School of Mining Engineering

UNIVERSITY OF THE
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JOHANNESBURG

ASSESSING THE CHALLENGES IN THE VALUATION OF EARLY-STAGE SECONDARY DIAMOND DEPOSITS

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A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Engineering.

Johannesburg, 2025

DECLARATION

I declare that this research report is my own unaided work. It is being submitted for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other university.

I have familiarised myself with the University of the Witwatersrand Student Academic Misconduct Policy (SAMP). I hereby declare that the work I am submitting for assessment is my original work. I affirm that I have not plagiarised, misrepresented, or colluded with any other person or source. I have properly acknowledged, cited, and referenced all the sources that I have used in my work. I also declare that I have used artificial intelligence (AI) tools only as a means of guidance. The ideas and arguments presented in my work are my original thoughts and interpretations. I acknowledge that any academic misconduct, such as plagiarism or collusion will result in serious consequences. These consequences may include a reduced grade, a fail mark, or disciplinary action according to the SAMP. The School of Mining Engineering has my consent to investigate any potential academic misconduct in my work. This investigation may include the use of similarity and AI detection software to check the originality of my work. I undertake to abide by the decision of any such investigation.

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(Signature of Candidate)

16th day of January 2025

"…In the world, you will have tribulation but take courage!... Your strength will be in keeping calm and showing trust…"

John16:33 and Isaiah 30:15b, New World Translation

ABSTRACT

Diamond mining is a fundamentally important part of the economy in many countries. Globally, some of these countries are home to early-stage alluvial diamond projects that attract significant interest from investors. Often, these investors need to understand the project's value to make informed decisions. However, valuing early-stage alluvial projects is a complex and challenging process.

This research report identifies and assesses the challenges associated with the valuation of early-stage alluvial projects through a case study of a project in Angola. For the case study, a valuation exercise was conducted using both the Cost Approach and the Market Approach. The research identified challenges specific to the Cost Approach, such as data availability and compliance with internationally recognised Resources and Reserves reporting codes. Likewise, challenges specific to the Market Approach included estimating current commodity prices and checking the performance of alluvial diamond properties on an applicable stock exchange. Additionally, it became clear that complications related to both approaches, such as experience and resource estimation methodologies, need to be addressed before a final valuation range can be determined. Although there are several difficulties, the valuation of early-stage alluvial projects is still possible. Nonetheless, these challenges impact the accuracy, consistency, and interpretation of the valuation results. Therefore, becoming familiar with these challenges and the recommendations made in the report will help valuators avoid potential pitfalls and contribute significantly to the field by guiding more informed decision-making in the valuation of early-stage alluvial diamond projects.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EQUATIONS

APPENDIX LIST OF TABLES

LIST OF UNITS

Unit	**Definition**
tph	Tonnes per hour
m^3	Cubic metre
m	Metre
km^2	Square kilometre
ct	Carat
ct/m^3	Carats per cubic meter

LIST OF ABBREVIATIONS

Abbreviation	Definition
BNA	Banco Nacional de Angola
CAR	Central African Republic
CIMVAL Code	The Canadian Institute of Mining, Metallurgy and Petroleum Code for the Valuation of Mineral Properties
CRIRSCO	Committee for Mineral Reserves International Reporting Standards
CV	Competent Valuator
CT	Comparable Transactions
DRC	Democratic Republic of Congo
EEB	Effective Expenditure Base
ENDIAMA	Empresa Nacional de Diamantes de Angola
IMVAL	International Mineral Valuation Committee
JORC Code	Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves
MEE	Multiples of Exploration Expenditure
NI 43 - 101	National Instrument 43-101 Standards of Disclosure for Mineral Projects
PEM	Prospectivity Enhancement Multiplier
RDPI	Rough Diamond Price Index
SAMREC Code	South African Code for the Reporting of Exploration Results, Mineral Resources and Mineral Reserves
SAMVAL Code	South African Code for the Reporting of Mineral Asset Valuation
SE	Stock Exchange
SME Valuation Standards	Society for Mining, Metallurgy and Exploration Standards and Guidelines for Valuation of Mineral Properties
VALMIN Code	The Australasian Code for Public Reporting of Technical Assessments and Valuations of Mineral Assets

1 INTRODUCTION

1.1 Research Background and Context

The global diamond market (2022) is worth some $96.4Bn, which pales in comparison with the gold and oil markets, estimated at around $193Bn and $5.3Tr, respectively (Statista, 2022; Grand View Research, 2023; Enerdata, 2022). Nonetheless, diamonds form a fundamentally important part of the economy of many countries. As shown in Figure 1.1, the Russian Federation leads the global diamond production in terms of value, followed by Botswana, Canada and Angola.

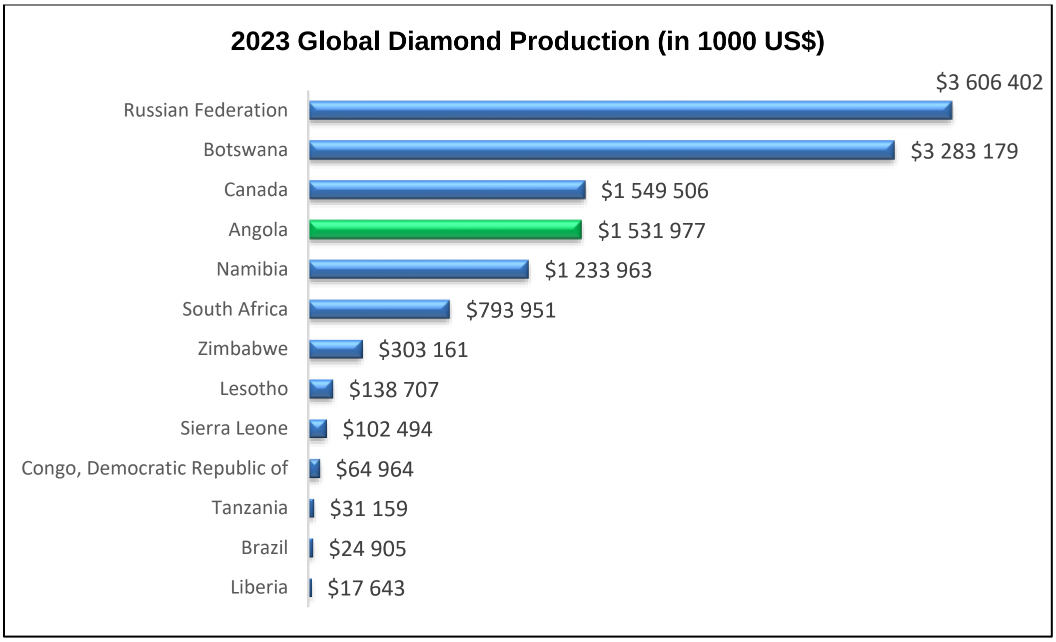

Figure 1.1 Global diamond production by value in 2023 (in 1000 US$) (Kimberley Process, 2023)

Considering the African continent alone, Figure 1.2 demonstrates that, in terms of production volume, Botswana is the largest producer of diamonds in Africa, followed by Angola, the Democratic Republic of Congo and the Republic of South Africa. As the fourth-largest producer of diamonds by value in the world and the second-largest producer by volume in Africa, Angola holds a significant position in the diamond industry.

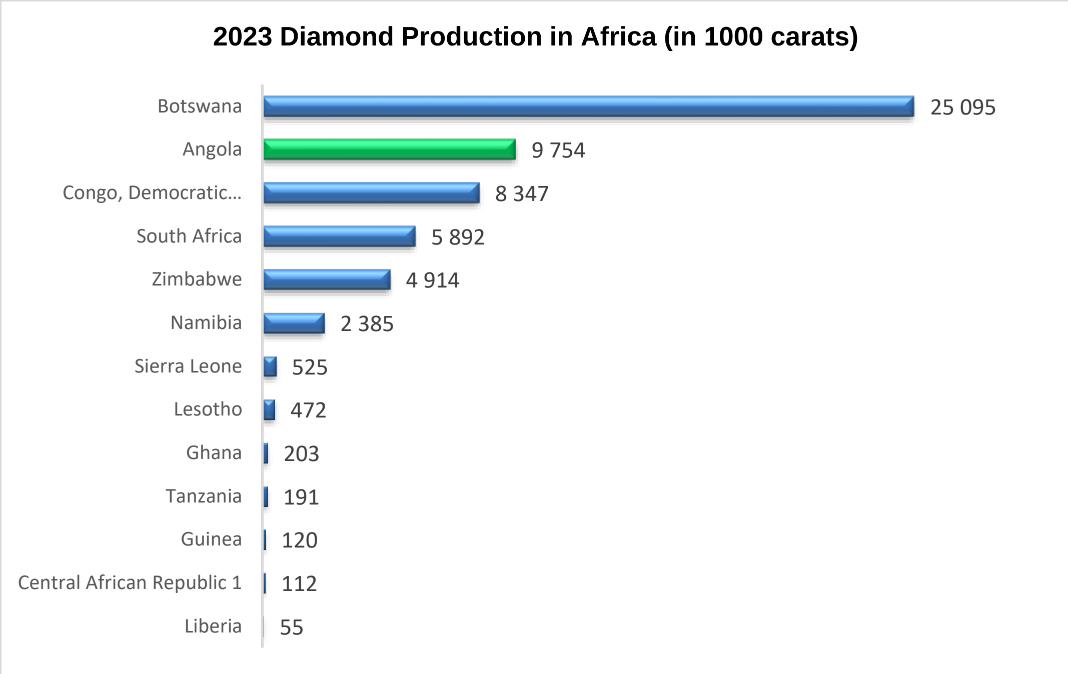

Figure 1.2 Africa's diamond production in 2023 (in 1000 carats) (Kimberley Process, 2023)

Situated on the western coast of Southern Africa, Angola has both primary and secondary diamond deposits. These deposits are mainly concentrated along the Lucapa Graben in the northeastern Lunda Norte and Lunda Sul provinces, although they can also be found in the Malange and Cuanza-Sul, Bié and Cunene provinces, as illustrated in Figure 1.3.

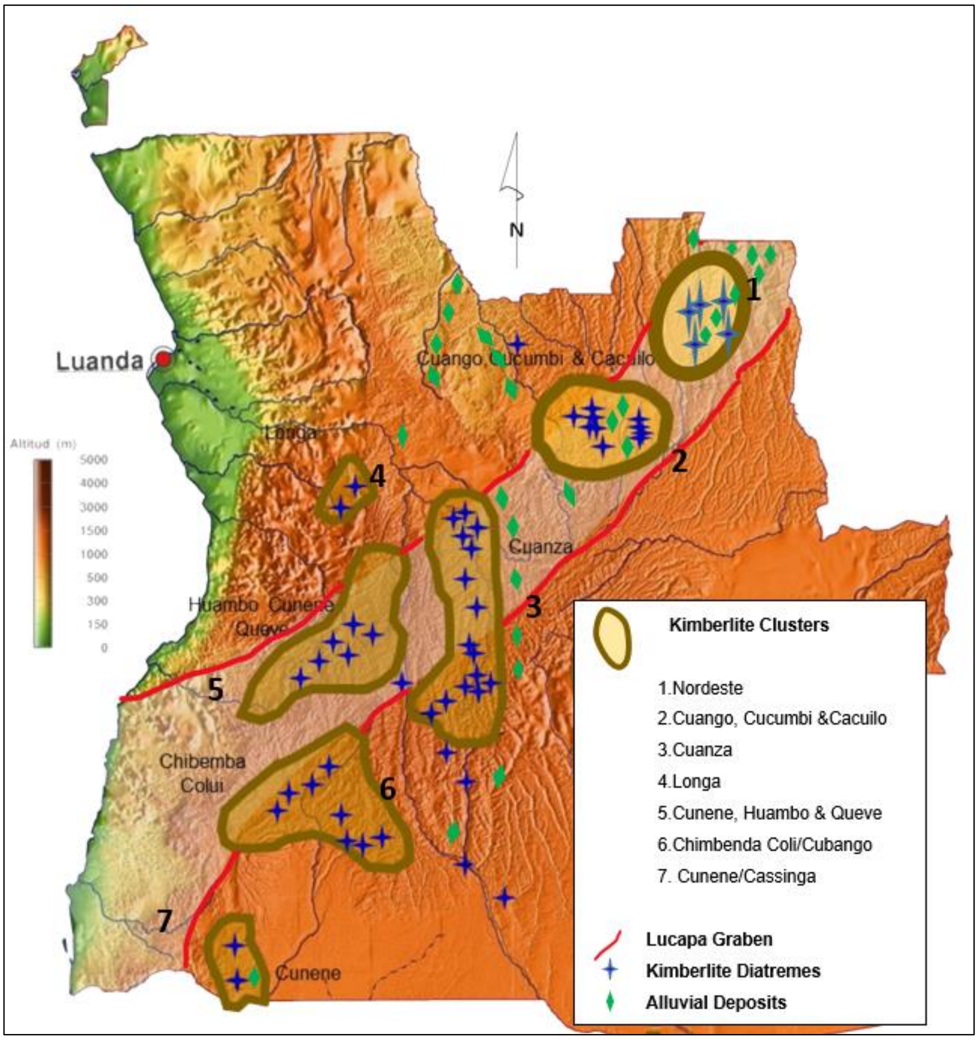

Figure 1.3 Kimberlite fields and alluvial diamond deposits of Angola *(*Modified after Reis, 1972)

As in many parts of Africa, Angola has both kimberlite and alluvial producing mines, as identified on Figure 1.4 Location of producing diamond mines in Angola . The country has four operating kimberlite mines which are managed as joint ventures between ENDIAMA (Empresa Nacional de Diamantes de Angola, the State-owned diamond mining company) and various major and medium/small scale companies (eg. Alrosa, Hipergesta SA, MAOMA – Exploração Mineira Limitada, VDB Group), together producing some 8, 5Mct annually (2023) (Ganga, 2024). In addition, 20 alluvial diamond mines are operated by Junior and medium/small-scale companies (for example, Lucapa Diamonds Company, ITM Mining Ltd, Trans Hex Group (Pty) Ltd, Mountain Stability Lda, Lumanhe Lda and Muapi Diamond Angola S.A), also in joint ventures partnerships with ENDIAMA and produce around 1,2Mct annually (2023) (Ganga, 2024)

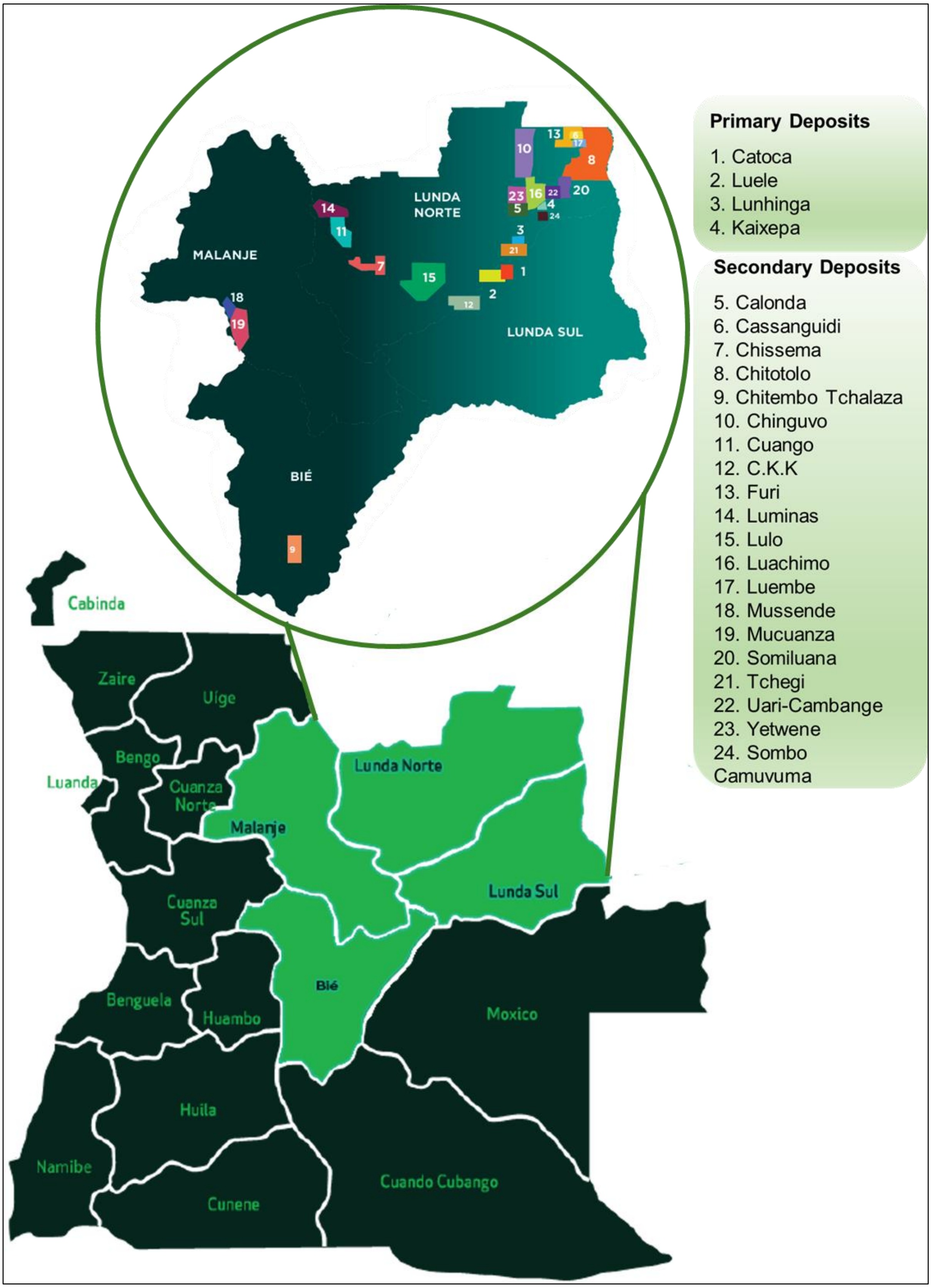

Figure 1.4 Location of producing diamond mines in Angola *(ENDIAMA, 2024).*

In addition to alluvial diamond mines in production, Angola also has 28 properties in early-stage exploration as shown in Figure 1.5. All of these projects are currently being actively explored by local/international Junior or small-scale companies.

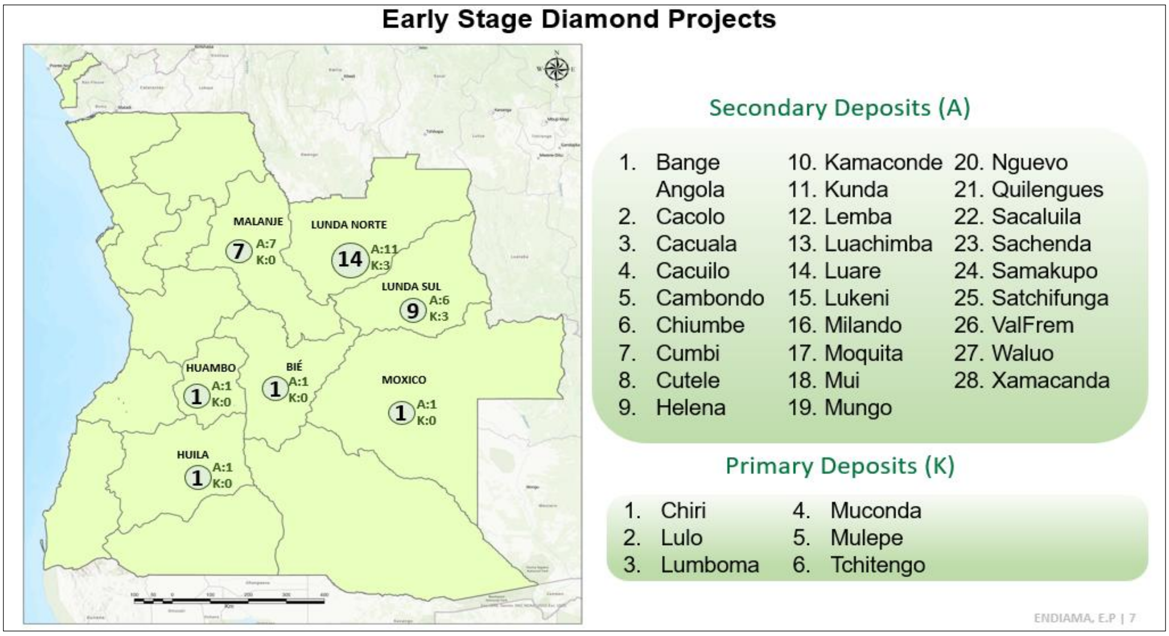

Figure 1.5 Location of early-stage diamond properties (Ganga, 2024).

Early-stage projects refer to properties where commercial production has not yet begun. Such projects include properties with no defined Diamond Resources (that is, those in early-to-advanced exploration) as well as Developmental properties that may only contain Inferred Resources.

According to the 2016 South African Code for the Reporting of Mineral Asset Valuation (the SAMVAL code), even early-stage properties may be of interest to investors. Given the appeal of these deposits for investments and joint ventures, parties often seek valuations to make informed decisions.

To prepare acceptable valuations for any mineral property, the Resource/Reserve report must align with one of the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) related codes (Marshall, 2016). Such codes include the South African Code for the Reporting of Exploration Results, Mineral Resources and Mineral Reserves (The SAMREC Code) (SAMREC, 2016), the Australasian Code for Reporting of Exploration Results, Mineral Resources and

Ore Reserves (The JORC Code) (JORC, 2012) or the National Instrument 43-101 Standards of Disclosure for Mineral Projects (NI – 43 -101) (CIM, 2011).

However, valuing early-stage alluvial diamond properties poses challenges due to their distinct characteristics when compared to other minerals, which can affect the resource estimation process (Marshall, 2016). Such differences are so relevant that the 2016 SAMREC code has a specific guideline document for the Resource estimation (evaluation) of diamond deposits (SAMREC, 2019). Consequently, the difficulties associated with the evaluation and valuation of alluvial diamond properties lead to challenges regarding what is or is not considered appropriate during the valuation of such deposits.

1.2 Problem Statement

Angola has 28 early-stage alluvial diamond properties currently being explored by Junior/small-scale companies in joint ventures partnerships with ENDIAMA. As these projects progress through the exploration programme, some of them will require additional investment. The question often raised before an investment takes place is what the value of the property is. As a result, reliable valuations of these properties are necessary for all current and potential stakeholders to make informed decisions regarding their future investments. However, such valuations present a unique set of challenges that demand careful examination and analysis (Lilford & Minnitt, 2002; Lawrence R. D., 2002).

The fundamental issue to be addressed in this research is whether the challenges relating to the valuation of secondary diamond deposits in their early stages can be identified and assessed. After using a case study to illustrate the challenges, as well as compiling and analysing these issues, the research explores potential solutions to ensure reliable valuations.

1.3 Justification for Research

Angola is the fourth-largest producer of diamonds by value in the world and the second-largest producer by volume in Africa. Twenty out of 24 producing diamond mines are alluvial and, in 2022, approximately 15% of the total diamond production was from alluvial mines (ENDIAMA, 2022). Before production on an alluvial mine begins, a considerable amount of investment is required. Valuations assist in determining the potential worth of early-stage properties. However, different challenges exist when valuing such properties. Some of these challenges include, but are not limited to:

- Diamond value – estimating diamond value depends on factors such as Carat weight (size), Cut (shape), Colour, and Clarity (often referred to as the 4C's). These features and, consequently, average diamond values can only be estimated after bulk sampling the deposit (Lilford & Minnitt, 2002);
- Deposit heterogeneity – secondary alluvial diamond deposits typically display significantly more geological and facies variation than primary deposits. This lack of homogeneity can make it more difficult to obtain both gravel volume and average diamond grade data which are sufficiently representative of the overall deposit (Marshall, 2012) and;
- Information availability – both resource estimation (evaluation) and valuation demand extensive geological and other data availability. One of the valuation approaches, the Market Approach, relies on transaction data for comparison. However, such data is rather scarce, posing challenges. According to Van der Merwe (2016, p.96), *"It's often a major challenge to find a reasonable number of arm's length transactions involving a mineral property comparable to the one being valued*..."

Valuation challenges need to be addressed before valuations can be carried out successfully. Thus, the questions addressed by this research are:

- What challenges need to be addressed in the valuation of alluvial diamond properties?
- What are some of the recommended solutions to overcome these challenges?

In answering these questions, issues relating to topics such as valuation codes and principles, diamond value, heterogeneity of these deposits, information availability, exploration and mineral reporting are addressed.

1.4 Research Objectives

This Research Report seeks to address the challenges mentioned above and others through literature analysis and a case study, aiming to enhance accuracy, transparency, and ethical standards in early-phase alluvial diamond property valuation. As more accurate and transparent valuations take place, investors may be attracted, and this could contribute to further enhance the country´s position in the global diamond industry while promoting responsible and sustainable practices. Thus, the following objectives were identified:

- Practically illustrate the challenges by looking at a case study;
- Identify the key challenges of valuing early-stage alluvial diamond deposits; and;
- Propose possible solutions for the challenges identified.

1.5 Research Methods

During the research, a combination of qualitative and quantitative methods are used. The qualitative and quantitative research methods used are described below.

1.5.1 Qualitative Research

Qualitative research, comprising desktop studies and an analysis of existing evaluation and valuation reports was carried out. Secondary sources such as journal papers and conference papers containing valuation examples were analysed and different valuation methodologies were compared.

1.5.2 Quantitative Research

The research is primarily quantitative. Quantitative information was obtained from a case study of an early-stage diamond property. The data from the case study was analysed to demonstrate and identify the different challenges and propose solutions.

1.6 Sources of Data

In conducting the research, diverse sources of data were utilised. The Literature Review was carried out using peer-reviewed journal articles and other published sources. Data for the valuation exercise was obtained from sources such as the Banco Nacional de Angola, NYU Stern and diamond specific websites such as idexonline.com and paulzimnisky.com. ENDIAMA's internal records, annual reports, presentations, and brochures were also sources of data. However, most of the information was obtained from an early-stage project that was used as a case study.

1.7 Research Validation

This research applied the Cost Approach and the Market Approach, both widely accepted approaches for valuing early-stage projects and adjusted them to the unique characteristics of early-stage alluvial diamond deposits. The reliability of the methods within these approaches in valuation supports the validity of the findings.

The challenges identified during the literature review are further validated by using a case study. During the case study a valuation exercise was carried out. The valuation exercise was compared to previous valuations, ensuring that the valuation model reflects realistic industry practices. Additionally, the fact that a real-world example was used to exemplify the challenges in the valuation of early-stage alluvial projects, reinforces the research applicability and the study's conclusions.

Personal communication with industry professionals specializing in diamond mining and valuation were conducted to ensure that data is accurate and relevant. Their feedback in terms was incorporated to enhance the reliability of the study and the study adheres to international best practice, ensuring that the methodology is both reliable and relevant to real-world applications.

