PT DANMAR EXPLORINDO

Jalan Padang Sulasi No 8
PADANGSAMBIAN, BALI
INDONESIA
mobile: 62 81 23851151
email: daniel.madre@danmar.asia
www.danmarexplorindo.com

PT HENGJAYA MINERALINDO

NICKEL RESOURCE ESTIMATE

Qualified Persons Report
using
JORC Code, 2012

30th June 2022

1 EXECUTIVE SUMMARY

1) PT Hengjaya Mineralindo (HM) nickel laterite mine is located in Morowali Regency of Central Sulawesi, Indonesia

2) The last estimate of nickel laterite Resources was 30 June 2020 and PT Hengjaya Mineralindo has asked PT Danmar Explorindo to update Nickel Resources remaining at the 30 June 2022, using the JORC Code for Estimating Mineral Resources

3) The HM mining license covers 5,983ha and is valid until 2031 and can be extended twice for a period of 10 years

4) HM have been mining nickel laterite since 2013 and since that time, approximately 6.6 million tons of saprolite has been produced with an average grade of around 1.8% nickel and around 4 million tons of limonite with an average grade of around 1.2% nickel

5) Hengjaya Mineralindo (HM) currently has offtake agreements targeting 3 million wet tons per year, to supply ore for two RKEF plants owned jointly by Nickel Industries Limited and Shanghi Decent Industries. The RKEF plants are located 12 kms from the mine site at the Indonesian Morowali Industrial Park (IMIP).

6) The Hengjaya Mineralindo mine commenced supplying limonite ore to the Huayue HPAL project in 2021, which is also located in the IMIP area and produces a nickel cobalt sulphate for the electric vehicle market.

7) Since 2018 geophysical surveys totaling 881km using Ultra GPR technology has covered 3,495ha of the HM license area and more than 400,000,000 BCM of laterite has been interpreted from the results

8) Validated drill data, used in this Resource estimate totals 4,657 holes with a cumulative total depth of 108,294m.

9) 111,643 XRF analyses have been performed on drill cores to document the grade characteristics throughout the Nickel Resource area at HM

10) Nickel Resource of laterite covering 2,226ha using a cut-off grade of 0.8% nickel is as follows:

MINERAL RESOURCE	Million ton (Dry)	XRF (DRY ANALYSIS)		
		Ni (%)	Co (%)	Fe (%)
MEASURED	85	1.3	0.1	30.4
INDICATED	130	1.2	0.1	28.6
INFERRED	85	1.2	0.1	29.1
TOTAL > 0.8% Ni	300	1.2	0.1	29.2

11) Exploration Targets, where additional laterite is known to occur, is summarized below. These have been estimated using the statistical conversion rate of laterite to Nickel Resources per hectare in other blocks already explored throughout the HM project area. Although at this time it is uncertain if further exploration will result in a Mineral Resource, the historical mapping, wide spaced scout drilling and Ultra GPR surveys within these areas gives confidence that with further infill drilling and assay results will upgrade at least some of these areas for future estimates.

EXPLORATION TARGET			
Target Name	Area (Ha)	Laterite	Millions Wet Tonnes
ALL	500	ore grade	25-50

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY i
2 COMPETENT PERSON'S STATEMENT AND DECLARATION 2
2.1 AUTHORS AND CONTRIBUTORS 2
2.2 REPORT OBJECTIVES 2
2.3 REPORTING STANDARD 2
2.4 AUTHORS QUALIFICATION STATEMENTS 2
2.5 STATEMENT OF INDEPENDENCE 3
2.6 DISCLAIMER 4
3 INTRODUCTION 5
3.1 BACKGROUND 5
3.2 LEASE DETAILS 6
3.3 LOCATION AND ACCESS 7
3.4 ENVIRONMENT, SOCIAL AND GOVERNANCE 8
3.5 FORESTRY AND LAND USE 11
3.6 REGIONAL GEOLOGY 12
3.7 LOCAL GEOLOGY 15
3.8 PREVIOUS EXPLORATION, RESOURCE STUDIES AND REPORTS 15
4 CURRENT EXPLORATION PROGRAM METHOD 17
4.1 ULTRA GROUND PENETRATING RADAR SURVEY 17
4.2 DRILLING 19
4.2.1 CORE RECOVERIES 20
4.2.2 DRILL COLLAR SURVEY 20
4.2.3 GEOLOGICAL LOGGING OF CORES 21
4.2.4 CORE PHOTOGRAPHY 21
4.2.5 DRILL CORE SAMPLE HANDLING 22
4.2.6 GEOTECHNICAL DRILLING AND HYDROGEOLOGY 24
4.3 LABORATORY SAMPLE AND ANALYSIS PROCEDURES 25
4.3.1 SAMPLE PREPARATION 25
4.3.1.1 Wet Sample Preparation 25
4.3.1.2 Dry Sample Preparation 27
4.4 SPECIFIC GRAVITY MEASUREMENT 32
4.5 MOISTURE MEASUREMENT 36
4.6 ANALYTICAL METHODS AND STANDARDS 38
4.6.1 QUALITY ASSURANCE / QUALITY CONTROL 40
4.6.1.1 Quality Assurance 40

4.6.1.2 Quality Control ... 41
4.6.1.3 Reporting and Review ... 42
4.6.1.4 Continuous Improvement ... 42
4.7 SAMPLE SECURITY, AUDITS AND REVIEW ... 42
5 RESULTS ... 43
5.1 GPR SURVEY ... 43
5.2 DRILL RESULTS ... 47
5.3 GEOTECHNICAL AND HYDROGEOLOGY STUDIES ... 49
5.4 SURVEY RESULTS ... 52
5.5 ASSAY ANALYSIS RESULTS ... 54
5.5.1 SPECIFIC GRAVITY MEASUREMENTS ... 55
5.5.2 MOISTURE MEASUREMENT ... 56
5.5.3 SAMPLE ASSAY QUALITY CONTROL ... 57
5.5.3.1 Coarse Blanks ... 58
5.5.3.2 Coarse Duplicates ... 58
5.5.3.3 Particle Sizing Test- -200# Screen Test ... 59
5.5.3.4 Pulp Duplicates, or Duplicate Assay ... 60
5.5.3.5 Check Standards, or Certified Reference Materials (CRM's) ... 62
5.5.3.6 Replicate Samples ... 64
5.5.3.7 Interlaboratory Check Samples ... 66
5.5.3.7.1 HM Lab vs PT Geoservices Lab ... 66
5.5.3.7.2 Comparison PT HM Assay Lab vs IMIP Smelter Results ... 67
5.5.3.8 Control Sample Insertion Rates ... 69
5.5.3.9 Review, Reporting and Continuous Improvement ... 70
5.6 DOMAINS AND MINERALIZATION ... 73
5.7 DATA COMPILATION ... 78
5.7.1 DATABASE ... 78
5.7.2 DATA VALIDATION PROCESS ... 78
5.7.3 SURVEY ACCURACY ISSUES ... 79
5.7.4 RECONCILIATION OF LITHOLOGY AND ASSAY RESULTS ... 79
5.7.5 DOWNHOLE STATISTICAL ANALYSIS ... 80
5.7.6 GEOSTATISTICAL ANALYSIS ... 86
6 MINERAL RESOURCE ESTIMATE ... 90
6.1 SOFTWARE ... 90

6.2 SURFACE GRIDDING & WIREFRAMING 90
6.3 ASSAY DATA AND COMPOSITING 91
6.4 BULK DENSITY 93
6.5 BLOCK MODELING 93
6.6 GRADE INTERPOLATION 94
6.7 RESOURCE CLASSIFICATION STRATEGY 95
6.8 MODEL VALIDATION 98
6.9 RECONCILIATION OF PREDICTED GRADES WITH MINING 102
6.10 MINERAL RESOURCE STATEMENT 112
6.11 COMPARISONS TO PREVIOUS ESTIMATES 116
6.12 RISKS AND OPPORTUNITIES 118
6.13 EXPLORATION TARGETS 119
7 CONCLUSIONS AND RECOMMENDATIONS 121
8 REFERENCES 122
9 APPENDIX 123
9.1 TABLE 1 OF THE JORC COMMITTEE 123
9.2 PT HENGJAYA MINERALINDO LEGAL DOCUMENTATION 123
9.3 ENVIRONMENT SOCIAL AND GOVERNANCE REPORTS 123
9.4 HENGJAYA STATISTICAL ANALYSIS 123
9.5 HENGJAYA LABORATORY REPORTS; PROCEDURES & QA/QC 123
9.6 GEOTECHNICAL & HYDROGEOLOGICAL REPORT 123
9.7 RESUME: DANIEL MADRE, CHARLES WATSON, TOBIAS MAYA 123

LIST OF TABLES

Table 1 Authors and contributors 2
Table 2 License details 6
Table 3 Results of Hengjaya's ESG program 2020-21 10
Table 4 Forestry (IPPKH) land borrow permits details 11
Table 5 Drilling history at Hengjaya 16
Table 6 Topography survey history 16
Table 7 Hengjaya Mineralindo previous reports and Resource studies 16
Table 8 Ultra GPR survey summary 43
Table 9 Ultra GPR survey results interpretation 44
Table 10 Drill data statistics 47
Table 11 Drilling distribution per domain 47
Table 12 Core recoveries 49
Table 13 Slope Stability Analysis Results 51
Table 14 Material Properties Result of Reverse Analysis 52
Table 15 Excavation and Dig-ability per Lithology 52
Table 16 Survey mis-close between drill collars and LiDAR survey 52
Table 17 Sample interval statistics 55
Table 18 specific gravity measurements 55
Table 19 Moisture content 56
Table 20 Exploration Control Sample Insertion Rates July 2021-2022 69
Table 21 Drilling Excluded from the Mineral Resource database 78
Table 22 Collar survey validation 79
Table 23 Specification for reconciliation of assay records 80
Table 24 Summary of recommended statistical top cuts for each domain 81
Table 25 Summary Result of the variogram model created 87
Table 26 Ni % top cut applied to saprolite composites by domain 92
Table 27 Moisture Content records domain averages applied to composites 92
Table 28 Moisture Content records applied domain averages to composites 92
Table 29 Block model dimensions 93
Table 30 Summary search ellipsoids applied to the model 94
Table 31 Coverage area of the Mineral Resource by classification 96
Table 32 Interpolation pass influence on Resource classification 97
Table 33 Composite model against block model statistical validation 101
Table 34 Life of Mine yearly production history updated to 30 June 2022 102
Table 35 Reconciliation of the life of mine production against the new resource model 104

Table 36 Bete Bete mine production reconciliation against new model prediction 106
Table 37 APL mine production reconciliation against new model prediction 108
Table 38 Central pits production reconciliation against new model (OK) prediction 109
Table 39 Nickel Mineral Resource Estimate 114
Table 40 Mineral Resource shown at various cutoffs 115
Table 41 Nickel Resource comparison by classification 116
Table 42 Global Nickel Resource comparison 117
Table 43 Exploration Targets in addition to the HM Nickel Resource Areas 120

LIST OF FIGURES

Figure 1 Hengjaya Mineralindo concession map 6
Figure 2 HM project location map Indonesia 7
Figure 3 Access to HM area from Morowali airport.. 8
Figure 4 Forestry situation map of PT Hengjaya Mineralindo mining area, including IPPKH permits already granted 11
Figure 5 Satellite map depicting land clearing status of the HM concession 12
Figure 6 Regional tectonic geology map of Sulawesi (R McCaffery 2009).......................... 13
Figure 7 Regional stratigraphy in the PT Hengjaya Mineralindo area on the published 1:250,000 scale Bungku Geology Map Sheet.. 14
Figure 8 Published regional geology of the PT Hengjaya Mineralindo project area 14
Figure 9 Local geology map.. 15
Figure 10 Diagrammatic representation of a typical laterite profile in Sulawesi................... 18
Figure 11 Example UltraGPR survey of a typical laterite profile in Sulawesi 18
Figure 12 Ultra GPR survey lines on topographic map... 44
Figure 13 Ultra GPR section line interpretation example from Central East (phase 7)......... 45
Figure 14 Limonite thickness interpreted from the Ultra-GPR survey.................................. 45
Figure 15 Saprolite thickness interpreted from the Ultra-GPR survey 46
Figure 16 Depth to bedrock interpreted from Ultra-GPR 46
Figure 17 Drill hole location map 48
Figure 18 Geotechnical & hydrogeological drilling location map 50
Figure 19 LiDAR topography map of the HM IUP.. 53
Figure 20 Drillhole location and survey status map 54
Figure 21 Sample interval distribution.. 54
Figure 22 Average density measurement from cores 56
Figure 23 Average moisture content.. 57
Figure 24 Scatterplot showing results of 1020 Coarse Reject original vs duplicate assays . 59
Figure 25 Screen test results – March 2022 60
Figure 26 Scatterplot results of 1,396 plots for pulp original vs duplicate assays................. 61
Figure 27 CRM OREAS 182 - 537 Exploration Sample Analyses 63
Figure 28 CRM OREAS 187 – 582 Exploration Analyses 63
Figure 29 CRM OREAS 192 – 339 Exploration Analyses 63
Figure 30 CRM OREAS 195 – 193 Exploration Analyses 64
Figure 31 Scatterplot showing results of 2,130 plots for original vs replicate assays 65
Figure 32 Scatterplot results of 1033 plots of HM original vs Geoservices duplicate assays 67

Figure 33 Graphic showing results of 54 saprolite samples assayed at HM and IMIP Smelter 68
Figure 34 Domain location map 74
Figure 35 Diagrammatic sections through HM nickel laterite deposit showing relative elevation and geological characteristics 75
Figure 36 Laterite thickness chart per domain 76
Figure 37 Ni grade average over the 7 domains 76
Figure 38 Silica / Magnesia ratio over the 7 main domain areas 77
Figure 39 Cobalt grade over the 7 main domain areas 77
Figure 40 Histogram of Ni Grade (without laterite profile restriction) 82
Figure 41 Histogram of Ni Grade with top cut applied 82
Figure 42 Composite Thickness for the Limonite zone based on drilling 84
Figure 43 Composite nickel grade for the Limonite zone based on drilling 84
Figure 44 Composite thickness for the Saprolite zone based on drilling 85
Figure 45 Composite nickel grade for the Saprolite zone based on drilling 85
Figure 46 Geostatistical analysis process flow 86
Figure 47 Semi variogram models for Bete Bete and Central domains, Ni in Limonite 88
Figure 48 Semi variogram models for Bete Bete and Central domains, Ni in Saprolite 88
Figure 49 Semi variogram models for Bete Bete Far West domain, Ni in Limonite 88
Figure 50 Semi variogram models for Bete Bete Far West domain, Ni in Saprolite 89
Figure 51 Resource classification boundaries 96
Figure 52 Resource classification boundaries overlay with Ordinary Kriging pass map 98
Figure 53 Section examples used for visual validation of the model 99
Figure 54 Plan view of the results of the Ordinary Kriging Ni grade model 100
Figure 55 Swath plots of limonite for Central West 101
Figure 56 Swath plots of saprolite for Central West 101
Figure 57 Monthly production history from the Hengjaya mine to 30 June 2022 103
Figure 58 Bete Bete Mine situation – 30 June 2022 106
Figure 59 APL Mine situation – 20 April 2020 108
Figure 60 Central East mine production comparison with new model compliance 109
Figure 61 Central East Pit situation in 2022 110
Figure 62 Central West pit situation – 30 June 2022 110
Figure 63 Global Mineral Resource tonnage (dry) and Ni% grade relationship 116
Figure 64 Nickel Resource limit comparison map 118
Figure 65 Exploration Target areas are shown as within domain boundaries and outside the shaded Resource areas 120

LIST OF PHOTOS

Photo 1 Mine rehabilitation progress at Bete Bete pit 9
Photo 2 Example survey acquisition using Ultra GPR equipment (source: Groundradar.com) 17
Photo 3 Dexdrill 200 at HM 19
Photo 4 Drill collar survey using E-survey RTK GPS 20
Photo 5 Core boxes of a completed hole arranged in consecutive order in preparation for geological logging 21
Photo 6 Core photo example 22
Photo 7 Sample packing at the well site 23
Photo 8 Sample recheck and re-labelling at drill camp office 24
Photo 9 Drill core samples delivered to HM sample store 26
Photo 10 Raw core sample preparation for quartering 27
Photo 11 Jaw crushing to -10mm 28
Photo 12 -3mm sample, manual incremental reduction JIS M 8109-1996 29
Photo 13 Sample placed in pulverizer 30
Photo 14 Pulverized sample sieve analysis 31
Photo 15 Sieve analysis results measurement 32
Photo 16 Density samples delivered to sample store 33
Photo 17 Core samples ready for density measurement 34
Photo 18 Weighing density samples at the sample preparation lab 34
Photo 19 Density sample volume measurement by the displacement of water 35
Photo 20 Density data record 35
Photo 21 Drill core sample delivery to HM preparation lab and wet sample weight measurement 36
Photo 22 Wet samples are placed in oven 37
Photo 23 Dry samples removal from oven 37
Photo 24 Dry sample weight measurement 37
Photo 25 Sample pulp storage in desiccating oven and pressed pellet preparation 38
Photo 26 Pressed pellet production from sample pulp ready for XRF analysis 39
Photo 27 Pressed pellets being loaded into XRF machine 40
Photo 28 Drone image of HM Port stockpile, 2022 (Source; Hengjaya) 103
Photo 29 Drone Image of Bete Bete Pit in operation 2019 (Source; Hengjaya) 107
Photo 30 Bete Bete Pit rehabilitation, 2022 (Source; Hengjaya) 107
Photo 31 Bete Bete East Pit Operation, 2022 (Source; Hengjaya) 107
Photo 32 Mining operations APL in Pit B1, 2013 (Source; Hengjaya) 108

Photo 33 Central East pit 2022 (Source; Hengjaya) 111
Photo 34 Central West (CW2) pit progress 2022 (Source; Hengjaya) (1) 111
Photo 35 Central West (CW2) pit progress 2022 (Source; Hengjaya) (2) 112
Photo 36 Drone image of Bete mine with IMIP facility in background (Source; Hengjaya). 113

LIST OF ABBREVIATIONS

Al_2O_3	aluminum oxide
APL	areal penggunaan lain (Forestry status for land with no Forestry restriction)
asl	above sea level
AT	Acceptance Testing
BRK	bedrock
cm	centimeter
Co	cobalt
COA	certificate of analysis
CRM	certified reference material
DA	pulp duplicate sample
DEX	PT Danmar Explorindo
dmt	dry metric tons
DR	coarse reject sample
DSO	direct shipping ore
Fe	iron
g	gram
GPR	ground penetrating radar
GPS	global positioning system
Ha	hectare
HM	PT Hengjaya Mineralindo
HNI	Hengjaya Nickel Indonesia
HPAL	high pressure acid leach
IDW2	Inverse distance weighted squared
IMIP	Indonesia Morowali Industrial Park
ISO	international standards organization
IUPOP	Indonesian mining business permit for operation and production
JORC	Joint ore reserve committee
LiDAR	Laser imaging detection and ranging
LIM	Limonite
m	Meters
MC	Moisture content
MgO	Magnesium oxide
NIL	Nickel Industries Limited
NIC	Nickel Industries Limited
Ni	nickel
OK	Ordinary Kriging
OREAS	Ore Research and Exploration Australia Limited
QA/QC	quality assurance / quality control
RKEF	rotary kiln electric furnace
REP	replicate sample
RNI	Ranger Nickel Indonesia
RTK GPS	Real-Time Kinematic GPS giving high accuracy survey positioning
SAP	saprolite
SED	sediment
SGS	survey and analysis company
SiO_2	quartz/silica
t	metric tons
wmt	wet metric tons
wmtpa	west metric ton per annum
XRF	x-ray refraction

2 COMPETENT PERSON'S STATEMENT AND DECLARATION

2.1 AUTHORS AND CONTRIBUTORS

Table 1 Authors and contributors

Position	Name	Qualifications	Signature	Date
Competent Person / Author	Daniel Madre	MSc MAusIMM MAIG CPI-MIAGI	Digital Signature shown	30th June 2022
Contributing Author / Peer Review	Tobias Maya	BSc MAusIMM	Digital Signature shown	30th June 2022
Contributing Author / Peer Review	Charles Watson	BSc FellowAusIMM	Digital Signature shown	30th June 2022
Reconciliations / UltraGPR	Michael Maya	B Eng MAusIMM	Digital Signature shown	30th June 2022

2.2 REPORT OBJECTIVES

This report was prepared for PT Hengjaya Mineralindo for the purpose of updating nickel Resource estimate last carried out in June 2020. The report utilizes exploration data until 15th July 2022 and mining progress data until 30 June 2022.

2.3 REPORTING STANDARD

This report is intended to comply with the 2012 Code, of the Joint Ore Reserve Committee (JORC) of Australia for the reporting of Mineral Resources and Reserves (http://www.jorc.org/docs/jorc_code2012.pdf). All the information used in this report was assessed for compliance with the JORC Code and only information that was considered compliant was included in the estimate of a nickel Resource as specified in the JORC Code of 2012. The competent persons, contributing to this report, have memberships to the Australasian Institute of Mining and Metallurgy that are current and in good standing.

2.4 AUTHORS QUALIFICATION STATEMENTS

The information in this report that relates to Exploration Results and Mineral Resources based on information compiled by Daniel Madre, member no: 100878, Tobias Maya, member no: 304661, and Charles Watson member no: 313716 of the Australasian Institute of Mining and Metallurgy.

Daniel Madre has a Master of Science degree majoring in geology and more than 40 years of experience as an exploration geologist of which more than 34 years has been working in

Indonesia. Since 2003, Daniel Madre has been involved in numerous laterite nickel exploration and mining projects in Indonesia and has held several senior roles in laterite nickel projects including, Director of PT Telen Paser Prima, which opened the first laterite nickel mine in Kalimantan in 2005 and President Director of PT Itamatra Nusantara, that discovered laterite nickel in Morowali Regency in Central Sulawesi. Daniel Madre is currently a director of PT Danmar Explorindo and a consultant to PT Hengjaya Mineralindo for the purpose of this study. PT Danmar Explorindo has also been the exploration contractor to PT Hengjaya Mineralindo since April 2019, providing exploration services including geological management, drilling, well site geology and core sample preparation.

Tobias Maya has a Bachelor of Science degree majoring in Spatial Science from Charles Sturt University, Australia. Tobias Maya is a Mineral Resource modeling specialist with more than 17 years of experience in exploration and modeling lateritic nickel resources in Indonesia. Tobias Maya is currently a director of PT Geo Search and a consultant to PT Danmar Explorindo for the purpose of this study. PT Geo Search has also provided Ultra-GPR (Ground Penetrating Radar) survey services to Hengjaya Mineralindo.

Charles Watson is a geologist with more than 45 years' experience in Indonesia, Africa, Australia and New Zealand and has provided a detailed review of laboratory procedures, quality control procedures and assay result reliability at the Hengjaya Project for the purpose of this report. Charles is a consultant to Nickel Industries Limited that owns 80% of the Hengjaya Nickel Project.

Daniel Madre, Charles Watson and Tobias Maya have sufficient experience which is relevant to the style of mineralization and type of deposit under consideration and to the activity that they are undertaking, Reporting of Exploration Results, Mineral Resources and Reserves. Daniel Madre, Tobias Maya and Charles Watson consent to the inclusion in the report of the matters based on this information in the form and context in which it appears. Resumes for Daniel Madre, Tobias Maya and Charles Watson are attached in Appendix 9.7

2.5 STATEMENT OF INDEPENDENCE

Daniel Madre, Tobias Maya, Charles Watson and PT Danmar Explorindo's partners, directors, substantial shareholders and their associates are independent of PT Hengjaya Mineralindo, its directors and substantial shareholders, its advisers and their associates.

Neither Daniel Madre, Tobias Maya and or PT Danmar Explorindo nor any of its partners, directors, substantial shareholders, advisor's and their associates have any interest, direct or indirect in Nickel Industries Limited (NIL), its subsidiaries, associated companies, or any related entities in Indonesia or elsewhere in the world. Charles Watson is a private shareholder in NIL and has declared this investment while contributing to this report.

Daniel Madre, Tobias Maya, Charles Watson and PT Danmar Explorindo have no potential conflicts of interest that might affect their objectivity in writing this report. PT Danmar Explorindo's fee for completing this report is based on normal commercial terms and the payment is not contingent upon the outcome and findings of this report.

2.6 DISCLAIMER

PT Danmar Explorindo has used the results of exploration programs provided by PT Hengjaya Mineralindo as well as the results of exploration drilling done on their behalf for the purpose of writing this report. In making this Mineral Resource estimation PT Danmar Explorindo has assumed as follows:

1) all the relevant data available was provided without prejudice

2) key assumptions are accepted as described in this report

In view of the above assumptions PT Danmar Explorindo has made reasonable enquiries and exercised their judgment on the reasonable use and validity of the data and found no reason to doubt its accuracy and reliability. For this reason, we believe that this report is an objective, accurate and reliable representation of the laterite nickel project at HM nickel mine concession based on the exploration results until 15th July, 2022. PT Danmar Explorindo makes no warranty to PT Hengjaya Mineralindo or any third parties with regard to any commercial investment on the basis of this report. The use of this report by PT Hengjaya Mineralindo or any other parties shall be at their own risk. The report must always be read in its entirety so that all the data and assumptions are fully considered and properly understood.

3 INTRODUCTION

3.1 BACKGROUND

On behalf of PT Hengjaya Mineralindo (HM), PT Danmar Explorindo (DEX) was asked to provide an update of the nickel Resources remaining at the Hengjaya Mineralindo laterite nickel mine, using the Joint Ore Reserve Committee of Australia (JORC) Code, 2012. The last Nickel Resource report was dated 30 June 2020.

Historic exploration work, carried out over various stages since 2007 until 2017 was obtained from HM. However, since November 2018 until July 2022, a new systematic exploration program has been implemented and 4,009 holes with a total cumulative depth of 93,154m have been drilled. The objective is to delineate sufficient Resources of nickel laterite to support the mining operation into the future.

During the period November 2018 until July 2022, all three competent persons for this report worked at the HM site on numerous occasions. During the site work the exploration program was set up, monitored and the sample handling and laboratory operation of the project was reviewed and upgraded. This work is continuing.

Hengjaya Mineralindo has been mining laterite nickel ore since 2013. Initially, direct ore shipments were made to export markets in China and Japan. A total of 328,000t of nickel ore was produced with an average nickel grade of 1.97% and 38% moisture in 2013. Direct shipping of nickel ore to export markets was banned by the Indonesian Government in 2014. Production resumed in 2015 and nickel ore was barged to the local smelter at Morowali (SMI). Since 30 June 2020, more than 4,700,000Wmt of 1.8% Ni saprolite and 3,800,000Wmt of approximately 1.2% Ni limonite have been mined until the end of June 2022.

Hengjaya Mineralindo (HM) currently has offtake agreements targeting 3 million wet tons per year since June 2021, to supply ore for two RKEF plants (4 lines) owned jointly by Nickel Industries and Shanghai Decent Industries. An additional third RKEF plant (4 lines) is also under construction with the same partner. The RKEF plants are located 12 kms from the mine site at the Indonesian Morowali Industrial Park (IMIP).

The Hengjaya Mineralindo mine also commenced supplying limonite ore to the Huayue HPAL project in 2021 which is located in the IMIP area and produces a nickel cobalt sulphate for the electric vehicle market.

Construction works on a haul road, to link the Hengjaya mine to the IMIP facility, are well advanced and awaiting approvals to complete the final section of road in 2023. This will allow saprolite production to further increase to 3.5 wmtpa and limonite production and sales, forecasted to increase to between 6 and 7 wmtpa beyond 2023.

3.2 LEASE DETAILS

Mining rights for the area are held under an Operation and Production Mining Business Permit (IUP OP), with Area Code 540.3/SK.001/DESDM/VI/2011. The area covers 5,983Ha and gives HM the right to mine nickel and its associated minerals. The IUP OP was originally granted by the Regent of Morowali in 2011 and is valid until 26th May 2031. Table 2 shows the tenement license details of the Hengjaya lease. The Operation Production IUP may be renewed twice, each for a period of 10 years.

Table 2 License details

License holder	Province	Permit Type	Area (Ha)	Date of Issue	IUP Area Code	Duration (Years)
PT HENGJAYA MINERALINDO	CENTRAL SULAWESI	IUP OPERATION PRODUCTION	5,893	16-Jun-11	540.3/SK.001/DESDM/VI/2011	20

The IUP is located in the East Indonesian Ophiolite Belt and for this reason is surrounded by numerous other nickel mining tenements as well as one of Indonesia's largest nickel smelting and industrial hubs known as Indonesia Morowali Industrial Park (IMIP). The concession map for the area is shown in Figure 1.

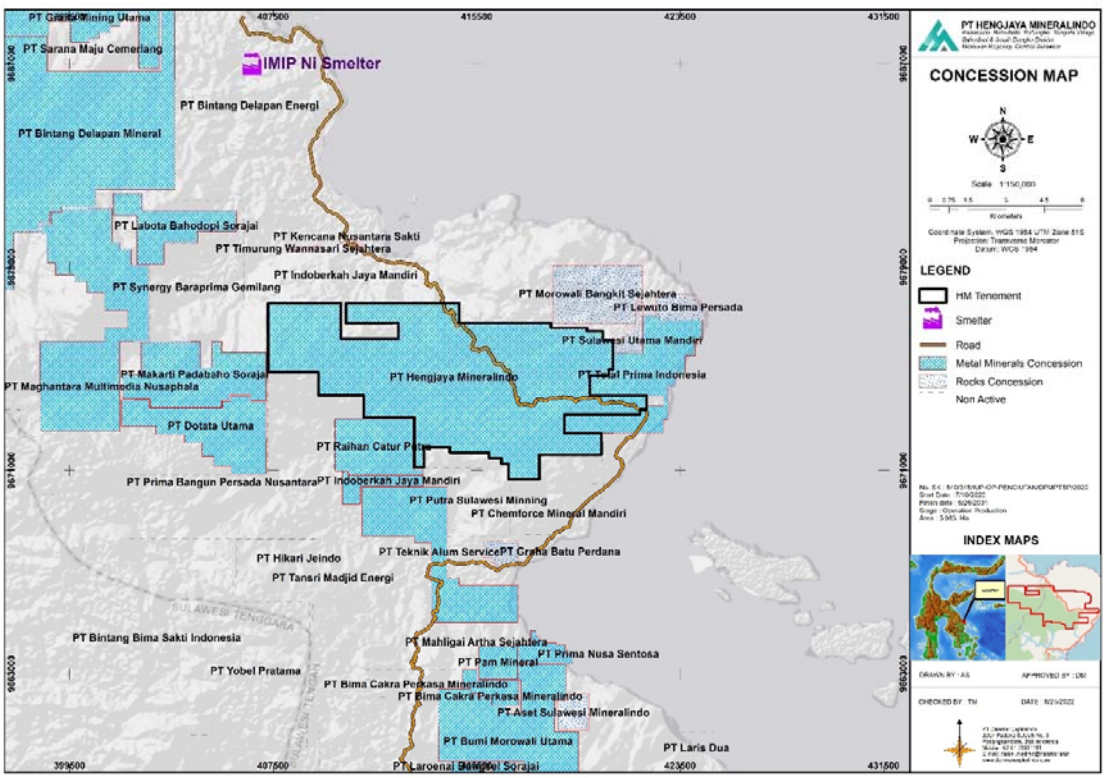


Figure 1 Hengjaya Mineralindo concession map

PT Hengjaya Mineralindo is owned by the following shareholders: 80% Nickel Mines Limited (now known as Nickel Industries Limited), 10% Adi Wijoyo, 5% Martin Unsulangi Heng and 5% Heng Leo Seputra Hidayat. The IUP OP mining license documents are shown in Appendix 9.2. Legal due diligence was not part of the scope of work for this report.

3.3 LOCATION AND ACCESS

The HM lease is within the villages of Padaboho, Bete Bete, Puunkeu and Tangofa in the shires of Bahodopi and Bungku Selatan, Regency of Morowali, in the Province of Central Sulawesi. The location of the area is shown in Figure 2.

Figure 2 HM project location map Indonesia

Direct access to the HM concession, from Jakarta, is by flight to 2.5 hours to the IMIP private airport. Alternatively, a commercial flight (2.0 hours) to Makassar then from Makassar commercial flight (1.0 hour) to Morowali, then to the site 3 hours by car via provincial highway. Figure 3 shows the access from Morowali airport to the HM project.

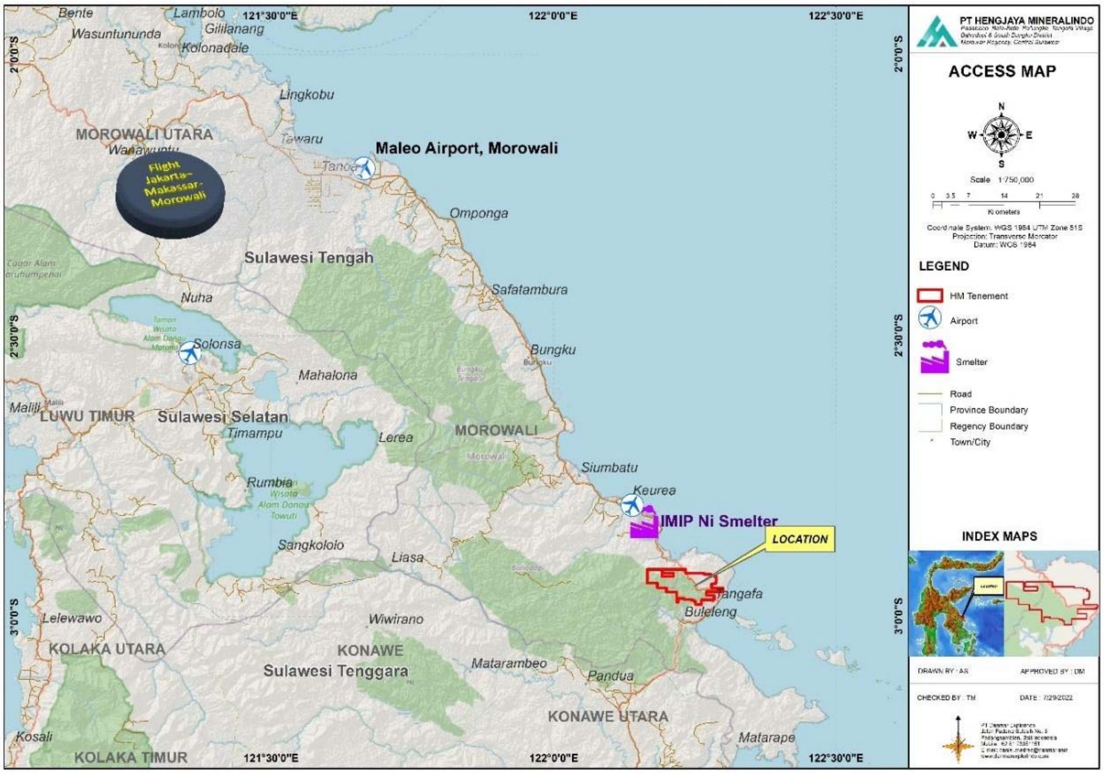


Figure 3 Access to HM area from Morowali airport

3.4 ENVIRONMENT, SOCIAL AND GOVERNANCE

Below is the Company's vision for the HM mine taken from the Nickel Industries Sustainability Report, 2021. A full copy of this report is contained in Appendix 9.3 as well as a summary of HM's recent Community Development and safety achievements.

Nickel Industries instills a culture of acting professionally, ethically and responsibly. It seeks to operate in line with the values set out below to ensure all employees within the Company and its subsidiaries work to reinforce these values.

The company prioritizes safety, health, community and environment. Operating safely with regards to the environment and communities in which it operates enhances the sustainability and performance of the business.

The Company is results and performance-driven, striving to generate returns for shareholders by meeting strategy and targets developed to drive continuous improvement for all stakeholders.

The company encourages its people to work together as a high performing team and values rewarding team success. The company encourages and values strong, open inclusive communication and treats all people, within and outside the company, ethically and with dignity and mutual respect.

The company manages business risk through sound business processes and high quality decision making. The Company is committed to following all applicable rules, regulations and standards.

Table 3 summarizes the Company's results for Environment, Social and Governance for 2021. Full details can be viewed in Appendix 9.3

Photo 1 Mine rehabilitation progress at Bete Bete pit

Table 3 Results of Hengjaya's ESG program 2020-21

Pillar	Sub-Pillar	Achievement(s)
Economic Development	Financial Performance	Strong production and EBITDA, with cotinued rapid growth over in the next 12 months.
	Procurement Practice	Focus on local hiring contributes to the local communities in our areas of operations.
	Economic Impacts	Significant contributor to economy of Morowali Regency & Central Sulawesi Province
Environmental	Biodiversity	1,781 Ha of mangrove and watershed rehabilitation in Central Sulawesi. This programme is acknowledged as one of the best in the region resuting in a coaching clinic attended by various forestry and environmental agencies, so that they can use these same methods and processes. Planted more than two million trees to help stimulate the local economy in the future. Absorbed 9,392 tonnes of CO_2 from reforestation using; pine, rattan, hazelnut & durian Plan to survey a potential biodiversity zone of 62 Ha inside Hengjaya Mine area
	Energy	Through collaboration with IMIP, we have supported emission reductions as follows: • nickel processing near the mine sites which reduce nickel ore transportation • The construction of waste heat boiler of 2x25 MW in the coke power plant and the use of high-temperature coke oven flue gas to generate additional electricity • The improvement of enterprise heat energy utilization ratio to conserve our energy consumption.
	Emissions	Working with Hatch and Pertiwi Consulting, to develop a decarbonization roadmap. The Company and Shanghai Decent launched its 'Future Energy' collaboration, aimed at exploring to transition to renewable energy and other lower carbon-emitting solutions. The installation of 450 KWp solar panels at our Hengjaya Mine in 2022, will reduce diesel consumption by around 31 million liters over the 25-year projected project life. At IMIP, the hot metals are sent direct to steel making and hot rolling, which avoids the need to re-melt nickel in the steelmaking process Controlling particulate pollution at our operations at IMIP, such as: • The installation of dust screen surrounding the coal yard, and more than 20 sets of atomization spray equipment for dust suppression • The improvement of dust collecting covers to effectively reduce the dust produced in the production process.
	Waste	Supporting Morowali Regency and Indonesia Free of Waste visions in 2025 by providing 20 motorcycle carts and one truck for waste collection activities.
	Water and Effluents	The Hengjaya Mine is one of only 2 companies that received Blue PROPER Award from the Indonesia Ministry of Environment in 2021 for full compliance with environmental regulations. Automatic continuous monitoring system for water effluent, advanced circulating water and sewage treatment facilities at IMIP, greatly improve the utilisation rate of water resources and realise zero water discharge.
Social Responsibility	Community Relations and Development	PT Hengjaya Mineralindo is committed to encouraging economic growth and providing quality welfare to the local communities. The company is committed to have positive impacts on the communities and the surrounding environment, including for internal and external stakeholders. Working to fulfil the Corporate social and environmental responsibility law as mandated by the Indonesia Limited Company Law No. 40/2007 and Indonesia Government Regulation no 47/2012. Supported various education, health services, infrastructure, social, cultural and religious programs in 2021. Funded 18 projects from eight surrounding villages, including local port rehabilitation and community health facility development. Distributing groceries to local villagers and many other beneficial programs. Preparing to initiate three flagship programs in 2022: • Coral reef conservation; • Community-based waste management; and • Regional library/community reading park to increase reading interest Supporting the teachers at the local schools near the IMIP.
	Anti-Corruption	Published its Anti-Bribery and Corruption Policy.
	Health and Safety	Providing free health clinic for local villagers around the IMIP. Achieved five million working hours without a lost-time injury in Hengjaya Mine operations until October 2021.

3.5 FORESTRY AND LAND USE

There are no Protected Forests in the HM project area and there are no other Forestry boundaries that prohibit surface mining. Approximately 86% of the concession area is a Production Forest and the remaining 14% of the area is free from any Forestry overlaps. Figure 4 shows the HM lease area on the published Forestry Map of Indonesia.

Two Forestry permits (IPPKH 1 & 2) to allow open cut mining within a 1845Ha area have been granted by the Minister of Forestry (see table 3) which covers approximately 34% of the Production Forest (see Figure 4). IPPKH 3 is a permit for exploration where new nickel laterite is being delineated. The IPPKH license (land borrow permit) documents are shown in Appendix 9.2.

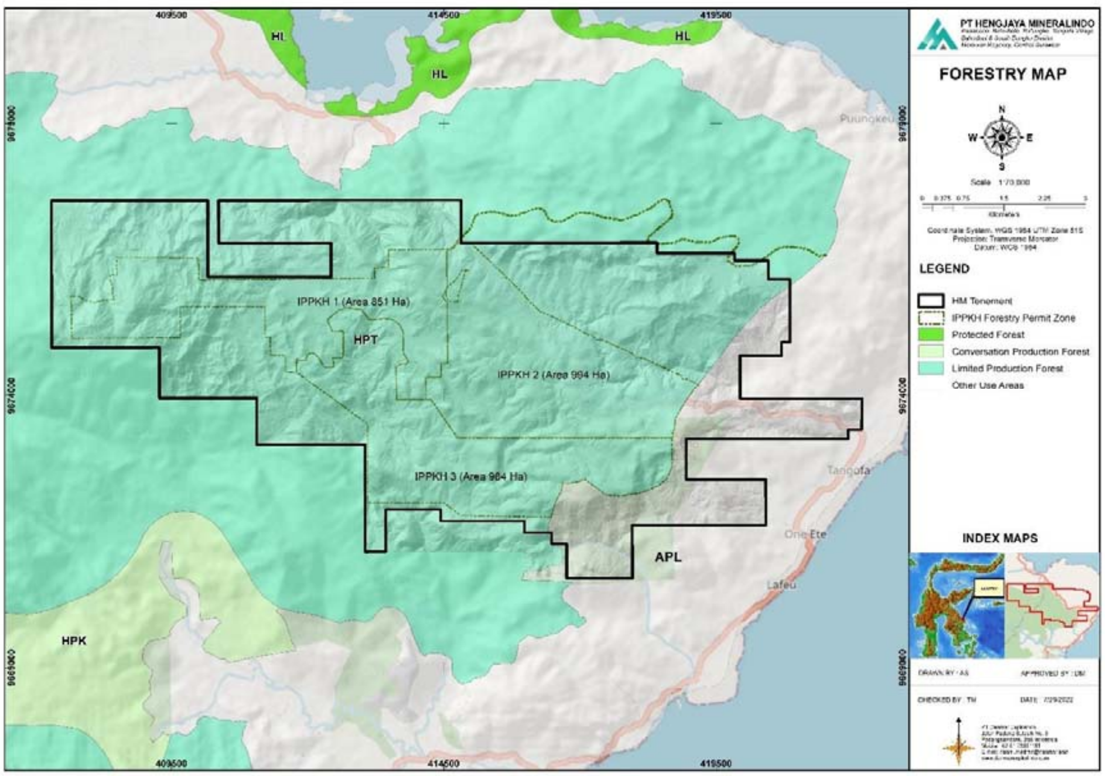


Figure 4 Forestry situation map of PT Hengjaya Mineralindo mining area, including IPPKH permits already granted

Table 4 Forestry (IPPKH) land borrow permits details

IPPKH	Licence	Status	Area (Ha)	Released Date	Expiry Date
IPPKH 1	SK.443/Menhut-II/2013	Production	851	20/Jun/2013	16/Jun/2031
IPPKH 2	3/1/IPPKH/PMA/2018	Production	994	6/Feb/2018	26/May/2031
IPPKH 3	SK.676/MENLHK/SETJEN/PL.0/9/2021	Exploration	984	9/Sep/2021	9/Sep/2023

Figure 5 shows a satellite image that displays the extent of land clearing in the area. No villages occur within the concession boundaries. Even though most of the concession is Government owned Production Forest, some areas, surrounding the Provincial Road, are cultivated with small, informal pepper plantations while the remaining area is covered in secondary forest regrowth. No formal, commercial plantations occur within the project area.

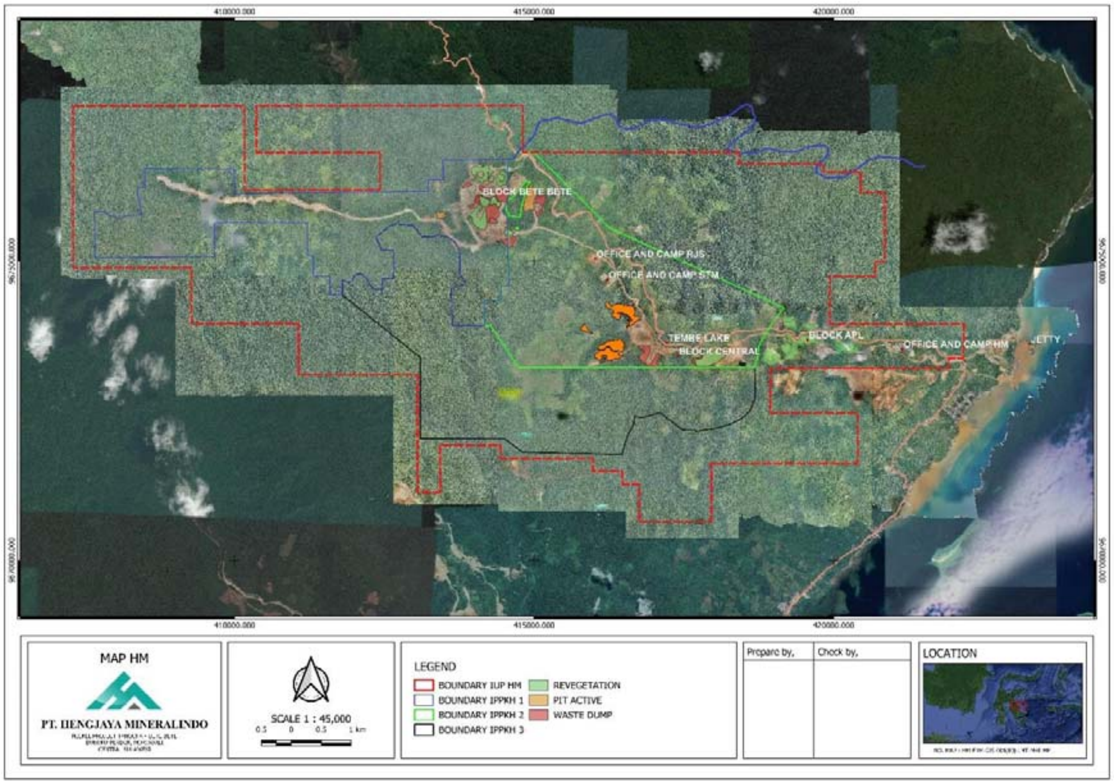


Figure 5 Satellite map depicting land clearing status of the HM concession

3.6 REGIONAL GEOLOGY

The regional tectonic setting for Central Sulawesi is the result of a complex collision between 3 of the earth's major crustal plates namely, the Australian plate, the Pacific plate and the Eurasian plate. As a result, three smaller plates have formed in this collision zone known as the Sunda Plate, Philippine Plate and Caroline Plates. The collision between all these tectonic plates is the cause of sections of the seafloor to be uplifted and deposited in Sulawesi, North Maluku and Papua. This is the origin of the East Indonesian Ophiolite Belt which is one of the largest ophiolite regions in the world and the source of nickel laterite deposits in East Indonesia. Ophiolites are the result of the process of overthrust of oceanic crust and mantle to a position on top of continental rocks. This intense structural geological setting is also the reason major geological structures such as the Palu, Matano and Lawanopo faults dissect the Central Sulawesi region and control the distribution of rocks in the area.

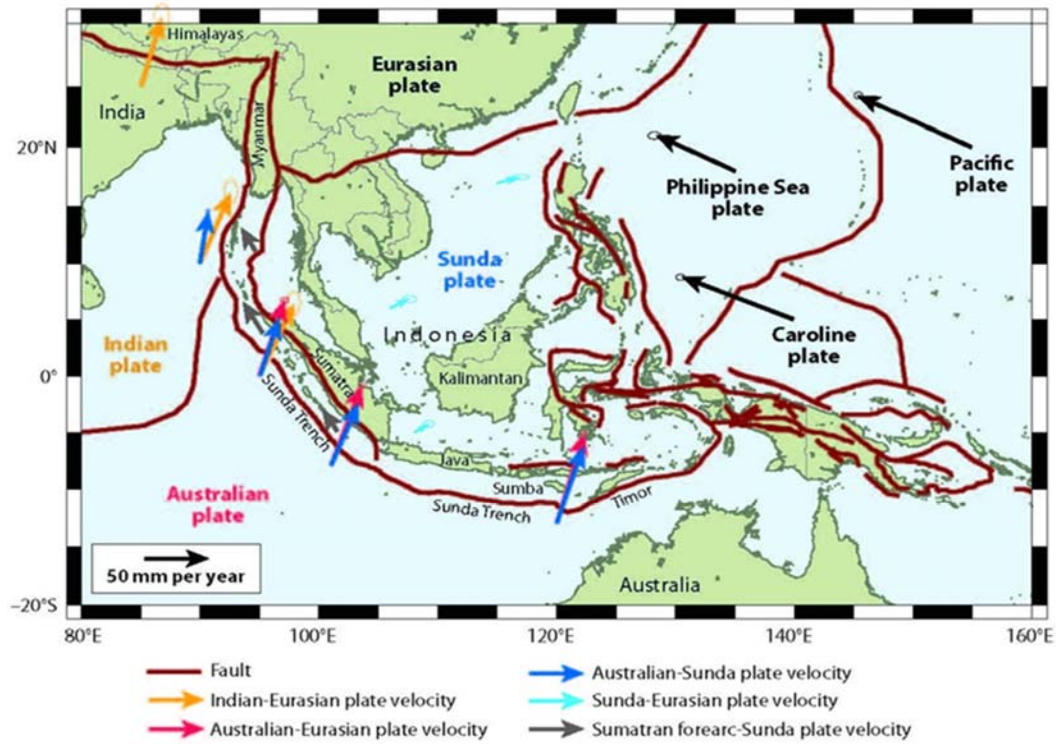


Figure 6 Regional tectonic geology map of Sulawesi (R McCaffery 2009)

When ophiolite rocks are exposed to humid, tropical climates over a long period of time laterization can occur as the rocks are weathered. In this process of weathering by rain, soluble minerals are leached away and less soluble minerals such as iron, nickel and cobalt are left behind in the weathering profile. This laterization process is influenced by climate, geological structure, rock type, permeability and topography over long periods of time, to form a soil profile in which minerals containing nickel and other elements can be depleted in some places and concentrated in other areas. Within the ground, the leaching process is enabled by the permeability of the bedrock often as a result of tectonic movement causing fracturing and shearing creating conduits for the flow of mineral rich solutions leached from above.

Figure 7 shows the naming and correlation of rock units on the published Regional Geology Map of the HM project area. According to the 1:250,000 scale Bungku Geology Map Sheet, most of the HM concession area is covered by the Tokala Formation which is marine in origin and dominated by limestone, sandstone and shales (see figure 8). The Tokala Formation underlies and is much older than the Ultramafic Complex of the East Sulawesi Ophiolite Belt.

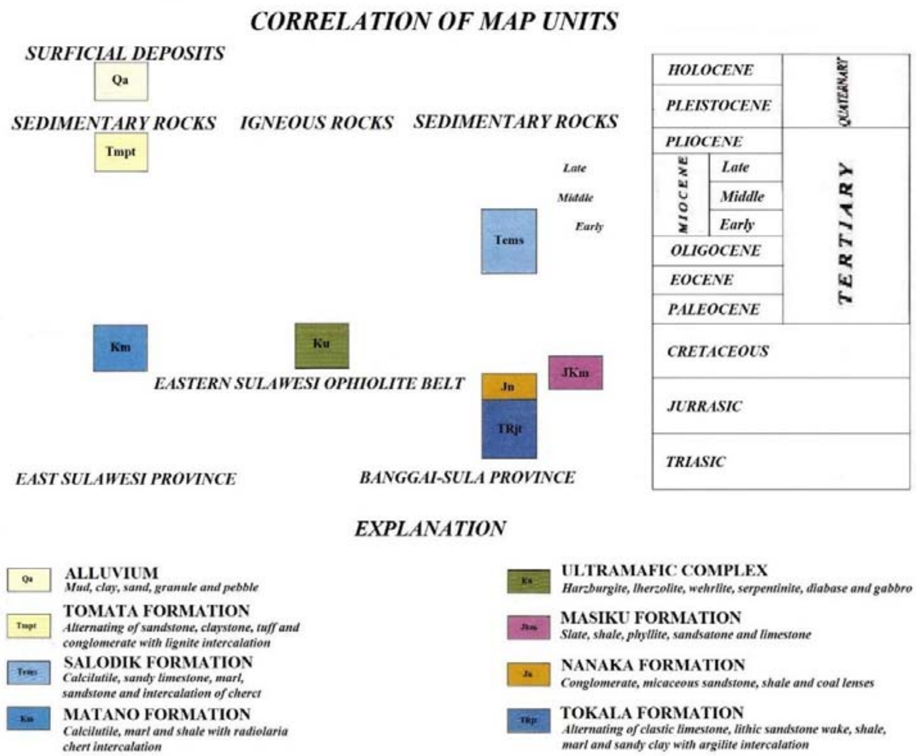


Figure 7 Regional stratigraphy in the PT Hengjaya Mineralindo area on the published 1:250,000 scale Bungku Geology Map Sheet

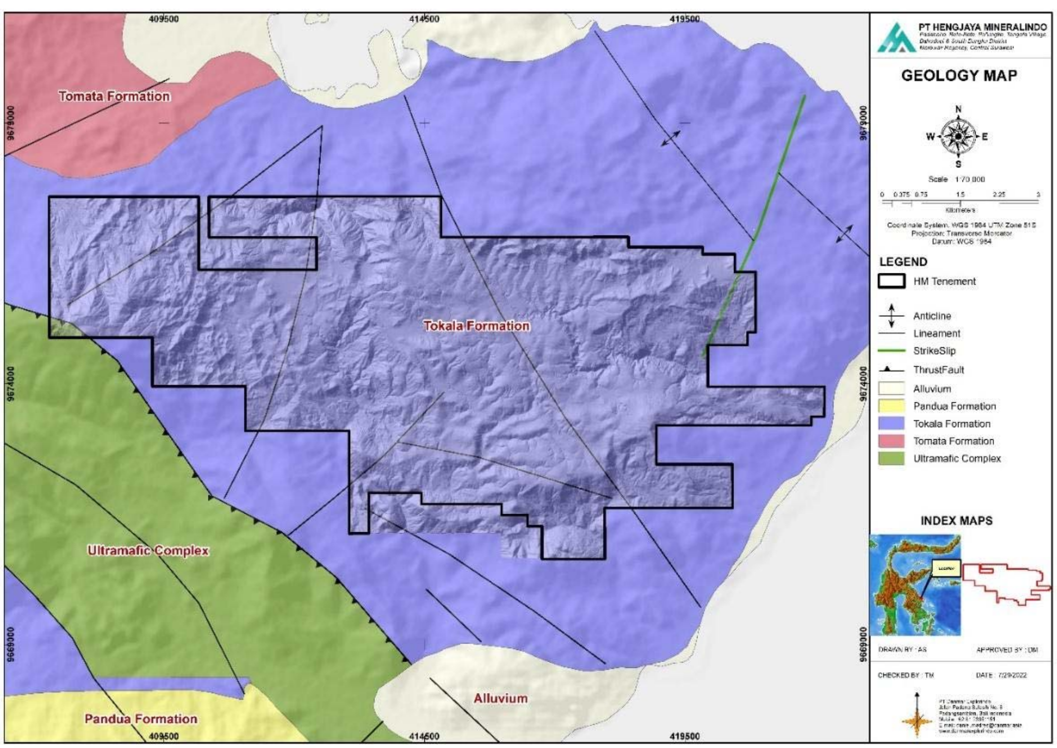


Figure 8 Published regional geology of the PT Hengjaya Mineralindo project area

3.7 LOCAL GEOLOGY

A geology map, produced by HM, has been used as a guide to the surface geology at HM during the most recent exploration program. The basic geology map is shown in Figure 9. The map is in sharp contrast with the published Regional Geology Map of the area (Figure 8) which shows the HM concession area to be covered entirely by the Tokala Formation. In reality ophiolite is the dominant rock type at the surface in the HM IUP area and extends over more than 60% of the IUP concession. The Tokala Formation is older and lies underneath the ophiolites.

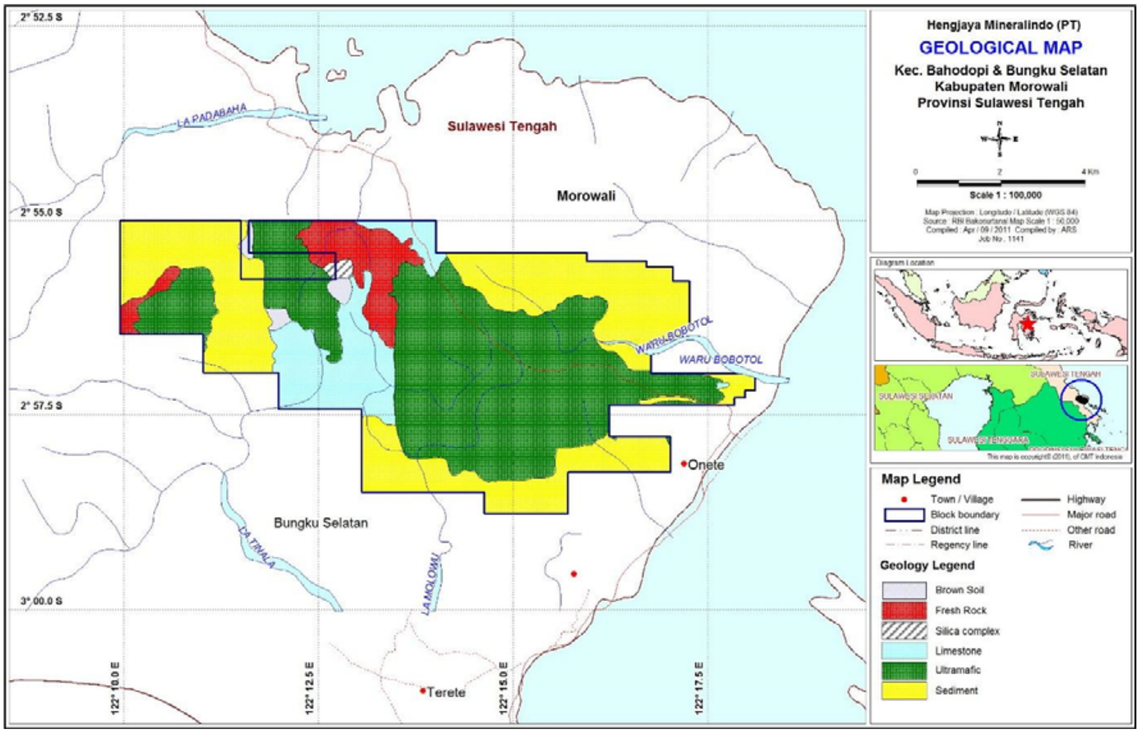


Figure 9 Local geology map

3.8 PREVIOUS EXPLORATION, RESOURCE STUDIES AND REPORTS

PT Aneka Tambang (Indonesian Government mineral company) explored the nickel potential of a broad area which included the location of where the HM concession is currently located around 2007. The work included mapping and wide spaced drilling. The data is poorly documented with many holes having ambiguous hole identification, coordinate location and or no analysis information.

