

## **Annexure 1: Grant Application Form**

<b>Section 1 – Applicant’s Details</b>		
Title of the Project: <b>Slope Stability Risk Management in Open Pit Mines: A Hazard Zonation Investigation Along Jwaneng Mine CUT-8 Haul Roads</b>		
<b><u>Name of Applicants</u></b> <b>RAHUL VERMA</b>		
<b><u>Group:</u></b> Department of Mining & Geological Engineering/Civil Engineering		
1. Principal Investigator: <b>RAHUL VERMA</b>		
Name of institution (or affiliated to): BIUST (Botswanan International University of Science & Technology)		
1.2 Postal Address: <b>PRIVATE BAG.16, PALAPYE,BOTSWANA</b>		
1.3 Cell number: <b>74118012/73148542</b>		
1.4 Email: <b>vermar@biust.ac.bw</b>		
1.5 Age <b>56</b>	1.6 Sex <b>Male</b>	1.7 Nationality: <b>Indian</b>
1.8 ID Number: <b>Z 6340191</b> (Passport)		
1.9 Qualifications (PI): <b>B.Sc.; M. Sc. ;Ph.D., CDM (Certificate in Disaster Management)</b>		
<b><u>Section 2 – Project Details</u></b>		
2.1	Expected Commencement Date: <b>01.04.2023</b>	
2.2	Expected Completion Date: <b>31.03.2025</b>	
2.3	Project Title: <b>Slope Stability Risk Management in Open Pit Mines: A Hazard Zonation Investigation Along Jwaneng Mine CUT-8 Haul Roads</b>	
2.4	<b><u>Detailed Description of the Technology or Innovation</u></b>	

- Rockfalls present a major safety hazard in open pit mining, predominantly in large scale deep pits. Generally, slopes of an open pit mine are excavated to the steepest angle possible. Steeper slope angles are economic; however, they result in an increased risk of slope failure in combination with other causative factors. Geotechnical zoning allows accurate risk prediction for potential loss of stability elements at different stages of the pit development.
- The failure of these slopes is a result of factors such as **slope geometry (angle & height), type of lithology, geological discontinuities, seismicity**, etc.
- Evaluation of the stability of excavated slopes is a vital component of any open pit mine and for smooth operations.

## **2.5 Potential impact of the proposed project:**

- Hazard Zonation (HZ) mapping involves the **discrimination** of areas of varying hazard levels based on degrees of actual or potential damage. Hence, the findings of the current project, will facilitate safe mining and thereby enhance the economic productivity of the mine.
- It will help in minimizing the number of casualties though the sudden rock fall/ wall collapse.
- It will serve as the tool for better risk management.
- It will pave way for the further development model.

## **2.6 Proposed Project Activities:**

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- Literature review – on the study area and work that has been done on the topic
- Data Collection
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- A} FIELD DATA COMPONENTS
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- Generation of structural profiles (geological and geomorphic) Satellite imagery
- Generation of Steronet maps (manual and software based)
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### ***Field Studies:***

- 1. Collection of attitude data on primary discontinuities
- (Dip/strike of the bedding planes)

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- 2. Collection of attitude data on secondary discontinuities (faults, joints, fractures etc.)
  - (Spacing, waviness, nature of infillings – specific to joints)
- 3. Collection of data base of the instability causative factors
  - (natural/human)
- Collection of representative samples (Oriented)
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- Laboratory Studies:
  - Collection of mechanical properties of rock units.
  - 
  - Analyses of representative samples (Physicomechanical/ Geochemical)
  -
- B) GIS COMPONENTS
  - Digitization
  - Generation of Thematic Layers

**Interpretation of Data:**

- Determine the major causative factors
- Generation of Hazard Zonation Map
- Kinematic analysis using Rocscience software.
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**2.7 Expected Outputs of the project:**

A **hazard zonation map** will be created by digitizing the data collected into layers using the **weighted overlay** tool on ArcGIS software of all the parameters with each layer assigned their due weightage.

**Summary of outcome**

- Demarcated regions and areas of potential slope failure within the mining areas.
- Determined Slope Stability Index from 'suitable hazard zonation techniques such as (Bureau Indian Standard 1998 , Mine Slope Instability Index 2013 and Slope Mass Rating (SMR) and Falling Rock Hazard Index (FRHI)
- Detailed "kinematic analysis" on high hazard level areas.
- Determined relationship for causative dominant parameter and slope instability.
- Determined hazard zonation technique validity by comparing the slope behaviour in reality versus predicted behaviour.

**2.8 Describe the commercialisation potential of the technology/innovation:**

The mine authorities can use the findings of the current research in the following manner:

- a) Designing a safer sequence excavation plan.
- b) Managing the hazardous patches.
- c) Apply the safety model to further mining activities.