1.8 Structure of the Research Report

As illustrated in the systematic workflow (Figure 1.6) this research report consists of six chapters followed by references and appendices:

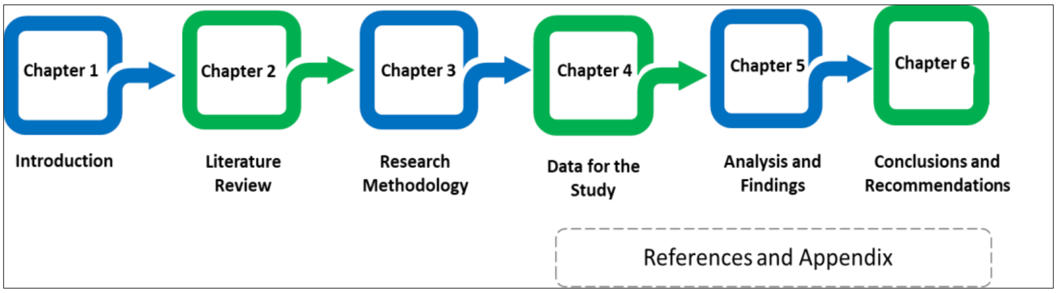

Figure 1.6 Structure of the Report

- Chapter 1 serves as an introduction. It covers the context of the research topic, the problem statement, the rationale for the investigation, and the research objectives. An introduction is given to the information sources and research procedures used in this study. The research validation criteria, as well as the structure of the report, are described.
- Chapter 2 explores the literature related to the topic. It defines the main concepts and discusses the approaches, methods and codes related to the topic. Key debates and controversies are also discussed to assist in identifying the challenges of valuing alluvial diamond deposits in their early stages so that such challenges can posteriorly be assessed.
- Chapter 3 discusses the research methodology, including the data collection process from a case study, the data validation process and the data analysis approach. The assumptions made during the research are also covered in this chapter.
- Chapter 4 presents the data collected for the study. The data for the case study is presented and a valuation is carried out.
- Chapter 5 discusses the analyses and findings from the data obtained. The main challenges of valuing early-stage projects are assessed, and
- Chapter 6 outlines the conclusions drawn by the researcher from the analysis and findings as well as the recommendations. The chapter is subdivided into observations which includes the key findings, research contributions and limitations. Recommendations for future research are also discussed.

2 LITERATURE REVIEW

2.1 Introduction

The present literature review defines Valuation of mineral assets and highlights the distinction and the fact that Valuation should not be confused with the concept of Evaluation. that it should not be confused with evaluation. It explains that Valuation is governed by internationally recognised codes and such codes identify the various approaches and methodologies that can be used to value mineral properties.

Through the literature review, challenges in valuing early alluvial diamond properties are identified. The chapter highlights these challenges through an identification of key debates and controversies which include the Angolan context. The chapter concludes with pertinent information for valuing early-stage alluvial diamond properties and raises the question as to how one should deal with the valuations of small-medium alluvial diamond properties, especially within the Angolan context.

2.2 Key Concepts, Theories and Studies

The SAMVAL code (2016, p.4) defines Valuation as "*the estimation of the value of a Mineral Asset in money or monetary equivalent.*". The SAMVAL code (2016, p.4), referring to The International Valuation Standards (IVS) Framework, para 9, p.13, further explains that "*the word* '*valuation*' *can be used to refer to the estimated value (the Valuation conclusion) or to the preparation of the estimated Value (the act of valuing)*". Investopedia, (2023) defines Valuation as the analytical process of estimating an asset's or a company's current (or anticipated) value. The Investopedia definition is in accordance with the SAMVAL´s definition as the asset is identified as a mineral. Njowa (2023) highlights the fact that Valuation aims to identify how much the project is worth in financial terms and should not be confused with Evaluation which refers to the process of determining the numerical values of all relevant variables that play a role in judging the value of a mining project.

Reporting of valuations of mineral properties is governed by internationally recognised codes. Among them are the Australasian Code for Public Reporting of Technical Assessments and Valuations of Mineral Assets (VALMIN) (VALMIN, 2015) the Canadian Institute of Mining, Metallurgy and Petroleum Code for the Valuation of Mineral Properties (CIMVAL) (CIMVAL, 2019), and the South African Code for the Reporting of Mineral Asset Valuation (SAMVAL) (SAMVAL, 2016). The United States of America (US) Society for Mining, Metallurgy and Exploration also has Standards and Guidelines for the Valuation of Mineral Properties (SME Valuation Standards) (SME, 2017).

To harmonise the different national valuation standards, discussions were started in 2012 that resulted in the International Mineral Valuation Committee (IMVAL) being formed (IMVAL, 2021). Consequently, the IMVAL template was developed, which "*is intended as a principles-based template to be recognised as a common set of minimum requirements for national codes or standards concerning the valuation of Real Property mineral assets (Mineral Property)."* (IMVAL, 2021, p. 2). Thus, IMVAL assists in having consistent valuation codes. One of the advantages of having consistent codes is that the terminology used in the various codes has the same meaning and, as a result, it is easier to compare valuations of projects across different jurisdictions.

The decision of which valuation code to use primarily depends on where the company is listed. Other, secondary considerations include the location of the deposit and the preference of the person responsible for the valuation, i.e., the Competent Valuator (CV). Angola does not impose a particular valuation code or a Mineral Resource and Reserve reporting code. However, in the Angolan diamonds sector, very often the unlisted Junior companies try to apply the JORC Code. The JORC code (and the associated VALMIN code) is generally the better-known Mineral Resource/Reserve estimation Code since it has been around the longest (the first JORC code was published in 1994). Other codes often used in Angola include the SAMREC and SAMVAL. This is a result of the large number of South African specialists involved in Resource/Reserve estimation and project valuations. Another reason why the SAMREC is a popular code choice is that it is the only Code that has a diamond-specific guideline document that is applicable to alluvial deposits.

2.2.1 Valuation Approaches and Methods

All of the major valuation codes identify a set of distinct approaches commonly used to value mineral properties according to development stage at which the property is. As illustrated in Table 2.1, the three main approaches used are the Income Approach, Market Approach and the Cost Approach. Table 2.1 also identifies which approach should be used at different stages of development.

Table 2.1 Relationship between stages of development and valuation approaches for Mineral Assets (SAMVAL, 2016)

Valuation Approach	Early-Stage Exploration	Advanced Stage Exploration	Development Properties	Production Properties	Dormant Properties		Defunct Properties
					Economically Viable	Economically not Viable	
Income	Not generally used	Less widely used	Widely used	Widely used	Widely used	Not generally used	Not generally used
Market	**Widely used**	**Widely used**	Less widely used	Quite widely used	Quite widely used	Widely used	Widely used
Cost	**Widely used**	**Widely used**	Not generally used	Not generally used	Not generally used	Less widely used	Quite widely used

Within each approach, there are a number of different methods that can be applied. The selection of a particular method is at the discretion of the CV and is, generally, dependent on the information that is available on the project. Table 2.2 identifies and ranks the better-known methods within each approach. Methods ranked “primary” are the most widely used while those ranked “secondary” are less widely used.

Table 2.2 Valuation Approaches and Methods (CIMVAL, 2019)

Valuation Approach	Valuation Method	Ranking
Income	Discounted Cash Flow (DCF)	Primary
Income	Real Options	Primary
Market	Comparable Transactions	Primary
Market	Option Agreement Terms	Primary
Market	Market Capitalization	Secondary
Cost	Appraised Value	Primary
Cost	Multiple of Past Exploration Expenditure (MEE)	Primary
Other	Geoscience Factor	Secondary

Income Approach

In the Income Approach, a mineral project's value is calculated by estimating the future yearly net revenues from the development or producing property, which are then discounted to the present using a suitable discount rate. The Income Approach may be applied through a number of valuation methods such as the Discount Cash flow method and the Real Options Valuation method. This approach relies on estimating cash flows from a property´s commodity production. Njowa, (2023) advises that this approach is favoured for valuing production properties due to its ease of incorporating readily available, realistic data into the analysis. As a result, this approach is not appropriate for early-to-middle-stage exploration properties.

Discounted Cash Flow Method

Kramná, (2014 p.455) described the Discounted Cash Flow (DCF) Method as a financial model that "*measures the intrinsic value of a company and are based on the principle that the current value of an asset is equal to the present value of all expected future cash flows.*" The DCF method is probably the best-known and most widely applied within the Income Approach. For this method, information which includes Mineral Resources and Reserves, tonnage, grade, expected recoveries, and prices is needed so that the Revenue can be determined. Regarding this method, Lilford & Minnitt (2002) explains that the direct and non-direct costs, capital expenditures, taxes and royalties are subtracted from the anticipated sales income (Revenue) of the commodity to produce a net forecasted cash flow for the project. The formula used to calculate the net cash flow is shown below as Equation 1:

$$\text{Net cash flow} = \text{Revenue} - \text{Costs (which includes taxes)} - \text{Capital}$$ ***Equation 1***

The forecast net cash flow is then discounted to the valuation date so that the Net Present Value (NPV) of the project can be determined (IVS Council, 2022) using Equation 2 (Cui, et al, 2022). Subsequently, an Internal Rate of Return can be calculated.

$$NPV = C_0 + \sum_{n=1}^{T} \frac{C_t}{(1+r)^t}$$ ***Equation 2***

Where:

C_0 is the cashflow at time 0; T is the life of the project; n is the cash flow period; C_t is the expected net cashflow at time t, and r is the discount rate.

The Real Options Valuation Method

According to Biotín, et al (2012), the Real Options Valuation (ROV) Method replicates an existing financial valuation method to real project characteristics and thus the name of “Real options”. The same authors further highlight that while conventional DCF methods yield consistent results in scenarios lacking flexibility or limited uncertainty, they display significant inconsistencies when parameters vary.

Shafiee & Abbate, (2012) explained that ROV is a modern method that provides a way to account for uncertainty when valuing mining projects and accommodating changes in important project variables. As an example, while DCF assumes constant time frames and risk levels, ROV allows for flexibility in timing and risk management. In addition, Shafiee & Abbate, (2012) also indicate that ROV can incorporate a broader array of variables when compared to the DCF method, recognising them as uncertain and interdependent and that modern valuation techniques such as ROV change DCF principles. Therefore, ROV offers greater adaptability to address risk and uncertainty, particularly concerning changes in commodity prices and reserve sizes.

From the descriptions above, it is possible to conclude that the income methods require information that would be readily available from a production property. These properties generally have completed a pre-feasibility study, and such a study usually includes all the information required to conduct a DCF or Real Options valuation. However, this is not the case with early-stage properties. Early-stage properties generally lack the necessary information to produce a cash flow, making the DCF and Real Options methods inappropriate for early-stage exploration and less widely used for advanced-stage exploration projects.

Market Approach

The SAMVAL code (2016, p.9) explains that *"the Market Approach relies on the principle of 'willing buyer, willing seller' and requires that the amount obtainable from the sale of the Mineral Asset is determined as if in an arm's-length transaction'.* The IVS (2022) informs that, in the Market Approach, a project's value is determined by comparing a project/asset to similar or identical projects/assets for which pricing data is available. The IVS Council, (2022) adds that one of the circumstances where the Market Approach should be applied is when there are recent and/or regular observable transactions in assets that are roughly identical.

As seen in Table 2.1 above, the Market Approach is consistently the second most common approach for all stages of development. Additionally, Table 2.2 demonstrates that CIMVAL ranks the Comparable Transaction method and the Option Agreement Method as "primary" valuation methods under the Market Approach, while the Market Capitalisation Method is ranked as a secondary method.

Comparable Transaction Method

A common method under the Market Approach is the Comparable Transaction Method as shown in Table 2.2. According to Roscoe, (2002) and Lawrence, (2002), the Comparable Transaction Method establishes the value of the subject property using the transaction prices of comparable properties. Examples of transactions that are commonly used for comparisons include joint ventures or mergers, acquisitions, and disposals. Njowa & Musingwini (2016) explain that the challenge with this strategy is that it can be difficult to find actual comparable properties in the mining sector. Each property is unique in terms of important elements such as geology, mineralisation, costs, stage of exploration, and infrastructure. This is particularly true for early-stage alluvial diamond deposits.

Option Agreement Method and the Market Capitalisation Method

Other methods within the Market Approach include the Option Agreement Method and the Market Capitalisation Method.

- Carmichael (2022) explains that an option agreement occurs when a prospective buyer enters into an agreement with the landowner for the opportunity to purchase their land/asset, usually in exchange for the landowner receiving a certain amount of money as an option fee.
- In the Market Capitalization Method, which is also known as the Market Value Method of a company, the total value of a company's outstanding shares is calculated by multiplying the current market price per share by the total number of outstanding shares, as explained by Fernando, (2023). For example, if a company has 30 Million shares priced at $100 each, its market capitalization would amount to $3bn. On the other hand, another company with a share price of $2,000 but only 10,000 shares in circulation would have a market capitalization of merely $20 Million.

With its different methods, although there are difficulties with finding comparable transactions, the Market approach is still the most widely used approach as ranked in the valuation codes. Table 2.1 shows that it is the only approach applicable to all stages of development of a property, being widely used not only in early and advanced stage properties but on economically not viable and defunct properties as well. The approach is also quite widely used in production and economically viable properties, only being less widely used in properties which are in the development stage.

Cost Approach

SAMVAL, (2016) explains that the Cost Approach is founded on the economic principle that a buyer is not going to pay more for an asset than it would cost to create or buy an equivalent useful asset. This approach is based on past and/or projected expenditures for the development of the mineral asset and as shown in Table 2.1 above, it is usually applicable to exploration properties in the early to advanced exploration stages. At an early stage of a project parameters such as grade, resources and reserves are not readily available (reasons for these in the context of the research topic are discussed in section 2.3). These characteristics make it impractical to use an Income method (IVS Council, 2022).

In the Cost Approach, costs incurred during the early phase become the main focus and thus the applicability of this approach to early and advanced exploration properties. Njowa (2023) advises that, given its lower reliability, the Cost Approach should prioritise adherence to principles of materiality and transparency in valuations. Two of the more commonly used methods in the Cost Approach are the method of Multiples of Exploration Expenditure (MEE) Method and the Appraised Value Method, while the Geoscience Factor Method is less commonly used.

Multiples of Exploration Expenditure Method

According to Onley (1994), properties that are in the early to moderately advanced stage of exploration but for which no resources have been identified, are seen to be suitable candidates for the MEE Method.

Van der Merwe (2017) states that the application of MEE comprises three steps:

I) Determine a cost base of reasonable and relevant exploration expenditure (Effective Expenditure Base (EEB));

II) Determine the Prospectivity Enhancement Multiplier (PEM) to put the Cost Base into perspective; and

III) The relevant and effective previous exploration expenditure on the property is multiplied by a PEM to determine the value for the specific asset as seen from Equation 3, as taken from Ellis (2011):

$$\text{Value} = (\text{Effective Expenditure Base})\ \text{x}\ (\text{PEM}) \qquad \textbf{\textit{Equation 3}}$$

In determining the Effective Expenditure, the words reasonable and relevant play a major part. An expense must be specifically related to the commodity and the mining asset for it to be considered relevant. Examples of irrelevant content, given by Van der Merwe, (2017) include:

- Historical Exploration for which the outcomes are missing or unclear;
- Exploration conducted and/or funded by a non-owner of the property;
- Expenses for the head office or other purposes unrelated to the aim and results of the exploration; however, reasonable expenses that are directly related to the asset may be included and;
- Historical acquisition price – it is preferable to include the asset's historical acquisition price as a historic cost if it is known. When the asset's historical price is included as a historic cost, it is assumed that all previous research that was conducted prior to the acquisition was included in the purchase price and is therefore irrelevant going forward.

The type, amount and cost of exploration must all be appropriate to the characteristics and status of the exploration of the mineral asset for the expenditure to be deemed reasonable (Van der Merwe, 2021). As explained by Van der Merwe (2021), once relevant and reasonable costs have been determined, there is a need to adjust such costs to account for time and inflation, either by re-costing them in current prices or by making the necessary adjustments for inflation. Re-costing can also be used in cases where the historical exploration work and results are well documented, but the costs are not. After deciding which expenses to add to the cost base and making the necessary adjustments to reflect the valuation date, the Effective Expenditure needs to be multiplied by a PEM so that the value of the property can be calculated.

As defined by Ellis (2011), a PEM is a relevant adjustment factor based on the valuer's assessment of the property's prospectivity. Onley, (1994) wrote that the

PEM is based on the findings of earlier exploration as well as the current estimation of the likelihood that an economic deposit will be found through further exploration. The values typically range from 0.5 to 3.0, although they might also be as high as 5.0 or as low as zero, with zero representing no prospectivity potential and values greater than 1.0 suggesting that the exploration work has increased the prospectivity of the project.

Duncan(1994) referenced in Onley (1994) used the scale below to determine the PEM's upper limit:

1. The next phase of exploration is justified by work to date or historical data.
2. There have been strong indications of economic mineralisation potential found, and
3. Ore-grade exposures or intersections that are suggestive of economic resources.

After analysing several tables of PEM values used in Mineral Asset Valuation (MAV), Van der Merwe (2021) compiled a set of guidelines that, in most cases might be regarded as a reasonable manner of selecting a PEM, including for projects involving diamonds. Table 2.3 summarises the compilation of reasonable PEM values and the typical case for their application.

Table 2.3 Summary of reasonable Prospectivity Enhancement Multiplier values (Van der Merwe (2021))

Multiplier	Typical Case
0 - 0.5	Little to no encouraging results from extensive exploration. Past work has downgraded property prospectivity significantly. Future exploration expenditure is not warranted.
0.5 – 1.0	Poor results, future exploration unlikely
1.0 – 1.3	Exploration potential has been maintained but not enhanced from regional potential.
1.3 – 1.5	Additional geology, geochemical and /or geophysical work to investigate the target warranted.
1.3 – 1.5	Exploration potential has been slightly enhanced, with some findings of a positive nature.
1.5 – 2.0	Exploration results (geological mapping, geochemistry and geophysics) have enhanced prospectivity. Direct evidence of an interesting target or targets.
2.0 – 2.5	Lease contains a defined drill target or targets, based on strong geological, geophysical and/or geochemical evidence/models. Scout drilling done with interesting intersections of mineralisation.
2.5 – 3.0	Mineralisation has been intersected by detailed drilling of defined targets. Follow-up work is likely to define a maiden resource.
3.0 – 4.0	Initial mineral resource estimated. Further exploration is expected to increase the size and quality of known resources.
4.0 – 5.0	Indicated mineral resource estimated. May form the basis for scoping or pre-feasibility study. Further exploration is very likely to increase the size and quality of the known resource.
> 5.0	Have already found a substantial resource at higher levels of confidence (that is likely to lead to a mine). May be ready to undergo a definitive feasibility study.

It has become standard procedure to determine lower and higher PEM values for each exploration activity due to the many uncertainties inherent to exploration (Van der Merwe, 2017). The quality of information may also be questioned, as to its effect on the PEM value. This can be the case with Angola where early-stage properties have historical data from early 1990´s and early 2000´s. Some of the information is illegible and some has not been audited. To account for this issue Van der Merwe (2017) suggested dividing the PEM into two attributes:

- A multiplier known as the Result Factor (RF) that is determined by the work's outcome;
- The Quality Factor (QF), a multiplier based on the quality and availability of the data, reports, and work that document the exploration work. It follows from logic that QF can only be unity.
- Applying RF and QF can increase the confidence of the valuation results presented or it can undervalue the property.
- When two components are taken into account, PEM = RF × QF is the final PEM that needs to be applied to the exploration activity.

A first order estimate of the intrinsic worth of the property is given by the product of the PEM and the base expenditure. An analogue of the fair value of the properties may then be derived by adjusting for the market premium/discount and the quality of the exploration work; alternatively, these variables may be included in the PEM (Van der Merwe, 2017).

Appraised Value Method

Lilford & Minnitt, 2002 clarify that the Appraised Value Method implies that an exploration property is worth at least the meaningful historical exploration expenditures plus estimated future exploration costs. This method resembles the MEE because a cost base of reasonable and relevant exploration expenditure must also be determined. However, in the Appraised Value Method, cognisance of future exploration costs is made by adding these to the effective expenditure. Roscoe (2002), called the future exploration costs as warranted future costs.

A reasonable exploration budget to test the identified potential of the specific property being valued makes up the warranted future costs. The warranted future costs are required to further comprehend the mineral asset's geology and only consider reasonable and productive expenses. Roscoe, (2002 p.107) clarified that "*productive means that the results of the work give sufficient encouragement to warrant further work by identifying potential for the existence and discovery of an economic mineral deposit."* The formula to calculate the estimated value using the Appraised Value Method is given in Equation 4 below (Ellis, 2011):

$$\text{Value} = \text{Effective Expenditure} + \text{Warranted Expenditure} \qquad \textbf{\textit{Equation 4}}$$

One of the advantages of the Appraised Value Method, according to Roscoe, (2002), is that exploration cost information and technical data can be readily accessed for most exploration properties. The method's primary disadvantage is that it can be improperly used because it requires experienced judgment to distinguish between past expenses that are thought to have added value to the property and those that do not, as well as to determine what a reasonable exploration programme (and associated cost) would be for the future. (Roscoe, 2002). To minimise the disadvantage stated above the valuation should be conducted by using more than one approach as advised by the IVS Council, (2022) and the major valuation codes.

Geoscience Factor Method

CIMVAL considers the Geoscience Factor (GF) as a method on its own and not part of the Income, Market or Cost Approaches. However, most literature considers the method as one of the Cost Approach methods. Lawrence, (1994) states that the Geoscience Matrix method originated as the Geoscience Ranking method. This was after Woodcock published a letter report in 1995 outlining a systematic geoscience factor ranking system that the British Columbia Securities Commission (Canada) intended to implement. By combining several factors including known geology, mineralisation, geochemical anomalies, and geophysical anomalies, Woodcock's method was to derive a geoscience rank using a point system. The Factors were then modified by climate, amount of prior exploration, environmental concerns, infrastructure, and access considerations.

According to Lawrence , (1994), Kilburn improved the GF system by using a matrix and developing the Kilburn Geoscience Method. Ellis, (2011) explains that in the Kilburn geoscience method, the Basic Acquisition Cost has to be adjusted by factors which represent the mineral property characteristics. Characteristics such as: geochemical, geophysical, location, nature of mineralisation and geological targets are used to arrive at a number of multiplier factors. Thus, the GF method is a technique used to value mineral properties based on various geological parameters.

Despite its advantages, the GF method also has its limitations such as relying on professional judgment to assign the weights of the different geological factors and interpret their significance. This translates into subjectivity which can introduce biases or inconsistency into the valuation process. The GF method also relies on the availability of geological data. In the case of Angola, this data may have been generated during the colonial era to the late 90s, which may render it outdated. In some cases, the data may be incomplete or even inaccurate. Outdated, incomplete and inaccurate data may lead to inaccuracies in the valuation process.

2.2.2 Mineral Asset Valuation Model

There are, typically several steps to a successful valuation. Figure 2.1 shows Deloitte's suggestion on the steps to take to value a mine (Deloitte, 2015).

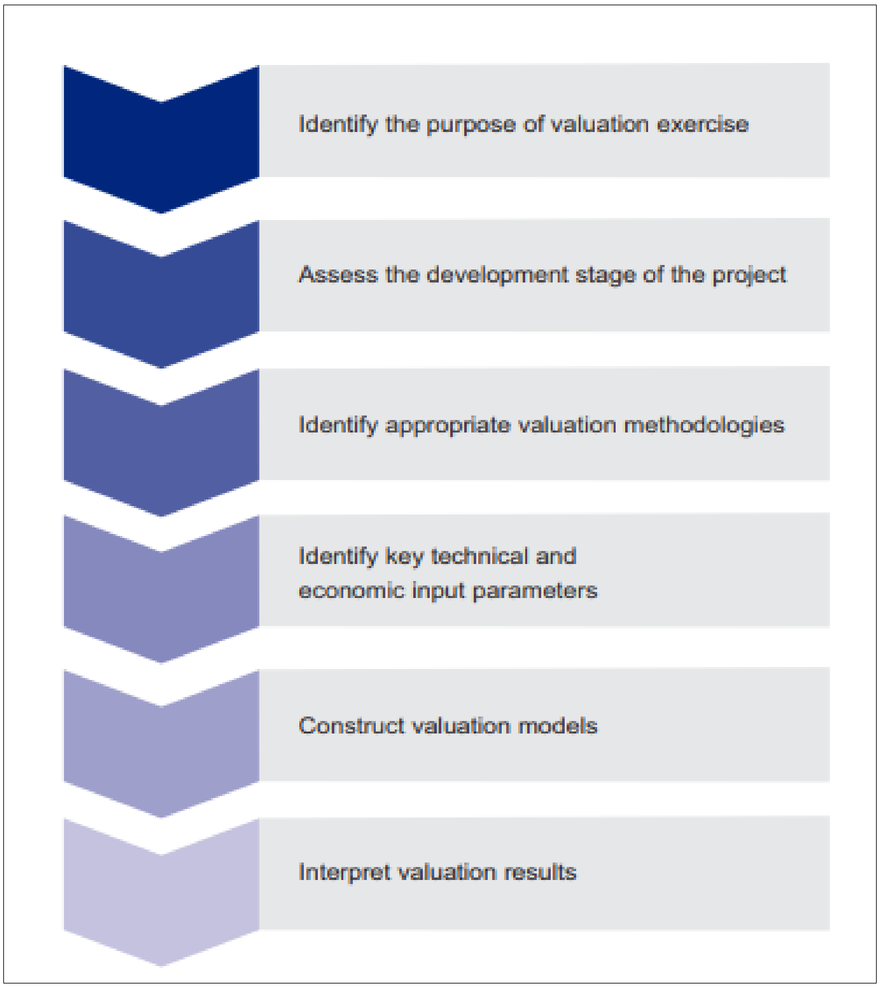

Figure 2.1 Stages in Mineral Asset Valuation Assessment (Deloitte, 2015)

1. **Identify the purpose of the valuation.** Valuations are needed for several reasons. According to Frimpong, (1992), a project's value, viability, and inherent uncertainty can be highlighted using mineral property valuations. Valuations can also be used to provide economic, technical, and operational guidelines for the property's exploitation, serve as the foundation for decisions about acquisitions, project financing, regulatory issues, and taxation, and give management the freedom to control operating variances and improve operating standards((Lilford & Minnitt, 2002).

   Further, Lilford & Minnitt, (2002) added that the following situations may need the valuation of mineral properties: major deals involving mergers and acquisitions, including the sale of mining assets, court cases, security factors for loan arrangements made by a financier, insurance claims, accounting needs, and new listings and other equity-raising activities. Identifying the purpose of valuation ensures that stakeholders understand the valuation’s objectives and outcomes.

2. **Assess the development stage of the project.** Before a valuation takes place, it is crucial to identify the development stage of the mineral property. Table 2.1 shows that these stages include: Early Exploration, Advanced Exploration, Construction, Development, Production, Dormant and Defunct. The development stage will influence the methodology used for the valuation.

