APPENDIX II. VALUATION APPROACHES AND METHODS

Valuation Approaches and Methods

Valuation Approaches of widely used national codes or standards are divided into three categories:

- Income Approaches
- Cost Approaches
- Market Approaches.

These three different Approaches to Valuation are applied to four main stages of Mineral Property status, namely:

- Exploration, early-stage or advanced
- Pre-development
- Development
- Production

The definitions of these Mineral Property stages are given below. They will help to understand why different Valuation Approaches apply to the different stages as do different Methods, as illustrated in Table 1.

1) **Exploration Properties** are those which are being actively explored for mineral resources. Exploration Properties have asset values derived from their potential for the discovery of mineral deposits. Exploration Property interests are bought and sold in the market. Many of these transactions involve partial-interest arrangements, such as farm-in, option or joint-venture arrangements[1]. The Value and structure of these transactions depends on informed subjective perceptions of risk and potential. Thus, adjusted historic costs and/or forecast expenditures to determine the potential are used as a proxy for Value. A very small percentage of Exploration Properties will become Production Properties.

    - **Early-stage Exploration Properties** are those on which mineralization may or may not have been identified, and where Mineral Resources have not been defined[2].
    - **Advanced Exploration Properties** are those where considerable exploration has been undertaken and specific targets identified that warrant further detailed evaluation, usually by drill testing, trenching or some other form of detailed geological sampling. A Mineral Resource estimate may or may not have been made, but sufficient work will have been undertaken on at least one prospect to provide both a good understanding of the type of mineralisation present and encouragement that further work will elevate one or more of the prospects to the Mineral Resources category[3];

2) **Development Properties** are those for which a decision has been made to proceed with construction or production or both, but which are not yet commissioned or operating at design levels and includes Properties for which economic viability of development has been demonstrated by at least a Pre-Feasibility Study, but which may not be financed or under construction. Such properties are at a sufficiently advanced stage or are former producing mines. There is enough reliable information available to value the property by discounted cash flow methods, with a reasonable degree of confidence. In general, such information includes reasonably assured mineable reserves,

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[1] SAMVAL 2016 terminology, pages 25-6, http://www.samcode.co.za or https://www.jse.co.za/content/JSEAnnouncementItems/20160223%20Appendix%202%20revised%20Samval%20Code.pdf

[2] SAMVAL 2016 and VALMIN 2015 terminology, http://www.valmin.org/code2015.asp

[3] VALMIN 2015 terminology, page 38-9, http://www.valmin.org/code2015.asp

workable mining plan and production rate, metallurgical test results and process recoveries, capital and operating cost estimates, environmental and reclamation cost estimates, and commodity price projections.

3) **Production Properties** have an operating mine, with or without processing plant, which has been fully commissioned and is in production[4].

Valuation Methods are, in general, subsets of Valuation Approaches. For example, the Income Approach includes several methods. Certain Valuation Methods are more widely used and may be more generally acceptable as industry practice than others, although this could change over time. Some methods can be considered to be primary methods for Valuation while others are secondary methods or rules of thumb considered suitable only to check Valuations by primary methods.

Table 1 lists a number of Valuation Methods for Mineral Properties, classifies them as to approach and specifies whether it is ranked as a primary or secondary Valuation Method. Methods with no primary or secondary ranking are considered to be unreliable or are not widely accepted. A variety of Valuation Methods have been identified and linked to each of these approaches.

Table 1. Valuation Methods and appropriateness for each Valuation Approach

Income Approach:

- DCF Conventional Method – Primary
- DCF + Monte Carlo – Primary, but not widely used
- DCF + Probabilistic Factors – No ranking, not widely accepted
- Real Options Methods – Primary, but not widely used

Cost Approach:

- Depreciated Replacement Cost (DRC)[5] – Secondary (buildings, plant & equipment)
- Multiple of Exploration Expenditure (MEE) – Primary
- Geoscience Factor (Kilburn Geoscience Factor) – Secondary
- Modified Appraiesed Value – Primary

Market Approach:

- Comparable Transactions Method – Primary
- Option Agreement Terms Method – Primary
- Value per unit area Method – Secondary

[4] CIMVAL 2003, page 11, http://web.cim.org/standards/documents/Block487_Doc69.pdf

[5] Depreciated Replacement Cost (DRC) included in list of Cost Approaches because it can be used for buildings, plant and equipment on the Mineral Property (See discussion in "*Exposure Draft, Proposed Technical Information Paper 2, Depreciated Replacement Cost*", February 2011, International Standards Valuation Council, London, UK, www.ivsc.org
and
Response on page 11 of the Valuation Standards Committee of the Society for Mining, Metallurgy, and Exploration, Inc. (SME) to the questions posed in the IVSC Discussion Paper that *"For buildings and plant and equipment, our members rarely find need for formal application of the Depreciated Replacement Cost Method. Such a level of detail is usually overwhelmed by the scale of value and uncertainties inherent in the mineral deposit."*

- Net Metal Value or Value per unit of metal Method – Secondary
- Gross in-situ value Method

<u>The Income Approach</u> is based on the economic theory that the value of an asset is equal to the economic benefit (utility) that it may yield. More specifically, an asset's value is equal to the Net Present Value (NPV) of all future cash flows that the asset may generate discounted at an appropriate risk-weighted rate. To provide an estimate of NPV, a Discounted Cash Flow (DCF) model must be constructed. Methods falling under the Income Approach may incorporate certain probabilistic factors, simulation, or real options modeling. These methods are also used for determining Investment Value in "evaluation" studies.

<u>The Market Approach</u>, also referred to as the Sales or Sales Comparison Approach, is based on the economic theory of substitution which infers that the value of an asset is equal to the observed prices of other identical assets. Obvious difficulties related to this approach include limited transaction data and lack of similarity between assets which give rise to conditions of imperfect substitution[6] 'Rule of thumb' methods such as the value per unit area or value per unit metal methods are also generally classified under the Market Approach but have limited use and acceptability[7].

<u>The Cost Approach</u> which lacks a firm theoretical basis[8] has limited use except in Valuation of Mineral Properties at an early stage of exploration where a mineralized zone may or may not have been discovered and there is no estimate of any category of Mineral Resource other than Inferred[9]. The IVS Glossary[10] states that it is *"A valuation approach based on the economic principle that a buyer will pay no more for an asset than the cost to obtain an asset of equal utility, whether by purchase or by construction."* Cost Approaches estimate Value of a Mineral Property based on past expenditures and, in some cases, can include adjusted future expenditures predicted ~~estimated~~ to be required to evaluate the potential as perceived to exist. Methods~~, which are~~ classified under the Cost Approach, such as the Appraised Value Method, also may be applied to a property at any stage of development, but not very commonly (see Table 3).

To guide Valuers, Valuation Approaches are ~~often~~ classified based on their applicability to Mineral Properties at different stages of development. Generally, early stage exploration properties are more amenable to the Cost and Market Approaches, whereas later stage developed properties are more amenable to the Income Approach. For example, it would not be appropriate to apply the Income Approach to a property which lacks a resource or reserve estimate.

[6] W. Roscoe, "Metal Transaction Ratio Analysis- A Market Approach for Valuation of Non-Producing Properties with Mineral Resources," in VALMIN Seminar Series, Sydney, Australia, 2012.

[7] I. S. Thompson, "A Critique of Valuation Methods for Exploration Properties and Undeveloped Mineral Resources," in Mining Millenium 2000, Toronto, 2000.

[8] C. Sorentino, "Valuation Methodology for VALMIN," in The Codes Forum, Sydney, 2000.
[9] T. O'Neil and D. Gentry, "Mine Investment Analysis," 1984.
[10] International Valuation Standards (IVS) Glossary, https://www.ivsc.org/standards/glossary

Table 2. General guide to the applicability of each Valuation Approach according to stage of Mineral Property evaluation or development, recognizing that approach chosen by the Valuer is time- and circumstance-specific[11].

Valuation Approach	Early-Exploration Properties	Advanced Exploration and Pre-Development Properties	Development Properties	Producing Properties
Income	No	In some cases	Yes	Yes
Cost	Yes	In some cases	No	No
Market	Yes	Yes	Yes	Yes

Table 3. Valuation Method appropriateness for use in Valuation Approaches applicable for each Mineral Property stage[12].