HM started drilling in 2010. At least 3 separate phases of drilling were carried out. Initially, wide spaced drilling on a 400m X 400m grid was conducted followed by 100 X 100m spacing and eventually 25 X 25m grids. From 2013 onwards, drilling operations had standard operating procedures implemented (GMT Hengjaya Mineralindo Resource Report dated 2018) that meet the requirements of the JORC Code for points of observation. In 2015 sample splits were transported to PT Geoservices in Kendari for preparation of pulps and sent on to Jakarta for fused bead XRF analysis. Table 4 summarizes the drilling history at HM until 2022.

Table 5 Drilling history at Hengjaya

Drilling Company	Date	Machine Type	Core Size	Drilling Method	Total Holes	Total Meters	Sample Analysis
ANEKA TAMBANG	2007-8	JAKRO 200	NQ	FULL CORE	435	7,980	unknown source
SARANA JAYA	2010-15	JAKRO 200	HQ	FULL CORE	1002	23,803	INTERTEK ISO 17025 GEOSERVICES XRF (fused bead)
DANMAR EXPLORINDO	2019-20	DEXDRILL 200	HQ	FULL CORE	1100	21,824	HM laboratory with extenal lab checks
DANMAR EXPLORINDO	2020-22	DEXDRILL 200	HQ	FULL CORE	3003	73,367	HM laboratory with extenal lab checks
Total Drilling Completed at the Hengjaya Project					**5540**	**126,974**	

Prior to 2015, topography used was based on Landsat data which has low accuracy. During 2015, LiDAR topography survey was carried out producing a topographic map of the IUP that has high accuracy. Details are summarized in Table 5. Field survey of drill collars, pit areas, roads and mine progress has further enhanced the survey detail in the HM project area.

Table 6 Topography survey history

Survey Company	Date of Survey	Topography Area (Ha)	Survey Activity
PT. SURTECH	2015		4 SURVEY BENCHMARKS
PT. SURTECH	2015	6,740	AIRBOURNE LiDAR TOPOGRAPHY
Total Area Survey		**6,740**	

Exploration progress and subsequent Resource estimations are documented in the following reports:

Table 7 Hengjaya Mineralindo previous reports and Resource studies

Reporting Company	Report issue date	Title of Report	Report Authors
PT GMT INDONESIA	May-12	TECHNICAL REVIEW AND RESOURCE ESTIMATION FOR HENJAYA MINERALINDO CONCESSION AREA	BRET GUNTER & KRISJNA ALIMOEDDIN
PT GMT INDONESIA	Aug-15	TECHNICAL REVIEW AND RESOURCE ESTIMATION FOR HENJAYA MINERALINDO CONCESSION AREA	BRET GUNTER & KRISJNA ALIMOEDDIN
PT GMT INDONESIA	Apr-18	TECHNICAL ASSESSMENT REPORT FOR NICKEL MINES LIMITED	BRET GUNTER & KRISJNA ALIMOEDDIN
PT GMT INDONESIA	Dec-18	RESOURCE ESTIMATE REPORT FOR NICKEL MINES LIMITED	BRET GUNTER & KRISJNA ALIMOEDDIN
PT DANMAR EXPLORINDO	Jun-20	PT HENGJAYA MINERALINDO, NICKEL RESOURCE ESTIMATE, QUALIFIED PERSONS'S REPORT USING THE JORC CODE	DANIEL MADRE, CHARLES WATSON, TOBIAS MAYA

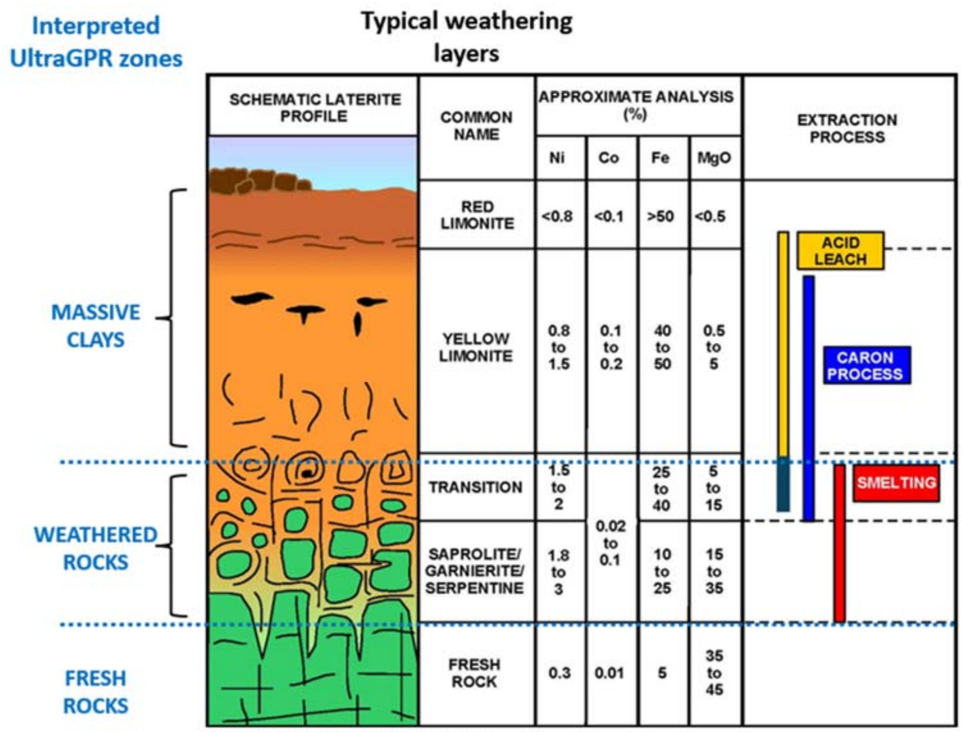
4 CURRENT EXPLORATION PROGRAM METHOD

4.1 ULTRA GROUND PENETRATING RADAR SURVEY

Groundradar's Ultra GPR technology is a geophysical survey technique that can be used to detect subsurface geological layering and structure in nickel laterite. Relatively quick and easy to apply in the field, Ultra GPR enhances the exploration process for laterites by detecting laterite thickness and bedrock morphology. The use of the Ultra GPR survey is designed to increase the confidence of geological interpretation, provide a guide to thickness and depth of the target layers and help to optimize drill programs to focus on the best areas. As with all geophysical methods, Ultra GPR provides supportive data for points of observation provided by drilling for Resource estimation.

Photo 2 Example survey acquisition using Ultra GPR equipment (source: Groundradar.com)

At HM, Ultra GPR has been a useful exploration tool to indicate the lithological contact between limonite (massive clays) and the saprolite (weathered rocks) as well as the bedrock. Results provide indicative volumes of potential limonite and saprolite located within the survey area. Results combined with drilling data can give greater confidence of nickel laterite ore body structure, dimensions and distribution. Figure 10 shows the close correlation of the interpreted GPR zones to the commonly named weathering profiles of nickel laterites



Source: Elias.M (2013) Edited with UltraGPR zones overlaid on image

Figure 10 Diagrammatic representation of a typical laterite profile in Sulawesi

Highly weathered laterite zones are typically structurally controlled. Geological structure can influence the distribution of where thicker, higher grade limonite and saprolite may be found. Although these structures can often be interpreted from the topographic surface relief, with the help of Ultra GPR, these structures can be delineated with relative confidence providing drill targets to optimize drill programs towards the thickest and most prospective locations. Figure 11 shows an example of typical survey results using Ultra GPR technologies on laterite deposits of Sulawesi.

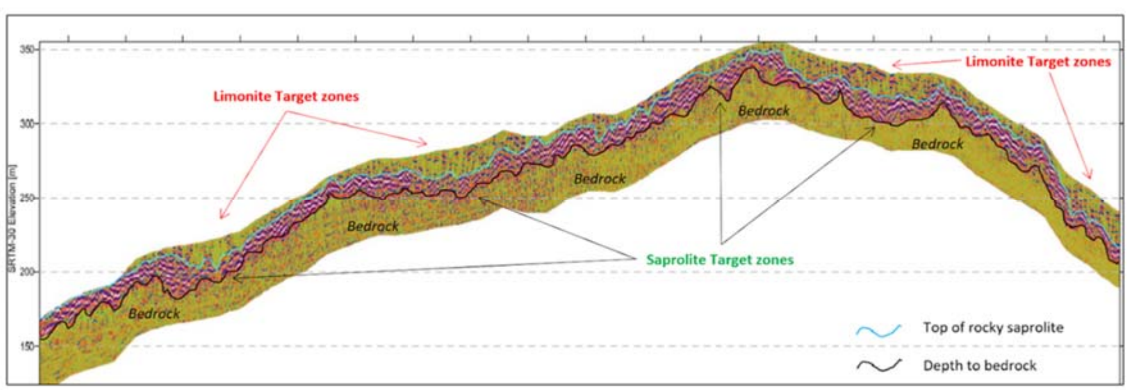


Figure 11 Example UltraGPR survey of a typical laterite profile in Sulawesi

4.2 DRILLING

In April 2019 three units of Dexdrill 200 started to systematically drill the HM nickel laterite project. This was increased to 5 units in September 2021, then 8 units in Jan 2022 and finally 14 units in April 2022. The drills are ideally suited to laterite core drilling as they are quick, lightweight and man portable. They have the added advantages of providing local people employment and also have low environmental impact with no need for road access or dozer support. The drills use HQ triple tube core barrels.

Photo 3 Dexdrill 200 at HM

Drilling was carried out using standard operating procedures designed to ensure drill data complies with the JORC Code to be used as points of observation in this study.

4.2.1 CORE RECOVERIES

In the current drill program core runs are restricted to a maximum of 1meter intervals to optimize core recoveries. Core is extracted from the inner tube and directly transferred to the core box core based on the core run. The core is then immediately measured for length to determine core recovery and or swelling. Core is arranged in maximum 1 meter runs inside the core box with each run filling a new row in the core box. Consecutive core runs are also arranged in new rows starting on the left side of the core box to avoid any mixing or contamination from other core samples. The bottom of each core interval is labeled for its depth so that the depth of the core is clearly displayed. Core boxes that are partially filled at the wellsite, and not yet completed, are carefully covered so that the samples are kept free from contamination and damage while drilling of the hole is completed.

4.2.2 DRILL COLLAR SURVEY

The topography of the Hengjaya IUP has been surveyed using LiDAR to produce a digital terrain model of the ground surface in the area. The accuracy of the LiDAR is within 15cm vertical and 40cm in the horizontal plain which is appropriate to support Resource estimates. Ground survey using E-Survey RTK GPS equipment is used to survey the drill hole collar locations.

Photo 4 Drill collar survey using E-survey RTK GPS

4.2.3 GEOLOGICAL LOGGING OF CORES

Once drilling the hole is complete, wherever possible, the full core boxes are positioned in a level place in consecutive order. In this way the full hole section can be viewed for ease of describing each run and determining the geological boundaries. The description starts at the surface and follows each 1meter core run until the total depth is reached. The core description is recorded in a standard format which has been provided by HM so that the data is easily usable and recognizable by the mine technical team. Core that contains more than 20cm of solid rock is recorded as a geological boundary. The core length is checked against the actual depth recorded in the core box. The detailed description is completed as required in the logging form. The well site geologists follow a standard operating procedure for the core logging process so that all geological logs are standardized.

Photo 5 Core boxes of a completed hole arranged in consecutive order in preparation for geological logging

4.2.4 CORE PHOTOGRAPHY

With the core boxes in position, in a level place, with no cover, in consecutive order, core photos can take place. Checks are carried out to make sure that the depth labels are clearly visible and in position at the bottom of each core run. Cores with swelling or core loss are clearly marked as well as labels showing where density samples have been removed or will be taken. The well site geologist checks to make sure the core box label shows the correct

Hole Identification, sequential arrangement, depth interval, date of start and finish drilling, EOH (end of hole), initials of the wellsite geologist and the rig identification number. When this is ready photos are taken in good light conditions making sure to minimize shadows and reflections.

Photo 6 Core photo example

4.2.5 DRILL CORE SAMPLE HANDLING

Plastic sample bags are always double layered to protect the integrity of the samples against accidental contamination, damage or loss. Samples are bagged according to the geological horizon from which they belong and or in 1meter intervals, if there is no geological boundary and the plastic identity label placed inside. After each core box is emptied the outer layer sample bag is tied with string in a bow so that it can easily be undone at the camp for rechecking and final labeling. During the sampling process, the sample form is continuously filled out so that as samples are bagged every sample is recorded. Checks are made to ensure the sample intervals and labels are correct. Rechecks are done so that the sample intervals can be reconciled and there are no gaps in the depth intervals. Samples are then packed in sacks and tied with flagging tape showing the hole identification. If stored in the field the sacks are covered for protection from the weather. Samples are transported to the field camp on a daily basis and immediately given a sample identification number provided by Hengjaya

Mineralindo laboratory. Sample numbers are determined by HM and provided for Danmar to use. Sample numbers and the depth interval labels are recorded on sampling forms which are photographed and sent to Danmar head office for recording in the HM database. During this sample labeling process, the condition of the sample bag is checked and changed if damaged. The total number of samples are rechecked against the total number of samples logged in the field at the wellsite. As a quality control protocol for every 92 exploration core samples submitted 4 sample standards (OREAS) are provided and 4 blank samples. Samples now labeled with HM sample numbers, including QA/QC samples, are repacked into the sacks tagged with the individual hole numbers ready for delivery to the HM sample store. Samples are delivered to HM core store, laid out in rows per hole and recorded in a formal sample receipt which is jointly signed by Danmar and HM.

Photo 7 Sample packing at the well site

Photo 8 Sample recheck and re-labelling at drill camp office

4.2.6 GEOTECHNICAL DRILLING AND HYDROGEOLOGY

PT Hengjaya Mineralindo (HM) is planning to significantly increase production at the mine site in the coming years. For this reason, Geomine Mining and Geotechnical Consultant ("GEOMINE") was engaged to conduct geotechnical and hydrology/hydrogeology studies. Nine geotechnical holes were drilled for the purpose of investigating the geotechnical and hydrogeological characteristics throughout the Hengjaya project area. Dexdrill 200 units were used with HQ size triple tube coring equipment.

4.3 LABORATORY SAMPLE AND ANALYSIS PROCEDURES

PT Hengjaya Mineralindo (HM) has dedicated facilities at the mine site for processing and assaying samples collected in the exploration drilling program and mining production operations at the site. At the Sample Preparation Laboratory (Prep Lab), samples are reduced from raw samples into 200# (75 micron) pulp samples. The Assay Laboratory is where the 200# pulp samples are assayed using XRF Spectrometers to provide the composition of the drill and mine samples, in particular, the weight percent of nickel, iron, cobalt, silica dioxide, magnesium oxide and calcium oxide.

The drill core samples are reduced in volume and sample particle size to produce a 60g pulp sample, from which a 10g sample is taken for a pressed pellet, or a fused bead, for XRF. The expectation is that the results obtained on the 10g pressed powder pellets or fused beads that are produced from the 1meter drill core sample are representative of the original samples. It is the primary responsibility of the HM QA/QC Department to ensure that this is the case.

4.3.1 SAMPLE PREPARATION

4.3.1.1 Wet Sample Preparation

Exploration samples from the drill program are delivered to the PT Hengjaya Mineralindo Sample Preparation Laboratory (prep lab) in batches, accompanied by a Job Sheet (Consignment Note), detailing the consignment number and the numbers of each sample contained therein. The sample bags, each containing a sample representing a 1meter advance in the drill hole, are laid out in sequence on the floor of the prep lab and the Laboratory Foreman checks each sample against the Job Sheet. Once all is in order the processing commences. Each 1meter drill sample weighs approximately 8 kgs, wet, on arrival at the preparation laboratory.

Photo 9 Drill core samples delivered to HM sample store

The drill sample is emptied from the poly-weave bags and placed on the floor, where it is broken down into smaller thumb sized pieces and built up into a cone. A metal quartering tool is then placed on top of this cone and pushed down to the floor and moved to separate the original cone of the sample into four separate unconnected portions. A trowel then takes one complete quarter portion of sample and places this into one stainless steel tray, and then a further quarter sample from the opposite side of the quartered cone is then placed into the same tray and a ticket placed into this tray. The remaining two quarters are then placed into a second tray, another sample ticket with the same number added to the second tray. The two sample trays are then weighed, using a digital balance, and the weight of the trays and “wet” sample recorded, and the trays stacked on a trolley to be taken through for drying.

Photo 10 Raw core sample preparation for quartering

The trolleys containing the trays of drill samples are then placed into drying ovens and the samples dried at different durations and temperatures depending on the source material:

Exploration samples	- 8 – 12 hours at 105° to 110° C
Mining samples	- 6 – 8 hours at 105° to 115° C
Moisture Content	- 24 hours at 105° C

4.3.1.2 Dry Sample Preparation

Once the drying process has been completed, the sample trays are removed from the ovens and then weighed, and the weights recorded. The difference between the wet weight of the sample and tray and the dry weight of the sample and the tray is recorded as the percentage moisture content. With the dry weight of the drill sample and the moisture content of the sample now recorded, the sample is ready to move to the next stage, the dry sample processing stage.

The preparation of drill samples at the HM sample preparation laboratory follows the Japanese Industrial Standard (JIS) Method for Sampling and Method of Moisture Content of Garnierite Nickel Ore - JIS M 8109 – 1996, which is a manual incremental reduction method for reducing the size of the drill sample for assay purposes, using scoops of different sizes to obtain representative samples at each of the different stages of sample preparation. The objective is to reduce the particle size of the sample by crushing and pulverizing and the size of the sample through incremental splitting, while maintaining the representativeness of the medium being sampled.

The first stage in the processing of the dried exploration drill sample is crushing, and the two sample trays of dried sample are poured into a Jaw Crusher which reduces the dried sample to a – 10 mm product which is collected in a bin underneath the jaw crusher.

Photo 11 Jaw crushing to -10mm

In the second stage, the jaw crusher product is poured into a Jones Riffle splitter which produces two similar sample products, one which is discarded, and the other bin of riffle splitter product is passed to the next stage in the processing operation.

In the third stage, the bin of Jones Riffle split product is poured into a Double Roll Crusher which reduces the -10 mm jaw crusher product into a – 3 mm product which is collected beneath the double roll crusher. This double roll crusher product is then presented to an operator for the next stage of incremental splitting.

Photo 12 -3mm sample, manual incremental reduction JIS M 8109-1996

Following the manual incremental reduction method described in the JIS M 8109 – 1996 standard, the fourth stage consists of the - 3 mm double roll crusher product being first leveled with a small metal backing plate and then 10 approximately identical increments are delineated in the tray, 5 increments along the long side of the tray, and 2 increments along the short side of the tray to produce a 2 x 5 matrix. Using a backing plate and a 5d sized scoop, the scoop is thrust into the bottom of the sample in one increment and this material is removed and placed into a plastic bag. The 5d scoop is then thrust into the remaining adjacent sample and this is then placed into a separate steel tray. Two smaller samples have now been collected from the original one increment. This process is repeated with the remaining 9 increments in the original tray until one plastic bag has been filled with ten scoops of the original sample and another 10 scoops have been collected from the same original sample and placed into a separate tray. Each of these two incremental split samples weighs approximately 500g each, and one will be labeled and sent to sample storage, while the other sample will be sent to the next stage in the processing cycle, the pulverizer.

In addition to the above, before discarding the remaining double roll crusher product, a further sample is collected, approximately every 20 samples, and placed in a brown paper envelope and numbered with a DR suffix, this being a Double Roll Crusher product sample that will be sent for assay to test the performance of the two crushing and splitting stages, often referred to as the Course Reject sample, or at HM or the Double Roll (DR) sample.

The fifth stage consists of the 500g -3 mm double roll sample being placed into a pulverizing bowl, a puck added, the lid is replaced, and this unit placed inside the Essa Pulverizer using a cradle. The cradle is removed, and the machine turned on and run for 5 minutes, after which the pulverizer bowl is removed from the machine using the cradle, the lid removed, the puck taken out, and the pulverized sample, the “pulp”, placed onto a tray, and passed on to the next stage of incremental splitting.

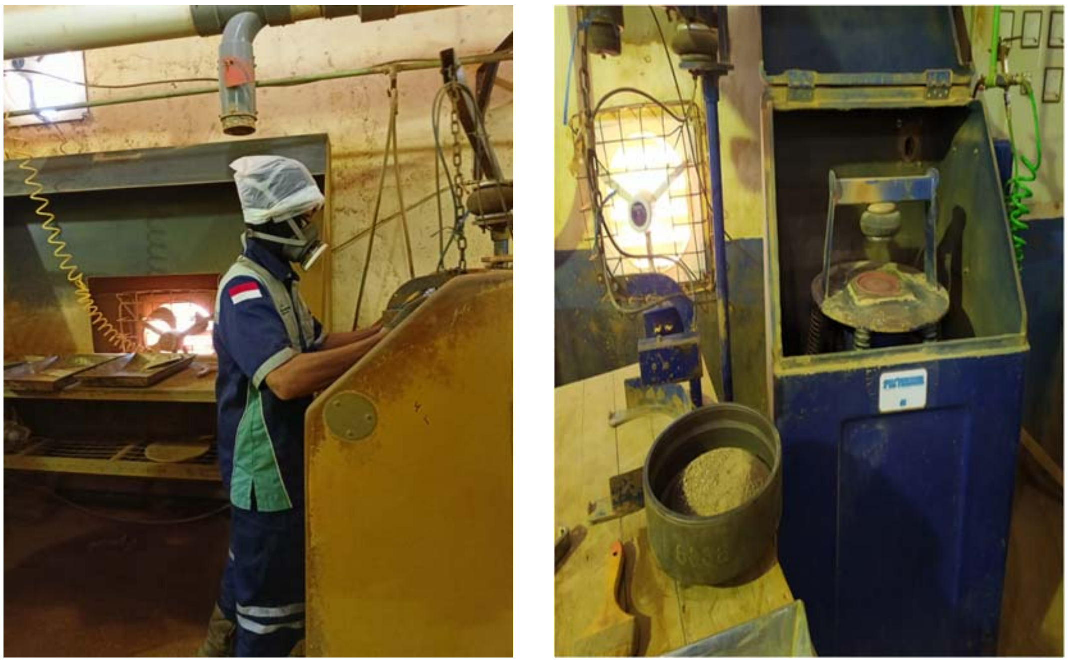


Photo 13 Sample placed in pulverizer

In the sixth stage of sample preparation, the pulp sample is then carefully mixed, flattened and cut into a 4 x 5 matrix to produce 20 increments in a similar way as for the double roll crusher product. Using the smallest sized 0.25 D scoop, and a metal backing plate, the scoop is thrust into one side of the increment, removed and placed in a brown paper envelope. The scoop is then thrust into the adjacent portion of the increment and then emptied into a second brown paper envelope. This process is continued until all 20 increments have been scooped and the pulp from each of the 20 increments have been transferred into two brown paper envelopes, one of which goes to the Assay Lab, and the second sample goes to storage. Any residual pulp remaining from this second incremental splitting is discarded as waste.

As part of the monitoring of the sample preparation process a particle sizing test is undertaken on one in ten of the pulverized product pulps, to ensure the pulverization has been done properly. This is undertaken after the pulverized product has been taken from the pulverizing bowl and prior to the incremental splitting stage. A small sample of material is weighed and then placed on a 200# (75 micron) stainless steel screen and screened until all the sample that can pass the 75 micron screen has passed, and the weight of the -75 micron material and the weight of the +75 micron products are both weighed and recorded. If the weight of the -75 micron product is more than 95% of the total pulp sample weight, then the pulverization process is acceptable. If the weight of the -75 micron product is less than 95% of the total weight then this is not acceptable and the sample will be returned to the pulverizer for further pulverization to ensure more than 95 % of the sample passes the 200# screen.

Photo 14 Pulverized sample sieve analysis

Photo 15 Sieve analysis results measurement

In addition to the standard sample processing procedures described above, two further sample processing techniques are performed at the PT HM sample preparation laboratory to provide additional information for the geological and mining databases, these being Specific Gravity (density) testing and the measurement of the Moisture Content of samples.

4.4 SPECIFIC GRAVITY MEASUREMENT

During the drilling of each drill hole, samples are collected from each of the four geological lithologies encountered in the hole, namely soil or overburden, limonite, saprolite and bedrock. These density samples are collected at the drill site, with a small section of unbroken drill core, at least 20cm long, being weighed and recorded. The average weight of these specific gravity samples is generally between 700g and 800g. Following weighing, each sample is then wrapped in plastic cling wrap and sealed with masking tape to maintain the natural condition and sent to the sample preparation laboratory as a priority.

Photo 16 Density samples delivered to sample store

Upon arrival, at the prep lab, the samples are carefully unwrapped and placed in a sample tray containing each separate lithology sample from that drill hole, including: soil or overburden, limonite, saprolite and bedrock.   The samples are then trimmed, weighed and placed back into a tray. A plastic measuring cylinder is then filled with a known volume of water, and the original level of water in the cylinder measured. The lithological sample is carefully lowered into the measuring cylinder and the displaced water level rises, and this second water level is measured and recorded. The mass of the lithological sample is then divided by the water displaced in the measuring cylinder to give the specific gravity, the density, of that particular lithology.

Photo 17 Core samples ready for density measurement

Photo 18 Weighing density samples at the sample preparation lab

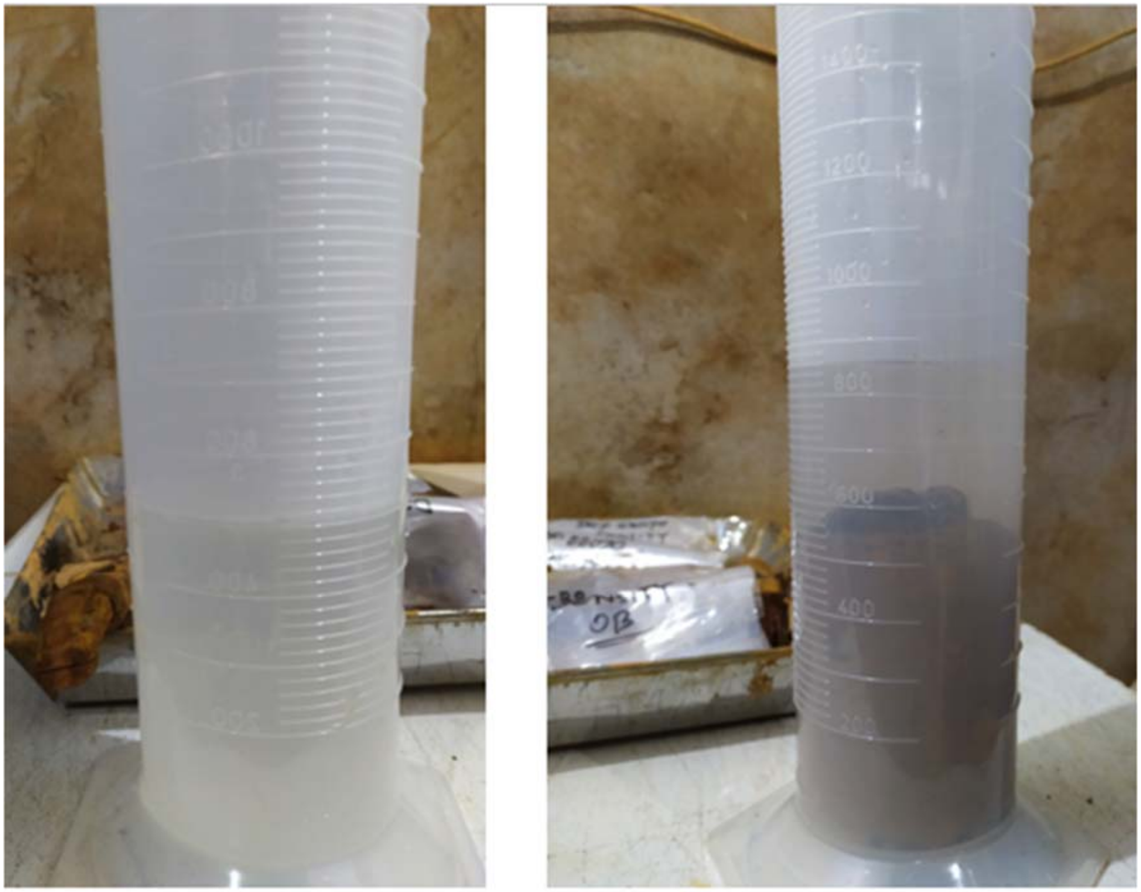
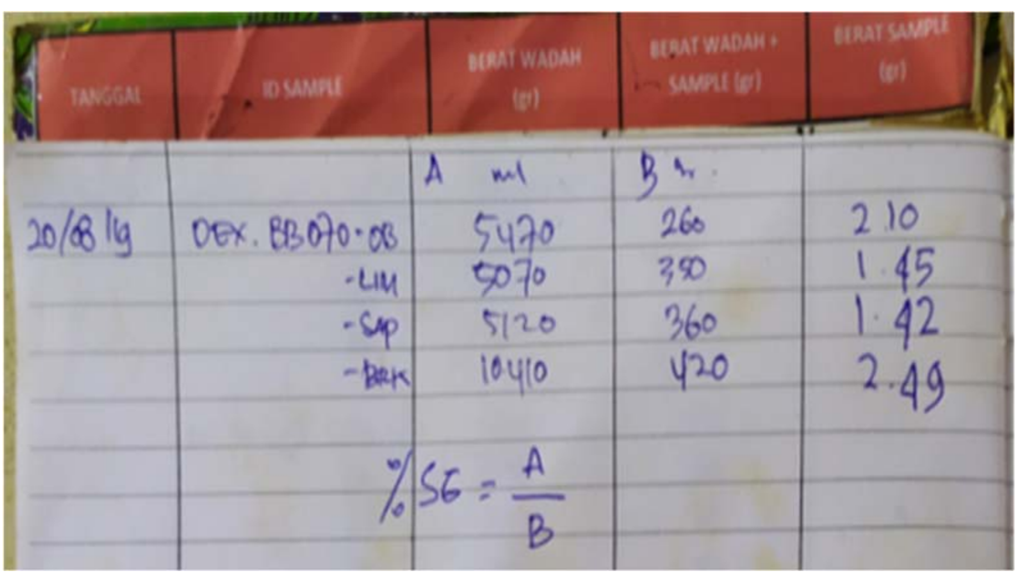


Photo 19 Density sample volume measurement by the displacement of water

Finally, the results are recorded and density is calculated by volume divided by the weight.



TANGGAL	ID SAMPLE	BERAT WADAH (gr)	BERAT WADAH + SAMPLE (gr)	BERAT SAMPLE (gr)
		A ml	B gr	
20/08/19	DEX. BB070-OB	5470	260	2.10
	-LIM	5070	350	1.45
	-SAP	5120	360	1.42
	-BRK	10410	420	2.49

$\% SG = \frac{A}{B}$

Photo 20 Density data record

4.5 MOISTURE MEASUREMENT

Moisture content is an important property of nickel laterite ore samples, being a hygroscopic material and able to absorb moisture in its natural state. This can affect the efficiency during the smelting process, which can result in a lower price received per ton of smelted ore.

The Moisture Content of the drill samples is calculated through weighing the drill samples wet, before they are placed in the ovens for drying, and again when they have been removed from the ovens and prior to the first stage of crushing. The difference in weight between the weights of the samples before and after drying, divided by the original wet weight of the sample gives the Moisture Content as a percentage figure, as per the equation below:

$$\textbf{Moisture Content:} \quad MC = \frac{w - d}{w} \times 100 \qquad \begin{array}{l} w = \text{wet weight} \\ d = \text{weight after drying} \end{array}$$

Photo 21 Drill core sample delivery to HM preparation lab and wet sample weight measurement

Wet exploration samples for Moisture Content measurement are placed in drying ovens and dried at 105^0 for 24 hours.

Photo 22 Wet samples are placed in oven

Photo 23 Dry samples removal from oven

Photo 24 Wet and dry sample weight measurement

4.6 ANALYTICAL METHODS AND STANDARDS

The pulp samples of 50 – 60g from each consignment completed at the sample prep lab are sent to the Assay Lab at the HM Camp where they are recorded into the production register and then placed into an oven to protect the samples from absorbing atmospheric moisture.

Photo 25 Sample pulp storage in desiccating oven and pressed pellet preparation

A new assay lab number is assigned to each pulp sample packet, this is undertaken at the same time as Certified Reference Materials (CRMs), pulp duplicate samples, coarse rejects, blank check and replicate check samples are inserted into the sample streams as part of the Quality Control procedures. After checking that the renumbering of these samples has been completed correctly, the samples are then taken through to the preparation room and placed in a desiccator to await the production of pressed pellets.

The sample numbers are written on the base of a Chemplex pellet cup and a 10g sample of pulp is carefully taken from the envelope containing the pulp sample, weighed and placed inside the Chemplex cup. This is then placed inside a 15tons Hydraulic Press and the press pumped to a load of 12tons, before the pressure is released, the die removed and the pressed powder pellet released. The pressed powder pellets are then placed in pyrex dishes, 9 pellets per dish, and returned to the desiccator before being taken through to the XRF Spectrometer Room.

Photo 26 Pressed pellet production from sample pulp ready for XRF analysis

The Assay Lab is now using a Malvern Panalytical Epsilon 4 and a Bruker Puma S2 XRF unit for the analytical work. At this time exploration samples are being assayed using pressed pellets while some mining samples are being assayed using Fused Beads.

Both the Epsilon 4 and Puma S2 XRF's are compact energy dispersive spectrometers capable of undertaking elemental analysis configured with dedicated software specifically for the nickel laterite suite of elements. Both units use Nickel XRF 12 Element Suites for Ni, Fe, Co, MgO, SiO2, CaO, Al2O3, Cr2O3, MnO, P2O5, SO3 and TiO2.

The sample tray is removed from the spectrometer and each pressed pellet sample is placed sequentially into the sample holders in positions two to ten. An Oreas CRM Ni standard is placed into the first sample holder of each run as part of the Quality Control procedures. The pellet sample numbers are then checked to ensure that the correct samples are in the correct positions on the carousel and the spectrometer lid is closed. The machine operator checks that the sample consignment information and sample numbers have been entered correctly onto the software program and the machine switched on, and the assaying run begins.

Photo 27 Pressed pellets being loaded into XRF machine

Each pressed powder pellet is subjected to a beam of X-rays which are reflected onto a detector which determines and records the elemental composition of the sample being assayed. Each sample is subjected to this procedure for approximately 4.5 mins each, and each run of ten samples takes approximately 45 min to complete. While the assaying is taking place, the information showing which numbered sample holder is being assayed, and the results of the samples assayed in that run appear on the computer screen, and the data is recorded. At the end of the run the machine stops, the lid is opened and the sample holder removed, the pressed pellets are removed from their sample cups and the equipment readied to receive a further ten pellets for the next run. The results from the analysis of the previous pressed powder pellets are then passed to the QA/QC lab staff for monitoring and printing of the assay results.

4.6.1 QUALITY ASSURANCE / QUALITY CONTROL

The Quality Assurance and Quality Control program at HM consists of four different aspects, these being:

4.6.1.1 Quality Assurance

Quality assurance (QA) is a proactive approach to ensure that the chemical analyses of samples are correct and accurate. Quality assurance systems and SOP’s are in place before a batch of samples is sent to the laboratory for analysis, aiming to prevent errors being made in the assay process. Quality assurance includes two principles, think “fit for purpose”, the product being suitable for the intended purpose, and the second being “right first time”, where mistakes should be eliminated.

The primary Standard Operating Procedure (SOP) for the samples submitted by the exploration and mining operations at PT HM is the “JIS Method for Sampling and Method of Determination of Moisture Content of Garnierite Nickel Ore” JIS M-8109-1996, by H.Kanazawa, August 1996. This Japanese industrial Standard specifies the following methods for this purpose of determination of the average grade and moisture content of a lot of garnierite nickel ore as follows:

1. Method of taking the sample
2. Method of sample preparation for moisture test sample and quality sample.
3. Method of measuring the moisture content
4. Method of determination of the moisture content and dry mass of the lot.

4.6.1.2 Quality Control

Quality control (QC) is a reactive process of analyzing the data returned from the lab. This is crucial for determining the quality of the data and revealing any deviations from the norm. This step should be conducted during the sampling campaign to ensure any issues are identified and quickly rectified.

A comprehensive quality control program will monitor the different stages of the sampling, preparation and assaying stages with the aim of controlling and minimizing any possible measurement error. This is done at the sample collection and splitting stage through controlling the sampling precision. It continues through the sample preparation and sub-sampling stages through controlling the sub-sampling precision and contamination during preparation. The final stage is controlling the analytical accuracy, analytical precision and contamination during assaying.

Quality Control is ensuring that checks and balances are implemented and are constantly reviewed and assessed, in order to identify whether the sampling /measuring systems and the laboratory are providing quality assays, meaning they are “in control”. In the minerals industry, the checks and balances commonly used to monitor the sample preparation and assaying processes includes standards, blanks and duplicates.

Sterk discusses how geoscientists should be aware of variance, and QA/QC and Acceptance Testing (Reporting and Review) are relevant at every stage of the sample collection, sample preparation and assaying treatment. This is important, and we should assess the QA, QC and AT at each and every sample treatment stages. At HM, these are considered as Primary

Sample, 1st Split, 2nd Split, 3rd Split etc., and Analytical, and a summary of these different stages is given in Section 4.3 of this report. These samples are collected at the HM Sample Prep Lab.

4.6.1.3 Reporting and Review

Continuous reviewing and reporting is important to ensure that processes are monitored for quality in order to identify problems and improve systems, and when identified should be incorporated into protocols for staff to follow.

4.6.1.4 Continuous Improvement

Quality data management should be dynamic, with protocols, procedures and sampling practices undergoing regular examination for continual improvement with the aim of removing sources of error and quality degradation. It is an ongoing process. Current international mining standards such as JORC Code 2012, require that a program of data verification is included with any exploration program to confirm the validity of the exploration data, and this is normally done by inclusion of JORC Code, 2012 Edition – Table 1 Report Template, a copy of which is attached Appendix 1 of this report. By implementing a Quality Assurance/Quality Control (QA/QC) program, it is possible to identify and measure any errors within the system, with the objective of reducing uncertainty within our ore Resource estimates, and adding value to our project, the company and all its stakeholders.

4.7 SAMPLE SECURITY, AUDITS AND REVIEW

Sample core store at the mine office can be locked when unattended and is located in front of the security post which operates 24 hours per day.

A Sample Dispatch Form SOP and construction of a special purpose sample storage facility, adjacent to the Sample Prep Lab at the port, ensures samples are properly recorded and duplicates stored for future reference if required. Sample store at the port is locked when unattended and is adjacent to a security post that has 24 hour security.

5 RESULTS

5.1 GPR SURVEY

Ultra GPR surveys to date and the results are summarized as shown in Table 8.

Table 8 Ultra GPR survey summary

IPPKH AREA	PROSPECT AREA	Survey area (Ha)	Total Traverse Lines	Total UltraGPR Survey Length (km)
IPPKH 1	BETE BETE EXTENSION	94	40	37
IPPKH 2	BETE BETE EAST	107	27	22
IPPKH 2	BETE SOUTH / CENTRAL WEST	472	66	100
IPPKH 1	BETE WEST (MIA)	175	33	38
IPPKH 2	CENTRAL EAST	204	55	39
IPPKH 1	BETE FAR WEST	259	47	52
IPPKH 3	CENTRAL EAST / CENTRAL WEST	727	95	156
IPPKH 5	CENTRAL NORTH / BETE WEST	395	95	84
Total		**2434**	**458**	**529**

The survey lines shown in Figure 12 below. The Ultra GPR survey data from all areas were of good quality and were easily interpretable. Maps were created showing the interpreted thickness of limonite, saprolite and depth to bedrock. The total area surveyed was approximately 2,434Ha. The nominal spacing between radar lines was approximately 100m with some 50m spacing in the Bete Bete mining area. The Ultra GPR survey grid, where possible, is in the same location as the drill lines. Table 9 shows the resulting interpretation for laterite volumes using the Ultra GPR data.

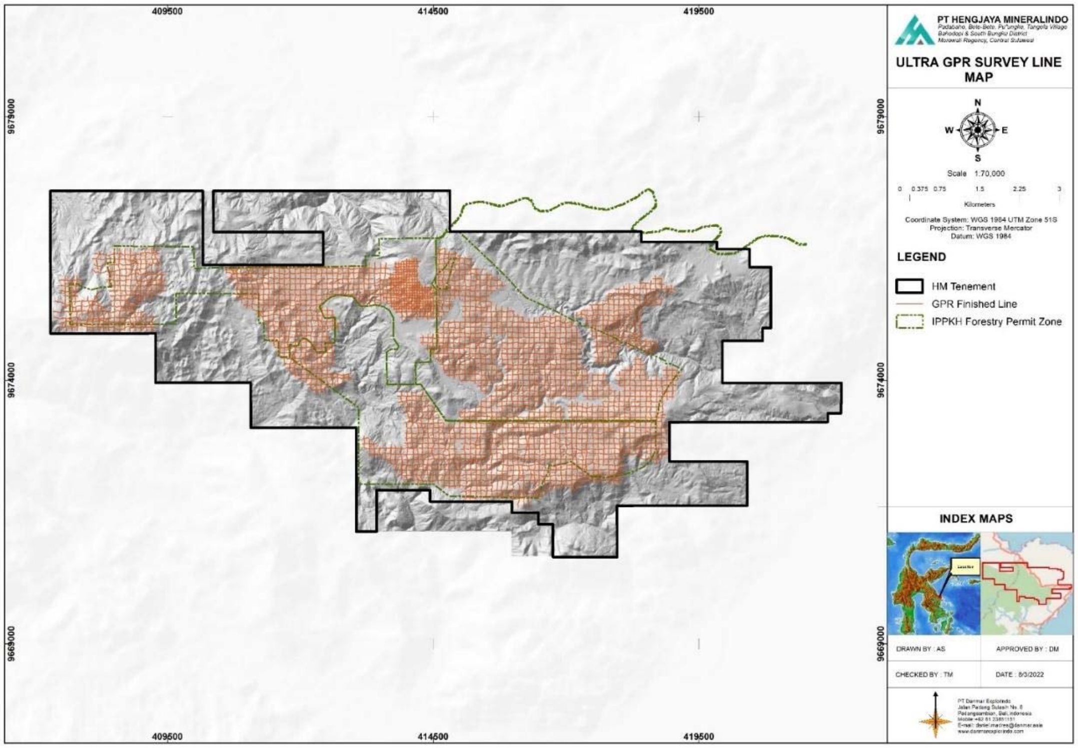


Figure 12 Ultra GPR survey lines on topographic map

Table 9 Ultra GPR survey results interpretation

Block Id	Block size (Ha)	Material Type	Volume (m3)
BETE BETE – EXTENTSION	94	Massive clays (Limonite)	5,400,000
		Weathered Rocks (Rocky Saprolite)	7,000,000
Sub Total		TOTAL LATERITE	12,400,000
BETE BETE - EAST	107	Massive clays (Limonite)	5,200,000
		Weathered Rocks (Rocky Saprolite)	7,000,000
Sub Total		TOTAL LATERITE	12,200,000
CZ21 - WEST	472	Massive clays (Limonite)	42,200,000
		Weathered Rocks (Rocky Saprolite)	69,700,000
Sub Total		TOTAL LATERITE	111,900,000
BETE WEST (MIA)	175	Massive clays (Limonite)	6,500,000
		Weathered Rocks (Rocky Saprolite)	12,300,000
Sub Total		TOTAL LATERITE	18,800,000
CZ21 - EAST	204	Massive clays (Limonite)	18,800,000
		Weathered Rocks (Rocky Saprolite)	31,000,000
Sub Total		TOTAL LATERITE	49,800,000
BETE FAR WEST	259	Massive clays (Limonite)	16,800,000
		Weathered Rocks (Rocky Saprolite)	26,100,000
Sub Total		TOTAL LATERITE	42,900,000
IPPKH3	727	Massive clays (Limonite)	39,300,000
		Weathered Rocks (Rocky Saprolite)	88,300,000
Sub Total		TOTAL LATERITE	127,600,000
IPPKH5 / BETE WEST	395	Massive clays (Limonite)	14,300,000
		Weathered Rocks (Rocky Saprolite)	23,500,000
Sub Total		TOTAL LATERITE	37,800,000
ALL	2434	Massive clays (Limonite)	148,500,000
		Weathered Rocks (Rocky Saprolite)	264,900,000
Grand Total		**TOTAL LATERITE (m3)**	**413,400,000**

An example of an Ultra-GPR section interpretation covering 1,850m in the Central East area is shown in Figure 13.

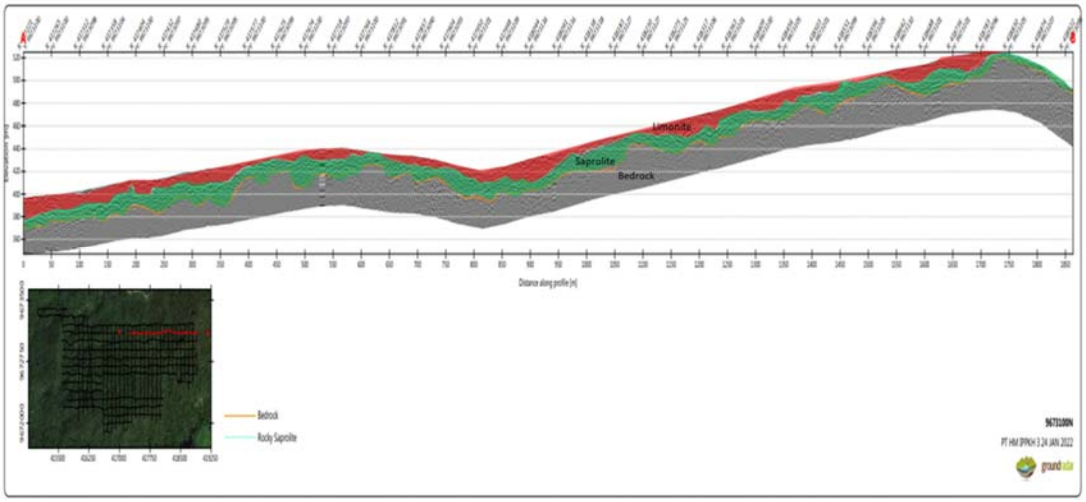


Figure 13 Ultra GPR section line interpretation example from Central East (phase 7)

Figure 14 shows the limonite thickness interpreted from the UltraGPR survey data. Figure 16 shows the saprolite thickness interpreted from the UltraGPR survey data.

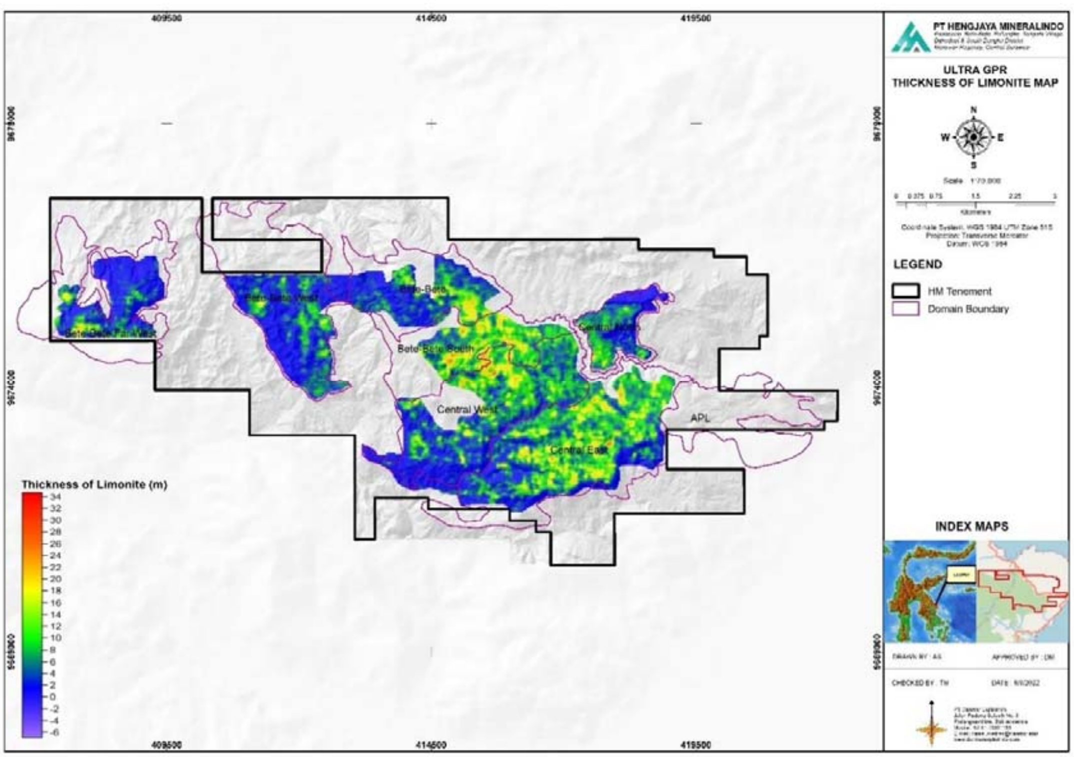


Figure 14 Limonite thickness interpreted from the Ultra-GPR survey

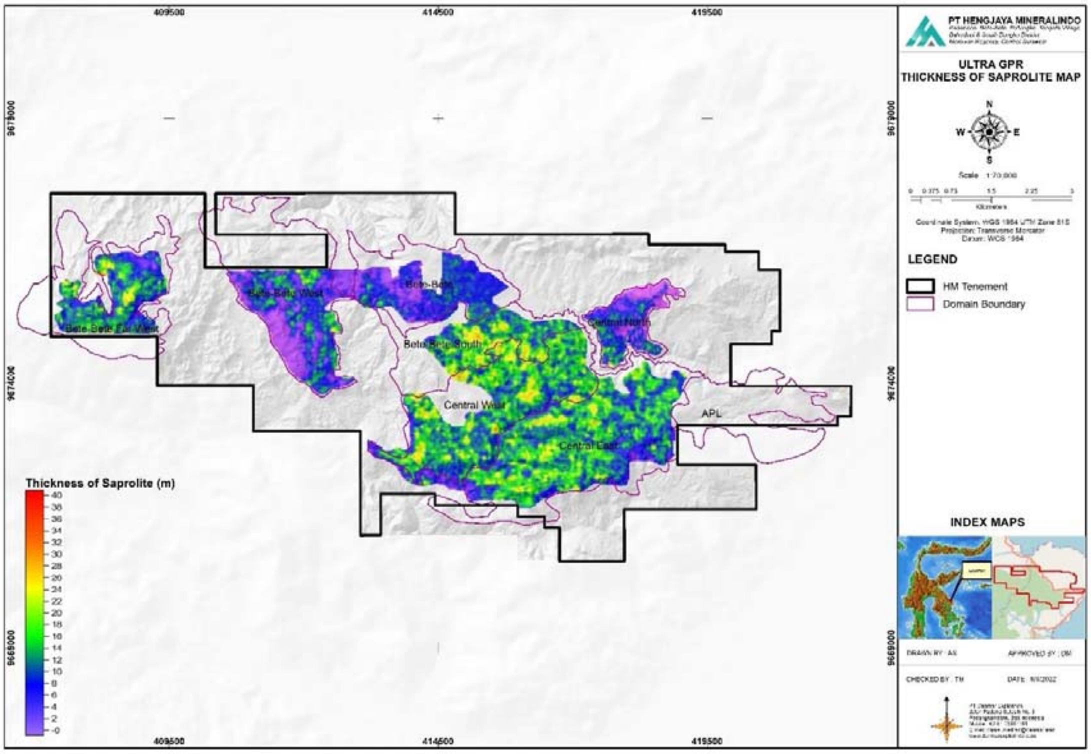


Figure 15 Saprolite thickness interpreted from the Ultra-GPR survey

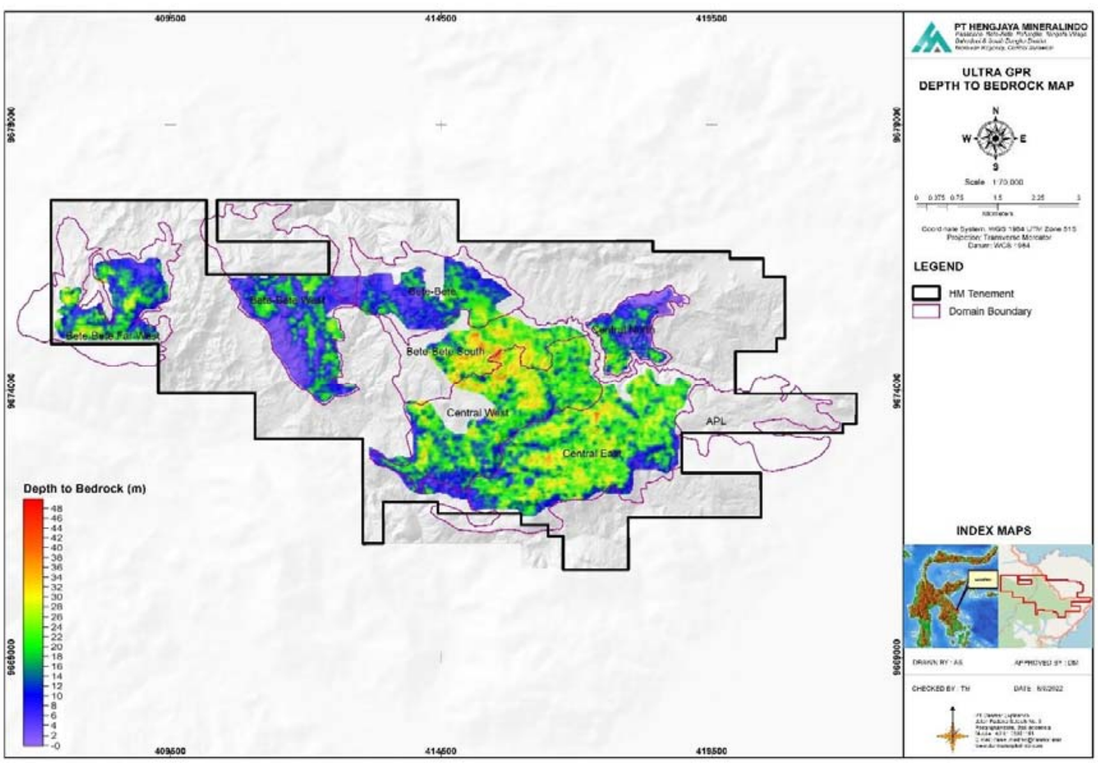


Figure 16 Depth to bedrock interpreted from Ultra-GPR

5.2 DRILL RESULTS

Validated drill data used in this study is summarized below in Table 10.

Table 10 Drill data statistics

DOMAIN		DRILLING USED IN RESOURCE			DRILLING EXCLUDED FROM RESOURCE		
Name	Area (Ha)	Drillholes	Cummulative Meters	Sample Assay Completed	Drillholes	Cumulative Meters	Sample Assay Completed
Bete Far West	371	129	2,101	2,174	7	60	64
Bete West	419	49	703	704	27	308	322
Bete Bete	348	600	10,680	11,246	52	772	421
Bete South	325	563	12,909	13,263	116	2,833	2,122
Central East	698	856	20,882	21,443	141	2,845	2,320
Central North	151			-	9	137	131
Central West	550	2,105	51,603	53,262	338	7,383	6,368
APL	178	355	9,417	9,551	193	4,343	4,112
TOTAL	**3,040**	**4,657**	**108,294**	**111,643**	**883**	**18,680**	**15,860**

For the purpose of this Resource estimate, a database of validated drilling data including 4,657 drill holes with a cumulative total depth of 108,294m and 111,643 analyses results has been constructed. Most of the drilling is on a systematic grid, providing a regular spread of drill data over most of the laterite areas with Forestry permits. The drilling locations used in this study are displayed in Figure 17. Other drill data excluded from the Resource database has only been used for Exploration Target identification.

Most (75%) of the drilling has been done at less than 100m spacing on Ultra-GPR targets with the objective of Resource definition in these areas. The distribution of drilling in each Resource block area is summarized in Table 11.

Table 11 Drilling distribution per domain

Domain Name	Area (Ha)	No. of Drill holes by Average Drilling Spacing				
		Mined Out	<50m	50-100	100m	Exploration Targets *
Bete Far West	371	-	-	-	129	3
Bete West	419	-	-	-	49	21
Bete Bete	348	161	478	37	-	-
Bete South	325	-	57	362	146	-
Central West	550	158	1499	249	198	68
Central North	151	-	-	-	-	9
Central East	698	51	302	141	360	17
APL	178	243	101	11	-	167
TOTAL ALL BLOCKS	**3040**	**613**	**2437**	**800**	**882**	**285**
% OFTOTAL AREAS DRILLED		**12%**	**49%**	**16%**	**18%**	**6%**

** Drilling in Exploration targets are not included in the Mineral Resource*

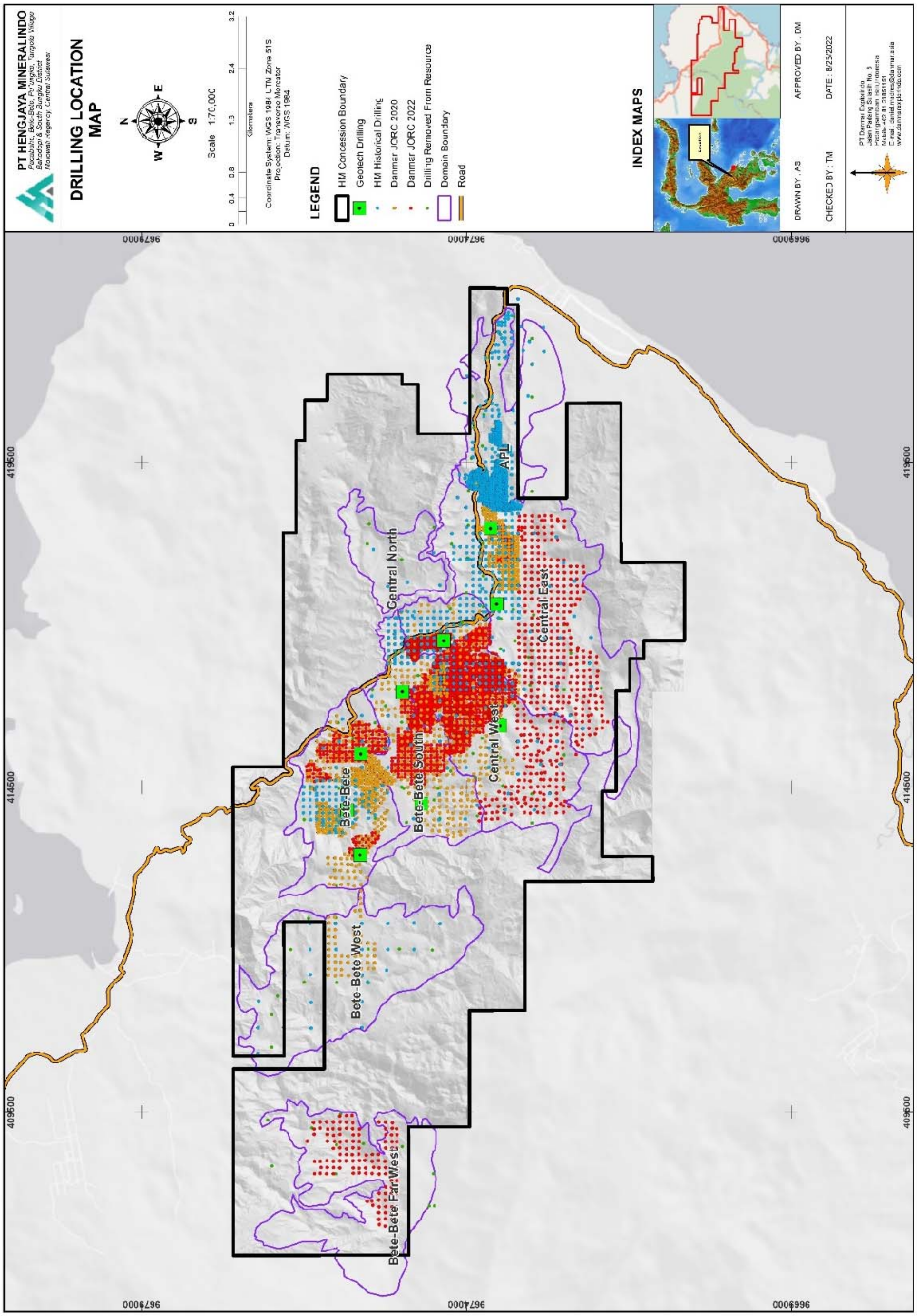


Figure 17 Drill hole location map

Core recovery data is summarized below. Data from the latest drilling programs was systematically recorded and includes core recovery measurements supported by core photography. Some of the older data did not include core recovery information but was used in the Resource because it had complete geological log and sample analysis data which was similar to the results found in the surrounding holes that had core recovery information. It is therefore considered unlikely that any bias was introduced to the Resource because of the inclusion of these holes. Core recovery data is summarized in Table 12.