3. **Identify the appropriate valuation methodologies.** The CIMVAL code (2019, p. 9) states the following: “*The choice of the specific approaches and methods used, or excluded, must be justified, and explained by the Qualified Valuator.*” The code further states that: “*More than one approach should be used in the Valuation of each Mineral Property if it is reasonably possible and appropriate to apply them."* (CIMVAL, 2019, p. 9). This means that if a property is valued using an Income Approach method, a second valuation using another approach should be done. Very often, the Market Approach is used as the second approach in valuations that were conducted using the Income and Cost Approaches.

Any of the approaches can be used, depending on the information that is available regarding the property in question. Figure 2.2 illustrates the applicable valuation methods throughout the various project development phases and demonstrates that in the early stages, a Cost Approach (Appraised Value) and a Market Approach (Comparable Transaction) are preferred and as confidence in the mineral property's geological, technical and economic parameters increases, the Income Approach (DCF) can be used.

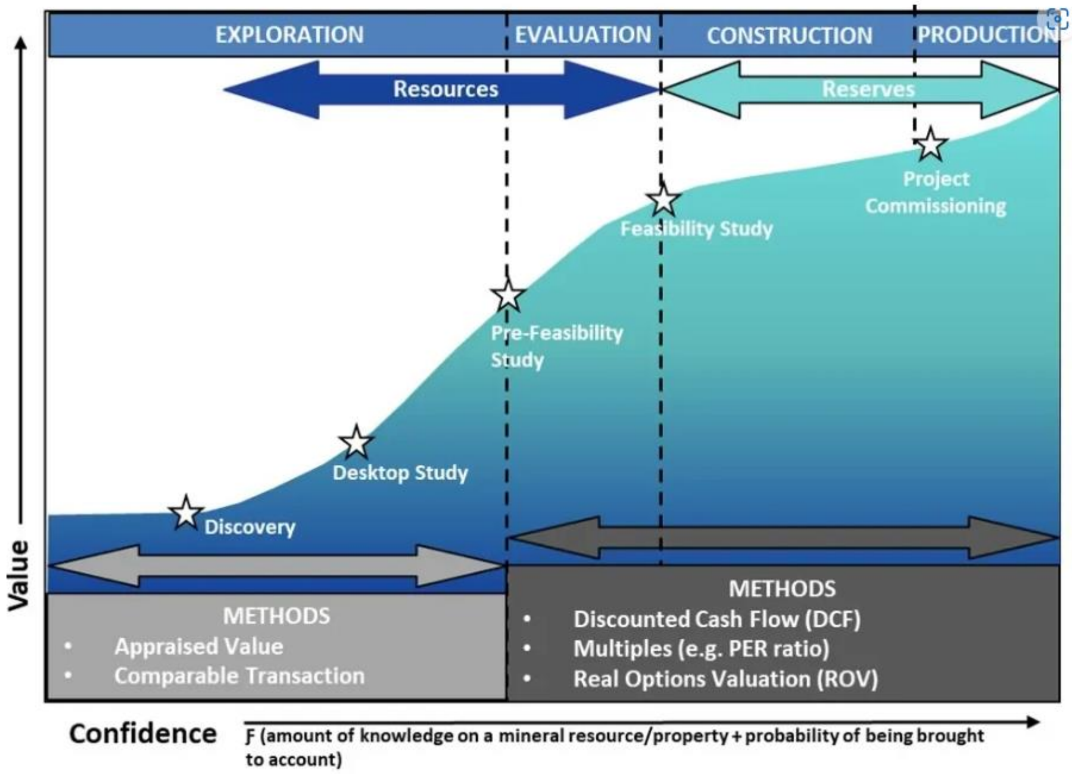

Figure 2.2 Valuation methods according to the stage of development of the mineral property (CSA Global, 2019)

4. **Identify key technical and economic input parameters.** For accuracy and reliability, identification of key technical and economic input parameters must be made. For example, parameters such as Mineral Resources and Reserves, tonnage, grade, expected recoveries, and working costs are needed for the DCF methodology, as discussed in section 2.2.1,. On the other hand, parameters such as exploration costs need to be identified for the MEE method to create a cost database as discussed in section 2.2.1.

5. **Construct a valuation model**. During the construction phase, a model is created. According to the (Internacional Valuation Standards Council, (2022 p.53), "*a valuation model refers collectively to the quantitative methods, systems, techniques and qualitative judgements used to estimate and document value*". The model should reflect the method chosen. Depending on the valuation method chosen, the identified parameters are combined using appropriate formulas and/or Excel-based models.

6. **Interpret the valuation results**. The CIMVAL code (2019, p. 9) states the following: "*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 within a range of Values."* Therefore, the interpretation of valuation results refers to the process of analysing and understanding the implications of the valuation findings. It involves examining the numbers generated through the valuation process and drawing meaningful conclusions to guide decision-making. Since more than one approach should be used for a valuation whenever possible, it is crucial to interpret the results from all the approaches.

2.3 Key Debates and Controversies

Some of the most robust debates concerning the valuation of diamond mineral properties range around addressing the difficulties of valuing early-stage alluvial diamond deposits. As discussed above, a project can only be valued once it has been evaluated in terms of its exploration potential or, in the case of a project in a more advanced stage, when a Diamond Resource estimation has been completed on a more advanced exploration project. The challenges with such resource estimations need to be properly understood before the challenges of valuation can be finalised.

2.3.1 Evaluation/valuation of early-stage alluvial diamond projects

Resource estimation of alluvial diamond properties is complicated by several peculiarities specific to alluvial deposits. The peculiarities mentioned below typically affect sample size and statistical estimation (Marshall, 2013):

Low grades

Commonly, a diamond deposit's grade is determined by estimating how many carats are present per hundred tonnes (cpht) or hundred cubic metres (ct/100m^3) of gravel, where a carat represents a weight unit equivalent to 0.20 grams For Angolan alluvial deposits, the average grade is around 16ct/100m^3 (ENDIAMA, 2022b).

Large relative size of individual diamonds

Diamonds are distinct units with various sizes (weight) that form distinct particle deposits rather than disseminated particle deposits. The average diamond size in all of Angola's alluvial deposits is between 0.11 and 1.77 ct/st. (ENDIAMA, 2022b) The size frequency distribution and value diamond stones vary significantly, and one stone may account for the majority of a parcel's value.

Variations in grade

Diamond grades can range from 0 cpht (barren) to over 100cpht in the same gravel unit (or even from samples within a few metres of each other) because of localised bedrock trap sites or hydraulic fractionation within a channel or bar. As a result, even amongst neighbouring samples, there is seldom repeatability in the diamond distribution pattern (grade) of alluvial deposits.

Depositional environments

Alluvial streams are extremely transient environments. Over time, the braided channels become unstable, and gravel bars continue to form and disappear. Diverse depositional assemblages are produced by large differences in local flow conditions caused by shifting bars and channels. Uneven bed thicknesses, limited lateral and vertical differences within the sediments, and an abundance of evidence of erosion and re-deposition are common characteristics of braided stream deposits, as shown in Figure 2.3.

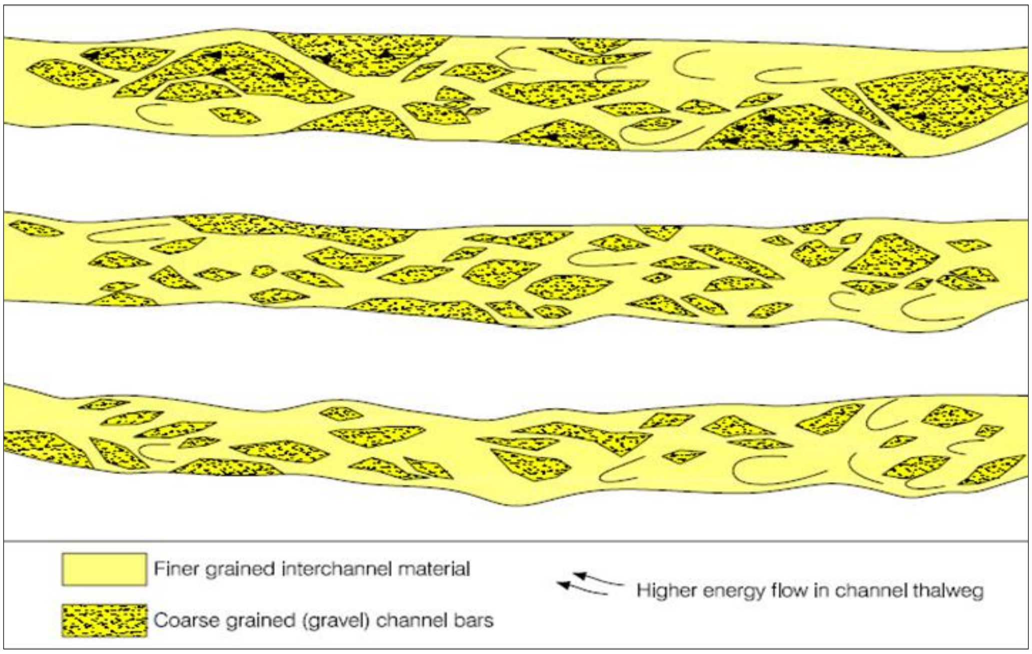

Figure 2.3 Schematic diagram indicating the development of alluvial gravel bars in a braided river environment (Modified after Gemanoski & Schumm, 1993)

The majority of deposits are often stratigraphically complicated, with units that don't extend very far laterally. Diamond concentration in alluvial deposits is influenced by bedrock features in the local area. Diamonds are found mostly in natural traps such gullies, potholes, and gravel bars as can be seen in Figure 2.4.

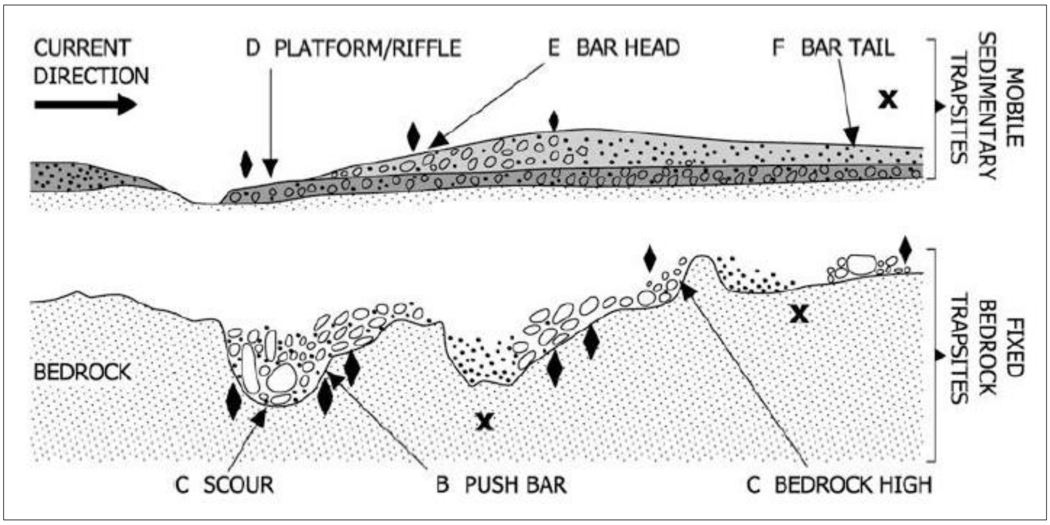

Figure 2.4 Variability of diamond trap-site locations, both in mobile and in bedrock deposits (redrawn from Jacob, 2005)

Low homogeneity of diamond distribution

Diamonds are not regularly distributed in an alluvial deposit; neither are they dispersed randomly. Instead, their distribution has been characterised as a random distribution of point clusters (Figure 2.5), where each cluster's point density is randomly distributed in addition to the clusters' random spatial distribution (Rombouts, 1987).

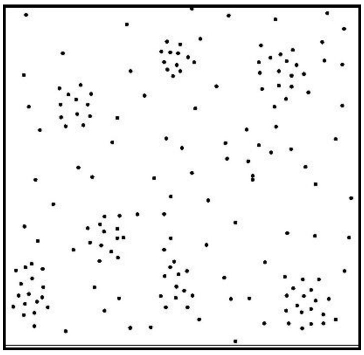

Figure 2.5 Schematic distribution of alluvial diamonds within an alluvial deposit random distribution of clusters of points *(Rombouts, 1987)*

As further illustrated in Figure 2.6, the combination of low grades and heterogeneity of diamond distribution can result in great difficulty in evaluating alluvial diamond deposits. In fact, Lock (2003) describes such deposits as being the most difficult to evaluate successfully.

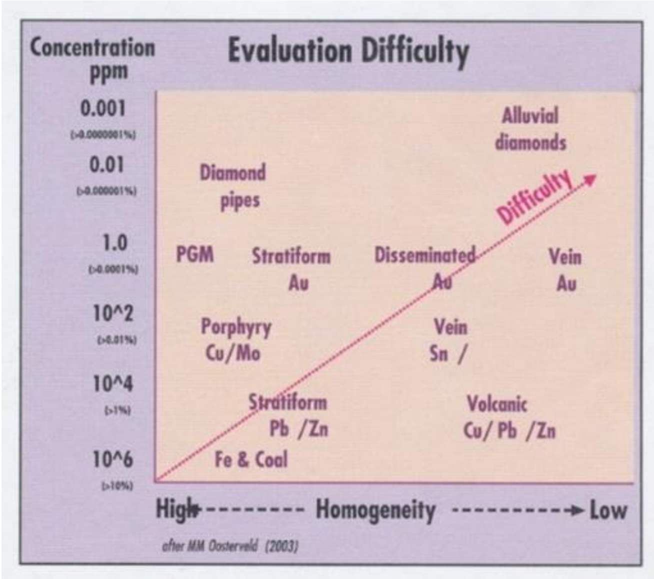

Figure 2.6 The extremely low concentrations of diamonds, combined with low homogeneity results in significant difficulties in the evaluation of alluvial diamond deposits (Lock, 2003)

Absence of a geochemical signature or associated minerals

Alluvial diamond deposits, as opposed to kimberlite deposits, lack any typical (or deposit-specific) satellite/indicator mineral assemblage that can exist at higher, more readily quantifiable concentrations than the diamonds. Additionally, there are no related geochemical signatures to the deposits that vary based on the grade of the diamonds (or any other geological feature).

In order to account for all of these issues, alluvial diamond deposits can only be sampled (and, subsequently evaluated) effectively through bulk sampling that may contain tens or hundreds of thousands of cubic metres of gravel. The process of bulk sampling is essentially the same as production mining, only on a much smaller scale. When bulk sampling yields positive results, it inevitably leads to trial mining, where all the modifying parameters are determined to decide on whether to move forward with full production (effectively, a prefeasibility study).

The resource estimation process is important because as stated by Lawrence R., (2002, p. 103) *"mineral properties without defined resources present one of the most challenging tasks to the mineral valuator"* and once the resource estimation has been completed, "t*he valuation of alluvial diamond properties can be difficult*"

(Lilford & Minnitt, 2002, p. 375). In giving reasons for the statement, Lilford and Minnitt (2002) and Marshall (2012) clarify that alluvial diamond deposits are characterised by substantial geological uncertainty and discontinuity. Although such heterogeneity can be considered a significant reason for the difficulties in the valuation of alluvial diamond properties, it is not the only reason.

For example, according to Roscoe, (2002) the availability of technical data and exploration cost information for the majority of exploration properties is one of the advantages of the Appraised Value Method (Cost Approach). However, Marshall (2016) highlights the fact that even using a recognised approach such as the Cost Approach, may pose a challenge as accurate historical costs for alluvial diamond projects (operated by professional or artisanal diggers, such as are common in Angola and South Africa) may not always be available. As a result, alluvial diamond properties are often undervalued using the Cost Approach.

Lilford and Minnitt, (2002) state that the challenge of valuing (*early stage*) alluvial deposits stems primarily from attempts to value alluvial mineral rights in the absence of bulk samples and/or exploratory drilling. This does not mean, however, that the valuation of properties where no bulk samples and/or exploratory drilling has taken place is impossible; it implies that the use of the Income Approach (eg. DCF method) is not applicable. Instead, Lilford and Minnitt, (2002) encouraged the use of the Comparable Transaction Method (Market Approach) to value such early-stage properties. While using the Comparable Transaction method is not impossible, Marshall (2016) points out that it can be difficult to assemble the valuation matrix recommended by Lilford and Minnitt, (2002); the reason being the lack of publicly available data for comparable transactions required in this method.

2.3.2 The Angolan context

Several complications in diamond project valuation exist in Angola. As described below, most of these have to do with Angola's exploration/mining history which has been marked by several periods of disruption due to the civil war which started immediately after independence in 1975 and lasted until 2022. In addition, the absence of a Minerals Bourse in Angola with specific requirements for Public Reporting hinders transparency and the adequate dissemination of fundamental technical information. This is because according to SAMREC p.7, (2019), "*Public*

Reports are reports prepared for the purpose of informing investors or potential investors and their advisers on Exploration Results, Mineral Resources or Mineral Reserves. They include, but are not limited to, annual and quarterly company reports, press releases, information memoranda, technical papers, website postings and public presentations."

One of the difficulties in the Angola situation derives from the exploration that was done during the colonial era (1912 - 1975). While significant sampling of alluvial deposits was done by Companhia de Diamantes de Angola (DIAMANG - the original state-owned diamond company) prior to 1971, much of the results remain unaudited and even unverifiable (McKechnie, 2019). Many of the areas thus sampled are negotiated or offered to investors without the benefit of a complete resource estimation or valuation assessment.

Since ENDIAMA took over from DIAMANG in 1981, all valuations on any diamond project have been required to be done using DCF calculations. This worked well particularly on large-scale operations where significant work was done by companies such as DIAMANG, De Beers, Trans Hex and Odebrecht who were active during the latter part of the 20^{th} century and early 21^{st} century. As time passed, however, projects that did not have the same level of technical information started being considered for development, even though some of the managers responsible for conducting negotiations with the Companies did not have the background to appreciate the impact that this would have on valuation techniques for such deposits.

A further challenge lies in the application of internationally recognised codes. While such codes are developed by national reporting organisations (typically professional or statutory bodies), the application of such codes are usually required by the minerals' bourse of an active stock exchange or by a regulatory body. In Angola, no such requirements exist and, therefore, neither regulators nor administrators have had much experience in their application for large or small operations.

As Angola emerges from the isolation imposed during many years of political instability, the regulators are increasingly recognising the benefits of international best practice, which requires that project valuations need to adhere to recognised valuation codes. Such adherence also means that the Resource/Reserve report on which the valuation is based must comply with one of the CRIRSCO codes (Marshall, 2016).

In the Angolan context where most alluvial diamond operations are non-listed, medium- to small-scale ventures operated by private companies (see section 1.1 for examples of such companies), Resource/Reserve estimations are generally not compliant with any internationally recognised code. This results in many companies not being able to access public funds to complete an effective resource estimation programme. As has been described above, accurate valuation of such properties for potential investment purposes without an effective resource estimation basis is not possible.

In addition, currently (March 2024) Angola has 26 dormant alluvial properties. SAMVAL p. 24, (2016), defines a dormant property as "*a Mineral Asset that is not being actively explored or exploited, in which the Mineral Resources and Mineral Reserves have not been exhausted, and that may or may not be economically viable*." Typically, a dormant property (in Angola) is one where diamonds have been explored in the past by DIAMANG or previous/current artisanal workers (locally termed "*Garimpeiros"*) but is currently inactive. They are currently inactive because they await investment for further determination of economic viability. Alternatively, exploration has taken place in the past but is not currently actively explored due to lack of technical information.

2.3.3 How to value early-stage alluvial diamond properties

It has been demonstrated in Section 2.2.1 above that Income Approaches (and the popular DCF method, in particular) are not applicable for accurate valuation of early-stage alluvial diamond projects. The Cost and Market Approaches have been identified as far more applicable, although there are significant challenges with these methods as well. The Cost Approach for example, depends on historical costs and such information might not be readily available. In some cases, such historical costs are more than 10 years old and unaudited. To add to the concerns, according to Roscoe, (2002) and as illustrated in Table 2.4, when using the

Appraised Value method not all of the historical costs/past expenditures should be retained in the valuation process.

Table 2.4 Guidelines for retained past expenditures/historical costs for marginal and inactive properties **(Roscoe, 2002).**

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 enough to attract exploration expenditures easily. May be at the underground exploration stage.
50%	Property with sub-economic resources, but may have some potential in future, conditional on commodity prices, infrastructure, improved technology, economic conditions, etc. No work is 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 sub-economic 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.
Nominal value of $5,000 to $10,000	Inactive property with indeterminate but low or negligible exploration potential. Could be a property with little or no data available but in a geologically uninteresting area.

An additional issue arises concerning the experience of the CV. Since the valuator's qualifications and expertise are fundamental to the process, valuing exploration properties is frequently seen as subjective rather than objective. As a result, both Roscoe (1986) and Lawrence (1988) (referenced in Lilford & Minnitt (2002)) note that it is typical that the conclusions reached by two or more valuators on an exploration property will vary to some extent. However, regardless of the valuation method used, valuators typically rely on common key input criteria to ensure a transparent valuation process, thereby resulting in minor variations in the final outcomes.

In light of the above concerns, questions arise as to how one should deal with the valuations of small-medium alluvial diamond properties. It is, further, pertinent to ask whether the above challenges are the only difficulties that such properties present. Additionally, the Angolan context brings its own issues as discussed above.

2.4 Chapter Summary

Chapter 2 discussed key concepts related to Valuation. It covers three valuation approaches namely: the Income, Market and Cost. Within each approach there are different methods used for valuations and mainly the primary methods were explained. The method chosen for the valuation will depend on factors such as the stage of the development of the project and the amount of information available.

Key debates and controversies showed that valuing early-stage alluvial diamond properties can be difficult, but not impossible. The difficulties are related to issues such as the low diamond grades and heterogeneous nature of these deposit types which, in turn, result in difficulties in resource estimation, upon which the valuation is subsequently based. Problems related to CRIRSCO codes and experience also play a role. The chapter also introduced the Angolan context which adds to the challenges assessed in this report and briefly discussed controversies under the topic of valuing alluvial early-stage properties.

3 RESEARCH APPROACH/ METHODOLOGY

3.1 Introduction

This chapter provides a description of the research approach, including the research methodology, design and data collection procedure for the case study. The data validation process is explained, the assumptions made are stated and the approaches for analysis of the data and results are also covered in this chapter.

3.2 Research Design

The research is primarily quantitative and comprises of an analysis of existing evaluation reports and valuation examples. Quantitative information was also obtained from a case study of an early-stage alluvial diamond project. One of the principles of all valuation codes is that a property should be valued by at least two different Approaches. Since the case study property is an early-stage exploration project, the Cost Approach and the Market Approach were selected as being the most appropriate.

The valuation process then followed the steps as explained in section 2.2.2:

1. The purpose of the valuation was identified, and the development stage of the project was assessed;
2. The appropriate valuation methodologies, and key technical and economic input parameters were identified;
3. The data obtained was validated and analysed before the researcher completed the valuation exercise and;
4. A valuation model was compiled, and the valuation results were interpreted.

The information available from the case study as well as the results from the valuation exercise were analysed to demonstrate the different challenges. The information that would be needed to value a project, but which was not readily available was also identified, such as the total drilling costs and detailed bulk-sampling costs. It was important to have these costs because they impact the valuation process, i.e., without them the project could be undervalued. The challenges were then assessed, and recommendations were made on how to deal with the difficulties identified during the literature review and the case study. The major steps of the research design are illustrated in Figure 3.1.

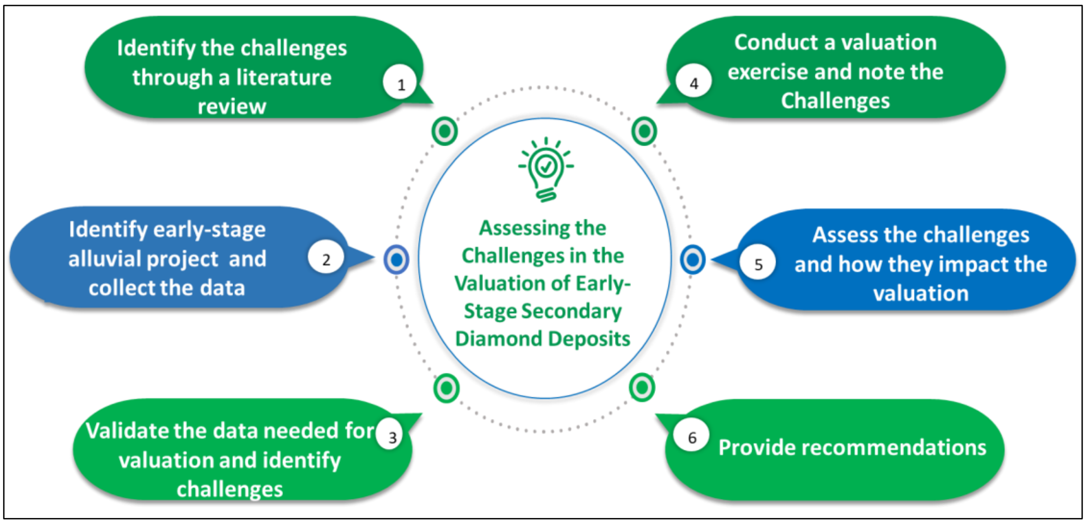

Figure 3.1 Research Design

3.3 Data Collection Process

In conducting the research, information was obtained from sources such as the Banco Nacional de Angola (BNA) and ENDIAMA´s website. Since the Research Report focuses on the Angolan context, the researcher obtained permission from ENDIAMA to use data that would assist in this research. Permission was granted to use technical and economic data from the company’s reports for the case study. This was supplemented with information about the project gathered from publicly available information, brochures and presentations.

Site visits were conducted to better establish the exploration stage in which the project is and to access reports available on-site that would assist in determining the exploration potential. Reports containing the workforce, equipment, earth moving vehicles (EMV) and relevant information were available on the mine site. Data pertaining to the EMV and other project-related equipment such as the pre-treatment plant was verified during the site visit. These were needed to assist in establishing and validating the expenditures.

3.3.1 Data associated with the Cost Approach

The information related to the project stage, equipment, EMV and workforce was collected to assist in conducting a valuation exercise using the Multiples of Exploration Expenditure Method (MEE), the most commonly used of the Cost Approach´s methods. For the MEE a Cost Base of reasonable and relevant exploration expenditure was also needed as an input.

The following information and data were also collected:

- General data regarding the size of the property,
- Maps and past reports (historical)
- Total Exploration cost;
- Bulk sampling costs;
- Drilling Plan and costs;
- Inflation for various years (2021 – 2023) and;
- Country Risk and Interest-free Risk.

For costs that were not readily available, but the corresponding activities were well documented, such as the Reverse Circulation (RC) drilling activity, the researcher obtained a quote to estimate present equivalent costs (March 2024). To assist in establishing the potential of the property, it was also necessary to gather information about the producing mines around the early-stage property, such information included:

- Total annual sales in carats;
- Average annual price in dollars/ct and;
- Weighted average grade in ct/100m^3.