Valuation Approach	**Description**	**Valuation Method**	**Exploration Properties**	**Development Properties**	**Production Properties**
Income	Relies on the "value-in use" principle and requires determination of the present value of future cash flow	Discounted Cash Flow (DCF)	Not generally used	Widely used	Widely used
		Real Options	Not widely used	Less widely used	Quite widely used
		Monte Carlo Analysis	Not widely used	Less widely used	Less widely used
		Probabilistic Method	Not used	Not widely used	Not widely used
Market	Relies on the principle of substitution. The Mineral Property being valued is compared with the transaction value of similar Mineral Properties, transacted on an open market.	Comparable Transactions	Widely used	Widely used	Widely used
		Option Agreement Terms	Widely used	Widely used	Quite widely used
		Market Capitalization	More applicable to single property asset junior companies		
		Net Metal Value per unit of metal	Widely used rule of thumb		
		Value per Unit Area	Some use - if large area mineralized	Not widely used	Not widely used
		Gross "in-situ" value	Not acceptable		
Cost	Relies on historical	Appraised Value	Quite widely used	Not widely	Not widely

[11] Table 2 adapted from VALMIN 2015 edition, Table 1, page 29; SAMVAL 2016 edition, Figure 1, page 14; and, CIMVAL 2003, Table 1, pages 22.

[12] Adapted from material in various sources, including Table 2, page 22, CIMVAL 2003; SAMVAL 2016 edition, *"VALUATION APPROACHES"*, page 26; Table 1, page 4, http://web.cim.org/mes/pdf/VALDAYBill_Roscoe.pdf; and, http://web.cim.org/mes/pdf/VALDAYKeithSpence.pdf .

	and/or future amounts spent on the Mineral Asset			used	used
		Multiples	Quite widely used	Quite widely used	Widely used
		Geoscience factor	Not widely used	Not widely used	Not generally used

The three approaches should not be viewed as being independent of each other. Generally, they draw mainly on the same sources of data, but the data are analyzed using different methods. The underlying idea is that the three approaches should complement the findings of each other[13].

Since all Valuation Approaches involve a high degree of uncertainty, it is rare that a single approach is used in isolation. Rather, by combining the results of multiple approaches it is possible to increase the reliability of the estimate[14]. This multiple approach and methods principle is common to all national codes or standards and guidelines. The IMVAL Template, ~~April~~ May 2015~~6~~ Final Exposure Draft states in Section 3.9, *"Valuation Process"* that:[15]

> "*For a particular Mineral Property, Valuation Methods from at least two of the three Valuation Approaches should be used. There are a variety of Valuation Methods within the Valuation Approaches, each of which may be more suited to the Valuation at hand than others.*
>
> *The results from the Valuation Approaches and Methods employed should be analysed and reconciled into a concluding opinion of Value. The reasons for giving a higher weighting to one Valuation Approach or Method over another, including any elimination of an outlier (Value), should be stated."*

The opinion of Value can be stated as a range of Values and/or as a single Value.

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[13] Svetlana Baurens, "Valuation of Metals and Mining Companies", in collaboration with the University of Zürich, Swiss Banking Institute and Prof. Dr. T. Hens, 7 Nov 2010, http://www.basinvest.ch/upload/pdf/Valuation_of_Metals_and_Mining_Companies.pdf

[14] T. R. Ellis, "Sales comparison valuation of development and operating stage mineral properties," Mining Engineering, pp. 89-104, April 2011. Slide presentation can be downloaded at: http://www.minevaluation.com/wp-content/uploads/2016/02/EllisSalesComparisonApproachSME2011.ppt.pdf

[15] IMVAL Template Final Exposure Draft of May 2015 can be downloaded at http://www.cim.org/en/News-and-Events/News/2015/Call-for-feedback-and-comments.aspx

Figure 1. Frequency of usage of Valuation Approaches and Methods by stage of Mineral Property Evaluation (left scale to illustrate relative usage only)
(Modified by D.Davis, 4 June 2016 from Chart 1, page 7 in http://web.cim.org/mes/pdf/VALDAYKeithSpence.pdf)

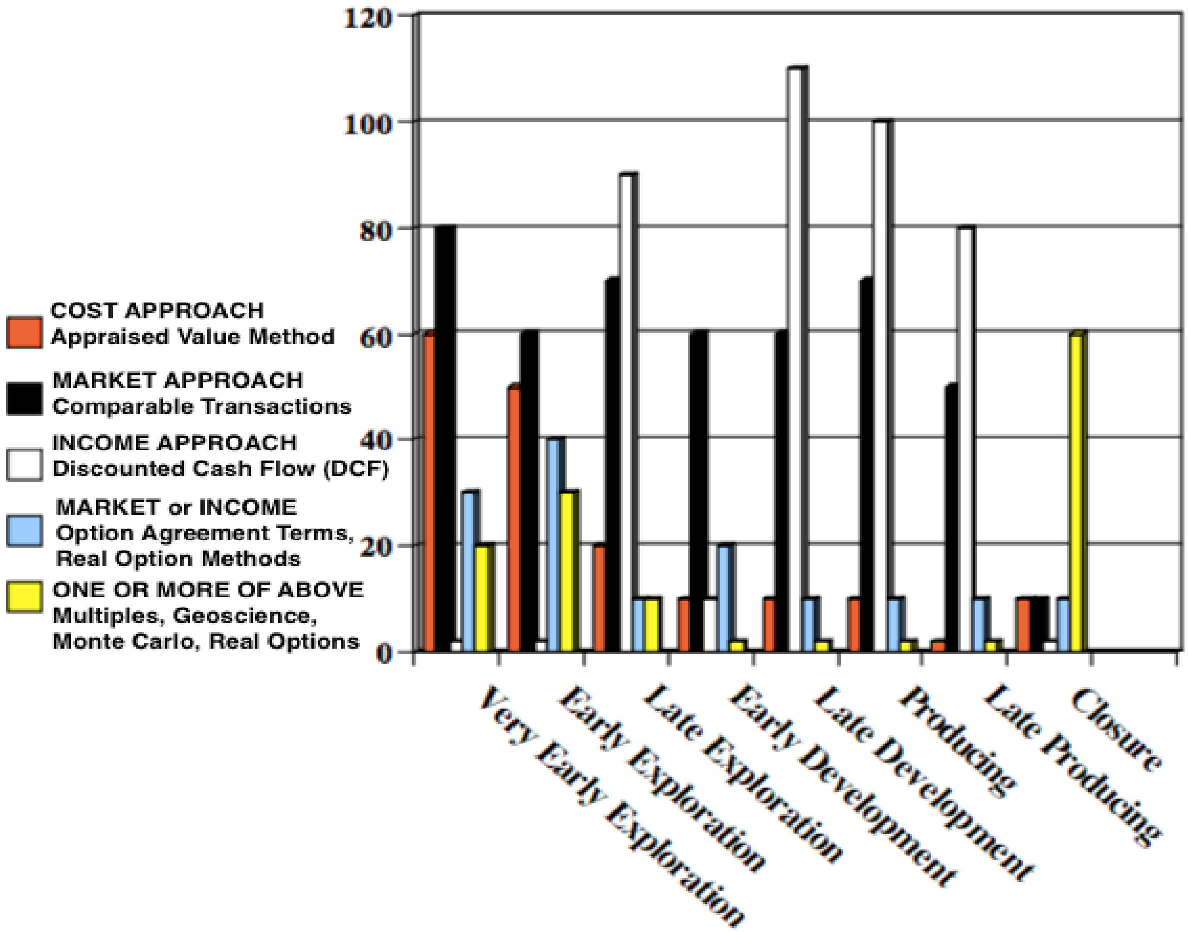

Figure 2 illustrates different applicable Valuation Methods which should be applied depending on the stages of development for the Mineral Property. It is, however, important to note that Mineral Properties represent a continuum from early stage to late stage and therefore the transition from one method to another will demand some level of judgment[16].