Table 12 Core recoveries

Data Source	Laterite Profile	Recorded Core Recovery				Unavailable Records
		≥ 95%	95%-90%	90%-85%	< 85%	
Hengjaya Historical Database	SOIL	65.2%	1.7%	4.9%	0.3%	27.9%
	LIM	72.2%	1.5%	2.7%	0.1%	23.5%
	SAP	59.4%	6.1%	12.4%	0.8%	18.4%
	BRK	59.9%	5.6%	22.7%	1.2%	19.8%
	AVERAGE	62.3%	4.4%	11.2%	0.6%	21.5%
Danmar New Drilling Database	SOIL	99.7%	0.1%	0.1%	0.1%	0.0%
	LIM	96.5%	0.3%	0.0%	0.1%	3.4%
	SAP	97.2%	0.4%	0.4%	0.9%	1.2%
	BRK	97.3%	0.6%	0.8%	1.3%	0.0%
	AVERAGE	97.4%	0.3%	0.3%	0.6%	1.5%
Average Total Samples Included in Mineral Resource		89.6%	1.2%	2.7%	0.6%	6.0%

An unofficial translation of the results of these studies are summarized below (see APPENDIX 9.6 Geomine, PT Hengjaya Mineralindo Geotechnical & Hydrogeological Report, Dec 2021).

5.3 GEOTECHNICAL AND HYDROGEOLOGY STUDIES

Based on the results of the interpretation of hydrogeological conditions at PT Hengjaya Mineralindo, it is known that the hydro-stratigraphic layers of groundwater system is divided into three units that are; clay lateritic soil (upper laterite), lower laterite and weathered ultramafic rock, and fresh ultramafic rock. The layers that form the main aquifer zone in this groundwater system are lower laterite and weathered ultramafic rock. Lower laterite layer and weathered ultramafic rock are grouped into one main aquifer zone with thickness ranges from 10-30 m. The clay laterite soil serves as an impermeable seal. The fresh, unjointed ultramafic rock layer acts as an aquifer floor, assumed to be continuous to a thickness of more than 100 meters.

Data requirements for groundwater level and hydraulic conductivity are considered to have met the minimum data requirements for analysis. The data was obtained from field Slug test measurements at nine geotechnical boreholes, with a total cumulative depth of 220m and from data collected at exploration wells and other reference sources in the area.

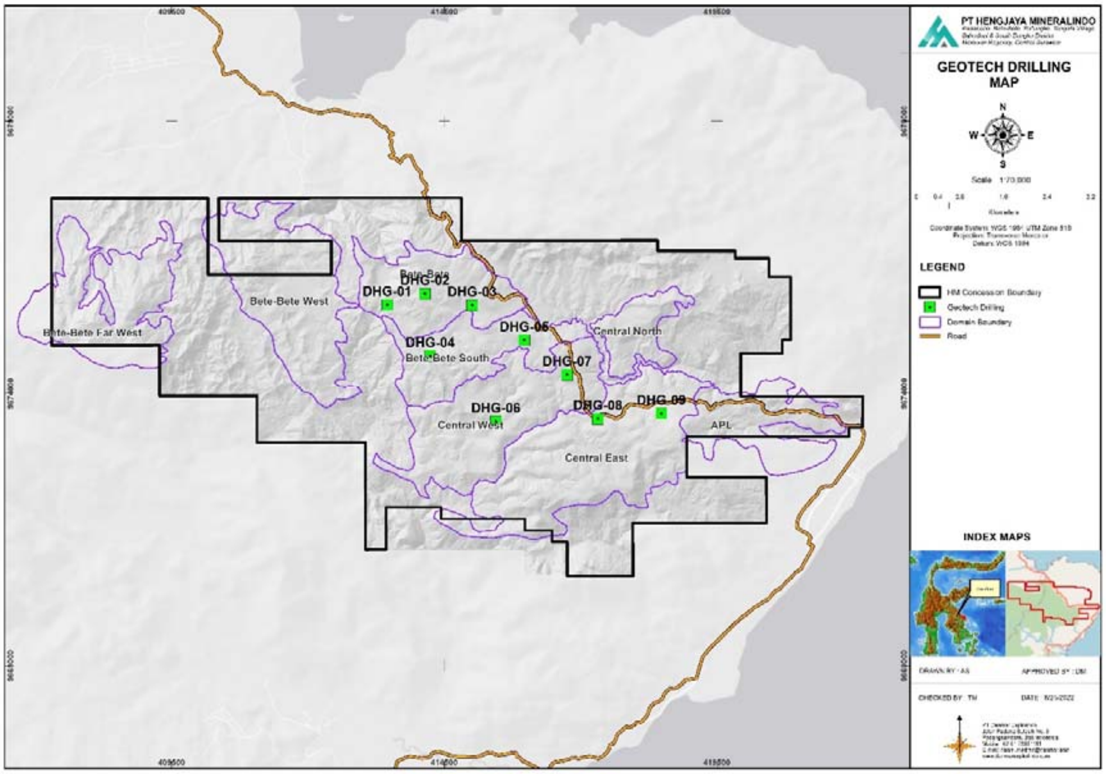


Figure 18 Geotechnical & hydrogeological drilling location map

Based on the prediction model, the estimated result of groundwater inflow in the first year is 22.19 liters/second and gradually decreases towards a steady line around 19.00 liters/second in the following years. Groundwater inflow discharge in general tends to be small due to the relatively low groundwater level, so that it is not expected to significantly intersect with the mine area.

Technical recommendations related to drainage plans including the design of drainage channels, sumps and pumping, as well as sediment ponds, have been provided.

The data collection of HM material properties was carried out through geotechnical logging of the cores of the nine geotechnical drilling holes and the results of physical and mechanical properties testing. Validation of properties using actual geometry and Reverse analysis, using instability indication was also carried out to determine the properties that represent the characteristics of the geotechnical domain in the HM area.

Single slope stability analysis shows that the majority of single slope geometries meet the minimum of Safety Factor criteria, especially for the saprolite and bedrock domains. For the limonite domain, a 3meter high bench level, with saturated conditions, meets the criteria, but for the 5meter high bench level a dry condition is required to be able to meet the safety criteria. Table 13 summarizes the results.

Table 13 Slope Stability Analysis Results

Lithology	Bench Height (m)	Slope (°)	*Saturated Moisture Condition*			
			FK Statik	POF	FK	POF
Limonite	3	45	1.68	0.00%	1.44	0.00%
		50	1.58	0.00%	1.36	0.00%
		55	1.46	0.00%	1.28	0.00%
		60	1.35	0.00%	1.19	0.00%
	5	45	1.2	0.00%	1.03	0.00%
		50	1.11	0.00%	0.96	0.00%
		55	1.02	0.00%	0.89	0.00%
		60	0.92	0.00%	0.82	0.00%
Saprolite	3	45	6.33	0.00%	4.96	0.00%
		50	6.25	0.00%	4.97	0.00%
		55	6.19	0.00%	4.98	0.00%
		60	6.15	0.00%	4.8	0.00%
	5	45	3.91	0.00%	3.23	0.00%
		50	3.82	0.00%	3.11	0.00%
		55	3.8	0.00%	3.04	0.00%
		60	3.77	0.00%	2.92	0.00%
Bedrock	3	45	17.13	0.00%	13.39	0.00%
		50	16.91	0.00%	13.41	0.00%
		55	16.76	0.00%	13.45	0.00%
		60	16.65	0.00%	12.97	0.00%
	5	45	10.63	0.00%	8.71	0.00%
		50	10.48	0.00%	8.59	0.00%
		55	10.38	0.00%	8.29	0.00%
		60	10.37	0.00%	8	0.00%
Lithology	Bench Height (m)	Slope (°)	*Dry Condition*			
			FK Statik	POF	FK	POF
Limonite	5	45	1.62	0.00%	1.4	0.00%
		50	1.49	0.00%	1.31	0.00%
		55	1.39	0.00%	1.22	0.00%
		60	1.3	0.00%	1.14	0.00%

The overall slope stability analysis shows that the final pit design of PT Hengjaya Mineralindo has met the criteria and shows a stable condition with a Safety Factor (FK) value above 1.3 for static conditions and above 1.05, except on Section KK' which is located in Central East. The results of the analysis on Section KK' show that the FK and PoF values are below the minimum criteria limit and indicate a marginally stable condition. To make the condition stable on Section KK', it is necessary to adjust the pit slope to the overall angle to 29° or decrease groundwater level to 6 m deep with the installation of a drain hole.

Slope stability analysis was also carried out on the waste dump located in Bete-bete (geotechnical drill point DHG-02). Based on the actual waste dump conditions in the monitored DHG-02 area experiencing instability, Reverse analysis is carried out to get the properties of the waste material as close as possible to represent the actual conditions observed and can be used in further analysis. The results of the Reverse analysis of the waste properties produced are shown in Table 14. With the waste properties from the result of the Reverse analysis, to maintain slope stability in the waste dump area, it is necessary to reduce the overall angle about 2° from the actual condition to obtain the FK value in accordance with the provisions. The overall slope angle that shows the safe FK value is 18° with a height of 33 m.

Table 14 Material Properties Result of Reverse Analysis

Lithology	Unit Weight (kN/m^3)	Mohr Coloumb	
		C (KPa)	Phi (Degree)
Limonite	18.77	11	27
Saprolite	20.21	61	18
Bedrock	26.71	217	35
Waste	21.9	9	20

Excavation and dig-ability analysis were carried out in each domain based on parameter data of rock compressive strength and joint spacing which were plotted into a Pettifer-Fookes graph. From the graph it can be concluded that the characteristic of each domain is distributed in a relatively homogeneous category so that the excavation or harrowing treatment is also relatively the same for each of these domains as summarized in Table 15.

Table 15 Excavation and Dig-ability per Lithology

Lithology	Method
Limonite	Easy Digging
Saprolite	Hard Digging
Bedrock	Easy-Hard Ripping

5.4 SURVEY RESULTS

LiDAR topography survey covering the HM IUP was completed in 2015. The resulting topographic map is shown in Figure 19. Ground survey drill hole collar mis-close with LiDAR topography is shown in Table 16.

Table 16 Survey mis-close between drill collars and LiDAR survey

SURVEY METHOD VALIDATED			COLLAR SURVEY MISCLOSE WITH LIDAR TOPOGRAPHY					
TOTAL STATION	GPS	COLLAR (%)	MINIMUM (m)	MAXIMUM (m)	AVERAGE (m)	STANDARD DEVIATION (m)	(-2) Std (m)	(+2) Std (m)
4476	181	96%	-4.97	12.74	0.01	0.56	-1.10	1.12

158 holes used in the model had only GPS coordinates available. 76 of these holes are located in the mined-out areas. The holes with GPS coordinates were used because they had complete drill log, analysis data, GPR data supporting laterite thickness and were surrounded by other holes with similar quality and depth with surveyed coordinates. It is considered appropriate to use these holes as the drill intersections match the surrounding holes and the analysis data does not introduce a bias to the nickel grades. Figure 20 shows the included drillhole collars with GPS locations in red. The data is considered sufficiently accurate and appropriate for use in this Resource estimation.

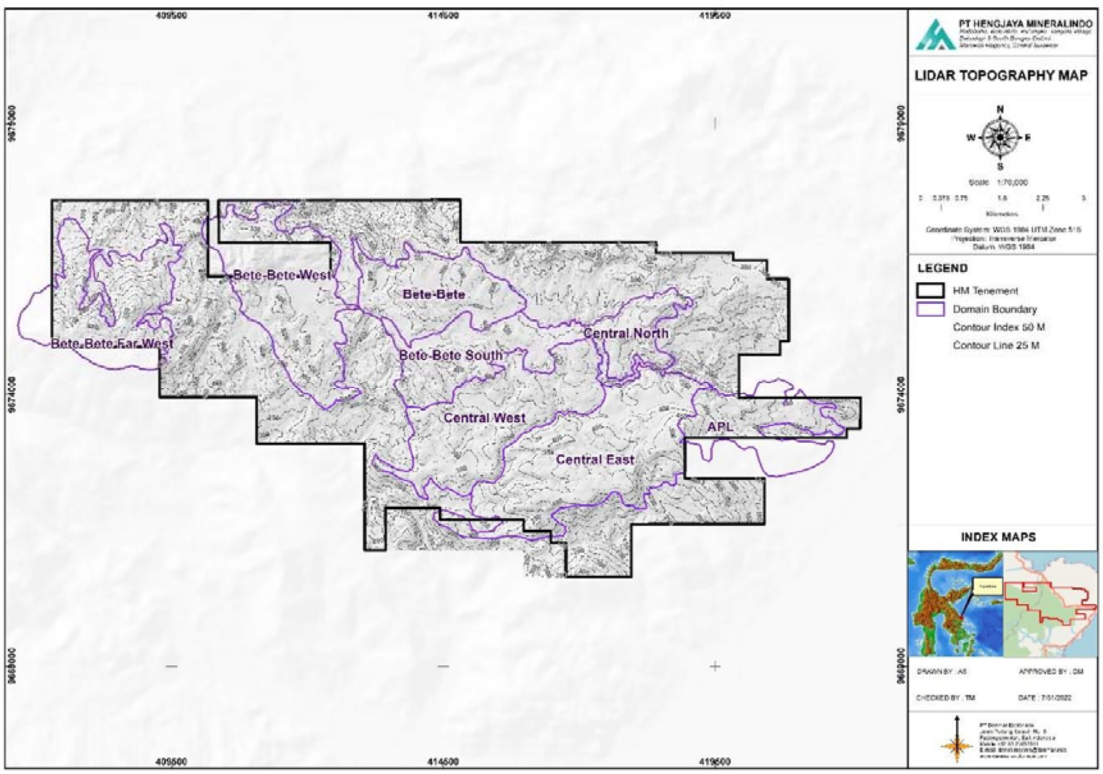


Figure 19 LiDAR topography map of the HM IUP

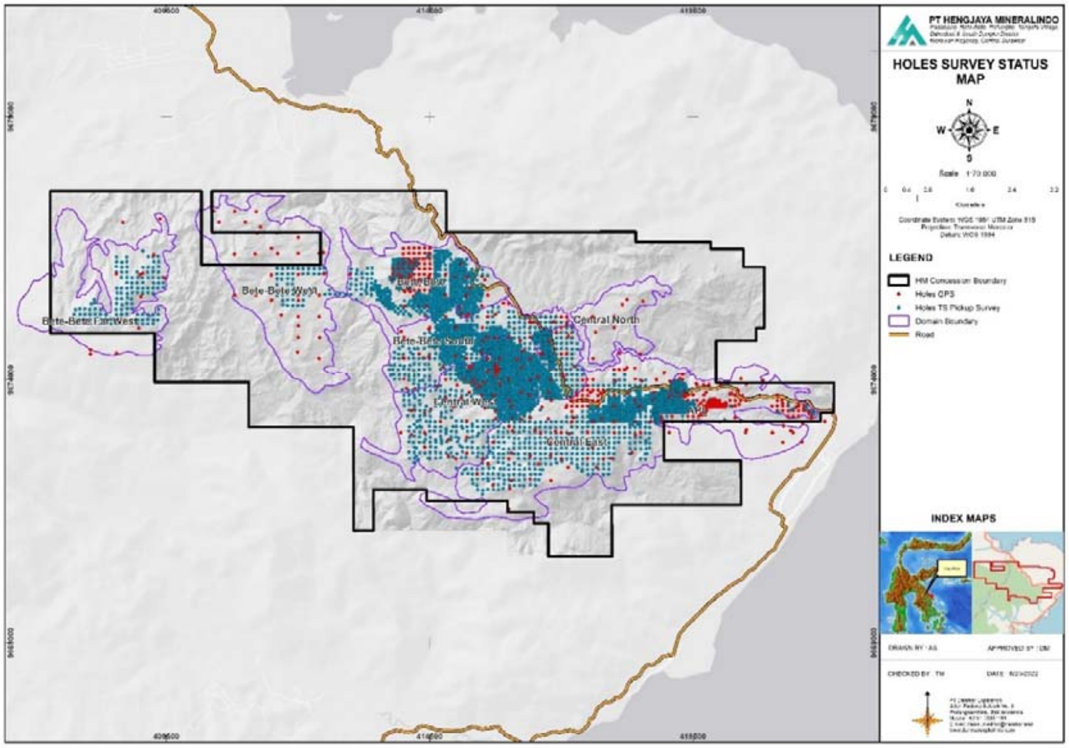


Figure 20 Drillhole location and survey status map

5.5 ASSAY ANALYSIS RESULTS

111,692 XRF sample analyses have been performed on drill core samples to document the grade characteristics throughout the nickel Resource area at HM. Sample interval has been predominantly 1m as per each core run. Where the sample interval has been less than 1m the analysis result has been weighted for the interval that it represents. Figure 21 displays the sample interval data and Table 14 shows the sample interval statistics.

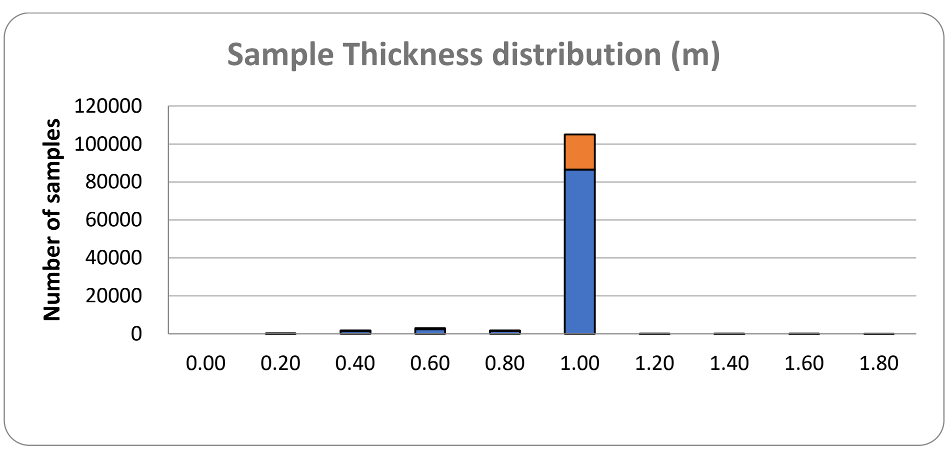


Figure 21 Sample interval distribution

Table 17 Sample interval statistics

Parameter	Drilling Program	
	Hengjaya	Danmar
Mean	0.97	0.97
Median	1.00	1.00
Mode	1.00	1.00
Standard Deviation	0.13	0.13
Sample Variance	0.02	0.02
Kurtosis	18.95	16.61
Skewness	-4.36	-4.15
Range	1.50	1.63
Minimum	0.05	0.01
Maximum	1.55	1.64
Sum	18951	89373
Count	19507	92185
Confidence Level(95.0%)	0.0018	0.0008

Since April 2019, the analysis of exploration samples has been largely in house at the HM mine site lab.

5.5.1 SPECIFIC GRAVITY MEASUREMENTS

Insitu density measurements on drill core were made for each stratigraphic layer in each of hole drilled since April 2019. A total 13,004 density measurements on drill core samples have been performed. The results are summarized in Table 18. These are insitu density measurements for laterite layers in the ground. Samples were immediately packed tightly using masking tape at the well site and prioritized for transfer to the lab.

Table 18 specific gravity measurements

Laterite Profile	Bete Far West	Bete West	Bete Bete	Bete South	Central West	Central East
SOIL	1.83	1.83	1.95	1.92	2.01	1.93
LIMONITE	1.78	1.77	1.85	1.76	1.83	1.81
SAPROLITE	1.72	1.50	1.53	1.64	1.85	1.66
BRK	2.88	2.25	2.67	2.87	2.80	2.79
Total Samples	**343**	**189**	**1677**	**1849**	**6912**	**2034**

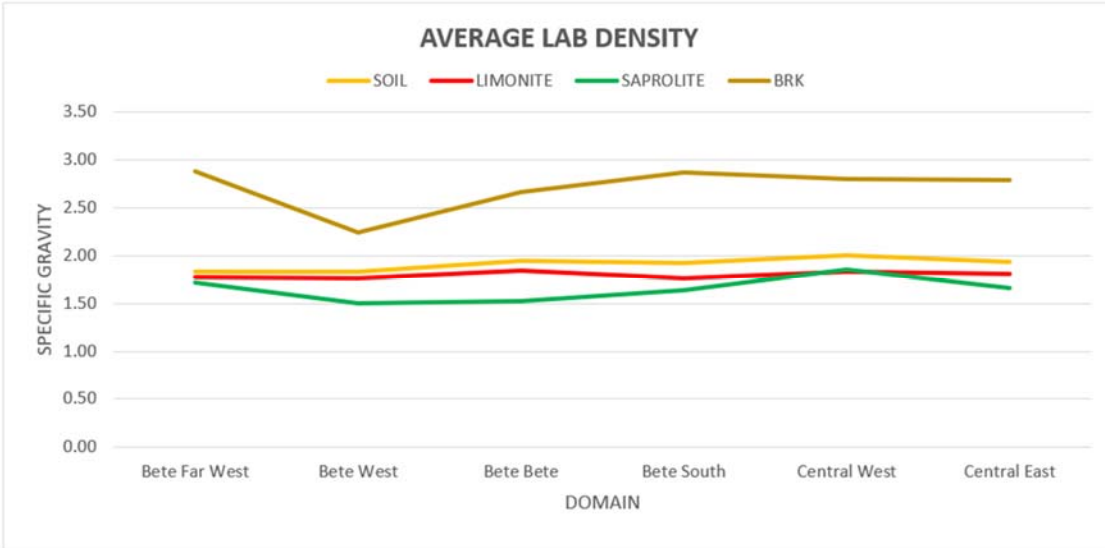


Figure 22 Average density measurement from cores

5.5.2 MOISTURE MEASUREMENT

Since April, 2019 every 1m drill core sample was measured for Moisture using the Japanese Industrial Standard (JIS). A total 33,544 Moisture measurements were performed. The results are summarized in Table 19. Figure 23 shows the average moisture content for each layer compared by domain.

Table 19 Moisture content

Laterite Profile	Average Moisture Content %					
	Bete Far West	Bete West	Bete Bete	Bete South	Central West	Central East
SOIL	36.5%	35.5%	32.5%	35.5%	34.2%	35.4%
LIMONITE	40.1%	41.8%	40.2%	43.3%	41.2%	41.9%
SAPROLITE	24.3%	35.7%	31.8%	32.9%	31.5%	31.8%
BRK	6.6%	24.7%	13.3%	10.3%	9.8%	12.2%
Total Samples	**2179**	**611**	**9867**	**12912**	**52514**	**15991**

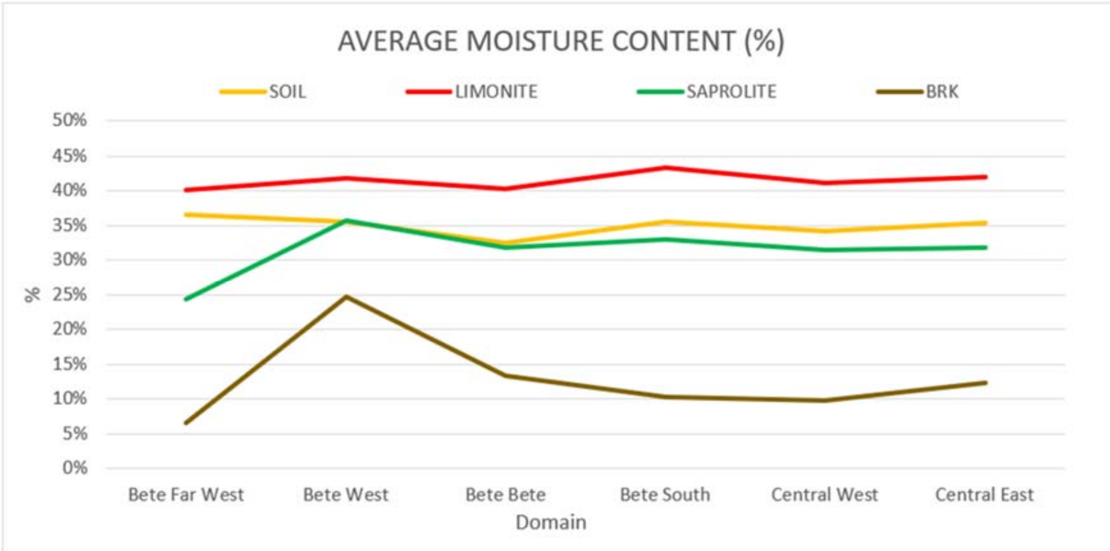


Figure 23 Average moisture content

5.5.3 SAMPLE ASSAY QUALITY CONTROL

Sample assay quality is defined through analytical accuracy, analytical precision and contamination during assaying. It is assessed using fine grained, pulverized samples that are inserted into the sample stream after the preparation stage and before the assaying stage. Samples used in testing assay quality include pulp duplicates, Certified Reference Materials (CRMs) and fine blanks. Sampling or analysis is said to be accurate when the mean error approaches zero. Sampling or analysis is said to be precise when there is a small spread of errors around the mean sampling error.

Data with “good” accuracy and “good“ precision can be regarded as “Good Quality” and as such, will be “fit for purpose”. The terminology “representative,” is used when the precision and accuracy are within acceptable tolerances.

Accuracy refers to the component of the measurement error that in replicate measurements remains constant or varies in a predictable manner. It is assessed by using Certified Reference Materials, for example OREAS 193, and by inserting these CRMs into the sample stream, it is possible to assess the performance of the assay lab undertaking the assay work for internal control. When sent to commercial laboratories with Interlaboratory Check samples it allows comparison of the HM Assay Lab performance against commercial laboratories and assess for any bias.

Accuracy is treated as a qualitative attribute, meaning low or lower accuracy, high or higher accuracy, and should not be given a quantitative value. Accuracy is measured through the bias, which is the difference between the expectation of the test results and an accepted reference value. There is an inverse relationship between accuracy and bias, the higher the absolute value of the bias, the lower the accuracy, and vice versa.

5.5.3.1 Coarse Blanks

Contamination is assessed by using coarse blank samples, these being barren samples in which the elements being tested, at HM these are Ni and Fe. At HM blank samples and OREAS are inserted within exploration batch streams at a rate of 4 OREAS and 4 coarse blanks for every 92 exploration core samples to test for cross contamination.

5.5.3.2 Coarse Duplicates

Figure 24 is a scatterplot showing the results for the four elements Ni, Fe, MgO and SiO2 from the original and duplicate roll sample results from a population of 1,020 exploration assays undertaken over the period July 2021 to March 2022. The graphs show the original and duplicate elemental values in red plotted on a middle grey line representing the mean elemental values of these samples. The two yellow lines above and below the mean line represent the correlation between the assay variables with a variance of +5% and -5%, and the outer green lines represent the variance between the assay variables of +10% and -10%. Scatterplots, where the results slope from the lower left to upper right, indicate a positive correlation.

Figure 24 shows that with all four elements the red dots plot within the +10% and -10% variance lines. In fact, the majority plotted between the +5% and -5% yellow lines, showing there is a high correlation between the original and the duplicate assay values. This is further confirmed with the correlation coefficient (R) values of > 0.999 for the elements being assayed. These figures confirm the high precision of the jaw crushing, the first splitting and roll crushing stages and supports the use of the Coarse Duplicate assay data for Resource estimation purposes.

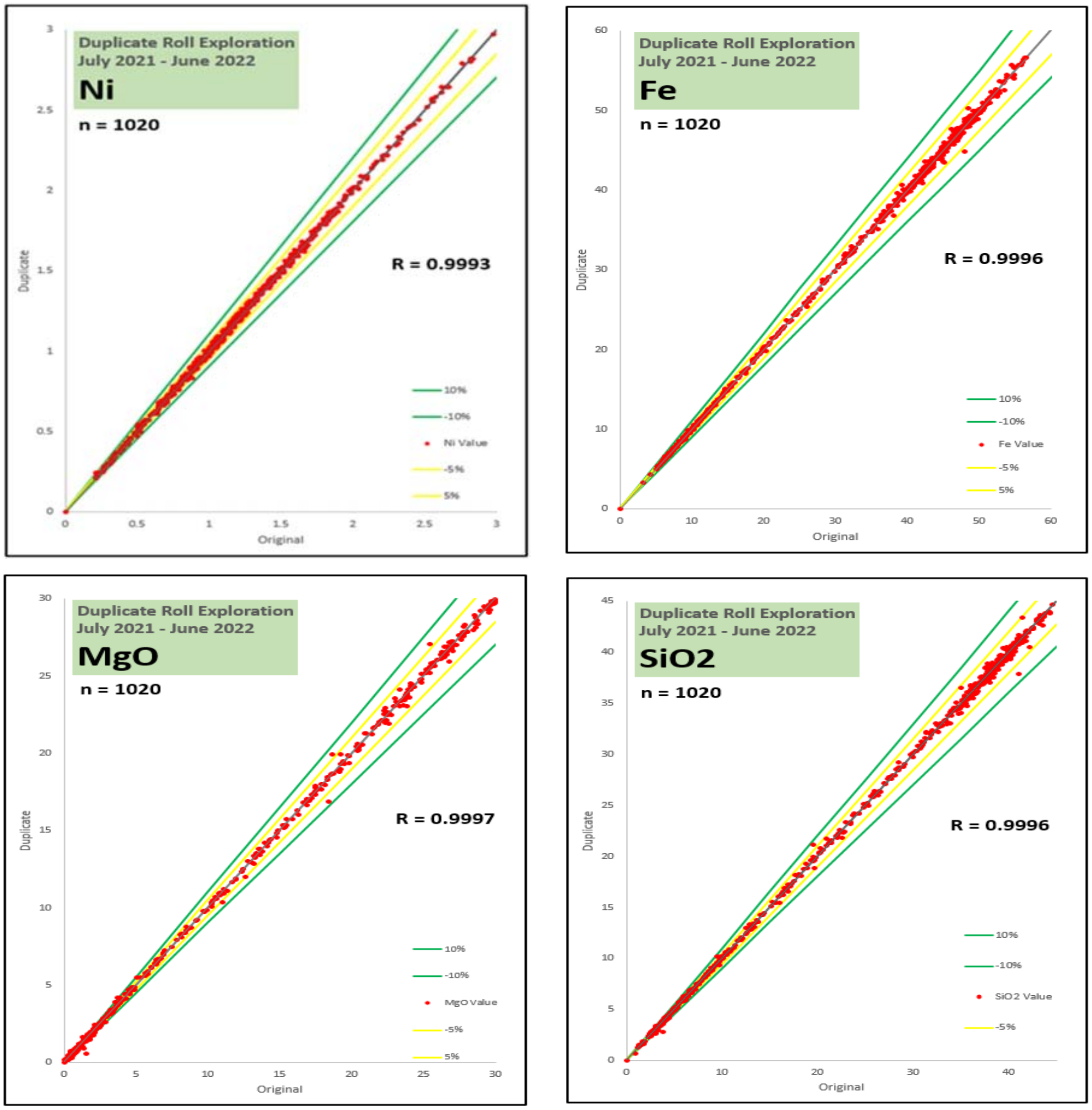


Figure 24 Scatterplot showing results of 1020 Coarse Reject original vs duplicate assays

5.5.3.3 Particle Sizing Test- -200# Screen Test

Figure 25 shows two graphs showing the results of the particle sizing tests undertaken on 111 exploration samples and 104 mining samples at the HM Prep Lab during March 2022. The yellow line is for 95% of the pulverized material passing the 200# screen and shows the majority of the samples returning a result of between 97% and 98% for both the exploration samples and the mining samples. These results show the repeatability precision of the pulverizing process in reducing the particle size of the samples to be high.

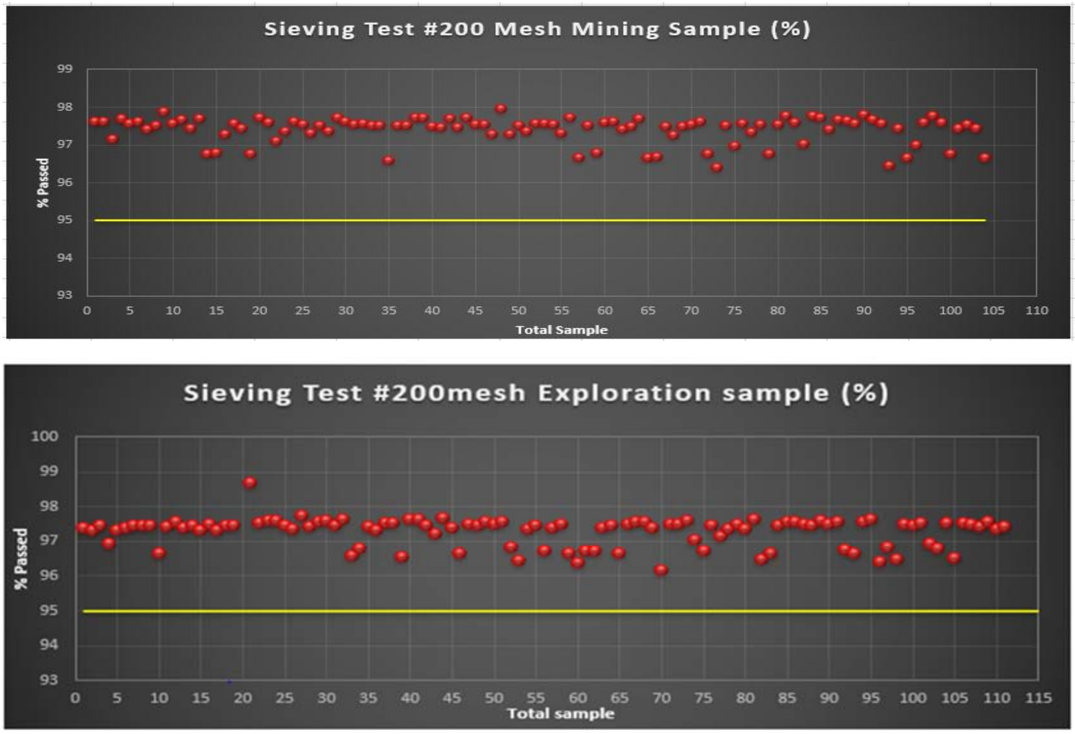


Figure 25 Screen test results – March 2022

5.5.3.4 Pulp Duplicates, or Duplicate Assay

Pulp duplicates, or Duplicate Assays (DA), as they are called at HM, are second splits of the fine, grained pulp samples that are collected in the final incremental splitting of the samples after pulverizing. Along with the incremental split sample that is taken and bagged for XRF assay at the HM assay lab and the sample taken for storage and future reference if required, a third sample is collected from each batch and analyzed at the same time as the original sample, but with a different sample number. The pulp duplicates are indicators of the analytical precision, which can be affected by the quality of the pulverization process and the homogenization of the sample.

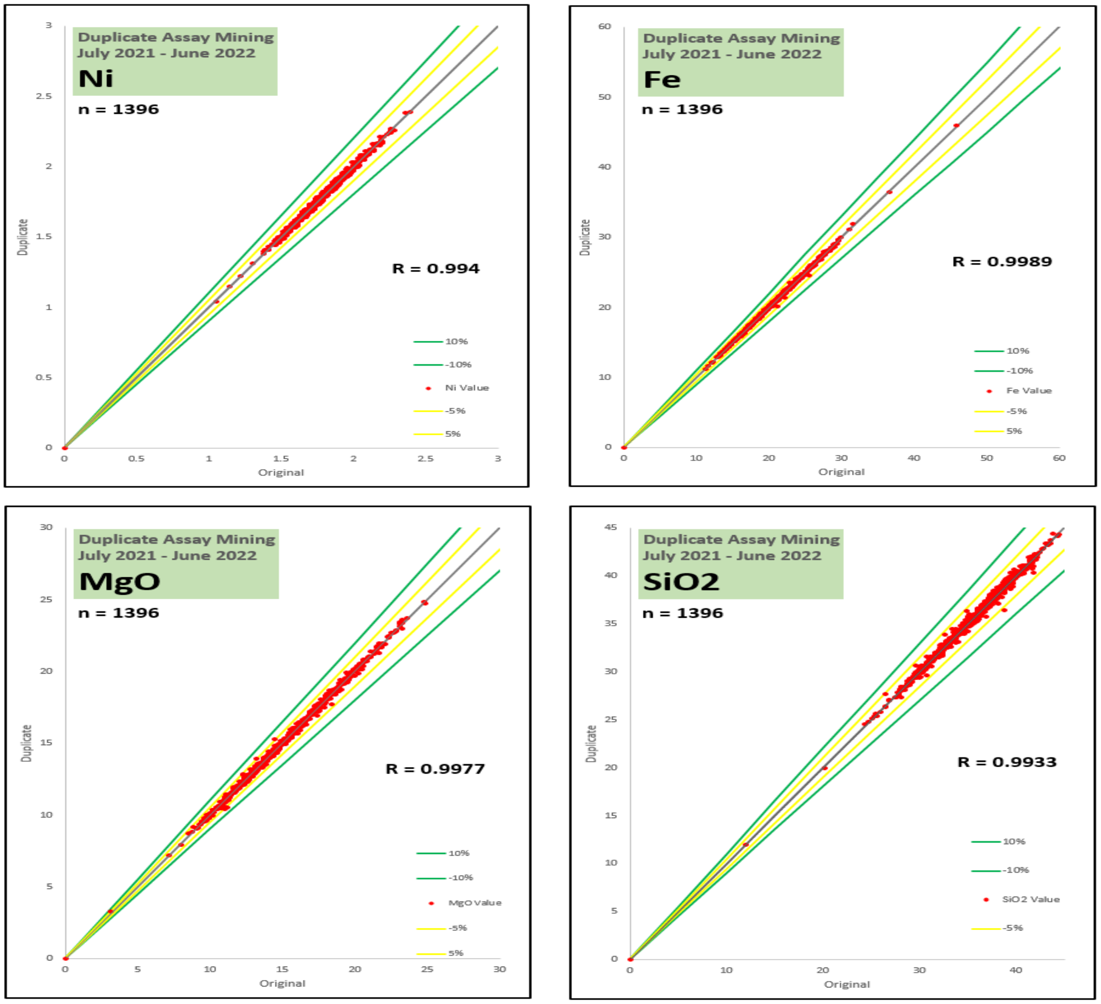


Figure 26 Scatterplot results of 1,396 plots for pulp original vs duplicate assays

Figure 26 shows scatterplots for the elements Ni, Fe, MgO and SiO2 from original and duplicate assays from 1,396 pulp samples analyzed between July 2021 and June 2022. The scatterplots are similar to those shown in Figure 24 for the Coarse Reject assays, with the majority of the Ni and Fe falling within the two yellow lines representing a +/- 5% variance from the assay, a high precision, and reflected with correlation coefficients of 0.994 and 0.9989 respectively.

One difference between the Pulp Duplicate and the Duplicate Roll Graphs is the lack of data points at the lower values of Ni, Fe, MgO and SiO2. The reason for this is that Figure 24 shows the wider range of elemental results for exploration samples, while Figure 26 shows results for mining samples where cut-off grades around 1.5% Ni are reflected in the average saprolite grades of around 1.75% Ni. Similarly, average saprolite Fe results are around 20%, for MgO an average of 23%, and for SiO2, around 38%.

5.5.3.5 Check Standards, or Certified Reference Materials (CRM's)

Certified Reference Materials, (CRM's), are samples with certified grades, prepared under specially controlled conditions and have a certified mean value for the contained elements in that standard, along with associated confidence and tolerance limits. They are used in Quality Control to monitor the values of the standard against those of the unknown samples being assayed and allow the accuracy of the assay process to be monitored. HM use CRMs produced by OREAS (Ore Research & Exploration P/L, from Victoria, Australia. OREAS CRMs currently used are Standards 182, 187, 192, 193, 194 and 195 with certified Nickel values of 0.707, 1.37, 1.77, 1.93, 2.13 and 2.94, respectively. In addition, these standards have certified standard deviations and state the 95% Confidence and Tolerance Limits with low and high values.

CRMs are generally placed into the sample stream at a frequency of one in 20 samples with mine samples and higher frequency of one in 10 exploration samples. This higher value due to the first sample in each run on the Epsilon 4 and Puma S2 XRF spectrometers being a standard as described in the Standard Operating Procedure.

Figures 27, 28, 29 & 30 are Shewart Control Charts for the results of assays using the OREAS standards 182, 187, 192 and 195 over a ten month period. The assay results obtained, over a period of time, are plotted on a chart of showing certified values against the number of samples assayed, with one line showing the certified mean value and two green lines showing the expected value plus/minus two standard deviations, also referred to as Upper and Lower Warning Limits, and two red lines representing the Upper and Lower Control Limits at three standard deviations.

Abzalov describes how specific analytical problems have recognizable patterns on certain diagrams, the different distribution patterns of the analytical results being indicative of the error sources and types, being most effective when applied to certified standards such as the OREAS CRM's. Good quality analyses will be characterized by random distribution points around the certified mean value, with 95% of the data points lying within two standard deviations of the mean. The same number of analyses should fall above and below the mean.

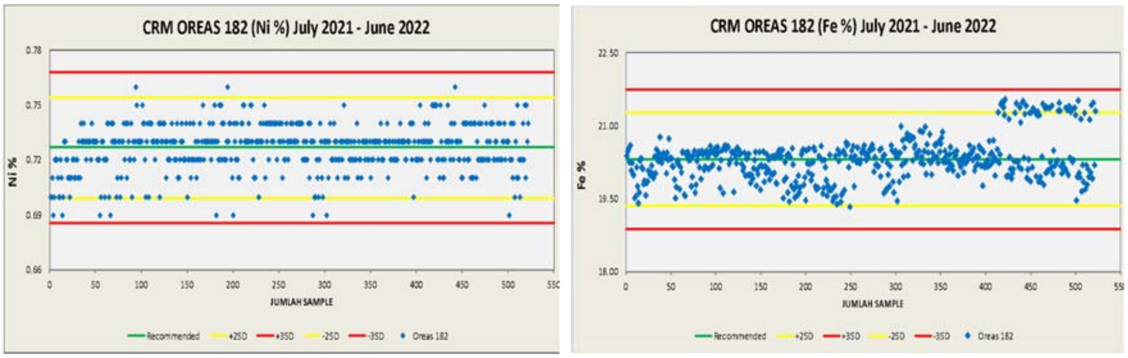


Figure 27 CRM OREAS 182 - 537 Exploration Sample Analyses

Figure 27, the OREAS Standard 182 shows the results plotting with 95% within two standard deviations of the mean for both Ni and Fe and showing good precision. However, with the Fe graph, the accuracy is not as good on the right hand side of the graph.

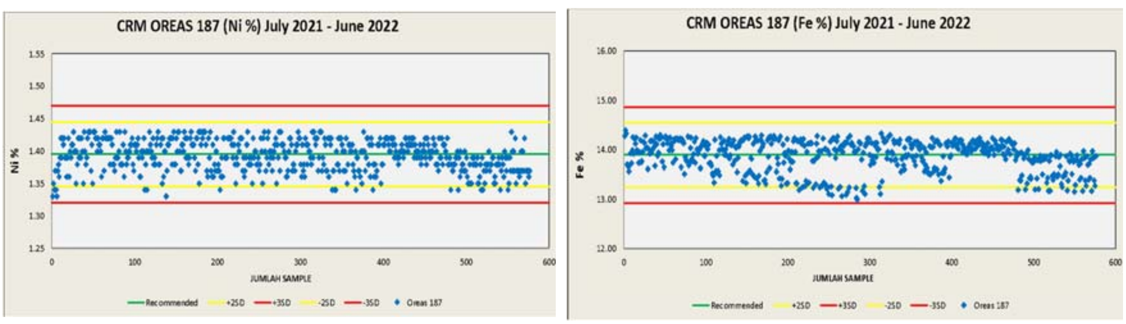


Figure 28 CRM OREAS 187 – 582 Exploration Analyses

Figure 28 shows the results for 582 exploration samples for Ni and Fe, with both elements showing good precision, 95% of the results plotting within two standard deviations of the mean, and similar numbers of samples above and below the mean. Accuracy in the Fe graph is not as good, with the appearance of more sample results below the mean.

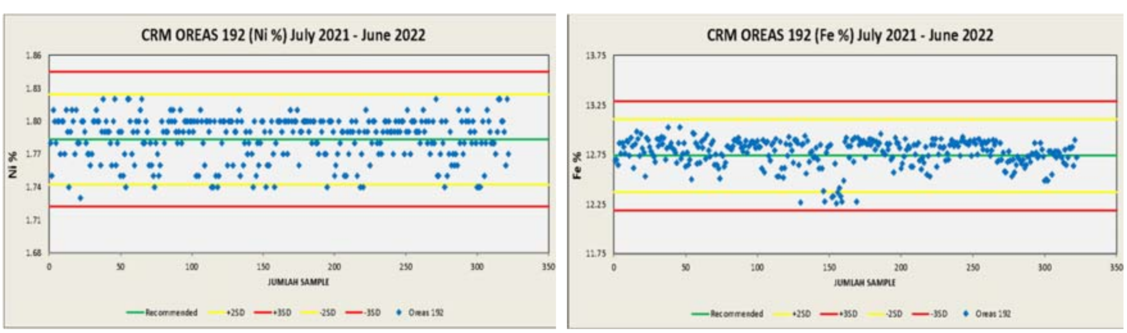


Figure 29 CRM OREAS 192 – 339 Exploration Analyses

Figure 29 shows good distribution of 339 exploration data results, with 95% of the data points plotting within two standard deviations of the mean, and similar numbers of data points above and below the mean for excellent precision, but the Fe graph shows a number of data points close to the negative -10% warning line which reduces the accuracy in this graph.

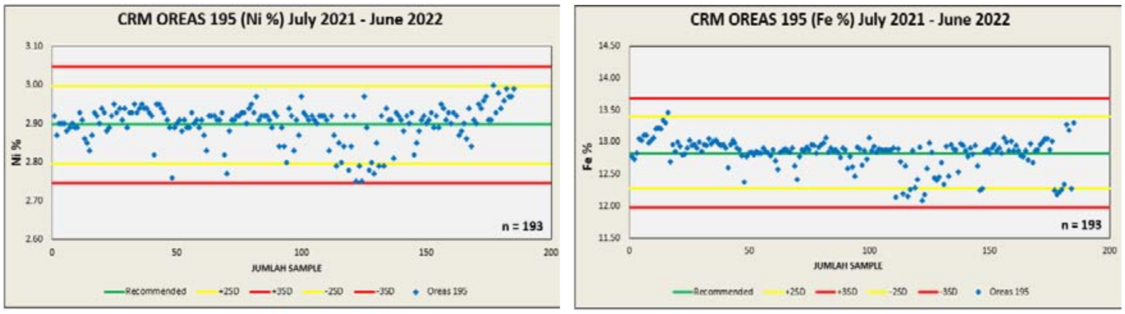


Figure 30 CRM OREAS 195 – 193 Exploration Analyses

Figure 30 shows a good distribution of the 193 exploration data points with 95% of the results plotting within two standard deviations of the mean for both Ni and Fe, but as with the previous graphs, the accuracy appears to drop around the 100 sample mark for approximately 10 samples which indicates less accuracy.

These graphs show that for the 1,651 exploration samples assayed using 4 different OREAS Laterite Suite CRM's the precision between the original and the CRM values are generally excellent, whilst the accuracy for the Ni is good to excellent whilst for the Fe it is of lower quality.

5.5.3.6 Replicate Samples

These are two portions of the same pulp samples that are used to produce two separate pressed pellets or fused beads, that are given different sample numbers before being inserted into the same batch, or Job Sheet. At HM they are taken as part of the standard package of check samples, these being one DA or pulp assay, one DR or coarse reject assay, one REP or replicate sample and one CRM.

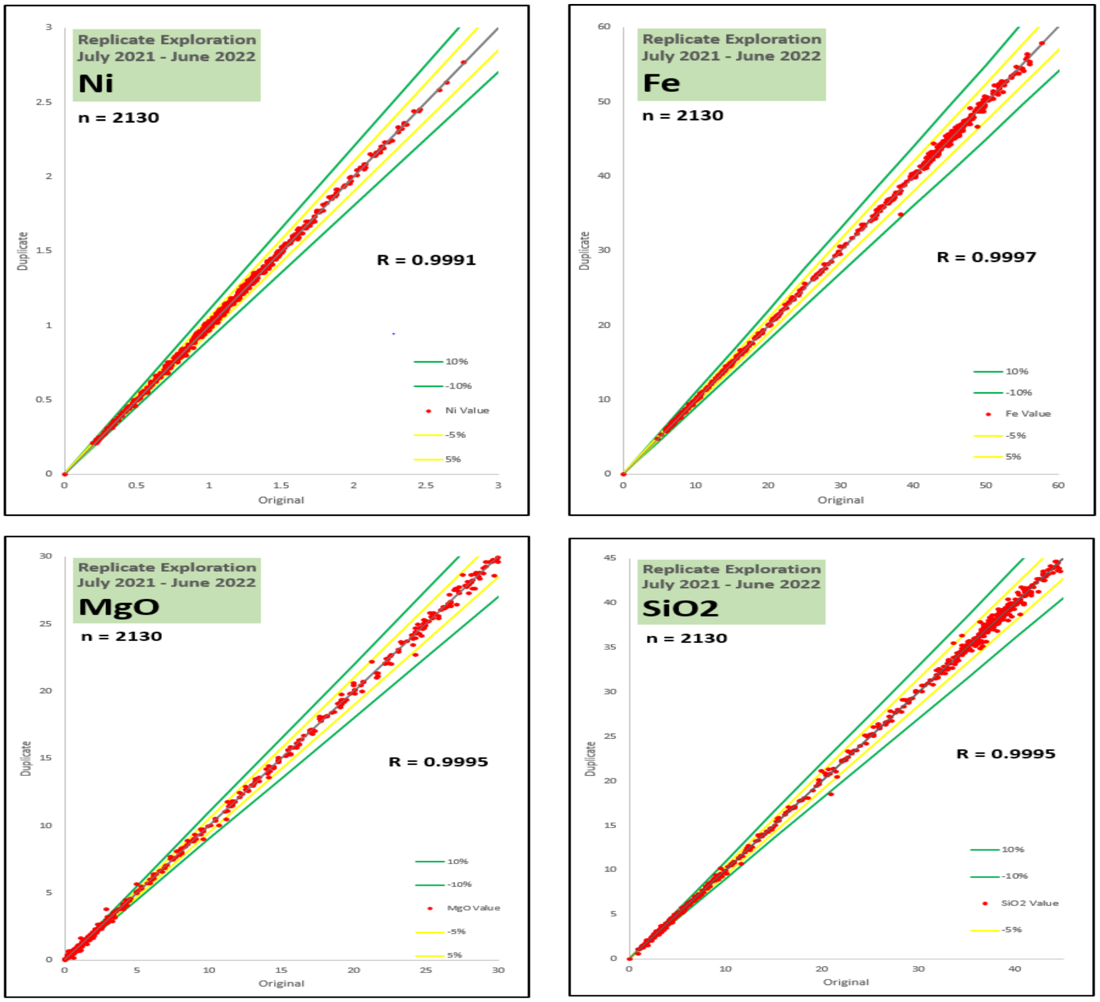


Figure 31 Scatterplot showing results of 2,130 plots for original vs replicate assays

Figure 31 shows scatterplots for 2,130 replicate analyses undertaken between July 2021 and June 2022. The format of the scatterplots is the same as for the previous scatterplots for the Coarse Rejects (DR) and the Pulp Duplicates (DA), with these results showing the wider range in values for the elements due to the samples being tested originating from exploration samples.

The scatterplots for replicate sample assays show the majority of the results plotting within the two yellow lines indicating a 95% confidence in the result plotting within these limits and is considered an excellent result. The graphs also show correlation coefficients of more than 0.999, indicating high precision. Spreadsheet data shows there is also an even spread of the replicate assay being both similar to, higher than and lower than the primary assay in the case of Ni, whilst for Fe, MgO and SiO2 there are slightly more duplicate assays in the Assay less than Original category with a corresponding lower figure in the Assay equal to Original category. This confirms a normal distribution of assay values for these elements and indicates there is little evidence of systematic bias occurring in this replicate check assay program.

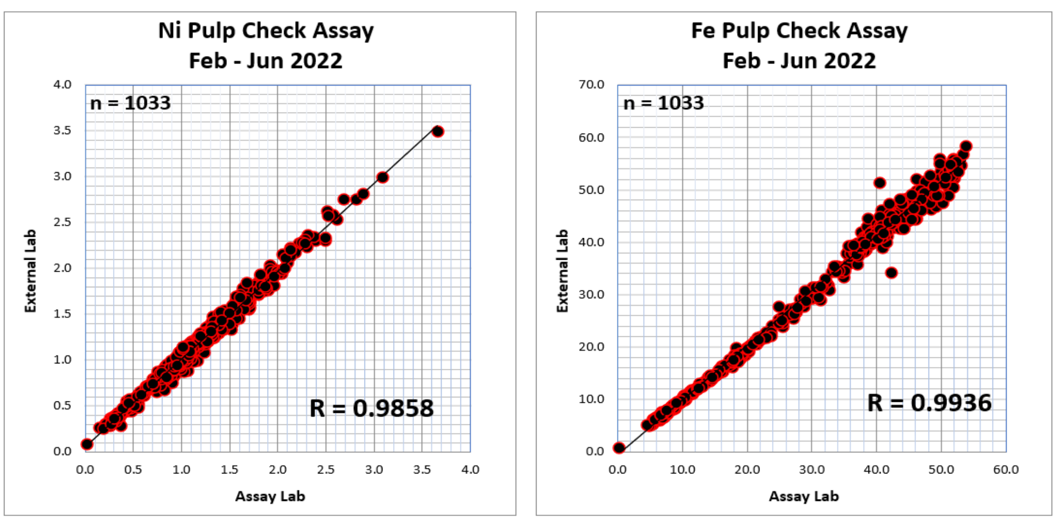
5.5.3.7 Interlaboratory Check Samples

5.5.3.7.1 HM Lab vs PT Geoservices Lab

Interlaboratory Check samples are second splits of both the coarse reject samples and the finer 200 # pulp samples that are routinely assayed at the HM Assay Lab and submitted to second, commercial, laboratories under a different sample number. These samples are used to assess the assay accuracy of the HM laboratory relative to the secondary, Geoservices Laboratory.

Batches of Exploration samples were sent to the Geoservices Laboratory in Kendari on a periodic basis where the coarse reject samples underwent pulverizing and incremental splitting, to be sent off for XRF assay at the Geoservices Analytical Laboratory in Bandung, along with duplicate pulp assay samples. Geoservices then forwarded the HM pulp sample checks to their analytical lab as a different consignment, and once assayed, the results were returned to the Assay Laboratory at the Tangofa site.

Figure 32 shows the results of the inter laboratory check sample tests comparing the results of 1033 split Exploration coarse reject and 200# pulp samples assayed at the original HM assay laboratory with samples sent to the Geoservices assay Laboratory in Bandung.



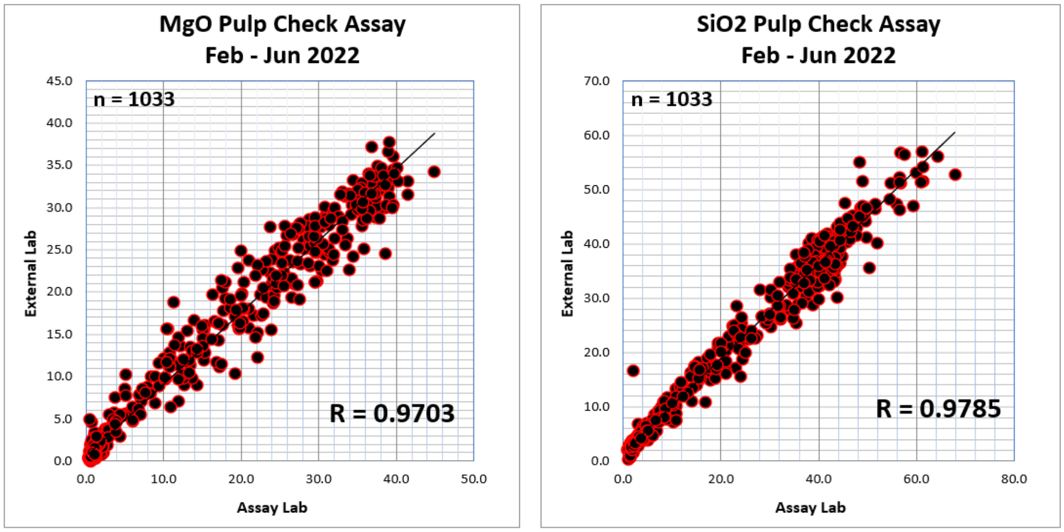


Figure 32 Scatterplot results of 1033 plots of HM original vs Geoservices duplicate assays

The scatterplots show differing precision for the different elements, with the best correlation between the results for Fe and Ni, 0.9936 and 0.9858 respectively, MgO and SiO2 have lower correlations at 0.9785 and 0.9703.

Data for the results for the two laboratories shows a difference between the mean for the Ni and Fe values for the HM Lab as 1.15 % Ni and 27.52 % Fe against 1.13 % Ni and 26.93 % Fe for Geoservices, a difference of 1.74% for Ni and 2.14% for Fe. These represent a +/- 5% variance from the assay, a high precision and reflected with correlation coefficients of 0.9858 and 0.9936.

These results show lesser precision than was the case with the internal checks using Coarse Rejects, Pulp Assays and Replicate Assays at the HM Lab. This indicates the difference is likely to be due to different sample processing procedures at the two laboratories, and different accuracies and precision due to different equipment. There is a difference between the pressed powder pellets used at the HM Lab with the Fused Bead system used at Geoservices. Similarly, the HM Assay Lab uses a Malvern Panalytical Epsilon 4 XRF and a Buker Puma S2 XRF that was brought into operation in 2021 and any differences between these XRF Units and those used at Geoservices could results in the small differences being recorded.