3.3.2 Data associated with the Market Approach

Besides the information used to carry out the Cost Approach, data was also collected to conduct a valuation using the Market Approach (Comparable Transactions method). The data collected for the Market Approach included past transactions of alluvial diamond properties obtained from various publicly available sources. To establish if the transactions are similar to the case study the following information was obtained:

- Location, concession area, type of deposit ;

- Date of transaction, transaction summary;
- Stage of development and total transaction value.
- To adjust the transactions´ value to a present value, rough diamond prices were obtained from www.paulzimnisky.com and Consumer Price Indexes were determined by using graphs from www.Fred.org.

3.4 Data Validation Process

Considering the concept of reasonable and relevant exploration expenditure, to validate the data for the MEE method, the following measures were taken:

- Where the outcomes of historical exploration have been lost or are unknown, the related expenditures were not considered.
- Costs such as the head office costs, that are not directly associated with exploration were removed from the database. However, reasonable administrative costs that are directly related to the asset were included.
- A quality factor was applied to account for unavailable and unaudited information.
- Site visits assisted in validating some information such as the amount of existing equipment and the human resources in the project.

Roscoe (2002) recommended a 5-year restriction on historic expenditures (expiration date on past expenditures). However, in the Angolan context where considerable exploration work was done in the 1970s, it is relevant to consider the work done more than 5 years ago. This is necessary when establishing an area's diamond-bearing potential, identifying target areas for further exploration or even discarding an area that has been explored in the past. Thus, some information older than 5 years was considered for historical purposes and to assist in establishing the potential of the property used for the case study.

Concerning the data for the Comparable Transactions Method, the following assumptions were made:

- Public domain Information such as industry statistics, historical data, and diamond market trends is accurate and
- Results of past valuations used for the Market Approach have been compiled in accordance with relevant code requirements.

3.5 Data Analysis Approach

Microsoft Excel was used to analyse the data. The data was uploaded into a spreadsheet and tables were redrawn when necessary to facilitate the calculations and graphs were plotted to better understand the information and possible relationships or outliers.

To assist in determining the potential of the area, maps were checked for the presence of previously explored areas and any indication of informal work done by artisanal workers. Reports from different years and different companies containing information about the project under analysis were compared.

The exploration potential and exploration work carried out were analysed to determine a Data QF and a PEM value. These were selected after careful consideration of the work that has been done on the project and by comparing such work to the typical cases described in Table 2.3. Furthermore, to determine the QF, the quality of the data and records of historical exploration work was also assessed. This was necessary because some of the exploration work done that was considered relevant, took place during the colonial era and the results justified work that was later carried on. However, the data available was not audited and some of the most recent data (2021-2023) was available as a total and not as unit costs for each step or phase that took place during exploration. Considering a QF ranging from 0 (no results or data accessible) to 1 (all results and data available with an entire audit trail), a quality factor of less than one was selected.

For the Market Approach, the researcher searched various online databases and company websites to identify public transactions for the period 2004 to 2024. Filtering of the transactions highlighted 134 transactions related to diamonds. The diamond transactions were then further analysed to exclude incomplete transactions, transactions related to primary deposits, mines in production, and infrastructure or share acquisitions.

Valuations on early exploration stage alluvial projects were then used to create a statistical/numerical model representing the market for properties of the same type. The final comparable list contained 10 transactions. To assist in the necessary matching, data such as location, commodity type, and stage of development were compared to the characteristics of the case study property. The numerical model was then used to determine a range of values that represents the value of the case study property.

3.6 Chapter Summary

Chapter 3 discussed the research methodology and shows that two valuation approaches were used, namely the Cost and the Market Approach. For each of the approaches the data that was needed is listed. The sources of the data that were identified and the data collection analysis and validation processes were described.

4 DATA FOR THE STUDY

4.1 Introduction

The purpose of the valuation exercise is to assist in the identification of difficulties that might arise when valuing early-stage projects, especially in the Angolan context. For the valuation exercise, an alluvial exploration property in the Lunda Norte province was considered. The property is bordered by alluvial diamond mines currently in production and a prospective value for the exploration target is determined in accordance with the SAMVAL Code's standards. During the valuation exercise the property´s prospectivity was considered. The Cost and Market Approaches of valuation were applied.

4.2 Background

The exploration potential in the Lunda Norte dates back to 1912 when a diamond was discovered along the Mussalala stream, which is a branch of the Chiumbe River in the Lunda Norte Province. Production begun in 1916, and in 1917 the original state-owned company named Companhia de Diamantes de Angola known as DIAMANG, emerged. All diamond mining rights in Angola were ceded to DIAMANG in 1918. In 1952, Camafuca Camazambo, the first kimberlite, was discovered followed by the discovery of rich alluvial diamond deposits on the Cuango River in 1955 (ENDIAMA, 2020). Further multiple discoveries were made since then, primarily along the Lucapa Corridor, a graben-type feature that extends from the Benguela Province on the south-west coast, through Lunda Sul and Lunda Norte provinces to the Democratic Republic of Congo (DRC) border in the north-east.

In 1981 ENDIAMA emerged from DIAMANG, which was subsequently dissolved. In May 2020 an Angolan presidential decree 143/20 (Decreto Presidential 143/20) was approved by the Angolan president. (Diário da República, 2020). In the decree, major changes in the Governance Model for the Angolan mining sector were made. For example, the National Agency for Mineral Resources also known as ANRM (Agência Nacional de Recursos Minerais) is introduced. The agency's main responsibility is to manage mining concession contracts of all commodities in the country including diamonds. In addition, ENDIAMA, the state-owned diamond mining company that had been the holder of mining rights since 1981, ceased to perform administrative and regulatory functions and became a diamond operator in its own right.

As part of this new exploration and mining endeavour, in 2021 ENDIAMA obtained the rights to two wholly owned diamond concessions which were later combined into a single concession. Exploration was started on the concession without any joint venture partners. This project, called Project A for the sake of confidentiality, was chosen as the case study for this research.

4.2.1 Property geology

The property comprises river flats, terraces and Calonda Formation gravel. All three units are typically diamondiferous and are considered primary targets for exploration.

Calonda Formation

The Calonda Formation (mid-to-late Cretaceous (80-100 Million years); also referred to as the Kwango Formation in the DRC), unconformably overlies the basement and is typically overlain by varying thicknesses up to 40m of Kalahari Sands. As seen in Figure 4.1 and Figure 4.2, it comprises a continental sedimentary red-bed sequence of feldspathic sandstone, shales and gravels, which can vary from 0.5-30m in thickness.

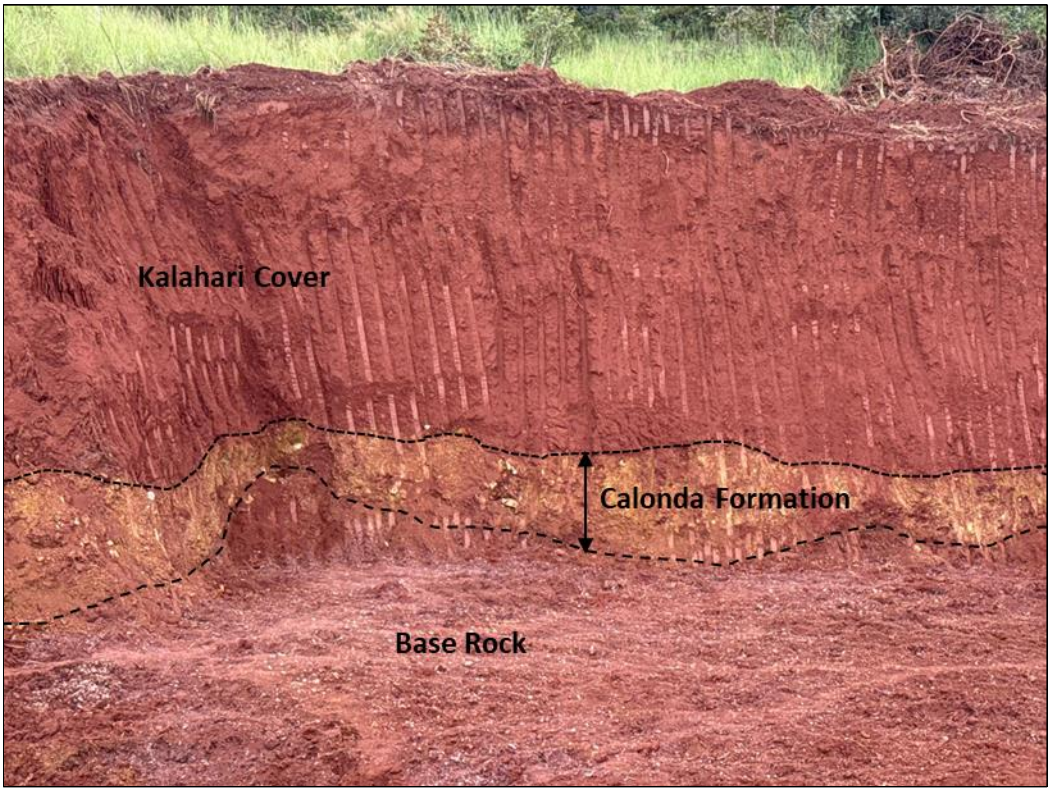

Figure 4.1 Cut showing the Kalahari upper group and the Calonda Formation

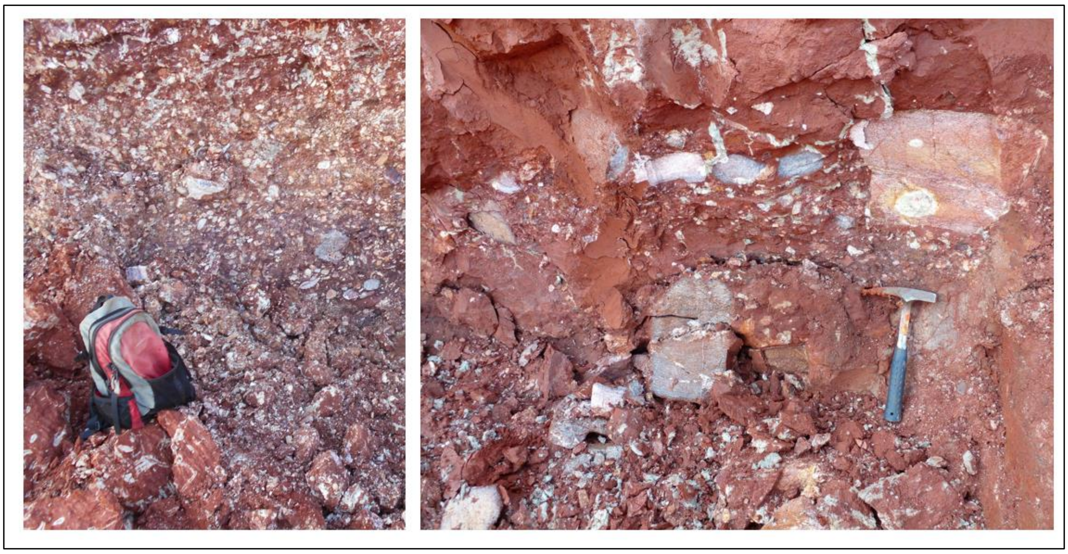

Figure 4.2 Calonda Formation (Horne, 2024)

Diamonds were introduced into the Calonda by concomitant erosion of local kimberlites as shown in Figure 4.3. The Calonda is an upward-fining fluvial sequence, with the Basal Gravel Unit being the primary exploration target.

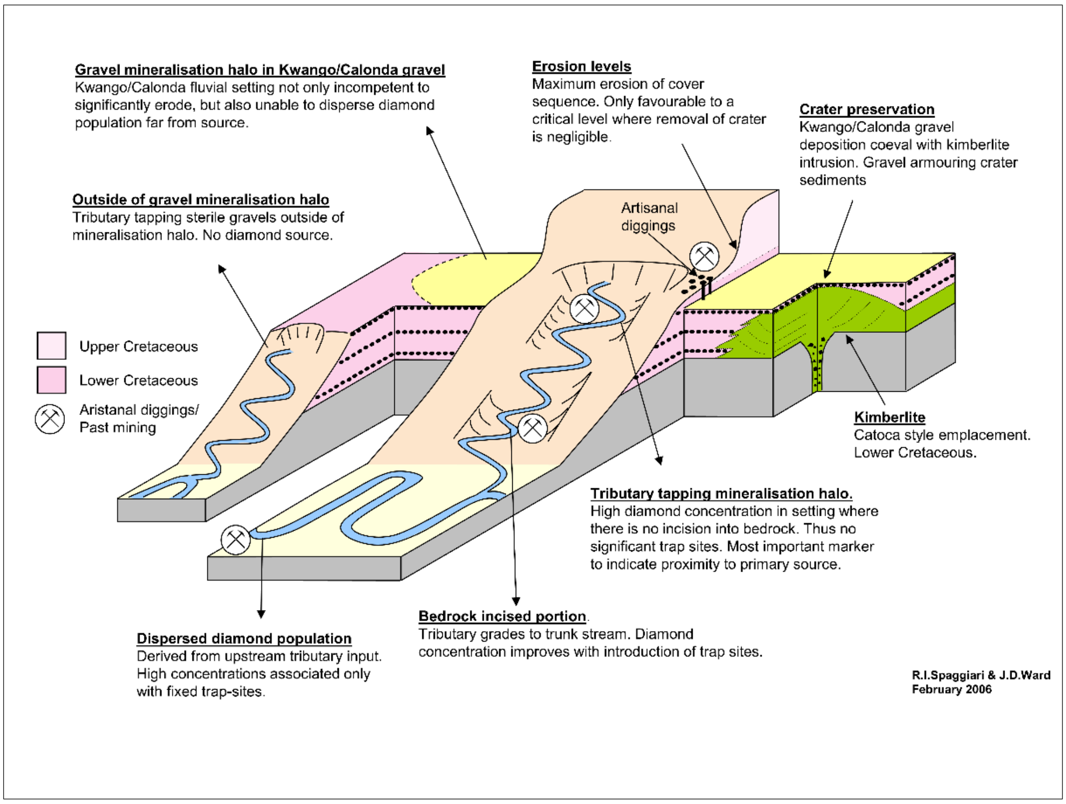

Figure 4.3 Model for the formation of the diamond-bearing Calonda formation
(Spaggiari & Ward, 2006)

Since the Calonda gravels generally occur on hillslopes at some distance from the present rivers, they are preferentially mined during the wet season, when the lower terraces, flood plains and current rivers are inaccessible. This expands the ability of the project to operate year-round.

Terraces and River Flats

River flats (locally called *lezirias*) are remnants of the former floodplain of a river. They are formed by the downcutting of the river into its former floodplain, as demonstrated in Figure 4.4. Multiple downcutting events results in flights of terraces as discontinuous remnants of older floodplains left perched above the present floodplain. Terraces are typically flat areas separated from one another by a sloping surface. Terraces young downward towards the present river. Higher terraces can be lateritised or calcreted, depending on the prevailing climatic conditions.

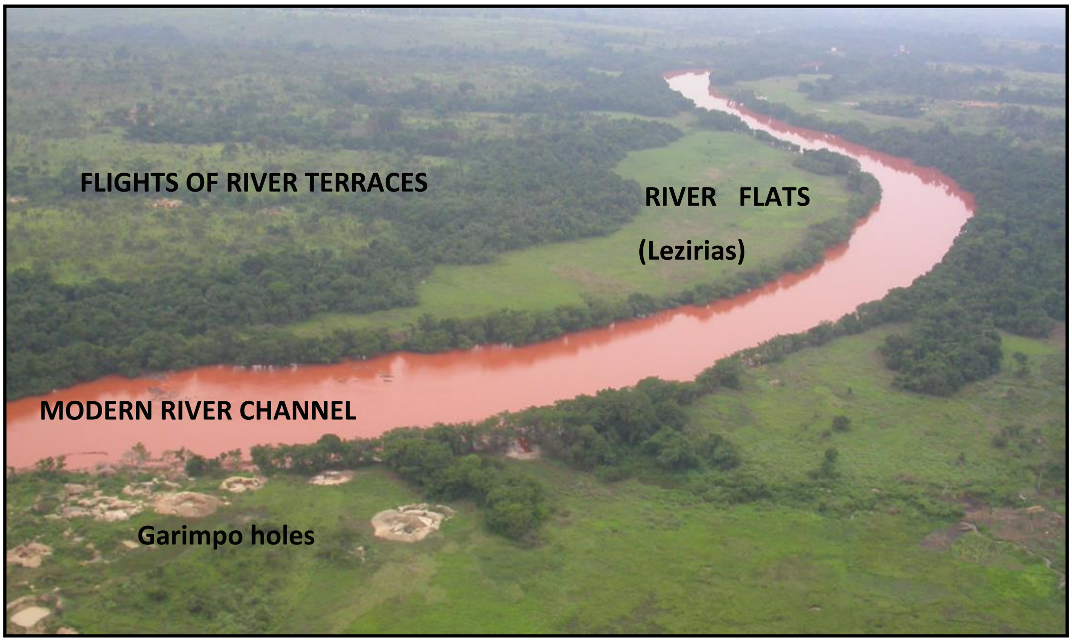

Figure 4.4 Terraces and River Flats location in relation to a modern river channel *(Marshall, TR, Pers. Comm)*

Diamonds in the terraces and/or lezirias are derived from the weathering of or either pre-existing Calonda Formation, higher terraces or directly from local kimberlites, as can be seen in Figure 4.3 above. The present rivers, in turn, rework all the existing fluvial deposits, resulting in diamondiferous deposits accumulating in the current rivers and streams as well.

4.2.1 Property location

Project A is located in the Lunda Norte province which is shown in Figure 4.5. It has a total area of approximately 60,100 ha.

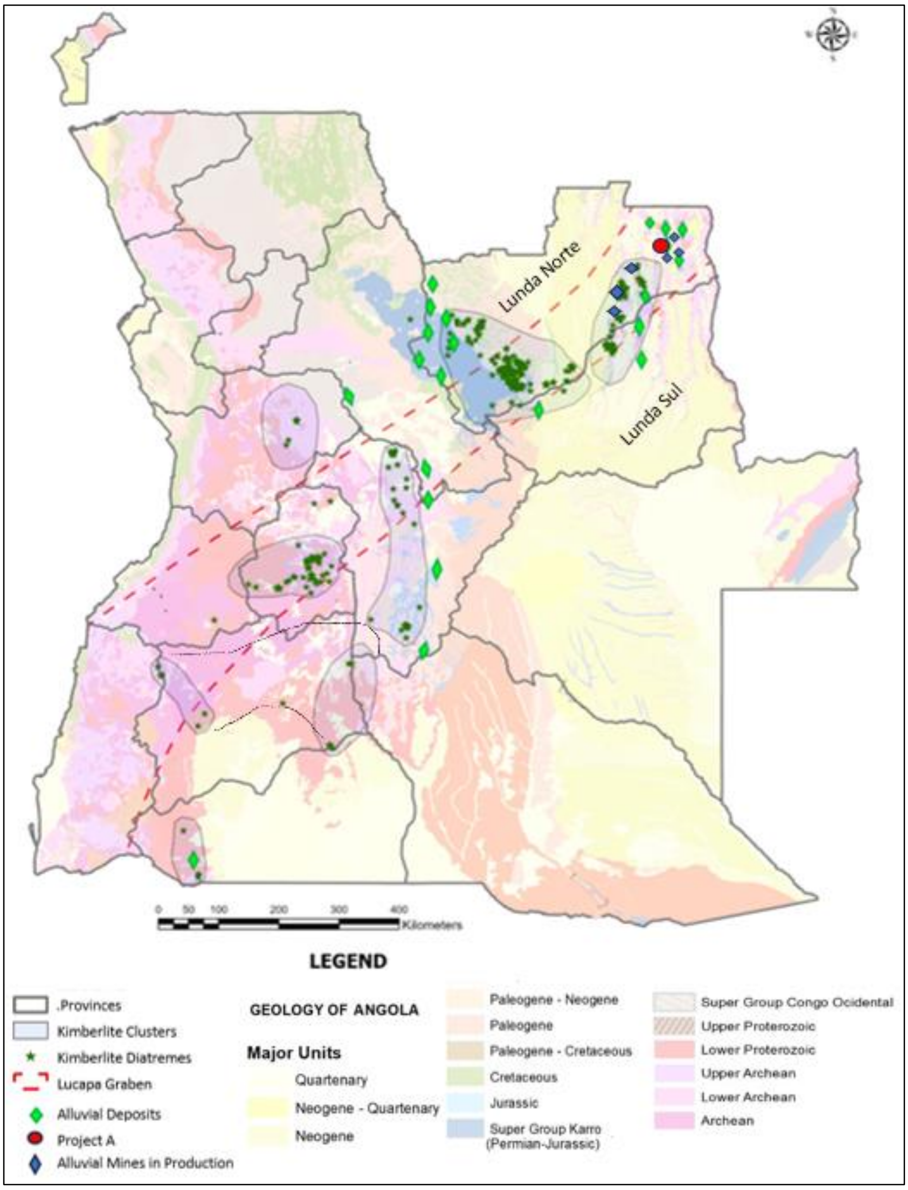

Figure 4.5 Location and basement geology of Project A - *(Modified after Geophysics Department, 2024)*

4.2.2 Access to the property

Lunda Norte Province can be accessed from Angola´s capital city called Luanda, some one hour by air. Flights land at the Dundo city airport. Alternatively, the province can be accessed by road; it is approximately 1 100 km from Luanda. However, part of the road is not well maintained, and the journey from Luanda to Dundo can easily take approximately a day. Project A is about 250 km from Dundo, and is reached through a well-maintained, but unpaved, gravel road.

4.2.3 General Infrastructure

Since 2021, infrastructure is being put in place to advance the project. As depicted in Figure 4.6 (see also Area Y in Figure 4.8 and Figure 4.9 below), the project has a tent camp accommodation type for the security personnel and a container-type accommodation for the workers. It also has offices, a workshop and a dining area.

Figure 4.6 Infrastructure at Project A

To assist with sample processing, the project also has a Pre-Treatment (PT) plant comprised of a 70 tonne-per-hour (tph) scrubber unit, a 30tph Dense Medium Separation (DMS) unit, a Concentrate Re-Treatment Plant (CRP) and a Flowsort® X-ray unit for final recovery. The outcome, which is an X-ray concentrate, is held in securely sealed containers. The locked containers are then transported to a facility where hand-sorting takes place, and the diamonds are meticulously selected in a highly secure setting. Process water is pumped from one of the Luana River´s tributaries, the Mussunege and power is generated by diesel generators.

The roads are unpaved (gravel mine roads) and although the roads are susceptible to becoming muddy during the rainy season, they remain wide and meticulously maintained. Therefore, despite the seasonal weather challenges, the road's maintenance regime ensures its continued functionality and accessibility, facilitating the flow of personnel and equipment to and from the site.

4.2.4 Economic potential of Project A

Project A is crossed by the Chiumbe and the Luana Rivers. Both rivers are diamond-related historical rivers. The rivers main tributaries are the Mussunege, Luaco, Cassanza, and Camupopo. Geologically, the project is located within the Lucapa Graben and is surrounded by six operational alluvial mines (mines U-Z) as depicted in Figure 4.7.

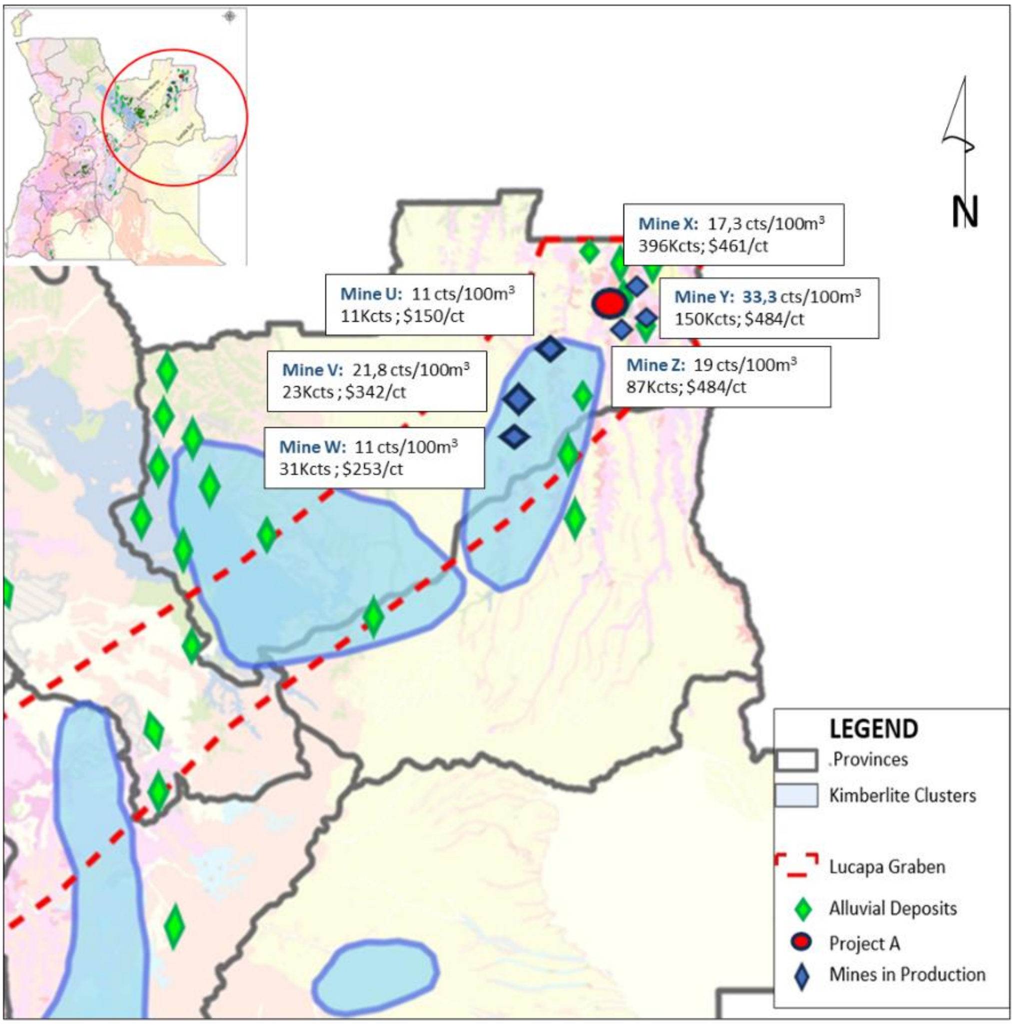

Figure 4.7 Location of Project A in relation to alluvial mines in production.
(Modified after ENDIAMA's Geophysics Department, 2024)

The Lunda Norte region's alluvial diamond mineralisation and the Project´s proximity to alluvial diamond mines provide context for understanding the property's economic potential. The map on Figure 4.8 indicates areas X and Y where significant *Garimpo* work has taken place. However, there is no historical information on diamond recovery. *Garimpo* refers to excavations/work done by artisanal workers (*Garimpeiros*) and is generally accepted as evidence of the presence of diamond-bearing gravel.