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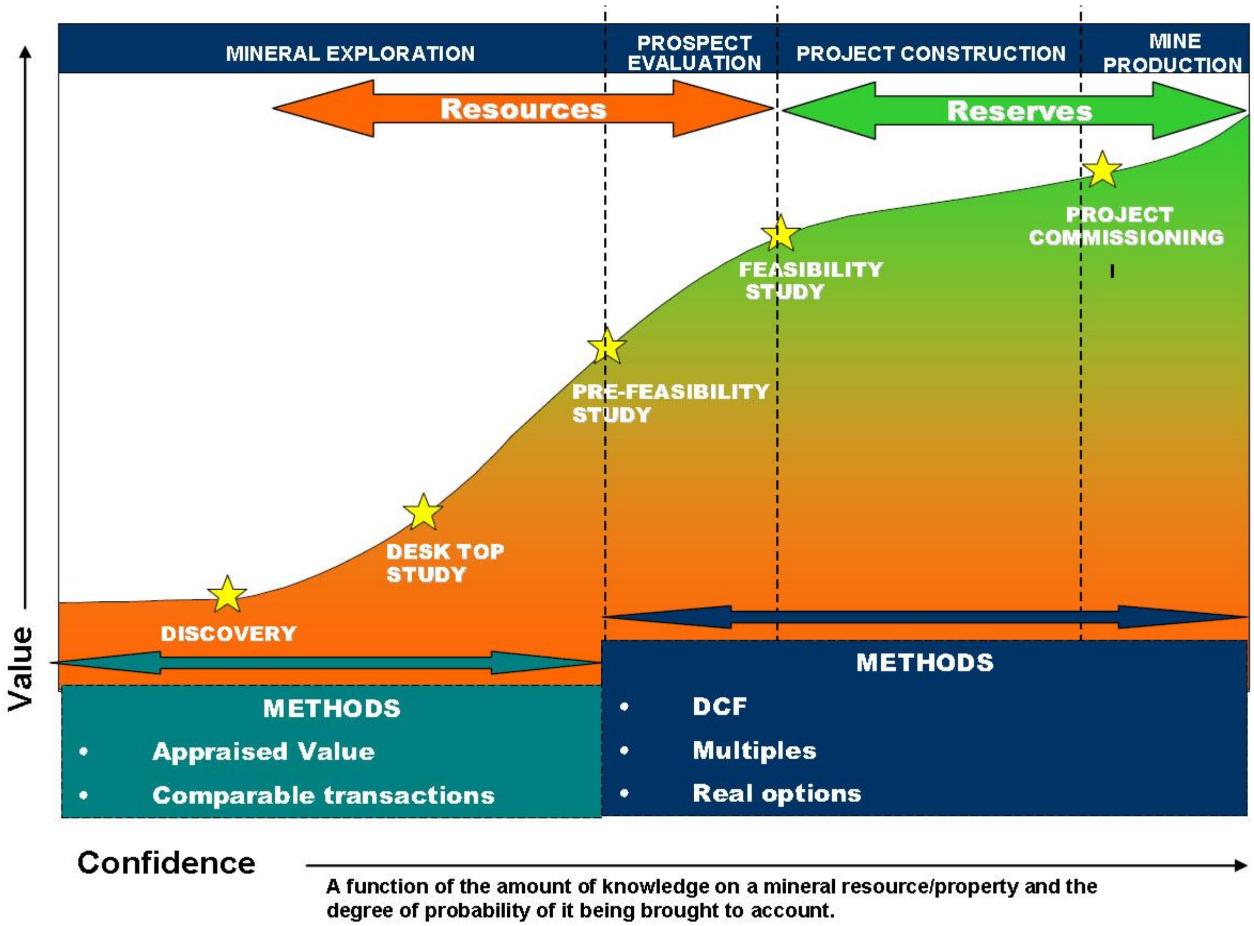
[16] CIM Special Volume 56, "Valuation Standards", Canadian Institute of Mining, Metallurgy and Petroleum, Montreal, 2009, pages 527-532

Figure 2. Valuation methods depending on the stage of exploration and development on the mineral property.[17]



Defining Value

The methodologies used for Valuation reporting are a function of the purpose of the report and by extension, the nature of the Value being defined. Performing a Valuation may be required for a number of reasons including accounting, insurance, taxation or financing purposes[18] [19]. Under most

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[17] Svetlana Baurens, "Valuation of Metals and Mining Companies", in collaboration with the University of Zürich, Swiss Banking Institute and Prof. Dr. T. Hens, 7 Nov 2010, page 17 http://www.basinvest.ch/upload/pdf/Valuation_of_Metals_and_Mining_Companies.pdf . Source was attributed to "MVENMYN, found at www.infomine.com/.../docs/ValuationMethodsMineralProjects.ppt, accessed date 10.04.2010".

[18] K. N. Spence, "An Overview of Valuation Practices and the Development of a Canadian Code for the Valuation of Mineral Properties," in Mining Millennium 2000, Toronto, 2000.

situations, the Value being estimated in a Valuation Report is *Fair Value* and formerly the common term was *Fair Market Value (FMV)*. The reason for adopting the term *Fair Value* in the latest national standards or codes and in the IMVAL May 2015~~6~~ Final Exposure Draft Template, Section 4.9 is because *FMV "Meanings differ depending on jurisdiction and the term may not be used in some"*. Section 4.09 states that *"For Valuations that are not applicable to financial reporting, Fair Value is:*

> '*the estimated price for the transfer of an asset or liability between identified knowledgeable and willing parties that reflect the respective interests of those parties'.* (IVS Definitions and Framework 38).
>
> *"For the purpose of financial reporting, Fair Value is:*
> *'the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date'.* (IVS 300 G1)[20]."

To understand how the definition may affect the Valuation process, this section briefly reviews the concept of Value with respect to mineral assets.

A mineral property holds intrinsic value because of its potential to confer an economic benefit upon the owner[21]. A rational buyer will seek to obtain a Mineral Property to gain its potential economic benefit, while a rational seller will seek compensation equal to the potential economic benefit that he is foregoing. At the conclusion of a transaction, the buyer will pay a price to obtain the mineral property's intrinsic value. To understand the concept of Market Value, it is useful to identify the two types of markets; open markets and notional markets[22].

In an open market, negotiations take place between two arm's length parties in order to determine the price that will be paid for a particular asset. This type of market is most analogous to a residential real estate market. In an open market, the price is established through the transaction.

The task of a Valuer is to determine what price is most likely to be paid at a specified future date if a negotiation were to occur[23]. In order to accomplish this, the valuator must assume a notional market. The notional market is a hypothetical market assumed by the Valuer at the time of the Valuation. In an open market context, price represents what was paid for an asset, and in a notional market context value represents what is likely to be paid on a specified future date, i.e. there is no actual price only a projected Value. Consequently, in any actual transaction the buyer obtains the "value" of the property while the

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[19] VALMIN 2015 Edition, page 18, lists purposes for Valuation Reports as including, *but are not limited to: a) compensation for compulsory acquisitions* (by governments or other parties), *(b) protection of the rights of shareholders in transactions between associated parties, (c) public floats* (of shares), *(d) 'fairness and reasonableness' reports (RG111) relating to an expressed opinion on a proposed acquisition or disposal of an asset or Securities, (e) the justification for raising debt or equity finance from an outside party, (f) facilitating negotiations between partners, (g) the assessment of Government charges and taxes, (h) estate settlements, (i) litigation, (j) reports for receivers and administrators, or, (k) accounting and financial reporting* (http://www.valmin.org/code2015.asp)

[20] IVSC, "2011 International Valuation Standards," International Valuation Standards Council (IVSC), London, UK, 2011.

[21] C. Sorentino, "Valuation Methodology for VALMIN," in The Codes Forum, Sydney, 2000.

[22] T. McCallum, "Valuation of a business," Chartered General Accountants, 2011.

[23] Ibid.

seller receives the "price"[24]. It is important to note that the price paid in an open market does not necessarily reflect either the "fair value" or "fair market value" as estimated in a notional market.

In order to estimate a Fair Value, the Valuer has several approaches at his/her disposal as discussed earlier in this document. It is important to note than any approach used will only yield a reasonable estimate of Fair Value if great care is taken to incorporate market-based inputs[25]. For further discussion related to market-based inputs in valuations, readers are directed to Torries[26], Roscoe[27], and Cartwright[28]. By combining multiple Approaches the valuer has a better chance of arriving at a reasonable estimate of Fair Value.

It is worth noting that several other bases of "value" may also be estimated such as book value, insured value, salvage value, and full cash value. In all cases, due to the various subjective inputs involved in Valuation, the outcome must be regarded as an opinion, and not as a fact[29]. For this reason, Value is most appropriately stated as a range from which the most likely value is identified based on stated assumptions.

Below is given short description of each of the Valuation Methods.

Income Approaches

The International Valuation Standards Council in *IVS 105: Valuation Approaches and Methods Exposure Draft* published 7 April 2016 states in Section 50.1 that *Although there are many ways to implement the income approach, all methods under the income approach are effectively based on discounting future amounts of cash flow to present value. They are all variations of the Discounted Cash Flow (DCF) method and the concepts below apply in part or in full to all income approach methods.*[30]

a) Discounted Cash Flow (DCF) Method

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[24] ibid.

