



Towards sustainable mining (part II): Accounting for mine reclamation and post reclamation care liabilities



R. David Espinoza^{a,*}, Jeremy W.F. Morris^b

^a Geosyntec CAT (Capital, Assets, and Transactions) Advisory, 1220 19th NW Suite 210, Washington, D.C. 20036, USA

^b Geosyntec Consultants, 10211 Wincopin Circle, Floor 4, Columbia, MD 21044, USA

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ABSTRACT

Valuation of mining investment opportunities typically focuses on revenues (i.e., amount of ore, mineral grade, and commodity prices), pre-production capital expenditures (CAPEX), and recurring operating expenditures (OPEX). Less emphasis is generally placed on longer-term costs that are harder to quantify, such as decommissioning, closure, and reclamation. Less emphasis still is placed on valuation of the very long term (or perpetual) costs of post-reclamation care (PRC) and long-term management (LTM) that should follow mine closure and reclamation, primarily due to technical and environmental uncertainties and the widespread practice of discounting, which renders the present value of distant future costs virtually nil particularly when typically high discount rates are used. Following on from the discussion of mine asset valuation in Part I (Espinoza and Rojo, 2017) of this two-part dissertation on sustainable mining, Part II discusses the inherent issues with the current practice of valuing project opportunities and accounting for PRC liabilities and LTM within the mining sector. The paper argues that mining sustainably starts with recognizing all potential future liabilities (routine and non-routine) through the life of a mine, ensuring that sufficient funds are available to address these liabilities, and investing these funds appropriately. Decoupled net present value (DNPV) analysis, which separates risk from the time value of money and treats risks as a cost to the project, is presented as a robust alternative to current accounting practices. This method can identify the effects of individual risk factors on the value of a project. A hypothetical example taken from the mining literature is used to compare the DNPV method with net present value (NPV) and modern asset pricing (MAP) analysis, and clearly illustrates the unsustainable consequences of using risk adjusted discount rates to value long term mining investments.

1. Introduction

Reclamation and post-reclamation are important considerations in the valuation of mining assets, because mining involves generation of inordinate amounts of waste per unit of extracted mineral, which is concentrated in the form of spent heap leach pads (HLPs), tailings storage facilities (TSFs), or waste rock dumps (WRDs). The scale of modern mining operations and quantities of waste generated dwarfs all other industrial waste management activities, and arguably represent the most significant barrier to sustainability (Mudd, 2009a). For instance, the 2008 reported worldwide average grade of commercial copper ore was 0.8% (8000 g/Mg), which means that about 5.7 t of waste is generated for every 100 pounds (lbs.) of copper extracted (Mudd, 2009b). Assuming copper grades have remained relatively constant, at about 18.3 million tonnes in 2013 (CDA, 2015) worldwide copper production gives rise to over 2.25 billion tonnes of waste annually. The average grade of gold ore is even lower at about 0.0001%

(1 g/Mg), meaning over 30 t of waste is generated for every troy ounce (tr. oz.) extracted (Korelin Economics Report, 2012). Although only 2,700 t of gold were mined in 2013 (NRHR, 2013), at nearly 2.7 billion tonnes annually gold mining nevertheless generates more waste than copper mining. Modern surface mining operations typically involve the disturbance of large tracts of land as open cuts to extract ore, with resulting waste deposits encompassing hundreds of hectares. As a result, mines are enormous: examples include La Quebrada Copper Mine in Antofagasta, Chile (1,000 ha), Bingham Canyon Copper Mine in Utah, USA (3,000 ha), and Yanacocha Gold Mine in Cajamarca, Peru (9,000 ha).

To compound the scale of the problem, because of the chemical processes used to extract mineral from ore (for example, copper is leached out using sulfuric acid, while gold uses cyanide-rich solutions as a leaching agent), the waste generated can be quite toxic. These aggressive leaching processes take place over large HLPs or via industrial processes that dispose of finely ground tailings in TSFs.

* Corresponding author.

E-mail addresses: despinoza@geosyntec-cat.com (R.D. Espinoza), jmorris@geosyntec.com (J.W.F. Morris).

Residual sulfide minerals in HLPs and TSFs are susceptible to oxidation and resulting acid mine drainage (AMD), which is harmful to human health and the environment (HHE) and poses a potential threat to local water resources (Plumlee, 1999). In many instances, the excavation process itself exposes virgin material susceptible to AMD; as a result, surface water management at WRDs is needed to minimize AMD. The sheer size of HLPs, TSFs, and WRDs means that very large quantities of contaminated contact water in the form of surface water runoff and/or leachate percolating through the deposits will require treatment over the very long term (i.e., long after mineral extraction activities at the site are terminated), adding significantly to the true cost of decommissioning and closing a mine. Ongoing water management and treatment will be required until the mine does not pose a risk to HHE. Very long term post-reclamation care (PRC) activities and costs should thus be carefully evaluated and included in the total extraction cost of a given mineral when deciding whether or not a proposed mining project would be profitable. Further, an environmental impact assessment (EIA) should be performed in an attempt to value lost local amenities, access, and/or ecological resources and charge these to the pre-development cost of the project (Davis, 2002).