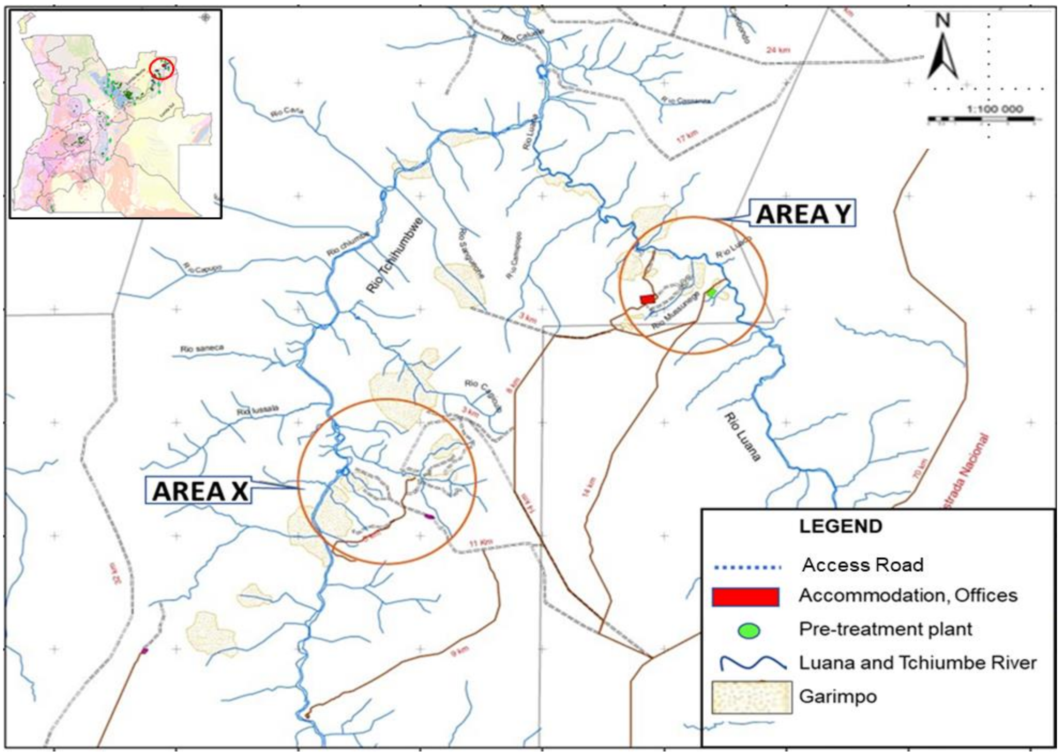

Figure 4.8 Details of Project A (Modified after ENDIAMA's Geology Department, 2023)

In addition to the *Garimpo* operations, DIAMANG also prospected the property during the late 1960s to early 1980s, as evidenced by the presence of old stockpiles and a PT plant. Figure 4.9 shows the location of the "production mining" (explored area) that took place on the *lezirias* as well as the location of the *Garimpo* operations.

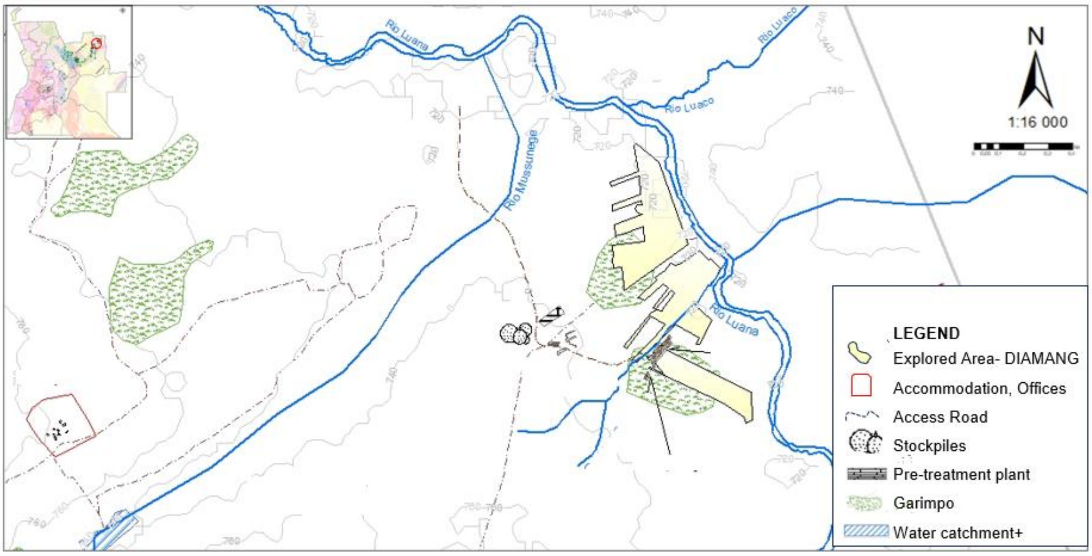

Figure 4.9 Previously explored (Area Y) and infrastructure on Project A. (Modified after ENDIAMA's Geology Department, 2023)

Records from the DIAMANG era, depicted in Table 4.1, show the grades obtained from the *lezirias* deposits in Area X. In this programme, some 243.46m^3 of gravel was processed to recover 17.75ct for an average grade of 0.08ct/m^3, with an average stone size of 0.19ct/stn.

Table 4.1 Results from exploration in the 1960s/1970s (DIAMANG records,1960/1970)

Type of Deposit	Area (m^2)	Overburden Average Thickness (m)	Gravel Thickness (m)	Gravel Volume (m^3)	Carats (ct)	Nº of Stones	Grade (ct/m^3)	Stone Size (ct/st)
Leziria	12	1.70	0.44	12.30	0.55		0.05	
Leziria	38	2.06	0.46	9.40	0.11	2.00	0.01	0.06
Leziria	42	1.32	0.44	18.36	1.59		0.09	
Leziria	8	1.15	0.49	3.90	0.73	6.00	0.19	0.12
Leziria	66	1.40	0.50	32.30	3.65	8.00	0.11	0.46
Leziria	48	4.77	0.85	18.80	0.04		0.00	
Leziria	110	1.46	0.51	54.20	0.59	5.00	0.01	0.12
Leziria	80	2.73	0.84	65.20	6.9		0.11	
Leziria	62	2.93	0.66	29.00	3.59		0.12	
Total	**466**	**2.17**	**0.58**	**243.46**	**17.75**	**21.00**	**0.08**	**0.19**

In 2004 a third-party potential joint-venture company conducted a Pre-Feasibility Study (PFS) on Area X. The PFS seems to have been based on the reports available from DIAMANG, mining results from the 1970s and work carried out by the company. However, the information available regarding the PFS is not publicly available due to confidentiality constraints. Table 4.2 contains limited information related to the type of deposit, gravel volume and grade obtained from a 2004 company report**.**

Table 4.2 Results from the 2004 sampling programme (ENDIAMA Geology Department, 2023)

Block N.	Type of Deposit	Area (m^2)	Gravel Thickness (m)	Gravel Volume (m)	Grade (ct/m^3)	Caracts (ct)	Average Price (US$/ct)	Revenue (US$)
1.A Probable Reserve	Leziria	4 678 000	0.60	2 806 800	0.31	592 908	300	177 872 400
1.B Known Resource	Leziria	7 667 000	0.60	4 600 200	0.20	920 040	300	276 012 000
2 Known Resource Presumed Resource	Leziria	56 461 000	0.60	33 876 600	0.20	6 775 320	300	2 032 596 000
TOTAL	Leziria	68 806 000		41 283 600		8 288 268		2 486 480 400

This 2004 sampling programme processed some 41 283 600m^3 of gravel to recover 8 288 268cts for an average recovered grade of 0.2ct/m^3. The grades from this programme are significantly higher than the earlier DIAMANG results (Table 4.1). They are also much higher than the regional grades, as noted in Figure 4.7. The reasons for such variation may result from the nature of the sampling equipment, the size of the samples, the type of gravel being sampled, and/or the depositional environment of the gravel units themselves.

Since much of this information is not available, and it is not possible to reconcile the grades from the project, the current, updated ENDIAMA exploration plan is to estimate Diamond Resources and Diamond Reserves and establish whether the infrastructure already in place is well located. The exploration plan includes drilling and bulk sampling to identify Diamond Resources. Table 4.3 shows the activities and exploration plan that comprise the Effective Expenditure Base for the valuation exercise. Further information regarding the exploration programme, such as bulk sampling data is found in Appendix A, Table A.1 and Table A.2.

Table 4.3 Project A – Activities and Exploration Programme

Phase	Activity	Comment
1	**Implementation Phase**	
1.1	Acquisition of EMV	Excavators, dump trucks, Load haul and dump (LHD), tanker trucks, Bulldozers, Dump trucks
1.2	Salaries	Excludes head office costs
1.3	Pre-Treatment Plant (MB70), DMS and CRP assembly and testing	Pre-treatment Plant with a capacity of 70tph, DMS with a capacity of 30tph and 1 CRP
1.4	Pre-treatment Plant (MB 200) – Calonda area	Pre-treatment Plant with a capacity of 200 tph (MB200) for Area X.
1.5	Opening of access roads	Shorter Accesses, connecting Area X and Area Y
1.6	Operating expenditures	Diesel, maintenance, living base
2	**Exploration Phase**	
2.1	Geological mapping and topographic survey	Start with 200m x 200m grid, followed by 100m x 50m grid and end with 50m x 50m grid.
2.2	Target delineation	
2.3	Cut Lines	
2.4	Excavator Pitting	To confirm the existence of gravel, appearance and thickness
2.5	Bulk Sampling	To recover at least 1000 m^3 of gravel to determine grade and stone value
2.6	Bulk Sample Processing	X-ray sorting
2.7	RC Drilling	To estimate the thickness, and depth of the Calonda Formation
3	**Estimation and Classification of Resources**	
4	**Pre-Feasibility study and estimation Reserves**	How much of the resource can I effectively mine
4.1	Preparation of the Environmental Impact Assessment	

4.3 Development Stage

Project A is an early-stage project. Early-stage projects refer to properties where commercial production has not yet begun. Such projects include properties with no defined Diamond Resources (that is, those in early-to-advanced exploration) as well as developmental properties that may only contain Inferred Resources.

The following development stages are defined by the SAMVAL code (SAMVAL, 2016, p. 26) and apply to Project A:

Early-stage exploration property – "*Early stage means tenure holdings where Mineralisation may or may not have been identified, and where Mineral Resources have not been defined."*

Advanced-stage exploration property – *"Advanced' means tenure holdings where considerable exploration has been undertaken and specific targets have been identified that warrant further detailed evaluation, usually by drill testing, trenching, or some other form of detailed geological sampling. A Mineral Resource estimate has been defined and a Scoping Study has been applied to determine whether there are reasonable prospects for eventual economic extraction."*

Based on the given descriptions, Project A would be classified as an early-stage exploration property since it lacks both a Mineral Resource estimate and a Scoping Study.

4.4 Valuation Methodology

For projects in the exploration stage such as in the case of Project A, the Cost and Market Approaches are widely used, as discussed in section 2.2.1 above. For the Cost Approach, the MEE method was selected as an appropriate method and for the Market Approach, the Comparable Transactions Method was chosen as a suitable method for the valuation of Project A.

4.4.1 Valuation 1 (Cost Approach)

In order to estimate the project's value by using the Cost Approach an EEB was considered, (Value = (EEB) x (PEM)). The EEB shown in Table 4.4 considers effective and relevant past expenditures as well as the drilling plan that started in June 2024. A total EEB of US$22.6 Million is obtained.

Table 4.4 Project A - Effective Expenditure Base in US$

Phase	Activity	Costs US$			
		Year 1	Year 2	Year 3	Year 4
		2021	2022	2023	2024
1	**Implementation Phase**				
1.1	Acquisition of EMV	1 319 238	2 374 628	1 583 085	1 305 606
1.2	Salaries	35 251	216 732	1 607 100	1 750 000
1.3	Pre-Treatment Plant (MB70), DMS and CRP assembly and testing	0	0	840 631	0
1.4	Pre-treatment Plant (MB 200) – Calonda area	0	0	0	1 800 000
1.5	Opening of access roads	311 000	311 000	0	0
1.6	Operating Expenditures	9 761	1 001 366	1 431 500	1 286 790
2	**Exploration Phase**			2 559 606	
2.1	Geological mapping and topographic survey		0	0	
2.2	Target delineation				
2.3	Cut Lines				
2.4	Excavator Pitting				0
2.5	Bulk Sampling	0	0	1 014 000	
2.6	Bulk Sample Processing				
2.7	RC Drilling (Calonda)	0	0	0	1 747 112
3	**Estimation and classification of Resources**	0	0	0	0
4	**Pre-feasibility study and estimation of Reserves**	0	0	0	0
4.1	Preparation of the Environmental Impact Assessment	0	0	0	114 516
	Total	1 675 250	3 903 726	9 035 922	8 004 024
	Total Effective Expenditure Base (EEB)	**22 618 922**			

Adjusting Costs to the Valuation Date

To bring the costs included in the EEB in line with the average costs at the time of valuation, it is necessary to adjust the cost for time and inflation. The options available to adjust the EEB are re-costing the work to current prices and adjusting the EEB for inflation. The latter option was used and the costs from 2021 to 2023 were documented and adjusted for inflation. The inflation rates were readily available from Angola´s central bank (BNA). Table 4.5 illustrates that for the years 2021 to 2023 the average discount rates were 26.19%, 21.69% and 13.57% respectively (Banco Nacional de, 2024). After applying the discount rate, the adjusted EEB total is US$27.4 Million.

According to Van der Merwe, 2021, due to technological advancements, the cost of many exploration techniques has not increased in parallel with monetary inflation, which presents a drawback when applying inflation rates to historical expenses. However, re-costing the work in current prices for some of the exploration expenses at the time of valuation was not possible. The reason was that although the total expenses of the exploration activities were available, the individual activities that made up the total expenses were not.

Table 4.5 Adjusted Effective Expenditure Base

	Year 1 2021	Year 2 2022	Year 3 2023	Year 4 2024	Total
Total EEB (US$)	1 675 249	3 903 726	9 035 922	8 004 025	22 618 922
Applied inflation (%)	26.19	21.69	13.57		
Adjusted EEB (US$)	**3 366 311**	**5 780 815**	**10 262 097**	**8 004 025**	**27 413 247**

Discount Rate

It is important to carefully consider the discount rate relevant to the project. In determining the discount rate, the location and the level of resource/reserve data available are considered. For early-stage projects the level of resource data is usually low or non-existent, resulting in much higher risk to the investor. Hence, higher discount rates are expected for projects in their early stages.

Determining a discount rate for an early-stage mineral project is not a simple task because the discount rate is usually comprised of three main components namely: (i) the risk-free interest rate, (ii) the country risk interest rate, representing the risk associated with a specific country and (iii) the mineral project risk, representing the risk associated with a mineral project (Baurens, 2010). This is not to be confused with the Weighted Average Cost of Capital (WACC), which is a discount rate (weighted sum of the cost of debt and equity) used to find the present value of a company's future cash flows that is applied in various DCF analyses. (Nhleko & Musingwini, 2016)

Although Project A is located in Angola and local expenditure is in Angolan Kwanzas, all diamond transactions are denominated in United States Dollars. The

US risk-free rate is at the time of writing is 4.41% (Y Charts, 2024).The risk-free interest rate in Angola as set by the Banco Nacional de Angola for the period November 2023 - May 2024 is 18.3% (Banco Nacional de Angola, 2024). However, using the Angolan risk rate effectively double discounts the risk, since the risk-free rate typically takes into account the political risk associated with Angola. Therefore, only the US rate will be considered as the risk-free rate.

Country risk considers factors such as political risk, foreign exchange, fraud, corruption and infrastructure challenges. Applying country risk discount is particularly relevant to alluvial diamond projects in Angola where some of the above-mentioned factors cannot be ignored. Damodaran (2024) estimated the current country risk rate for Angola at 9.51%.

Lattanzi, (2003) explained that discount rates associated with project/resource risk typically fall between 8% and 20% per annum. Lower values apply to operating mines and higher values of 15% to 20% for early-stage projects. Project A is still in the process of identifying its mineral resources and, to account for mineral project risks, the researcher chose a discount rate of 18%.

Consequently, as demonstrated in Table 4.6, the total discount rate applied to Project A is rounded off to 32%. This figure comprises the US risk-free long-term interest rate of 4.4%, the Angolan country risk rate of 9.5% and a project/resource risk rate of 18%. Since using the Angolan risk rate would result in double discounting because the Angolan risk-free rate also accounts for the political risk associated with Angola, only the US rate was used.

Table 4.6 Typical discount rates relative to Project A

Component	Typical Discount Rates	Project A
US Risk-free, long-term interest rate:	4.4%	4.4%
Country risk	0% - 25%	9.5%
Project/Resource risk	8% - 20%	18%
Total		**31.92%**

The Quality Factor (QF)

As mentioned in Section 2.2.1, the QF is a multiplier based on the quality and availability of the data, reports, and work that document the exploration work. For Project A, the total expenses of the exploration activities were available, however, the individual expenses of each activity were not well documented. Some of the available information was also not audited, therefore, considering a QF ranging from 0 (no results or data accessible) to 1 (all results and data available with an entire audit trail) (Van der Merwe, 2021), a QF of less than one was selected (0.85).

Prospectivity Enhancement Multiplier (PEM)

Considerable exploration work has been accomplished on Project A. While no Mineral Resources have not yet been estimated, the current prospecting results have produced diamond-bearing gravel. Therefore, the findings thus far are positive and there is a good likelihood that the exploration will continue to produce favourable results. The identification of additional suitable exploration targets justified further exploration activities.

The ideal result of having diamond-bearing gravels with an economic grade and value is highly probable due to the geological location of the project (within the Lucapa Graben) and given its proximity to current-producing mines. Additionally, excavator pitting has also intersected Calonda Formation gravels.

Following the rationale discussed in Section 2.2.1, it is reasonable to assume that the current exploration results have enhanced prospectivity and there is evidence of an interesting target. Therefore, considering the possible PEM values presented in Table 2.3, a PEM interval ranging from 2 to 2.5 was selected. Using the EEB and Equation 3 explained in Section 2.2.1, the range of value estimates using the Cost Approach is between US$31,7 Million and US$39,7 Million as calculated in Table 4.7.

Table 4.7 Multiples of Exploration Expenditure Valuation

Detail		
Adjusted Effective Expenditure Base (EEB)	**US$27 413 247**	
Data Quality Factor	DF	
Historic data is accessible and in decent shape. Audits were not traced.	0.85	
Prospectivity Enhancement Multiplier (PEM)	Lower PEM	Higher PEM
Motivation		
The area contains a defined drill target. Scout drilling (excavator pitting) done with interesting intersections of mineralisation. There is a good likelihood that the exploration will continue to produce favourable results. Further exploration activities were justified by the identification of additional suitable exploration targets.	2	2.5
Valuation		
MEE estimate (EEB x PEM x DQM)	US$46 602 520	US$58 253 150
Discount Rate	31.92%	
Final Range of Market Values	**US$31 726 996**	**US$39 658 745**

An alternative approach to creating a value range is to vary the result by a specified percentage on either side of the base estimate. A range of values rather than a single value estimate assists in accounting for various uncertainties and assumptions. The uncertainties can be due to insufficient exploration to estimate Mineral Resources.

Smartsheet's Guide on Project Cost Estimating (Smartsheet, 2022) highlights the importance of accounting for uncertainty in cost estimates and suggests using different ranges depending on the degree of uncertainty. Eby (2017) explains that for well-understood costs, ranges of some 10-20% are suitable; for moderate uncertainty, ranges of 20-30% are recommended; and for high uncertainty, ranges of 30-50% are more appropriate. Therefore, to account for the low-to-moderate uncertainty in cost estimates associated with Project A, it was considered reasonable to use a range of 20% around the adjusted EEB of US$27.4Million.

Consequently, the range of estimation values thus created varies from US$21.9 Million to US$32.9 Million at a valuation date of 1 June 2024.

4.4.2 Valuation 2 (Market Approach)

The value derived from the Market Approach is termed the market value of a mining project. The IVS Council (2022, p. 7), defines market value as "*the estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction, after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion."*

Of the different methods within the Market Approach, the Comparable Transactions Method was selected because it is the most widely used for early-stage valuations. In the Comparable Transactions Method, the value of a project is determined by comparing it to similar or identical projects for which pricing data is available. The method relies on databases of past mineral asset transactions, including acquisitions, disposals, and mergers. These transactions are believed to have been done under perfect conditions at arm's length, with the parties involved not being forced to transact.

Project A was compared to similar projects where transaction values were available to determine its market value. The strategy in this method is predicated on the notion that the most suitable alternative can be identified by carefully choosing a small number of transactions that closely resemble the subject property (Lawrence R. D., 2002).

The purpose of researching and selecting comparable transactions is to accurately represent the valuation by considering the existing market conditions and sentiment (Njowa & Musingwini, 2016). However, unlike the Real Estate sector, where many comparable transactions exist, the mining industry has few true comparable transactions, available in the public domain, making the identification of comparable transactions a difficult process. The fundamental reason being that unlike the real estate sector, every mineral asset has various distinctive features, such as location, geology, mineralisation, incurred exploration costs, development stage, and pre-existing infrastructure which make it unique and difficult to compare

(Njowa & Musingwini, 2016). Notwithstanding, the Market Approach is the second most used approach for the various stages of project development, including for early-stage projects.

Public sources were investigated for transactions to select those most applicable for comparison to Project A. From the list of transactions identified, eleven transactions were selected a potentially comparable to project A, Table 4.8 lists the transactions considered as potentially comparable to Project A. These alluvial diamond projects were initially considered comparable because they are all exploration projects located within Central and West African countries, with similar climate, infrastructural, economic and political challenges.

Table 4.8 Comparable Transactions (Venmyn, 2008a; Venmyn, 2008b)

Company and Project Name	Year	Country	Area (Km²)	Price Paid (US$)
ESCOM - Cobuia	2008	Angola	2 937	11 748 000
ESCOM - Sanjungo	2008	Angola	1 397	10 477 500
ESCOM - Vulege	2008	Angola	844	37 700 000
ESCOM - Itengo	2008	Angola	389	4 980 000
Transhex Cachimba	2007	Angola	249	4 980 000
Transhex Cachimba	2008	Angola	249	7 400 000
Diamondworks - CAMCO Concessions	2001	CAR	11 527	35 000 000
Gem Diamonds - Lubembe Project	2007	DRC	1 157	47 600 000
Gem Diamonds - Mamberere Project	2007	DRC	855	37 700 000
BHP Billiton - Mano River Resources	2004	Sierra Leone	9700	6 700 000

Factors of value that are time-related

The transactions listed in Table 4.8 occurred between 2001 and 2008. The prices for the comparable transactions had to be adjusted to reflect a cash value on the valuation date (1 June 2024). The value of the transactions as estimated historically will not be the same today because a mineral asset's value changes over time for a variety of reasons. Some of the reasons are related to the market (demand and supply, commodity prices), and some are not (technological advances, Reserve estimate, geopolitical and economic factors). As such, the transaction value cannot be easily adjusted for time elapsed based only on changes in inflation. (Van der Merwe, 2016). Adjusting the value of mineral property transactions based solely on inflation may not fully capture the complexities involved in such transactions due to limitations such as:

- Market Dynamics: Mineral properties are subject to market conditions, which can fluctuate due to supply and demand, geopolitical events, technological advancements, and other factors. Inflation adjustment alone may not reflect these changes.
- Commodity Prices: The value of minerals is directly linked to their market prices, which can vary significantly over time. Inflation adjustment does not account for the volatility in commodity prices.

Van der Merwe, (2016) explains that commodity price and the performance of the sector on the relevant stock exchange, are two helpful metrics for adjusting the value for time. Commodity prices are driven by factors such as supply and demand and, consequently, can be used as a proxy for market conditions. The performance of a specific mineral sector can generally be checked by analysing small capital markets, such as the NASDAQ Small Cap Mining Index.

The NASDAQ Small Cap Mining Index (NASDAQ & Hoffman, 2024) tracks the performance of small-capitalisation companies within the mining sector. It is primarily focused on precious metals, with a significant emphasis on gold mining companies. The index is more aligned with companies involved in the mining of metals and other resources rather than gemstones. Because the NASDAQ Small Cap Mining Index does not specifically focus on diamonds, it is not ideally suited for adjusting the past value of transactions related to diamond commodities to present value. Since performance on the stock exchange is not applicable to this exercise, a combination of inflation and commodity prices was used to adjust the transactions.

Adjustment for Inflation over time

The value of the transactions was first adjusted using inflation. To determine inflation between the various years in which the transaction took place and the current year (i.e. between 2001 and 2024, or between 2008 and 2024), the Consumer Price Index (CPI) was used to account for general increases over time as per formula below (Equation 5):

$$Adjusted\ Value = Initial\ Value\ x\ \frac{CPI\ at\ Present}{CPI\ at\ Initial\ Valuation}$$ ***Equation 5***

Figure 4.10 shows how the CPI changed from 2001 to 2024. The factor for each transaction year was estimated by using the graph and the adjustment for inflation was made as shown in Table 4.9.