[25] T. R. Ellis, "Sales comparison valuation of development and operating stage mineral properties," Mining Engineering, pp. 89-104, April 2011.

[26] T. F. Torries, "Evaluating Mineral Projects, Applications and Misconceptions," Society of Mining, Metallurgy and Exploration (SME), Denver, 1998.

[27] W. Roscoe, "Metal Transaction Ratio Analysis- A Market Approach for Valuation of Non-Producing Properties with Mineral Resources," in VALMIN Seminar Series, Sydney, Australia, 2012.

[28] M. R. Cartwright, "Direct sales comparison approach to value," American Institute of Minerals Appraisers Newsletter, 2001.

[29] T. McCallum, "Valuation of a business," Chartered General Accountants, 2011.

[30] https://www.ivsc.org/files/file/view/id/648?utm_source=IVSC%20&utm_medium=email&utm_campaign=7174817_IVS%20Complete%20Exposure%20Drafts%20emailer%20June%202016&dm_i=PRO,49S4H,6ECB81,FLY1B,1 , page 14; A complete IVS 2017 Exposure Draft is now available to download for review and comment on the proposed revisions to IVS 2013 - https://www.ivsc.org/files/file/view/id/677?utm_source=IVSC%20&utm_medium=email&utm_campaign=7174817_IVS%20Complete%20Exposure%20Drafts%20emailer%20June%202016&dm_i=PRO,49S4H,6ECB81,FLY1B,1

A discounted cash flow (DCF) is a Valuation Method used to estimate the attractiveness of an investment opportunity. DCF analysis uses future free cash flow projections and discounts them to arrive at a present value (PV) or net present value (NPV) estimate, which is used to evaluate the potential for investment. If the NPV arrived at through DCF analysis is higher than the current cost of the investment, the opportunity may be a good one.

While both present value (PV) and net present value (NPV) are discounted cash flows to estimate the current value of future income, these calculations differ in one important way. The NPV formula accounts for the initial capital outlay required to fund a project, making it a net figure, whereas the PV calculation only accounts for cash inflows. Though understanding the concept behind the PV calculation is important, the NPV formula is a much more comprehensive indicator of a given project's potential profitability.[31]

The basic principles of the time-value-of- money and the mechanics of conducting a discounted cash flow (DCF) analysis to derive a NPV **must** be understood and have been applied on a number of projects by all Valuers.

DFC is calculated as: $DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n}$

Where:

CF – cash flow for each year from 1 to n;
r – discount rate.

The DCF Valuation Method involves constructing a financial model of the cash flow covering the expected life of the mine, generally up to first 20 years of production.
To perform Valuation estimate using this method, the following inputs are required:

- Mineral Reserves over the life of mine. Mineral Resources can be included if factored for their probability of conversion to reserves; however, the Valuer should be cognizant of regulatory requirements, such as the Ontario Securities Commission's National Instrument (NI) 43-101 and other regulations)[32] applicable for companies with shares listed or applying to list on the TSX Venture Exchange (a Canadian stock exchange) and which does not allow inclusion of Inferred Resources in a disclosed economic analysis[33], i.e. a cash-flow model
- Production rates
- Operating costs, including on-site general and administrative (G&A) costs, ongoing development costs, royalties, income tax, withholding and other taxes[34]
- Capital costs—preproduction and sustaining/replacement
- Environmental and reclamation costs
- Commodity prices
- Discount rate

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[31] http://www.investopedia.com/ask/answers/033115/what-difference-between-present-value-and-net-present-value.asp

[32] http://www.osc.gov.on.ca/en/15019.htm where the latest "*National Instrument (NI) 43-101 Standards of Disclosure for Minerals Projects"* can be downloaded.

[33] NI 43-101 Section 2.3 (1) (b) *states "An issuer must not disclose the results of an economic analysis that includes or is based on inferred mineral resources or an estimate permitted under subsection 2.3(2) or section 2.4", http://www.osc.gov.on.ca/en/SecuritiesLaw_ni_20110624_43-101_mineral-projects.htm*

[34] See VALMIN 2015, Section 9.1, page 31; and Section 3.2.13, page 28 in http://www.ausimm.com.au/content/docs/guidelines_tech_economic_evaluation2012.pdf

The commodity prices and discount rate utilized in the DCF Valuation are two critical items that are based on the Valuer's experience and judgment. Because of the critical impact these two inputs have on the income approach valuation, they should be developed by the valuator from first principles.

Commodity price selection. While Valuations are forward-looking, Income Approach Valuations should normally incorporate a constant commodity price based on long term historical data. Commodity prices should reflect the up-and-down cycles, common to the mineral industry and this is done in simulations under the DCF + Monte Carlo Method. When valuing an operating property or one near operating status, however, it is acceptable and appropriate to include consensus pricing for the first 2 or 3 years of operation prior to returning to the long-term price.

Discount rate determination. The discount rate essentially reflects the risks present in an investment and is the rate at which the predicted cash flow from a Mineral Property will be discounted. It is never appropriate when conducting a Valuation to arbitrarily assign a discount rate, rather the discount rate should be derived from first principles

Three methods are employed for deriving a suitable discount rate, the method selected is based on the nature of the asset being valued:

1 Weighted average cost of capital (WACC) method
2 Capital asset pricing model (CAPM)
3 Risk buildup method

1) **Weighted average cost of capital discount rate derivation.** The WACC method is based on the proportional cost of equity and debt for a particular corporation at a specific time. It should be used as a discount rate only for companies; it is **not appropriate for valuing single projects.** The key strength of the WACC method is that it incorporates the global risks of all of a company's operations and projects into a single rate, which should reflect the melded risks of the company's assets.

2) **Capital asset pricing model.** The CAPM was developed as a valuation tool for shares of publicly traded stocks. It incorporates various elements of an investment, including the risk-free rate of return offered by US Treasury bills and notes, the greater risks inherent in stocks versus other investments, and the volatility of the shares of a company compared to the average company's shares as measured by its beta (Note: Beta is a measure of a price volatility of the company's shares in relation to the rest of the market. In other words, it is a guide on how a stock's price is likely to move relative to the overall market. Beta is calculated using regression analysis. The whole market, which for this purpose is considered to be the Standard and Poor's 500 (S&P 500), is assigned a beta of 1. Stocks that have a beta greater than 1 have greater price volatility than the overall market and are more risky. Conversely, a beta lower than 1 denotes less volatility than the market and therefore less risk. For example, if the market with a beta of 1 is expected to return 8% annually, a stock with a beta of 1.5 should return 12%.)

   The CARM method is appropriate only for valuing companies, it is **not appropriate for establishing the discount rate for individual mining projects or properties.** Importantly, the discount rate derived is after-tax for a seller of the shares, and pretax for a buyer of the shares.

3) **Risk buildup discount rate derivation.** The risk buildup method reflects the values relevant to the specific properties. In form it is similar to the CAPM method, however, it is **differentiated by its inclusion of the technical and other risks associated with the typical mining project**. Essentially it adds the components of risk at the project to arrive at an overall risk rate for a given specific property or group of properties. The usual components incorporated are:
   - The real risk-free rate of return;
   - The risk premium expected by an investor who would invest in mining projects;
   - Mining industry specific risk; and
   - Site and jurisdiction-specific risk for individual properties.

The real risk-free rate of return is the difference between the interest rate on US Treasury notes of a maturity approximating that of the project life and the current inflation rate.

With a public company risk premium, investors clearly require a greater return on their investment than that provided by risk-free U S. Treasury notes. They are willing to accept additional risk for the expectation of a greater return.

With mining industry risk, based on historic company and industry returns on equity, there is an above-average risk premium for certain industries. These include the aggregate, mining, and petroleum industries, all of which are dependent on the vagaries of natural resources.

With site-specific project risk, multiple risk factors exist at Mineral Properties ranging from reserve risk through processing, environmental, political, and geotechnical risk. Following are some of the factors that need to be considered:

- Project status
- Quality of analytical data
- Processing-related risk
- Infrastructure-related factors
- Environmental considerations
- Operating and capital costs, and working capital
- Prices and markets
- Labor/Management issues
- Political and social issues, and the social license to operate

It is not always possible to secure good information on all of these factors affecting site-specific project risk. If possible, a matrix should be constructed with a ranking from 1 to 10 assigned to each factor. From this, an overall risk factor can be assigned. For an exceptionally low-risk project, a factor of 1% or 2% may be chosen, for one with many uncertainties, the factor is likely to be 5% or higher.

