteroid mining eventually develops at sufficient scale to return substantial quantities of PGMs to Earth, increased supply could place downward pressure on commodity prices. This creates a potential feedback mechanism in which successful technological deployment may reduce the commodity revenues that initially justify investment. Conversely, the economic value of asteroid resources may increasingly arise from their use within space itself, particularly where water, metals, and other materials can support refueling, manufacturing, construction, and other forms of space infrastructure (Gaffey, Helin and O'Leary, 1979; Elvis, 2014).

Looking forward, the financial outlook for asteroid mining would depend on developments in several areas, particularly launch economics, asteroid characterization, extraction efficiency, autonomous operations, resource-processing technology, commodity markets, and the regulatory environment. Improvements in these areas could materially alter the assumptions underlying the present model and potentially improve project economics. In particular, more accurate identification of accessible, resource-rich asteroids would reduce uncertainty around the resource base, while lower transportation costs and improved extraction technologies could reduce the capital intensity of future missions (Adilov, Alexander and Cunningham, 2026).

Overall, the analysis suggests that asteroid mining is unlikely to represent a conventional near-term mining investment, but its long-term economic potential should not be dismissed. Its development may depend on a gradual convergence of lower transportation costs, improved resource characterization, technological maturity, and access to capital capable of tolerating unusually long investment horizons. If these conditions emerge, asteroid mining could evolve from a highly speculative resource-extraction concept into a component of a broader space economy, creating new questions for finance concerning valuation, risk, capital allocation, and the economics of extraterrestrial resources.

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## Appendix A - Full DCF Model Output

This appendix presents the complete year-by-year DCF model output for the moderate scenario from 2035 to 2100. The model reports annual mission expenditure, estimated extraction yield, platinum price, revenue, cash flow, discount factor, and discounted cash flow.

| Year | Mission Cost (\$M) | Yield (kg)  | Price (\$/kg) | Revenue (\$M) | Cash Flow (\$M) | Discount Factor | NPV (\$M)    |
|------|--------------------|-------------|---------------|---------------|-----------------|-----------------|--------------|
| 2035 | 500                | 1000        | 30000         | 30            | -470            | 1               | -470         |
| 2036 | 487.5              | 1030        | 30450         | 31.3635       | -456.1365       | 0.8             | -364.9092    |
| 2037 | 475.3125           | 1060.9      | 30906.75      | 32.78897108   | -442.5235289    | 0.64            | -283.2150585 |
| 2038 | 463.4296875        | 1092.727    | 31370.35125   | 34.27922981   | -429.1504577    | 0.512           | -219.7250343 |
| 2039 | 451.8439453        | 1125.50881  | 31840.90652   | 35.83722081   | -416.0067245    | 0.4096          | -170.3963544 |
| 2040 | 440.5478467        | 1159.274074 | 32318.52012   | 37.46602249   | -403.0818242    | 0.32768         | -132.0818522 |
| 2041 | 429.5341505        | 1194.052297 | 32803.29792   | 39.16885321   | -390.3652973    | 0.262144        | -102.3319205 |
| 2042 | 418.7957967        | 1229.873865 | 33295.34739   | 40.94907759   | -377.8467192    | 0.2097152       | -79.24020028 |
| 2043 | 408.3259018        | 1266.770081 | 33794.7776    | 42.81021317   | -365.5156887    | 0.16777216      | -61.3233566  |
| 2044 | 398.1177543        | 1304.773184 | 34301.69926   | 44.75593736   | -353.3618169    | 0.134217728     | -47.42742023 |
| 2045 | 388.1648104        | 1343.916379 | 34816.22475   | 46.79009471   | -341.3747157    | 0.1073741824    | -36.65483099 |
| 2046 | 378.4606902        | 1384.233871 | 35338.46812   | 48.91670451   | -329.5439857    | 0.08589934592   | -28.30761282 |
| 2047 | 368.9991729        | 1425.760887 | 35868.54514   | 51.13996873   | -317.8592042    | 0.06871947674   | -21.84311819 |