5.5.3.7.2 Comparison PT HM Assay Lab vs IMIP Smelter Results

When the barges carrying ore from the HM Jetty to the IMIP smelter arrive, samples are collected from the saprolite ore and assayed at the IMIP facility. These results are used to determine the price paid for the nickel laterite ore. These results are provided in a Certificate of Analysis (COA) and Certificate of Quality by PT Intertek Utama Services, Indonesia.

Figure 35 shows graphics of the plots of the Ni and Fe results from the HM Assay Lab and the IMIP COA for 54 samples from barge numbers BP 774 and BP 828 which delivered saprolite ore from the HM Mining Operations to the IMIP Smelter between May 2022 and July 2022.

These graphs represent HM assay results with means of 1.78% Ni and 19.10 % Fe, standard deviations of 0.04 and 1.30, and variances of 0.0016 and 1.6834 respectively. Similar results of 1.74% Ni and 18.66% Fe, standard deviations of 0.04 and 1.20, and variances of 0.0017 and 1.4441 were recorded on the IMIP COA's. Interestingly, the difference between the two sets of data shows a mean difference of 0.04, or 2.2% for the Ni values, with 50 of the 54 COA values being less than the HM assay values. With the Fe values, there is a 2.3% difference between the HM and COA values, with 41 of the 54 COA's returning lower values than HM.

The consistency of results from these 54 samples is interesting, and as before, can be the result of sample processing differences, for example, pressed pellet vs fused bead, different equipment and calibration issues. The other problem is the hygroscopic nature of nickel ore, and how the increase in moisture content of the saprolite between leaving the HM stockpiles and being fed into the smelter is likely to result in differences in the Ni values and may explain the variation between the Ni and Fe graphs.

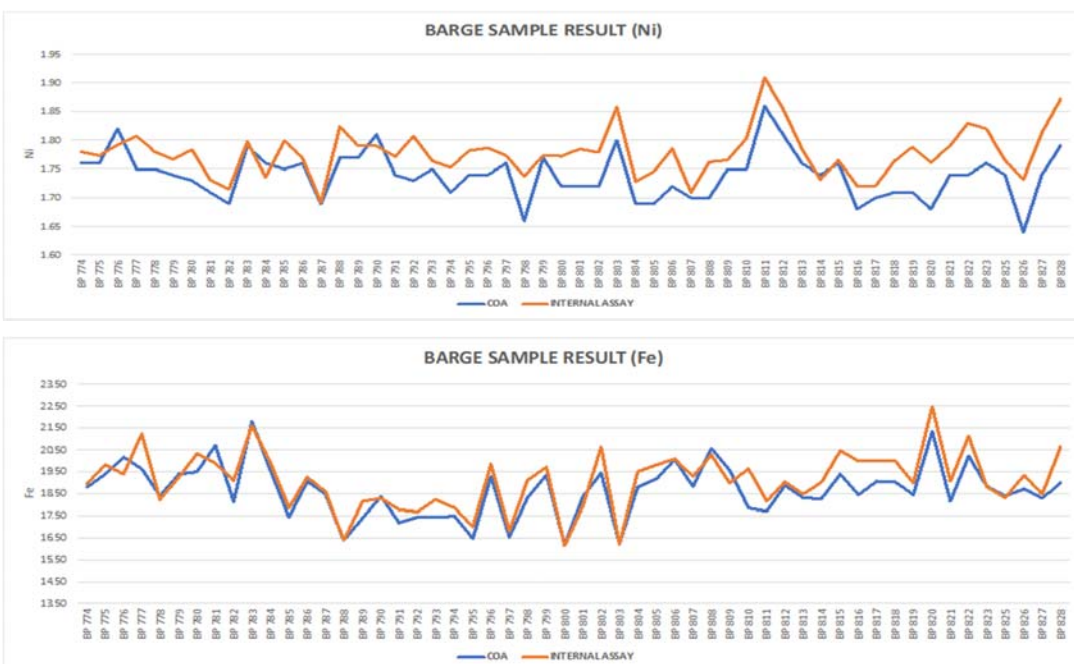


Figure 33 Graphic showing results of 54 saprolite samples assayed at HM and IMIP Smelter

5.5.3.8 Control Sample Insertion Rates

HM operates a quality control program at its Tangofa Laboratories where different types and sub-types of control samples are inserted into the sample stream in order to monitor precision, accuracy and possible contamination at the different stages in the sampling, sample preparation and sample assaying sequence.

Sample collection is usually controlled through the use of twin samples and field duplicates, but due to all the triple tube barrel, drill core being sent for sample preparation and assay, these control samples are not sent for checking. At HM blank samples and OREAS are inserted within exploration batch streams at a rate of 4 OREAS and 4 blanks for every 92 core samples to test for cross contamination.

Sample preparation is controlled through the use of coarse blanks, coarse rejects (DR) and 200# particle sizing tests at the HM Prep Lab.

Sample assay is controlled through the use of pulp duplicates (DA), CRM's, Replicate samples and Interlaboratory check samples.

Mendez (2011) described the frequency of control samples using information from International QA/QC consultants, Exploration and Mining Companies, various authors and the Toronto Stock Exchange and found that a figure of 20% (1 in 5) of the total samples assayed comprise control samples of various types.

During the period July 2021 to June 2022 a total of 50,102 exploration samples were processed at the HM Sample Prep and Assay Labs. The following check samples were added into this original sample stream:

Table 20 Exploration Control Sample Insertion Rates July 2021-2022

Period	Exploration	Coarse Rejects/DR		Pulp Duplicates/DA		Replicates		CRM's		Interlab Checks	
	Samples	No.	%	No.	%	No.	%	No.	%	Checks	%
May - July 2022	50,102	1,020	2	1,110	2.2	2,130	4.2	1,997	4.0	1,951	3.9

The Coarse Reject and Pulp Duplicate samples comprise 2.0% and 2.2% of the samples submitted. These figures correspond to those proposed by Mendez, of 2% and 2% respectively.

Replicate samples and CRMs comprise 4.2% and 3.98% respectively of the samples submitted. Although Mendez does not appear to specifically include replicates, this figure of 4.2% allows an additional measurement of the Assay Quality at the HM labs and is due to two replicate samples being inserted into the sample stream instead of the one coarse reject and one pulp duplicate sample per batch.

The differences between the % of check samples proposed by Mendez, 1 in 5, or 20%, and the 12.5% at HM is due to the lack of Twin Samples collected at the sample collection stage, 2%, because the whole drill core is sent for sample preparation and assay, and a further 2% by way of pulp blanks are also not collected at HM. With 4% of the samples being CRM's this is less than the 6% CRM's suggested by Mendez, but 1,951 Interlaboratory Check samples were sent for assay at Geoservices, 3.9% of the total exploration samples, and in line with the 4% suggested by Mendez.

In summary, a total of 8,208 check samples were inserted into the sample stream of 50,102 exploration samples and submitted for assay at the Geoservices Assay Laboratory, a total of 16.4% as compared to the 20% suggested by Mendez.

5.5.3.9 Review, Reporting and Continuous Improvement

This section covers three aspects of the activities undertaken at the QA/QC Department that give added confidence to the culture and systems that are in place at Hengjaya project.

The Review section is similar to the Acceptance Testing that Sterk discusses and which he believes should accompany each QA and QC stage in the sample collection, preparation and analysis stages of the sample processing stream. At present, the HM QC team undertake the following:

- Receive printout of assay results for the batches/consignments of exploration samples
- Check results to confirm check samples inserted into sample stream by HM staff/client
- Identify check samples and compare with original results to confirm acceptable precision and accuracy, and present to the Supervisor to confirm acceptability of results, and whether or not samples need to be re-assayed in the event of contamination, bias or poor precision.
- If CRM results are not acceptable,the analyst and Foreman will consult and clean the Tube Filter and repeat the analysis. If the next assay is in order the sample assaying will continue.
- If the repeat assay is not acceptable, the next assay will be conducted with a different CRM. If this assay produces an acceptable result, the assay sampling will continue. If this assay produces an unacceptable result, the Supervisor will inform the Lab Superintendent and the Supervisor will undertake recalibration of the unit.
- Lab Foreman then decides and approves circulation of results internally
- Lab Superintendent decides and approves results going out to client

- ● Lab Foreman decides and approves entry of sample results data onto HM database
- ● Lab Supervisor checks and confirms data entry is correct and in order

In addressing any issues with Interlaboratory Check Samples, Sterk emphasizes the importance of communicating with the commercial laboratory which undertook the assaying of check samples and discussing what may have caused any serious differences in precision or accuracy.

Reporting of the analysis of the Quality Control samples is continual, ongoing process and the HM QA/QC Department issues a Monthly Report detailing the activities of the department for each calendar month. Contents covered in the QA/QC Laboratory Monthly Report for June 2022 are:

- Health & Safety – Near Miss Report
- Accident Report
- Radiation Accident Report
- Preparation Lab Production Report
- Assay Lab Production Report
- Sample Type Statistics
- Monthly Sample Split eg Mining, Exploration, Barging, QAQC
- Quality Control – Sieving Test
- Precision
- Accuracy
- CRM's
- Interlaboratory Check Samples
- Personnel
- Planning, Implementation and Constraints
- Photos

Continuous Improvement is an ongoing procedure that is necessary to maintain the quality of the sample preparation and assay at the HM Laboratories in response to the increase in production at the PT HM Tangofa Mine, from 75,000 wmt per month during 2019 to 300,000 wmt per month in June 2022. Accompanying this threefold increase in the production of saprolite ore, Nickel Industries is now commencing the mining of limonite to feed an HPAL Plant at IMIP to produce batteries for electric vehicles in Sulawesi. This increase in production has seen a corresponding increase in the staffing levels at the Sample Prep and Assay laboratories, as well as the purchase of additional equipment to meet the increased production with upgrading the equipment at the sample prep lab, the assay lab and associated storage.

Nickel Industries have been signing MOU's and other agreements to acquire additional resources to provide additional feedstock for additional RKEF lines at IMIP at Morowali and IWIP at Halmahera.

To meet the challenges of the increased production and implementation of additional technologies and equipment to handle these increases it will be important to upgrade the skill sets of the staff to ensure that the increase in production will see a corresponding increase in the quality of the data generated at the labs and continue to seek higher standards of precision and accuracy through improved techniques.

Current international standards the reporting of exploration and mining results such as JORC Code 2012 and Canadian NI43-101, require that a program of data verification is included with any exploration program to confirm the validity of the exploration data, and this is normally done by inclusion of JORC Code, 2012 Edition – Table 1 Report Template, a copy of which is attached in Appendix 9.1.

HM operates a quality control program at its Tangofa Laboratories where different types and sub-types of control samples are inserted into the sample stream, in order to monitor precision, accuracy and possible contamination at the different stages in the sampling, sample preparation and sample assaying sequence.

Mendez (2011) described the frequency of control samples using information from International QA/QC consultants, Exploration and Mining Companies, various authors and the Toronto Stock Exchange and found that a figure of 20% (1 in 5) of the total samples assayed comprise control samples of various types.

During the period July 2021 to June 2022 a total of 50,102 exploration samples were recorded as being processed at the HM Sample Prep and Assay Labs. The following check samples were added into this original sample stream:

Coarse Rejects/Duplicate Rejects	– 1,020
Pulp Duplicates/Duplicate Assays	– 1,110
Replicates/Replicate Assays	– 2,130
Certified Reference Materials	– 1,997
Total Check Samples	**– 6,257**

The Coarse Reject and Pulp Duplicate samples comprise 2.0% and 2.2% respectively of the samples submitted. These figures correspond to those proposed by Mendez, of 2% and 2% respectively.

Replicate samples and CRMs comprise 4.2% and 3.98% respectively of the samples submitted. Although Mendez does not appear to specifically include replicates, this figure of 4.2% allows an additional measurement of the Assay Quality at the HM labs and is due to more replicate samples being taken for Barge Samples that are sent to the smelter and for which HM require as accurate data as possible. The CRM total presently used is less than the 6% suggested by Mendez but reflects equipment constraints on the production program when the XRF's are down due to equipment issues, for example faulty X-Ray tubes and limitations on capacity. The complete Lab report is attached in Appendix 9.5.

5.6 DOMAINS AND MINERALIZATION

Historically the Hengjaya mine project has been divided into separate blocks based on their geographical position. As the exploration results have accumulated it appears that several distinct geological domains can be identified where exploration work has been concentrated. These domains can be defined based on the following characteristics:

a) laterite thickness and Ni grade

b) mineralogical characteristics

c) distinct statistical population

d) elevation and geological environment

At this time 7 separate domain areas have been detected. These are as follows:

1) Bete Far West
2) Bete West
3) Bete Bete
4) Bete South
5) Central West
6) Central East
7) APL

Figure 34 shows the location of these domains within the IUP.

Central North may be an additional domain area but at this time there is insufficient sample data to determine if this is a distinct statistical population or part of one of the Central domain areas.

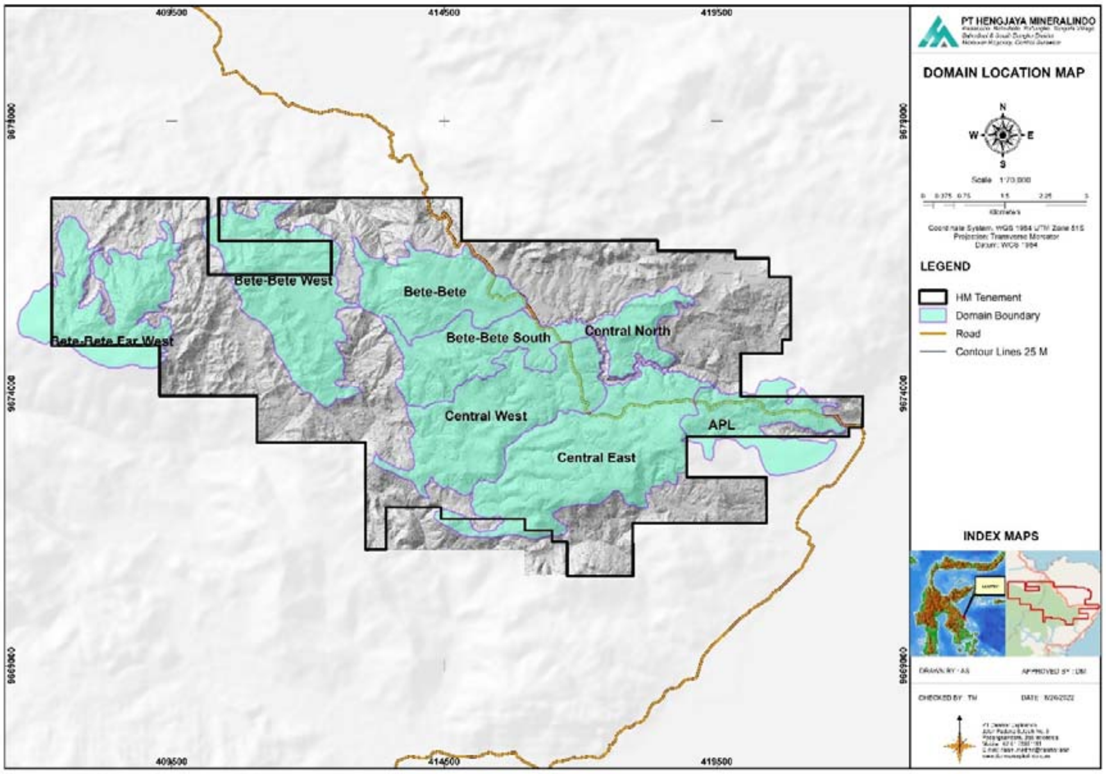


Figure 34 Domain location map

Diagrammatic sections through the 7 main domain areas have been constructed based on the geological model used in this report to show the relative location and characteristics of the laterite and bedrock morphology (see figure 35). Relative elevation and topographic conditions tend to be a key factor in the type of laterite that forms.

Laterite thickness characteristics from the current drill data is shown in Figure 36.

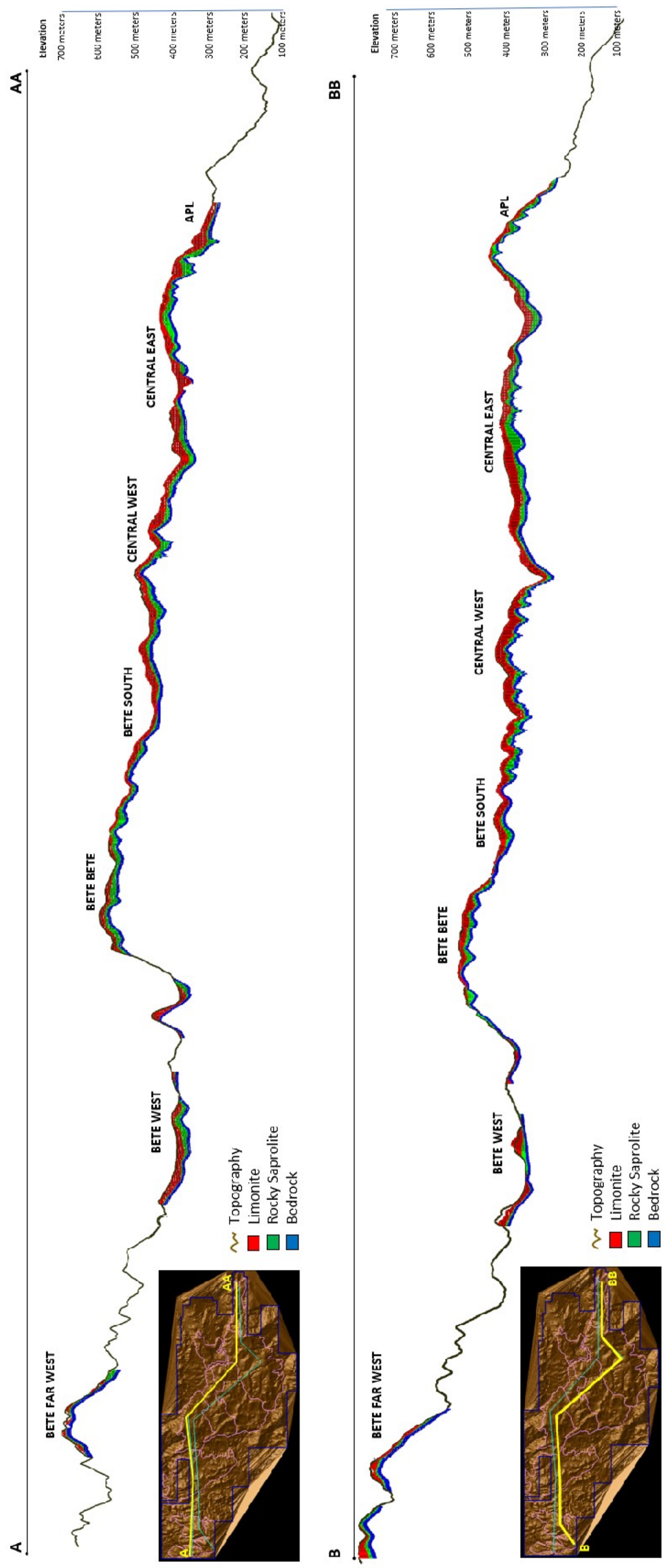


Figure 35 Diagrammatic sections through HM nickel laterite deposit showing relative elevation and geological characteristics

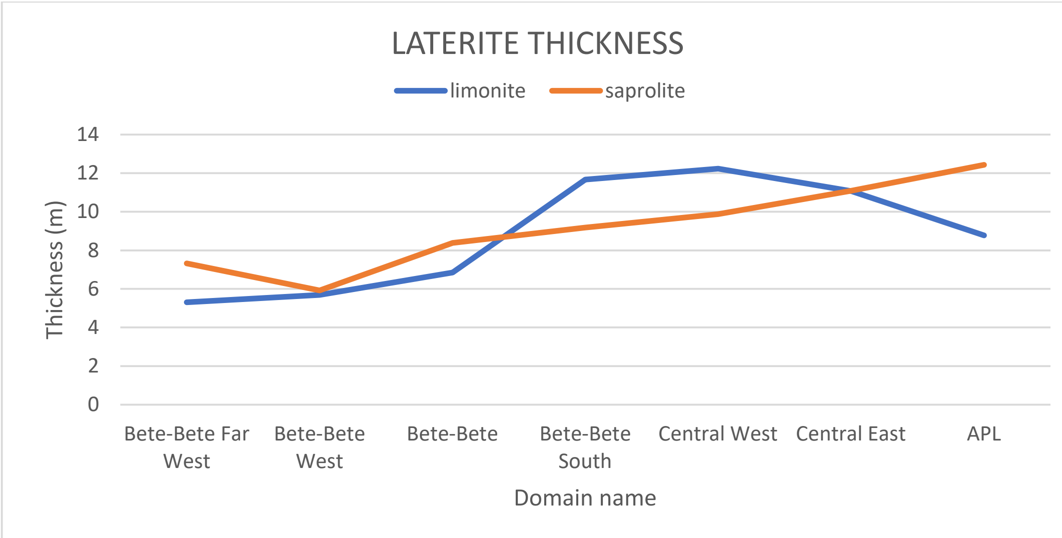


Figure 36 Laterite thickness chart per domain

From west to east, the thickness of limonite and saprolite appears to gradually increase. In the domains with the highest elevations saprolite is relatively thicker than limonite, probably as a result of erosion of limonite to surrounding areas with lower elevations. Bete Bete South, Central West and Central East have the thickest limonite probably due to the accumulation of limonite transported by erosion from higher elevated areas.

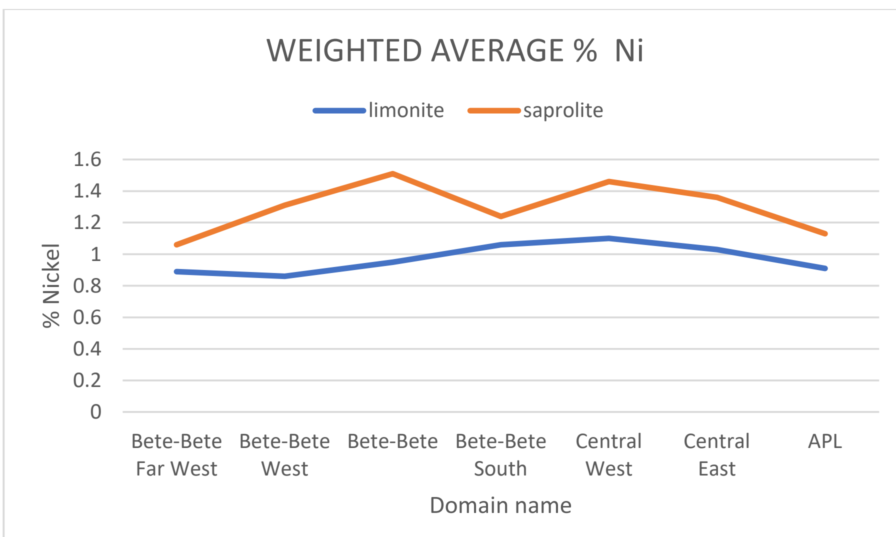


Figure 37 Ni grade average over the 7 domains

Average nickel grade of saprolite in Bete Bete and Central West are the highest of all the domains. This may be because the bedrock and surface topography in these areas is relatively gently sloping, creating conditions suitable for saprolite development. Bete Bete South, Far West and APL nickel grade in saprolite is significantly lower, possibly due to steeper surface and bedrock topography.

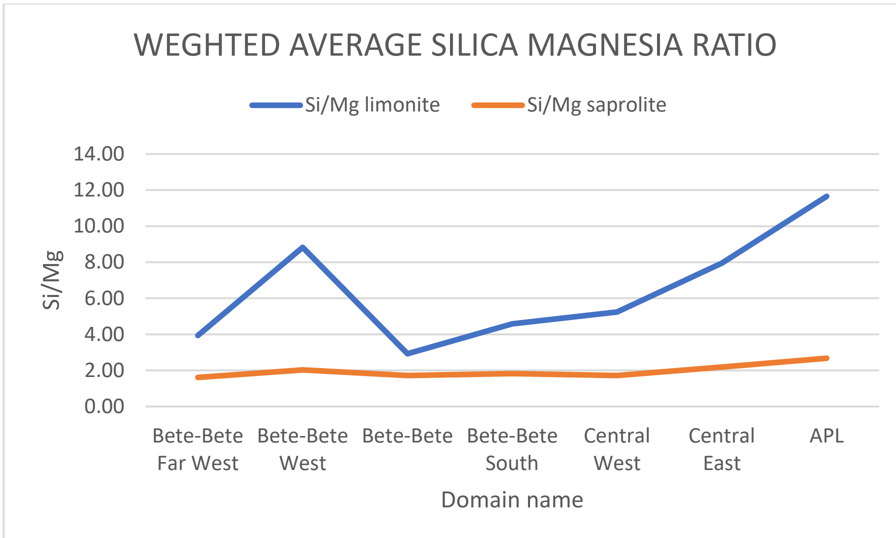


Figure 38 Silica / Magnesia ratio over the 7 main domain areas

The Silica Magnesia Ratio in limonite peaks at Bete Bete West and APL areas. These areas are near the edge of the ultramafic rock contact with the underlying sediments.

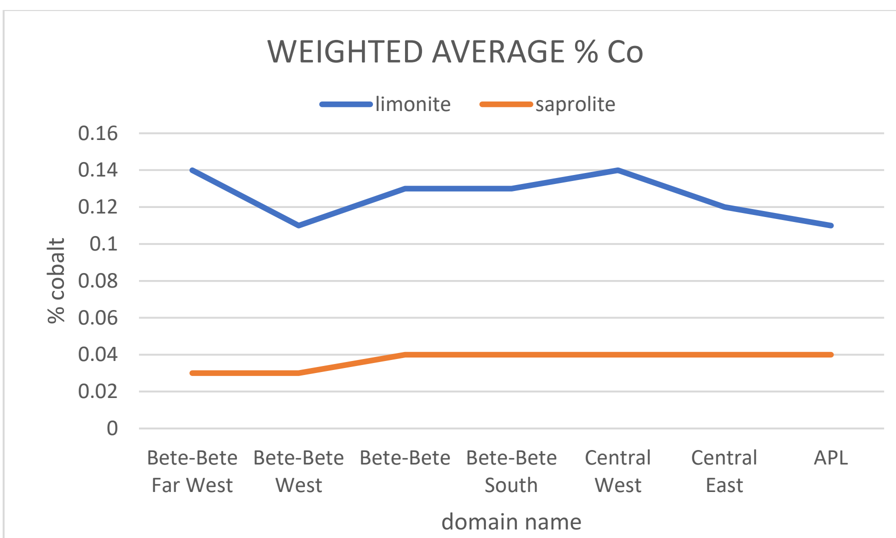


Figure 39 Cobalt grade over the 7 main domain areas

Cobalt grade in limonite peaks in the Central West and Bete Bete Far West domains.

Complete descriptive statistics for each domain are summarized in Appendix 9.4.

5.7 DATA COMPILATION

5.7.1 DATABASE

The Hengjaya Project Database compilation, validation and correlation uses Surpac® mining software with Microsoft® Access Relational Database Management System (RDBMS) providing the storage of collar, downhole survey, lithology and assays.

The project database is comprised of 2 parts;

1) The historical drilling supplied by Hengjaya used for ongoing mining operations as well as previous Mineral Resource estimates
2) New infill drilling data collected by PT Danmar Explorindo from April 2019 until June 2022

5.7.2 DATA VALIDATION PROCESS

The collar survey, assay and geology tables of both these datasets were validated to correct data error issues such as:

- missing or duplicate collar records
- overlapping intervals in the assay records
- collar elevation errors compared to current LiDAR topography
- downhole survey accuracy issues, total depths, from/to intervals
- core recoveries and swelling
- lithology description from wellsite geologists
- reconciliation of lithology with laboratory assay results
- moisture records from core lab analysis
- downhole statistical analysis

If these errors could not be fixed to a suitable level of confidence or failed to meet the accuracy standards during the validation process, they were removed from the data set. Approximately 50% of the excluded data was from samples still in process of analysis at the laboratory. Table 21 summarizes the reasons drill holes were excluded from the final validated dataset.

Table 21 Drilling Excluded from the Mineral Resource database

Reason for Data Exclusion	No. Drillholes	Comments
Duplicate Hole	4	Same coordinate with other hole
No Assay	411	No assay records because still in lab for assay process
Partial Assay	15	Partial records of assay
Outside IUP	70	Outside IUP permit
Twin hole New Drilling	62	Historical drilling records where newer drilling has superseeded the older data
Close to a new resurved hole	34	Close to a new resurved hole
Reliability of Historical Records	327	Colllar record & lab assay results insufficient accuracy (mostly original ANTAM exploration data)
Total Drillholes Excluded	**923**	

5.7.3 SURVEY ACCURACY ISSUES

Approximately 22% (1042) of drillhole collars included in the validated database were draped onto the LiDAR surface for better correlation to the topography for the geological modeling process. The majority of these were from the historical data, including Bete Bete and APL mined out areas, where older survey benchmarks from local grids were used to match a non-LiDAR surface.

Table 22 Collar survey validation

Drill Collar Source	No. Drillhole in Sample set	Drillhole in Sample set (%)	Comment
NEW DEX	3671	79%	TOTAL STATION LESS THAN 1 M VARIANCE
OLD HENGJAYA DATABASE	715	15%	DATA EXTACTED FROM HISTORICAL DATA (DAPED)
NEW DEX	44	1%	MORE THAN 1 M VARIANCE (DRAPED)
NEW DEX	30	1%	MORE THAN 2 M VARIANCE (DRAPED)
NEW DEX OTHER	197	4%	BETE-BETE ACTIVE MINE/DUMP AREA
COLLAR RESURVEY	**4657**	95%	INCLUDED IN RESOURCE
GPS MINE OUT	72	1%	BETE-BETE& APL MINE AREA (DRAPED)
GPS IN RESOURCE	181	4%	GPS COORDINATE ONLY (DRAPED)
TOTAL HOLE INCLUDED	**4910**	84%	ASSESED FROM MINERAL RESOURCE
TOTAL HOLE EXCLUDELUDED	923	16%	IGNORED FROM MINERAL RESOURCE
GRAND TOTAL	**5833**		ALL DRILLHOLE COLLAR RECORD

5.7.4 RECONCILIATION OF LITHOLOGY AND ASSAY RESULTS

During the database validation process the downhole lithological description provided at the initial observations of the mineralization and lithological zones by the wellsite geologists was reconciled once the lab assay results were available. These corrections were then applied to lithology and composite code to be used in the modeling process. These zones were classified using the generalized limits shown in Table 23.

Limonite (LIM) zones were relatively homogenous due to the highly weathered laterite layer consisting mostly of massive clay formations, with only minimal boulders of bedrock. This layer was divided further for the extraction of composites into Topsoil and Limonite as several different characteristics can be identified in assay, density and moisture content. It is generally assumed in the mining process that the Soil layer is waste (overburden) due to the particular nickel grade cut-offs used. The Limonite layer is designed to meet the specifications for supply to a HPAL(high pressure acid leach) facility at the IMIP smelter. Limonite barging began in November 2021.

The underlying Rocky Saprolite (SAP) zone is in a less homogeneous geological environment. Compared to the Limonite it is only moderately weathered. The Saprolite layer often includes a transition zone, from the overlying Limonite, fresh rock boulders and weathered bedrock which are all composited into the Saprolite (SAP) code to provide an unbroken composite within the modeled laterite horizon.

Bedrock (BRK) definition was given to intersections of the fresh ultramafic rock zone intersected at the bottom of drill holes, indicating the lower boundary to the total extent of the laterization process.

Assay results were reconciled into lithology codes using Table 22. Some single assays, within the contact between lithological zones that were unconformable, were composited into the dominant surrounding lithology type to provide unbroken zones for modeling.

Table 23 Specification for reconciliation of assay records

Lithological Zones	Model Zones	Composite Zones	No. Assay Records	Ni %	MgO %	Fe %	Co %
Top Soil (Overburden)	LIMONITE (LIM)	OB-LIM	19,498	< 1.0 %	< 1 %	> 40%	< 0.08 %
Limonite Clays, Highly weathered laterite		ORE-LIM	30,358	> 1.0 %	< 5 %	> 30 %	> 0.08 %
Saprolite rocks, Patrially Weathered laterite	ROCKY SAPROLITE (SAP)	ORE-SAP	26,076	> 1.2 %	> 5 %	< 30 %	< 0.08 %
		WST-SAP	22,669	> 0.8 %	> 5 %	< 30 %	< 0.08 %
Fresh rock of Ultramafic formation	BEDROCK (BRK)	WST-BRK	12,964	< 0.8 %	> 20 %	< 10 %	< 0.01 %
TOTAL ASSAY RECONCILED AND INCLUDED IN MINERAL RESOURCE			111,565				
Underlaying Tokala Formation (Older)	SEDIMENT (LIMESTONES)	SED	58				

Several assay intersections have been identified as sedimentary (SED) which is likely part of the older underlying Tokala Formation that consists of conglomerate and limestone. All of these intersections are located in the Bete West and lower APL domains. It is assumed these are contact points between the younger Ultramafic rocks and the Tokala Formation.

5.7.5 DOWNHOLE STATISTICAL ANALYSIS

Downhole descriptive statistical analysis was conducted on the validated database used in the Mineral Resource in order to check the distribution and ranges of the analyzed elements and identify any anomalous or outlying data before the interpreted lithological surface horizons were correlated into the final model.

These simple statistical checks were completed for Ni, Co, Fe, MgO / SiO2, Al2O3, CaO, Cr2O3, MnO which comprise the main elements for the mining extraction and smelting processes already being applied at the Hengjaya site.

Histograms of these unrestricted assay data subsets were created for each domain split by Limonite, Saprolite and Bedrock zones to assess the distribution of assay results. Most of these show relatively normal distributions typical with similar type laterite deposits from Sulawesi, Indonesia. Most histograms also show some skewness of the population due to outliers. These are likely due to the compositing process of the assay reconciliation and transition between the assigned lithology zone breaks. In many cases outliers were accepted due to the geological zoning, with most identified as bedrock boulders inside the Limonite and Saprolite layers.

The histogram plots for nickel grade values show positively skewed data, which suggests outliers could cause possible overestimation to the Mineral Resource grade due to bias caused by the extreme grade which is commonly known as the nugget effect. To reduce the impact of these outliers, top cuts are calculated by estimating the range from 2 standard deviations from the mean, which assumes that 95% of the values are within this adjusted range. This top cut strategy is considered adequate for this project since the frequency of the outliers are considered relatively low. The summary of recommended statistical top cuts for each domain is shown in Table 24.

Table 24 Summary of recommended statistical top cuts for each domain

Block	Lith_comp	Samples	Mean	Median	StDev	Minimum	Maximum	TOP CUT
BETE BETE	ORE-LIM	1906	1.17	1.14	0.21	0.56	2.39	1.59
	ORE-SAP	3267	1.81	1.80	0.51	0.21	4.23	2.83
BETE SOUTH	ORE-LIM	3897	1.22	1.20	0.20	0.48	2.59	1.61
	ORE-SAP	1999	1.56	1.56	0.43	0.26	3.88	2.42
CENTRAL WEST	ORE-LIM	17300	1.23	1.22	0.21	0.23	2.85	1.66
	ORE-SAP	13191	1.76	1.73	0.57	0.19	6.36	2.90
CENTRAL EAST	ORE-LIM	4921	1.22	1.21	0.24	0.14	3.38	1.70
	ORE-SAP	4934	1.71	1.68	0.59	0.02	6.02	2.88
BETE WEST	ORE-LIM	93	1.19	1.16	0.20	0.81	1.80	1.59
	ORE-SAP	141	1.70	1.58	0.42	0.82	3.75	2.55
BETE FAR WEST	ORE-LIM	305	1.09	1.07	0.18	0.63	1.56	1.45
	ORE-SAP	204	1.72	1.62	0.43	0.75	2.95	2.58
APL	ORE-LIM	1198	1.16	1.16	0.20	0.10	1.93	1.57
	ORE-SAP	1719	1.63	1.58	0.64	0.12	5.20	2.91

The application of these top cuts to normalize the distribution of the statistical percentage nickel grades were reviewed. From these recommendations, a top cut for each domain was applied to nickel composites and used in the model grade interpolations to limit the influence of statistical outliers within each of the grade domains. Bottom cuts of 0.25% Nickel were also applied to all domains.

Figure 40 shows the histogram of all Ni grade values (without laterite profile restriction) indicating the positive skew of the dataset which indicates we have a large group of low nickel values compared to the high nickel values. Figure 41 shows the application of the top cut on the distribution of the nickel grade values used in the model.

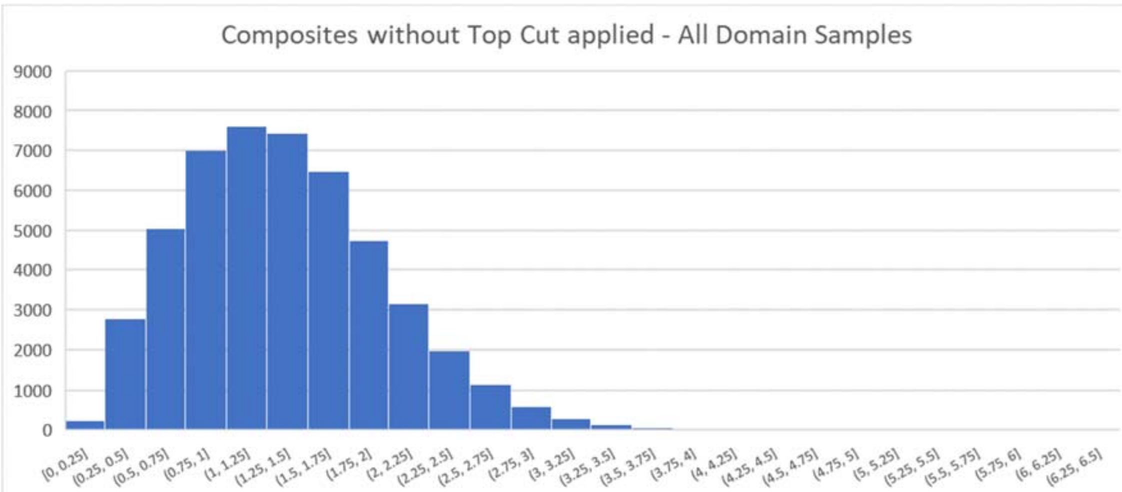


Figure 40 Histogram of Ni Grade (without laterite profile restriction)

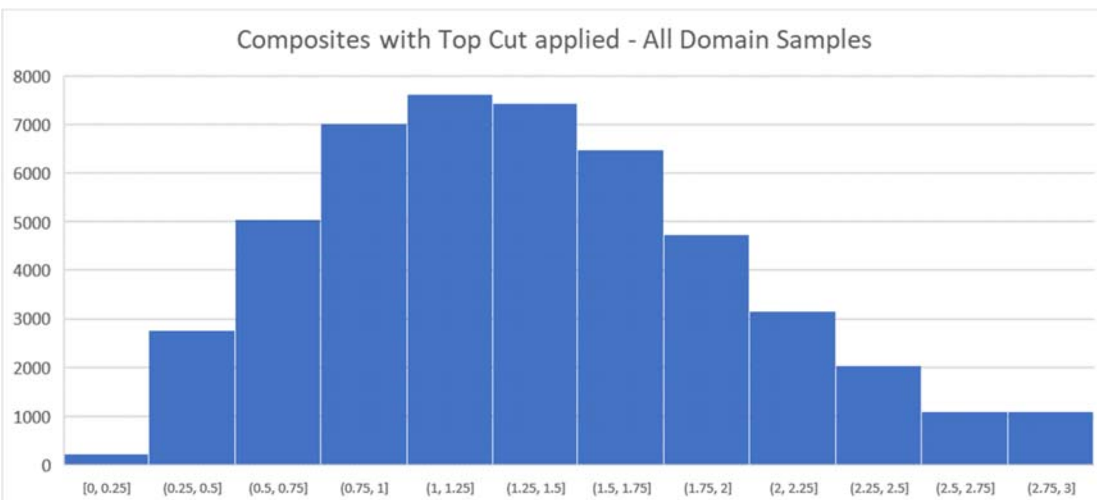


Figure 41 Histogram of Ni Grade with top cut applied

Composited, down hole statistics extracted by zone thickness and average nickel grades for Limonite and Saprolite were plotted on a map to identify the spatial distribution of each zone respectively as shown in figures 42 and 43 for Limonite and figures 44 and 45 for Saprolite.

Composite Limonite grades are highest in the Central West and Central East domain areas. Composite Saprolite grades tend to be highest in the Bete Bete and Central West areas.

From these plots it is observed that the lateral statistical distribution for both Limonite and Saprolite conform to several interpreted geological breaks that influence the laterization process from one location to another. The statistical analysis process was also split into the corresponding geological domains. These statistical subsets were constrained using hard polygon boundaries interpreted in Section 5.5 of this report.

For further details on downhole statistical analysis information please see Appendix 9.4.

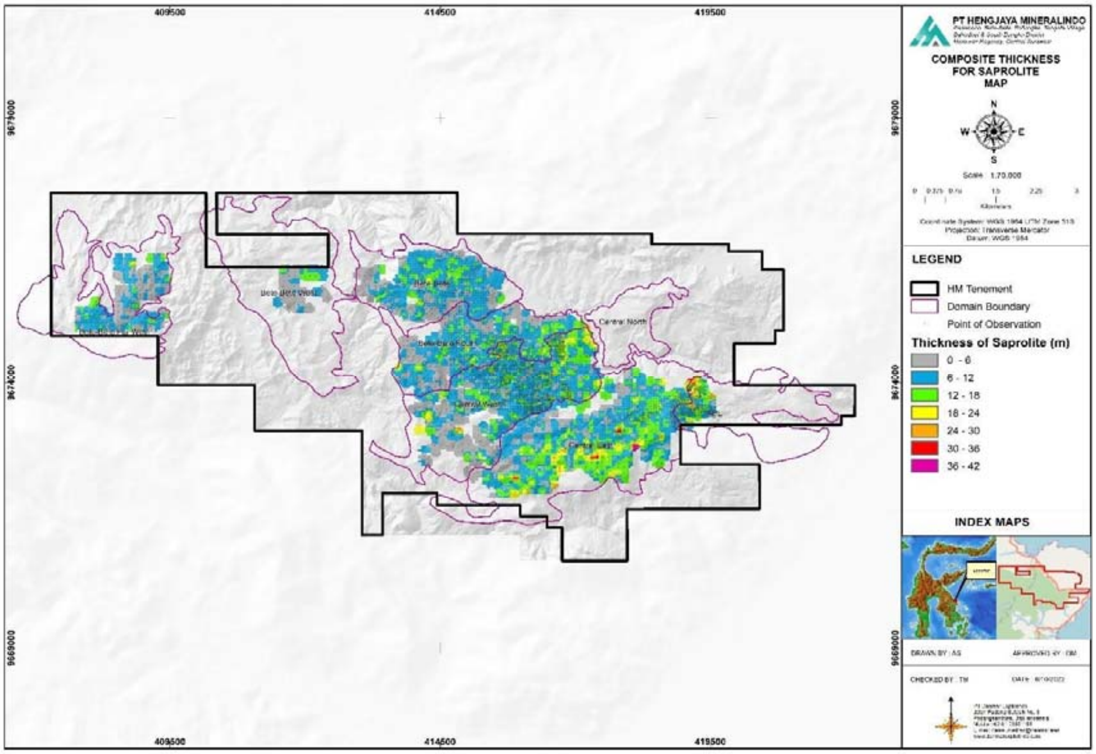


Figure 42 Composite Thickness for the Limonite zone based on drilling

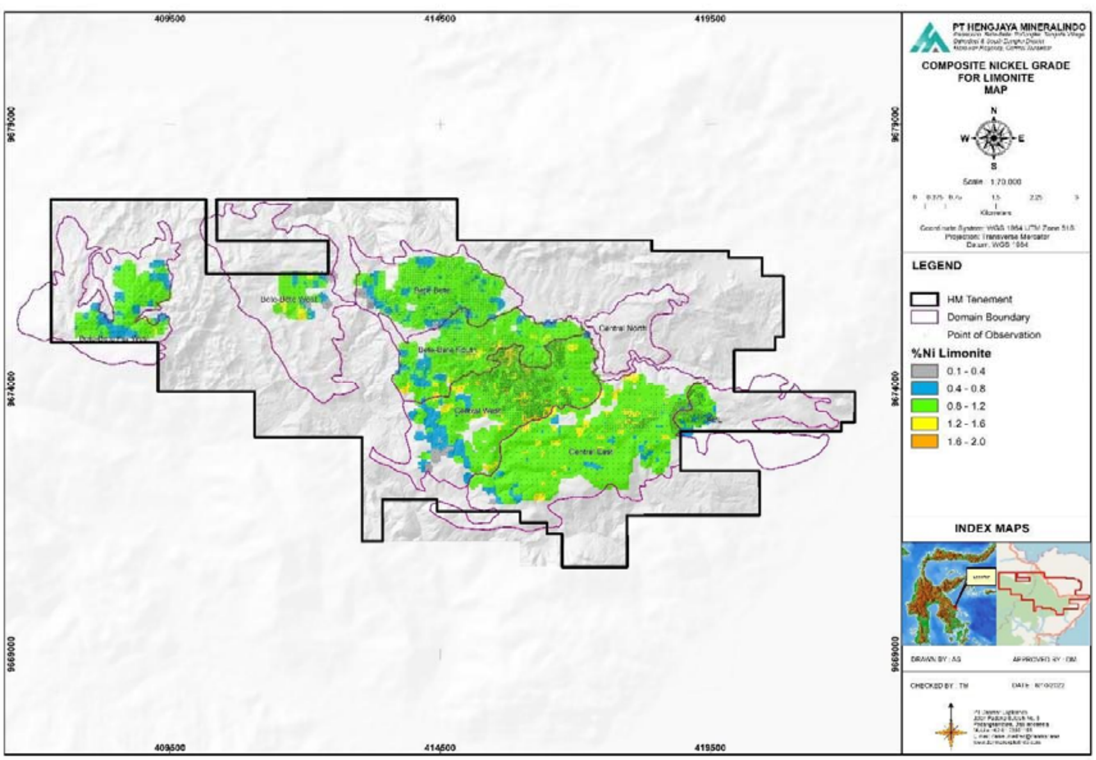


Figure 43 Composite nickel grade for the Limonite zone based on drilling

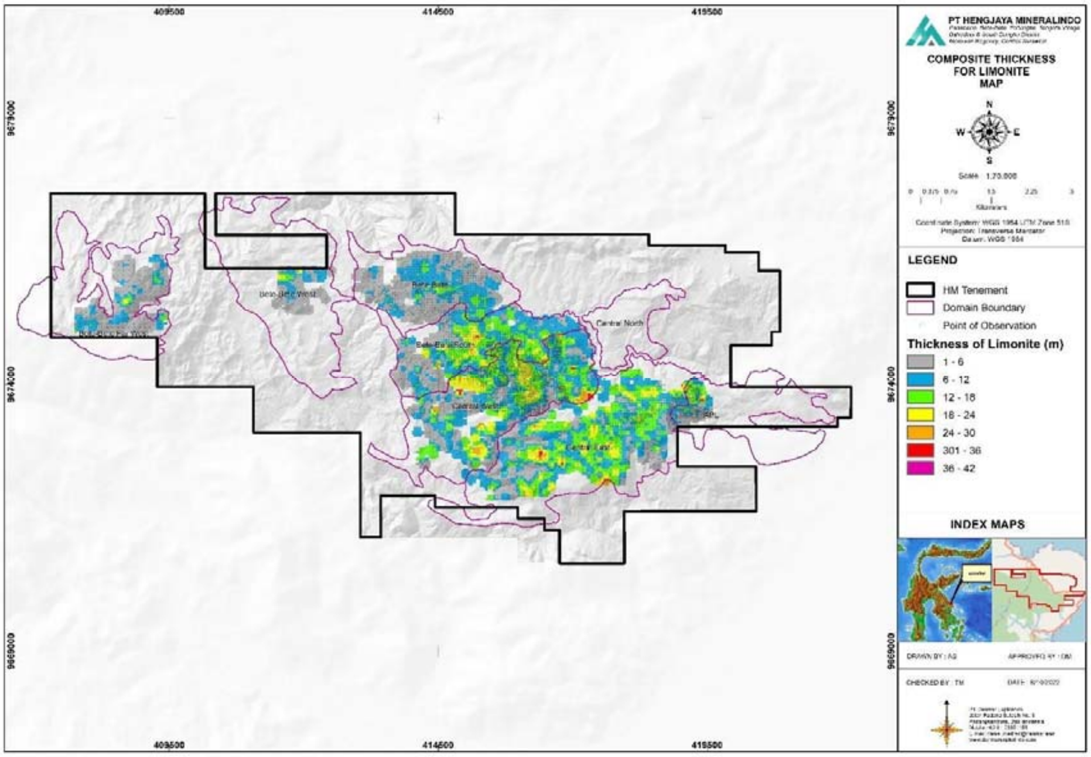


Figure 44 Composite thickness for the Saprolite zone based on drilling

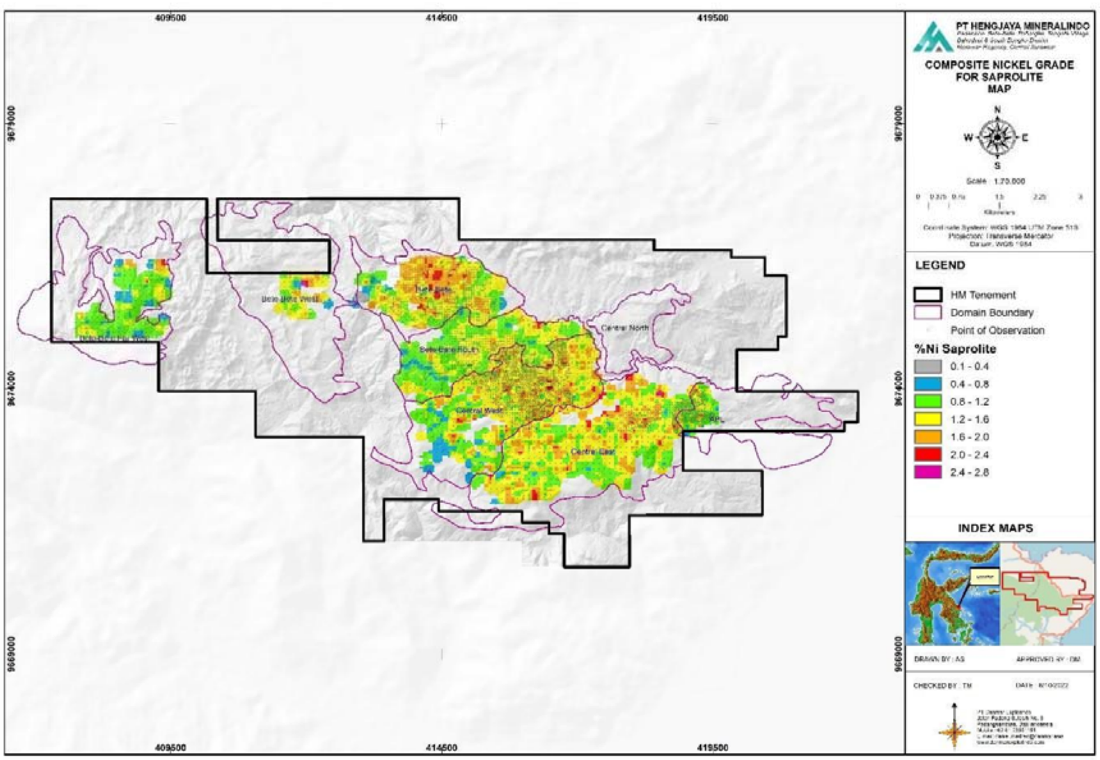


Figure 45 Composite nickel grade for the Saprolite zone based on drilling

5.7.6 GEOSTATISTICAL ANALYSIS

The continuity of the nickel mineralization within each domain was assessed using the spatial relationship between composites extracted from the validated database. This process is used to identify direction and continuity of the grades.

Geostatistical analysis was applied to the Ni value grades only for each of the geological domains for both Limonite and Saprolite layers. The purpose of this was to generate several semi variogram models so that these parameters could be used to input into the Kriging algorithms when populating the final models with interpolation of nickel grades.

These semi variogram ranges, based on the geostatistical analysis, were used to define the spatial continuity, direction and distances of search ellipsoids to be applied to the nickel Mineral Resource estimate as follows;

- determination of directional anisotropy of the mineralized zones
- estimation of spatial continuity of the grades aligned with the main directions determined by the anisotropy ratios, providing a distance for the search
- calculation of the Sill or Nugget effect and range to be used in the Kriging process

This process was conducted with many iterations until the model validation was checked to provide sufficient confidence for a Mineral Resource. Figure 46 shows the typical process flow used when completing the geostatistical analysis

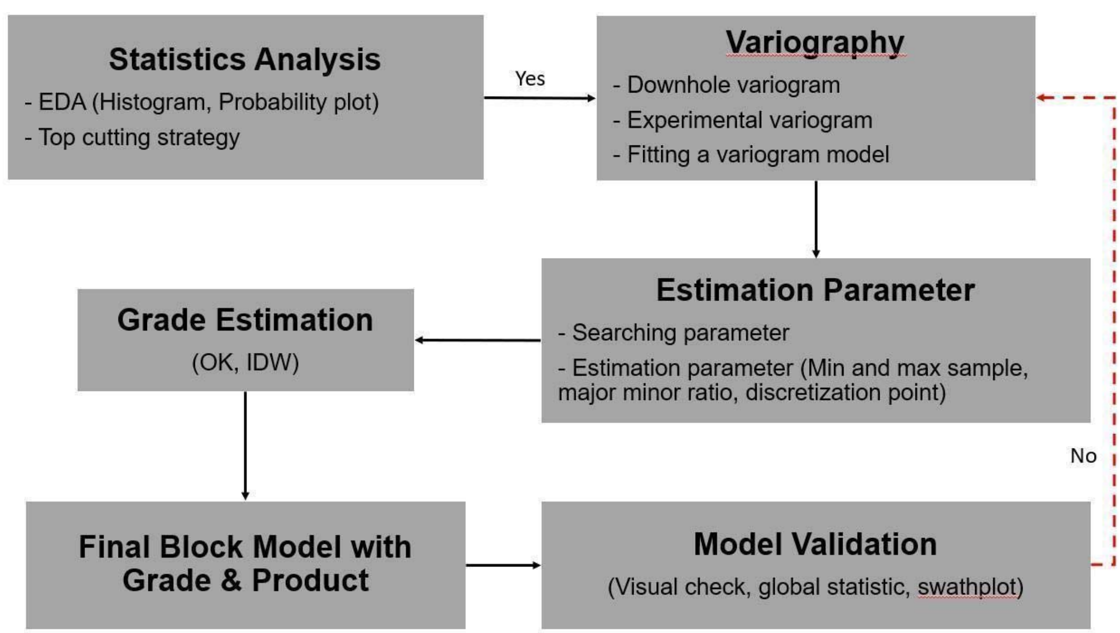


Figure 46 Geostatistical analysis process flow

All the semi variogram models for each domain were calculated using statistical top-cuts for Saprolite were applied to composites and constrained by hard boundary surfaces of the corresponding mineralized lithology zones for Limonite and Saprolite.

In general, the distribution of mineralization within the laterite was considered to be relatively flat lying, with no significant dip or plunge observed between points of observation the variograms were modeled as horizontal planes.

Variograms are first aligned along the major axis bearing which represents the main direction of mineralized continuity, with the semi-major axis direction aligned 90o to the first axis. A third axis (minor) represents the vertical search. The combination of these 3 axes, weighted by the anisotropy ratios, provide the guide for search ellipsoids to be applied to the model.

The result of the variogram models are summarized in Table 25.

Table 25 Summary Result of the variogram model created

Domain	Variogram model: Spherical								Anisotropy Factor	
	Experimental Variogram type: Standard								Major/ Semi-Major	Major/ Minor
	Profile	Element	Bearing	Plunge	Dip	Range	Nugget	Structure 1 (Sill)		
BBW, BB, BBS, CW, CE, APL	LIM	ni	120	0	0	71.409	0.006	0.067	1	9.18
	SAP	ni	105	0	0	52.35	0.067	0.3	1.01	7.14
BETE FAR WEST	LIM	ni	70	0	0	164.25	0.008	0.055	1	19.57
	SAP	ni	45	0	0	218.83	0.025	0.2	1.113	24.25

Figure 47 shows the semi variogram models produced for Bete Bete and Central domains for Ni in Limonite.

Figure 48 shows the semi variogram models produced for Bete Bete and Central domains for Ni in Saprolite.

Figure 49 shows the semi variogram models produced for Bete Bete Far West domain, Ni in Limonite.

Figure 50 shows the semi variogram models produced for Bete Bete Far West domain, Ni in Saprolite.