Summary of risk-buildup discount rate. Table 4 is an example of a risk-buildup discount rate, showing both pretax tax, it must be converted to an after-tax basis.

Table 4. Summary of risk-buildup discount rate[35].

Item	Rate, %
Real risk-free rate of return	2.5
Public company risk premium	7.0
Small cap premium	3.0
Industry-specific risk	2.5
Site-specific risk*	3.0*
Total (pre-tax)	18.0
Total (after-tax)	12.01

*A low-average risk rate of 3% has been chosen for this example. From Lerch 1990; The example assumes a tax rate of 33.3%.

b) DCF + Monte Carlo simulation Method

[35] SME Mining Engineering Handbook, Third edition, Edited by Peter Darling, 2011. E-Book download - http://www.worldcat.org/title/sme-mining-engineering-handbook/oclc/704258028

~~The~~ Monte Carlo simulation ~~approach~~ is a method of analysis based on the use of random numbers and probability statistics to investigate problems with variable potential outcomes. In financial analysis and valuation, there is a fair amount of uncertainty and risk involved with estimating the future value of financial numbers or quantity amounts because of wide variety of potential outcomes (i.e. grade of deposit, reserve tonnage, commodity price, operating costs, capital costs etc.). The use of Monte Carlo simulation is one technique that can be applied to evaluate the uncertainty in estimating future outcomes, and allows for the development of plans to mitigate or cope with risk.

Typically, with conventional spreadsheet models, the engineer, geologist or analyst creates models with the best-case, worst case and average case scenarios, only to find later that the actual outcome was very different. With Monte Carlo simulation, the analyst explores thousands of combinations of the what-if factors, analyzing the full range of possible outcomes – an interactive process yielding certain of the predictions that have a greater probability of accuracy with only a small amount of extra work, thanks to the numerous choices of Monte Carlo simulation software that are available. The Monte Carlo simulation cannot eliminate the uncertainty and risk, but it does make them easier to understand by ascribing probabilistic characteristics to the inputs and output of a model. The determination of different risks and factors affecting forecasted variables can lead to more accurate predictions – the desire of all mining managers.

The Monte Carlo simulation method can be used for any properties that are at least at the advanced exploration phase. Monte Carlo simulations allow multiple variables to be changed simultaneously while a specific operation is mathematically performed literally thousands of times. The probabilistic value results from a range of probabilities assigned to each variable in the analysis (i.e. capital and operating costs, commodity prices etc.) to arrive a most likely value, or range of values, as based on iterations of cases that sample the distribution of each variable.

The AusIMM "Guidelines for Technical Economic Evaluation of Mineral Industry Projects" cautions that:

> *Monte Carlo simulation may be a more rigorous way to account for business risk, but only if reliable probability distributions for various data items are available. All key parameters including production rate and mineable resource need to be included: not just the easier-to-quantify parameters of operating costs, capital costs, grades and recoveries, etc.*[36]

c) DCF + Probabilistic Factors Method

An alternative Valuation ~~m~~Method for undeveloped Mineral ~~p~~Properties is risk adjusted ~~i~~Income ~~a~~Approach using probabilistic factors. Undeveloped properties include these with blocked-out resources or properties with drill holes that have "ore-grade" intercepts. Although lack of concrete information makes ~~the v~~Valuation of such properties more difficult, a "probability" approach, such as the risk adjusted income approach, can be used. The Approach entails the construction of a financial model of the property using likely production rates, ore grades, mining and processing methods, and capital and operating costs. A justifiable commodity price is chosen, the real risk-free rate of return is used for discount rate, and the discounted cash flow is calculated. The ~~v~~Value of an example property then becomes the NPV (say USD 100 million), as adjusted for the percentage of probability that the items incorporated in the financial model, such as ore reserves, costs, and environmental risks, have been correctly estimated. If the risk for the stated items are, respectively 80%, 90%, and 50%, the valuation would be USD36 million (USD100 million x 0.8 x 0.9 x 0.5).[37]

With respect to all probabilistic approaches, the AusIMM "Guidelines for Technical Economic Evaluation of Mineral Industry Projects" offers further cautionary advice that:

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36 http://www.ausimm.com.au/content/docs/guidelines_tech_economic_evaluation2012.pdf, p. 52

37 SME Mining Engineering Handbook, Third edition, Edited by Peter Darling, 2011

If introduced into the component cash streams a risk can be reflected by adjusting the input related to the risk e.g. metallurgical recovery rate – lower recovery, lower valuation. Care must be exercised if "worst case" values are used for a number of variables: the probability of all the "worst case" scenarios occurring concurrently is generally very low. A probabilistic analysis is preferable if suitable distributions can be developed for all key input parameters.[38]

d) Real Options Methods[39] [40] [41]

Real option valuation (ROV) is one of the modern Valuation Methods that provide a tool to adapt and revise mining projects under uncertainty and future variable movements. A real option is a right, but not an obligation to choose to take an action on an underlying nonfinancial asset, referred to as a real asset. The key to any Valuation is to take multiple perspectives, exercise judgement and envision the future in creative ways. Real Options Methods have received considerable promotion by academics and a number of mining analysts, but have not gained in usage to the degree predicted[42], except for operating mines or projects for which a feasibility or pre-feasibility study has provided evidence of high uncertainty with the underlying asset value and where management has significant flexibility to change the course of the project in a favorable direction and is willing to exercise the options for doing so.

Mr. Stephen Gemell, VALMIN 2016 Committee Member reports that:

A survey undertaken by KPMG in 2013 on applied valuation practices fails to mention real options theory, notwithstanding that income-based methods (specifically DCF) were the predominantly popular approach. I suspect that additional sophistication in DCF with probability applied to outcomes has perhaps (at least partially) supplanted real options. When reading the paper[43] you kindly provided, I felt that the authors' views on the ability of mines to respond to change in commodity price to the extent and in the timeframe premised were a little unrealistic, so perhaps the practice rather than the theory is the sticking point with valuation practitioners[44].

Many real options are contingent on more than one source of uncertainty and so should be classified as compound real options or options on an option.

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38 http://www.ausimm.com.au/content/docs/guidelines_tech_economic_evaluation2012.pdf, p. 29

39 Prasad Kodukula and Chandra Papudesu, "Project valuation using real options : a practitioner's guide", J. Ross Publishing, Inc., 5765 N. Andrews Way, Fort Lauderdale, Florida 33309, 234 pages, 2006, http://www.petronet.ir/documents/10180/2323250/project_valuation_using_real_options

40 Robert T. McKnight, "Valuing Mineral Opportunities as Options",

41 Margaret E. Slade, *Valuing Managerial Flexibility:An Application of Real-Option Theory to Mining Investments*, Journal of Environmental Economics and Management 41, pages 193-233, 2001, doi:10.1006rjeem.2000.1139, available online at http:rwww.idealibrary.com

42 Hall & Nicholls, *Valuation of mining projects using option pricing techniques, 2007,"..we expect option pricing techniques to be the predominant valuation method adopted in Australia within 10 years"* https://www.finsia.com/docs/default-source/jassa-new/jassa-2007/4_2007_valuation_mining.pdf?sfvrsn=6

43 Ibid

44 Stephen Gemell, e-mail dated 5 June 2016

An example of a compound real option is when a senior mining company enters into a joint venture with a junior company which has discovered a mineral occurrence which has apparent potential for drilling to define a major commercially viable deposit. In effect, the mining firm's managers are betting on a promising outcome of a more detailed phase of exploration (Phase II) and they hope the project will make it to the pre-development phase, a positive feasibility study and a successful mining development, all in a linked staged process. By investing in Phase II exploration, the senior company is buying one option and paying to play. If the project makes it through Phase II testing successfully, the company will exercise its next real option and decide to invest more money in the pre-development (Phase III, pre-feasibility, feasibility studies, environmental impact assessment). If Phase III outcome is positive and financing secured, the mine may turn out to be a huge success, barely break even, or be a failure. If a moderate or huge success, the senior company can exercise the next real option and invest heavily exploring for deposit extensions and similar deposits in the surrounding area and increase chances of more reserves, production and justification for on-site further processing.