| Year | Mission Cost (\$M) | Yield (kg)  | Price (\$/kg) | Revenue (\$M) | Cash Flow (\$M) | Discount Factor | NPV (\$M)     |
|------|--------------------|-------------|---------------|---------------|-----------------|-----------------|---------------|
| 2048 | 359.7741936        | 1468.533713 | 36406.57332   | 53.46428031   | -306.3099133    | 0.05497558139   | -16.83956557  |
| 2049 | 350.7798388        | 1512.589725 | 36952.67192   | 55.89423185   | -294.8856069    | 0.04398046511   | -12.96920615  |
| 2050 | 342.0103428        | 1557.967417 | 37506.962     | 58.43462469   | -283.5757181    | 0.03518437209   | -9.977433581  |
| 2051 | 333.4600842        | 1604.706439 | 38069.56643   | 61.09047838   | -272.3696058    | 0.02814749767   | -7.666522846  |
| 2052 | 325.1235821        | 1652.847632 | 38640.60993   | 63.86704063   | -261.2565415    | 0.02251799814   | -5.882974314  |
| 2053 | 316.9954926        | 1702.433061 | 39220.21907   | 66.76979762   | -250.2256949    | 0.01801439851   | -4.507665386  |
| 2054 | 309.0706052        | 1753.506053 | 39808.52236   | 69.80448492   | -239.2661203    | 0.01441151881   | -3.448188193  |
| 2055 | 301.3438401        | 1806.111235 | 40405.6502    | 72.97709876   | -228.3667413    | 0.01152921505   | -2.63288927   |
| 2056 | 293.8102441        | 1860.294572 | 41011.73495   | 76.2939079    | -217.5163362    | 0.009223372037  | -2.006234093  |
| 2057 | 286.464988         | 1916.103409 | 41626.91097   | 79.76146602   | -206.703522     | 0.007378697629  | -1.525202788  |
| 2058 | 279.3033633        | 1973.586511 | 42251.31464   | 83.38662465   | -195.9167387    | 0.005902958104  | -1.1564883    |
| 2059 | 272.3207792        | 2032.794106 | 42885.08436   | 87.17654674   | -185.1442325    | 0.004722366483  | -0.874318918  |
| 2060 | 265.5127597        | 2093.77793  | 43528.36062   | 91.13872079   | -174.374039     | 0.003777893186  | -0.6587664936 |
| 2061 | 258.8749407        | 2156.591268 | 44181.28603   | 95.28097565   | -163.5939651    | 0.003022314549  | -0.4944324209 |

| Year | Mission Cost (\$M) | Yield (kg)  | Price (\$/kg) | Revenue (\$M) | Cash Flow (\$M) | Discount Factor | NPV (\$M)        |
|------|--------------------|-------------|---------------|---------------|-----------------|-----------------|------------------|
| 2062 | 252.4030672        | 2221.289006 | 44844.00532   | 99.61149599   | -152.7915712    | 0.002417851639  | -0.369427351     |
| 2063 | 246.0929905        | 2287.927676 | 45516.6654    | 104.1388385   | -141.9541521    | 0.001934281311  | -0.2745792634    |
| 2064 | 239.9406658        | 2356.565506 | 46199.41538   | 108.8719487   | -131.0687171    | 0.001547425049  | -0.202819016     |
| 2065 | 233.9421491        | 2427.262471 | 46892.40661   | 113.8201788   | -120.1219704    | 0.001237940039  | -0.1487037967    |
| 2066 | 228.0935954        | 2500.080345 | 47595.79271   | 118.9933059   | -109.1002895    | 0.0009903520314 | -0.1080476934    |
| 2067 | 222.3912555        | 2575.082756 | 48309.7296    | 124.4015516   | -97.98970389    | 0.0007922816251 | -0.07763544184   |
| 2068 | 216.8314741        | 2652.335238 | 49034.37555   | 130.0556022   | -86.77587198    | 0.0006338253001 | -0.0550007431    |
| 2069 | 211.4106873        | 2731.905296 | 49769.89118   | 135.9666293   | -75.44405801    | 0.0005070602401 | -0.03825468217   |
| 2070 | 206.1254201        | 2813.862454 | 50516.43955   | 142.1463126   | -63.97910752    | 0.0004056481921 | -0.0259530093    |
| 2071 | 200.9722846        | 2898.278328 | 51274.18614   | 148.6068625   | -52.36542212    | 0.0003245185537 | -0.01699355105   |
| 2072 | 195.9479775        | 2985.226678 | 52043.29894   | 155.3610444   | -40.5869331     | 0.0002596148429 | -0.01053697026   |
| 2073 | 191.049278         | 3074.783478 | 52823.94842   | 162.4222039   | -28.6270742     | 0.0002076918743 | -0.005945610697  |
| 2074 | 186.2730461        | 3167.026983 | 53616.30765   | 169.804293    | -16.46875308    | 0.0001661534995 | -0.002736340956  |
| 2075 | 181.6162199        | 3262.037792 | 54420.55226   | 177.5218981   | -4.09432181     | 0.0001329227996 | -0.0005442287174 |