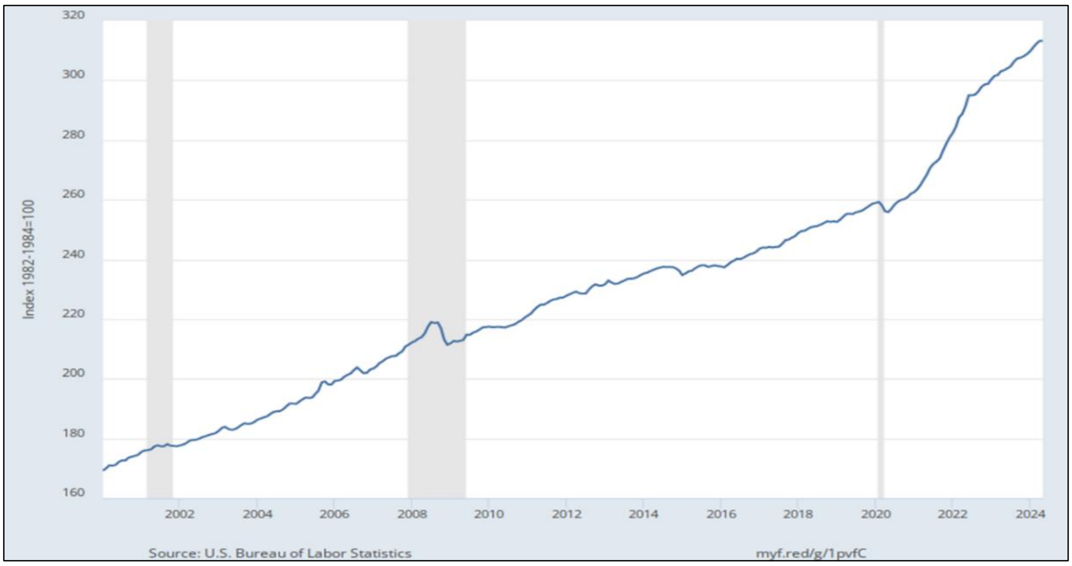

Figure 4.10 Consumer Price Index in US$ (FRED, 2024)

Table 4.9 Inflation Adjustment

Company and Project Name	Year	Country	Area (km²)	Price Paid (US$m)	Implied Price Paid US$/Km²	Inflation Change %	Inflation Adjusted Price Paid US$/Km²
ESCOM - Cobuia	2008	Angola	2 937	11,75	4 000	45%	5 786
ESCOM - Sanjungo	2008	Angola	1 397	10,48	7 500	45%	10 849
ESCOM - Vulege	2008	Angola	844	6,33	7 500	45%	10 849
ESCOM - Itengo	2008	Angola	389	2,92	7 500	45%	10 849
Transhex Cachimba	2008	Angola	249	7,40	29 719	45%	42 988
Transhex Cachimba	2007	Angola	249	4,98	20 000	50%	30 032
Diamondworks - CAMCO CAR Concessions	2001	CAR	11 527	35,00	3 036	76%	5 340
Gem Diamonds - Lubembe Project	2007	DRC	1 157	47,60	41 141	50%	61 777
Gem Diamonds - Mamberere Project	2007	DRC	855	37,70	44 094	50%	66 211
BHP Billiton - Mano River Resources	2004	Sierre Leone	9 700	6,70	691	65%	1 138

Adjustment for Commodity Prices

One useful source of diamond pricing is the Zimnisky Global Rough Diamond Price Index (RDPI). This index was developed to aggregate dependable data on the prices of natural rough diamonds and provide regular updates on their current price fluctuations on a weekly basis. The index's objective is to precisely monitor the price fluctuations of natural uncut diamonds priced in U.S. dollars, considering the global market's influence. It considers an index starting value of 100 in 2007 and offers essential information about the rough diamond market (Paul Zimnisky, 2024).

The periodic fluctuation of commodity prices is a characteristic of the diamond industry and reflects external global conditions. For example, Figure 4.11 shows that after the global economic crisis of 2008/2009, diamond prices reached a record high in early 2012 of around US$185/ct.

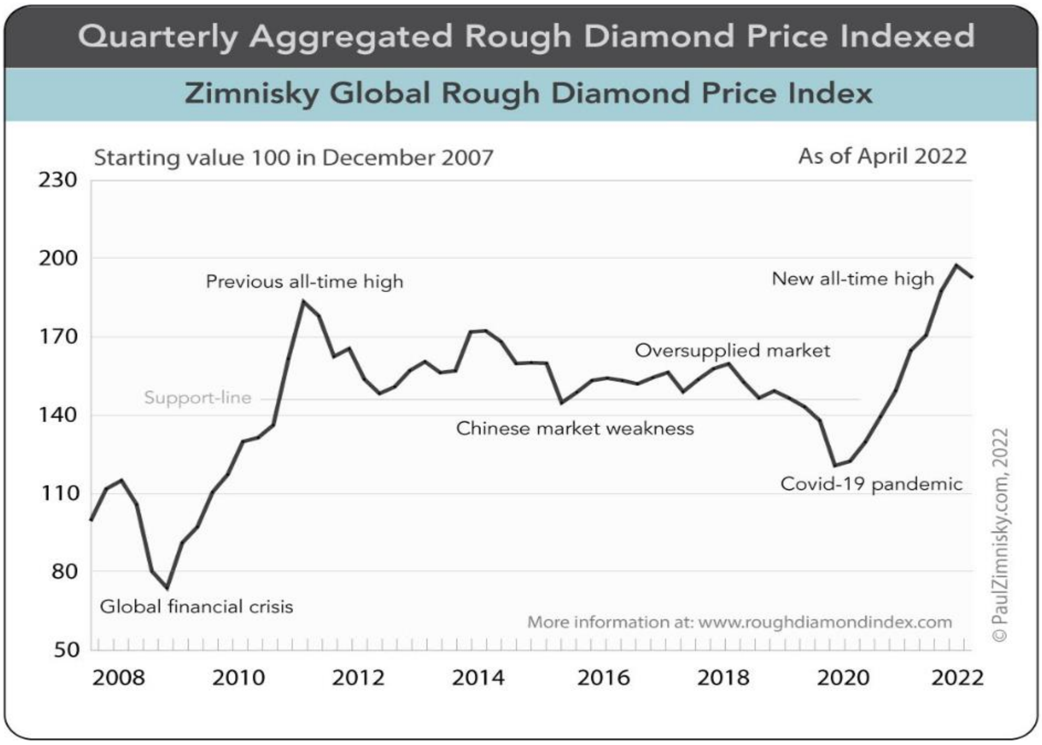

Figure 4.11 Zimnisky Global Rough Diamond Index for the period 2008-2022
(Paul Zimnisky, 2022)

The price of diamonds declined shortly thereafter, oscillating around US$160/ct for a few years because of an oversupply in the market. This was followed by a sharp drop to around USD115/ct during the COVID-19 pandemic. This low was then followed by an upward trajectory as lockdown conditions eased worldwide, reaching a new all-time peak in 2022 of some US$200/ct. The recent RDPI, as of

01 June 2024 (Paul Zimnisky, 2024), shows that the diamond price has fallen back to around US$144/ct primarily as a result of the current poor global economy. The RDPI between the various years in which the transaction took place and the current year was used to adjust the transaction values as per Equation 6.

$$Adjusted\ Value = Initial\ Value\ x\ \frac{RDPI\ at\ Present}{RDPI\ at\ Initial\ Valuation} \qquad \text{Equation 6}$$

The adjusted value for each transaction year was estimated by using the graphs shown in Figure 4.11, Figure 4.12 and adopting the 1 June 2024 RDPI of US$144/ct. The graph shown in Figure 4.11, which has an index starting value of 100 in 2007, was used to adjust the initial Price Paid to a Present Value (adjusted value) for transactions that took place between 2008 – 2024. However, some of the transactions took place earlier than 2008. Hence, Figure 4.12 and Figure 4.13 which have indexes ranging from 2001 to 2017, were used to bring the remaining transactions to 2007. Once the transaction prices were adjusted to 2007, it was possible to adjust all prices paid to 2024 using the 1 June RDPI of US$144/ct. The adjustment for commodity price yielded the results shown in Table *4.10*.

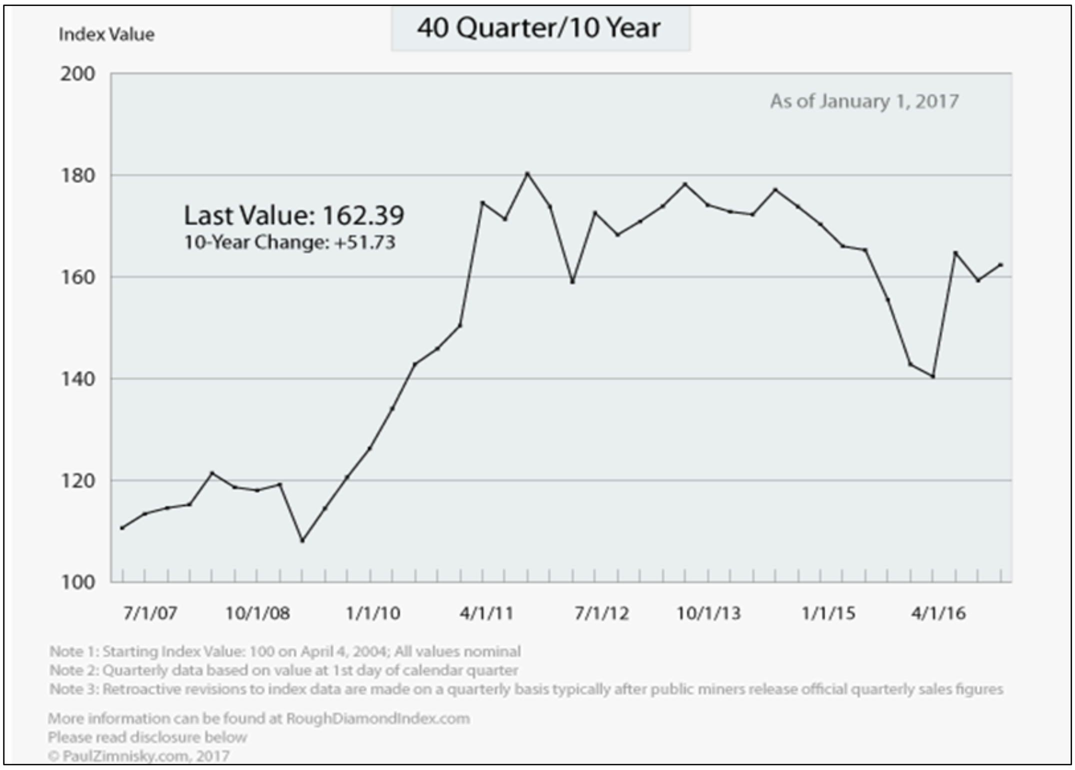

Figure 4.12 Zimnisky Global Rough Diamond Index for the period 2007-2017

(McDonald, 2017)

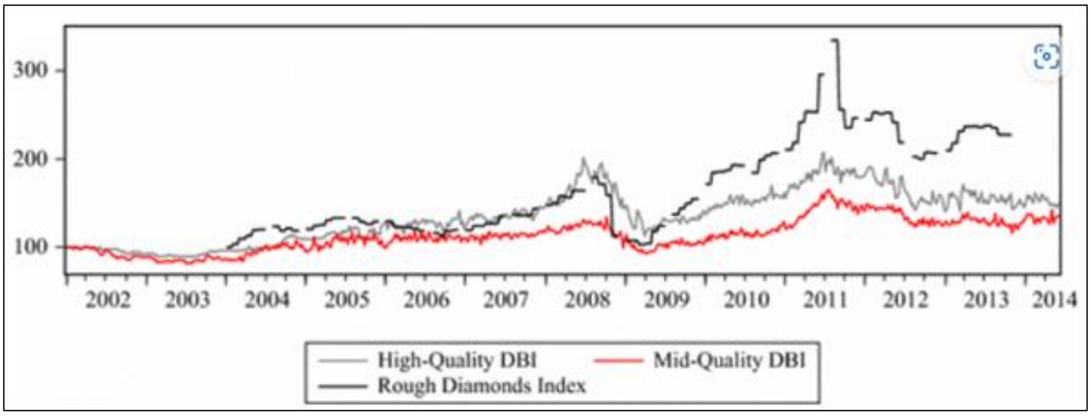

Figure 4.13 Rough Diamond Index 2001 - 2014 (D´ecclesia & Jotanovic, 2018)

Table 4.10 Rough Diamond Price Index Adjustment

Company and Project Name	Year	Inflation Adjusted Price Paid US$/Km^2	RDPI change %	Adjusted Price Paid US$/Km^2 2007	RDPI change %	Adjusted Price Paid US$/Km^2 2024
Transhex Cachimba 2 - Angola	2008	42 988			42%	61 043
43ESCOM Cobuia - Angola	2008	5 786			42%	8 216
ESCOM Itengo - Angola	2008	10 849			42%	15 405
ESCOM Sanjungo - Angola	2008	10 849			42%	15 405
ESCOM – Angola Vulege	2008	10 849			42%	15 405
Transhex Cachimba 1 - Angola	2007	30 032			44%	43 246
Gem Diamonds - Lubembe - DRC	2007	61 777			44%	88 959
Gem Diamonds – Mamberere -DRC	2007	66 211			44%	95 344
BHP Billiton - Mano River Resources - SL	2004	1 138	15%	799	44%	1 885
Diamondworks - CAMCO CAR -CAR	2001	5 340	15%	3 522	44%	8 843

The comparable transaction-adjusted prices were analysed, and to improve the overall quality and accuracy as well as to counteract any extreme effects that could skew the data, the lowest and highest values were purposefully excluded. Hence, the adjusted prices resulted in estimated low, median, and high values of

US$8 216/km^2, US$43 246/km^2, and US$88 959/km^2 respectively, as shown in Table 4.10.

Presenting a range of valuation results helps stakeholders understand the potential variability and risk associated with the project. Exploration projects have risks and uncertainties (refer section 2.3.1). The SAMREC Code acknowledges the inherent risks and uncertainties in mineral exploration (SAMREC, 2016). Similarly, SAMVAL also requires that a reasonable range of values be presented to reflect the uncertainties and risks involved in the valuation of exploration projects.(SAMVAL, 2016). Since Project A covers an area of 601 km^2, the estimated values were multiplied by the area to determine the project's low, median, and high values, as seen in Table 4.11.

Table 4.11 Project A Range of Values – Market Approach 1

Details	Comparable Transactions (US$/km^2)	Project A Area (km^2)	Project A Values
Low	8 216	601	4 937 888
Median	43 246		25 990 894
high	88 959		53 464 415

Considering the area target property and using the low, median, and high values in accordance with the Market Approach gives a potential value for the property of approximately US$26 Million, within the range of US$4.9 Million to US$53.5 Million, as shown in Table 4.11. To assist in analysing Project A's position, present values of comparable transactions were plotted on a bubble graph, as shown in Figure 4.14. This graph plots the total concession area(km^2) against the total price paid (US$) and adopts the price per unit area (US$/km^2) as the size of each sphere. It indicates that Project A falls within the typical size and value ranges observed in Angola.

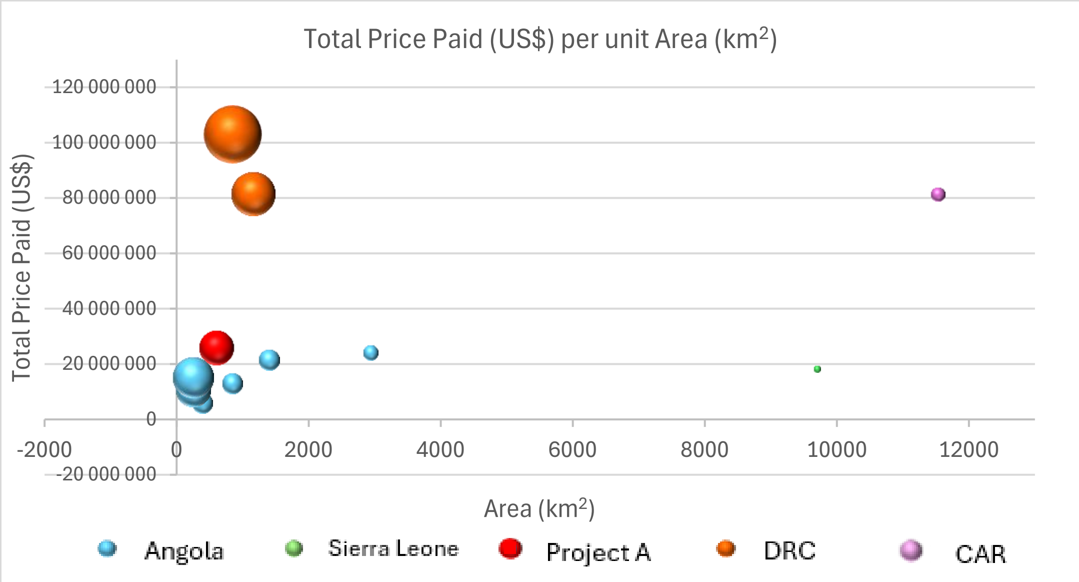

Figure 4.14 Total Price Paid vs Area with Price per Unit Area Representation

Figure 4.14 also reveals that, an increase in area typically corresponds with an increase in value. However, this trend is not universal, as factors other than size, such as existing infrastructure, resources, and location, also significantly impact value. Further analysis of the various projects led to the following conclusions:

- The Sierra Leone project has a low value despite its large area because it is in the early exploration stage and the country´s civil war from 1991-2002 rendered it politically unstable. Sierra Leone only joined the Kimberley Process in 2003 following a ban in 2000. The projects 2004 valuation date still reflects the instability associated with the civil war.
- The DRC projects are at a more advanced exploration stage and benefited from a period of more political stability in the DRC as compared to Sierra Leone.
- The low value of Angolan projects can be attributed to the country's recovery from a more than 20-year civil war (1975-2002), which left it politically unstable. At the time of valuation, the country was still recovering from political uncertainty.
- Project A, although smaller in area compared to most projects, has the highest value among Angolan projects, perhaps partly due to the current political stability in the country and partly to the amount of exploration work carried out recently.

In order to produce a more accurate comparison, the values corresponding to Sierra Leone, DRC and CAR projects, were considered outliers and therefore excluded from the original sample set. Table 4.12 lists the projects without the outliers. By concentrating on Angolan projects, the study ensures a more controlled and homogeneous group of projects to be used for comparison. These are all relatively similar early stages of development, although they vary dramatically in size (area).

Table 4.12 Rough Diamond Price Index Adjustment (without outliers)

Company and Project Name	Year	Inflation Adjusted Price Paid US$/Km²	RDPI change %	Adjusted Price Paid US$/Km² 2024
Transhex Cachimba 2 - Angola	2008	42 988	42%	61 043
ESCOM Cobuia - Angola	2008	5 786	42%	8 216
ESCOM Itengo - Angola	2008	10 849	42%	15 405
ESCOM Sanjungo - Angola	2008	10 849	42%	15 405
ESCOM – Angola Vulege	2008	10 849	42%	15 405
Transhex Cachimba 1- Angola	2007	30 032	44%	43 246

Based on the new reduced sample of projects, the adjusted prices resulted in estimated low, median, and high values of US$8 216/km^2, US$43 246/km^2, and US$61 043/km^2 respectively, as shown in Table 4.13. The data was replotted using the median value and Figure 4.15 illustrates Project A's position amongst similar projects in Angola.

Table 4.13 Project A Range of Values – Market Approach 2 (focussed properties only/without outliers)

Details	Comparable Transactions (US$/km²)	Project A Area (km²)	Project A Values
Low	8 216	601	4 937 888
Median	43 246		25 990 846
High	61 043		36 687 121

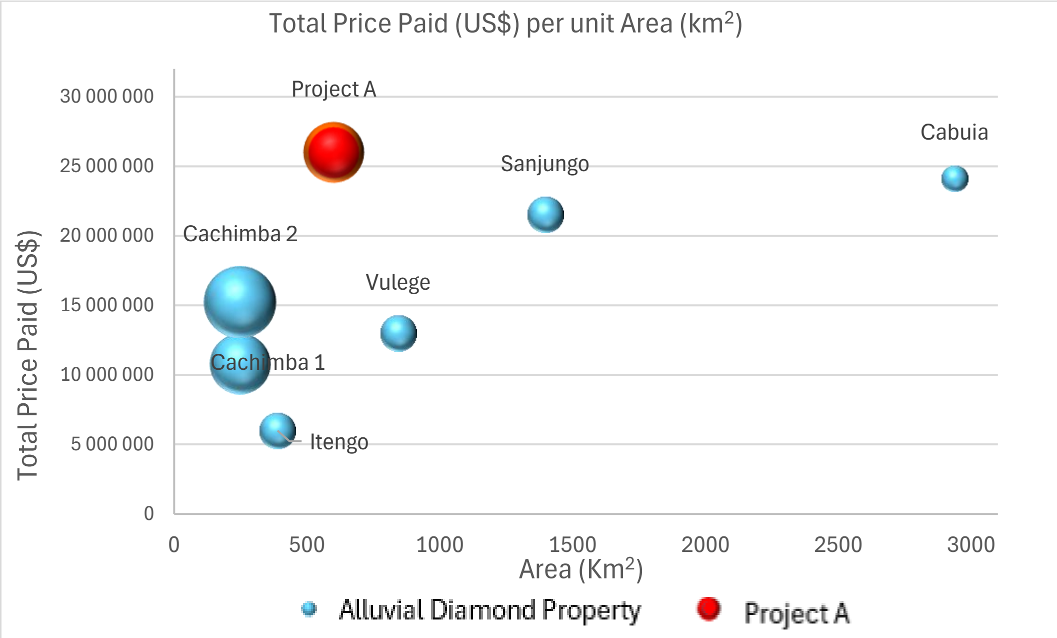

Figure 4.15 Total Price Paid vs Area with Price per Unit Area (highlighting Project A's position amongst similar projects in Angola)

4.4.1 Comparison of valuation results

The values obtained from various approaches are summarised in Table 4.14. The identified values were computed as the mean of each set of values, not including the results of Market Valuation 1, which was based on the entire range of alluvial projects, some of which had to be discarded for the reasons already discussed. Looking simply at the mean of the median values, Project A would be valued at US$29.7 Million, within a range of US$19.5 to US$36.4 Million. However, the selection of a value should not be based simply on mean values. Instead, selecting an appropriate value often relies heavily on professional experience and judgment. This expertise allows for an understanding that can account for various factors, which can ensure a more accurate and reliable project value.

Table 4.14 Overview of calculated and mean values for Project A

Valuation Approach	Details	Minimum (US$M)	Median (US$M)	Maximum (US$M)
Cost Approach	Actual PEM values	31.7	35.7	39.7
Cost Approach	Range +/-20%	21.9	27.4	32.9
**Market Approach 1*	*Comparable Transactions (all alluvial diamond transactions)*	*4.9*	*26.0*	*53.5*
Market Approach 2	Comparable Transactions (Angolan alluvial diamond transactions)	4.9	26.0	36.7
Mean Values		**19.5**	**29.7**	**36.4**

**The values associated with this valuation exercise are excluded from the final computation, however, they are shown in this table to demonstrate how values can be skewed by outlier data.*

The difference between the median values of the Cost Approach (actual PEM Values) and the Market Approach is approximately 37% (US$35.7m and US$26m). Such difference can pose a challenge when selecting a final range for the valuation exercise. The maximum value estimated by both Cost Approaches is closely aligned to that of the Market Approach 2 (MA2). Looking at the difference between the median values of the Cost Approach (Range +/-20%) and the MA2 which is about 5.4% shows that the median lies within these values (US$27.4m and US$26m).

The mean value of US$29.7m is affected by the low minimum value of MA2. The minimum is so low because of the Cabuia project which is a very large project with a low US$/unit area value as a result of its very early stage of exploration. The range of MA2 could be further contracted by removing the Cabuia project. In doing so, the range of MA2 becomes US$9.3 Million to US$36.7 Million as shown in Table 4.15.

Table 4.15 Overview of calculated and mean values for Project A (excluding Cabuia)

Valuation Approach	Details	Minimum (US$M)	Median (US$M)	Maximum (US$M)
Cost Approach	Actual PEM values	31.7	35.7	39.7
Cost Approach	Range +/-20%	21.9	27.4	32.9
**Market Approach 1*	*Comparable Transactions (all alluvial diamond transactions)*	*4.9*	*26.0*	*53.5*
Market Approach 2	Comparable Transactions (Angolan alluvial diamond transactions)	9.30	26,0	36,7
Mean Values		**21.0**	**31.6**	**36.4**

**The values associated with this valuation exercise are excluded from the final computation, however, they are shown in this table to demonstrate how values can be skewed by outlier data.*

Reassessing the mean of the median values, Project A would be valued at US$31.6 Million, within a range of US$21 Million to US$36.4 Million. It can be seen from this exercise that the selection of properties included in the comparison greatly affects the ranges – again highlighting the importance of professional experience and judgment.

4.5 Chapter Summary

Chapter 4 focused on the data utilised for the study, derived from a case study of an early-stage project termed Project A. The chapter detailed the valuation exercise carried out using Project A's data, including its location, geology, general infrastructure, and economic potential. Given Project A's early stage of development, the two most widely used valuation approaches, the Cost Approach and the Market Approach, were employed.

For the Cost Approach exercise, the MEE method was used due to the availability of past and future committed exploration expenditures. Past effective exploration expenditures were adjusted to the valuation date using the inflation rate which yielded an EEB of US$27.4 Million. A discount rate was applied to account for factors such as political risk, foreign exchange risk, and Resource risk, while a Quality Factor was considered to account for less well-documented data. The PEM was used to contextualize the cost base. Using the MEE method, the range of estimated value was between US$31.7 Million and US$39.7 Million.

An additional approach to creating a value range is to vary the result by a specified percentage on either side of the base estimate. Thus, by considering a range of +/-20% (used to signify moderate uncertainties), the range of estimation values created varied from US$21.9 Million to US$32.9 Million, with a mean value of US$27.4 Million at a valuation date of June 1, 2024.

For the Market Approach, the Comparable Transaction method was employed, as it is one of the most widely used methods for early-stage projects. This strategy relies on identifying a small number of transactions that closely resemble the subject property. Before the comparison, the available comparable transactions were adjusted for inflation and commodity prices. Project A was then compared to similar projects with available pricing data to determine its market value. After removing outliers, the mean value of the property was US$26 Million, within the range of US$9.3 Million to US$36.7 Million.

The chapter concluded with a comparison of the results from both approaches. The mean value identified for Project A was US$31.6 Million, within a range of US$21 Million to US$36.4 Million. It was noted, that a mean value is not necessarily the most appropriate value. Selecting a preferred value within an identified range requires professional judgement and experience.

5 ANALYSIS AND FINDINGS

The valuation of early-stage alluvial deposits presents unique difficulties that must be addressed in order to produce reliable valuations. This chapter highlights the findings that address the research questions and objectives. The complexities encountered in the valuation of early-stage alluvial diamond deposits are identified and discussed. Suggested mitigations as well as the mitigations adopted during the valuation exercise are explained. An impact prioritisation is recommended based on the criteria that high priority requires immediate attention and mitigation. Medium priority impacts are those that should be addressed after high-priority challenges have been dealt with and low priority are those that the researcher recommends being addressed after medium priority challenges have been mitigated. While the case study and the conclusions apply specifically to the Angolan context, many of the principles identified here are applicable to all early-stage alluvial diamond deposits, wherever they may be located.

5.1 Challenges

The findings identify several challenges to conducting valuations of early-stage alluvial diamond projects, including issues related to data availability and accuracy, adherence to CRIRSCO codes, comparable transactions, commodity prices, and other pertinent factors. The influence and importance of each of the identified elements is discussed in greater detail in the sections below.

5.1.1 Data availability and accuracy

Assessing information from previous exploration work

Obtaining information from third parties presents significant challenges, particularly when dealing with historical data from previous private companies that conducted exploration work in an area. In the case of Project A, this difficulty was highlighted when it was found that information regarding a PFS in the study area was incomplete (refer to section 4.2.4). Despite efforts to gather this data, the previous company, which considered itself the owner of the information, was unwilling to share it. This situation highlights a common issue: if the sharing of such information is not explicitly included in the initial joint venture agreements, accessing it later often becomes problematic.