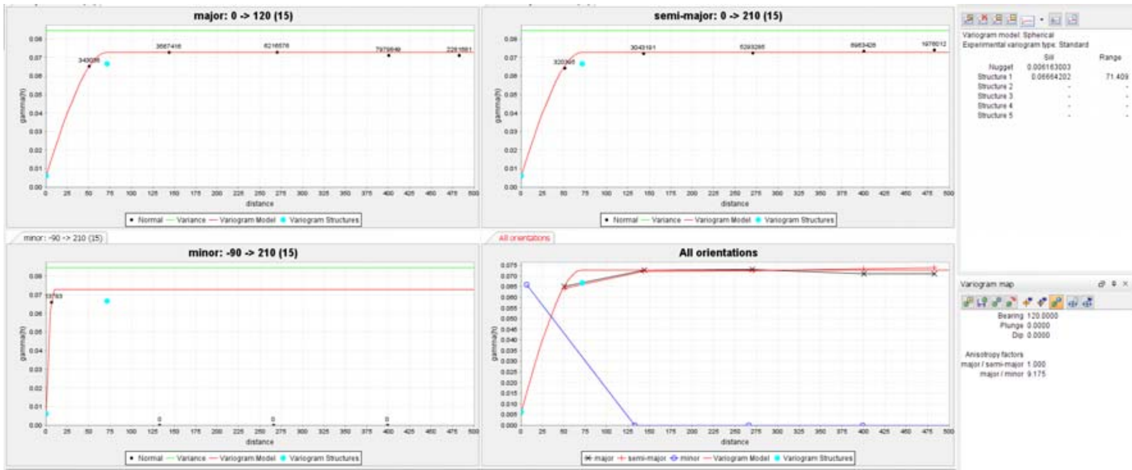


Figure 47 Semi variogram models for Bete Bete and Central domains, Ni in Limonite

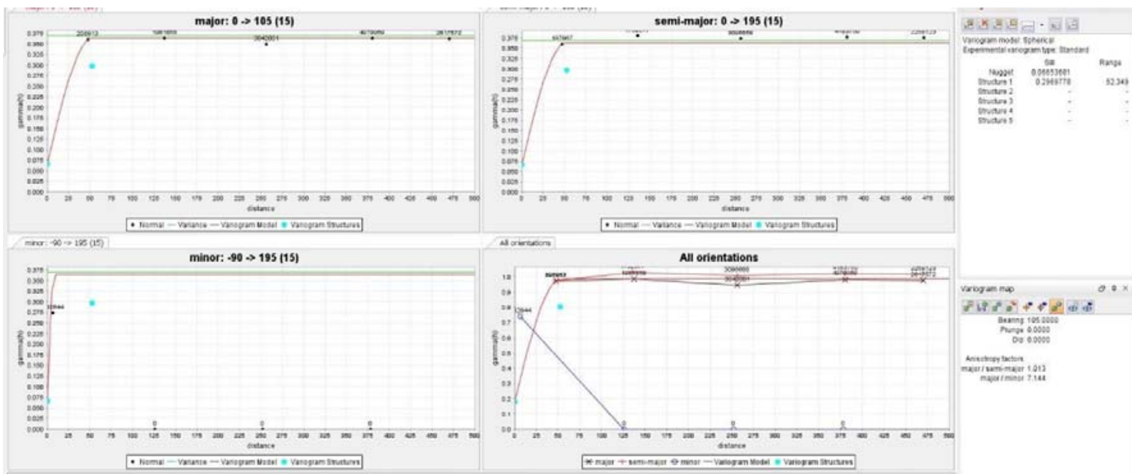


Figure 48 Semi variogram models for Bete Bete and Central domains, Ni in Saprolite

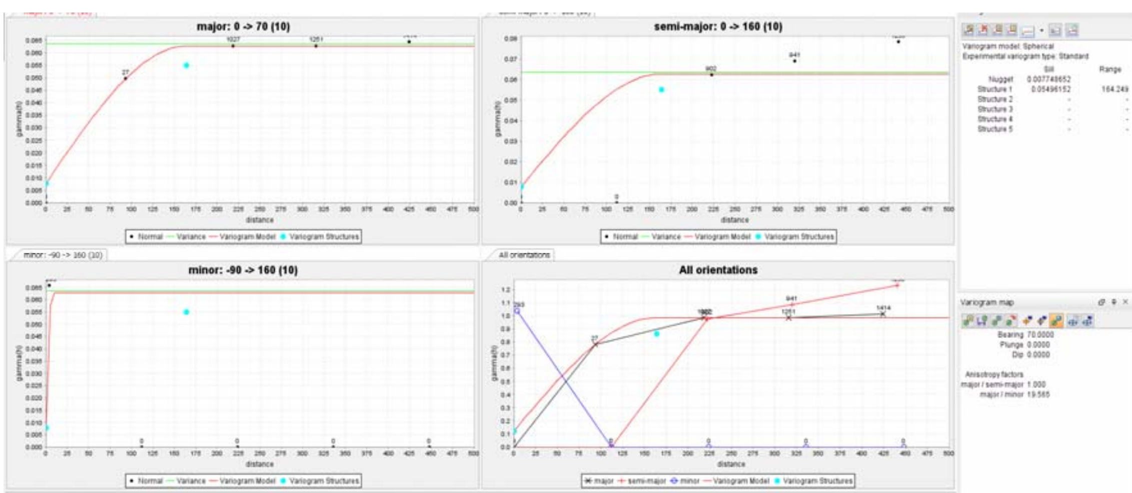


Figure 49 Semi variogram models for Bete Bete Far West domain, Ni in Limonite

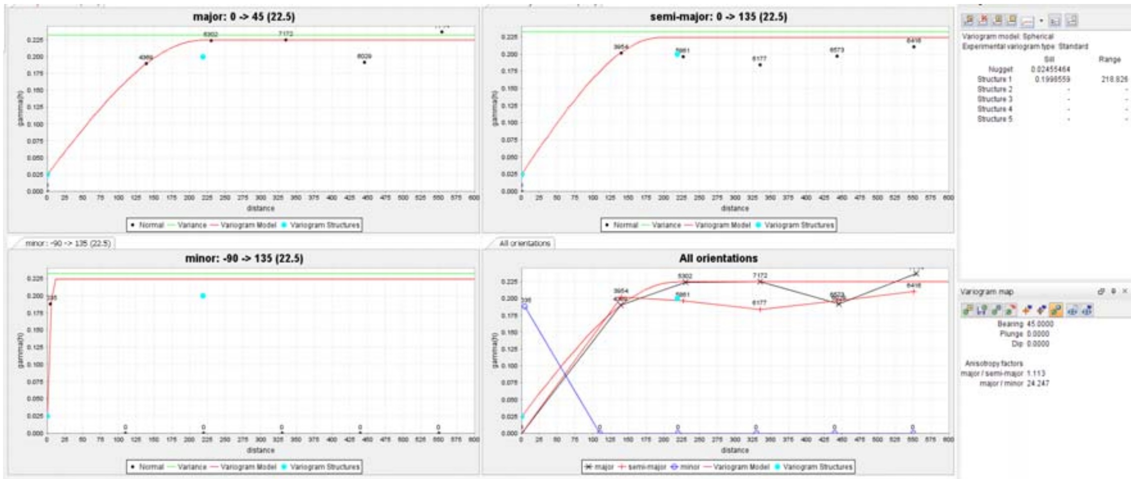


Figure 50 Semi variogram models for Bete Bete Far West domain, Ni in Saprolite

6 MINERAL RESOURCE ESTIMATE

This report is an update to the last Mineral Resource estimate dated 30 June 2020. Since that time an additional 2,909 drill holes have been completed with a total cumulative depth of 71,330m.

6.1 SOFTWARE

Geological modeling and Mineral Resource estimates were completed using GEOVIA Surpac® mining software (version 6.1). compilation, validation and correlation using Surpac® mining software with Microsoft® Access Relational Database Management System (RDBMS) providing the storage of collar, downhole survey, lithology and assay.

6.2 SURFACE GRIDDING & WIREFRAMING

Wireframing was set up on each drill line in both east-west & north-south directions to create a 10X10m grid over the entire database area. First digitized, the lines were then draped onto the LiDAR surface to develop a morphology wireframe. This was done to assess any aspect and slope angle weathering patterns obvious from the topography.

The wireframe sections were then generated into gridded surfaces from the drilling/assay database (points of observation). From this process 2 dominate horizons were interpreted;

- top of rocky Saprolite – contact zone between Limonite clay and rocky Saprolite
- top of Bedrock – contact zone between rocky Saprolite and bedrock

A third gridded surface was extracted from the top of the bedrock by dropping the elevation by 10m to represent the floor of bedrock in the model.

The gridded surfaces were produced to represent the roof and floor limits of limonite, saprolite and bedrock zones. 10m grids were set up and interpolation of the gridded points were using Inverse Distance Weighted Squared (IDW^2) methods.

These final gridded surfaces were then checked visually using sections to the contact of the drilling database to correct any over-smoothing with the process. This visual check provided some small corrections to ensure the drilling intersected the surfaces with no interpretational errors.

6.3 ASSAY DATA AND COMPOSITING

Only assay data from the validated database from included holes (INCL) were extracted for use in the compositing process. Composite lengths of 1m were used, which correlates with the majority of the sample length records and within statistical ranges suggested by the variography modeling. Composites were split into 5 distinct zones:

- SOIL (OB-LIM)
- LIMONITE (ORE-LIM)
- SAPROLITE (ORE-SAP)
- ROCKY SAPROLITE (WST-SAP)
- BEDROCK (WST-BRK)

For each of the zones the following elements were composited from the assay results in the database as follows;

- Ni (%) – Nickel content
- Co (%) – Cobalt content
- Fe (%) – Iron content
- MgO (%) – Magnesium Oxide content
- SiO2 (%) – Silica Oxide content
- Al2O3 (%) – Aluminum Oxide content
- CaO (%) – Calcium Oxide content
- Cr2O3 (%) – Chromite Oxide content
- MnO (%) – Manganese Oxide content
- Moisture Content (%)

Based on analysis of the downhole statistical data additional top and bottom cut constraints were applied to Ni% content to impose a domain limit of no greater than 2 standard deviations from the ORE-SAP average to avoid over-estimation of nickel content due to possible nugget effect. For this reason, all core sample measurements over statistical cuts (Ni) were assigned a default value. Table 26 shows the influence of the applied Ni top cuts to final composites for each domain.

Table 26 Ni % top cut applied to composites by domain

Domain	Nickel top cut (Ni%)			total assay
	Cut applied	No. assay	No. cut %	
BETE_FAR_WEST	2.58	8	0.37%	2,167
BETE_WEST	2.55	5	0.71%	704
BETE_BETE	2.83	80	0.71%	11,238
BETE_SOUTH	2.42	83	0.62%	13,292
CENTRAL_WEST	2.90	441	0.83%	53,198
CENTRAL_EAST	2.88	146	0.68%	21,441
APL	2.91	75	0.79%	9,550
TOTAL ADJUSTED ASSAY RECORDS		838	0.75%	111,590

In areas where Moisture content measurements were not available the domain default weighted average was applied to the corresponding composite zone. Moisture content for APL Zone was applied from Central East Domain sampling. Table 27 summarizes the number of composite samples that were used to estimate the domain weighted moisture content. Table 28 summarizes the number of composite samples that were used to estimate the domain weighted sample Moisture content.

Table 27 Moisture Content records domain averages applied to composites

Laterite Profile	Average Moisture Content %					
	Bete Far West	Bete West	Bete Bete	Bete South	Central West	Central East
SOIL	36.5%	35.5%	32.5%	35.5%	34.2%	35.4%
LIMONITE	40.1%	41.8%	40.2%	43.3%	41.2%	41.9%
SAPROLITE	24.3%	35.7%	31.8%	32.9%	31.5%	31.8%
BRK	6.6%	24.7%	13.3%	10.3%	9.8%	12.2%
Total Samples	**2179**	**611**	**9867**	**12912**	**52514**	**15991**

Table 28 Moisture Content records applied domain averages to composites

Domain	Moisture Content records using domain averages					
	OB-LIM	LIM	SAP	BRK	No.Assay	(%)
BETE_FAR_WEST	0	0	0	0	0	0.0%
BETE_WEST	17	0	28	41	86	12.2%
BETE_BETE	271	162	682	260	1,375	12.2%
BETE_SOUTH	84	43	159	52	338	2.5%
CENTRAL_WEST	201	104	355	43	703	1.3%
CENTRAL_EAST	1,675	656	2,633	577	5,541	25.8%
APL	2,091	1,198	4,918	1,343	9,550	100.0%
total adjusted records	4,339	2,163	8,775	2,316	17,593	15.8%
	3.9%	1.9%	7.9%	2.1%		

6.4 BULK DENSITY

Relative density was manually added to the composites based on the weighted average recorded for each zone within the corresponding domain (see Table 18). APL block was assumed to be similar in geological characteristics to Central East as they are located at the same area so the density was assumed to be the same as well.

6.5 BLOCK MODELING

A 3D block model was created covering the Mineral Resource area constrained using the final gridded surface models from the wireframing process to use as the base of volume estimation of the laterite zones of limonite, saprolite and bedrock. A total of 2 block models were created as follows;

1) Master model covering Bete Bete and Central domains
2) Bete Far West model

This division was done to reduce the size of the combined block model for practical use within computer processing capacity. Table 29 shows the block model dimensions and block sizes used during this process. The assumption of the block sizes was designed to match the composite sample lengths and practical mining bench dimensions for ongoing mine planning at the Hengjaya site.

Table 29 Block model dimensions

BETE BETE / CENTRAL MODEL				BETE FAR WEST MODEL			
Type	Y	X	Z	Type	Y	X	Z
Minimum Coordinates	9671600	411200	180	Minimum Coordinates	9674830	407500	450
Maximum Coordinates	9676840	419900	580	Maximum Coordinates	9676710	409700	860
User Block Size	20	20	2	User Block Size	20	20	2
Min. Block Size	10	10	1	Min. Block Size	10	10	1
Rotation	-	-	-	Rotation	-	-	-
Axis Length (m)	5240	8700	400	Axis Length (m)	1880	2200	410
Total Blocks	94498			Total Blocks	24495		
Storage Efficiency %	99.94			Storage Efficiency %	99.85		

Attribute Name	Type	Decimal	Background	Description
density	Real	2	-99	Insitu lab density measurement (wet s.g)
domain_id	Character	-	UNDEF	BETE BETE, BETE SOUTH, CENTRAL WEST, CENTRAL EAST, APL, BETE WEST, BETE FAR WEST
geology	Character	-	UNDEF	LATERITE=LIMONITE/SAPROLITE
grade	Real	2	0	1=LIM/RSAP/BRK
idw_al2o3	Real	2	-99	IDW interpolated grades for Alumunium Oxide (Al2O3%)
idw_cao	Real	2	-99	IDW interpolated grades for Calcium Oxide (CaO%)
idw_co	Real	2	-99	IDW interpolated grades for Cobalt (Co%)
idw_cr2o3	Real	2	-99	IDW interpolated grades for Chromite (Cr2O3%)
idw_fe	Real	2	-99	IDW interpolated grades for Iron (Fe%)
idw_mgo	Real	2	-99	IDW interpolated grades for Magnesium Oxide (MgO%)
idw_mno	Real	2	-99	IDW interpolated grades for Manganese Oxide (MgO%)
idw_ni	Real	2	-99	IDW interpolated grades for Nickel (Ni%)
idw_pass	Integer	-	0	Krigging Pass 0=Undefined, 1=Pass 1, 2=Pass 2, 3=Pass 3, 4=Pass 4
idw_sio2	Real	2	-99	IDW interpolated grades for Silica (SiO2%)
lith_type	Character	-	UNDEF	LIM=Limonite, RSAP=Saprolite. BRK=Bedrock
material_class	Character	-	WASTE	OVERBURDEN=Limonite, ORE=Saprolite
moisture_content	Real	2	-99	Moisture content (%) of core sample
ni_keff	Real	2	-99	Krigging Efficiency
ni_kvar	Real	2	-99	Krigging Variance
ni_ok	Real	2	-99	Ordinary Kriging interploation for Nickel (Ni%)
ni_ok_top_cut	Real	2	-99	Ordinary Kriging interploation for Nickel (Ni%) with top cut applied
ni_pass	Integer	-	0	Krigging Pass 0=Undefined, 1=Pass 1, 2=Pass 2, 3=Pass 3, 4=Pass 4
res_class	Character	-	UNDEF	MEASURED, INDICATED, INFERRED

Constraints applied are all below the LiDAR topography surface and within the Resource boundary polygon limited to the edge of the domains and extent of the included drilling data. Further constraints to distinct laterite zones are;

- Limonite – above top of rocky saprolite
- Saprolite – below top of saprolite / above top of bedrock
- Bedrock – above floor of bedrock / below top of bedrock

6.6 GRADE INTERPOLATION

For the purpose of this report, Ordinary Kriging (OK) algorithm was used in the grade interpolation for nickel in limonite and saprolite zones. These surface constraints were applied as hard surface boundaries when estimating nickel in each domain.

In the absence of geostatistical analysis for other elements, Inverse Distance Weighted Squared (IDW²) methods were used to estimate the model grade interpolation for other elements including: Ni, Co, Fe, MgO & SiO2, Al2O3, CaO, Cr2O3, Mn0 and Moisture Content. Population of the model used the same search ellipsoids and constrained passes as OK modeling for nickel.

The subsequent model validation process showed a similar Ni to volume ratio between OK and IDW² results, so it is not expected the other elements interpolated are biased combining the 2 methods together.

In total three main passes were applied to both the OK and IDW² methods when interpolating the model grades, with increasing search ellipsoid distances between drilling, a fourth pass was completed to ensure all blocks within the model are given a grade within the Mineral Resource area. Table 30 shows the summary of the final model search ellipsoids applied to the Mineral Resource.

Table 30 Summary search ellipsoids applied to the model

Lithology zone by Domain	Limonite								Saprolite							
	Bete Bete				Bete Far West				Bete-Bete				Bete Far West			
Search Type	Ellipsoid								Ellipsoid							
Bearing	120				70				105				45			
Plunge	0								0							
Dip	0								0							
Major-Semi Major Ratio	1				1				1.013				1.113			
Major-Minor Ratio	9.18				19.57				7.14				24.25			
Search Pass	Pass 1	Pass 2	Pass 3	Pass 4	Pass 1	Pass 2	Pass 3	Pass 4	Pass 1	Pass 2	Pass 3	Pass 4	Pass 1	Pass 2	Pass 3	Pass 4
Max Search Radius (m)	37.5	75	150	300	37.5	75	150	300	37.5	75	150	300	37.5	75	150	300
Max Vertical Search Distance (m)	2	4	8	16	2	4	8	16	2	4	8	16	2	4	8	12
Minimum Samples	3	3	2	1	3	3	2	1	3	3	2	1	3	3	2	1
Maximum Samples	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Max. Samples per Hole	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Block Discretisation	3 X by 3 Y by 2 Z								3 X by 3 Y by 2 Z							

Each of the domain search ellipsoids applied to Limonite and Saprolite layers, both bearing and anisotropy factors were applied as recommended by the geostatistical study for the Kriging interpolation of nickel grades. However, based on the review of the suggested ranges and assessment of the regular drilling grid pattern, standard search radius was applied to all blocks at; 37.5m, 75m and 150m, representing the extrapolation distances between drilling grids of 25, 50 and 100 meters respectively. These passes were considered with reasonable tolerances and rechecked during the model validation process (see Table 25). Then they were used as a guide to the Resource categorization.

6.7 RESOURCE CLASSIFICATION STRATEGY

Determination of the Resource categories were applied to the Mineral Resource with a digitized polygon boundary based on the spatial continuity of each geological domain around regular spaced drilling grids of 25, 50, 100, 200m from included (INCL) points of observation in the final validated database. Also taken into account was the Ultra GPR data on grid lines between the drilling locations increasing confidence in interpretation of the laterization contact surface between the points of observation in the model. Resources were classified as follows;

- MEASURED - Areas of 25-50m of drilling spacing on a continuous grid pattern, where significant influence from Pass 1 and 2 dominate the search ellipsoids, with no extrapolation from the last line of drilling
- INDICATED - Areas of 50-100m of drilling spacing on a continuous grid pattern, where significant influence from Pass 1, 2 and 3 dominate the search ellipsoids, with 50m extrapolation from the last line of drilling
- INFERRED - Areas of 100-200m of drilling spacing on a continuous grid pattern, where reasonable influence from Pass 1, 2 and 3 dominate the search ellipsoids, with 100m extrapolation from the last line of drilling. In some areas between holes greater than 200m the polygon was included into the Inferred category to allow for more practical polygon shape to fit to the model area

Bete Bete, APL and Central mine areas were given the Resource class MINED OUT as it is considered mining depletion has sterilized these areas. Figure 51 shows the polygons applied to the model to prepare the statement of Mineral Resource in this report.

Bete Bete Far West and Bete West matched drill spacing criteria for Indicated Resource but were downgraded to Inferred status because of insufficient drilling over the entire area to give confidence to the Resource continuity for both thickness and grade.

Table 31 shows the coverage area of influence of each assigned classification on the Mineral Resource within the model limits. The coverage areas (Ha) split by domain of the polygon boundaries are shown in Table 10 of this report.

Table 31 Coverage area of the Mineral Resource by classification

Mineral Resource Classification			
Classes Applied	DANMAR, June 2020 Area (Ha)	DANMAR, June 2022 Area (Ha)	Difference Areas (%)
MINED OUT	97	113	116%
MEASURED	121	425	352%
INDICATED	559	739	132%
INFERRED	453	620	137%
TOTAL CLASSED	1230	1897	154%
NOT CLASSED	241	330	137%
TOTAL MODEL AREA	1471	2226	151%

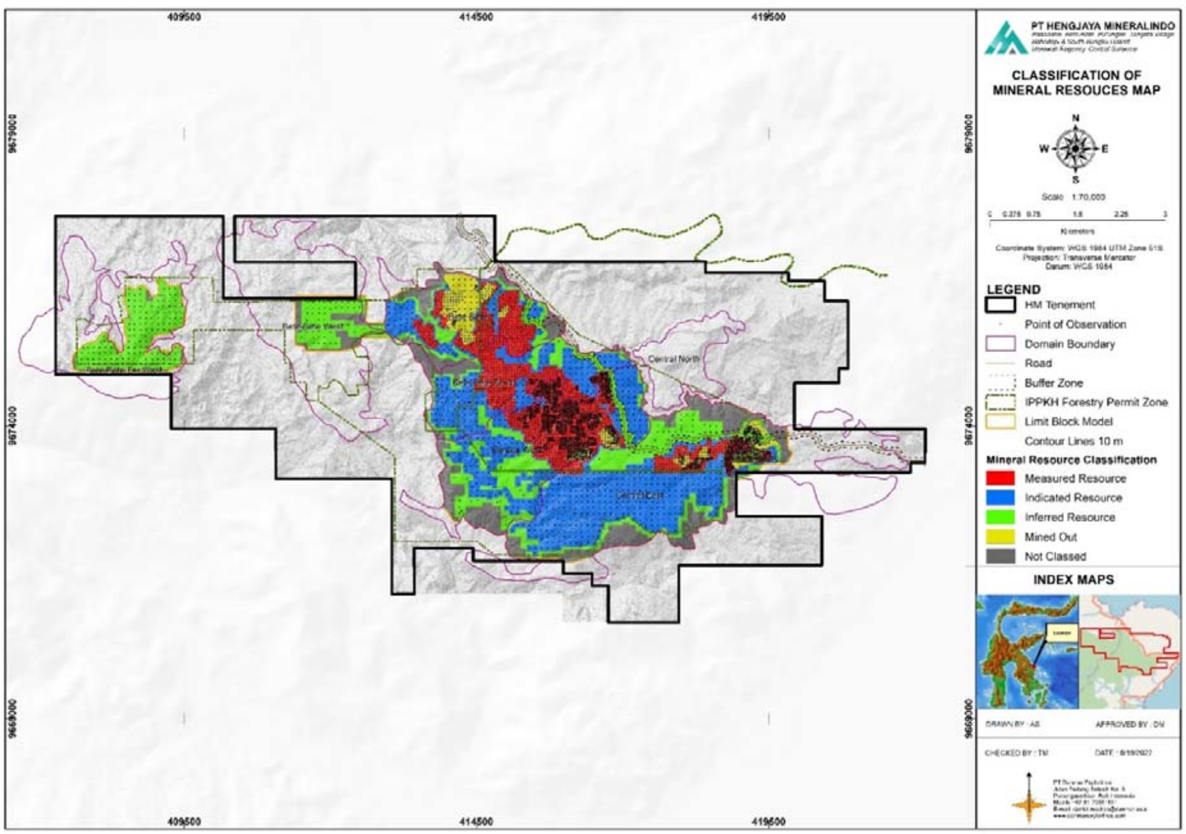


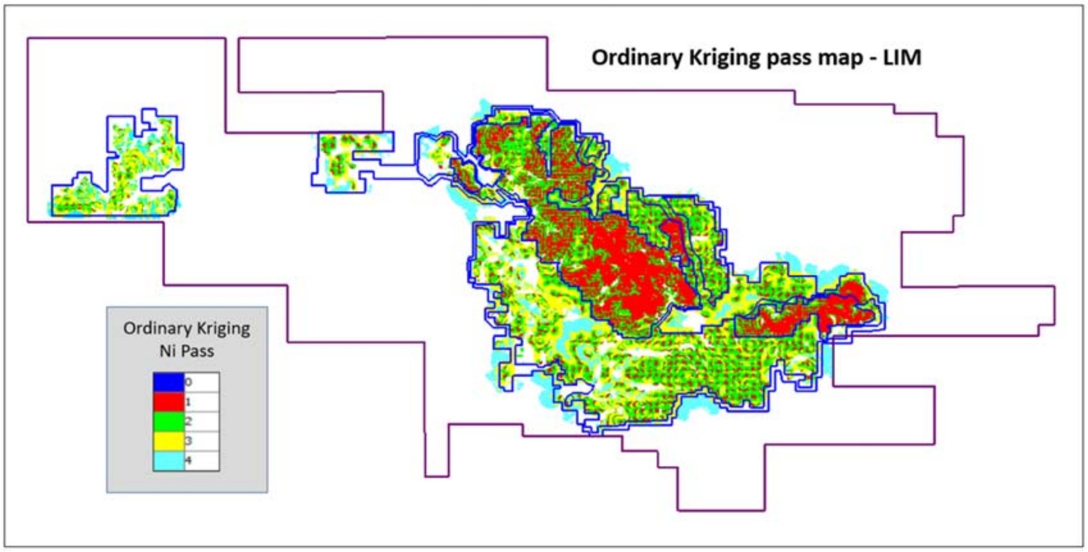
Figure 51 Resource classification boundaries

Another factor in selection of Resource polygon limits used for the Mineral Resource was a review of the geostatistical inputs and the weighting on each category. This was done by comparing the influence of each pass within the polygon boundaries. Table 32 shows the results of this validation process.

The results show that 98% of the blocks in the Measured class are interpolated by Pass 1 & 2 and the Indicated class is approximately 98% interpolated by Passes 1, 2 and 3. These results give sufficient confidence in the polygon strategy respectively. The lowest class of Inferred still has majority portions of the first 3 passes with 18% of pass 4 which is considered acceptable in this selection. Figure 52 shows the Resource classification boundaries overlay with the pass map.

Table 32 Interpolation pass influence on Resource classification

Resource class	Interpolation pass	Ton (Dry)	Influence (%)
MEASURED	PASS 1	67	79%
	PASS 2	17	19%
	PASS 3	2	2%
	PASS 4	0	0%
TOTAL PORTION OF MINERAL RESOURCE		85	28%
INDICATED	PASS 1	34	26%
	PASS 2	63	49%
	PASS 3	30	23%
	PASS 4	3	2%
TOTAL PORTION OF MINERAL RESOURCE		130	43%
INFERRED	PASS 1	9	11%
	PASS 2	22	26%
	PASS 3	39	46%
	PASS 4	15	18%
TOTAL PORTION OF MINERAL RESOURCE		85	28%
ALL	PASS 1	110	37%
	PASS 2	102	34%
	PASS 3	71	24%
	PASS 4	18	6%
total Mineral Resource >0.80% Ni		**300**	**Million Ton (Dry)**



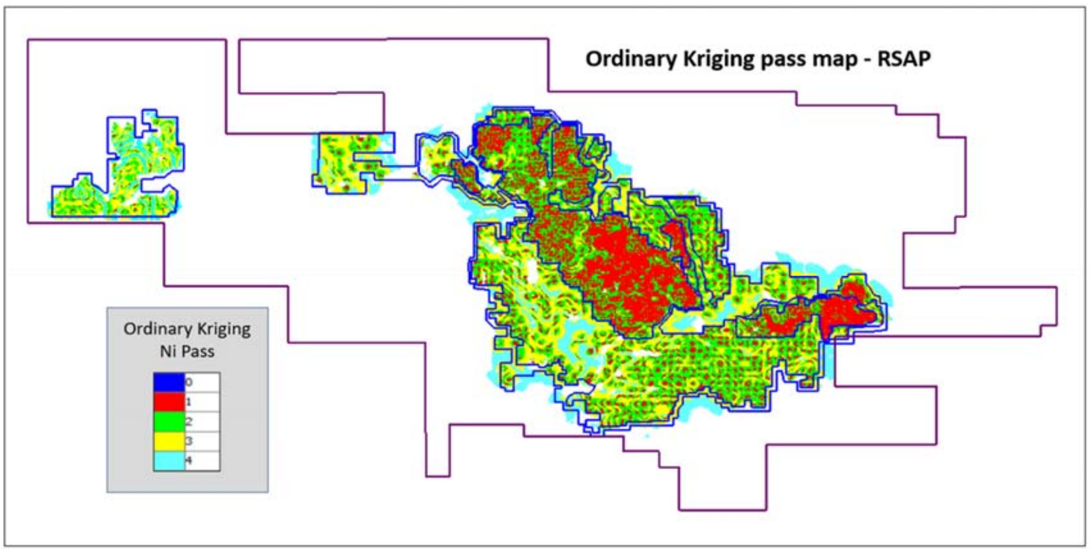


Figure 52 Resource classification boundaries overlay with Ordinary Kriging pass map

6.8 MODEL VALIDATION

Final block model and interpolated grades were validated using several visual and statistical techniques to gain further confidence in the Mineral Resource estimates stated in this report.

Firstly, visual inspection of the block models in plan and sectional views to assess the grade interpolations performed conform with the lithological wireframes, surface models and drilling database. For each domain several sections were reviewed along drilling grid lines both in North-South and East-West directions. Additional sections at approximately 45 degree angle to these directions were also viewed. Figure 53 shows section examples used for visual validation of the model. Figure 54 shows plan views also used for visual validation of the model for each lithological layer.

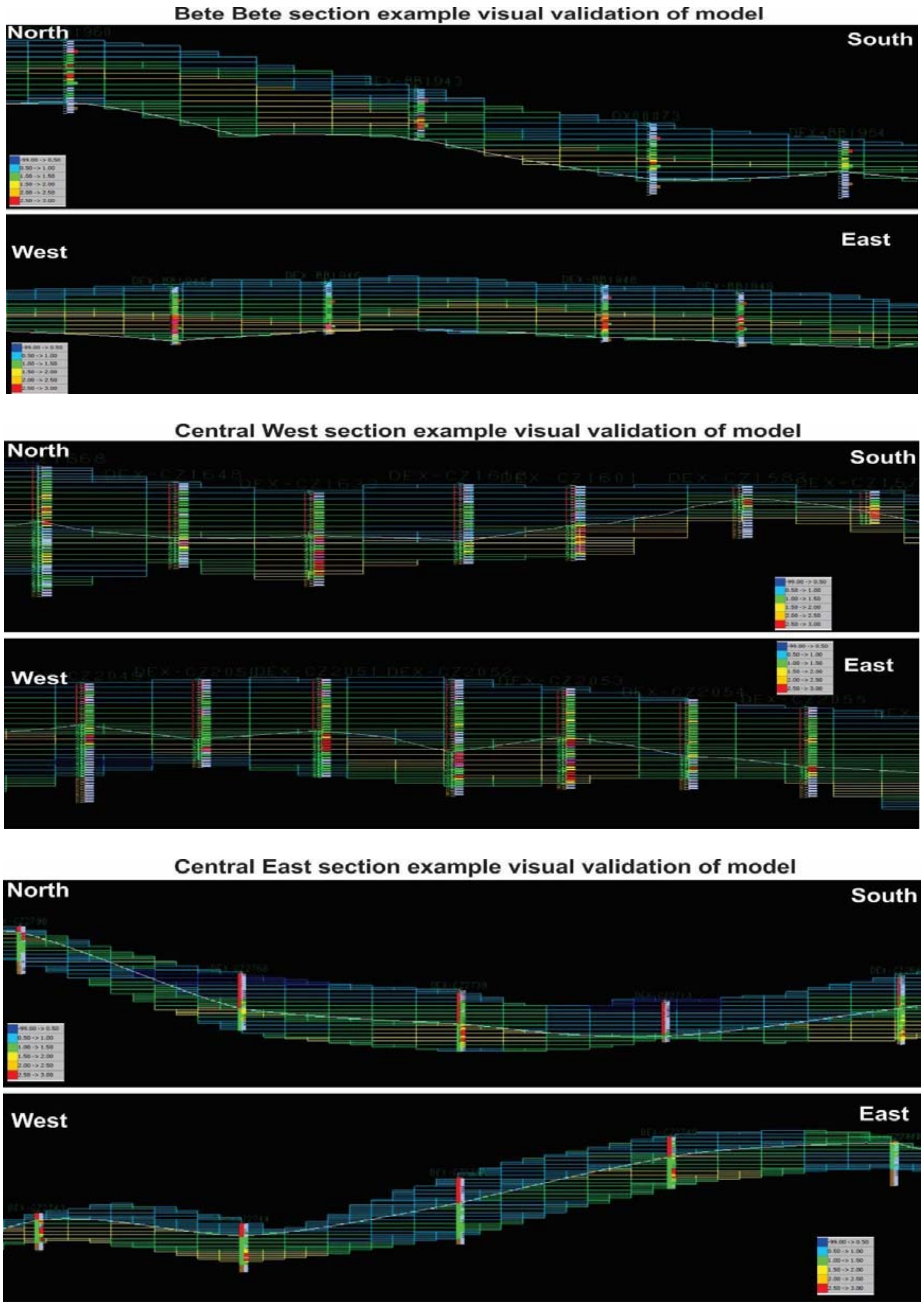


Figure 53 Section examples used for visual validation of the model

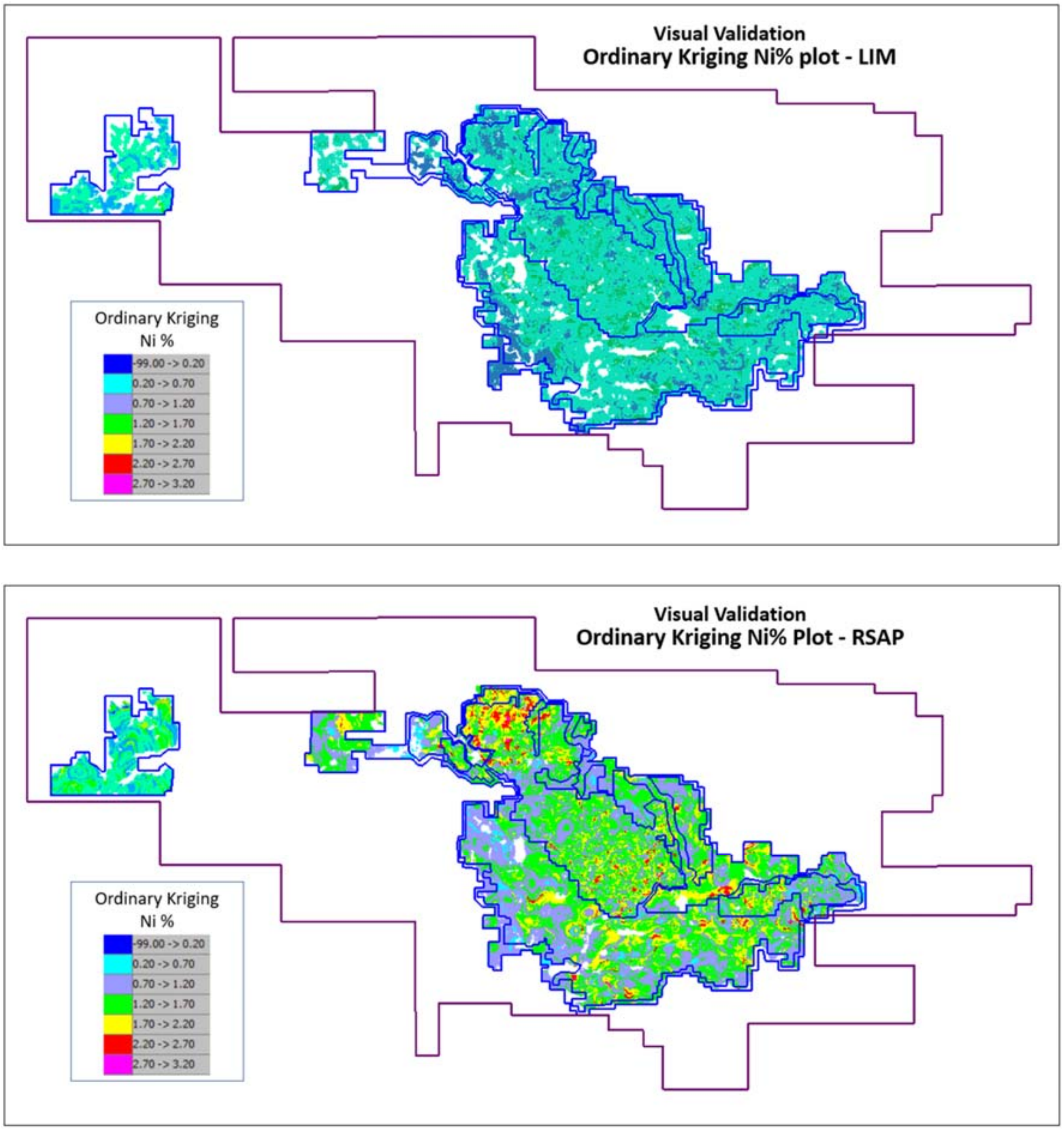


Figure 54 Plan view of the results of the Ordinary Kriging Ni grade model

Further statistical validation of the Nickel Resource estimate was completed by comparing global averages of the sample composites against the block model global averages. Both sample sets show very little difference between average grade values for nickel, cobalt and iron and within the standard deviation of the mean. Table 33 shows the sample populations for composites and assigned blocks within the model and average grades for nickel, cobalt and iron.

Table 33 Composite model against block model statistical validation

DOMAIN	LITHOLOGY TYPE	MEAN GRADE COMPOSITE				MEAN BLOCK MODEL			
		sample	Ni (%)	Co (%)	Fe (%)	sample	Ni (%)	Co (%)	Fe (%)
BETE FAR WEST	LIMONITE	675	0.89	0.14	44.16	79,813	0.89	0.14	44.62
	SAPROLITE	971	1.05	0.03	12.43	97,279	1.06	0.03	12.43
BETE WEST	LIMONITE	273	0.89	0.12	42.67	44,489	0.88	0.11	41.76
	SAPROLITE	260	1.36	0.04	17.03	42,574	1.39	0.04	17.18
BETE BETE	LIMONITE	4,005	0.95	0.13	46.68	157,149	0.92	0.13	46.62
	SAPROLITE	5,232	1.48	0.04	14.68	201,060	1.50	0.04	14.67
BETE SOUTH	LIMONITE	6,557	1.06	0.13	43.10	270,758	1.03	0.13	43.05
	SAPROLITE	5,390	1.22	0.04	16.55	229,974	1.18	0.04	16.75
CENTRAL WEST	LIMONITE	25,723	1.10	0.14	44.85	540,518	1.00	0.12	43.90
	SAPROLITE	22,108	1.45	0.04	14.86	415,756	1.38	0.04	15.02
CENTRAL EAST	LIMONITE	9,325	1.03	0.12	42.63	591,022	1.02	0.12	42.95
	SAPROLITE	9,853	1.34	0.04	14.82	557,492	1.36	0.04	15.03
APL	LIMONITE	3,289	0.93	0.11	38.03	41,454	0.97	0.11	38.73
	SAPROLITE	4,918	1.17	0.04	14.21	55,183	1.15	0.04	14.62

Swath plots were used as a final model validation tool to provide comparisons between sample composites and estimated block model values. This process identifies any bias towards under-estimation or overestimation or any smoothing in the results.

Figure 55 and 56 shows the Swath plots created to check the review of these plots show good correlation of the 1m down hole drilling composites selected for the interpolation process against the assigned block grades in the model.

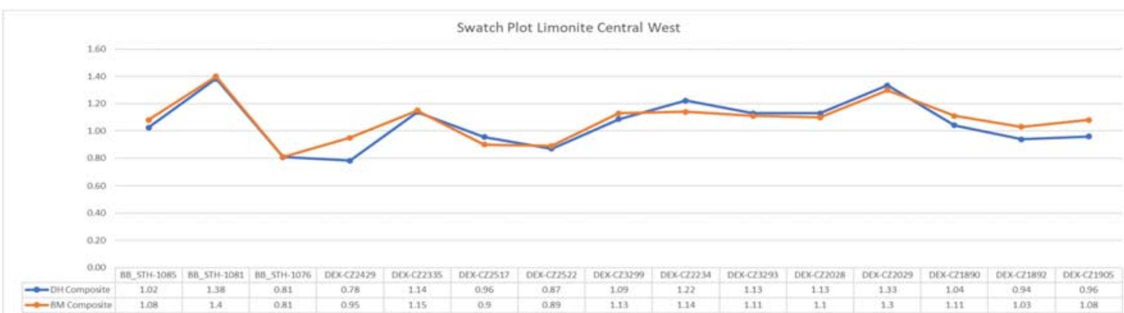


Figure 55 Swath plots of limonite for Central West

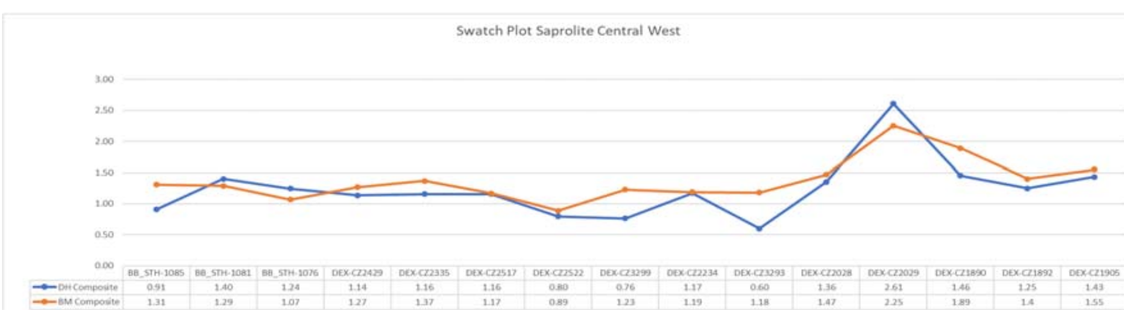


Figure 56 Swath plots of saprolite for Central West

See Appendix 9.4 for additional swath plots created to check each domain area.

6.9 RECONCILIATION OF PREDICTED GRADES WITH MINING

Mining first commenced in the Hengjaya concession in October 2012 and continued until the end of 2013. Most of the material produced, during this initial phase was from APL & Bete Bete domains, being direct shipped ore (DSO) to China. Shipping records show approximately 328,000Wmt at an average grade 1.97% nickel content was sold in seven shipments.

No production was recorded from Jan 2014 to June 2015 when direct shipment of nickel ore was banned by the Indonesian Government. Since then, Hengjaya recommenced mine production for monthly domestic supply to the nearby Indonesia Morowali Industrial Park (IMIP). All of this nickel ore production was from the Bete Bete domain, until March 2020 when mining moved to the new areas of Central East and Central West domains. During this second phase of production approximately 6,800,000 wmt at an average grade of 1.83% nickel content was sold. Table 34 shows a summary of ore production by year. Figure 57 shows the monthly production history.

Table 34 Life of Mine yearly production history updated to 30 June 2022

Year	Pit Area	Month	OB (wmt)	Ore Production (wmt)	Stripping Ratio	Ni (%)	Fe (%)
2012	APL	Jan - Dec	394,970	44,770	8.82	2.01	15.00
2013	APL	Jan - Jun	394,422	43,766	9.01	1.85	15.00
	Bete Bete	Jul-Dec	406,779	299,901	1.36	1.98	18.86
2014	No Production due to export ban						
2015	Bete Bete	June-Dec	50,579	12,735	3.97	2.05	18.86
2016	Bete Bete	Jan-Dec	217,600	377,020	0.58	2.05	18.86
2017	Bete Bete	Jan-Dec	517,367	431,344	1.20	2.14	18.58
2018	Bete Bete	Jan-Dec	603,878	374,346	1.61	2.10	21.39
2019	Bete Bete	Jan-Dec	1,097,669	630,350	1.74	1.82	20.88
2020	Bete Bete	Jan-Dec	902,441	277,962	3.25	1.86	21.93
	Central	Mar-Dec	1,774,932	543,608	3.27	1.83	19.83
2021	Bete Bete	Jan-Dec	2,524,048	1,178,454	2.14	1.81	20.81
	Central	Jan-Dec	4,585,042	1,080,740	4.24	1.72	17.87
2022	Bete Bete	Jan-Jun	1,088,341	1,008,534	1.08	1.77	21.24
	Central	Jan-Jun	1,414,337	516,705	2.74	1.78	19.41
Total Ore Production from Hengjaya			**15,972,404**	**6,820,235**	**2.34**	**1.85**	**19.89**

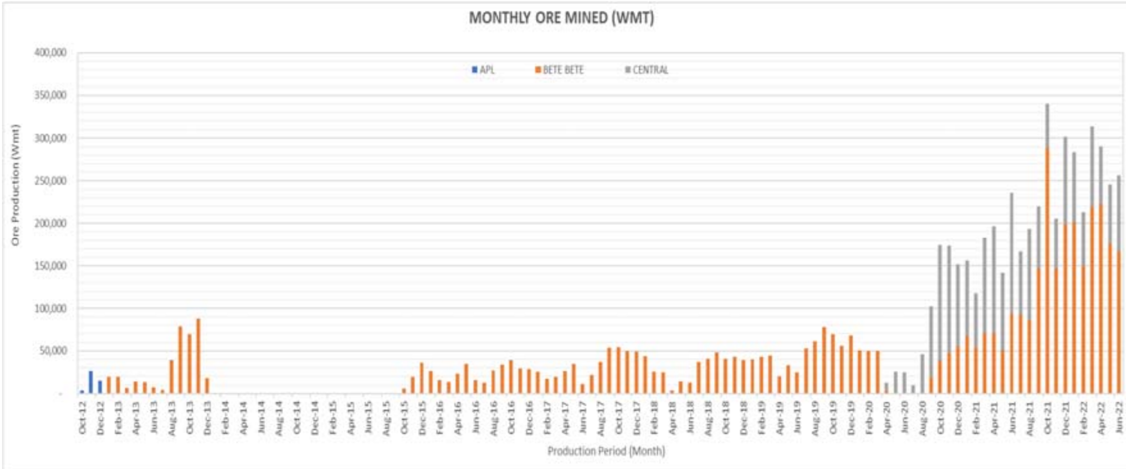


Figure 57 Monthly production history from the Hengjaya mine to 30 June 2022

Since mid-2019, the Hengjaya mine plan has commenced in pit stockpiling of Limonite ore (HGL, LGL) with Fe > 30%, Co >0.1% & Mg0 < 5%, to be used for planned future ore sales to IMIP once the HPAL processing facility is completed. These volumes have not yet been added to the production records under Ore in this reconciliation. Limonite ore sales started in November 2021 and total sales of 357,000t of Limonite have been completed until 30 June 2022 . Limonite inventory at 30th June 2022, is 3.3million tons.

Photo 28 Drone image of HM Port stockpile, 2022 (Source; Hengjaya)

A life of mine production reconciliation was performed on the mining survey surfaces for APL, Bete Bete and Central Pits. This process was conducted against the new model (OK) to check the predicted outcomes. Overall the results show good correlation between mining records for Ore (High grade saprolite) and Overburden (waste) over all pit areas. Table 35 shows the summary of the reconciliation of the life of mine production against the new Resource model with 70% recovery applied to the Ore volumes >1.5% Ni.

Table 35 Reconciliation of the life of mine production against the new resource model

Pit Areas	Waste (Wet ton)	Ore (Wet ton)	Stripping Ratio	Total Waste + Ore Volumes (Wet ton)
Production records Waste & Saprolite Ore				
APL	789,392	88,536	8.9	877,928
Bete bete	7,408,702	4,590,645	1.6	11,999,347
Central	7,774,311	2,141,053	3.6	9,915,364
Total by New Models	15,972,404	6,820,235	2.3	22,792,639
Model Prediction Waste & Saprolite Ore				
APL	811,288	95,143	8.5	906,431
Bete bete	8,180,808	4,500,854	1.8	12,681,662
Central	7,664,124	2,170,063	3.5	9,834,187
Total by New Models	16,656,220	6,766,060	2.5	23,422,280
Production v Model Variance Waste & Saprolite Ore				
APL	- 21,896	- 6,607	0.4	- 28,503
Bete bete	- 772,107	89,792	- 0.2	- 682,315
Central	110,187	- 29,010	0.1	81,177
Total by New Models	- 683,816	- 54,175	- 0.1	- 629,641
Production v Model (%) Waste & Saprolite Ore				
APL	97%	93%	105%	97%
Bete bete	91%	102%	89%	95%
Central	101%	99%	103%	101%
Total by New Models	96%	101%	95%	97%

The first comparison against the insitu model (100% recovery) was completed to assess the actual mining losses. This helps indicate what mining dilutions can be expected. Both APL & Bete Bete show more than 70% recovery of the high grade Saprolite Ore produced from the new model predictions.

A second comparison is using the recovery factors from the Hengjaya mine planning department applied to respective pit areas in the past to produce a predicted internal mine reserve, production scheduling and medium-term planning. These results for APL, Bete Bete and Central pits show good reconciliation of the mining recoveries of more than 90% against the new model adjusted for mining (diluted). Figure 58 shows the location of active pits and dumps curretly at the HM project.

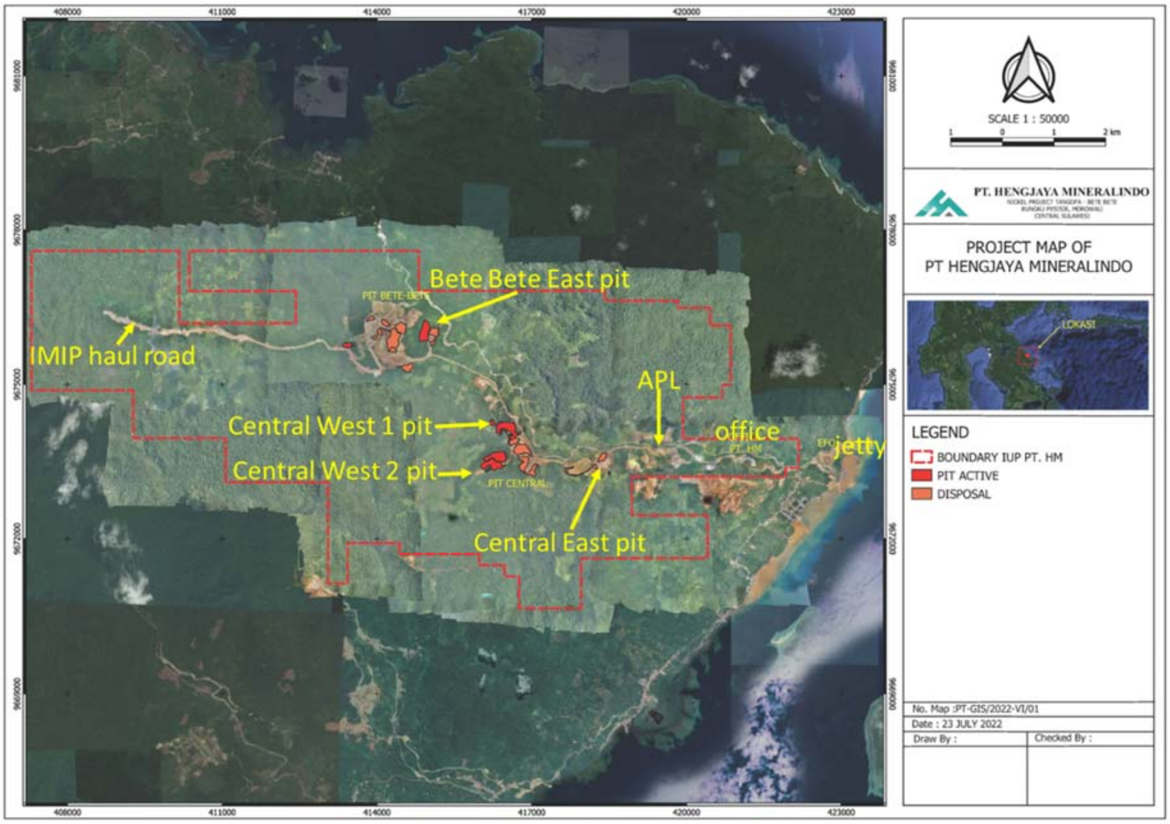


Figure 58 Hengjaya Mineralindo project situation map

Table 36 shows the mine production against the new model predictions for Bete Bete, Figure 59 shows the current mine survey situation of the Pit area in Bete Bete in June 2022.

Photo 29 shows drone image taken of the Bete Bete mine operation during 2019.

Photo 30 shows the Bete Bete mine rehabilitation progress and mining in 2022

Photo 31 shows Bete Bete East Pit Operation, 2022

Table 36 Bete Bete mine production reconciliation against new model prediction

Year	Month	OB (wmt)	Ore Production (wmt)	Stripping Ratio	Ni (%)	Fe (%)
2013	Jul-Dec	406,779	299,901	1.36	1.98	18.86
2014	No Production due to export ban	-	-	-	-	-
2015	June-Dec	50,579	12,735	3.97	2.05	18.86
2016	Jan-Dec	217,600	377,020	0.58	2.05	18.86
2017	Jan-Dec	517,367	431,344	1.20	2.14	18.58
2018	Jan-Dec	603,878	374,346	1.61	2.10	21.39
2019	Jan-Dec	1,097,669	630,350	1.74	1.82	20.88
2020	Jan-Dec	902,441	277,962	3.25	1.86	21.93
2021	Jan-Dec	2,524,048	1,178,454	2.14	1.81	20.81
2022	Jan-Jun	1,088,341	1,008,534	1.08	1.77	21.24
Total Production from Bete Bete		7,408,702	4,590,645	1.61	1.89	20.53
Total Predicted from insitu model		6,251,871	6,429,791	0.97	1.93	16.06
Variance Insitu Model		1,156,831	(1,839,146)	0.64	(0.04)	4.47
Variance %		119%	71%	166%	98%	128%
Total Predicted from 70% Diluted model		8,180,808	4,500,854	1.82	1.93	16.06
Variance 70% Diluted Model		(772,107)	89,792	(0.20)	(0.04)	4.47
Variance %		91%	102%	89%	98%	128%

* Ni Grade Based on Barge data
* OB removal Based on Truck Count
*Ore Production Based on Weight Bridge
*Ore grade cutoff applied > 1.5% Ni for ETO acceptance
*EoM surface 30 June 2022 MTD
*Ore recovery 70% Ni for mine reserve

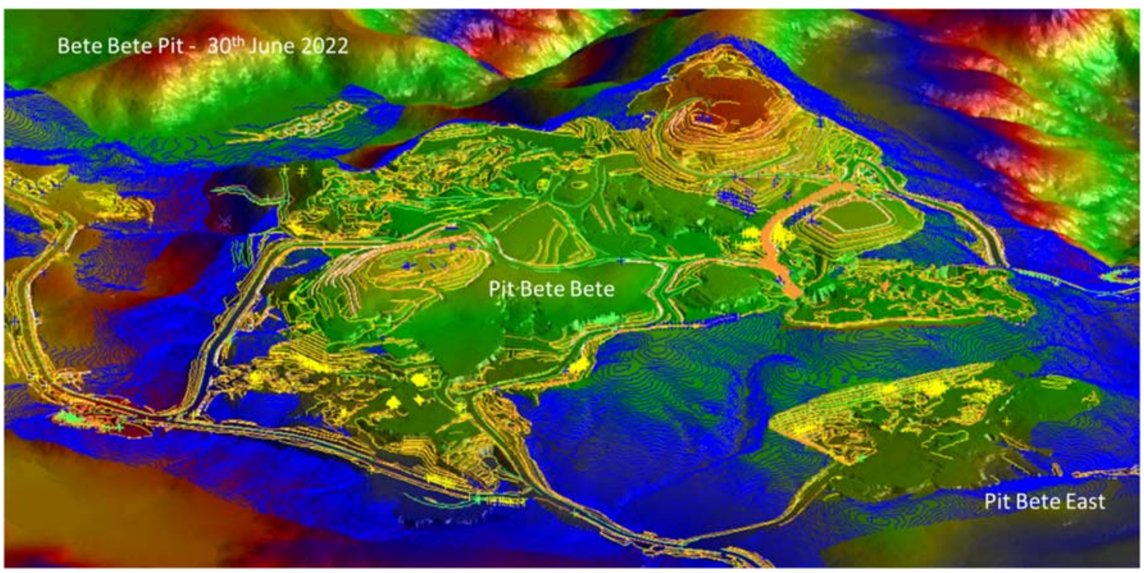


Figure 58 Bete Bete Mine situation – 30 June 2022

Photo 29 Drone Image of Bete Bete Pit in operation 2019 (Source; Hengjaya)

Photo 30 Bete Bete Pit rehabilitation, 2022 (Source; Hengjaya)

Photo 31 Bete Bete East pit operation, 2022 (Source; Hengjaya)

Table 37 shows the mine production against the new model predictions for APL. Figure 60 shows the current mine survey situation of the Pit area in APL. This mine area has been closed indefinitely and is now rehabilitated to comply with environmental requirements. Photo 32 shows mining operations at APL in Pit B1, 2013.

Table 37 APL mine production reconciliation against new model prediction

Year	Month	OB (WMT)	Ore Production (WMT)	Stripping Ratio	Ni (%)	Fe (%)
2012	Jan - Dec (APL)	394,970	44,770	8.82	2.01	15.00
2013	Jan - Jun (APL)	394,422	43,766	9.01	1.85	15.00
2014	No Production due to export ban	-	-	-	-	-
Total Production from APL		789,392	88,536	8.92	1.93	15.00
Total Predicted from insitu model		860,940	124,292	6.93	2.03	12.99
Variance Insitu Model		(71,548)	(35,756)	1.99	(0.10)	2.01
Variance %		92%	71%	129%	95%	116%
Total Predicted from 70% Diluted model		811,288	95,143	8.53	1.97	13.82
Variance 70% Diluted Model		(21,896)	(6,607)	0.39	(0.04)	1.18
Variance %		97%	93%	105%	98%	109%

* Ni Grade Based on Barge data
* OB removal Based on Truck Count
*Ore Production Based on Weight Bridge
*Ore grade cutoff applied > 1.7% Ni for ETO acceptance
*EoM surface july 2013 MTD
*Ore recovery 70% Ni for mine reserve

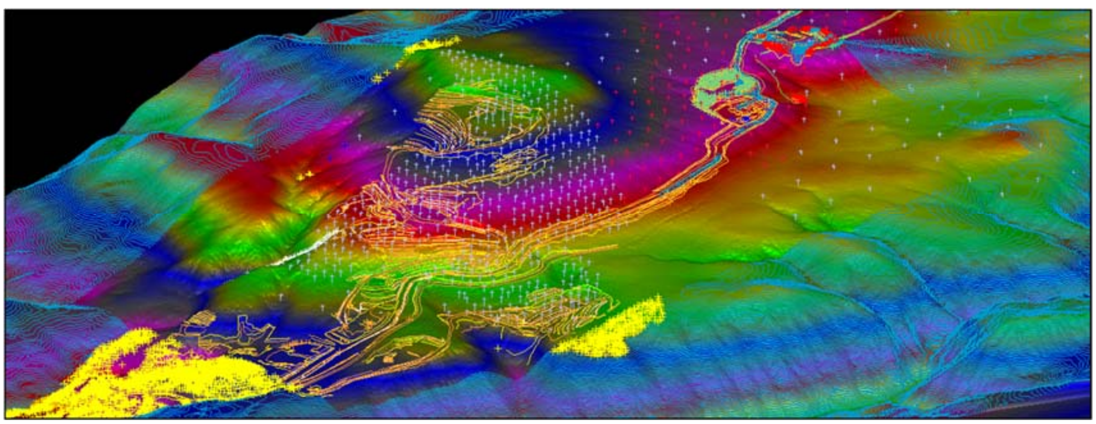


Figure 59 APL Mine situation – 20 April 2020

Photo 32 Mining operations APL in Pit B1, 2013 (Source; Hengjaya)

A more detailed mine reconciliation was possible in the Central East mine area as the production records are more complete. Table 38 shows the mine production against the new model predictions for Central East and West pits combined.

Figure 61 shows a graph of Central East mine production against new model compliance. These reconciliations show good correlation of the predicted Resource curve against the mining ores recovered along a similar curve of the graph. Figure 62 shows the current mine survey situation of the pit areas in Central East and Figure 63 shows the pit area in Central West. Photo 33 shows Central East Pit in 2022. Photo 34 shows Central West Pit progress in 2022.