2. Accounting for reclamation and post-reclamation care

Different from many other business activities, mining is by its nature a temporary activity, generating revenues during a finite (sometimes relatively short) period but potentially incurring liabilities that can last a very long time or even in perpetuity (e.g., Allan, 2016). Developers need a good understanding of this if they are to attain a socially responsible and sustainable mining operation. While practices vary by company and continue to evolve, mine reclamation (i.e., engineered closure) plans and cost estimates are now increasingly prepared through self-imposed standards for corporate governance or as a regulatory requirement to prevent unfunded environmental legacies being imposed on future generations of taxpayers who derive no benefit from the years of active mining (Ackerman, 1998; Mudd, 2009a). Policies for reclamation and management of long-term liabilities have been developed (e.g., Cowan et al., 2010), and providing for sustainable reclamation and PRC has been considered from a technical perspective (e.g., Fourie and Tibbett, 2007; DeJong et al., 2015). This poses many challenges with regard to the very long-term performance of construction materials and engineered systems. However, assuring financial sustainability is equally challenging. Although some companies treat mine closure as a continuous process, thereby accounting for some reclamation and PRC expenses during the mine's operational lifetime, in many cases these activities are assumed to occur far in the future and their estimated costs are artificially reduced by the use of popular simplified valuation methods such as net present value (NPV), discounted cash flows (DCF), and internal rate of return (IRR). Because these methods combine the time value of money and risk in a single factor (the discount rate) which is increased to account for risk, the results of the analysis are often misleading. In other words, where estimating the present value of future liabilities associated with projects with very long duration, the distant future costs are rendered virtually nil by discounting (Zeckhauser and Viscusi, 2008). This can lead to design and operational decisions that are detrimental to society and shareholders alike.

The shortcomings of the NPV method have been recognized by many industry experts (e.g., Salahor, 1998; Samis et al., 2006; Guj and Garzon, 2007), including with regard to valuation of mining assets and liabilities (e.g., Davis, 2002). Alternative valuation methods (e.g., real options valuation or modern asset pricing methods) have been proposed to correct for some of these shortcomings (e.g., Laughton et al., 2000). Nevertheless, NPV, DCF and, IRR remain the valuation methods of choice. As a result, inappropriate funding is often set aside for reclamation and PRC activities (Boyd, 2001; Chambers, 2005), beguiling mines into selling a valuable commodity at prices that do not

account for the actual total cost of production. This promotes unsustainable mining practices that are not environmentally protective and may leave future taxpayers exposed to significant liabilities if the company dissolves or the mine permit expires. This problem is exacerbated when expensive-to-operate mines are rushed into production in response to high commodity prices only for a subsequent downturn to force bankruptcy and sudden closure.

The lack of consistent reclamation and PRC standards across the mining industry further aggravate problems with liability valuation and hinders development of sustainable practices between global competitors. Closure and PRC obligations and timeframes are typically not well defined and, although provision of financial assurance for mine closure and rehabilitation is required in many countries (Sassoon, 2009), bonding levels vary from the complete cost of mine cleanup in some US, Canadian, and Australian jurisdictions to less than 40% in others, while Ghana requires only 5–10% of the estimated cost to be provided (Miller, 2005). It is typically assumed that it will take less than 10 years to shut down a mine and complete reclamation, although it is acknowledged that water monitoring and treatment “may take longer.” However, as discussed previously, the actual PRC period required could be several decades to a century or more. In essence, this means that society will sooner or later bear the unfunded PRC costs. The only questions are which future generation (i.e., timing effects) and what region (i.e., location effects) will be saddled with these costs. Examining location effects first, some mining activities have a predominantly local/regional effect (e.g., mining coal to fire a nearby power plant). In this case, ignoring (or understating) future liabilities will affect the same locality that took advantage of the extracted mineral. However, current generations will be the beneficiaries of cheaper energy at the expense of future generations that will be saddled with the resulting environmental liabilities, effectively transferring wealth from the future society to the present, but within the same region. On the other hand, extraction of commodities such as gold, copper, iron, or oil is, in most cases, a local/regional activity with a global effect (i.e., resources are extracted locally and consumed globally). Resource extraction is undertaken by large corporations who enter into host agreements with national/subnational authorities and pay royalties for mining rights. In such cases, understanding future liabilities associated with mining activities and accurately including these in the total production cost becomes more critical. Otherwise, global consumers are not only benefiting from an artificial reduction of future liabilities (i.e., transferring wealth from future generations) but are also leaving understated environmental liabilities to the local society hosting the mine. The problem is more acute if said future society belongs to a developing or emerging economies with insufficient resources to take care of the potential environmental legacies. For many such economies, revenue associated with the mine in the form of royalties, jobs, and local economic activity represents a significant percentage of gross domestic product (GDP) and is difficult for current generations to decline. Enforcement of tougher environmental standards along with stricter accounting practices are politically hard to enact as such measures could risk a reduction in GDP and hence the wealth of current generations. Citizens from future societies do not get to cast their votes in today's elections to voice their dissatisfaction.

This paper is forward looking and does not seek to address the major legacy of mining-impacted land for which the gap between disturbance and rehabilitation is significant (Anderson, 2002). Despite rising community expectations and modern legislation (Mudd, 2009a), generational and locational wealth transfer remains prevalent in many modern economic activities (Kralj, 2013) and mining is certainly not the exception in this regard. It is also not the intent of this paper to imply that mining corporations are underhand at extracting profits at the expense of future society. Indeed, there is a growing trend within the mining industry to act with greater environmental and social responsibility as evidenced by recent improvements in mine reclamation standards and recognition of PRC activities and costs (e.g., Javier,

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