When there is little uncertainty and not much room for managerial flexibility, the real options approach offers little value. It does not provide much value in investment decisions on projects with very high NPVs, because the projects are already attractive for investment and the additional value that may be provided would not change the decision. Similarly, on projects with very low NPVs, the additional value provided by real options would most likely be so negligible that the investment decision would still be a "no go." Real options offer the greatest value on projects with an NPV close to zero (either positive or negative) and high certainty.45 (pages 58-59)

ROA does not provide much value in investment decisions on projects with very high NPVs, because the projects are already attractive for investment and the additional value that may be provided would not change the decision. Similarly, on projects with very low NPVs, the additional value provided by real options would most likely be so negligible that the investment decision would still be a "no go." As illustrated in Figure 4-3, real options offer the greatest value on projects with an NPV close to zero (either positive or negative) and high certainty.

For further information and formulas for application of real options methodology, readers are encouraged to consult references listed as footnotes.

Cost approaches

The economic principle of *contribution to value* is predominant in the Cost Approach.

For market valuations, most Cost Approach methods should be used in combination with another approach if possible.

Main Cost Approach Methods

a. Depreciated Replacement Cost (DRC)
b. Multiple of Exploration Expenditure (MEE)
c. Appraised Value
d. Geoscience Matrix

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[45] Prasad Kodukula and Chandra Papudesu, "Project valuation using real options : a practitioner's guide", J. Ross Publishing, Inc., 5765 N. Andrews Way, Fort Lauderdale, Florida 33309, 2006, pages 58-59, http://www.petronet.ir/documents/10180/2323250/project_valuation_using_real_options

a) Depreciated Replacement Cost (DRC) Method - Commonly applied to buildings and other surface structures, plant and equipment

Value = Replacement Cost – (Physical Depreciation + Functional Obsolescence + External Obsolescence).

b) Multiples of Exploration Expenditure (MEE) Method

Value is determined by how much was spent on exploration in the past plus future expenditures.
The total figure is adjusted by a factor, so called Prospective Enhancement Factor (PEM) related to the prospectivity of the area.
It should be noted that:

- Only include those past expenditures that are reasonable and productive (ie exclude expenditures that were ineffective);
- Only count those future expenditures which are committed to the project
- Only use a high PEM is the exploration results are compelling.

A Prospective Enhancement Multiplier (PEM), based upon a Valuer's assessment of the property's prospectivity to date, is applied to the relevant and effective past exploration expenditure on the property.

The DRC Method is applicable for exploration properties without delineated resources.

Value = Effective Expenditure x PEM (*M. Lawrence and P. Onley, 1994).*[46]

Below is a simplified example of Typical Adjustment Factors:[47]

Multiplier	Explanation
x 0.5	Previous exploration indicates that the area has limited potential for a major discovery
x 1.0	Existing data is sufficient to warrant further exploration
x 1.5	Have direct evidence of an interesting target. Further work is warranted to evaluate the target
x 2.0	The leases contain a defined drill target with significant geochemical intersections
x 2.5	Exploration is well advanced and limited in-fill drilling is likely to define a resource
x 3.0	Have already found a substantial resource (that is likely to lead to a mine). Further exploration is likely to lead to an increase in the size and quality of the resource

The Prospectivity Enhancement Multiplier (PEM) can range from 0 to 5 but is usually in the range 0.5 to 3 .0 . The average is ~1.8

M.E.E. METHOD - TYPICAL PROSPECTIVITY ENHANCEMENT MULTIPLIERS[48]

CATEGORY	**TECHNICAL APPRAISAL**	**APPLICABLE PEM RANGE**
1	Limited potential for mineralisation of economic significance and/or prospectivity has been downgraded by exploration carried out prior to valuation date.	0.5 – 0.9
2	Exploration data (historical and/or current) consists of pre-drilling surveys with results sufficiently encouraging to warrant further exploration.	1.0 – 1.4

[46] http://www.minevaluation.com/wp-content/uploads/2016/02/EllisCostApproachSME2011ppt.pdf
[47] Richard Shodde, How to explore exploration project, Mineral Exploration Conference, 2002
[48] Robert Adamson, John McIntyre, Carlos Sorentino, Valuation and Appraisal of Mineral Projects, 2014

3	One or more prospects defined by geology, geochemistry and/or geophysics to the extent they present drill targets having likely economic potential.	1.5 – 1.9
4	One or more targets with significantly mineralised drill hole intersections within a clearly prospective geological context.	2.0 – 2.4
5	Exploration well advanced and infill drilling warranted in order to define or up-grade to the stage that mineral resources can be estimated.	2.5 – 2.9
6	Indicated resources have been defined but a pre-feasibility study has not recently been completed.	3.0

c) Appraised Value Method

Sum of warranted future expenditures and effective past exploration expenditures.

Warranted future expenditures consist of a "reasonable exploration budget" to test the remaining exploration potential of the exploration property.

The Appraised Value Methos is applicable to exploration and marginal development properties.

Value = Effective Expenditure + Warranted Expenditure[49]

The Appraised Value Method is based on the premise that the real value of an Exploration Property or a marginal development property lies in its potential for the existence and discovery of an economic mineral deposit. The Appraised Value Method assumes that the amount of exploration expenditure is related to its value.

The Appraised Value is the sum of the meaningful past exploration expenditures and warranted future costs. Only those past expenditures that are considered reasonable and that have contributed to identification of exploration potential are retained as contributors to value. Warranted future costs comprise a reasonable exploration budget to test the identified potential. However, the Exchanges do not generally accept the inclusion of warranted future expenditures for the purposes of the appraised value method. Also associated administrative costs will generally not be accepted.

Past expenditures are usually analyzed on an annual basis, using technical expertise to assess which expenditures to retain and which to reject in terms of identifying remaining exploration potential. Usually little of the expenditures more than five or so years prior to the effective valuation date are retained. In the case of dual or multiple property ownership, the Appraised Value of the whole property is determined first, and then the value is apportioned to one or more of the property owners.

In this method a property is deemed to be worth what has been spent on it, with a premium, if results are positive, or a discount if results are poor. If we are valuing past producing mines which have some usable infrastructure available, we should take into account what the replacement value of this infrastructure might be at today's prices and accordingly add some premium to the value of the mine.

R. Lawrence and Agnerian[50] restrict the accumulation of such expenditures to the past three or four years, rather than to all historic costs, with the accumulation basis ranging from 100% positive results, to 25% for negative results but with some exploration potential, to 0%-10% with little or no potential.

For marginal development properties and inactive exploration properties, Roscoe Postle Associates has developed a set of guidelines for what proportion of the past expenditures to retain as value.

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[49] http://web.cim.org/mes/pdf/VALDAYBill_Roscoe.pdf

[50] http://web.cim.org/mes/pdf/VALDAYIanThompson.pdf

Table 5. Guidelines for Retained Expenditures for Marginal and Inactive Properties Retained Portion of Past Expenditures Guidelines

75%	Property with resources but no work done for some years. Some future work is warranted. Usually a property with marginal resources and potential for more but not quite exciting enough to attract exploration expenditures easily. May be at the underground exploration stage.
50%	Property with subeconomic resources, but may have some potential in future, conditional on commodity prices, infrastructure, improved technology, economic conditions, etc. No work recommended at time of valuation. Could be a property with potential for a commodity with a low price or low demand at the time of valuation.
25%	Inactive property with subeconomic resources with very little hope for development, but cannot write them off completely. The resources represent in situ mineral inventory with only a long shot at eventual development. No work recommended.
0 – 10%	Inactive property with no resources and negligible or very little exploration potential. Could be a property with all of the geophysical targets tested that will be dropped when assessment credits run out.

The Appraised Value Method is best applied to properties which are actively being explored. It is more difficult to apply the method to properties that have been idle for some years, especially those which have had substantial expenditures in the past.

One advantage of the Appraised Value Method is that exploration cost information and technical data are readily available for most exploration properties and marginal development properties. It is a good way of comparing the relative values of exploration properties. The main disadvantage is that experienced judgment is required to separate the past expenditures considered to be productive from those considered not to contribute to the value of the property, and to assess what is a reasonable future exploration program and cost. This leaves the method open to misuse and possible abuse. It is prudent to compare the Appraised Value of an exploration property with values obtained from other methods, particularly those which use Market Approach[51].

d) Geoscience Matrix Method

The Geoscience Matrix Valuation Method was developed by Lionel Kilburn for the British Columbia's Security Commission in validating the values being assigned to exploration properties by junior mining companies. Five major criteria are considered, which are divided into nineteen possibilities:

1. The location of property with respect to off-property mineralization;
2. The presence of any on-property mineralization;
3. The location of property with respect to off-property geochemical/geophysical/geological targets;
4. The presence of any on-property geochemical/geophysical/geological targets;
5. Geological pattern on the property associated with known commercial deposits.