Table 38 Central pits production reconciliation against new model (OK) prediction

Year	Month	OB (wmt)	Ore Production (wmt)	Stripping Ratio	Ni (%)	Fe (%)
2020	Mar-Dec	1,774,932	543,608	3.27	1.83	19.83
2021	Jan-Dec	4,585,042	1,080,740	4.24	1.72	17.87
2022	Jan-Jun	1,414,337	516,705	2.74	1.78	19.41
Total Production from Central		7,774,311	2,141,053	3.63	1.76	18.74
Total Predicted from insitu model		6,734,097	3,100,090	2.17	1.86	15.96
Variance Insitu Model		1,040,214	(959,037)	1.46	(0.10)	2.78
Variance %		115%	69%	167%	95%	117%
Total Predicted from 70% Diluted model		7,664,124	2,170,063	3.53	1.86	15.96
Variance 70% Diluted Model		110,187	(29,010)	0.10	(0.10)	2.78
Variance %		101%	99%	103%	95%	117%

* Ni Grade Based on Barge data
* OB removal Based on Truck Count
*Ore Production Based on Weight Bridge
*Ore grade cutoff applied > 1.5% Ni for ETO acceptance
*EoM surface 30 June 2022 MTD
*Ore recovery 70% Ni for mine reserve

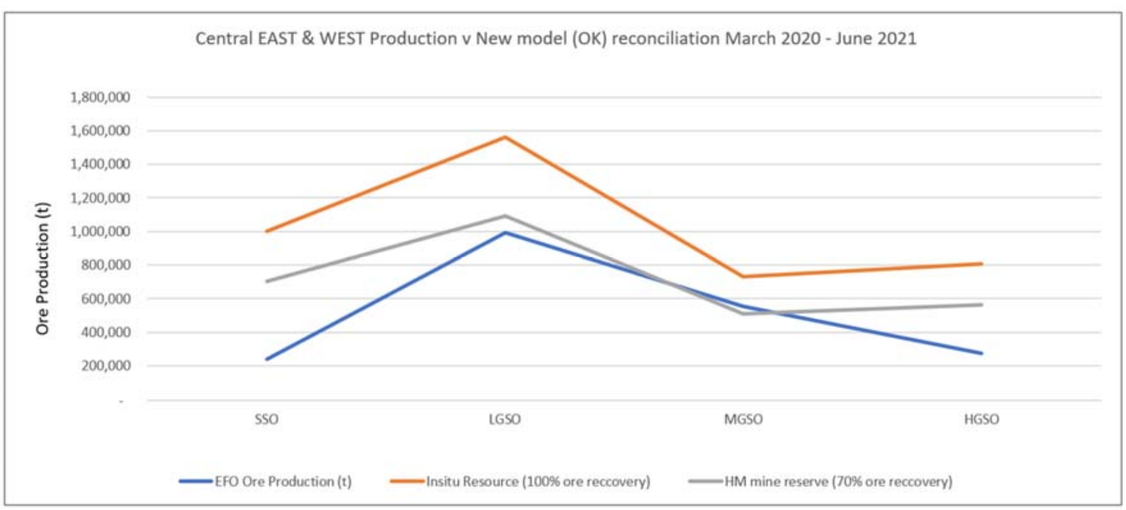


Figure 60 Central East mine production comparison with new model compliance

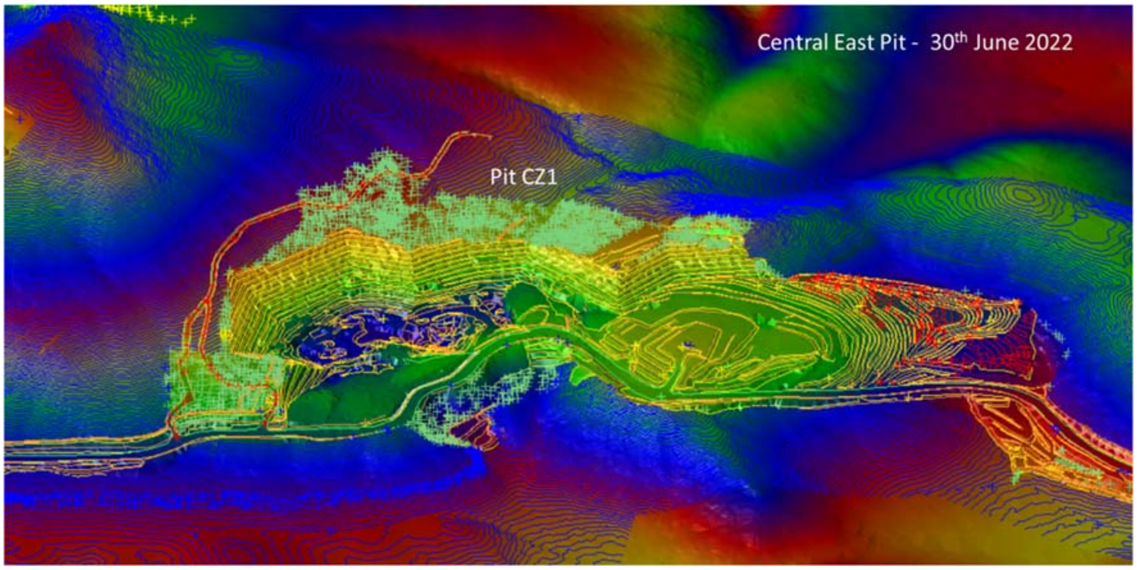


Figure 61 Central East Pit situation in 2022

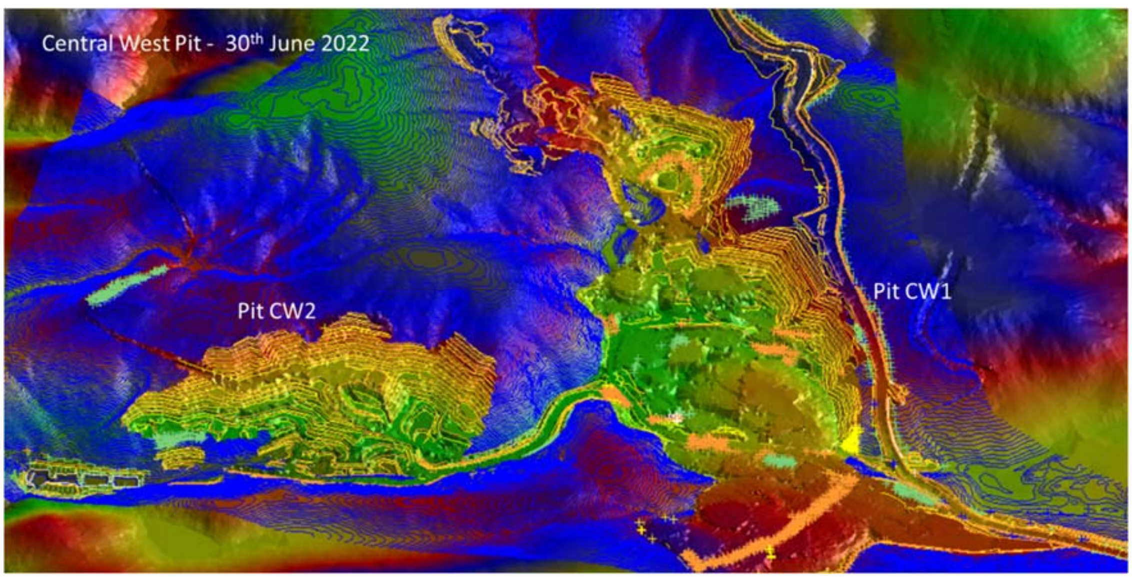


Figure 62 Central West CW 1 & CW 2 pit situation – 30 June 2022

Photo 33 Central East pit 2022 (Source; Hengjaya)

Photo 34 Central West (CW1) pit progress 2022 (Source; Hengjaya)

Photo 35 Central West (CW2) pit progress 2022 (Source; Hengjaya)

6.10 MINERAL RESOURCE STATEMENT

The Nickel Resource estimate for PT Hengjaya Mineralindo has been updated to the 30 June 2022.

It is considered, by the Competent Persons, that data and methodologies applied in the estimation process are appropriate for this type of deposit.

All results are represented as remaining volumes presented as millions of dry tons includes mining depletion excluded up to 30th June 2022. A rounding of the Resource estimate numbers has been applied to reflect the level of accuracy of the Mineral Resource estimate.

Photo 30 shows a drone image of the Bete Bete pit with IMIP in the distance.

Photo 36 Drone image of Bete mine with IMIP facility in background (Source; Hengjaya)

Table 39 below shows the Nickel Resource estimate with a cutoff >0.80% Ni content. Table 40 shows the global Mineral Resource shown at various Ni cutoffs. Figure 64 shows the global Mineral Resource tonnage and Ni% grade relationship.

Table 39 Nickel Mineral Resource Estimate

> 0.80% Ni CUT OFF APPLIED TO GLOBAL RESOURCE ESTIMATE (Ni OK)

	LIMONITE	XRF (DRY ANALYSIS)			SAPROLITE	XRF (DRY ANALYSIS)		
MEASURED RESOURCE BY BLOCK	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)
BETE FAR WEST								
BETE WEST								
BETE BETE	5.5	1.06	0.14	46.86	7.3	1.48	0.04	15.02
BETE SOUTH	10.8	1.12	0.14	43.37	8.6	1.29	0.05	17.33
CENTRAL WEST	21.1	1.13	0.14	45.11	19.2	1.49	0.05	15.44
CENTRAL EAST	5.4	1.09	0.12	43.96	5.9	1.39	0.04	14.85
APL	0.25	0.97	0.12	39.42	0.60	1.11	0.04	14.54
SUB TOTAL MEASURED	**43**	**1.11**	**0.14**	**44.72**	**42**	**1.43**	**0.05**	**15.66**
TOTAL MEASURED	**85**	**1.27**	**0.09**	**30.44**				

	LIMONITE	XRF (DRY ANALYSIS)			SAPROLITE	XRF (DRY ANALYSIS)		
INDICATED RESOURCE BY BLOCK	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)
BETE FAR WEST								
BETE WEST								
BETE BETE	1.6	0.96	0.12	46.05	3.5	1.40	0.04	15.08
BETE SOUTH	11.7	1.07	0.12	42.61	11.5	1.18	0.04	17.13
CENTRAL WEST	13.6	1.10	0.13	45.16	16.3	1.38	0.05	15.15
CENTRAL EAST	33.4	1.07	0.14	43.28	38.0	1.38	0.04	15.19
APL	0.15	0.88	0.10	38.43	0.40	1.23	0.03	13.55
SUB TOTAL INDICATED	**60**	**1.07**	**0.13**	**43.63**	**70**	**1.35**	**0.04**	**15.49**
TOTAL INDICATED	**130**	**1.22**	**0.08**	**28.56**				

	LIMONITE	XRF (DRY ANALYSIS)			SAPROLITE	XRF (DRY ANALYSIS)		
INFERRED RESOURCE BY BLOCK	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)
BETE FAR WEST	6.2	0.97	0.15	44.95	9.9	1.17	0.03	13.06
BETE WEST	3.4	0.99	0.12	44.20	3.9	1.40	0.04	17.17
BETE BETE	1.6	0.98	0.12	44.22	2.0	1.30	0.03	13.52
BETE SOUTH	2.1	1.04	0.13	43.98	2.7	1.21	0.04	16.06
CENTRAL WEST	11.6	1.05	0.12	44.13	10.8	1.32	0.04	15.18
CENTRAL EAST	15.1	1.09	0.11	43.48	12.7	1.46	0.04	15.68
APL	1.4	1.06	0.13	38.32	1.3	1.25	0.05	14.15
SUB TOTAL INFERRED	**41**	**1.04**	**0.12**	**43.82**	**43**	**1.32**	**0.04**	**14.97**
TOTAL INFERRED	**85**	**1.19**	**0.08**	**29.07**				

	LIMONITE	XRF (DRY ANALYSIS)			SAPROLITE	XRF (DRY ANALYSIS)		
TOTAL COMBINED RESOURCE BY BLOCK	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)
BETE FAR WEST	6.2	0.97	0.15	44.95	9.9	1.17	0.03	13.06
BETE WEST	3.4	0.99	0.12	44.20	3.9	1.40	0.04	17.17
BETE BETE	8.7	1.03	0.13	46.23	12.8	1.43	0.04	14.80
BETE SOUTH	24.6	1.09	0.13	43.06	22.8	1.23	0.04	17.08
CENTRAL WEST	46.3	1.10	0.13	44.88	46.3	1.41	0.05	15.28
CENTRAL EAST	53.9	1.08	0.13	43.40	56.6	1.40	0.04	15.26
APL	1.8	1.03	0.13	38.48	2.3	1.21	0.04	14.15
GRAND TOTAL RESOURCE	**145**	**1.08**	**0.13**	**44.01**	**155**	**1.36**	**0.04**	**15.39**
TOTAL Resource > 0.8% Ni	**300**	**1.22**	**0.09**	**29.24**				

TOTAL RESOURCE ALL	LIMONITE	XRF (DRY ANALYSIS)			SAPROLITE	XRF (DRY ANALYSIS)		
	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)
SUB TOTAL MEASURED	43	1.11	0.14	44.72	42	1.43	0.05	15.66
SUB TOTAL INDICATED	60	1.07	0.13	43.63	70	1.35	0.04	15.49
SUB TOTAL INFERRED	41	1.04	0.12	43.82	43	1.32	0.04	14.97
TOTAL RESOURCE ALL	**145**	**1.08**	**0.13**	**44.01**	**155**	**1.36**	**0.04**	**15.39**

TOTAL RESOURCE ALL	LATERITE	XRF (DRY ANALYSIS)		
	Million ton (Dry)	Ni (%)	Co (%)	Fe (%)
TOTAL MEASURED	85	1.27	0.09	30.44
TOTAL INDICATED	130	1.22	0.08	28.56
TOTAL INFERRED	85	1.19	0.08	29.07
TOTAL Resource > 0.8% Ni	**300**	**1.22**	**0.09**	**29.24**

Table 40 Mineral Resource shown at various cutoffs

LIMONITE - GLOBAL MINERAL RESOURCE ESTIMATE (OK 4 pass)													
GRADE CUT-OFF RANGE	MINERAL RESOURCE		XRF (DRY ANALYSIS)								Moisture Content (%)	Relative Density (sg Wet)	METAL CONTENT EQUIVALENT (Ni)
	MILLION TONNES (Wet)	MILLION TONNES (DRY)	Ni %	Co %	Fe %	Mg0 %	Si02 %	SM Ratio	Al203 %	Ca0 %			
>0.8	242	146	1.08	0.13	43.96	1.56	8.75	5.62	9.02	0.07	39.95	1.87	1,574,099
>0.9	199	119	1.13	0.14	44.12	1.58	8.65	5.48	8.81	0.07	40.58	1.85	1,336,837
>1.0	151	89	1.18	0.14	44.25	1.61	8.56	5.32	8.69	0.06	41.36	1.84	1,048,723
>1.1	101	58	1.25	0.15	44.42	1.64	8.42	5.15	8.58	0.06	42.28	1.83	727,006
>1.2	58	33	1.32	0.16	44.47	1.71	8.47	4.96	8.43	0.06	43.15	1.82	434,180
>1.3	27	15	1.40	0.17	44.74	1.78	8.47	4.76	8.19	0.06	43.72	1.82	212,969
>1.4	11	6	1.49	0.18	45.17	1.75	8.31	4.75	7.80	0.05	44.34	1.82	87,422
>1.5	4	2	1.58	0.19	45.26	1.83	8.61	4.70	7.69	0.06	45.10	1.81	30,612
>1.6	1	1	1.68	0.18	44.90	2.12	9.25	4.36	7.69	0.07	45.72	1.81	8,480
>1.7	0.3	0.2	1.78	0.19	45.15	2.27	9.38	4.14	7.03	0.08	44.87	1.81	2,711
>1.8	0.1	0.04	1.89	0.21	46.70	3.04	11.06	3.64	3.93	0.09	42.56	1.81	809
>1.9	0.04	0.02	1.92	0.25	49.60	1.81	8.69	4.80	3.33	0.05	41.75	1.80	458
>2.0													

SAPROLITE - GLOBAL MINERAL RESOURCE ESTIMATE (OK 4 pass)													
GRADE CUT-OFF RANGE	MINERAL RESOURCE		XRF (DRY ANALYSIS)								Moisture Content (%)	Relative Density (sg Wet)	METAL CONTENT EQUIVALENT (Ni)
	MILLION TONNES (Wet)	MILLION TONNES (DRY)	Ni %	Co %	Fe %	Mg0 %	Si02 %	SM Ratio	Al203 %	Ca0 %			
>0.8	230	155	1.37	0.04	15.55	19.69	37.31	1.89	3.12	0.77	33.18	1.70	2,124,652
>0.9	216	145	1.40	0.04	15.67	19.64	37.18	1.89	3.11	0.76	33.36	1.70	2,031,850
>1.0	196	131	1.45	0.05	15.81	19.62	37.01	1.89	3.08	0.73	33.55	1.70	1,888,958
>1.1	170	113	1.50	0.05	15.96	19.62	36.88	1.88	3.01	0.70	33.83	1.70	1,697,101
>1.2	144	95	1.57	0.05	16.13	19.63	36.68	1.87	2.96	0.66	34.12	1.71	1,486,745
>1.3	118	77	1.64	0.05	16.28	19.62	36.50	1.86	2.90	0.62	34.40	1.71	1,265,407
>1.4	94	62	1.71	0.05	16.39	19.67	36.34	1.85	2.79	0.58	34.63	1.71	1,052,942
>1.5	72	47	1.79	0.05	16.43	19.79	36.28	1.83	2.66	0.54	34.78	1.71	838,164
>1.6	53	34	1.87	0.05	16.42	19.97	36.23	1.81	2.53	0.49	35.01	1.71	642,176
>1.7	38	25	1.96	0.05	16.18	20.43	36.38	1.78	2.32	0.46	34.99	1.71	485,897
>1.8	27	18	2.04	0.06	16.12	20.62	36.43	1.77	2.17	0.43	35.21	1.71	360,574
>1.9	19	12	2.12	0.06	16.01	20.88	36.43	1.74	2.08	0.40	35.43	1.71	260,821
>2.0	12	8	2.22	0.06	15.73	21.04	36.70	1.74	2.02	0.38	35.74	1.71	173,857

LIMONITE & SAPROLITE - COMBINED GLOBAL MINERAL RESOURCE ESTIMATE (OK 4 pass)													
GRADE CUT-OFF RANGE	MINERAL RESOURCE		XRF (DRY ANALYSIS)								Moisture Content (%)	Relative Density (sg Wet)	METAL CONTENT EQUIVALENT (Ni)
	MILLION TONNES (Wet)	MILLION TONNES (DRY)	Ni %	Co %	Fe %	Mg0 %	Si02 %	SM Ratio	Al203 %	Ca0 %			
>0.8	473	300	1.22	0.09	30.11	10.39	22.66	2.18	6.15	0.41	36.65	1.79	3,674,261
>0.9	415	263	1.27	0.09	29.31	10.97	23.49	2.14	5.84	0.43	36.82	1.78	3,347,265
>1.0	347	219	1.33	0.09	28.20	11.77	24.61	2.09	5.52	0.44	36.95	1.77	2,919,609
>1.1	271	171	1.41	0.09	26.56	12.92	26.28	2.03	5.09	0.46	36.98	1.75	2,410,101
>1.2	201	128	1.50	0.08	24.27	14.48	28.58	1.97	4.53	0.49	36.71	1.74	1,911,516
>1.3	145	93	1.59	0.07	21.61	16.28	31.25	1.92	3.89	0.52	36.15	1.73	1,473,358
>1.4	105	68	1.68	0.06	19.30	17.86	33.51	1.88	3.30	0.53	35.61	1.72	1,138,291
>1.5	75	49	1.78	0.06	17.78	18.94	34.98	1.85	2.90	0.51	35.27	1.72	868,037
>1.6	54	35	1.87	0.06	16.91	19.66	35.77	1.82	2.62	0.49	35.20	1.71	650,468
>1.7	38	25	1.95	0.06	16.38	20.30	36.19	1.78	2.36	0.45	35.06	1.71	488,560
>1.8	27	18	2.04	0.06	16.21	20.57	36.36	1.77	2.17	0.43	35.23	1.71	361,375
>1.9	19	12	2.12	0.06	16.08	20.84	36.37	1.75	2.08	0.40	35.45	1.71	261,273
>2.0	12	8	2.22	0.06	15.73	21.04	36.70	1.74	2.02	0.38	35.74	1.71	173,857

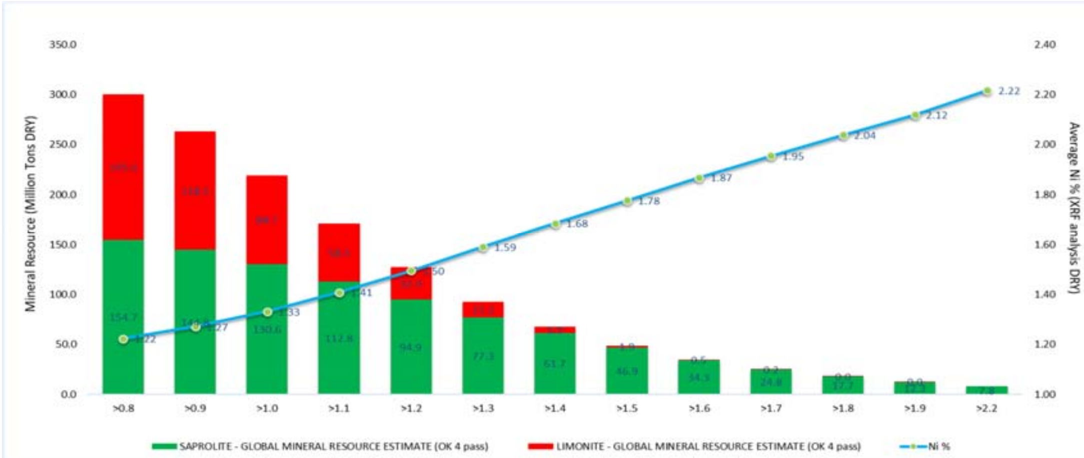


Figure 63 Global Mineral Resource tonnage (dry) and Ni% grade relationship

6.11 COMPARISONS TO PREVIOUS ESTIMATES

In 2012, 2015 and 2018 GMT consultants prepared Mineral Resource estimates using the JORC Code 2004 and 2012 respectively. A comparison of the new updates were conducted to validate the materiality of the volumes stated in this report against the updated DANMAR estimate in July 2022, Table 41 shows the comparison of estimates by classification. The results show a significant increase for the total volume of Nickel Resource, including significant upgrades of Measured and Indicated Resource categories from the Inferred class in the 2020 Resource estimate. This is primarily due to the ongoing infill drilling in the Bete Bete & Central areas since March 2019.

Table 41 Nickel Resource comparison by classification

RESOURCE COMPARISON Ni 0.8% CUTOFF 2020 REPORT FOR COMPARISON 2022 RESOURCE UPDATE (million ton Dry)				
BLOCK-ID	MEASURED	INDICATED	INFERRED	TOTAL
BETE FAR WEST	-	-	-	**-**
BETE WEST	-	-	6	**6**
BETE BETE	6	15	3	**24**
BETE SOUTH	2	34	13	**48**
CENTRAL WEST	1	54	11	**66**
CENTRAL EAST	10	6	22	**39**
APL	-	-	-	**-**
Total Resource 2020 Ni >0.8%	20	109	56	**184**
Total Resource 2022 Ni >0.8%	**85**	**130**	**85**	**300**
INCREASE (Million ton Dry)	65	21	29	116
PERCENTAGE INCREASE	333%	20%	53%	63%

Other major differences in estimates are:

- The mining depletion from Bete Bete and Central pits, approx. 4,700,000t of Ore Production and;
- An estimated 57% increase in areal extent of the previous Resource class polygon area of influence.
- The exclusion of most of APL Resource due to downgrading over poor data records & mine rehabilitation.

Table 42 shows the global Mineral Resource comparisons from the most recent DANMAR report dated July, 2020 to the current results in this report. Overall, the new estimates show significantly more tonnage below the 1.7% Nickel cut off. This variance is assumed to be the influence of the 57% increase of previous Resource class polygon area. Above this cut-off range the 4,800,000t mining depletion of High grade saprolite since July, 2020 has influenced the reduction of these ranges.

Figure 65 shows the overlay of the 2018 resource polygon on the new Resource boundaries.

Table 42 Global Nickel Resource comparison

GRADE CUT-OFF RANGE	MINERAL RESOURCE COMPARISONS GLOBAL ESTIMATES Ni > 0.80%				
	DANMAR,2020 (OK)		DANMAR,2022 (OK-TC)		DANMAR, 2020 VARIANCE (%)
	MILLION TONNES (DRY)	Ni %	MILLION TONNES (DRY)	Ni %	
>0.8	**184**	1.28	**300**	1.22	63.4%
>0.9	**167**	1.32	**263**	1.27	57.8%
>1.0	**144**	1.38	**219**	1.33	52.5%
>1.1	**118**	1.45	**171**	1.41	45.1%
>1.2	**93**	1.53	**128**	1.50	37.0%
>1.3	**71**	1.62	**93**	1.59	29.7%
>1.4	**53**	1.71	**68**	1.68	26.8%
>1.5	**39**	1.80	**49**	1.78	24.0%
>1.6	**30**	1.89	**35**	1.87	17.9%
>1.7	**22**	1.97	**25**	1.95	13.9%
>1.8	**16**	2.06	**18**	2.04	11.7%
>1.9	**11**	2.14	**12**	2.12	7.6%
>2.0	**8**	2.22	**8**	2.22	-4.4%

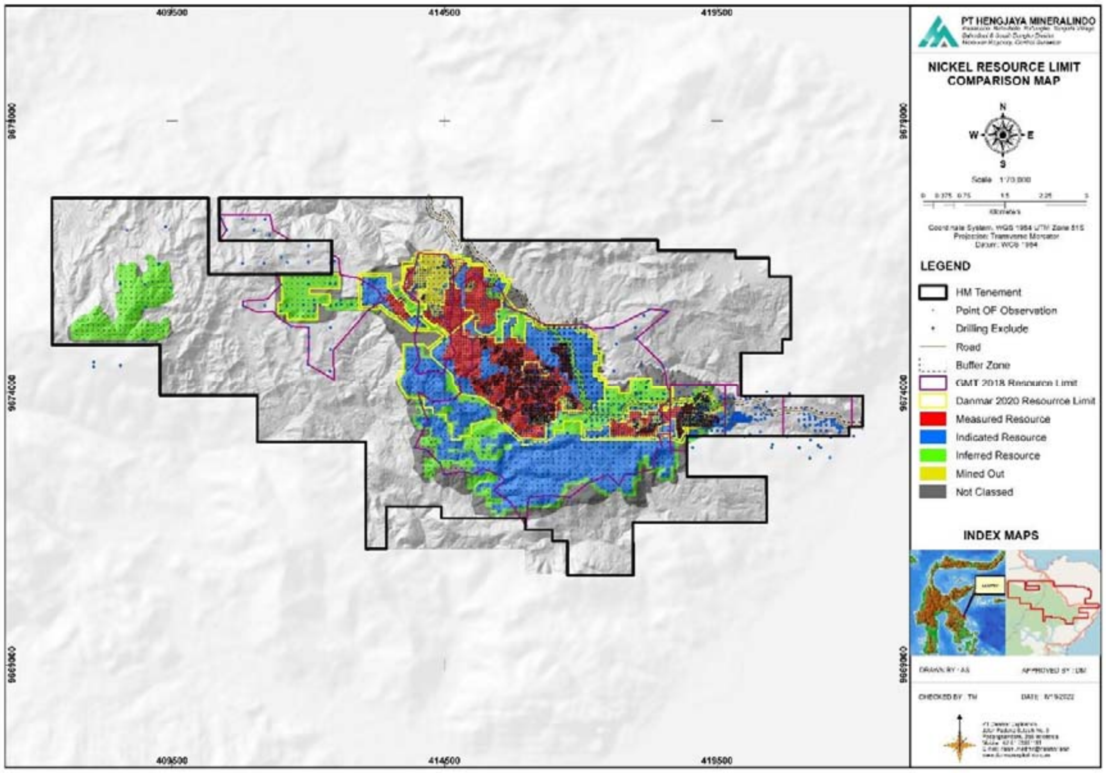


Figure 64 Nickel Resource limit comparison map

6.12 RISKS AND OPPORTUNITIES

Close spaced, systematic drilling since April 2019 and the supportive data provided by Ultra GPR surveys on the same drilling grid, has greatly enhanced the confidence in the geological interpretation and resulting geological model at Hengjaya Mineralindo.

The database, although containing some historic data, has been validated and rechecked for errors. Holes with GPS coordinates, used in the geological model, are considered to have a low risk of introducing bias or lowering accuracy as they are surrounded by numerous new points of observation with similar assay results, surveyed location and relatively high confidence.

The final geological models for Limonite, Saprolite and Bedrock have been interpreted separately using lithological logs and analysis results so that all blocks in the geological model are correctly coded according to their occurrence in the laterite profile. For this reason, it is considered unlikely that any misallocation of lithology will have significant influence on the Nickel Resource.

High confidence in the laboratory analysis results is supported by rigorous quality assurance and quality control protocols including, sample blanks, sample standards, duplicate samples, interlaboratory replicates. Mining reconciliations of predicted tonnage and grades to actual ore recovered provides further evidence for the reliability of the assay results used in this study. Product sales to IMIP totaling 4.5million wet tons since 2020, have met the required specification for grade with Certificate of Analyses showing close correlation with Hengjaya internal lab assay results.

Reconciliation of the predicted Resource in mining production since June 2020 shows relatively good correlation between the Resource prediction and actual recovery in mining. This adds confidence to the current Resource estimate.

Check modeling internally at Danmar using the same Resource boundaries adds confidence to the reliability of the Nickel Resource estimate.

The planned haul road to IMIP provides an opportunity for alterative transportation options to enhannce the economics of the western part of the HM project area and increased production of particularly limonite ore which could reach around 6 million tons per annum for HPAL processing.

6.13 EXPLORATION TARGETS

Exploration Targets, where nickel laterite has been identified by surface mapping, historical drilling and Ultra GPR surveys, are located in the Central North (proposed IPPKH 5A) area, the area at Bete Bete West, Bete Bete North (proposed IPPKH 5B) and Bete Bete Far West. Figure 66 below shows the Exploration Targets areas which are outside the coloured Resource areas. These Exploration Targets are in addition to the current Nickel Resource. Nickel laterite ore grade targets of between 25-50 million tons are postulated. These have been estimated using the statistical conversion rate of laterite to Nickel Resources per hectare in other blocks already explored throughout the HM project area. Although it must be stated that at this time the potential quantity and grade is conceptual in nature and that there has been insufficient exploration to estimate a Mineral Resource. Although it is uncertain if further exploration will result in a Mineral Resource, the historical mapping and Ultra GPR surveys within these Exploration Target areas provides greater confidence that with further drilling and assay results will upgrade these areas for future Resource estimates. Table 43 shows the details of the Exploration Target areas.

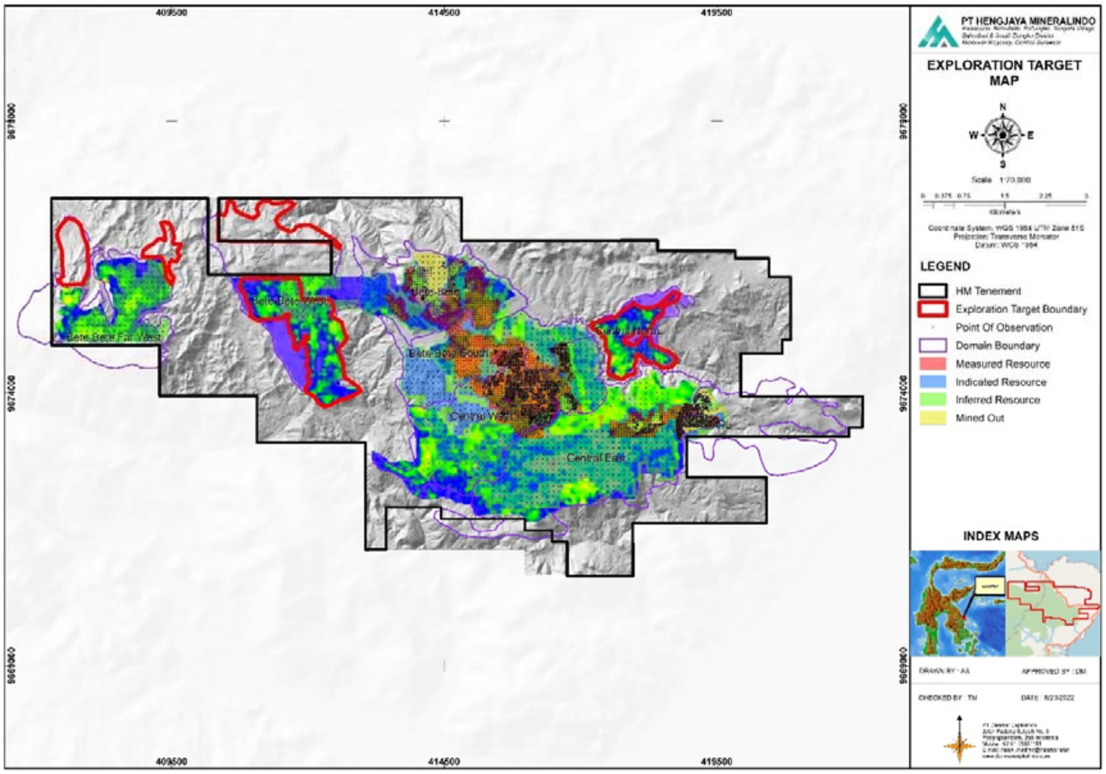


Figure 65 Exploration Target areas are shown as within domain boundaries and outside the shaded Resource areas

Table 43 Exploration Targets in addition to the HM Nickel Resource Areas

Domain	Target Area (Ha)	Material Type	Laterite WetTonnes
BETE WEST	215	Limonite (LIM)	5.0 - 10.0
		Rocky Saprolite (RSAP)	6.0 - 12.0
Sub Total		TOTAL LATERITE	10.0 - 20.0
IPPKH5 - A	105	Limonite (LIM)	2.0 - 4.0
		Rocky Saprolite (RSAP)	3.0 - 6.0
Sub Total		TOTAL LATERITE	5.0 - 10.0
IPPKH5 - B	95	Limonite (LIM)	2.0 - 4.0
		Rocky Saprolite (RSAP)	3.0 - 6.0
Sub Total		TOTAL LATERITE	5.0 - 10.0
BETE FAR WEST	85	Limonite (LIM)	2.0 - 4.0
		Rocky Saprolite (RSAP)	3.0 - 6.0
Sub Total		TOTAL LATERITE	5.0 - 10.0
ALL	**500**	**Limonite (LIM)**	**10.0 - 20.0**
		Rocky Saprolite (RSAP)	**15.0 - 30.0**
Grand Total Laterite Exploration Target			25.0 - 50.0

7 CONCLUSIONS AND RECOMMENDATIONS

This Mineral Resource covering 2,226ha has been reported in compliance with the JORC Code of 2012.

The geology at the Hengjaya Mineralindo project is ideal for the formation of thick and relatively high grade nickel laterite. At least 7 separate domain areas have been identified where the laterite varies in both physical and chemical characteristics.

Drilling, Points of Observation are systematically and relatively evenly spread across current Resource areas. 51% of the drilling is spaced less than 50m apart. Drill data is well documented, most drill collars accurately surveyed and checked. For this reason, the drill data used in this report, is considered to be of high quality and reliability and appropriate for use in this Mineral Resource estimation.

Quality Assurance and Quality Control team at the HM Sample Prep Lab and Assay Lab is also of Good Quality and Fit for Purpose, with the precision and accuracy within acceptable limits that is suitable for inclusion in this estimation of Mineral Resources for the JORC Compliant Report for PT Hengjaya Mineralindo.

Offtake agreements to provide Saprolite and Limonite ore to the nearby IMIP smelter ensures economic extraction of nickel ore into the foreseeable future from the project area.

Exploration Targets covering more than 500ha have potential for 25-50 million wet metric tons of additional laterite product in a similar geological environment. Although it is uncertain if further exploration will result in a Mineral Resource, the historical mapping and Ultra GPR surveys in these areas gives confidence that future exploration will upgrade at least some of these areas for future estimates.

To maximize the nickel resource potential of the Hengjaya project a combination of Ultra GPR surveys followed by systematic drilling, optimized to focus on the GPR targets, is recommended to cover the entire nickel laterite deposit in the area.

8 REFERENCES

FRANKE, RESOURCE DEFINITION COST REDUCTION THROUGH HIGH RESOLUTION GROUND PENETRATING RADAR

GUNTER & ALIMOEDDIN MAY 2012, TECHNICAL REVIEW AND RESOURCE ESTIMATION FOR HENJAYA MINERALINDO CONCESSION AREA

GUNTER & ALIMOEDDIN AUGUST 2015, TECHNICAL REVIEW AND RESOURCE ESTIMATION FOR HENJAYA MINERALINDO CONCESSION AREA

GUNTER & ALIMOEDDIN APRIL 2018, TECHNICAL ASSESSMENT REPORT FOR NICKEL MINES LIMITED

GUNTER & ALIMOEDDIN DECEMBER 2012, RESOURCE ESTIMATE REPORT FOR NICKEL MINES LIMITED

LIPTON AND HORTON, MEASUREMENT OF BULK DENSITY FOR RESOURCE ESTIMATION GUIDELINES AND QUALITY CONTROL

RAIANTO ET AL 2012, SERPENTINE RELATED NICKEL SULFIDE OCCURRENCES FROM LATAI, SE SULAWESI, A NEW FRONTIER IN NI EXPLORATION IN INDONESIA

SILVER AND McCAFFERY , 1981 OPHIOLITE EMPLACEMENT BYCOLLISION BETWEEN THE SULA PLATFORM AND THE SULAWESI ISLAND ARC, INDONESIA

UBISINOV & ELIAS, 2015, MINERAL RESOURCE ESTIMATE, SORAWOLIO NICKEL PROJECT, BUTON ISLAND, SE SULAWESI

9 APPENDIX

9.1 TABLE 1 OF THE JORC COMMITTEE

9.2 PT HENGJAYA MINERALINDO LEGAL DOCUMENTATION

9.3 ENVIRONMENT SOCIAL AND GOVERNANCE REPORTS

9.4 HENGJAYA STATISTICAL ANALYSIS

9.5 HENGJAYA LABORATORY REPORTS; PROCEDURES & QA/QC

9.6 GEOTECHNICAL & HYDROGEOLOGICAL REPORT

9.7 RESUME: DANIEL MADRE, CHARLES WATSON, TOBIAS MAYA

Appendix 1

JORC Code, 2012 Edition

Table 1 Report

JORC Code, 2012 Edition – Table 1 report template

Section 1 Sampling Techniques and Data

(Criteria in this section apply to all succeeding sections.)

Criteria	JORC Code explanation	Commentary
Sampling techniques	• *Nature and quality of sampling (eg cut channels, random chips, or specific specialised industry standard measurement tools appropriate to the minerals under investigation, such as down hole gamma sondes, or handheld XRF instruments, etc). These examples should not be taken as limiting the broad meaning of sampling.* • *Include reference to measures taken to ensure sample representivity and the appropriate calibration of any measurement tools or systems used.* • *Aspects of the determination of mineralisation that are Material to the Public Report.* • *In cases where 'industry standard' work has been done this would be relatively simple (eg 'reverse circulation drilling was used to obtain 1 m samples from which 3 kg was pulverised to produce a 30 g charge for fire assay'). In other cases more explanation may be required, such as where there is coarse gold that has inherent sampling problems. Unusual commodities or mineralisation types (eg submarine nodules) may warrant disclosure of detailed information.*	• HQ core samples taken in 1m intervals and all new core since April, 2019 photographed • Drill on systematic 100 X 100m grid over GPR targets for Indicated Resource and 50X50m and 25X25m grid for Measured Resource • Since April 2019, all core photographed and described by well site geologists as well as sample preparation and moisture determination follow the Japanese Industrial Standard, Method for Sampling and the Determination of Moisture Content of Garnieritic Nickel Ore, 1996 • High confidence in the laboratory analyses results are supported by rigorous quality assurance and quality control protocols including; sample blanks, sample standards, duplicate samples and interlaboratory checking. A complete report on this is provided in the Appendix 9.5 Mining reconciliations of predicted tonnage and grades to actual ore recovered provides further evidence for the reliability of the assay results used in this study.
Drilling techniques	• *Drill type (eg core, reverse circulation, open-hole hammer, rotary air blast, auger, Bangka, sonic, etc) and details (eg core diameter, triple or standard tube, depth of diamond tails, face-sampling bit or other type, whether core is oriented and if so, by what method, etc).*	• HQ wireline triple tube coring in 1m runs to ensure accurate measurement of core expansion (swelling) and recovery • Vertical drilling, core orientation not required
Drill sample recovery	• *Method of recording and assessing core and chip sample recoveries and results assessed.* • *Measures taken to maximise sample recovery and ensure representative nature of the samples.* • *Whether a relationship exists between sample recovery and grade and whether sample bias may have occurred due to preferential*	• Full coring used and core recovery data collected for all runs since 2019 (4009 holes), core recoveries documented by photography • Minimum 95% recovery maintained for all holes • If 3 consecutive runs are less than 95% the hole is re-drilled • Some lower recoveries in silica boxwork zones but overall drilling conditions are relatively good and recoveries remain consistently high

Criteria	JORC Code explanation	Commentary
	loss/gain of fine/coarse material.	• Historic data has less core recovery information; depths and assay results can be checked against GPR and assay using statistical methods • Most historic assays were done at external certified laboratories
Logging	• *Whether core and chip samples have been geologically and geotechnically logged to a level of detail to support appropriate Mineral Resource estimation, mining studies and metallurgical studies.* • *Whether logging is qualitative or quantitative in nature. Core (or costean, channel, etc) photography.* • *The total length and percentage of the relevant intersections logged.*	• 100% of laterite layers drilled have been logged and photographed in drilling since 2019 • Logging includes core recoveries and core swelling measurements • Since April 2019, all holes have 1 density sample (700-800g of solid core) taken from each stratigraphic layer to give representative density data throughout the deposit • Every meter of the core is logged and sampled separately
Sub-sampling techniques and sample preparation	• *If core, whether cut or sawn and whether quarter, half or all core taken.* • *If non-core, whether riffled, tube sampled, rotary split, etc and whether sampled wet or dry.* • *For all sample types, the nature, quality and appropriateness of the sample preparation technique.* • *Quality control procedures adopted for all sub-sampling stages to maximise representivity of samples.* • *Measures taken to ensure that the sampling is representative of the in situ material collected, including for instance results for field duplicate/second-half sampling.* • *Whether sample sizes are appropriate to the grain size of the material being sampled.*	• With the exception of a small density sample weighing 700-800g taken from each of the 4 main geological horizons observed in each drill hole, full drill core was submitted to the lab for analysis • Industry standard laboratory sample preparation methods suitable for nickel laterite mineralization style and involve drying, crushing, incremental splitting & pulverizing to -75um pulps for assay. • Representivity at sub-sampling stages at sample prep lab maintained by following JIS M-8109-1996 SOP to maintain accuracy and precision at all sub-sampling stages eg coarse blanks, coarse replicates and 200# pulp sieve tests, whilst reducing sample particle size and volume. • Sample sizes are according to JIS M-8109-1996 Industry Standard and have shown to be effective re accuracy and precision during life of project to date.
Quality of assay data and laboratory tests	• *The nature, quality and appropriateness of the assaying and laboratory procedures used and whether the technique is considered partial or total.* • *For geophysical tools, spectrometers, handheld XRF instruments, etc, the parameters used in determining the analysis including instrument make and model, reading times, calibrations factors applied and their derivation, etc.* • *Nature of quality control procedures adopted (eg standards, blanks, duplicates, external laboratory checks) and whether acceptable levels of accuracy (ie lack of bias) and precision have been established.*	• Industry standard laboratory sample preparation methods suitable for nickel laterite mineralization style and involve drying, crushing, incremental splitting & pulverizing to -75um pulps for assay. • Representivity at sub-sampling stages at sample prep lab maintained by following JIS M-8109-1996 SOP to maintain accuracy and precision at all sub-sampling stages eg coarse blanks, coarse replicates and 200# pulp sieve tests, whilst reducing sample particle size and volume.

Criteria	JORC Code explanation	Commentary
		• Sample sizes are according to JIS M-8109-1996 Industry Standard and have shown to be effective re accuracy and precision during life of project to date.
Verification of sampling and assaying	• *The verification of significant intersections by either independent or alternative company personnel.* • *The use of twinned holes.* • *Documentation of primary data, data entry procedures, data verification, data storage (physical and electronic) protocols.* • *Discuss any adjustment to assay data.*	• Geological logs of the drill core are reconciled against assay results to verify lithology for any misallocation. • Database checked and rechecked for errors and anomalies • Based on analysis of the downhole statistical data additional top and bottom cut constraints were applied to Ni% content to impose a domain limit of no greater than 2 standard deviations from the ORE-SAP average, to avoid over-estimation of nickel content due to possible nugget effect.
Location of data points	• *Accuracy and quality of surveys used to locate drill holes (collar and down-hole surveys), trenches, mine workings and other locations used in Mineral Resource estimation.* • *Specification of the grid system used.* • *Quality and adequacy of topographic control.*	• All recent drilling located by ground RTK GPS survey methods • From a total of holes 120 holes had GPS coordinates only. These holes were used because they had a complete drill log, analysis data, GPR data supporting laterite thickness and were surrounded by numerous holes with ground survey. It is considered appropriate to use these holes as their depth match the surrounding holes and the assay results. It is considered to have low potential to introduce a bias to the nickel grades • UTM (Universal Traverse Mercator) Projection; WGS 1984 UTM Zone 51S grid is being applied in the Resource estimation • LiDAR topographic surface was used • Average mis-close between the LiDAR and drill collar survey is -0.01m
Data spacing and distribution	• *Data spacing for reporting of Exploration Results.* • *Whether the data spacing and distribution is sufficient to establish the degree of geological and grade continuity appropriate for the Mineral Resource and Ore Reserve estimation procedure(s) and classifications applied.* • *Whether sample compositing has been applied.*	• Random spacing of old data used for Exploration Targets only • 100-200m grid drilling used for Inferred Resource, 50-100m grid for Indicated Resources and 25-50m for Measured Resources to match previous Resource estimate from 2020 • Geostatistical analysis of Ni mineralization was used to confirm the direction and distances to be applied to the Nickel Resource model • Reconciliation of predicted grades and volumes have been recovered in actual mining confirming data reliability • Semi-variogram models for each domain were calculated using statistical top-cuts applied to composites and constrained by hard boundary surfaces of Limonite and Saprolite lithologies to prevent over-estimation of nickel grades

Criteria	JORC Code explanation	Commentary
Orientation of data in relation to geological structure	• *Whether the orientation of sampling achieves unbiased sampling of possible structures and the extent to which this is known, considering the deposit type.* • *If the relationship between the drilling orientation and the orientation of key mineralised structures is considered to have introduced a sampling bias, this should be assessed and reported if material.*	• Vertical drilling is appropriate for nickel laterite as the laterite is relatively horizontal so the drilling intersects a true thickness • No bias is considered to be introduced as a result of the drilling orientation
Sample security	• *The measures taken to ensure sample security.*	• Samples left in the field are properly stored, covered and guarded by night security at each rig • Sample stores are locked and continuously guarded
Audits or reviews	• *The results of any audits or reviews of sampling techniques and data.*	• Sampling review was carried out by the Competent Person and regular (monthly) progress reports were provided by the onsite lab documenting improvements and forward planning

Section 2 Reporting of Exploration Results

(Criteria listed in the preceding section also apply to this section.)

Criteria	JORC Code explanation	Commentary
Mineral tenement and land tenure status	• *Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings.* • *The security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area.*	• Mining rights are held under an Operation and Production Mining Business Permit (IUPOP), Area Code 540.3/SK.001/DESDM/VI/2011. The area covers 5,893Ha and gives HM the right to mine nickel and its associated minerals. The IUPOP was granted by the Regent of Morowali in 2011 and is valid until 26th May 2031.The Operation Production IUP may be renewed twice, each for a period of 10 years. • Two Forestry permits (IPPKH) to allow open cut mining within a 1845Ha area have been granted by the Minister of Forestry, the mining permits doesn’t overlap with any protected forests or nature reserves • A third Forestry Permit for exploration covering 984Ha is valid until 9 Sept 2023
Exploration done by other parties	• *Acknowledgment and appraisal of exploration by other parties.*	• The exploration work has been carried out over various stages since 2007 until 2017, under the direction of experienced nickel laterite geologists. All the historic data, (pre April 2019) relating to the project was obtained from HM for the purpose of this study. • Exploration of the area began in 2007 when the state owned

Criteria	JORC Code explanation	Commentary
		minerals company, PT Aneka Tambang, explored the nickel potential of a broad area which included the location of where the HM project is located today. The work included mapping and wide spaced drilling. The data is poorly documented with many holes having ambiguous hole identification, coordinate location and or no analysis information. • HM started drilling in 2010. At least 3 separate phases of drilling were implemented. Initially wide spaced drilling on a 400m X 400m grid was conducted followed by 200 X 200m spacing and eventually 25 X 25m grids in subsequent mining areas.
Geology	• *Deposit type, geological setting and style of mineralisation.*	• Laterization of Ophiolite bedrocks, formed in a tropical climate environment through a process of surface leaching over time, two distinct enriched zones of Limonite clays and Saprolite clays & weathered rocks are typically found in this type of geological setting where concentrations of Ni, Co, Fe and other associated metals are common
Drill hole Information	• *A summary of all information material to the understanding of the exploration results including a tabulation of the following information for all Material drill holes:* ○ *easting and northing of the drill hole collar* ○ *elevation or RL (Reduced Level – elevation above sea level in metres) of the drill hole collar* ○ *dip and azimuth of the hole* ○ *down hole length and interception depth* ○ *hole length.* • *If the exclusion of this information is justified on the basis that the information is not Material and this exclusion does not detract from the understanding of the report, the Competent Person should clearly explain why this is the case.*	• The drill database at HM contains 5,412 holes with a cumulative total depth of 125,996m. Assays total 127,503 • It is not practical or relevant to include these individual results to understand this report because; • Ni laterite deposits are at relatively low concentrations (1.2% Ni average) and the Resource can only be represented by a compilation of large numbers of points of observations. For this reason, the report has described the deposit using maps of borehole locations, Ni grade isopacs and thickness isopacs, statistical analyses of assay results, variograms and swath plots of the data to understand the data and check its validity and variability
Data aggregation methods	• *In reporting Exploration Results, weighting averaging techniques, maximum and/or minimum grade truncations (eg cutting of high grades) and cut-off grades are usually Material and should be stated.* • *Where aggregate intercepts incorporate short lengths of high grade results and longer lengths of low grade results, the procedure used for such aggregation should be stated and some typical examples of such aggregations should be shown in detail.* • *The assumptions used for any reporting of metal equivalent values*	• Only assay data from the validated database from included holes (INCL) were extracted for use in the compositing process. Composite lengths of 1m were used, which correlates with the majority of the sample length records and within statistical ranges suggested by the variography modeling. Composites were split into 5 lithologies • Based on analysis of the downhole statistical data additional top and bottom cut constraints were applied to Ni% content to ensure grades were not over estimated

Criteria	JORC Code explanation	Commentary
	should be clearly stated.	• metal equivalents for Nickel content were shown in the Resource table with ore grades as wet and dry tons
Relationship between mineralisation widths and intercept lengths	• *These relationships are particularly important in the reporting of Exploration Results.* • *If the geometry of the mineralisation with respect to the drill hole angle is known, its nature should be reported.* • *If it is not known and only the down hole lengths are reported, there should be a clear statement to this effect (eg 'down hole length, true width not known').*	• Vertical drilling provides good representation of the deposit geometry and depth and reasonably assumed to represent true thickness, 1m core and assay sampling procedures were sufficient to provide accurate wellsite observations and reconciliation of logs • Mineralization is basically horizontally orientated • Total depths of drilling were guided by the interpretation of the GPR surfaces to target at least 2-3m of bedrock was intersected at the end of each hole
Diagrams	• *Appropriate maps and sections (with scales) and tabulations of intercepts should be included for any significant discovery being reported These should include, but not be limited to a plan view of drill hole collar locations and appropriate sectional views.*	• Diagrams, maps, sections are all included in the body of the report
Balanced reporting	• *Where comprehensive reporting of all Exploration Results is not practicable, representative reporting of both low and high grades and/or widths should be practiced to avoid misleading reporting of Exploration Results.*	• All reliable(validated) data included without prejudice • Thickness established through drilling intercepts supported with Ground Penetrating Radar (UltraGPR) geophysics, reliable assays and exposed lithological layers observed in the open cut mining operation
Other substantive exploration data	• *Other exploration data, if meaningful and material, should be reported including (but not limited to): geological observations; geophysical survey results; geochemical survey results; bulk samples – size and method of treatment; metallurgical test results; bulk density, groundwater, geotechnical and rock characteristics; potential deleterious or contaminating substances.*	• Approx. 900km of ground penetrating radar (UltraGPR) survey lines were completed since Jan 2019, providing excellent section profiles views of limonite, saprolite and bedrock layers, global volumes and thickness grids were used for exploration planning and understanding of the weathering patterns of the nickel laterites to best optimize the drilling patterns by domains • Reconciliation of mining production in several ongoing mine areas, providing additional information of ore characteristic's, materials handling, densities, recoveries and dilution of grades
Further work	• *The nature and scale of planned further work (eg tests for lateral extensions or depth extensions or large-scale step-out drilling).* • *Diagrams clearly highlighting the areas of possible extensions, including the main geological interpretations and future drilling areas, provided this information is not commercially sensitive.*	• Plans for infill drilling in Indicated and Inferred Resource areas • Exploration Target and extension areas will first be surveyed using Ultra GPR and then drilled to focus on the thickest laterite areas. • Exploration Target areas map is provided

Section 3 Estimation and Reporting of Mineral Resources

(Criteria listed in section 1, and where relevant in section 2, also apply to this section.)

Criteria	JORC Code explanation	Commentary

Database integrity	• *Measures taken to ensure that data has not been corrupted by, for example, transcription or keying errors, between its initial collection and its use for Mineral Resource estimation purposes.*
	• *Data validation procedures used.*
		• The collar survey, assay and geology tables of both these datasets were validated to correct data error issues such as:
		  • missing or duplicate collar records
		  • overlapping intervals in the assay records
		  • collar elevation errors compared to current LiDAR topography
		  • downhole accuracy issues, total depths, from/to intervals
		  • core recoveries and swelling
		  • lithology description from wellsite geologists
		  • reconciliation of lithology with laboratory assay results
		  • moisture records from core lab analysis
		  • downhole statistical analysis
		• If these errors could not be fixed to a suitable level of confidence or failed to meet the accuracy standards during the validation process they were removed from the dataset. Approximately 98% of the excluded data was from the historical records supplied by Hengjaya.

Site visits	• *Comment on any site visits undertaken by the Competent Person and the outcome of those visits.* • *If no site visits have been undertaken indicate why this is the case.*	• Numerous site visits by all the CP's have been completed since the end of 2018 to review exploration progress; drilling, and sampling procedures, review sample handling, preparation and analyses, including monitoring Mine planning and reconciliations of ore production against predicted Resource modelling • All the CP's for this work have an intimate knowledge of the HM site
Geological interpretation	• *Confidence in (or conversely, the uncertainty of) the geological interpretation of the mineral deposit.* • *Nature of the data used and of any assumptions made.* • *The effect, if any, of alternative interpretations on Mineral Resource estimation.* • *The use of geology in guiding and controlling Mineral Resource estimation.* • *The factors affecting continuity both of grade and geology.*	• Due to a very large systematic drill program on the same grid as more then 800km of UltraGPR survey, allows for a relatively high confidence in geological interpretation of the Hengjaya nickel laterite deposit. Historical records for surface mapping, drilling, assay & mine production combined with the more recent UltraGPR survey traverse on 50-100m spaced infill grids over more than 90% of the Resource area provides good correlation and understanding if the laterization distribution, bulk volumes and mineralization. Considered sufficient in statement of the Mineral Resource • All data included into the geological interpretation was validated to be free of errors and downhole wellsite logging reconciled with assay results into composited zones of Limonite, Saprolite & Bedrock lithology zones • Use of Ground Penetrating Radar (UltraGPR) interpretative data

Criteria	JORC Code explanation	Commentary
		source was used in combination with points of observations from the validated database in extrapolating between holes • Laterite grades are not laterally or vertically persistent and tend to be relatively random distributed through the leaching of minerals during the laterization process. The inclusion of the GPR interpretive data provides increased confidence of the geological model controls between points of observation for transition contacts between Limonite-Saprolite-Bedrock • Geological structure and bedrock topology, which are often displayed on Ultra-GPR interpretations, helped to target thick, high grade laterite areas
Dimensions	• *The extent and variability of the Mineral Resource expressed as length (along strike or otherwise), plan width, and depth below surface to the upper and lower limits of the Mineral Resource.*	• Resource dimensions; approximately 8000m in length, 4000m in width, laterization thickness for up to 40m to bedrock in some places • Limonite thickness varies from 4-9m and saprolite thickness is consistently 8-10m • laterization of ophiolite formations occurs between an elevation range of 300 – 600 meters above mean sea level

Estimation and modelling techniques	• *The nature and appropriateness of the estimation technique(s) applied and key assumptions, including treatment of extreme grade values, domaining, interpolation parameters and maximum distance of extrapolation from data points. If a computer assisted estimation method was chosen include a description of computer software and parameters used.*
	• *The availability of check estimates, previous estimates and/or mine production records and whether the Mineral Resource estimate takes appropriate account of such data.*
	• *The assumptions made regarding recovery of by-products.*
	• *Estimation of deleterious elements or other non-grade variables of economic significance (eg sulphur for acid mine drainage characterisation).*
	• *In the case of block model interpolation, the block size in relation to the average sample spacing and the search employed.*
	• *Any assumptions behind modelling of selective mining units.*
	• *Any assumptions about correlation between variables.*
		• Modelling techniques & assumptions applied were considered appropriate for estimation of Mineral Resource for this style of Nickel laterite deposit based on the CP's experience. Key assumption's include;
		  ◦ Domaining by elevation, laterite thickness and Ni grade, mineralogical, characteristics, distinct statistical population & geological environment, no unfolding was preformed
		  ◦ Downhole and spatial geo-statistical analysis of the data & domain sub-sets of data providing search ellipsoids ranges for grade interpolation and maximum extrapolation distances for Ni between data points
		• Geological modelling and Mineral Resource estimates were completed using GEOVIA Surpac® mining software (version 6.1). Ordinary Kriging (OK) algorithm was used in the grade interpolation for nickel grades for limonite and saprolite laterite zones. In the absence of detailed geostatistical analysis for other elements Inverse Distance Weighted Squared (IDW^2) methods were used to estimate the model grade interpolation for other elements Co, Fe, Mg0, Si02, Al203, Ca0 and moisture content.
		• A comparison against previous Mineral Resource estimates from 30 June 2020 were conducted to validate the materiality of the volumes

Criteria	JORC Code explanation	Commentary
	• *Description of how the geological interpretation was used to control the resource estimates.* • *Discussion of basis for using or not using grade cutting or capping.* • *The process of validation, the checking process used, the comparison of model data to drill hole data, and use of reconciliation data if available.*	stated in this report, further life of mine production reconciliation of historical mine areas of Bete Bete & APL pits were completed, showing reasonable correlation of the model prediction's to actual ore recovery • Since Jan 2020, limonite (by product of mining high grade saprolite ores) was stockpiles in expectation for supply to HPAL processing facilities at IMIP. Limonite shipments have started since Nov 2021 • Deleterious elements or acid drainage of the mineral resource was not considered in the model at time of Mineral Resource estimation as pits are shallow, backfilled and rehabilitated progressively • Block size selected 20m x 20m x 2m (sub-block 10m x10 x 1m) were considered appropriate for the style of mineralization reported. The assumption of the block sizes was designed to match the division of drilling spacing grids, composite sample lengths, geostatistical studies and practical mining bench dimensions for ongoing mine planning at the Hengjaya site • Wireframing was set up on each drill line in both east-west and north-south directions to create a 10X10m grid over the entire database to develop a morphology wireframe. From these wireframes, gridded surfaces were produced to represent the roof and floor limits of limonite, saprolite and bedrock zones. 10m grids were set up and interpolation of the gridded points was conducted using Inverse Distance Weighted (IDW^2) methods. • Based on analysis of the downhole statistical data additional constraints were applied to Ni% content to impose top cuts to avoid over-estimation of nickel content due to possible nugget effect. For this reason, all core sample measurements were subjected to a top cut for(Ni) estimated for each domain using downhole statistics • Final block model and interpolated grades were validated using several visual and geostatistical techniques to gain further confidence in the Mineral Resource estimates stated in this report. visual inspection of the block models in plan and sectional views to assess the grade interpolations performed conform with the lithological wireframes, surface models and drilling database. Further statistical validation, including swath plots of the Nickel Resource estimate was completed by comparing global averages of the sample composites against the block model global averages.
Moisture	• *Whether the tonnages are estimated on a dry basis or with natural moisture, and the method of determination of the moisture content.*	• Since April, 2019 a total 94,074 Moisture measurements were performed every 1m drill core sample using the Japanese Industrial

Criteria	JORC Code explanation	Commentary
		Standard (JIS M8109-1996IS). • In areas where Moisture content measurements were not available from core lab analysis the domain default weighted average was applied to the corresponding composite zone • Moisture content were used to adjust Wet to Dry tonnage for mineral Resource estimates
Cut-off parameters	• *The basis of the adopted cut-off grade(s) or quality parameters applied.*	• Based on statistical analysis of the domain databases & ongoing ore mining operations a 0.80% cutoff for nickel was applied to both Limonite and Saprolite to best represent the global Mineral Resource estimate for representation of eventual economic extraction. A range of Ni cut-off up to 2.0% split by laterite type to better understand the other elements (Co, Fe, MgO, SiO2, Al2O3, CaO, Density & Moisture) in relation to Nickel (Ni) was also supplied
Mining factors or assumptions	• *Assumptions made regarding possible mining methods, minimum mining dimensions and internal (or, if applicable, external) mining dilution. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential mining methods, but the assumptions made regarding mining methods and parameters when estimating Mineral Resources may not always be rigorous. Where this is the case, this should be reported with an explanation of the basis of the mining assumptions made.*	• no mining or modifying factors were applied to the Mineral Resource statement that would result in a conversion to Ore Reserve. • assumptions for open cut mining operation similar to current production and supply agreements with nearby IMIP smelter provide sufficient evidence for determination of reasonable prospects of eventual economic extraction of the Hengjaya Mineral Resource • proximity to the smelter and the prospect of direct haul road access in addition to barging indicates excellent prospect for eventual economic extraction
Metallurgical factors or assumptions	• *The basis for assumptions or predictions regarding metallurgical amenability. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential metallurgical methods, but the assumptions regarding metallurgical treatment processes and parameters made when reporting Mineral Resources may not always be rigorous. Where this is the case, this should be reported with an explanation of the basis of the metallurgical assumptions made.*	• Metallurgical factors and assumption based on ongoing supply requirement to the RNI & HNI smelters (majority owned by NIC) at the IMIP facility were considered when selecting the cutoff ranges for the Mineral Resource and by product splits between Limonite & Saprolite
Environmen-tal factors or assumptions	• *Assumptions made regarding possible waste and process residue disposal options. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider the potential environmental impacts of the mining and processing operation. While at this stage the determination of potential environmental impacts, particularly for a greenfields project, may not always be well advanced, the status of early consideration of*	• Environmental Impact studies were completed as part of the mining operation permitting process, • Limits of the 2 IPPKH forestry land borrow permits were reviewed when selecting the data, most holes outside these permits were excluded from the model estimation • Top soil composites were extracted separately and considered overburden waste for future mine planning & rehabilitation of ex-

Criteria	JORC Code explanation	Commentary
	these potential environmental impacts should be reported. Where these aspects have not been considered this should be reported with an explanation of the environmental assumptions made.	opencast pit areas, usually represented as the first 1-4meters from surface below grade cutoff ranges and not included in the Mineral Resource
Bulk density	• *Whether assumed or determined. If assumed, the basis for the assumptions. If determined, the method used, whether wet or dry, the frequency of the measurements, the nature, size and representativeness of the samples.* • *The bulk density for bulk material must have been measured by methods that adequately account for void spaces (vugs, porosity, etc), moisture and differences between rock and alteration zones within the deposit.* • *Discuss assumptions for bulk density estimates used in the evaluation process of the different materials.*	• Since April 2019 a total of 13,004 density measurements on drill core samples have been performed. Bulk density was measured on solid core from each stratigraphic layer in every bore hole. Density was measured by measuring the volume by displacement of water and the weight of the fresh sample • Insitu density used in the Resource estimate was the weighted average laboratory core density for each particular lithology for that particular domain.