Furthermore, if the property owner fails to properly archive the required information, it becomes more difficult to access it. This illustrates the broader challenge of obtaining information emphasising the need for clear agreements and robust data management practices from the outset of any project. Without such information, work from previous exploration cannot be assessed and the valuation exercise can become difficult; thus, assessing information from previous exploration work is of high priority.

Expiration date on past expenditures data

Managing expiration dates on past expenditures data is a significant issue in the context of early-stage alluvial projects in Angola. According to Roscoe (2002), there is a recommended 5-year restriction on the use of historic expenditure data. Deciding on which whether to adhere to the recommended 5-year restriction should be of medium priority because, in practice, some information older than five years can be valuable for historical context and assessing the potential of an area. This creates a dilemma: determining the appropriate timeframe for reviewing historical expenditures and deciding whether past exploration activities should be included in the current expenditure database or simply not add any value to the property and be just dismissed.

For instance, in alluvial projects in Angola, DIAMANG did extensive exploration work on alluvial projects in the Lunda Sul and Lunda Norte provinces. Examining historical data from the 1960s to the early 2000s is essential for establishing the potential of a given area. This long-term historical data provides critical insights (maps, drilled areas, grades, tonnages). Despite the importance of this historical data, additional confirmation drilling or sampling is necessary when utilising historical data for Resource Estimation in order to adhere to best practice, ensuring accuracy and reliability in the estimates made.

Unaudited information

Another concern with historical data in early-stage projects is the reliability of unaudited information. The valuation of early-stage projects heavily depends on the accuracy and validity of the available data and therefore this concern becomes a high priority. Ensuring that this data can be relied upon often requires it to be audited. Effective expenditure records should ideally comprise of audited data to provide a solid foundation for decision-making and investment. However, in the context of Angolan projects, it is often the case that historical data that has not been audited. This is particularly problematic for alluvial projects where historical data, sometimes dating back several decades, is crucial for establishing the potential of an area. The absence of audited data introduces uncertainties and risks, as unaudited information may be incomplete, inaccurate, or misleading. To mitigate these uncertainties and risks, the need to engage geologists or industry experts to evaluate the plausibility of the data arises. At times, new samples should be taken to validate the information. In addition, as shown in Table 4.7, risk adjustments such as reduced quality factors or high discount rates become necessary.

5.1.2 Cost assumptions

During the valuation exercise, it was realized that early-stage projects often lack well-documented unit costs for specific activities such as prospecting lines, excavator pitting, and bulk sampling. This presents a significant difficulty when establishing a cost database necessary for an accurate valuation and it is therefore a high priority to address this challenge. The absence of detailed cost records complicates the process of establishing a cost database upon which the valuation can be carried out.

Another critical aspect to consider is avoiding the duplication of operational costs. For instance, salaries and equipment costs might be provided as individual figures, but they could also be embedded within broader cost categories such as bulk sample processing or total exploration costs. Hence, it is important to ensure that costs such as bulk sample processing costs or the total exploration cost do not also include salaries if they have already been included as stand-alone figures.

Bringing cost to present-day values using inflation rates also presents a problem. To bring the costs included in the EEB in line with average costs at the time of valuation, adjustments for time and inflation are necessary. For the drilling activities current prices were obtained. Since the two options available to adjust the EEB are re-costing the work to reflect current prices or adjusting the historical EEB for inflation, the latter option was also used. Costs from 2021 to 2023 were documented and adjusted for inflation because it can be challenging and time-consuming to re-cost all activities. However, for certain historical expenses, it may not be totally suitable to change prices based on monetary inflation only. The reason being that the cost of exploration techniques may not have increased in the same proportion as monetary inflation due to technological advancements.

5.1.3 Discount Rate

Estimating an appropriate discount rate is critical and of high priority, as it directly influences the project's valuation and investment decisions. This process requires careful consideration of various factors, including the project's location, political stability and infrastructure availability. Additionally, one must account for the risk expectations and understand the perspectives at both government and company levels. In the case of a company like ENDIAMA, these expectations can significantly impact the chosen discount rate. Balancing these diverse elements to arrive at a precise and justifiable discount rate can be a complex task.

In addition to determining the discount rate, other concerning issues must be carefully considered, particularly for smaller operations or companies seeking to attract investment. Time and cost constraints are significant factors, as these can limit the ability to conduct thorough analyses of the data for a valuation. The qualifications, registration, and experience of valuators are crucial, especially when dealing with the specialized nature of alluvial diamonds, where expertise is paramount.

5.1.4 Finding comparable transactions

Identifying similar transactions for alluvial diamond deposits is a not a simple task. While searching for comparable transactions, it was evident that the majority of public diamond-related transactions over the last two decades primarily involved kimberlite deposits. According to Figure 5.1 approximately 53% of the transactions initially singled out for further analysis were associated with kimberlite deposits, while only 37% were related to alluvial deposits alone and 10% involved projects that had both kimberlite and alluvial resources.

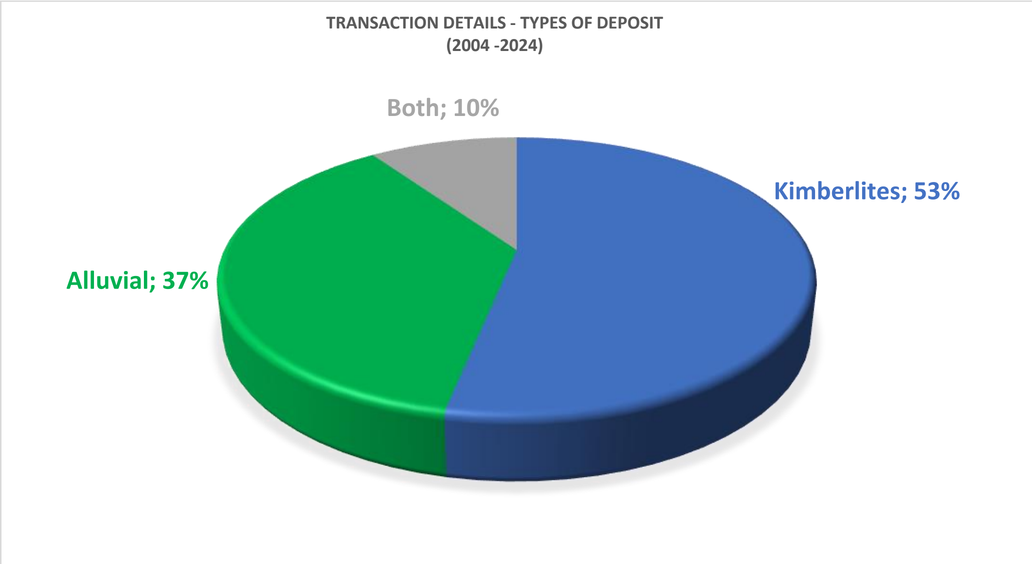

Figure 5.1 Number of kimberlite transactions vs alluvial diamond public transactions ((Snowden, 2016; Snowden, 2018; Venmyn, 2008a; Venmyn, 2008b) and personal communication)

During the search for comparable transactions, it also became evident that since 2008, there has been a decrease in the number of published valuations for early-stage alluvial diamonds. One possible explanation for this is that since kimberlite deposits tend to produce higher returns, they are more popular with larger, public companies currently prospecting for diamonds. By contrast, it is common for smaller private and/or junior companies, which are typically owners of alluvial diamond projects, to refrain from publishing valuations. In fact, many of these companies may not even rely on formal valuations to determine transaction costs.

The exact stage of development for a project

The exact stage of the project can also be a problem and is of high priority because without the stage of the project a valid comparison cannot be made. Publicly available data on transactions may provide limited or vague information about the precise development stage of the project. A project described as "advanced exploration" or "development" might include a wide range of conditions, from having initial Resource estimates to being close to production, leading to difficulties in drawing accurate comparisons. After careful consideration of the information regarding the development stage of the projects analysed, Figure 5.2 shows the number of transactions of alluvial deposits at different life-cycle stages.

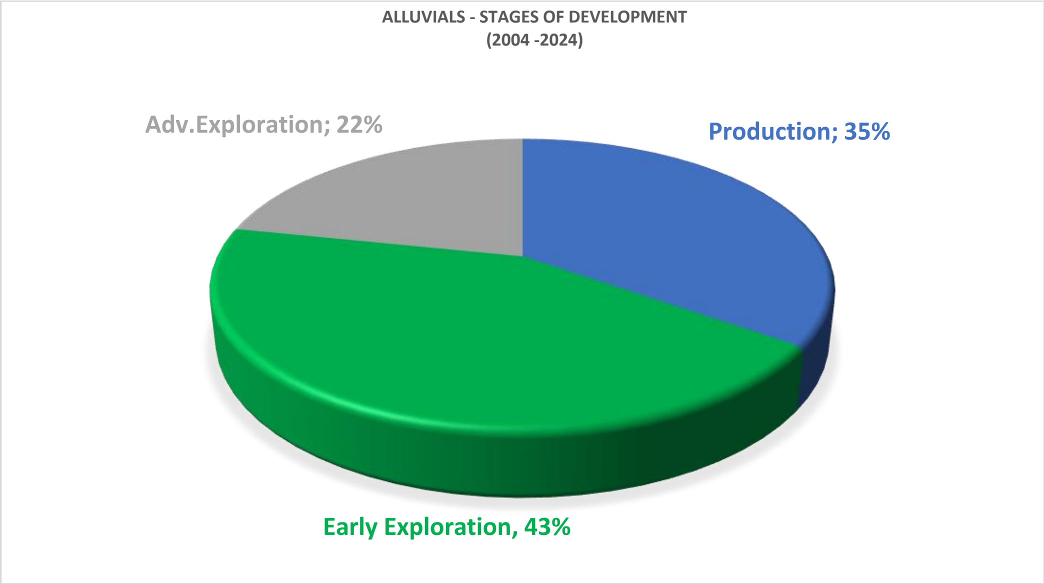

Figure 5.2 Number of Transactions of alluvial deposits at different life-cycle stages (Snowden, 2016; Snowden, 2018; Venmyn, 2008a; Venmyn, 2008b) and personal communication

Market Sentiment and Timing

The market's perception of risk and value changes depends on external factors such as commodity prices or geopolitical stability. Two projects at seemingly similar development stages might be valued differently depending on when the transactions occurred, reflecting changes in the market's risk appetite and expectations. Valuations of Angolan projects and operating mines conducted prior to 2008 may reflect low values due to the country's historical context of political instability and its status as a less desirable investment destination at the time. The reason for this is that Angola experienced an intermittent civil war that lasted for more than two decades (from 1975 to 2002), with peace only being declared in 2002. This prolonged period of conflict severely impacted the country's infrastructure, governance, and economic conditions, making it a high-risk environment for investment. Consequently, the valuations determined during this turbulent period and close to it are likely to be lower when compared to those conducted in more politically stable times. Therefore, comparisons of valuations across different periods must account for the distinct stages of political stability, recognising that the post-war era, presented a more stable and conducive environment for investment, which likely contributed to higher valuations.

5.1.5 Adjusting past values to present values

Two metrics used to convert past values to present values are the commodity price and the performance of the sector on the relevant stock exchange. However, it can also be problematic to use these metrics.

Commodity prices

Although alluvial projects risk being undervalued if the correct index is not used, adjusting past values to present values based on commodity prices was rated a medium priority impact due to the fact that the valuation exercise can still be conducted in its absence. As explained in section 4.4.2, commodity prices significantly influence adjusting past transaction values to present values. As a historical index of diamond prices, the RDPI is essential for comparing the values of past transactions to the potential value of the project being analysed. However, a problem arises from the fact that public available RDPI tables date back only to 2004. This limitation became particularly problematic in the research, given the scarcity of alluvial diamond transactions, which necessitates examining past transaction data from periods prior to 2004 to find transactions. This introducing a critical issue: commodity prices from before 2004 are not readily accessible. As a result, converting historical values to present-day values becomes a complex task.

An additional concern with using the RDPI relates to the diamond prices used in the index. Figure 5.3 shows the number of carats and the value of alluvial diamonds as a percentage of global production for the period 1870 to 2017 (Marshall, Ward, & de Wit, 2018) demonstrating that the ratio between global diamond production and relative value of alluvial vs kimberlite stones varies dramatically over time. This graph indicates that, in 2017, alluvial diamonds accounted for only some 30% of global diamond production and 20% of global value.

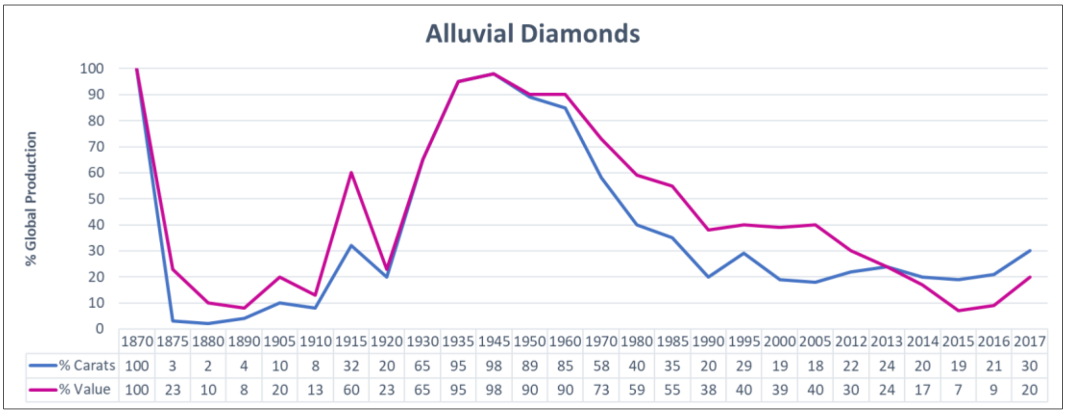

Figure 5.3 Contribution of alluvial diamonds to the Global diamond Production *(Marshall, Ward, & de Wit, 2018)*

Figure 5.4a and Figure 5.4b show Angola's diamond sales in the first five months of 2024. While significantly more diamonds were recovered from the kimberlites (Fig. 5a), it is readily apparent that the value of the diamonds from the alluvial deposits (Fig. 5b) is some 400-500% higher (kimberlite diamonds – 2,53 Million ct @ US$113.65/ct as against 0.51 Million ct @US$505.41/ct for alluvial diamonds).

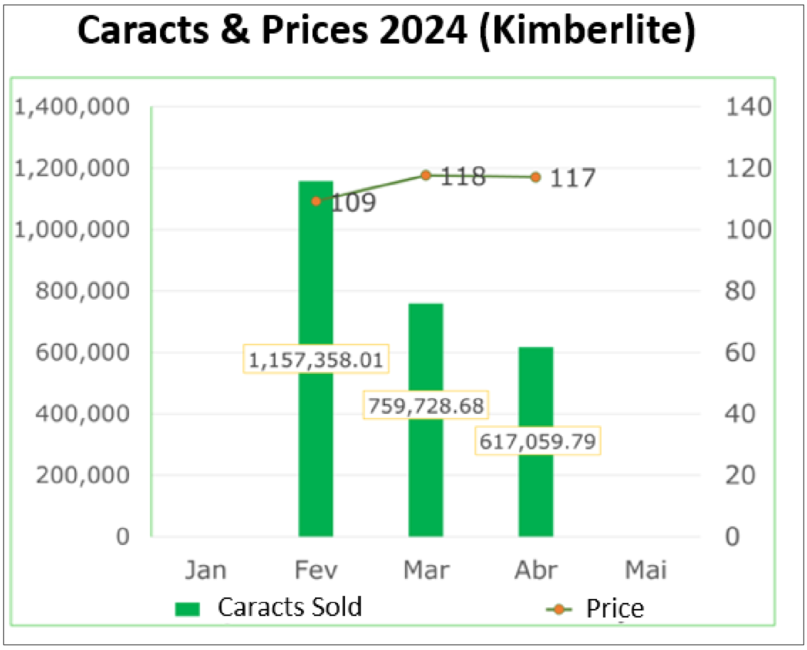

Figure 5.4a Prices derived from the sale of kimberlite diamonds *(Results of the Angolan diamond subsector, I semester's 2024, Lunda Norte, Angola,)*

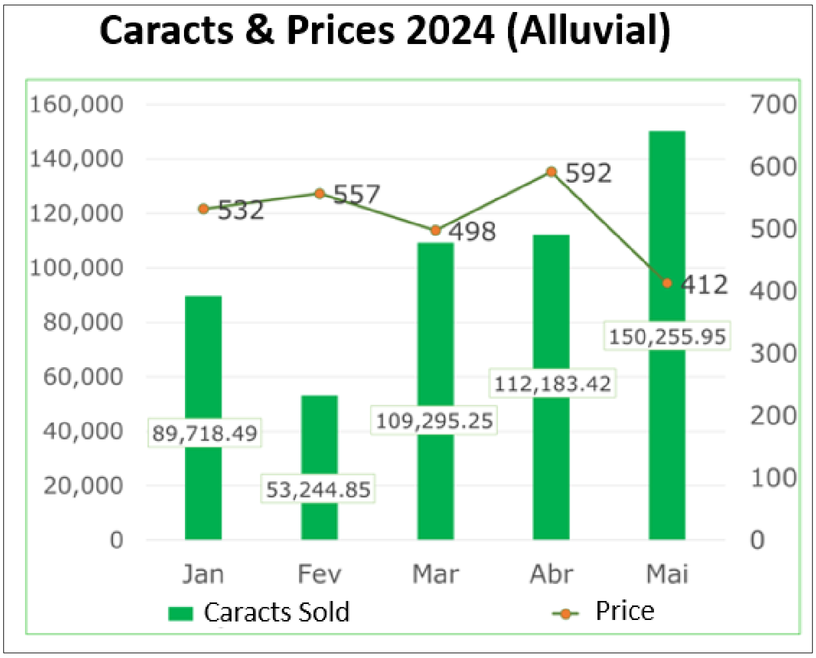

Figure 5.4b Prices derived from the sale of alluvial diamonds *(Results of the Angolan diamond subsector, I semester's 2024, Lunda Norte, Angola,)*

Figure 5.5 shows the 2024 top diamond-producing countries. Production from Russia, Botswana, Canada, Tanzania as well as much of South Africa and Zimbabwe is from kimberlite, resulting in a roughly 80:20 split by volume.

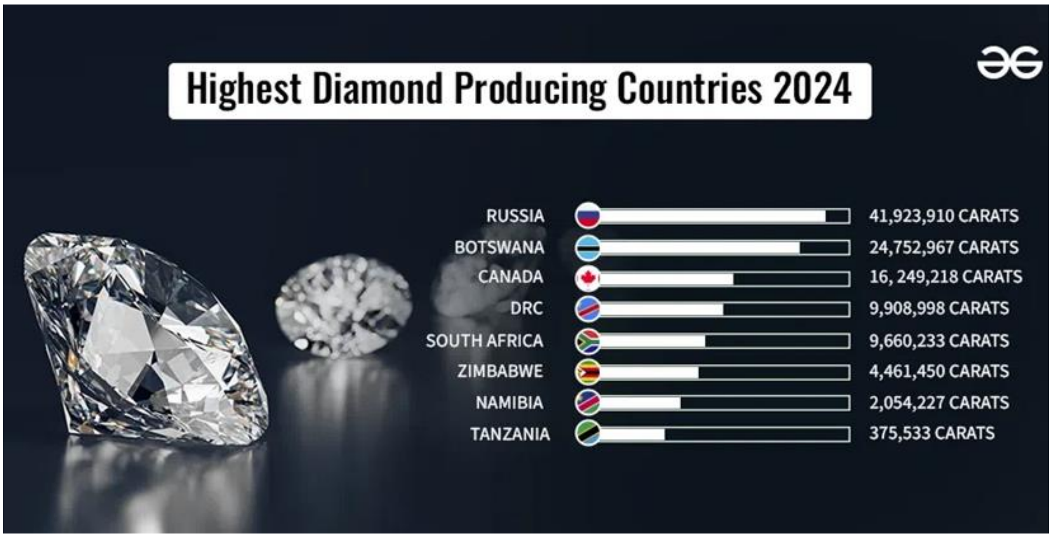

Figure 5.5 Highest Diamond Producing Countries 2024 (GeeksforGeeks, 2024)

So, considering that most of the world's production comes from kimberlites, the diamond prices as identified on the Zimnisky RDPI are heavily skewed towards values of diamonds derived from kimberlites. No publicly available diamond statistics are available which detail precise global kimberlite vs alluvial production figures, making it difficult to use simple diamond price correlations to compare diamond project valuations across different years.

Performance on the Stock Market

Another significant challenge in checking the performance of the diamond sector, particularly for alluvial diamond companies, is the difficulty of gathering Stock Market data. Unlike other commodities, it is not possible to use performance on a Stock Exchange because there is no exchange sector applicable to alluvial diamonds. Most alluvial diamond mining companies are not listed or are scattered across various exchanges. This lack of centralised market data complicates efforts to analyse and compare the performance of the sector. Since the performance of the alluvial sector on a Stock Exchange was not used, the impact of this challenge on the valuation exercise is null.

5.1.6 Other challenges

Code Compliance

The aforementioned PFS (see section 4.2.4) , undertaken by a company that aimed to establish a joint venture with ENDIAMA, appears to have relied on reports available from DIAMANG, additional results from the 1970s and work carried out by the company itself. However, the results of the 2004 PFS (refer to Table 4.2), classified the Resources and Reserves using terms that are not CRIRSCO code compliant. Using terms such as "Known Resources" and "Presumed Resources" indicates that the PFS is not CRIRSCO code compliant and raises doubts on whether it isn't merely a preliminary technical study rather than a PFS. In addition, such terms make the interpretation of previous results rather difficult, as it is a challenge to determine if "known" and "presumed" mean Inferred, Indicated or Measured Resources, or if they are simply some random or company standard terms. Thus, the aforementioned PFS was used as a historical reference when establishing the potential of the project. Code compliance can also be a concern when applying the Comparable Transactions Method, since it is often the case that transaction information lacks details such as the project stage and whether a resource estimate is compliant with recognised standards (e.g., JORC, NI 43-101). Code compliance was considered a medium priority concern since one can decide not to use the information or use it as historical reference.

Experience

Interpreting the price values of various projects presents a significant challenge for valuators lacking in-depth knowledge and experience and therefore it is crucial that valuators have experience. As illustrated in Figure 4.14 above, the disparity in project values can be substantial, with some projects being valued significantly higher or lower than others. Understanding these differences is crucial for accurate valuation. Without comprehensive knowledge and hands-on experience, it is difficult to discern the underlying factors influencing the values of each valuation. Experience gives valuators the capacity to contextualize data, recognize industry-specific details, and evaluate the impact of various risk factors and opportunities on project value. Therefore, a valuator’s depth of knowledge and practical experience are essential for interpreting the reasons behind certain project values being low while others are high. These insights enable a more informed understanding of the valuation outcomes.

In the MEE method experience is needed to compile an EEB because it requires experienced judgment to distinguish between past expenses that are thought to have added value to the property and those that do not, as well as to determine what a reasonable exploration programme is. When analysing the valuation outcomes of final results, the selection of the final preferred value is also a challenge. There is much uncertainty in an early-stage project and a range of final results must be given to account for this. In the MEE method it is possible to vary the adjusted EEB by considering a range that varies based on the level of confidence on the information. On the other hand, PEM values of high and low provide a range of results as well.

In the Market Approach, comparisons to different projects assists in obtaining a range of values. Although having a range is important, it also presents a problem in the sense that ranges from different methods may differ substantially. The investor might want to pay the lower value, and the owner might insist on charging the higher value. While a mean or a median value might solve a dispute, the selected final value need not be the median or mean values (generally not). Hence, experience on the part of the CV is needed to select a final range of values or to indicate a preferred value for the valuation exercise.

Valuation and Resource Estimation

The impact of Resource estimation was considered high because the valuation of mineral assets centres critically on the accuracy of Resource estimation and this is no different for early-stage alluvial deposit. Resource estimation involves assessing the quantity, quality, and distribution of the mineral deposit. One primary difficulty in ensuring accurate Resource estimation is the inherent variability and unpredictability of alluvial deposits (see section 2.2). If the Resource estimation is inaccurate, the project can be undervalued or overvalued because of the selection of the PEM value.

As discussed in section 2.2.1, for projects in their initial phase the Cost Approach is used. In this approach, different PEM values are attributed depending on several factors including Resource estimation. As shown in Table 2.3 if a project already has an Indicated Mineral Resource estimate, its PEM will be higher than that of a project that is in the Initial phase of a Mineral Resource estimation (4.0 - 5.0 > 3.0 - 4.0). The fundamental concern here is that any inaccuracies in the Resource estimation can affect the valuation outcomes since the PEM value is directly proportional to the Value of the project (refer to Equation 3 above). Similarly, the valuation outcomes can also be affected by choosing higher discount rates to account for mineral project risks, which includes resource estimation issues (refer to Table 4.6 above).

5.2 Chapter Summary

This chapter provided a detailed analysis and presentation of findings on the challenges associated with valuing early-stage alluvial deposits. It confirmed that valuing early-stage alluvial deposits has distinct challenges that need to be resolved to ensure accurate valuations. A discussion of the findings that address the research questions and objectives was made. The chapter also identified and explained the complications involved in valuing early-stage alluvial diamond resources by analysing the case study termed as Project A located in Angola. Although the case and its findings are specific to the Angolan environment, the principles revealed in this study can be applied to all early-stage alluvial diamond deposits, regardless of their location.

The research identified six groups of primary challenges to valuation of early-stage alluvial diamond deposits namely: data availability and accuracy, cost assumptions, discount rate, finding relevant comparable transactions, adjusting past values to present values, experience, resource estimation issues and code compliance. Some of these challenges are related to the MEE method and some are specific to the CT method, while others are common to both methods.

The challenges specific to the MEE method included data availability and accuracy issues, cost assumptions and discount rate. Issues with data availability included assessing information from previous work when the data is not properly stored and when it is distributed among different companies that were contracted to conduct work on the same property. Issues regarding data accuracy included the use of unaudited information and establishing an expiration date on past expenditures – specifically related to whether information from the colonial era in Angola could still be relevant.

Challenges around cost assumptions were related to re-costing the exploration activities using inflation or by re-costing the work to current prices. The latter can be time-consuming, but inflation is not always appropriate because the cost of exploration techniques does not necessarily increase in line with inflation due to technological advancements.

Determining a discount rate involves considering factors like location, political stability, infrastructure, and aligning risk expectations from both government and company perspectives. All the factors need to be considered to determine the discount rate and the influence of this discount rate on the final value of a project might not be what the stakeholders are hoping to see.

Table 5.1 shows the challenges related to the MEE method. It summarizes the suggested mitigations as well as the mitigations adopted during the valuation exercise and an impact prioritisation is recommended.