The starting point, or the base value, for the valuation is the per-acre or per-hectare cost of acquiring the right to mineral property, usually the cost of staking and maintaining a claim for one year. The property is then rated on the basis of its score from the matrix, and the rating is them used to adjust the base value. The value from the matrix is arrived at by assigning points in the five categories, based on whether the property is above or below average. The table below illustrates how the matrix rating is derived.

Category		Rank	Value factor
A	Location with respect to off-property mineralization		

[51] http://web.cim.org/mes/pdf/VALDAYBill_Roscoe.pdf

	Sub ore grade in two horizontal directions	17	1.5
	Ore grade with two horizontal dimensions	13	2.0
	Sub ore grade with three dimensions known	12	2.5
	Ore grade with three dimensions known	8	3.0
	A past or present producing mine	5	4.0
	A major past or present mine	4	5.0
B	Location with respect to on-property mineralization		
	Interesting, but sub ore grade in two horizontal directions	13	2.0
	Ore grade with two horizontal dimensions of economically interesting size	8	3.0
	Interesting, but sub ore grade in three dimensions	4	5.0
	An economically interesting ore grade zone in three dimensions	3	6 – 8
	Past producer with ore grades measured in three dimensions	2	7 – 8
	Major past or present producer with ore grades measured in three dimensions	1	9 – 10
C	Location with respect to off-property geochemical/geophysical/geological targets		
	One target or two, based on different methods	19	1.3
	Three or more targets	17	1.5
D	Location with respect to on-property geochemical/geophysical targets		
	One target	13	2.0
	Two or three targets	8	3.0
	Four or more targets	7	3.5
E	Geological patterns associated with known commercial deposits		
	One or two patterns	13	2.0
	Three or more patterns	8	3.0

Source: adopted from Kilburn, 1990[52]

The adjustment factors are multiplicative.

Subject claim value = (unexplored claim cost) x (location factor) x (grade factor) x (geophys/geochem factor) x (geology factor)

One ~~C~~calculates for each claim in the tract and then sums.

Market approaches

a) Comparable Transactions Method
b) Option Agreement Terms Method
c) Value per unit area Method
d) Net Metal Value or Value per unit of metal Method
e) Gross in-situ value Method

a) Comparable Transaction Method

The comparable transaction method uses the transaction price of comparable properties to establish a value for the subject property (Thompson, 1991; Roscoe, 1994, 1999; Ward and Lawrence, 1998)[53].

The difficulty of this approach in the mining industry is that there are no true comparables (unlike real estate or oil and gas), since each property is unique with respect to key factors such as geology,

[52] SME Mining Engineering Handbook, Third edition, Edited by Peter Darling, 2011
[53] http://web.cim.org/mes/pdf/VALDAYIanThompson.pdf

mineralization, costs, stage of exploration, and infrastructure. In addition, there are relatively few transactions for mineral properties compared to the frequency of real estate transactions in general.

When transactions do occur they rarely involve strictly cash, leaving the valuator the task of converting blocks of shares, royalties or option terms into present day money equivalent.
In spite of the above qualifications, transaction prices of comparable properties can indicate a range of values for a particular property. Exploration property transactions also give an indication of how active the market may be at any given time. For example, in recent years there have been relatively few exploration property transactions across Canada because of the depressed state of the exploration and mining industries. Consequently, market values have been relatively low.
As discussed previously, the value of an exploration property depends on its potential for the existence and discovery of an economic mineral deposit. The potential of a mineral exploration property depends to some extent on its area, but depends to a greater extent on its geological attributes, mineralization, exploration results and targets, neighbouring properties, and other factors. There is an analogy with real estate properties in that location is important. Exploration properties in established mining areas often have a premium value because of the higher perceived potential for discovery of a mineral deposit, and because of developed infrastructure.

The main advantage of this method is that it 'ground truths' the value of mineral properties derived by other methods, and provides a general measure of relative property values. The main disadvantage is that there are no true comparables; each mineral property is unique as noted above. Subjective judgement is needed to identify similar properties.

Adjustment Factors

- Minority Interest
- Product Market Stability
- Project Development Status
- Discovery and Expansion Potential
- Deposit Grade
- Location and Access
- Deposit/Project Size
- Infrastructure
- Property Control and Security of Tenure
- Permitting Issues
- Capital Investment Requirement
- Reclamation
- Operating Cost/Net Operating Income
- Country Risk
- Production Loss/Recovery /Metallurgical Complexity
- Project Risk
- Product Quality
- Taxes, Royalties, Levies

Sales Adjustment Factors

- Time and Price adjustment: Adjusts for change in price, to that at the effective date of valuation. This percentage adjustment factor is the ratio of the operating margins at the two dates.
- Developed v. Undeveloped Reserve adjustment
- Reserves v. Resources balance adjustment
- Deposit/project size adjustment
- Open Pit v. Underground Mining adjustment
- Operating Cost (including energy price factors) adjustment
- Country Risk adjustment
- Other Risk adjustment

Comparable methods allow the value estimated for a mining project to be benchmarked against mining project values established in the market. Comparable methods thus are a key tool for ensuring value estimates are congruent with what the market would actually pay.

The comparable transaction method uses the transaction price of comparable properties to establish a value for the subject property.

Determinative factors of the value an exploration property:

- potential for the existence and discovery of an economic deposit geological attributes: ore grade (high or low) depends of the amount of impurities in the ore. Separation of impurities gives rise to higher cost. A low grade ore will mean more material has to be processed to produce a tonne of metal versus a higher grade ore.
- mineralization, exploration results and targets, neighboring properties
- Infrastructure: a fully developed infrastructure will benefit mines through cheaper and more efficient transport links, water supply, energy supply etc.
- area and location of an exploration property: exploration properties in established mining areas often have a premium value because of the higher perceived potential for discovery of a mineral deposit, and because of developed infrastructure. Ore bodies located in remote areas, such as some Chilean copper mines high in the Andes, or deep underground, such as some South African gold mines, will have higher unit costs due to the difficulties of extraction. However, this can normally be compensated by other beneficial factors such as a high ore grade and / or valuable by-products.
- Existing permits

Challenges:

- There are a limited number of transactions for mineral properties
- There are no true comparables in the mining industry (unlike oil and gas). Each property is unique with respect to key factors such as geology, mineralization, costs and stage of exploration.
- Effective date of valuation is important (value of a property will vary widely from day to day, week to week and year to year because of the volatility of mineral price). Therefore, especially for purposes of litigation, it is necessary to establish a date on which to value the asset.
- Subjective judgment is needed to identify similar properties.

Exploration property transactions give an indication of how active the market may be at any given time. It should be noted again that exploration is cyclical, and in periods of low metal prices there is often no market, or a market at a very low price. For example, if there are relatively few explorations property transactions, because of the depressed state of exploration and mining industries, market values will be relatively low.~~[52]~~
Comparable transactions are indispensable for valuing speculative and exploration properties, where there is not enough information to perform a reasonable fundamental NPV analysis. This method, when available, can provide a benchmark for development and producing properties when calculating the fundamental value of the asset.
Comparable transactions also take into account the market factor for reserve and other risk.

To allow market values to be compared among projects, they are generally expressed (or normalized) as ratios of the form: **Market value / Fundamental project parameter**
Table 6 ~~2~~ summarizes the terminology typically used to distinguish between fundamental and market value, and between project and corporate value.

Table 6: Value Matrix

	Fundamental Value	Market Value
Project Value	Net Present Value (NPV)	Adjusted Market Capitalization (AMC) Enterprise Value (EV) Asset Transaction Price

The principle is that in addition to value the projects held by a mining company, the market also takes into account things such as working capital, debt, hedge book value and other investments when deciding what to pay for a share in a company. When taking these considerations into account the market value have to be adjusted according to the table above. After the adjustment, the value of the mining project itself is isolated from the other assets and liabilities undertaken by the company.

b) Option Agreement Terms Method

The ~~o~~Option ~~a~~Agreement ~~t~~Terms ~~m~~Method can be applied where a property is subject to an existing option agreement. In a typical option agreement, a schedule of committed and optional cash payments and work commitments applies over a period of several years. An approximation of the value of the property is reflected in the payments made and work commitments fulfilled, plus the subjective probability of the optionee making the rest of the payments and fulfilling the balance of the exploration programs.

This method is best applied to properties being actively explored during the early years of the option period. The method is generally not applicable to properties on which the option has been exercised by fulfillment of the payment terms and work commitments. At that time, the property value usually exceeds the payments made.