Classification	• *The basis for the classification of the Mineral Resources into varying confidence categories.*
	• *Whether appropriate account has been taken of all relevant factors (ie relative confidence in tonnage/grade estimations, reliability of input data, confidence in continuity of geology and metal values, quality, quantity and distribution of the data).*
	• *Whether the result appropriately reflects the Competent Person's view of the deposit.*
		• Determination of the Resource classes, were applied to the Mineral Resource with a digitized polygon boundary based on the spatial continuity of each geological domain around regular spaced drilling grids of 25, 50, 100, 200m from included points of observation in the final validated database. Also taken into account was the GPR grid lines between the drilling locations increasing confidence in interpretation of the laterization contact surface between the points of observation in the model. Resources were classified as follows;
		  • MEASURED - Areas of 25-50m of drilling spacing on a continuous grid pattern, where significant influence from Pass 1 dominate the search ellipsoids, with no extrapolation from the last line of drilling.
		  • INDICATED - Areas of 50-100m of drilling spacing on a continuous grid pattern, where significant influence from Pass 1 and 2 dominate the search ellipsoids, with 50m extrapolation from the last line of drilling.
		  • INFERRED - Areas of 100-200m of drilling spacing on a continuous grid pattern, where significant influence from Pass 1, 2 and 3 dominate the search ellipsoids, with 100m extrapolation from the last line of drilling. In some areas between holes greater than 200m the polygon was included

Criteria	JORC Code explanation	Commentary
		into the Inferred category to allow for more practical polygon shape fit to the model area. • Bete Bete and APL mine areas were given the Resource class MINED OUT as it is considered mining depletion has sterilized these areas. • Another factor in selection of resource polygon limits used for the Mineral Resource was a review of the geostatistical inputs and the weighting on each category. This was done by comparing the influence of each pass within the polygon boundaries. The results show that 90% of the blocks in Measured class are interpolated by Pass 1 & 2 and the Indicated class is approximately 90% interpolated by Passes 1, 2 and 3. These results give sufficient confidence in the polygon strategy respectively. The lowest class of Inferred still has majority portions of the first 3 passes with 30% of pass 4 which is considered acceptable in this selection • Bete Bete Far West and Bete West matched drill spacing criteria for Indicated Resource but were downgraded to Inferred status because of insufficient drilling over the entire area to give confidence to the Resource continuity for both thickness and grade.
Audits or reviews	• *The results of any audits or reviews of Mineral Resource estimates.*	• No external audits or reviews were done before release of the Mineral Resource statement for Nickel, dated 30th Aug 2022 • Charles Watson and Tobias Maya provided several peer review during the report drafting process in collaboration with principle author Daniel Madre
Discussion of relative accuracy/ confidence	• *Where appropriate a statement of the relative accuracy and confidence level in the Mineral Resource estimate using an approach or procedure deemed appropriate by the Competent Person. For example, the application of statistical or geostatistical procedures to quantify the relative accuracy of the resource within stated confidence limits, or, if such an approach is not deemed appropriate, a qualitative discussion of the factors that could affect the relative accuracy and confidence of the estimate.* • *The statement should specify whether it relates to global or local estimates, and, if local, state the relevant tonnages, which should be relevant to technical and economic evaluation. Documentation should include assumptions made and the procedures used.*	• Sufficient exploration has been carried out at the Hengjaya project to delineate a significant deposit of laterite nickel. The drilling used for the Mineral Resource estimate is based on systematic drill grids ranging from 25 to 50 to 100m apart. The resource classifications are based on this spacing of points of observation. According to the geostatistical analysis, provides sufficient detail for the purpose of this report. • It is likely with further infill and exploration drilling in all domains the Mineral Resources estimated in this report will increase • Confidence of these estimates are greatly improved with the reconciliation of the historical mining of the same laterite nickel deposit since 2013. These comparisons show good correlation of

Criteria	JORC Code explanation	Commentary
	• *These statements of relative accuracy and confidence of the estimate should be compared with production data, where available.*	actual produced ores of high grade saprolite and predicted Resources. Long term supply contracts to refining facilities already in operation nearby significantly increase the potential for eventual economic extraction of the Hengjaya nickel laterite Mineral Resource

Section 4 Estimation and Reporting of Ore Reserves (Not Required)

(Criteria listed in section 1, and where relevant in sections 2 and 3, also apply to this section.)

Criteria	JORC Code explanation	Commentary
Mineral Resource estimate for conversion to Ore Reserves	• *Description of the Mineral Resource estimate used as a basis for the conversion to an Ore Reserve.* • *Clear statement as to whether the Mineral Resources are reported additional to, or inclusive of, the Ore Reserves.*	• Insert your commentary here…
Site visits	• *Comment on any site visits undertaken by the Competent Person and the outcome of those visits.* • *If no site visits have been undertaken indicate why this is the case.*	•
Study status	• *The type and level of study undertaken to enable Mineral Resources to be converted to Ore Reserves.* • *The Code requires that a study to at least Pre-Feasibility Study level has been undertaken to convert Mineral Resources to Ore Reserves. Such studies will have been carried out and will have determined a mine plan that is technically achievable and economically viable, and that material Modifying Factors have been considered.*	•
Cut-off parameters	• *The basis of the cut-off grade(s) or quality parameters applied.*	•
Mining factors or assumptions	• *The method and assumptions used as reported in the Pre-Feasibility or Feasibility Study to convert the Mineral Resource to an Ore Reserve (i.e. either by application of appropriate factors by optimisation or by preliminary or detailed design).* • *The choice, nature and appropriateness of the selected mining method(s) and other mining parameters including associated design issues such as pre-strip, access, etc.* • *The assumptions made regarding geotechnical parameters (eg pit slopes, stope sizes, etc), grade control and pre-production drilling.* • *The major assumptions made and Mineral Resource model used for*	•

Criteria	JORC Code explanation	Commentary
	pit and stope optimisation (if appropriate). • *The mining dilution factors used.* • *The mining recovery factors used.* • *Any minimum mining widths used.* • *The manner in which Inferred Mineral Resources are utilised in mining studies and the sensitivity of the outcome to their inclusion.* • *The infrastructure requirements of the selected mining methods.*	
Metallurgical factors or assumptions	• *The metallurgical process proposed and the appropriateness of that process to the style of mineralisation.* • *Whether the metallurgical process is well-tested technology or novel in nature.* • *The nature, amount and representativeness of metallurgical test work undertaken, the nature of the metallurgical domaining applied and the corresponding metallurgical recovery factors applied.* • *Any assumptions or allowances made for deleterious elements.* • *The existence of any bulk sample or pilot scale test work and the degree to which such samples are considered representative of the orebody as a whole.* • *For minerals that are defined by a specification, has the ore reserve estimation been based on the appropriate mineralogy to meet the specifications?*	•
Environmen-tal	• *The status of studies of potential environmental impacts of the mining and processing operation. Details of waste rock characterisation and the consideration of potential sites, status of design options considered and, where applicable, the status of approvals for process residue storage and waste dumps should be reported.*	•
Infrastructure	• *The existence of appropriate infrastructure: availability of land for plant development, power, water, transportation (particularly for bulk commodities), labour, accommodation; or the ease with which the infrastructure can be provided, or accessed.*	•
Costs	• *The derivation of, or assumptions made, regarding projected capital costs in the study.* • *The methodology used to estimate operating costs.* • *Allowances made for the content of deleterious elements.* • *The source of exchange rates used in the study.* • *Derivation of transportation charges.* • *The basis for forecasting or source of treatment and refining charges, penalties for failure to meet specification, etc.*	•

Criteria	JORC Code explanation	Commentary
	• *The allowances made for royalties payable, both Government and private.*	
Revenue factors	• *The derivation of, or assumptions made regarding revenue factors including head grade, metal or commodity price(s) exchange rates, transportation and treatment charges, penalties, net smelter returns, etc.* • *The derivation of assumptions made of metal or commodity price(s), for the principal metals, minerals and co-products.*	•
Market assessment	• *The demand, supply and stock situation for the particular commodity, consumption trends and factors likely to affect supply and demand into the future.* • *A customer and competitor analysis along with the identification of likely market windows for the product.* • *Price and volume forecasts and the basis for these forecasts.* • *For industrial minerals the customer specification, testing and acceptance requirements prior to a supply contract.*	•
Economic	• *The inputs to the economic analysis to produce the net present value (NPV) in the study, the source and confidence of these economic inputs including estimated inflation, discount rate, etc.* • *NPV ranges and sensitivity to variations in the significant assumptions and inputs.*	•
Social	• *The status of agreements with key stakeholders and matters leading to social licence to operate.*	•
Other	• *To the extent relevant, the impact of the following on the project and/or on the estimation and classification of the Ore Reserves:* • *Any identified material naturally occurring risks.* • *The status of material legal agreements and marketing arrangements.* • *The status of governmental agreements and approvals critical to the viability of the project, such as mineral tenement status, and government and statutory approvals. There must be reasonable grounds to expect that all necessary Government approvals will be received within the timeframes anticipated in the Pre-Feasibility or Feasibility study. Highlight and discuss the materiality of any unresolved matter that is dependent on a third party on which extraction of the reserve is contingent.*	•
Classification	• *The basis for the classification of the Ore Reserves into varying confidence categories.* • *Whether the result appropriately reflects the Competent Person's*	•

Criteria	JORC Code explanation	Commentary
	view of the deposit. • *The proportion of Probable Ore Reserves that have been derived from Measured Mineral Resources (if any).*	
Audits or reviews	• *The results of any audits or reviews of Ore Reserve estimates.*	•
Discussion of relative accuracy/ confidence	• *Where appropriate a statement of the relative accuracy and confidence level in the Ore Reserve estimate using an approach or procedure deemed appropriate by the Competent Person. For example, the application of statistical or geostatistical procedures to quantify the relative accuracy of the reserve within stated confidence limits, or, if such an approach is not deemed appropriate, a qualitative discussion of the factors which could affect the relative accuracy and confidence of the estimate.* • *The statement should specify whether it relates to global or local estimates, and, if local, state the relevant tonnages, which should be relevant to technical and economic evaluation. Documentation should include assumptions made and the procedures used.* • *Accuracy and confidence discussions should extend to specific discussions of any applied Modifying Factors that may have a material impact on Ore Reserve viability, or for which there are remaining areas of uncertainty at the current study stage.* • *It is recognised that this may not be possible or appropriate in all circumstances. These statements of relative accuracy and confidence of the estimate should be compared with production data, where available.*	•

Appendix 2
License Documents

PEMERINTAH PROVINSI SULAWESI TENGAH
DINAS PENANAMAN MODAL DAN
PELAYANAN TERPADU SATU PINTU
Jalan : Cik Ditiro No 29 Palu - Telp. (0451) 4017755 - Kode Pos.94111

KEPUTUSAN GUBERNUR SULAWESI TENGAH
NOMOR : 540/345/IUP-OP-PENCIUTAN/DPMPTSP/2020

TENTANG

PENCIUTAN WILAYAH IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI PT. HENGJAYA MINERALINDO BERDASARKAN KEPUTUSAN BUPATI MOROWALI NOMOR : 540.3/SK.001/DESDM/VI/2011 TENTANG PERSETUJUAN PENINGKATAN IZIN USAHA PERTAMBANGAN EKSPLORASI MENJADI IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI KEPADA PT. HENGJAYA MINERALINDO

GUBERNUR SULAWESI TENGAH,

Menimbang :

a. Bahwa berdasarkan pasal 74 ayat (1) Peraturan Pemerintah Nomor 23 Tahun 2010 tentang Pelaksanaan Kegiatan Usaha Pertambangan Mineral dan Batu Bara, Pemegang IUP sewaktu-waktu dapat mengajukan Permohonan kepada Gubernur untuk menciutkan sebagian atau mengembalikan seluruh WIUP;

b. bahwa dengan memperhatikan Surat Tim Teknis Dinas Energi dan Sumber Daya Mineral Provinsi Sulawesi Tengah Nomor : 540/9519/VI/BID.MINERBA/2020 Tanggal 23 Juni 2020, Perihal Pertimbangan Teknis Penciutan Wilayah IUP Operasi Produksi PT. Hengjaya Mineralindo telah memenuhi syarat untuk diberikan Penciutan IUP Operasi Produksi;

c. bahwa berdasarkan Pasal 173 C ayat (1) Undang-Undang Nomor 3 Tahun 2020 tentang perubahan atas Undang-Undang Nomor 4 Tahun 2009 tentang Pertambangan Mineral dan Batubara menyebutkan “Pelaksanaan kewenangan pengelolaan pertambangan mineral dan batubara oleh pemerintah provinsi yang telah dilaksanakan berdasarkan Undang-Undang Nomor 4 Tahun 2009 tentang Pertambangan Mineral dan Batubara (Lembaran Negara Republik Indonesia Tahun 2009 Nomor 4, Tambahan Lembaran Negara Republik Indonesia Nomor 4959) dan Undang-Undang lain yang mengatur tentang Kewenangan Pemerintah Daerah dibidang Pertambangan Mineral dan Batubara tetap berlaku untuk jangka waktu paling lama 6 (enam) bulan terhitung sejak Undang-Undang ini mulai berlaku atau sampai dengan diterbitkannya Peraturan Pelaksanaan Undang-Undang ini;

d. bahwa berdasarkan pertimbangan sebagaimana dimaksud huruf a, huruf b dan huruf c, perlu menetapkan Keputusan Gubernur tentang Penciutan Wilayah Izin Usaha Pertambangan Operasi Produksi PT. Hengjaya Mineralindo Berdasarkan Keputusan Bupati Morowali Nomor 540.3/SK.001/DESDM/VI/2011 Tentang Persetujuan Peningkatan Izin Usaha Pertambangan Eksplorasi Menjadi Izin Usaha Pertambangan Operasi Produksi Kepada PT. Hengjaya Mineralindo;

Mengingat : 1. Undang-Undang Nomor 13 Tahun 1964 tentang Penetapan Peraturan Pemerintah Pengganti Undang-Undang Nomor 2 Tahun 1964 tentang Pembentukan Daerah Tingkat I Sulawesi Tengah dan Daerah Tingkat I Sulawesi Tenggara dengan mengubah Undang-Undang Nomor 47 Prp Tahun 1960 tentang Pembentukan Daerah Tingkat I Sulawesi Utara-Tengah dan Daerah Tingkat I Sulawesi Selatan–Tenggara (Lembaran Negara Republik Indonesia Tahun 1964 Nomor 07), Menjadi Undang-Undang (Lembaran Negara Republik Indonesia Tahun 1964 Nomor 94, Tambahan Lembaran Negara Republik Indonesia Nomor 2687);

2. Undang-Undang Nomor 4 Tahun 2009 tentang Pertambangan Mineral dan Batubara (Lembaran Negara Republik Indonesia Tahun 2009 Nomor 4, Tambahan Lembaran Negara Republik Indonesia Nomor 4959) Sebagaimana telah diubah dengan Undang-Undang Nomor 03 Tahun 2020 tentang Perubahan atas Undang-Undang Nomor 4 Tahun 2009 tentang Pertambangan Mineral dan Batubara (Lembaran Negara Republik Indonesia Tahun 2020 Nomor 147, Tambahan Lembaran Negara Republik Indonesia Nomor 6525);

3. Undang-Undang Nomor 23 Tahun 2014 tentang Pemerintahan Daerah (Lembaran Negara Republik Indonesia Tahun 2014 Nomor 244, Tambahan Lembaran Negara Republik Indonesia Nomor 5587) sebagaimana telah diubah terakhir dengan Undang-Undang Nomor 9 Tahun 2015 tentang Perubahan Kedua atas Undang-Undang Nomor 23 Tahun 2014 tentang Pemerintahan Daerah (Lembaran Negara Republik Indonesia Tahun 2015 Nomor 58, Tambahan Lembaran Negara Republik Indonesia Nomor 5679);

4. Peraturan Pemerintah Nomor 22 Tahun 2010 tentang Wilayah Pertambangan (Lembaran Negara Republik Indonesia Tahun 2010 Nomor 28, Tambahan Lembaran Negara Republik Indonesia Nomor 5110);

5. Peraturan Pemerintah Nomor 23 Tahun 2010 tentang Pelaksanaan Kegiatan Usaha Pertambangan Mineral dan Batubara (Lembaran Negara Republik Indonesia Tahun 2010 Nomor 29, Tambahan Lembaran Negara Republik Indonesia Nomor 5111), sebagaimana telah diubah terakhir dengan Peraturan Pemerintah Nomor 77 Tahun 2014 tentang Perubahan Ketiga atas Peraturan Pemerintah Nomor 23 Tahun 2010 tentang Pelaksanaan Kegiatan Usaha Pertambangan Mineral dan Batubara (Lembaran Negara Republik Indonesia Tahun 2014 Nomor 263, Tambahan Lembaran Negara Republik Indonesia Nomor 5597);

6. Peraturan Pemerintah Nomor 55 Tahun 2010 tentang Pembinaan dan Pengawasan Penyelenggaraan Pengelolaan Usaha Pertambangan Mineral dan Batubara (Lembaran Negara Republik Indonesia Tahun 2010 Nomor 138, tambahan lembaran Negara Republik Indonesia Nomor 5172);

7. Peraturan Pemerintah Nomor 78 Tahun 2010 tentang Reklamasi dan Pascatambang (Lembaran Negara Republik Indonesia Tahun 2010 Nomor 138, Tambahan Lembaran Negara Republik Indonesia Nomor 5172);

8. Peraturan Pemerintah Nomor 9 Tahun 2012 tentang Jenis dan Tarif Atas Jenis Penerimaan Negara Bukan Pajak Yang Berlaku Pada Kementerian Energi dan Sumber Daya Mineral (Lembaran Negara Republik Indonesia Tahun 2012 Nomor 16, Tambahan Lembaran Negara Republik Indonesia Nomor 5276);
9. Peraturan Presiden Nomor 97 Tahun 2014 tentang Penyelenggaraan Pelayanan Terpadu Satu Pintu;
10. Peraturan Menteri Energi dan Sumber Daya Mineral Nomor 7 Tahun 2020 Tentang Tata Cara Pemberian Wilayah, Perizinan, dan Pelaporan Pada Kegiatan Usaha Pertambangan Mineral dan Batubara;
11. Peraturan Daerah Nomor 08 Tahun 2016 tentang pembentukan dan Susunan Perangkat Daerah Provinsi;
12. Peraturan Daerah Nomor 02 Tahun 2018 tentang Pengelolaan Pertambangan Mineral dan Batubara;
13. Peraturan Gubernur Sulawesi Tengah Nomor 71 Tahun 2016 tentang Tugas, Fungsi dan Tatacara Kerja Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu Provinsi;
14. Peraturan Gubernur Sulawesi Tengah Nomor 43 Tahun 2016 tentang Kedudukan dan Susunan Organisasi Dinas Daerah;
15. Peraturan Gubernur Sulawesi Tengah Nomor 26 Tahun 2018 tentang Pendelegasian Kewenangan Penerbitan dan Penandatanganan Perizinan dan Non Perizinan;

Memperhatikan :

1. Keputusan Menteri Energi dan Sumber Daya Mineral Nomor : 2737.K/30/MEM/2013 tentang Penetapan Wilayah Pertambangan Pulau Sulawesi;
2. Surat Edaran Menteri Dalam Negeri Republik Indonesia Nomor: 120/253/Sj tentang Penyelenggaraan Urusan Pemerintahan Setelah Ditetapkan Undang–Undang Nomor 23 Tahun 2014 tentang Pemerintahan Daerah;
3. Surat Direktorat Jenderal Mineral dan Batubara Kementerian Energi dan Sumber Daya Mineral Republik Indonesia Nomor : 321/06/SDB/2015 Perihal Pelayanan Urusan ESDM setelah Pemberlakuan UU 23 Tahun 2014;
4. Keputusan Bupati Morowali Nomor : 540.3/SK.001/DESDM/VI/2011 Tanggal 16 Juni 2011 Tentang Persetujuan Peningkatan Izin Usaha Pertambangan Eksplorasi Menjadi Izin Usaha Pertambangan Operasi Produksi Kepada PT. Hengjaya Mineralindo;
5. Keputusan Kepala Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu Provinsi Sulawesi Tengah Nomor 800/09.90.A/DPMPTSP Tanggal 28 Juni 2018 tentang Standar Pelayanan dan Standar Operasional Prosedur Perizinan dan Non Perizinan.
6. Surat Tim Teknis Dinas Energi dan Sumber Daya Mineral Provinsi Sulawesi Tengah Nomor : 540/9519/VI/BID.MINERBA/2020 Tanggal 23 Juni 2020, Perihal Pertimbangan Teknis Penciutan Wilayah IUP Operasi Produksi PT. Hengjaya Mineralindo;
7. Surat Permohonan Direktur Utama PT. Hengjaya Mineralindo Nomor : 020/LGD.DIR-HM/II/2020 Tanggal 17 Februari 2020, Perihal Permohonan Penciutan Areal IUP Operasi Produksi PT. Hengjaya Mineralindo;

8. Surat Direktur Utama PT. Hengjaya Mineralindo Nomor : 035/LGD.DIR-HM/IV/2020 Tanggal 23 April 2020 Perihal Pemenuhan Persyaratan Penciutan Areal IUP-OP;

MEMUTUSKAN:

Menetapkan	:	KEPUTUSAN GUBERNUR SULAWESI TENGAH TENTANG PENCIUTAN WILAYAH IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI PT. HENGJAYA MINERALINDO BERDASARKAN KEPUTUSAN BUPATI MOROWALI NOMOR 540.3/SK.001/DESDM/VI/2011 TENTANG PERSETUJUAN PENINGKATAN IZIN USAHA PERTAMBANGAN EKSPLORASI MENJADI IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI KEPADA PT. HENGJAYA MINERALINDO
KESATU	:	Melakukan Penciutan Wilayah Izin Usaha Pertambangan (IUP) Operasi Produksi PT. Hengjaya Mineralindo Berdasarkan Keputusan Bupati Morowali Nomor 540.3/SK.001/DESDM/VI/2011 Tentang Persetujuan Peningkatan Izin Usaha Pertambangan Eksplorasi Menjadi Izin Usaha Pertmabangan Operasi Produksi Kepada PT. Hengjaya Mineralindo.
KEDUA	:	Penciutan sebagaimana dimaksud dalam dictum KESATU adalah dari luas Wilayah semula 6.249 Ha (Enam Ribu Dua Ratus Empat Puluh Sembilan) menjadi 5.983 Ha (Lima Ribu Sembilan Ratus Delapan Puluh Tiga) yang menjadi Wilayah Izin Usaha Pertambangan Operasi Produksi setelah dilakukan Penciutan, sesuai dengan Peta dan Daftar Koordinat sebagaimana tercantum dalam lampiran I dan lampiran II yang merupakan bagian tidak terpisahkan dari Keputusan Gubernur ini.
KETIGA		Hak dan kewajiban pemegang IUP Operasi Produksi PT. Hengjaya Mineralindo tetap berpedoman pada Ketentuan Peraturan Perundang-Undangan yang Berlaku.
KEEMPAT	:	Keputusan Gubernur ini mulai berlaku pada tanggal ditetapkan.

Ditetapkan di : Palu
pada tanggal : 10 Juli 2020

a.n GUBERNUR SULAWESI TENGAH
KEPALA DINAS PENANAMAN MODAL DAN PELAYANAN TERPADU SATU PINTU PROVINSI SULAWESI TENGAH

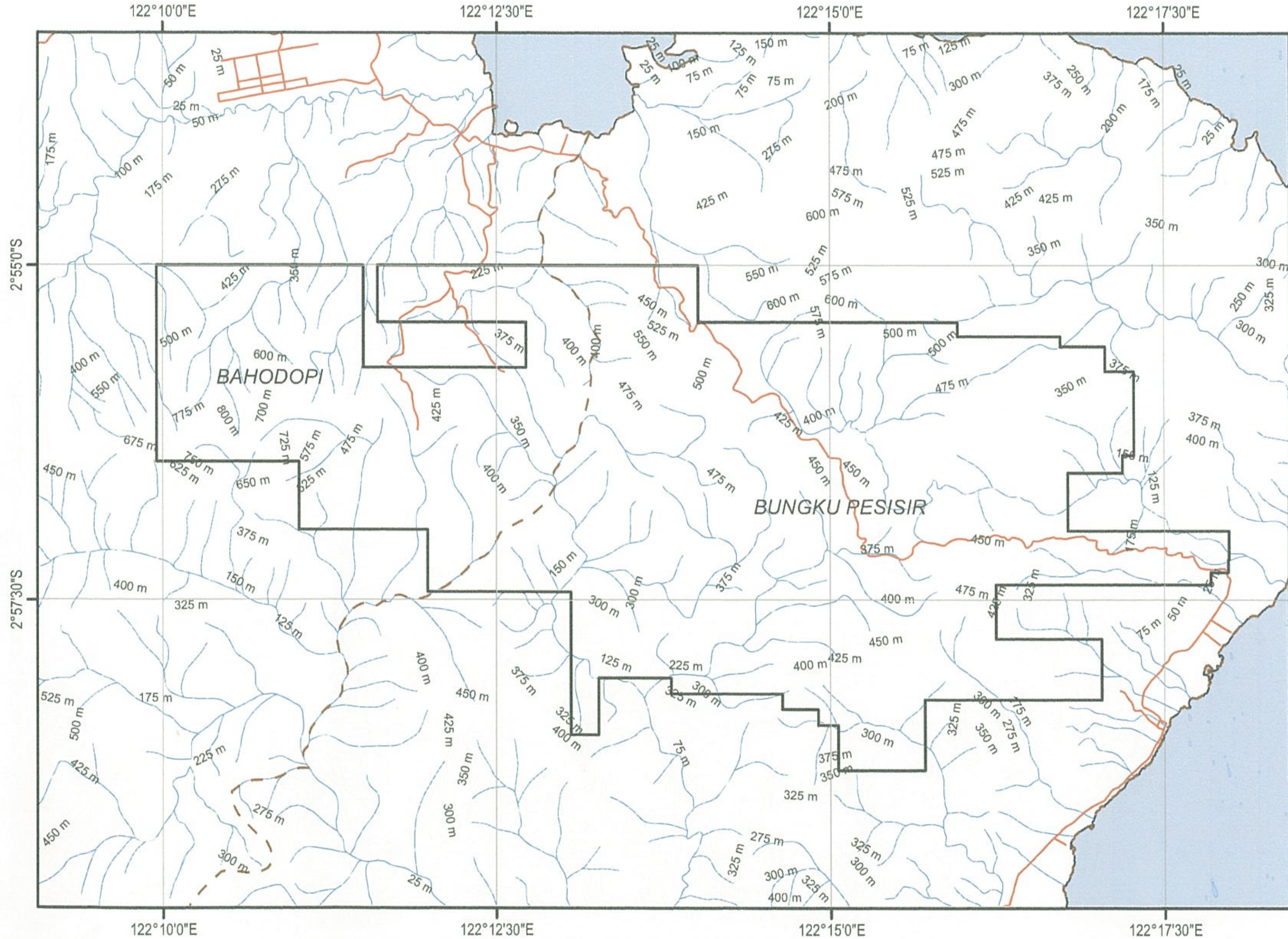
PEMERINTAH PROVINSI SULAWESI TENGAH
DPMPTSP

Ir. CHRISTINA SHANDRA TOBONDO, MT
Pembina Utama Madya
NIP. 19670526 199203 2 006

Tembusan Yth. :
1. Gubernur Sulawesi Tengah (sebagai laporan) di Palu;
2. Sekretaris Daerah Provinsi Sulawesi Tengah di Palu;
3. Bupati Morowali di Bungku;
4. Kepala Dinas ESDM Provinsi Sulawesi Tengah di Palu;
5. Kepala Badan Pendapatan Daerah Provinsi Sulawesi Tengah di Palu;
6. Kepala Dinas PM-PTSP Kabupaten Morowali di Bungku;
7. Direktur Utama PT. HENGJAYA MINERALINDO.

LAMPIRAN I
KEPUTUSAN GUBERNUR SULAWESI TENGAH
NOMOR : 540/345/IUP-OP-Penciutan/DPMPTSP/2020
TENTANG : PENCIUTAN WILAYAH IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI PT. HENGJAYA MINERALINDO BERDASARKAN KEPUTUSAN BUPATI MOROWALI NOMOR: 540.3/SK.001/DESDM/VI/2011 TENTANG PERSETUJUAN PENINGKATAN IZIN USAHA PERTAMBANGAN EKSPLORASI MENJADI IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI KEPADA PT. HENGJAYA MINERALINDO

PETA LOKASI IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI PT. HENGJAYA MINERALINDO



PETA IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI

PROVINSI : SULAWESI TENGAH
KABUPATEN/KOTA : MOROWALI
KECAMATAN : BAHODOPI DAN BUNGKU SELATAN
DESA/KELURAHAN : PADABAHO, BETE-BETE, PU'UNGKEU DAN TANGOFA
LUAS : 5.983 Ha

Skala 1 : 80.000
0 350 700 1,400 2,100 2,800 3,500 Meter

Keterangan
Lokasi IUP
Sistem Koordinat Geografis
Sistem Koordinat UTM WGS' 84 Zona 51S

Legenda
IUP
Kontur
Laut
Jalan
Sungai
Batas Kecamatan

Sumber Peta :
1. Peta Rupa Bumi Indonesia Skala 1 : 50.000

Lokasi Peta :

a.n. GUBERNUR SULAWESI TENGAH
KEPALA DINAS PENANAMAN MODAL DAN PELAYANAN TERPADU SATU PINTU
GUBERNUR SULAWESI TENGAH

DPMPTSP

Ir. CHRISTINA SHANDRA TOBONDO, MT
Pembina Utama Madya
NIP. 19670526 199203 2 006

LAMPIRAN II
KEPUTUSAN GUBERNUR SULAWESI TENGAH
NOMOR : 540/345/iup-op-penciutan/DPMPTSP/2020
TANGGAL : Palu, 10 Juli 2020
TENTANG : PENCIUTAN WILAYAH IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI PT. HENGJAYA MINERALINDO BERDASARKAN KEPUTUSAN BUPATI MOROWALI NOMOR: 540.3/SK.001/ DESDM/VI/2011 TENTANG PERSETUJUAN PENINGKATAN IZIN USAHA PERTAMBANGAN EKSPLORASI MENJADI IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI KEPADA PT. HENGJAYA MINERALINDO

KOORDINAT IZIN USAHA PERTAMBANGAN OPERASI PRODUKSI
PT. HENGJAYA MINERALINDO

LOKASI
DESA : PADABAHO, BETE-BETE, PU'UNGKEU DAN TANGOFA
KECAMATAN : BAHODOPI DAN BUNGKU SELATAN
KABUPATEN : MOROWALI
PROVINSI : SULAWESI TENGAH
LUAS : 5.983 Ha

NO	BUJUR TIMUR			LINTANG SELATAN		
	°	'	"	°	'	"
1	122	15	3.21	2	58	46.15
2	122	15	3.21	2	58	25.82
3	122	14	54.21	2	58	25.82
4	122	14	54.21	2	58	18.74
5	122	14	38.25	2	58	18.74
6	122	14	38.25	2	58	11.84
7	122	13	48.27	2	58	11.84
8	122	13	48.27	2	58	4.76
9	122	13	15.69	2	58	4.76
10	122	13	15.69	2	58	30.21
11	122	13	3.34	2	58	30.21
12	122	13	3.34	2	57	26.14
13	122	11	59.03	2	57	26.14
14	122	11	59.03	2	56	58.25
15	122	11	1.10	2	56	58.25
16	122	11	1.10	2	56	27.81
17	122	9	57.11	2	56	27.81
18	122	9	57.11	2	54	59.84
19	122	11	29.99	2	54	59.84
20	122	11	29.99	2	55	45.58
21	122	12	43.24	2	55	45.58
22	122	12	43.24	2	55	25.34
23	122	11	36.37	2	55	25.34
24	122	11	36.37	2	54	59.84
25	122	14	0.47	2	54	59.84
26	122	14	0.47	2	55	25.18
27	122	15	57.13	2	55	25.18
28	122	15	57.13	2	55	31.55

29	122	16	43.09	2	55	31.55
30	122	16	43.09	2	55	36.02
31	122	17	3.20	2	55	36.02
32	122	17	3.20	2	55	47.17
33	122	17	16.12	2	55	47.17
34	122	17	16.12	2	56	24.78
35	122	17	11.01	2	56	24.78
36	122	17	11.01	2	56	32.75
37	122	16	46.44	2	56	32.75
38	122	16	46.44	2	56	58.73
39	122	17	58.99	2	56	58.73
40	122	17	58.99	2	57	11.48
41	122	17	58.73	2	57	11.48
42	122	17	58.73	2	57	17.38
43	122	17	50.75	2	57	17.38
44	122	17	50.75	2	57	22.80
45	122	16	14.20	2	57	22.80
46	122	16	14.20	2	57	47.18
47	122	17	1.60	2	57	47.18
48	122	17	1.60	2	58	14.43
49	122	15	42.29	2	58	14.43
50	122	15	42.29	2	58	46.15

a.n. GUBERNUR SULAWESI TENGAH
KEPALA DINAS PENANAMAN MODAL DAN
PELAYANAN TERPADU SATU PINTU
PROVINSI SULAWESI TENGAH

PEMERINTAH DAERAH PROVINSI SULAWESI TENGAH
DPMPTSP

Ir. CHRISTINA SHANDRA TOBONDO, MT
Pembina Utama Madya
NIP. 19670526 199203 2 006

MENTERI KEHUTANAN
REPUBLIK INDONESIA

KEPUTUSAN MENTERI KEHUTANAN REPUBLIK INDONESIA
NOMOR : SK.443/Menhut-II/2013

TENTANG

IZIN PINJAM PAKAI KAWASAN HUTAN UNTUK KEGIATAN OPERASI PRODUKSI NIKEL DAN SARANA PENUNJANGNYA PADA KAWASAN HUTAN PRODUKSI TERBATAS ATAS NAMA PT. HENGJAYA MINERALINDO, YANG TERLETAK DI KECAMATAN BAHODOPI DAN KECAMATAN BUNGKU SELATAN, KABUPATEN MOROWALI, PROVINSI SULAWESI TENGAH SELUAS 851,22 (DELAPAN RATUS LIMA PULUH SATU DAN DUA PULUH DUA PERSERATUS) HEKTAR

MENTERI KEHUTANAN REPUBLIK INDONESIA,

Menimbang : a. bahwa berdasarkan surat Menteri Kehutanan Nomor S.2/Menhut-VII/2013 tanggal 4 Januari 2013, PT. Hengjaya Mineralindo mendapat persetujuan prinsip penggunaan kawasan hutan untuk kegiatan operasi produksi nikel dan sarana penunjangnya seluas 862 (delapan ratus enam puluh dua) hektar, pada Kawasan Hutan Produksi Terbatas, terletak di Kabupaten Morowali, Provinsi Sulawesi Tengah, dengan kompensasi membayar Penerimaan Negara Bukan Pajak (PNBP) Penggunaan Kawasan Hutan dan melakukan penanaman dalam rangka rehabilitasi daerah aliran sungai dengan ratio 1 : 1 ditambah dengan luas rencana areal terganggu dengan kategori L3;

b. bahwa PT. Hengjaya Mineralindo telah memenuhi kewajiban sebagaimana surat Menteri Kehutanan Nomor S.2/Menhut-VII/2013 tanggal 4 Januari 2013, serta Peraturan Menteri Kehutanan Nomor P.18/Menhut-II/2011 tentang Pedoman Pinjam Pakai Kawasan Hutan, sebagaimana telah beberapa kali diubah terakhir dengan Peraturan Menteri Kehutanan Nomor P.14/Menhut-II/2013, yaitu:

1. Melaksanakan inventarisasi tegakan sesuai Berita Acara Supervisi Inventarisasi Tegakan Hutan pada Areal Izin Persetujuan Prinsip Penggunaan Kawasan Hutan Produksi, Untuk Kegiatan Operasi Produksi Nikel dan Sarana Penunjangnya pada Kawasan Hutan Produksi Terbatas atas nama PT. Hengjaya Mineralindo, di Kabupaten Morowali, Provinsi Sulawesi Tengah, tanggal 28 Januari 2013;
2. Melaksanakan tata batas sesuai dengan Berita Acara Pelaksanaan Tata Batas Persetujuan Prinsip Penggunaan Kawasan Hutan Untuk Operasi Produksi Nikel dan Sarana Penunjangnya pada Kawasan Hutan Produksi Terbatas atas nama PT. Hengjaya Mineralindo, Kelompok Hutan Bungku Selatan, Kecamatan Bungku Pesisir, Kabupaten Morowali, Provinsi Sulawesi Tengah, yang disetujui dan disahkan oleh Kepala Balai Pemantapan Kawasan Hutan Wilayah XVI Palu tanggal 25 Februari 2013, seluas 851,22 (delapan ratus lima puluh satu dan dua puluh dua perseratus) hektar;

3. Pernyataan ...

3. Pernyataan Direktur PT. Hengjaya Mineralindo di hadapan Ferry Gustiawan, SH, Notaris di Bekasi sesuai Akta Nomor 2 tanggal 5 April 2013, sanggup:
   a) Melaksanakan reklamasi dan revegetasi pada kawasan hutan yang sudah tidak dipergunakan tanpa menunggu selesainya jangka waktu pinjam pakai kawasan hutan;
   b) Melaksanakan perlindungan hutan sesuai ketentuan peraturan perundang-undangan;
   c) Memberikan kemudahan bagi aparat kehutanan baik pusat maupun daerah pada saat melakukan monitoring dan evaluasi di lapangan;
   d) Menanggung seluruh biaya sebagai akibat adanya pinjam pakai kawasan hutan;
   e) Membayar Penerimaan Negara Bukan Pajak (PNBP) Penggunaan Kawasan Hutan dan melakukan penamanan dalam rangka rehabilitasi Daerah Aliran Sungai;
   f) Membayar Provisi Sumber Daya Hutan (PSDH), Dana Reboisasi (DR), dan penggantian nilai tegakan, dan kewajiban keuangan lainnya sesuai dengan ketentuan peraturan perundang-undangan;
   g) Mengembangkan ekonomi berkelanjutan masyarakat lingkar tambang dan memberdayaan masyarakat di sekitar areal;
4. Menyampaikan beseline penggunaan kawasan hutan;
5. Menyampaikan Revisi Rencana Kerja yang disesuaikan dengan hasil tata batas;
6. Menyampaikan rencana reklamasi dan revegetasi;
7. Memiliki Policy Advisor dan Tenaga Teknis Bidang Kehutanan;
8. Akta Pendirian Perusahaan, profil perusahaan, Nomor Pokok Wajib Pajak, dan Neraca Keuangan yang diaudit oleh Akuntan Publik;

c. bahwa berdasarkan Pasal 1 ayat (1) Peraturan Pemerintah Nomor 2 Tahun 2008 tentang Jenis dan Tarif Atas Jenis Penerimaan Negara Bukan Pajak yang Berasal dari Penggunaan Kawasan Hutan untuk Kepentingan Pembangunan di Luar Kegiatan Kehutanan yang Berlaku pada Departemen Kehutanan, Jenis Penerimaan Negara Bukan Pajak dalam Peraturan Pemerintah ini adalah Penerimaan Negara Bukan Pajak yang berasal dari penggunaan kawasan hutan untuk kepentingan pembangunan di luar kegiatan kehutanan yang luas kawasan hutannya di atas 30% (tiga puluh persen) dari daerah aliran sungai dan/atau pulau;

d. bahwa berdasarkan Pasal 7 ayat (2) huruf b angka 2 Peraturan Menteri Kehutanan Nomor P.18/Menhut-II/2011 tentang Pedoman Pinjam Pakai Kawasan Hutan, sebagaimana telah beberapa kali diubah terakhir dengan Peraturan Menteri Kehutanan Nomor P.14/Menhut-II/2013, izin pinjam pakai kawasan hutan pada provinsi yang luas kawasan hutannya di atas 30% (tiga puluh perseratus) dari luas daerah aliran sungai, pulau, dan/atau provinsi, dengan ketentuan penggunaan untuk komersial dikenakan kompensasi membayar Penerimaan Negara Bukan Pajak Penggunaan Kawasan Hutan dan melakukan penanaman dalam rangka rehabilitasi daerah aliran sungai dengan ratio 1:1 ditambah dengan luas rencana areal terganggu dengan kategori L3;

e. bahwa ...

e. bahwa berdasarkan Pasal 13 Peraturan Pemerintah Nomor 24 Tahun 2010 tentang Penggunaan Kawasan Hutan, sebagaimana telah diubah dengan Peraturan Pemerintah Nomor 61 Tahun 2012, dalam hal pemegang persetujuan prinsip telah memenuhi seluruh kewajiban Menteri menerbitkan izin pinjam pakai kawasan hutan;

f. bahwa berdasarkan surat Direktur Jenderal Planologi Kehutanan Nomor S.769/VII-PKH/2013 tanggal 3 Juni 2013, sesuai Peta Indikatif Penundaan Izin Baru Lampiran Keputusan Direktur Jenderal Planologi Kehutanan atas nama Menteri Kehutanan Nomor SK.6315/Menhut-VII/ IPSDH/2012 tentang Penetapan Peta Indikatif Penundaan Izin Baru Pemanfaatan Hutan, Penggunaan Kawasan Hutan, dan Perubahan Peruntukan Kawasan Hutan dan Areal Penggunaan Lain (Revisi III), Kawasan Hutan Produksi Terbatas yang terletak di Kabupaten Morowali, Provinsi Sulawesi Tengah seluas 851,22 (delapan ratus lima puluh satu dan dua puluh dua perseratus) hektar untuk kegiatan operasi produksi nikel dan sarana penunjangnya atas nama PT. Hengjaya Mineralindo, tidak terindikasi sebagai hutan alam primer dan lahan gambut, sehingga tidak termasuk dalam wilayah penundaan pemberian izin baru;

g. bahwa berdasarkan pertimbangan sebagaimana dimaksud di atas, perlu menetapkan Keputusan Menteri Kehutanan tentang Izin Pinjam Pakai Kawasan Hutan Untuk Kegiatan Operasi Produksi Nikel dan Sarana Penunjangnya pada Kawasan Hutan Produksi Terbatas atas nama PT. Hengjaya Mineralindo, yang Terletak di Kecamatan Bahodopi dan Bungku Selatan,Kabupaten Morowali, Provinsi Sulawesi Tengah seluas 851,22 (delapan ratus lima puluh satu dan dua puluh dua perseratus) hektar;

Mengingat : 1. Undang-Undang Nomor 41 Tahun 1999 tentang Kehutanan, sebagaimana telah diubah dengan Undang-Undang Nomor 19 Tahun 2004;

2. Undang-Undang Nomor 32 Tahun 2004 tentang Pemerintahan Daerah, sebagaimana telah beberapa kali diubah terakhir dengan Undang-Undang Nomor 12 Tahun 2008;
3. Undang-Undang Nomor 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup;
4. Peraturan Pemerintah Nomor 44 Tahun 2004 tentang Perencanaan Kehutanan;
5. Peraturan Pemerintah Nomor 45 Tahun 2004 tentang Perlindungan Hutan, sebagaimana telah diubah dengan Peraturan Pemerintah Nomor 60 Tahun 2009;
6. Peraturan Pemerintah Nomor 6 Tahun 2007 tentang Tata Hutan dan Penyusunan Rencana Pengelolaan Hutan, serta Pemanfaatan Hutan, sebagaimana telah diubah dengan Peraturan Pemerintah Nomor 3 Tahun 2008;
7. Peraturan Pemerintah Nomor 38 Tahun 2007 tentang Pembagian Urusan Pemerintahan antara Pemerintah, Pemerintahan Daerah Provinsi dan Pemerintahan Daerah Kabupaten/Kota;
8. Peraturan Pemerintah Nomor 76 Tahun 2008 tentang Rehabilitasi dan Reklamasi Hutan;

9. Peraturan Pemerintah Nomor 15 Tahun 2010 tentang Penyelenggaraan Penataan Ruang;
10. Peraturan Pemerintah Nomor 24 Tahun 2010 tentang Penggunaan Kawasan Hutan, sebgaimana telah diubah dengan Peraturan Pemerintah Nomor 61 Tahun 2012;
11. Peraturan Presiden Nomor 47 Tahun 2009 tentang Pembentukan dan Organisasi Kementerian Negara, sebagaimana telah beberapa kali diubah terakhir dengan Peraturan Presiden Nomor 91 Tahun 2011;
12. Keputusan Presiden Nomor 84/P Tahun 2009 tentang Pembentukan Kabinet Indonesia Bersatu II, sebagaimana telah diubah dengan Keputusan Presiden Nomor 59/P Tahun 2011;
13. Peraturan Presiden Nomor 24 Tahun 2010 tentang Kedudukan, Tugas dan Fungsi Kementerian Negara serta Susunan Organisasi, Tugas dan Fungsi Eselon I, sebagaimana telah beberapa kali diubah terakhir dengan Peraturan Presiden Nomor 92 Tahun 2011;
14. Instruksi Presiden Nomor 6 Tahun 2013 tentang Penundaan Pemberian Izin Baru dan Penyempurnaan Tata Kelola Hutan Alam Primer dan Lahan Gambut;
15. Peraturan Menteri Kehutanan Nomor P.18/Menhut-II/2007 tentang Petunjuk Teknis Tata Cara Pengenaan, Pemungutan dan Pembayaran Provisi Sumber Daya Hutan (PSDH) dan Dana Reboisasi (DR);
16. Peraturan Menteri Kehutanan Nomor P.56/Menhut-II/2008 tentang Tata Cara Penentuan Luas Areal Terganggu dan Areal Reklamasi dan Revegetasi untuk Perhitungan Penerimaan Negara Bukan Pajak Penggunaan Kawasan Hutan;
17. Peraturan Menteri Kehutanan Nomor P.60/Menhut-II/2009 tentang Pedoman Penilaian Keberhasilan Reklamasi Hutan;
18. Peraturan Menteri Keuangan Nomor 91/KMK.02/2009 tentang Tata Cara Pengenaan, Pemungutan dan Penyetoran Penerimaan Negara Bukan Pajak yang Berasal dari Penggunaan Kawasan Hutan untuk Kepentingan Pembangunan di Luar Kegiatan Kehutanan;
19. Peraturan Menteri Kehutanan Nomor P.40/Menhut-II/2010 tentang Organisasi dan Tata Kerja Kementerian Kehutanan, sebagaimana telah diubah dengan Peraturan Menteri Kehutanan Nomor P.33/Menhut-II/2012;
20. Peraturan Menteri Kehutanan Nomor P.14/Menhut-II/2011 tentang Izin Pemanfaatan Kayu, yang telah diubah dengan Peraturan Menteri Kehutanan Nomor P.20/Menhut-II/2013;
21. Peraturan Menteri Kehutanan Nomor P.18/Menhut-II/2011 tentang Pedoman Pinjam Pakai Kawasan Hutan, sebagaimana telah beberapa kali diubah terakhir dengan Peraturan Menteri Kehutanan Nomor P.14/Menhut-II/2013;
22. Peraturan Menteri Kehutanan Nomor P.63/Menhut-II/2011 tentang Pedoman Penanaman Bagi Pemegang Izin Pinjam Pakai Kawasan Hutan Dalam Rangka Rehabilitasi Daerah Aliran Sungai;
23. Keputusan Direktur Jenderal Planologi Kehutanan atas nama Menteri Kehutanan Nomor SK.2796/Menhut-VII/IPSDH/2013 tentang Penetapan Peta Indikatif Penundaan Izin Baru Pemanfaatan Hutan, Penggunaan Kawasan Hutan, dan Perubahan Peruntukan Kawasan Hutan dan Areal Penggunaan Lain (Revisi IV);

Memperhatikan: 1. Keputusan Bupati Morowali Nomor 540.3/SK.001/DESDM/VI/2011 tanggal 16 Juni 2011, tentang Persetujuan Izin Usaha Pertambangan Operasi Produksi kepada PT. Hengjaya Mineralindo, untuk jangka waktu 30 (tiga puluh) tahun sampai dengan tanggal 16 Juni 2031;

2. Surat Menteri Kehutanan Nomor S.2/Menhut-VII/2013 tanggal 4 Januari 2013, hal Pemberian Persetujuan Prinsip Penggunaan Kawasan Hutan atas nama PT. Hengjaya Mineralindo untuk Kegiatan Operasi Produksi Nikel dan Sarana Penunjangnya di Kabupaten Morowali, Provinsi Sulawesi Tengah;

3. Berita Acara Supervisi Inventarisasi Tegakan Hutan pada Areal Izin Persetujuan Prinsip Penggunaan Kawasan Hutan Produksi, Untuk Kegiatan Operasi Produksi Nikel dan Sarana Penunjangnya pada Kawasan Hutan Produksi Terbatas atas nama PT. Hengjaya Mineralindo, di Kabupaten Morowali, Provinsi Sulawesi Tengah, tanggal 28 Januari 2013;

4. Berita Acara Pelaksanaan Tata Batas Persetujuan Prinsip Penggunaan Kawasan Hutan Untuk Operasi Produksi Nikel dan Sarana Penunjangnya pada Kawasan Hutan Produksi Terbatas atas nama PT. Hengjaya Mineralindo, Kelompok Hutan Bungku Selatan, Kecamatan Bungku Pesisir, Kabupaten Morowali, Provinsi Sulawesi Tengah, yang disetujui dan disahkan oleh Kepala Balai Pemantapan Kawasan Hutan Wilayah XVI Palu tanggal 25 Pebruari 2013;

5. Pernyataan Direktur PT. Hengjaya Mineralindo di hadapan Ferry Gustiawan, SH, Notaris di Bekasi sesuai Akta Nomor 2 tanggal 5 April 2013;

MEMUTUSKAN :

Menetapkan : **KEPUTUSAN MENTERI KEHUTANAN TENTANG IZIN PINJAM PAKAI KAWASAN HUTAN UNTUK KEGIATAN OPERASI PRODUKSI NIKEL DAN SARANA PENUNJANGNYA PADA KAWASAN HUTAN PRODUKSI TERBATAS ATAS NAMA PT. HENGJAYA MINERALINDO YANG TERLETAK DI KECAMATAN BAHODOPI DAN KECAMATAN BUNGKU SELATAN, KABUPATEN MOROWALI, PROVINSI SULAWESI TENGAH SELUAS 851,22 (DELAPAN RATUS LIMA PULUH SATU DAN DUA PULUH DUA PERSERATUS) HEKTAR.**

KESATU : Memberikan izin pinjam pakai kawasan hutan untuk kegiatan operasi produksi nikel dan sarana penunjangnya pada Kawasan Hutan Produksi Terbatas atas nama PT. Hengjaya Mineralindo yang terletak di Kecamatan Bahodopi dan Kecamatan Bungku Selatan,Kabupaten Morowali, Provinsi Sulawesi Tengah seluas 851,22 (delapan ratus lima puluh satu dan dua puluh dua perseratus) hektar, sebagaimana Peta Lampiran Keputusan ini, dengan rincian penggunaan sebagai berikut :

a. Areal penambangan, seluas 751,45 (tujuh ratus lima puluh satu dan empat puluh lima perseratus) hektar;
b. Sarana dan prasarana, seluas 62,69 (enam puluh dua dan enam puluh sembilan perseratus) hektar, dengan rincian :
    1. Disposal, seluas 54,70 (lima puluh empat dan tujuh puluh perseratus) hektar;
    2. Mess, seluas 2,76 (dua dan tujuh puluh enam perseratus) hektar;
    3. Stockpile, seluas 5,23 (lima dan dua puluh tiga perseratus) hektar;

c. Jalan ...

c. Jalan angkutan tambang seluas 37,08 (tiga puluh tujuh dan delapan perseratus) hektar,terdiri dari:
   1. Jalan tambang di dalam areal tambang, seluas 19,33 (sembilan belas dan tiga puluh tiga perseratus) hektar;
   2. Jalan angkutan tambang di luar areal tambang, seluas 17,75 (tujuh belas dan tujuh puluh lima perseratus) hektar.

KEDUA : Pemberian izin pinjam pakai kawasan hutan sebagaimana dimaksud dalam Amar KESATU adalah untuk pelaksanaan kegiatan operasi produksi nikel dan sarana penunjangnya, bukan untuk kegiatan lain serta arealnya tetap berstatus sebagai kawasan hutan.

KETIGA : PT. Hengjaya Mineralindo, berhak :

a. berada, menempati dan mengelola serta melakukan kegiatan-kegiatan yang meliputi kegiatan operasi produksi nikel dan sarana penunjangnya, serta melakukan kegiatan-kegiatan lainnya yang berhubungan dengan itu dalam kawasan hutan yang dipinjam pakai;
b. memanfaatkan hasil kegiatan yang dilakukan sehubungan dengan kegiatan operasi produksi nikel dan sarana penunjangnya pada kawasan hutan yang dipinjam pakai;
c. melakukan penebangan pohon dalam rangka pembukaan lahan dengan membayar penggantian nilai tegakan dan Provisi Sumber Daya Hutan (PSDH) dan/atau Dana Reboisasi (DR) sesuai dengan ketentuan peraturan perundang-undangan.