| Year | Mission Cost (\$M) | Yield (kg)  | Price (\$/kg) | Revenue (\$M) | Cash Flow (\$M) | Discount Factor   | NPV (\$M)       |
|------|--------------------|-------------|---------------|---------------|-----------------|-------------------|-----------------|
| 2076 | 177.0758144        | 3359.898926 | 55236.86054   | 185.5902684   | 8.514453959     | 0.0001063382397   | 0.0009054120457 |
| 2077 | 172.6489191        | 3460.695894 | 56065.41345   | 194.0253461   | 21.37642702     | 0.00008507059173  | 0.001818505296  |
| 2078 | 168.3326961        | 3564.51677  | 56906.39465   | 202.8437981   | 34.51110198     | 0.00006805647338  | 0.002348703893  |
| 2079 | 164.1243787        | 3671.452273 | 57759.99057   | 212.0630487   | 47.93867        | 0.00005444517871  | 0.002610029455  |
| 2080 | 160.0212692        | 3781.595842 | 58626.39043   | 221.7013143   | 61.68004503     | 0.00004355614297  | 0.00268654486   |
| 2081 | 156.0207375        | 3895.043717 | 59505.78629   | 231.777639    | 75.7569015      | 0.00003484491437  | 0.002639742746  |
| 2082 | 152.1202191        | 4011.895028 | 60398.37308   | 242.3119327   | 90.19171363     | 0.0000278759315   | 0.002514178031  |
| 2083 | 148.3172136        | 4132.251879 | 61304.34868   | 253.32501     | 105.0077964     | 0.0000223007452   | 0.002341752112  |
| 2084 | 144.6092833        | 4256.219436 | 62223.91391   | 264.8386317   | 120.2293485     | 0.00001784059616  | 0.002144963253  |
| 2085 | 140.9940512        | 4383.906019 | 63157.27262   | 276.8755476   | 135.8814964     | 0.00001427247693  | 0.001939365522  |
| 2086 | 137.4691999        | 4515.423199 | 64104.63171   | 289.4595412   | 151.9903413     | 0.00001141798154  | 0.001735422911  |
| 2087 | 134.0324699        | 4650.885895 | 65066.20118   | 302.6154773   | 168.5830074     | 0.000009134385233 | 0.001539902134  |
| 2088 | 130.6816581        | 4790.412472 | 66042.1942    | 316.3693508   | 185.6876926     | 0.000007307508187 | 0.001356914334  |
| 2089 | 127.4146167        | 4934.124846 | 67032.82711   | 330.7483378   | 203.3337211     | 0.000005846006549 | 0.001188690265  |
| 2090 | 124.2292513        | 5082.148592 | 68038.31952   | 345.7808497   | 221.5515985     | 0.000004676805239 | 0.001036153676  |
| 2091 | 121.12352          | 5234.613049 | 69058.89431   | 361.4965894   | 240.3730694     | 0.000003741444192 | 0.0008993424242 |
| 2092 | 118.095432         | 5391.651441 | 70094.77773   | 377.9266093   | 259.8311773     | 0.000002993155353 | 0.0007777150794 |
| 2093 | 115.1430462        | 5553.400984 | 71146.19939   | 395.1033737   | 279.9603275     | 0.000002394524283 | 0.0006703718025 |
| 2094 | 112.26447          | 5720.003014 | 72213.39238   | 413.0608221   | 300.796352      | 0.000001915619426 | 0.0005762113352 |
| 2095 | 109.4578583        | 5891.603104 | 73296.59327   | 431.8344364   | 322.3765781     | 0.000001532495541 | 0.0004940406685 |

| Year | Mission Cost (\$M) | Yield (kg)  | Price (\$/kg) | Revenue (\$M) | Cash Flow (\$M) | Discount Factor    | NPV (\$M)       |
|------|--------------------|-------------|---------------|---------------|-----------------|--------------------|-----------------|
| 2096 | 106.7214118        | 6068.351197 | 74396.04217   | 451.4613116   | 344.7398997     | 0.000001225996433  | 0.0004226498873 |
| 2097 | 104.0533765        | 6250.401733 | 75511.9828    | 471.9802282   | 367.9268516     | 0.0000009807971462 | 0.0003608616061 |
| 2098 | 101.4520421        | 6437.913785 | 76644.66254   | 493.4317295   | 391.9796874     | 0.0000007846377169 | 0.000307562047  |
| 2099 | 98.91574107        | 6631.051199 | 77794.33248   | 515.8582017   | 416.9424606     | 0.0000006277101735 | 0.0002617190243 |
| 2100 | 96.44284754        | 6829.982735 | 78961.24747   | 539.3039569   | 442.8611094     | 0.0000005021681388 | 0.0002223907391 |