One advantage of this method is that it has some real world validity in the early years of the option period. A disadvantage is that the valuation is meaningful only during the early years of the option period. As time goes on and more exploration results are collected, the property value is likely to diverge either up or down from the option agreement terms. Either the results will not justify continued expenditures and the option is dropped, or results will be good enough that further expenditure and payment terms will seem to be a bargain compared to the property value.

The option agreement terms method can be used to determine the value of comparative transactions, since most exploration property transactions are option or joint venture earn-in agreements.

c) Value per unit area Method (Dollar Per Hectare and Lilford TEM Method)

If insufficient techno-economic and geological data governing a mineral project exists, the $/ha method of valuing mineral properties can be used.

Adapting the generic $/ha model resulted in the development of the Lilford TEM Method (TEM – techno economic matrix) for the valuation of non-producing, gold properties.
The method considers four key input parameters attributable to the mineral project under consideration, being the depth of mineralization below surface, the mineral reserve / resource category, its grade and the project's proximity to existing infrastructure.

The determination of values for mineral properties using the Lilford TEM Method relies upon the generation and use of a valuation matrix. The matrix incorporates a number of factors combined to provide an indicative valuation tool.

The Lilford TEM Method uses the transaction price of comparable properties to establish a value for the subject project (Thompson, 1991; Roscoe, 1994, 1999; Ward and Lawrence, 1998). To keep the method current and applicable, it is the valuer's responsibility to ensure that updating, modifying and improving the information base used as inputs for the $/ha valuations occurs after each new transaction is completed in the industry. Furthermore, the valuation of any mineral project will change as either the US$ gold price (or other commodity price) changes or in the event that the currency of the country in which the project is located appreciates or depreciates against its reference currency. If the commodity price or the local currency moves significantly over a relatively short period of time, the reference matrix discussed below, Table 4, will have to be adjusted accordingly. A short period of time will be determined depending on the period that has lapsed since the last valuation was completed using that specific matrix. For small moves in either of the two dependents, price or currency, the changes rendered to the matrix can be considered linear.

If the commodity price and/or the relative strength of the currency move significantly over a short time period of time, the historical information used to compile the matrix will have to be adjusted accordingly. The adjustment will not be linear and a new matrix may have to be compiled from updated information. It is incorrect to assume that the percentage change in the commodity price or currency over that period of time can simply be applied to the historical value attributable to the valuation matrix. This is largely due to the non-linear relationship of a mineral project's value to commodity prices and currency changes.

The author has devised a valuation matrix, continually updated, against which the key parameters are compared and awarded points. This caters for the dynamic nature of mineral project transactions. Although the matrices below are for gold hosting deposits, similar matrices can be developed for non-gold deposits.

The four key assessment parameters important to a mineral project are:

1. the depth of mineralisation below surface;
2. the reserve / resource categorisation;
3. the in-situ grade; and
4. the proximity of that mineral project to existing mining and / or other essential infrastructure.

These four parameters are not all-inclusive. Other factors such as multi-mineral occurrences (i.e. multiple reefs or two or more mineral types occurring in one reef or on one project) as well as potential metallurgical and environmental inhibitors may impact on the final value determined for that area. Nevertheless, a discussion of each of the above factors will be based upon the matrix shown in Table 7 4.

Table 7. Lilford TEM Valuation Matrix for Gold Properties

Depth below surface,	Points
0.00 – 0.25 km	0
0.25 – 2.00 km	1
2.00 – 4.00 km	2
4.00 – 5.00 km	3
+ 5.00 km	4
Resource category	
Proven	0
Probable	1
Measured	2
Indicated	2
Inferred	3
Blue sky	4
In-situ grade	
0 – 1 g/t	7
1 – 2 g/t	6
2 – 3 g/t	5
3 – 4 g/t	4
4 – 5 g/t	3
5 – 6 g/t	2
6 – 8 g/t	1
+8 g/t	0
Proximity	
Continuous to high grade	1
Adjacent to low grade	2
Non-continuous	3
Remote and large	4

Remote and small	5

The data considered in the matrix are the chief elements influencing costs and revenue in gold mines and provide the basis for the assessment of fair value for mineral project transactions.
The objective of developing the previous tables is to ensure that the valuation matrices result in mineral properties being valued on a consistent and equitable basis. This equitability covers valuations from one transaction to the next and from one jurisdiction to the next, as well as on a market-related basis.

The matrix provided in Table 7 4 above is used as follows:

- assign the necessary category to the mineral project;
- attribute the points associated with the assigned parameter;
- sum the attributed points;
- take the attributed points to Table 7 below;
- assign the corresponding attributable rating; and
- match the attributable rating with the applicable $/ha rating.

It can be seen that in the points summed column in the above table, gaps exist in the numerical sequencing. It then becomes discretionary as to which value to apply, taking into account other factors not already included in the critical input parameters. Additional factors would include reef width and type, rock mechanics factors, potential mining conditions and comparisons with other mining operations nearby or demonstrating similar conditions. This highlights the importance of valuation experience before contemplating this specific valuation methodology.

In Table 8, the final column has been determined based upon mineral project transactions. It is therefore subject to continual refining and modification as new transactions are completed or economic fundamentals change.

Table 8. Determination of Applicable Value Rating - Lilford TEM[54]

Points summed	Attributable rating	Attributable rating	$/ha applicable
1	1	1	15000
2	2	3	14000
4	3	3	13000
		4	11200
6	4 – 5	5	9400
		6	8000
9	6 – 7	7	6400
		8	4800
11	8 – 9	9	3600
		10	2800
13	10 – 11	11	2200
		12	1600
15	12 – 13	13	1000
		14	700
17	14 – 15	15	300
+17	16	16+	1

d). Net Metal Value or Value per unit of metal Method

54 Dr. Eric Lilford, Advanced Methodologies for Mineral Project Valuation, 2011 (copyrighted document)
https://www.researchgate.net/publication/274333011_Advanced_Methodologies_for_Mineral_Project_Valuation

Although it is not regarded as a robust, accurate method of valuation, the US Dollar per ounce ("US$/oz") method is often used. It is applied in a similar way to that already discussed for the Lilford TEM Method, other than it not being dependent on a series of matrices. To use it, an in-situ gold resource is determined as accurately as possible and, based upon recently concluded comparable transactions within that country, a US$/oz value is attributed.

Unit values vary regionally, nationally and internationally dependent upon factors removed from typical technical factors. These factors include the political stability of the region and country at large, its economic and taxation policies and the perceived ease with which transactions and operations can be implemented and effected. Another essential factor is security of tenure. To elucidate, a country in which mining activities are already taking place obviously provides the valuer with some useful insight into factors such as the application of mining law and general mining taxation principles. Numerous countries wishing to establish an industry around their mineral resources for economic development offer entrants into their minerals industries tax holidays for finite periods, typically five years, and do not impose onerous tax rates to mining operations once these holidays have expired. However, those same countries also impose a policy of "free-carried interest" clauses in their mining agreements to ensure that their returns are fixed at a minimum.

On this latter point, these free-carried interests typically range from between 5 to 15 per cent of the project and are often guised as a state royalty based upon derived revenue on exploitation. It is tantamount to a super-tax. In terms of mineral properties rather than mining operations valuations, the anticipated royalty resulting from the free carried interest should be deducted from the value determined for that property or the resulting value should be reduced by the free carried percentage interest. This represents consistency in that the free-carried interest for a mining operation is deducted from the revenue used as the basis for that specific valuation.

The Dollar per ounce method can be extended to non-gold properties by either determining gold-equivalent compositions of the properties, or by modifying the matrices to reflect transactions that have taken place in non-gold mineral rights[55].

e). Gross in-situ value Method

In-situ valuation is a fairly straightforward method of valuing miners. In essence, it is simply the value of all mineral resources (measured + indicated + inferred) that mining company owns.

An alternative is the multiple of in-situ value at which recent trade sales of mines have taken place.

The ratio above provides a rough correction for one flaw of in-situ valuation, that it does not take into account the cost of mining and purifying the resource. However, this is a far from perfect correction as it does not take into account variations in the cost of mining.

In-situ valuation has many other flaws. It does not even take into account whether the reserves are economically viable (it may cost more to extract them than the value of the end product). This is easily corrected, but there are more problems.

In-situ valuation does not take into account other factors that affect the value of the company, as opposed to its resources, most importantly its other assets and liabilities.

Therefore, it is not recommended and not used in valuing Mineral Properties.

[55] Ibid