2.9 Proposed Budget (**Please attach a detailed itemised budget**)

2.10 Have you received a grant from other sources for this project?

Yes / **No**

If yes, please complete the following:

Date Amount

Funding Agency

***(Please supply supporting documentation)***

2.11 Innovators/Technologists

- i. **Rahul Verma**
- ii. **Jerome A.Yendaw**
- iii. **Gabatsoswe Lebitsa**

2.12 Location of the proposed project (i.e., *Location of operation/performance site*)

***Debswana Diamond Mine, Jwaneng, Botswana***

**Declaration of applicant**

1. I/We **Rahul Verma** do attest that the information given in this application form is true.

*(False disclosure will render the application void)*



(Signature)

29.08.2022

(Date)

The completed application form together with a Covering Letter, Technology/Innovation Brief and any required supporting Documents should be submitted to:

The Director  
Department of Research, Science and Technology  
Plot 54357, Varsha House  
Central Business District  
Private Bag BR279  
Gaborone

Phone: +267 396 0221

E-mail: [drstbots@gov.bw](mailto:drstbots@gov.bw)

## **Annexure-2 : Budget**

<b>ITEM</b>	<b>ESTIMATED COST (BWP)</b>
<b>6.1 Assistance (specify)</b> a) Daily wages for labour hire b) Protective gears for the PI, Co PI and labors	<b>20000</b>
<b>6.2 Consumables (specify)</b> a) Purchase of High Precision GPS b) Purchase of high-resolution camera c) Purchase of a state of art clinometer compass	<b>50000</b>
<b>6.3 Purchase of GIS related stuff (specify)</b> a) ArcGIS software b) Satellite Imageries of specific resolution	<b>50000</b>
<b>6.4 Sample Analysis (specify)</b> a) Cost of Physicomechanical Analyses b) Cost of Geochemical Analyses c) Cost of other tests required	<b>40000</b>
<b>6.5 Travelling Expenses (specify)</b> a) Cab hire for field work (Several times during the project duration)	<b>80000</b>
<b>6.6 Subsistence (specify)</b> b) Cost of hotel accommodation for PI, & Co PI c) Cost of fooding for PI, Co PI	<b>80000</b>
<b>6.7 Printing (specify)</b> d) Purchase of Printer e) Purchase of Scanner f) Purchase of Copier g) Blank Papers (rolls)	<b>40000</b>
<b>6.8 Other (specify)</b> h) Tracing Papers i) Other Stationery j) Medical Aid k) Procurement of specialized maps and topographic sheets l) Miscellaneous	<b>10000</b>
<b>TOTAL</b>	<b>350000</b>

### **Annexure-3: Summary of Team Profile**

The team of the Innovators/Technologists for the current project, consist of three members. The summary of the team members in order is as under:

#### **1- DR. RAHUL VERMA (Principal Investigator)**

Dr.Rahul has an overall teaching and research experience of 30 years in different capacities. In addition, the PI has a professional experience of 4 years as an “Exploration Geologist”.

He has successfully completed two major research projects on the Slope Stability Problem and Landslide Hazard Zonation Zone. The first project was sponsored by the University Grants Commission (UGC) , Government of India and the second was funded by Department of Science and Technology (DST), Government of India.

Dr.Rahul has supervised/supervising 2 Ph.D., 7 Master’s and 35 Undergraduate students.

Under the category of research activity, Dr.Rahul has published 27 refereed journal papers, 12 reviewed book chapters. Furthermore, the PI has presented his research findings in 60 national/international level conferences. Many keynote addresses, lectures as resource person and session Chairs are also credited to his achievements.

Two organizations of India have conferred him the award of excellence in science.

#### **2- DR. JEROME A YENDAW ( Co Principal Investigator-1)**

Dr. Jerome has an overall teaching experience of 13 years and a professional experience of 7 years as Geotechnical Consultant. He has supervised 14 Postgraduate, 30 Undergraduate students.

Dr. Jerome has 7 refereed journal papers to his credit.

#### **3- DR. GABATSOSWE LEBITSA ( Co Principal Investigator-2)**

Dr. Lebitsa has an overall teaching experience of 19 years.

Apart from the teaching experience, he has a vast professional experience of 16 years in various capacities. He has supervised 8 Postgraduate, 30 plus Undergraduate students. He has produced 1 Ph.D. also.

In addition, Dr. Lebitsa has successfully completed 10 research projects.

Dr. Lebitsa has 4 refereed journal papers to his credit. He has also presented his work in 14 national/international conferences.

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