Table 5.1 Valuation Challenges, Mitigations and Impact Priority (related to the Multiples of Exploration Expenditure (MEE) method)

Method	Challenges	Mitigation	Impact Priority
MEE	Data availability and accuracy - *Assessing Information of previous work*	Proper archives which can be digital and physical. Clear agreements on data sharing if another company carries the exploration work. Robust data management from the outset of the project.	High
	Data availability and accuracy - *Unaudited information*	Engage geologists or industry experts to evaluate the plausibility of the data based on their knowledge of the region and its geological potential. Collect new samples or data in key locations to compare against historical records. Discrepancies can guide data validation efforts. Do a risk adjustment by applying a reduced quality factor and/or higher discount rate to valuations where data reliability is uncertain.	High
	Cost assumptions	Establish a cost database with specific categories for each activity (e.g., prospecting lines, excavator pitting, bulk sampling). Where historical costs are critical for valuation but not available (e.g., bulk sampling, drilling), consider re-costing these activities based on current market rates for labour, equipment, and materials or making adjustments for time and inflation.	High
	Discount rate	Carefully consider of various factors, including the project's location, political stability and infrastructure availability. Account for risk expectations and understand the perspectives at both government and company levels.	High
	Data availability and accuracy - *Expiration date on past expenditures data*	Categorize data by relevance and classify historical expenditures based on their age, type, and reliability to decide whether the data should be taken into account or not.	Medium

The challenges related to the CT method involved finding relevant comparable transactions, estimating current commodity prices and checking the performance of alluvial diamond properties on an applicable stock market. Finding comparable transactions was a challenge, especially for alluvial diamond companies. Most public diamond transactions in the past two decades have focused on kimberlite deposits, with fewer published valuations for early-stage alluvial diamonds. This is thought to be due to the predominance of kimberlite transactions and the tendency for smaller companies involved in alluvial projects to rarely publish information on the valuation of mineral assets.

Commodity prices were needed to adjust past transaction values to present values. Publicly available diamond prices are heavily skewed towards diamonds from kimberlite deposits, while the valuation of Project A required information regarding alluvial diamond prices.

Lastly, checking the performance of alluvial diamonds on a stock exchange was not possible. Unlike many other commodities, it is not possible to use performance on a Stock Exchange to convert past values to present values because there is simply no exchange sector applicable to alluvial diamonds.

Table 5.2 shows the challenges related to the CT method and the recommended impact prioritisation. It summarizes the suggested mitigations as well as the mitigations adopted during the valuation exercise.

Table 5.2 Valuation Challenges, Mitigations and Impact Priority (related to the Comparable Transactions (CT) method)

Method	Challenges	Mitigation	Impact Priority
CT	Finding relevant Comparable Transactions - *Exact stage of project*	Gather information about the projects used for comparisons by checking public sources and if possible, by personal communication. Careful consideration of the information regarding the development stage of the projects needs to be made.	High
		Exclude transactions from the Comparable Transactions Method if they lack clarity on project stage.	
	Adjusting past values to present values - *Commodity Prices*	As a historical index of diamond prices, the RDPI is essential for comparing the values of past transactions to the potential value of the project being analysed. However, it has limitations when adjustments are done on alluvial projects only. The CV should apply the principle of transparency and inform which Index is being used to adjust past values to present values as well as inform on the limitations of using the chosen index.	High
	Finding relevant Comparable Transactions - *Market Sentiment and Timing*	Comparisons of valuations across different periods must account for the distinct stages of commodity prices or/ and geopolitical stability. Two projects at seemingly similar development stages might be valued differently depending on when the transactions occurred, reflecting changes in the market's risk appetite and expectations	Medium
	Adjusting past values to present values - *Performance on the stock exchange*	Since no publicly available diamond statistics are available which detail precise global kimberlite vs alluvial production figures, one needs to initially rely on a historical Index such as the Rough Diamond Price Index to adjust past values to present values.	NA

The issues that are common to both methods (MEE and CT) are code compliance, experience and resource estimation. Code compliance was considered to be an issue related to the MEE method since reports related to the property contained terminology that is not used in any of the CRIRSCO codes. Thus, interpreting crucial information that could assist in determining the potential of the property in terms of Resource estimation became a difficult task. For the CT method, relevant transactions lack information on whether the Resource estimate is compliant with recognised standards (e.g., JORC, NI 43-101) and valuators have to rely on knowledge, further research and experience to analyse the value of the transactions.

Without practical experience, it is challenging to understand the drivers of valuation values. Experience allows valuators to contextualize data, recognize industry specifics, and assess risks and opportunities. Therefore, a CV's experience is crucial for determining a final value range or preferred value in a valuation. Resource estimation involves evaluating the quantity, quality, and distribution of the mineral deposit. However, due to the inherent variability and unpredictability of alluvial deposits, achieving accurate Resource estimation can be difficult. Inaccuracies in this estimation can lead to the project being either undervalued or overvalued.

Table 5.3 shows the difficulties associated with both methods and an impact prioritisation is advised. It provides an overview of the mitigations used during the valuation process.

Table 5.3 Valuation Challenges, Mitigations and Impact Priority (related to the Multiples of Exploration Expenditure (MEE) and Comparable Transactions (CT) methods)

Method	Challenges	Mitigation	Impact Priority
CT,MEE	*Experience*	Have experienced valuators for interpreting the price values of various projects, contextualize data, recognize industry-specific details, and evaluate the impact of various risk factors and opportunities on project value.	High
	Resource Estimation Issues	Attribute PEM values depending on several factors including Resource estimation. As shown in Table 2.3 if a project already has an Indicated Mineral Resource estimate, its PEM will be higher than that of a project that is in the Initial phase of a Mineral Resource estimation (4.0 - 5.0 > 3.0 - 4.0). In the process of identifying its mineral resources and, to account for mineral project risks, one can chose a higher discount rate.	Medium
	Code Compliance	Highlight the limitations and uncertainties associated with non-compliant classifications in technical and valuation reports. One can treat non-compliant data as a historical reference material rather than a direct input for Resource estimation.	Medium

The analysis highlighted how some of these challenges impact the accuracy, consistency, and interpretation of the results. By examining these issues, this chapter aimed to contribute to a better understanding of the valuation process in the context of early-stage alluvial diamond deposits in general, and in Angola specifically.

6 CONCLUSIONS AND RECOMMENDATIONS

Diamond mining forms a fundamentally important part of the economy of many countries. In 2023, as the fourth-largest global producer of diamonds by value and the second-largest producer by volume in Africa, Angola held a significant position in the diamond industry. The country has both primary (kimberlite) and secondary (alluvial deposits) producing mines as well as alluvial diamond properties in early-stage exploration.

Early-stage properties are of interest to investors, as they provide an opportunity to get into a potentially lucrative project at relatively little cost. Given the appeal of these deposits for investments and joint ventures, parties often seek valuations to make informed decisions. However, valuing early-stage alluvial diamond properties poses challenges due to their distinct characteristics as compared to later stage deposits where DCF methods are commonplace.

Angola has 28 early-stage alluvial diamond properties which are currently in different stages of prospecting. As these projects progress through the exploration programme, some of them will require additional investment. As a result, reliable valuations of these properties are required so that all current and potential stakeholders can make informed decisions regarding their future investments.

Three fundamental issues associated with this topic were addressed in this research, namely, identifying the key challenges of valuing early-stage alluvial diamond deposits; illustrating these challenges by presenting a case study; and proposing possible solutions for the challenges.

6.1 Summary of Chapters

This report is comprised of six chapters. Chapter 1 served as the introduction and outlined the core problem. Angola is a significant producer of diamonds and has 28 early-stage alluvial diamond properties being explored. As these projects advance, some will require additional investment. To facilitate informed decision-making by current and potential stakeholders, reliable valuations of these properties are essential. The primary research question is whether the difficulties related to the valuation of secondary diamond deposits at early stages can be identified and assessed.

Chapter 2 provided an in-depth literature review on mineral asset valuation, focusing on the definition and the various valuation approaches and methods typically used at different stages of project development. The chapter also explores the internationally recognised codes. Each valuation approach was examined, highlighting not only the methods within them but also the formulas, their applicability, and relevance. Particular attention was given to the valuation approaches and methods most appropriate to early-stage projects.

The Cost Approach and the Market Approach were identified as particularly suitable for such projects. A mineral asset valuation model with six steps was briefly described to assist with the data collection and the valuation exercise in subsequent the chapters (chapter 3 and chapter 4). In addition, the literature review discussed the specific challenges and obstacles associated with valuing early-stage alluvial diamond properties. It highlighted key discussions and disputes in the field, including those that are particularly relevant to the Angolan context. The key discussions emphasized the difficulties involved in the valuation of early-stage alluvial properties.

Chapter 3 outlined the research approach for the case study, detailing the methodology, design, and data collection process. The chapter described the design of the study, specifying how the research was structured to achieve its objectives. The data collection process was then elaborated upon, providing information on how the data was gathered, which data is associated with the Cost Approach (MEE method) and which data is associated with the Market Approach (Comparable Transactions method). Following data collection, the chapter discussed data validation to ensure its reliability and accuracy. Finally, the approaches for analysing the collected data and deriving results were covered so that a valuation exercise could be completed.

Chapter 4 focused on a valuation exercise using Project A as a case study to assist in the identification of difficulties that emerge when valuing early-stage projects, particularly within the Angolan context. The exercise centred on an alluvial exploration property located in Lunda Norte province, and which is adjacent to active alluvial diamond mines. The valuation was conducted in accordance with the SAMVAL Code. The chapter includes comprehensive information on Project A's location, geology, general infrastructure, potential prospectivity and economic potential.

The two primary valuation methods identified in Chapter 2 were applied. MEE method (Cost Approach) and the Comparable Transaction method (Market Approach). The MEE method was used due to the availability of past and future exploration expenditures. Past expenditures were adjusted to the valuation date using the inflation rate, resulting in an EEB of US$27.4 Million. To account for prospectivity, risks and data that was not well documented, a PEM, a Discount Rate and a Quality Factor were applied. After applying these factors, an estimated value range for the project was estimated as being between US$31.7 Million and US$39.7 Million. By applying a variation of +/-20% to account for moderate uncertainties to the EEB value, the range was adjusted to between US$21.9 Million and US$32.9 Million, with a mean value of US$27.4 Million as of June 1, 2024.

In the Comparable Transaction method, comparable projects were adjusted for inflation and commodity prices, and outliers were removed. The mean value derived from this approach was US$26 Million, with a range from US$9.3 Million to US$36.4 Million. The chapter concluded with a comparison of the results from both valuation approaches. The final value for Project A, calculated at US$31.6 Million, fell within a range of US$21 Million to US$36.4 Million. The chapter noted that while the mean value provides a useful estimate, it is not necessarily the most appropriate value. Selecting a preferred value within the identified range requires professional judgment and experience and highlighted the complexities and variability in valuation outcomes.

Chapter 5 provided a detailed analysis and presentation of findings, mitigations and impact prioritization on the challenges associated with valuing early-stage alluvial deposits. The research identified several key obstacles. These obstacles were grouped into challenges related to data reliability and availability, costs, code compliance, availability of comparable transactions, commodity prices, and other relevant factors. Each of these factors presented unique challenges that complicated the valuation process. The analysis highlighted the specific ways in which these challenges impacted the accuracy, consistency, and the valuation exercise. For example, the lack of reliable data can lead to significant uncertainties and a quality factor had to be used, while issues with code compliance and the scarcity of comparable transactions made it difficult to establish values. Commodity price fluctuations added another layer of complexity, as they can drastically alter the perceived value of a project over time. Additionally, other challenges, such as adjusting past values to present values and accounting for various risk factors, further complicated the valuation process. The observations made in Chapter 5 contribute to a better understanding of the valuation process for early-stage alluvial diamond deposits. The insights provided in this chapter emphasized the need for careful consideration of these challenges to achieve more accurate and reliable valuations.

Chapter 6 outlines the conclusions of the research. The chapter is subdivided into research observations, contributions, limitations, followed by recommendations for future research and the conclusion. The research observations section synthesizes the main insights gained from the research. It highlights the distinct challenges faced when valuing early-stage alluvial diamond deposits. The recommendations aim at improving the accuracy and reliability of early-stage alluvial deposit valuations. They include suggestions for enhancing data collection, validation processes and developing more consistent methods for adjusting past values.

The chapter also details the contributions this research can make to the field of early-stage alluvial diamond deposit valuation. However, the chapter acknowledges the limitations of the study, including the context-specific nature of the findings and the potential for variability in other geographic or economic settings. These limitations suggest areas for further research and the need for caution when generalising the results. The conclusions emphasize the importance of reliable and accurate data and call for action in the sense that valuators need to take cognisance of these challenges to avoid pitfalls and provide more accurate and meaningful valuations.

6.2 Research Observations

Despite numerous challenges, the valuation of early-stage alluvial deposits is an achievable task. Reasonable and realistic valuations can be compiled if the CV is aware of the potential challenges and the impacts they can have on the results. The reliability of a valuation is dependent on the accuracy of the underlying Diamond Resource estimate which involves assessing the quantity, quality, and distribution of diamonds in-situ – highlighting the importance of CRIRSCO codes, combined with knowledge, education and experience. However, early-stage projects generally do not have identified Diamond Resources. As a result, valuations on such projects are inherently imprecise.

In addition, experience is essential for a CV. They need to be able to select and apply the most appropriate valuation approaches and methods correctly. In the CT method they need to be able to interpret why certain past transaction values are low or high, enabling a more informed understanding of the valuation outcomes.

Valuations methods such as the MEE and Comparable Transactions are, typically, used for early-stage projects. The usage of the MEE requires significant experience to distinguish between past expenditures that add value to the property and those that do not. Experience is also required to determine a PEM value and determine applicable productive warranted future costs.

Similarly, application of the Comparable Transactions also has specific conditions. One such requirements is to convert past values to present values by using commodity prices and/or performance on a Stock Exchange. With respect to diamond commodity prices, Zimnisky's RDPI is one of the standards most consulted. However, most of the world's diamond production comes from kimberlite sources. As a result, the RDPI is skewed towards values of diamonds from kimberlites. This distorted average value can affect the final valuation outcome when the RDPI is used for alluvial deposits. The lack of publicly available diamond statistics that detail precise global production figures for kimberlite versus alluvial sources further complicates this issue. Consequently, using simple diamond price correlations to compare diamond project valuations across different years is challenging and can lead to inaccuracies, particularly when applying these metrics to alluvial diamond projects.

The absence of a specialised alluvial diamond sector on any Stock Exchange means that available data might be fragmented or inconsistent, making it challenging to obtain a clear and accurate picture of market trends. The fact that many alluvial diamond projects are unlisted further complicates this issue, as these projects do not regularly report financial and operational data in a manner that can be easily accessed or verified.

Although the issues above posed challenges, it was still possible to use the MEE and Comparable Transactions to value Project A. In doing so, various uncertainties and complexities were identified. Such challenges included assessing information of previous exploration work, unaudited information, finding comparable transactions, choosing a discount rate and interpreting past reports that were not compliant with any CRIRSCO code.

When analysing the past exploration work of Project A, it was noticeable that terms non-compliant with CRIRSCO codes such as "*Known Resources*" and "*Presumed Resources*" were used. This complicated the interpretation of previous results, since it was difficult to ascertain if these terms corresponded to Inferred, Indicated, or Measured Resources, or whether there was any correlation at all.

Project A also had a substantial workforce. Typical projects in a similar phase across South Africa or other global locations generally maintain a workforce ranging from 40 to 60 individuals. However, Project A employed approximately 140 people. This could be related to Angola's history which included hiring for strategic social reasons, as opposed to purely economic necessity. Additionally, Project A had equipment listed, that required repairs, and the acquisition of second-hand equipment from other projects that needed to be assembled. (See Appendix A, Table A.3) Thus, while the valuation may be accurate based on the provided data, it may not fully reflect the actual reality.

6.2.1 Key findings

Valuation of early-stage projects in general, and early-stage alluvial diamond projects in particular, is not a simple task. Associated difficulties in Angola (and many other countries) can be related to the fact that most early-stage alluvial diamond projects are operated by junior non-listed companies that rarely disclose transaction details publicly.

While the Cost and Market valuation approaches are the most applicable for early-stage projects and they are the most widely used, the results from these approaches may not always be what project owners or government administrators are looking for. All valuation methods that deal with early-stage exploration projects in general, and alluvial diamond projects specifically, provide a range of values, with a preferred value selected by the experience of the CV (and not through a statistical estimation process). Most companies involved in mineral asset transactions as well as government administrators would prefer to see just a single value that has a high confidence (such as provided by a DCF method). This is never going to be the case for early-stage exploration properties since an accurate and realistic valuation requires information that is generally not readily available at this stage.

A key finding associated with the MEE method is that it necessitates a certain level of experience and understanding for effective utilisation. This is due to the requirement for critical decisions to be made regarding several factors, including the selection of a PEM value, the determination of an appropriate discount rate, the applicable costs for an EEB and the estimation of applicable productive warranted future costs. The complexity and importance of these decisions underline the need for experienced valuators to ensure accurate and reliable outcomes.

A key finding associated with the Comparable Transaction method is that identifying truly comparable projects in the valuation of early-stage alluvial deposits is a complex and challenging process. The inherent variability in geological characteristics, project scales, and regional economic conditions means that no two projects are perfectly alike. Consequently, valuators must exercise considerable judgment in selecting comparable transactions and be prepared to make the necessary adjustments. These adjustments account for differences in project size, prospecting stage, regulatory environments, and market conditions. Without such modifications, the valuation outcomes may not accurately reflect the unique attributes and potential of the project under consideration. Therefore, while identifying comparable transactions is an essential step in the valuation process, it is equally crucial to apply rigorous and insightful adjustments to ensure the final valuation is as accurate and reliable as possible. In the Market Approach in practice, the selected value out of a range or any conclusion drawn necessitates the implicit judgment of the CV.

6.2.2 Recommendations

Based on the observations and identified challenges several recommendations can be made. Whilst these are specifically linked to the Angolan situation, the same principles are applicable for all early-stage alluvial diamond projects, in fact, to early-stage projects in general.

Whenever possible, if a project is owned through a joint venture, an agreement should be made for the information to be shared amongst the owners. Clear agreements related to data sharing and proper documentation and archiving practices are essential for ensuring that valuable data can be retrieved when needed. Without such practices, the information may become sterile, leading to significant gaps in data that can hinder further exploration, development efforts and valuation efforts.

Addressing the problems of unaudited data involves doing risk adjustments and implementing rigorous verification processes to assess its reliability. These may include applying a quality factor and further prospecting to confirm historical findings and employing relevant statistical methods to assess the reliability of the data. Additionally, improving historical data archiving practices can mitigate these issues in the future, ensuring that critical information is both accessible and reliable.

Managing the expiration dates of past expenditures and determining their relevance in the determination of the area’s potential in valuation of early exploration projects, particularly in contexts like Angola's alluvial deposits, requires a nuanced approach. One strategy to address this challenge is to categorize data by relevance by developing a system to classify historical expenditures into tiers based on their age, type, and reliability. For example:

- Tier 1: Data < 5 years old, directly usable.

- Tier 2: Data > 5 years old but with high historical relevance (e.g., DIAMANG maps and grades).
- Tier 3**:** Data > 5 years old requiring significant validation (e.g., unaudited drilling logs).

To address the complications related to costs, meticulous attention to detail is required when compiling and verifying cost data. Experience is needed to establish clear guidelines and consistent methodologies for recording and categorizing expenses and thus prevent duplication or including irrelevant costs. Additionally, developing a standardised cost-tracking system for early-stage projects can improve the documentation of individual activities, facilitating the establishment of a reliable cost base which in turn could be used for a more precise and reliable valuation process.

Adjusting historical expenses based simply on inflation may not be entirely suitable. Technological improvements often lead to more efficient and cost-effective methods, which means that the actual cost increases of specific exploration activities may lag overall inflation rates. Consequently, it is not advisable to rely on inflation only. Thus, whenever possible, re-costing should be applied.

To determine an appropriate discount rate requires careful consideration of several factors to ensure it accurately reflects the project's risk profile. Factors to be considered include: project location, country-specific risks and. stakeholder perspectives (government and company). It is also important to communicate all the rationale for the selected discount rate.

As a historical index of diamond prices, the RDPI is essential for comparing the values of past transactions to the potential value of the project being analysed. However, it has limitations when adjustments are done on alluvial projects only. The CV should apply the principle of Transparency and inform which Index is being used to adjust past values to present values as well as inform on the limitations of using the chosen index.

The CV should also gather information about projects that will be used for comparisons when using the CT method. The information about the chosen comparable transaction must include details such as the stage of development of the chosen projects and location. An experienced CV will analyse this information to decide which transactions to use in the CT method.

Whenever possible, have experienced valuators for interpreting price values of various projects, contextualize data, recognize industry-specific details, and evaluate the impact of various risk factors and opportunities on project value.

Despite the difficulties inherent to valuing early-stage alluvial deposits, it is possible to estimate valuation ranges for early-stage alluvial projects using a suitable approach and appropriate expertise. The case study of Project A points out the impacts of uncertainties and complexities. Ultimately, with diligent application of the recommendations, the valuation process can provide more accurate and meaningful insights, thereby supporting informed investment and development decisions in the exploration and mining industry.

6.3 Research Contributions

The research contributes to a better understanding of the challenges involved in valuing alluvial early-stage diamond properties. The conclusions and recommendations of this research can assist both valuators of such projects and State administrators by highlighting the fact that valuations of early-stage alluvial projects are not simple exercises due the nature of the information required. It contributes to the appreciation that such valuations cannot simply be done using DCF models that are more appropriate for advanced, development and production projects.

The research further contributes to the existing body of knowledge by highlighting the challenges that professionals will encounter when attempting to value early-stage alluvial diamond projects. Familiarising themselves with such challenges and the recommendations made here will help valuators to avoid some pitfalls and be more aware of the limitations of their results.

6.4 Research Limitations

This research specifically addresses the challenges involved in valuing early-stage alluvial projects, and it is important to note that these challenges may differ from those encountered with kimberlite deposits, which may have similar or their own unique complications. Additionally, the case study focused on the Angolan context, and therefore, some of the identified problems may not occur in other countries or jurisdictions, where different legal, economic, and environmental factors could lead to different outcomes.

Due to the nature of the Angolan case study, accessing well-documented data for the early-stage alluvial project was challenging, and the findings were based on a single case study only. Including multiple case studies from different regions might have provided additional insights or could potentially have altered the key findings of this research.

Additionally, when addressing the challenge of converting past values to present, inflation was used as one of the adjustment factors. However, for the CT method, it may have been more appropriate to adjust solely based on commodity prices. The application of commodity prices, however, was not truly valid due to the paucity of information related to the prices of alluvial diamonds.

6.5 Recommendations for Future Research

Several recommendations for future research are proposed to address the limitations identified above. As alluvial diamond transactions are thought to become more important to the future economies of Angola and other Central and West African countries, it is expected that a better understanding of how these projects can be valued will be of use to CVs, company owners, potential investors and government administrators alike.

This research highlighted the fact that publicly available information, which is often used in the Market Approach valuations, primarily reflects prices for kimberlite diamonds due to their dominance in global production. To address this gap, future research should focus on developing a price database specifically for alluvial diamonds. This research might include examining variables such as distances from primary kimberlite sources and other relevant factors that influence the value of alluvial diamonds.

An additional challenge of converting past values to present values involved the applicability of inflation as a metric. Future research might explore more effective methods for adjusting past valuation values to current values. This includes investigating alternatives to inflation and commodity prices; the latter being often skewed towards kimberlite diamonds. Developing a tailored approach for alluvial diamonds could provide a more accurate and practical solution for addressing this issue.

Since this research used an Angolan case study to explore the valuation of early-stage alluvial projects, further research could benefit from including case studies from diverse geographic regions to assess how factors like the discount rate impact the valuation of alluvial projects in different countries. Additionally, it would be valuable to investigate whether challenges such as data availability, accuracy, code compliance, and finding comparable transactions are consistent across various locations.

The current study relied on the MEE and the CT method. Further research might examine some of the other valuation methods associated with Cost and Market Approaches for suitability to early-stage alluvial diamond projects and whether these methods yield similar or different results. A comparison can then be made between the results obtained with the other methods and the results of the MEE and CT methods.

For the CT method, the research showed that Market sentiment and timing affect values. The prices of transactions listed in easily accessible databases reflect the amounts that were paid, rather than the independent valuations provided by the CVs involved. These recorded prices are not only often influenced by market sentiment but also by strategic factors. Therefore, it would be ideal to consider the original valuation reports instead of the transaction prices. Hence, additional research can assist in determining if there are significant discrepancies between the values given by the CVs and the actual prices paid.

6.6 In Conclusion

Valuation of early-stage alluvial deposits, as demonstrated through the Angolan case study, is a complex and multifaceted challenge that demands a deep understanding of the inherent uncertainties. The research recognises that accurate valuations depend on addressing issues such as access to reliable information, finding comparable transactions and experience. The valuation of early-stage alluvial deposits, with its many challenges, should prompt CVs to reconsider how they approach these complex assessments. Therefore, this research calls for a collective effort to innovate and refine the tools and practices used in this field. Moving forward, the real question is: How can we better equip valuators to navigate these challenges and provide more accurate and meaningful valuations? By shedding light on these challenges, this research has provided vital insights for both valuators and State administrators, contributing significantly to the field and guiding more informed decision-making in the valuation of early-stage alluvial diamond projects.

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A. APPENDIX A. PROJECT A´s Information

Table A.1 2022 and 2023 Bulk Sampling Volumes

Year	Type of Deposit	Sample Volume (m³)
2022	Leziria	1 676,00
	Terrace	1 600,00
	Terrace	845,00
Subtotal		**4 121,00**
2023	Calonda Formation	670,00
	Terrace	2 419,00
	Leziria	2 080,00
	Leziria	2 340,00
	Leziria	2 370,00
	Leziria	2 882,00
	Leziria	720,00
	Leziria	4 667,00
Subtotal		**18 148,00**
TOTAL		**22 269,00**

Table A.2 Thickness of gravel and overburden obtained from bulk sampling

Samples	Type of Deposit	Overburden Thickness (m)	Gravel Thickness (m)
Test (T1)	Terrace	2,4	0,9
Test (T2)	Terrace	2	0,9
LZ01 (T3)	Leziria	2,5	0,6
LZ02	Leziria	2	0,9
Test (T4)	Calonda Formation	15	0,5
Test (T5)	Terrace	2,2	0,4
Test (T6)	Terrace	2,6	1,3
Total		**4,1**	**0,8**

Table A.3 Equipment available at the project on 5/09/23

Type of Equipment	Quantity	Condition
Bulldozer D8 - Liebbbherr - PR765	1	Operational
Excavator - Liebbbherr -R956	1	Operational
Motor Grader GLS	1	Operational
Excavator - Komatsu -PC 850	2	To be Assembled
Bulldozer D8 - Komatsu - 155A	1	Operational
Excavator- Komatsu - PC 500	1	Operational
Dump Truck	2	One on breakdown and 1Operational
Dump Truck SHACMAN	1	Operational
Articulated Dump Truck A45G-Volvo	1	Operational
Pre-treatment Plant MB70	1	Operational
Prospecting Plant	1	Operational
Pre-treatment Plant MB200	1	To be assembled
Total	**14**	