KEEMPAT : PT. Hengjaya Mineralindo, wajib:

a. membayar Penerimaan Negara Bukan Pajak Penggunaan Kawasan Hutan dan melakukan penanaman dalam rangka rehabilitasi daerah aliran sungai dengan ratio 1:1 ditambah dengan luas rencana areal terganggu dengan kategori L3;
b. menyampaikan Bank Garansi dari bank pemerintah yang besarnya 3/12 (tiga per dua belas) dari taksiran volume tebangan berdasarkan rekapitulasi LHC;
c. melaksanakan reklamasi dan revegetasi pada kawasan hutan yang sudah tidak dipergunakan, menggunakan bibit tanaman jenis pioner dan unggulan setempat tanpa menunggu selesainya jangka waktu izin pinjam pakai kawasan hutan;
d. membayar penggantian nilai tegakan dan PSDH dan DR serta kewajiban keuangan lainnya sesuai peraturan perundang-undangan, dengan mempekerjakan Tenaga Teknis Pengelolaan Hutan Produksi Lestari Pengujian Kayu Bulat Rimba (GANISPHPL- PKB-R);
e. melakukan pemeliharaan batas pinjam pakai kawasan hutan;
f. melaksanakan perlindungan hutan sesuai peraturan perundang-undangan;
g. memberdayakan masyarakat setempat melalui Program Bina Desa Hutan dan mempekerjakan Tenaga Teknis Pengelolaan Hutan Produksi Lestari Kelola Sosial (GANISPHPL-KESOS);
h. membangun sistem informasi kepada publik yang berkaitan dengan kerusakan lingkungan hidup dan pemberdayaan masyarakat;

i. menanggung ...

i. menanggung seluruh biaya sebagai akibat adanya pinjam pakai kawasan hutan;

j. melakukan koordinasi dengan instansi kehutanan provinsi dan kabupaten paling lambat 1 (satu) bulan sejak tanggal izin pinjam pakai kawasan hutan ini ditetapkan;

k. memberikan kemudahan bagi aparat kehutanan baik pusat maupun daerah pada saat melakukan monitoring dan evaluasi di lapangan;

l. menyerahkan rencana kerja pemenuhan kewajiban sebagaimana dimaksud pada huruf a sampai dengan huruf h kepada Menteri Kehutanan, selambat-lambatnya 100 (seratus) hari kerja setelah ditetapkan Keputusan Izin Pinjam Pakai Kawasan Hutan;

m. membuat laporan secara berkala setiap 6 (enam) bulan sekali kepada Menteri Kehutanan mengenai penggunaan kawasan hutan yang dipinjam pakai, dengan tembusan :
   1. Direktur Jenderal Planologi Kehutanan;
   2. Direktur Jenderal Bina Usaha Kehutanan;
   3. Direktur Jenderal Perlindungan Hutan dan Konservasi Alam;
   4. Direktur Jenderal Bina Pengelolaan Daerah Aliran Sungai dan Perhutanan Sosial;
   5. Kepala Dinas Kehutanan Provinsi Sulawesi Tengah;
   6. Kepala Dinas Kehutanan Kabupaten Morowali;
   7. Kepala Balai Pemantapan Kawasan Hutan Wilayah XVI Palu; dan
   8. Kepala Balai Pengelolaan Daerah Aliran Sungai Palu Poso;

   Laporan memuat :
   1. rencana dan realisasi penggunaan kawasan hutan;
   2. rencana dan realisasi reklamasi dan revegetasi;
   3. pemenuhan kewajiban membayar Penerimaan Negara Bukan Pajak Penggunaan Kawasan Hutan;
   4. rencana dan realisasi penanaman dalam wilayah daerah aliran sungai sesuai peraturan perundang-undangan; dan
   5. pemenuhan kewajiban lainnya sesuai izin pinjam pakai kawasan hutan;

n. membuat laporan dalam bentuk laporan keuangan yang diaudit oleh akuntan publik, khusus untuk kewajiban huruf a sampai dengan huruf h dan kewajiban sebagaimana dimaksud dalam Amar KEENAM setiap 6 (enam) bulan dengan dilampiri pos biaya kewajiban kepada Menteri Kehutanan dengan tembusan kepada Sekretaris Jenderal Kementerian Kehutanan dan Direktur Jenderal Planologi Kehutanan.

KELIMA : Ketentuan untuk melakukan penanaman dalam rangka rehabilitasi Daerah Aliran Sungai (DAS) sebagaimana dimaksud dalam Amar KEEMPAT huruf a mengacu pada Peraturan Menteri Kehutanan Nomor P.63/Menhut-II/2011.

KEENAM : Ketentuan untuk melakukan rehabilitasi, reklamasi dan/atau revegetasi pada kawasan hutan yang dipinjam pakai sebagaimana dimaksud dalam Amar KEEMPAT huruf a dan huruf c wajib mempekerjakan Tenaga Teknis Pengelolaan Hutan Produksi Lestari Rehabilitasi dan Reklamasi Pertambangan (GANISPHPL-REHAREKTAM) dan dilaksanakan sesuai dengan ketentuan peraturan perundang-undangan.

KETUJUH : ...

KETUJUH : PT. Hengjaya Mineralindo, dilarang:

a. memindahtangankan izin pinjam pakai kawasan hutan kepada pihak lain atau pengubahan nama perusahaan tanpa persetujuan Menteri Kehutanan;

b. menjaminkan atau mengagunkan areal izin pinjam pakai kawasan hutan kepada pihak lain;

c. melakukan penebangan pohon dalam kawasan hutan dengan radius atau jarak sampai dengan:

1. 200 (dua ratus) meter dari tepi mata air dan kiri kanan sungai di daerah rawa;
2. 100 (seratus) meter dari kiri kanan tepi sungai;
3. 50 (lima puluh) meter dari kiri kanan tepi anak sungai.

KEDELAPAN : Apabila di dalam kawasan hutan yang dipinjam pakai terdapat hak-hak pihak ketiga, penyelesaiannya menjadi tanggung jawab PT. Hengjaya Mineralindo yang dikoordinasikan oleh pemerintah daerah setempat.

KESEMBILAN : Apabila pemegang izin melakukan pelanggaran atas ketentuan-ketentuan sebagaimana dimaksud dalam izin ini, maka izin dicabut dan pemegang izin dikenakan sanksi sesuai dengan peraturan perundang-undangan, setelah diberi peringatan oleh Direktur Jenderal Planologi Kehutanan paling banyak 3 (tiga) kali dengan tenggang waktu masing-masing paling sedikit 30 (tiga puluh) hari kerja sejak diterimanya surat peringatan sebelumnya dan pemegang izin tidak melakukan usaha perbaikan dalam waktu 30 (tiga puluh) hari kerja sejak diterimanya surat peringatan yang ketiga.

KESEPULUH : Izin pinjam pakai kawasan hutan ini berlaku dan melekat sebagai izin pemanfaatan kayu, serta izin pemasukan dan penggunaan peralatan.

KESEBELAS : Penentuan areal terganggu, reklamasi dan revegetasi serta tata cara pengenaan, pemungutan dan penyetoran PNBP Penggunaan Kawasan Hutan berpedoman pada Peraturan Menteri Kehutanan Nomor P.56/Menhut-II/2008 dan Peraturan Menteri Keuangan Nomor 91/KMK.02/2009 sebagai tindak lanjut Peraturan Pemerintah Nomor 2 Tahun 2008.

KEDUA BELAS: a. Permohonan perpanjangan dilakukan oleh Pemegang Izin paling lambat 6 (enam) bulan sebelum berakhirnya jangka waktu izin;

b. Untuk perpanjangan izin sebagaimana dimaksud pada huruf a, Instansi Kehutanan melakukan evaluasi atas :

1. Kawasan hutan yang dipinjam pakai masih dipergunakan untuk operasi produksi nikel dan sarana penunjangnya oleh pemegang izin atau afiliasinya atau oleh pihak yang diperbolehkan berdasarkan ketentuan peraturan perundang-undangan;

2. Tidak ...

2. Tidak ada pelanggaran yang dilakukan oleh pemegang izin terhadap ketentuan-ketentuan dalam izin ini;
3. Telah memenuhi semua kewajiban dalam Keputusan ini.

KETIGA BELAS: Keputusan ini mulai berlaku pada tanggal ditetapkan dengan jangka waktu paling lama sampai dengan tanggal 16 Juni 2031, apabila dalam jangka waktu 2 (dua) tahun sejak ditetapkannya Keputusan ini tidak ada kegiatan nyata di lapangan, maka Keputusan ini batal dengan sendirinya.

Ditetapkan di Jakarta
pada tanggal 20 Juni 2013

MENTERI KEHUTANAN
REPUBLIK INDONESIA,

ttd

ZULKIFLI HASAN

Salinan sesuai dengan aslinya
KEPALA BIRO HUKUM DAN ORGANISASI,

KRISNA RYA

Salinan Keputusan ini disampaikan kepada Yth. :
1. Menteri Energi dan Sumber Daya Mineral;
2. Sekretaris Jenderal Kementerian Kehutanan;
3. Direktur Jenderal Planologi Kehutanan;
4. Direktur Jenderal Bina Usaha Kehutanan;
5. Direktur Jenderal Bina Pengelolaan DAS dan Perhutanan Sosial;
6. Direktur Jenderal Perlindungan Hutan dan Konservasi Alam;
7. Direktur Jenderal Mineral dan Batubara;
8. Gubernur Sulawesi Tengah;
9. Bupati Morowali;
10. Kepala Dinas Kehutanan Provinsi Sulawesi Tengah;
11. Kepala Dinas Pertambangan Provinsi Sulawesi Tengah;
12. Kepala Dinas Kehutanan Kabupaten Morowali;
13. Kepala Dinas Pertambangan Kabupaten Morowali;
14. Kepala Balai Pemantapan Kawasan Hutan Wilayah XVI Palu;
15. Kepala Balai Pemantauan Pemanfaatan Hutan Produksi Wilayah XIV Palu;
16. Kepala Balai Pengelolaan Daerah Aliran Sungai Ake Malamo;
17. Direktur Utama PT. Hengjaya Mineralindo.

BADAN KOORDINASI PENANAMAN MODAL

KEPUTUSAN KEPALA BADAN KOORDINASI PENANAMAN MODAL
NOMOR : 3 / 1 / IPPKH / PMA / 2018

TENTANG

IZIN PINJAM PAKAI KAWASAN HUTAN UNTUK KEGIATAN OPERASI PRODUKSI NIKEL DAN SARANA PENUNJANGNYA ATAS NAMA PT. HENGJAYA MINERALINDO SELUAS ± 994,32 (SEMBILAN RATUS SEMBILAN PULUH EMPAT DAN TIGA PULUH DUA PERSERATUS) HEKTAR PADA KAWASAN HUTAN PRODUKSI TERBATAS DI KABUPATEN MOROWALI, PROVINSI SULAWESI TENGAH

KEPALA BADAN KOORDINASI PENANAMAN MODAL,

Menimbang : a. bahwa PT. Hengjaya Mineralindo merupakan pemegang izin usaha pertambangan operasi produksi sesuai Keputusan Bupati Morowali Nomor 540.3/SK.001/DESDM/VI/2011 tanggal 16 Juni 2011 seluas ± 6.249 Hektar di Kabupaten Morowali, Provinsi Sulawesi Tengah, dengan masa berlaku 20 (dua puluh) tahun sampai dengan tanggal 26 Mei 2031;

b. bahwa Direktur Utama PT. Hengjaya Mineralindo sesuai surat Nomor 21.1/HM-IPPKH-BKPM/XI/2015 tanggal 13 November 2015 dan Nomor 18.1/HM-IPPKH-BKPM/II/2017 tanggal 20 Februari 2017 mengajukan permohonan Izin Pinjam Pakai Kawasan Hutan untuk kegiatan operasi produksi Nikel dan sarana penunjangnya seluas ± 994,32 Hektar di Kabupaten Morowali, Provinsi Sulawesi Tengah;

c. bahwa sesuai surat Direktur Jenderal Planologi Kehutanan dan Tata Lingkungan Nomor S.1715/PKTL /REN/PLA.0/12/2017 tanggal 28 Desember 2017, Permohonan izin pinjam pakai kawasan hutan untuk kegiatan operasi produksi nikel dan sarana penunjangnya a.n. PT. Hengjaya Mineralindo telah memenuhi persyaratan sesuai dengan ketentuan dalam Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.50/Menlhk/Setjen/Kum.1/6/2016 tentang Pedoman Pinjam Pakai Kawasan Hutan dan telah memenuhi ketentuan teknis seluas ± 994,32 Hektar yang seluruhnya berada pada kawasan Hutan Produksi Terbatas serta tidak dibebani izin pemanfaatan hutan di Kabupaten Morowali, Provinsi Sulawesi Tengah;

d. bahwa berdasarkan pertimbangan tersebut huruf a sampai dengan huruf c, perlu menetapkan Keputusan Kepala Badan Koordinasi Penanaman Modal tentang Izin Pinjam Pakai Kawasan Hutan untuk Kegiatan Operasi Produksi Nikel dan Sarana Penunjangnya atas nama PT. Hengjaya Mineralindo seluas ± 994,32 (Sembilan Ratus Sembilan Puluh Empat dan Tiga Puluh Dua Perseratus) Hektar Pada Kawasan Hutan Produksi Terbatas di Kabupaten Morowali, Provinsi Sulawesi Tengah;

Mengingat :

1. Undang-Undang Nomor 5 Tahun 1990 tentang Konservasi Sumberdaya Alam Hayati dan Ekosistemnya;
2. Undang-Undang Nomor 41 Tahun 1999 tentang Kehutanan, sebagaimana telah diubah dengan Undang-Undang Nomor 19 Tahun 2004;
3. Undang-Undang Nomor 26 Tahun 2007 tentang Penataan Ruang;
4. Undang-Undang Nomor 18 Tahun 2013 tentang Pencegahan dan Pemberantasan Perusakan Hutan;
5. Undang-Undang Nomor 23 Tahun 2014 tentang Pemerintahan Daerah sebagaimana telah beberapa kali di ubah terakhir dengan Undang-Undang Nomor 9 Tahun 2015;
6. Peraturan Pemerintah Nomor 44 Tahun 2004 tentang Perencanaan Kehutanan;
7. Peraturan Pemerintah Nomor 45 Tahun 2004 tentang Perlindungan Hutan, sebagaimana telah diubah dengan Peraturan Pemerintah Nomor 60 Tahun 2009;
8. Peraturan Pemerintah Nomor 6 Tahun 2007 tentang Tata Hutan dan Penyusunan Rencana Pengelolaan Hutan Serta Pemanfaatan Hutan, sebagaimana telah diubah dengan Peraturan Pemerintah Nomor 3 Tahun 2008;
9. Peraturan Pemerintah Nomor 26 Tahun 2008 tentang Rencana Tata Ruang Wilayah Nasional;
10. Peraturan Pemerintah Nomor 76 Tahun 2008 tentang Rehabilitasi dan Reklamasi Hutan;
11. Peraturan Pemerintah Nomor 24 Tahun 2010 tentang Penggunaan Kawasan Hutan, sebagaimana telah beberapa kali diubah terakhir dengan Peraturan Pemerintah Nomor 105 Tahun 2015;
12. Peraturan Pemerintah Nomor 12 Tahun 2014 tentang Jenis dan Tarif Atas Jenis Penerimaan Negara Bukan Pajak Yang Berlaku Pada Kementerian Kehutanan;
13. Peraturan Pemerintah Nomor 33 Tahun 2014 tentang Jenis dan Tarif Atas Jenis Penerimaan Negara Bukan Pajak Yang Berasal Dari Penggunaan Kawasan Hutan Untuk Kepentingan Pembangunan di Luar Kegiatan Kehutanan Yang Berlaku Pada Kementerian Kehutanan;
14. Peraturan Pemerintah Nomor 104 Tahun 2015 tentang Tata Cara Perubahan Peruntukan dan Fungsi Kawasan Hutan;

15. Peraturan Presiden Nomor 97 Tahun 2014 tentang Penyelenggaraan Pelayanan Terpadu Satu Pintu;
16. Peraturan Presiden Nomor 165 Tahun 2014 tentang Penataan Tugas dan Fungsi Kabinet Kerja;
17. Peraturan Presiden Nomor 7 Tahun 2015 tentang Organisasi Kementerian Negara;
18. Peraturan Presiden Nomor 16 Tahun 2015 tentang Kementerian Lingkungan Hidup dan Kehutanan;
19. Peraturan Presiden Nomor 44 Tahun 2016 tentang Daftar Bidang Usaha Yang Tertutup dan Bidang Usaha Yang Terbuka Dengan Persyaratan di Bidang Penanaman Modal;
20. Instruksi Presiden Nomor 6 Tahun 2017 tentang Penundaan dan Penyempurnaan Tata Kelola Pemberian Izin Baru Hutan Alam Primer dan Lahan Gambut;
21. Peraturan Menteri Kehutanan Nomor P.56/Menhut-II/2008 tentang Tata Cara Penentuan Luas Areal Terganggu dan Areal Reklamasi dan Revegatasi Untuk Perhitungan Penerimaan Negara Bukan Pajak Penggunaan Kawasan Hutan, sebagaimana telah diubah dengan Peraturan Menteri Kehutanan Nomor P.84/Menhut-II/2014;
22. Peraturan Menteri Kehutanan Nomor P.60/Menhut-II/2009 tentang Pedoman Penilaian Keberhasilan Reklamasi Hutan;
23. Peraturan Menteri Keuangan Nomor 91/PMK.02/2009 tentang Tata Cara Pengenaan, Pemungutan dan Penyetoran Penerimaan Negara Bukan Pajak Yang Berasal Dari Penggunaan Kawasan Hutan Untuk Kepentingan Pembangunan di Luar Kegiatan Kehutanan;
24. Peraturan Menteri Kehutanan Nomor P.44/Menhut-II/2012 tentang Pengukuhan Kawasan Hutan, sebagaimana telah diubah dengan Peraturan Menteri Kehutanan Nomor P.62/Menhut-II/2013;
25. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.97/Menhut-II/2014 tentang Pendelegasian Wewenang Pemberian Perizinan dan Non Perizinan di Bidang Lingkungan Hidup dan Kehutanan Dalam Rangka Pelaksanaan Pelayanan Terpadu Satu Pintu Kepada Kepala Badan Koordinasi Penanaman Modal, sebagaimana telah diubah dengan Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.1/Menhut-II/2015;
26. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.18/Menlhk-II/2015 tentang Organisasi dan Tata Kerja Kementerian Lingkungan Hidup dan Kehutanan;
27. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.43/MenLHK-Setjen/2015 tentang Penatausahaan Hasil Hutan Kayu Yang Berasal Dari Hutan Alam sebagaimana telah diubah dengan Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.60/MenLHK/Setjen/Kum.1 /7/2016;

28. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.62/MenLHK-Setjen/2015 tentang Izin Pemanfaatan Kayu;
29. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.29/Menlhk/Setjen/PHPL.3/2/2016 tentang Pembatalan Pengenaan, Pemungutan dan Penyetoran Penggantian Nilai Tegakan;
30. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.32/MenLHK/Setjen/Kum.1/3/2016 tentang Pengendalian Kebakaran Hutan dan Lahan;
31. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.50/Menlhk/Setjen/Kum.1/6/2016 tentang Pedoman Pinjam Pakai Kawasan Hutan;
32. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.71/MenLHK/Setjen/HPL.3/8/2016 tentang Tata Cara Pengenaan, Pemungutan, dan Penyetoran Provisi Sumber Daya Hutan dan Dana Reboisasi, Ganti Rugi Tegakan, Denda Pelanggaran Eksploitasi Hutan dan Iuran Izin Usaha Pemanfaatan Hutan;
33. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.89/Menlhk/Setjen/Kum.1/11/2016 tentang Pedoman Penanaman Bagi Pemegang Izin Pinjam Pakai Kawasan Hutan Dalam Rangka Rehabilitasi Daerah Aliran Sungai;
34. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.93/Menlhk/Setjen/Kum.1/12/2016 tentang Panitia Tata Batas Kawasan Hutan;
35. Keputusan Menteri Lingkungan Hidup dan Kehutanan Nomor SK.6559/MenLHK-PKTL/PSDH/PLA.1/12/2017 tanggal 4 Desember 2017 tentang Penetapan Peta Indikatif Penundaan Pemberian Izin Baru Pemanfaatan Hutan, Penggunaan Kawasan Hutan dan Perubahan Peruntukan Kawasan Hutan dan Areal Penggunaan Lain (Revisi XIII);

Memperhatikan :

1. Keputusan Bupati Morowali Nomor 660.1/71.A/KHL/2011 tanggal 13 Juni 2011 tentang Kelayakan Lingkungan Kegiatan Penambangan Bijih Nikel di Kabupaten Morowali Provinsi Sulawesi Tengah oleh PT. Hengjaya Mineralindo;
2. Surat Gubernur Sulawesi Tengah Nomor 522/13/DISHUTDA tanggal 05 Maret 2015 hal Rekomendasi Ijin Pinjam Pakai Kawasan Hutan untuk Kegiatan Operasi Produksi a.n. PT. Hengjaya Mineralindo di Desa Tangofa Kecamatan Bungku Pesisir Kabupaten Morowali Provinsi Sulawesi Tengah;
3. Akta Pernyataan Direktur PT. Hengjaya Mineralindo Nomor 02 tanggal 21 September 2015 yang dibuat dihadapan Ferry Gustiawan, S.H Notaris di Kota Bekasi;
4. Surat Direktur Jenderal Mineral dan Batubara Nomor 2023/30/DJB/2015 tanggal 5 Nopember 2015 hal Pertimbangan Teknis Pinjam Pakai Kawasan Hutan untuk Kegiatan Operasi Produksi a.n. PT. Hengjaya Mineralindo (PT. HM);

MEMUTUSKAN :

Menetapkan : **KEPUTUSAN KEPALA BADAN KOORDINASI PENANAMAN MODAL TENTANG IZIN PINJAM PAKAI KAWASAN HUTAN UNTUK KEGIATAN OPERASI PRODUKSI NIKEL DAN SARANA PENUNJANGNYA ATAS NAMA PT. HENGJAYA MINERALINDO SELUAS ± 994,32 (SEMBILAN RATUS SEMBILAN PULUH EMPAT DAN TIGA PULUH DUA PERSERATUS) HEKTAR PADA KAWASAN HUTAN PRODUKSI TERBATAS DI KABUPATEN MOROWALI, PROVINSI SULAWESI TENGAH.**

KESATU : Memberikan Izin Pinjam Pakai Kawasan Hutan dengan kompensasi membayar Penerimaan Negara Bukan Pajak penggunaan kawasan hutan dan melakukan penanaman dalam rangka rehabilitasi Daerah Aliran Sungai, untuk kegiatan operasi produksi Nikel dan sarana penunjangnya atas nama PT. Hengjaya Mineralindo seluas ± 994,32 (sembilan ratus sembilan puluh empat dan tiga puluh dua perseratus) Hektar pada kawasan Hutan Produksi Tetap di Kabupaten Morowali, Provinsi Sulawesi Tengah, sebagaimana Peta Lampiran Keputusan ini.

KEDUA : Pemberian izin sebagaimana dimaksud dalam amar KESATU adalah untuk operasi produksi Nikel dan sarana penunjangnya, bukan untuk kegiatan lain serta arealnya tetap berstatus sebagai kawasan hutan.

KETIGA : Dalam jangka waktu paling lama 1 (satu) tahun setelah terbit Izin Pinjam Pakai Kawasan Hutan ini, PT. Hengjaya Mineralindo wajib:

a. menyelesaikan tata batas areal izin pinjam pakai kawasan hutan dengan supervisi oleh Balai Pemantapan Kawasan Hutan Wilayah XVI Palu;
b. menyampaikan *baseline* penggunaan kawasan hutan sesuai dengan hasil tata batas;
c. menyampaikan peta lokasi rencana penanaman dalam rangka rehabilitasi daerah aliran sungai;
d. menyampaikan pernyataan dalam bentuk akta notariil bersedia mengganti biaya investasi pengelolaan/ pemanfaatan hutan kepada pengelola/pemegang izin usaha pemanfaatan hutan sesuai ketentuan peraturan perundang-undangan;
e. menyampaikan revisi rencana kerja penggunaan kawasan hutan sesuai dengan hasil tata batas.

KEEMPAT : Dalam hal PT. Hengjaya Mineralindo tidak memenuhi kewajiban sebagaimana dimaksud pada Amar KETIGA, Izin Pinjam Pakai Kawasan Hutan menjadi batal dan dinyatakan tidak berlaku.

KELIMA : Penetapan areal kerja Izin Pinjam Pakai Kawasan Hutan oleh Direktur Jenderal Planologi Kehutanan dan Tata Lingkungan atas nama Menteri Lingkungan Hidup dan Kehutanan dengan dibebani kewajiban-kewajiban, dilaksanakan dengan ketentuan:

a. pemegang izin pinjam pakai kawasan hutan menyampaikan permohonan penetapan areal kerja berdasarkan hasil tata batas areal izin pinjam pakai kawasan hutan kepada Direktur Jenderal Planologi Kehutanan dan Tata Lingkungan;
b. permohonan penetapan areal kerja sebagaimana dimaksud pada huruf a, dilampiri dengan bukti pemenuhan kewajiban sebagaimana dimaksud Amar KETIGA.

KEENAM : PT. Hengjaya Mineralindo dilarang:

a. memindahtangankan Izin Pinjam Pakai Kawasan Hutan kepada pihak lain atau perubahan nama pemegang izin pinjam pakai tanpa persetujuan Menteri Lingkungan Hidup dan Kehutanan;
b. menjaminkan atau mengagunkan areal Izin Pinjam Pakai Kawasan Hutan kepada pihak lain;
c. melakukan kegiatan didalam areal Izin Pinjam Pakai Kawasan Hutan sebelum memperoleh penetapan batas areal kerja Izin Pinjam Pakai Kawasan Hutan, kecuali melakukan kegiatan tata batas, membuat kegiatan persiapan berupa pembangunan direksi kit (*base camp* sementara), dan/atau pengukuran sarana dan prasarana;
d. menggunakan merkuri dalam kegiatan pertambangan;
e. melakukan kegiatan lainnya yang dilarang sesuai Peraturan Perundang-undangan.

KETUJUH : Menyelesaikan hak-hak pihak ketiga, apabila terdapat hak-hak pihak ketiga di dalam areal izin pinjam pakai kawasan hutan dengan meminta bimbingan dan fasilitasi Pemerintah Daerah setempat.

KEDELAPAN : Izin Pinjam Pakai Kawasan Hutan ini dicabut dan pemegang izin dikenakan sanksi sesuai peraturan perundang-undangan, apabila melakukan pelanggaran atas ketentuan dalam izin pinjam pakai kawasan hutan ini.

KESEMBILAN : Izin Pinjam Pakai Kawasan Hutan ini berlaku dan melekat sebagai izin pemanfaatan kayu, serta izin pemasukan dan penggunaan peralatan.

KESEPULUH : Perpanjangan Izin Pinjam Pakai Kawasan Hutan diberikan berdasarkan hasil evaluasi terhadap pemenuhan kewajiban Izin Pinjam Pakai Kawasan Hutan dan diajukan oleh pemegang izin dalam jangka waktu paling lambat 2 (dua) bulan sebelum berakhirnya izin.

KESEBELAS : Keputusan ini mulai berlaku pada tanggal ditetapkan untuk jangka waktu paling lama sampai dengan tanggal 26 Mei 2031, kecuali apabila dicabut oleh Menteri Lingkungan Hidup dan Kehutanan.

Ditetapkan di Jakarta
pada tanggal 06 FEB 2018

A.n. MENTERI LINGKUNGAN HIDUP DAN KEHUTANAN REPUBLIK INDONESIA, KEPALA BADAN KOORDINASI PENANAMAN MODAL,

TTD

THOMAS TRIKASIH LEMBONG

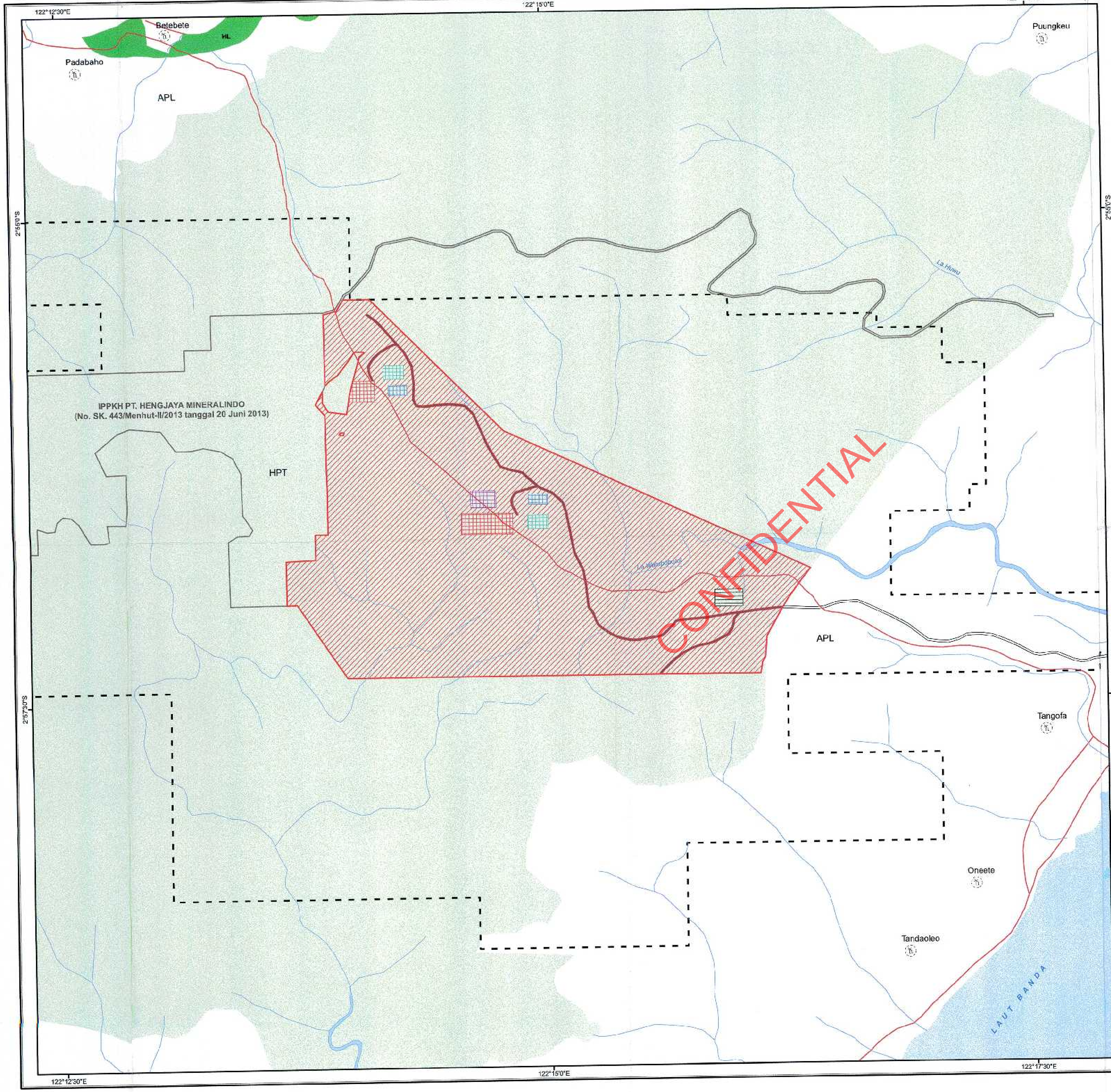
Salinan sesuai dengan aslinya
KEPALA BIRO PERATURAN
PERUNDANG-UNDANGAN,
UMUMAS DAN TATA USAHA
PIMPINAN

BKPM

ARIESTA R. PUSPASARI

Salinan Keputusan ini disampaikan kepada Yth:

1. Menteri Lingkungan Hidup dan Kehutanan;
2. Menteri Energi dan Sumber Daya Mineral;
3. Sekretaris Jenderal Kementerian Lingkungan Hidup dan Kehutanan;
4. Direktur Jenderal Planologi Kehutanan dan Tata Lingkungan;
5. Direktur Jenderal Pengelolaan Hutan Produksi Lestari;
6. Direktur Jenderal Pengendalian Daerah Aliran Sungai dan Hutan Lindung;
7. Direktur Jenderal Konservasi Sumber Daya Alam dan Ekosistem;
8. Direktur Jenderal Penegakan Hukum Lingkungan Hidup dan Kehutanan;
9. Direktur Jenderal Mineral dan Batubara;
10. Gubernur Sulawesi Tengah;
11. Bupati Morowali;
12. Kepala Dinas Kehutanan Provinsi Sulawesi Tengah;
13. Kepala Balai Pemantapan Kawasan Hutan Wilayah XVI Palu;
14. Kepala Balai Pengelolaan Hutan Produksi Wilayah XII Palu;
15. Kepala Balai Pengelolaan Daerah Aliran Sungai dan Hutan Lindung Palu Poso;
16. Direktur Utama PT. Hengjaya Mineralindo.



PETA

IZIN PINJAM PAKAI KAWASAN HUTAN UNTUK KEGIATAN OPERASI PRODUKSI BIJIH NIKEL DAN SARANA PENUNJANGNYA PADA KAWASAN HUTAN PRODUKSI TERBATAS (HPT)

a.n. PT. HENGJAYA MINERALINDO

DI KABUPATEN MOROWALI
PROVINSI SULAWESI TENGAH
LUAS : ± 994,32 Ha
SKALA 1 : 25.000

0 0,25 0,5 1 1,5 2 2,5 Km
0 1 2 4 6 8 10 Cm

U

LAMPIRAN KEPUTUSAN MENTERI LINGKUNGAN HIDUP DAN KEHUTANAN REPUBLIK INDONESIA
NOMOR : 3/1/IPPKH/PMA/2018
TANGGAL : 06 FEB 2018

a.n. MENTERI LINGKUNGAN HIDUP DAN KEHUTANAN REPUBLIK INDONESIA
KEPALA BADAN KOORDINASI PENANAMAN MODAL

THOMAS TRIKASIH LEMBONG

KEPALA BADAN KOORDINASI PENANAMAN MODAL
REPUBLIK INDONESIA

KETERANGAN :

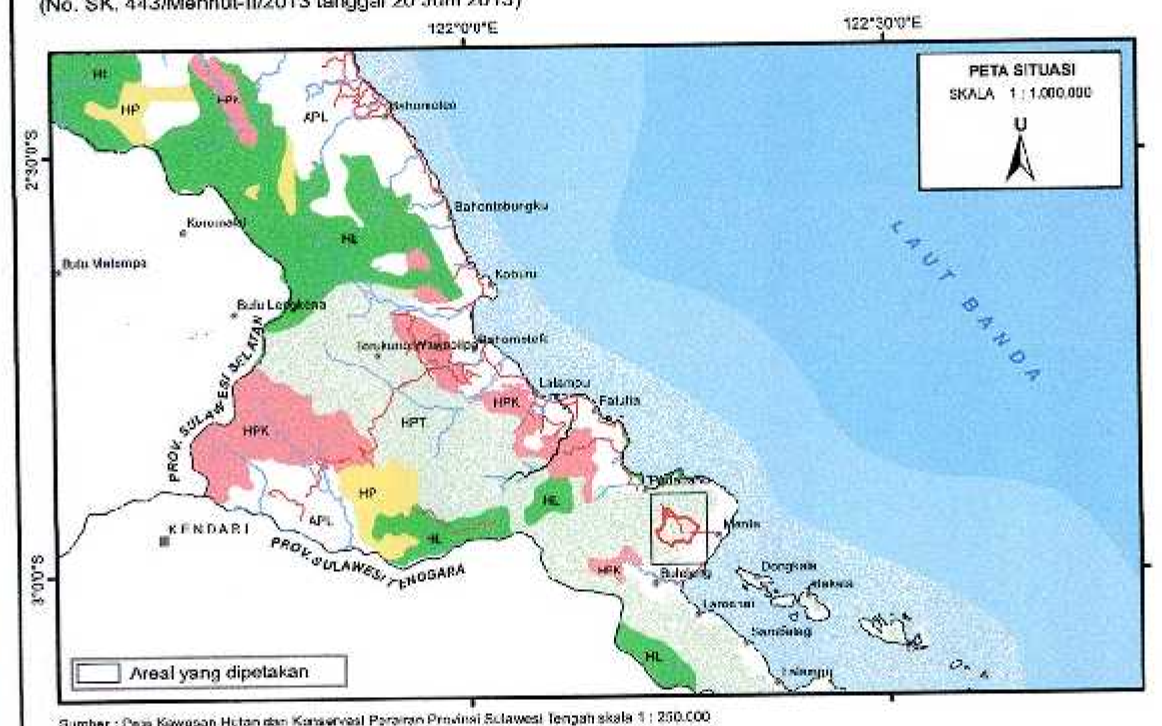
- Batas sebagian izin usaha pertambangan operasi produksi bijih nikel a.n. PT. Hengjaya Mineralindo
- Batas izin pinjam pakai kawasan hutan untuk kegiatan operasi produksi bijih nikel dan sarana penunjangnya a.n. PT. Hengjaya Mineralindo seluas ± 994,32 Ha, dengan rincian penggunaan :
  - a. Areal penambangan seluas ± 947,64 Ha
  - b. Sarana dan prasarana seluas ± 46,68 Ha, terdiri dari :

Camp, office dan workshop	seluas ± 4,29 Ha
ROM stockpile	seluas ± 3,78 Ha
Sedimen pond	seluas ± 3,52 Ha
Disposal top soil	seluas ± 5,09 Ha
Waste dump	seluas ± 14,19 Ha
Jalan angkut bijih nikel (p. 7.905 m; l. 20 m)	seluas ± 15,81 Ha

- HL Hutan Lindung
- HPT Hutan Produksi Terbatas
- APL Areal Penggunaan Lain
- Pemukiman
- Jalan
- Sungai dan anak sungai
- Batas areal IPPKH PT. Hengjaya Mineralindo sesuai Keputusan Menteri Kehutanan No. SK. 443/Menhut-II/2013 tanggal 20 Juni 2013

DASAR :
- Instruksi Presiden Republik Indonesia No. 6 Tahun 2017 tanggal 17 Juli 2017
- Rekomendasi Gubernur Sulawesi Tengah No. 522/13/DISHUTDA tanggal 5 Maret 2015
- Surat Direktur Jenderal Mineral dan Batubara No. 2023/30/DJB/2015 tanggal 5 November 2015
- Surat Direktur Utama PT. Hengjaya Mineralindo No. 21.1/HM-IPPKH-BKPM/XI/2015 tanggal 13 November 2015 dan No. 18.1/HM-IPPKH/II/2017 tanggal 20 Februari 2017

SUMBER :
- Peta Rupa Bumi Indonesia (RBI) skala 1 : 50.000 lembar 2213-21 dan 2213-22, Bakosurtanal
- Peta Kawasan Hutan dan Konservasi Perairan Provinsi Sulawesi Tengah skala 1 : 250.000 (Lampiran Keputusan Menteri Kehutanan No. SK. 869/Menhut-II/2014 tanggal 29 September 2014)
- Peta izin pinjam pakai kawasan hutan untuk kegiatan operasi produksi nikal a.n. PT. Hengjaya Mineralindo (No. SK. 443/Menhut-II/2013 tanggal 20 Juni 2013)



Sumber : Peta Kawasan Hutan dan Konservasi Perairan Provinsi Sulawesi Tengah skala 1 : 250.000

KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN

MENTERI LINGKUNGAN HIDUP DAN KEHUTANAN
REPUBLIK INDONESIA

KEPUTUSAN MENTERI LINGKUNGAN HIDUP DAN KEHUTANAN
REPUBLIK INDONESIA
NOMOR : SK.676/MENLHK/SETJEN/PLA.0/9/2021

TENTANG

PERSETUJUAN PENGGUNAAN KAWASAN HUTAN UNTUK KEGIATAN EKSPLORASI LANJUTAN PADA TAHAP OPERASI PRODUKSI BIJIH NIKEL ATAS NAMA PT. HENGJAYA MINERALINDO SELUAS ± 984,0 HA (SEMBILAN RATUS DELAPAN PULUH EMPAT HEKTARE) PADA KAWASAN HUTAN PRODUKSI TERBATAS DI KABUPATEN MOROWALI, PROVINSI SULAWESI TENGAH

DENGAN RAHMAT TUHAN YANG MAHA ESA

MENTERI LINGKUNGAN HIDUP DAN KEHUTANAN REPUBLIK INDONESIA,

Menimbang : a. bahwa PT. Hengjaya Mineralindo sebagai perusahaan Pemegang Perizinan, berdasarkan :

1) Keputusan Bupati Morowali Nomor 540.3/SK.001/ DESDM/VI/2011 tanggal 16 Juni 2011 tentang Persetujuan Peningkatan Izin Usaha Pertambangan (UIP) Eksplorasi menjadi Izin Usaha Pertambangan Operasi Produksi seluas ± 6.249 Ha (enam ribu dua ratus empat puluh sembilan hektare), berlaku selama 20 (dua puluh) tahun sampai dengan tanggal 26 Mei 2031;
2) Keputusan Kepala Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu Provinsi Sulawesi Tengah a.n Gubernur Sulawesi Tengah Nomor 540/345/IUP-OP-PENCUITAN/DPMPTSP/2020 tanggal 10 Juli 2020 tentang Pencuitan Wilayah Izin Usaha Pertambangan Operasi Produksi PT. Hengjaya Mineralindo sesuai Keputusan Bupati Morowali Nomor 540.3/SK.001/DESDM/VI/2011 menjadi seluas ± 5.983 Ha (lima ribu sembilan ratus delapan puluh tiga hektare);

b. bahwa Direktur PT. Hengjaya Mineralindo dengan surat Nomor 011/LGD.DIR-HM/II/2021 tanggal 23 Februari 2021, mengajukan permohonan Izin Pinjam Pakai Kawasan Hutan untuk Kegiatan Eksplorasi Lanjutan Bijih Nikel seluas ± 990,00 Ha (sembilan ratus sembilan puluh hektare) di Kabupaten Morowali, Provinsi Sulawesi Tengah;

c. bahwa Direktur Jenderal Planologi Kehutanan dan Tata Lingkungan dengan surat Nomor S.621/PKTL/REN/PLA.0/8/2021 tanggal 12 Agustus 2021, menyampaikan telaah terhadap permohonan Persetujuan Penggunaan Kawasan Hutan a.n. PT. Hengjaya Mineralindo :

   1) permohonan PT. Hengkaya Mineralindo telah dilampiri persyaratan sesuai ketentuan Pasal 379 sampai dengan Pasal 381 Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor 7 Tahun 2021 tentang Perencanaan Kehutanan, Perubahan Peruntukan Kawasan Hutan dan Perubahan Fungsi Kawasan Hutan, serta Penggunaan Kawasan Hutan;
   2) berdasarkan hasil perhitungan ulang secara digital, areal yang dimohon menjadi seluas ± 984,0 Ha (sembilan ratus delapan puluh empat hektare) berada pada Kawasan Hutan Produksi Terbatas dan berada pada Wilayah Pengelolaan Unit XIV-KPHP Tepe Asa Moroso;
   3) permohonan Persetujuan Penggunaan Kawasan Hutan untuk Kegiatan Eksplorasi Lanjutan pada Tahap Operasi Produksi Bijih Nikel a.n. PT. Hengjaya Mineralindo secara teknis dapat dipertimbangkan untuk diproses lebih lanjut seluas ± 984,0 Ha (sembilan ratus delapan puluh empat hektare) di Kabupaten Morowali, Provinsi Sulawesi Tengah;

d. bahwa berdasarkan :

   1) Peraturan Pemerintah Nomor 23 Tahun 2021 tentang Penyelenggaraan Kehutanan :
      a) Pasal 90 ayat (2), Penggunaan Kawasan Hutan dilakukan tanpa mengubah fungsi pokok Kawasan Hutan dengan mempertimbangkan batasan luas dan jangka waktu tertentu serta kelestarian lingkungan;
      b) Pasal 91 ayat (1) dan ayat (2) huruf b, Penggunaan Kawasan Hutan untuk kepentingan pembangunan di luar kegiatan Kehutanan hanya dapat dilakukan untuk kegiatan yang mempunyai tujuan strategis yang tidak dapat dielakkan meliputi kegiatan pertambangan;
      c) Pasal 94 ayat (1) dan Pasal 96 ayat (1), Penggunaan Kawasan Hutan untuk kepentingan pembangunan di luar kegiatan Kehutanan dilakukan berdasarkan Persetujuan Penggunaan Kawasan Hutan dan Persetujuan Penggunaan Kawasan Hutan diberikan oleh Menteri berdasarkan permohonan;
      d) Pasal 94 ayat (8) huruf b, Persetujuan Penggunaan Kawasan Hutan untuk kegiatan survei dan eksplorasi dikecualikan dari kewajiban membayar PNBP Penggunaan Kawasan Hutan, membayar PNBP kompensasi dan melakukan penanaman dalam rangka rehabilitasi DAS;

e) Pasal 294 huruf b, Kawasan Hutan Produksi Terbatas sebelum berlakunya Peraturan Pemerintah ini, dinyatakan tetap berlaku sesuai dengan tahap pengukuhannya serta diberlakukan peruntukan dan fungsinya sebagai Kawasan Hutan Produksi Tetap;

2) Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor 7 Tahun 2021 tentang Perencanaan Kehutanan, Perubahan Peruntukan Kawasan Hutan dan Perubahan Fungsi Kawasan Hutan, Serta Penggunaan Kawasan Hutan :

a) Pasal 366 ayat (1) dan ayat (2) huruf a, Penggunaan Kawasan Hutan untuk kepentingan pembangunan di luar kegiatan Kehutanan hanya dapat dilakukan untuk kegiatan yang mempunyai tujuan strategis yang tidak dapat dielakkan dilakukan dengan mekanisme Persetujuan Penggunaan Kawasan Hutan dengan keputusan Menteri;

b) Pasal 367 huruf b, Penggunaan Kawasan Hutan dengan mekanisme Persetujuan Penggunaan Kawasan Hutan dengan keputusan Menteri, meliputi pertambangan mineral, batubara, minyak dan gas bumi, pertambangan lain, termasuk sarana dan prasarana antara lain jalan, pipa, conveyor dan smelter;

c) Pasal 369 ayat (2) huruf b, Persetujuan Penggunaan Kawasan Hutan tanpa kewajiban membayar PNBP Penggunaan Kawasan Hutan, membayar PNBP Kompensasi, dan melakukan penanaman dalam rangka Rehabilitasi DAS, diantaranya untuk kegiatan survei dan eksplorasi;

d) Pasal 372 ayat (7), Dalam hal Persetujuan Penggunaan Kawasan Hutan untuk kegiatan pertambangan mineral dan batubara di Kawasan Hutan Produksi pada suatu provinsi berada pada areal KPH, kuota yang dapat dipertimbangkan paling banyak 10% (sepuluh perseratus) dari luas Kawasan Hutan Produksi pada masing-masing KPH yang tidak dibebani Perizinan Berusaha Pemanfaatan Hutan;

e) Pasal 372 ayat (10) huruf a, Ketentuan kuota 10% (sepuluh perseratus) diantaranya tidak berlaku bagi permohonan Persetujuan Penggunaan Kawasan Hutan untuk kegiatan eksplorasi atau eksplorasi lanjutan pertambangan;

f) Pasal 406 ayat (2) huruf a, Persetujuan Penggunaan Kawasan Hutan diberikan dalam jangka waktu paling lama sesuai perizinan di bidangnya atau keputusan tentang tahap kegiatan untuk kegiatan eksplorasi dan operasi produksi pertambangan meliputi pertambangan minyak dan gas bumi, mineral, dan batubara termasuk sarana dan prasarana;

g) Pasal 406 ayat (3), Persetujuan Penggunaan Kawasan Hutan diberikan dalam jangka waktu paling lama 2 (dua) tahun untuk kegiatan eksplorasi lanjutan pada tahap operasi produksi dan dapat diperpanjang;

e. bahwa berdasarkan pertimbangan tersebut huruf a sampai dengan huruf d, perlu menetapkan Keputusan Menteri Lingkungan Hidup dan Kehutanan tentang Persetujuan Penggunaan Kawasan Hutan untuk Kegiatan Eksplorasi Lanjutan pada Tahap Operasi Produksi Bijih Nikel atas nama PT. Hengjaya Mineralindo seluas ± 984,0 Ha (sembilan ratus delapan puluh empat hektare) pada Kawasan Hutan Produksi Terbatas di Kabupaten Morowali, Provinsi Sulawesi Tengah;

Mengingat : 1. Undang-Undang Nomor 5 Tahun 1990 tentang Konservasi Sumberdaya Alam Hayati dan Ekosistemnya;

2. Undang-Undang Nomor 41 Tahun 1999 tentang Kehutanan, sebagaimana telah diubah beberapa kali, terakhir dengan Undang-Undang Nomor 11 Tahun 2020 tentang Cipta Kerja;
3. Undang-Undang Nomor 26 Tahun 2007 tentang Penataan Ruang, sebagaimana telah diubah dengan Undang-Undang Nomor 11 Tahun 2020 tentang Cipta Kerja;
4. Undang-Undang Nomor 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup, sebagaimana telah diubah dengan Undang-Undang Nomor 11 Tahun 2020 tentang Cipta Kerja;
5. Undang-Undang Nomor 18 Tahun 2013 tentang Pencegahan dan Pemberantasan Perusakan Hutan, sebagaimana telah diubah dengan Undang-Undang Nomor 11 Tahun 2020 tentang Cipta Kerja;
6. Undang-Undang Nomor 23 Tahun 2014 tentang Pemerintahan Daerah, sebagaimana telah diubah beberapa kali, terakhir dengan Undang-Undang Nomor 11 Tahun 2020 tentang Cipta Kerja;
7. Peraturan Pemerintah Nomor 26 Tahun 2008 tentang Rencana Tata Ruang Wilayah Nasional, sebagaimana telah diubah beberapa kali, terakhir dengan Peraturan Pemerintah Nomor 21 Tahun 2021 tentang Penyelenggaraan Penataan Ruang;
8. Peraturan Pemerintah Nomor 26 Tahun 2020 tentang Rehabilitasi dan Reklamasi Hutan;
9. Peraturan Pemerintah Nomor 22 Tahun 2021 tentang Penyelenggaraan Perlindungan dan Pengelolaan Lingkungan Hidup;
10. Peraturan Pemerintah Nomor 23 Tahun 2021 tentang Penyelenggaraan Kehutanan;
11. Peraturan Pemerintah Nomor 24 Tahun 2021 tentang Tata Cara Pengenaan Sanksi Administratif dan Tata Cara Penerimaan Negara Bukan Pajak yang berasal dari Denda Administratif Bidang Kehutanan;

12. Peraturan Pemerintah Nomor 43 Tahun 2021 tentang Penyelesaian Ketidaksesuaian Tata Ruang, Kawasan Hutan, Izin dan/atau Hak atas Tanah;
13. Peraturan Presiden Nomor 68 Tahun 2019 tentang Organisasi Kementerian Negara, sebagaimana telah diubah dengan Peraturan Presiden Nomor 32 Tahun 2021;
14. Peraturan Presiden Nomor 92 Tahun 2020 tentang Kementerian Lingkungan Hidup dan Kehutanan;
15. Keputusan Presiden Nomor 113/P Tahun 2019 tentang Pembentukan Kementerian Negara dan Pengangkatan Menteri Negara Kabinet Indonesia Maju Periode Tahun 2019-2024, sebagaimana telah diubah beberapa kali, terakhir dengan Keputusan Presiden Nomor 72/P Tahun 2021 tentang Pembentukan dan Pengubahan Kementerian serta Pengangkatan beberapa Menteri Negara Kabinet Indonesia Maju Periode Tahun 2019-2024;
16. Instruksi Presiden Nomor 5 Tahun 2019 tentang Penghentian Pemberian Izin Baru dan Penyempurnaan Tata Kelola Hutan Alam Primer dan Lahan Gambut;
17. Peraturan Menteri Kehutanan Nomor P.60/Menhut-II/2009 tentang Pedoman Penilaian Keberhasilan Reklamasi Hutan;
18. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.32/MenLHK/Setjen/Kum.1/3/2016 tentang Pengendalian Kebakaran Hutan dan Lahan;
19. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor 4 Tahun 2021 tentang Daftar Usaha dan/atau Kegiatan yang Wajib Memiliki Analisis Mengenai Dampak Lingkungan Hidup, Upaya Pengelolaan Lingkungan Hidup dan Upaya Pemantauan Lingkungan Hidup atau Surat Pernyataan Kesanggupan Pengelolaan dan Pemantauan Lingkungan Hidup;
20. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor 7 Tahun 2021 tentang Perencanaan Kehutanan, Perubahan Peruntukan Kawasan Hutan dan Perubahan Fungsi Kawasan Hutan, Serta Penggunaan Kawasan Hutan;
21. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor 8 Tahun 2021 tentang Tata Hutan dan Penyusunan Rencana Pengelolaan Hutan, Serta Pemanfaatan Hutan di Hutan Lindung dan Hutan Produksi;
22. Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor 15 Tahun 2021 tentang Organisasi dan Tata Kerja Kementerian Lingkungan Hidup dan Kehutanan;
23. Keputusan Menteri Lingkungan Hidup dan Kehutanan Nomor SK.2111/MENLHK-PKTL/REN/PLA.0/4/2020 tentang Peta Indikatif dan Areal Perhutanan Sosial (Revisi V);
24. Keputusan Menteri Lingkungan Hidup dan Kehutanan Nomor SK.5050/MenLHK-PKTL/KUH/PLA.2/9/2020 tentang Peta Indikatif Alokasi Kawasan Hutan untuk

Penyediaan Sumber Tanah Obyek Reforma Agraria/TORA (Revisi V);

25. Keputusan Direktur Jenderal Planologi Kehutanan dan Tata Lingkungan atas nama Menteri Lingkungan Hidup dan Kehutanan Nomor SK.666/MenLHK-PKTL/IPSDH/ PLA.1/2/2021 tentang Penetapan Peta Indikatif Penghentian Pemberian Perizinan Berusaha, Persetujuan Penggunaan Kawasan Hutan, atau Persetujuan Perubahan Peruntukan Kawasan Hutan Baru pada Hutan Alam Primer dan Lahan Gambut Tahun 2021 Periode I;

Memperhatikan:

1. Dokumen ANDAL, RKL- RPL a.n. PT. Hengjaya Mineralindo;
2. Keputusan Bupati Morowali Nomor 660.1/71.A/KHL/ 2011 tanggal 13 Juni 2011 tentang Kelayakan Lingkungan Kegiatan Pertambangan Bijih Nikel di Kabupaten Morowali, Provinsi Sulawesi Tengah oleh PT. Hengjaya Mineralindo;
3. Surat Kepala Dinas Lingkungan Hidup Daerah Kabupaten Morowali Nomor 660.1/13/BID.P4LH-DLHD/IV/2021 tanggal 9 April 2021 perihal Rekomendasi Kelayakan Lingkungan Hidup Addendum Andal dan RKL-RPL Tipe A Kegiatan Pertambangan Bijih Nikel di Kecamatan Bahodopi dan Kecamatan Bungku Pesisir, Kabupaten Morowali, Provinsi Sulawesi Tengah oleh PT. Hengjaya Mineralindo;
4. Keputusan Kepala Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu Kabupaten Morowali Nomor 188.4/Kep.023/Ad/DPMPTSP/IV/2021 tanggal 21 April 2021 tentang Kelayakan Lingkungan Hidup Addendum Andal dan RKL-RPL Tipe A Rencana Kegiatan Pertambangan Bijih Nikel di Kecamatan Bahodopi dan Kecamatan Bungku Pesisir, Kabupaten Morowali, Provinsi Sulawesi Tengah oleh PT. Hengjaya Mineralindo;
5. Keputusan Kepala Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu Kabupaten Morowali Nomor 188.4/Kep.023.G/IL/DPMPTSP/IV/2021 tanggal 21 April 2021 tentang Izin Lingkungan Hidup Addendum Andal dan RKL-RPL Tipa A Rencana Kegiatan Pertambangan Bijih Nikel di Kecamatan Bahodopi dan Kecamatan Bungku Pesisir, Kabupaten Morowali, Provinsi Sulawesi Tengah oleh PT. Hengjaya Mineralindo;
6. Surat Kepala Dinas Kehutanan Provinsi Sulawesi Tengah Nomor 522/32.61/Bid.P2H tanggal 17 November 2020 hal Pertimbangan Teknis untuk Kegiatan Eksplorasi Lanjutan a.n. PT. Hengjaya Mineralindo di Kabupaten Morowali Provinsi Sulawesi Tengah;
7. Surat Direktur Jenderal Mineral dan Batubara, Kementerian Energi dan Sumber Daya Mineral Nomor 328/MB.04/DJB/2021 tanggal 10 Februari 2021 Hal Klarifikasi untuk IPPKH Eksplorsi Lanjutan a.n. PT. Hengjaya Mineralindo seluas 990 Ha;
8. Surat Direktur Rencana, Penggunaan dan Pembentukan Wilayah Pengelolaan Hutan, Direktorat Jenderal Planologi Kehutanan dan Tata Lingkungan Nomor S.322/REN/

PPKH/PLA.0/5/2021 tanggal 19 Mei 2021 hal Klarifikasi Dokumen Lingkungan untuk Kegiatan Eksplorasi lanjutan Bijih Nikel a.n. PT. Hengjaya Mineralindo di Kabupaten Morowali, Provinsi Sulawesi Tengah;

9. Surat Kepala Dinas Lingkungan Hidup Daerah Kabupaten Morowali Nomor 660/238/BID.P4LH-DLHD/VI/2021 tanggal 15 Juni 2021 perihal Hasil Klarifikasi Dokumen Lingkungan PT. Hengjaya Mineralindo;
10. Kronologis dan Telaah Persetujuan Penggunaan Kawasan Hutan untuk Kegiatan Eksplorasi Lanjutan pada Tahap Operasi Produksi Bijih Nikel pada Kawasan Hutan Produksi Terbatas atas nama PT. Hengjaya Mineralindo di Kabupaten Morowali, Provinsi Sulawesi Tengah, Lampiran surat Direktur Jenderal Planologi Kehutanan dan Tata Lingkungan Nomor S.621/PKTL/REN/PLA.0/8/2021 tanggal 12 Agustus 2021;

MEMUTUSKAN:

Menetapkan : KEPUTUSAN MENTERI LINGKUNGAN HIDUP DAN KEHUTANAN TENTANG PERSETUJUAN PENGGUNAAN KAWASAN HUTAN UNTUK KEGIATAN EKSPLORASI LANJUTAN PADA TAHAP OPERASI PRODUKSI BIJIH NIKEL ATAS NAMA PT. HENGJAYA MINERALINDO SELUAS ± 984,0 HA (SEMBILAN RATUS DELAPAN PULUH EMPAT HEKTARE) PADA KAWASAN HUTAN PRODUKSI TERBATAS DI KABUPATEN MOROWALI, PROVINSI SULAWESI TENGAH.

KESATU : Memberikan Persetujuan Penggunaan Kawasan Hutan untuk Kegiatan Eksplorasi Lanjutan pada Tahap Operasi Produksi Bijih Nikel kepada PT. Hengjaya Mineralindo seluas ± 984,0 Ha (sembilan ratus delapan puluh empat hektare) pada Kawasan Hutan Produksi Terbatas di Kabupaten Morowali, Provinsi Sulawesi Tengah, sebagaimana peta lampiran Keputusan ini, dengan rincian rencana pengeboran (*drilling*) sebanyak 200 (dua ratus) titik bor :

a. kedalaman titik bor 20 m (dua puluh meter);
b. jarak antar titik bor 200 m (dua ratus meter);
c. diameter titik bor 10 – 15 cm (sepuluh – lima belas centimeter).

KEDUA : Pemberian Persetujuan sebagaimana dimaksud dalam Amar KESATU adalah untuk Kegiatan Eksplorasi Lanjutan pada Tahap Operasi Produksi Bijih Nikel atas nama PT. Hengjaya Mineralindo, bukan untuk kegiatan lain serta arealnya tetap berstatus sebagai kawasan hutan.

KETIGA : PT. Hengjaya Mineralindo berhak :

a. berada, menempati dan mengelola serta melakukan kegiatan-kegiatan yang meliputi Kegiatan Eksplorasi Lanjutan pada Tahap Operasi Produksi Nikel, serta melakukan kegiatan-kegiatan lainnya yang berhubungan dengan kegiatan tersebut dalam kawasan hutan yang digunakan;
b. melakukan penebangan pohon dalam rangka pembukaan lahan yang tidak dapat dielakkan dengan membayar Provisi

Sumber Daya Hutan (PSDH) dan/atau Dana Reboisasi (DR) sesuai dengan ketentuan peraturan perundang-undangan.

KEEMPAT : PT. Hengjaya Mineralindo wajib :

a. melaksanakan reklamasi pada kawasan hutan yang sudah tidak dipergunakan tanpa menunggu selesainya jangka waktu Persetujuan Penggunaan Kawasan Hutan;

b. melakukan inventarisasi tegakan pada areal yang direncanakan untuk dilakukan pembukaan lahan sebagai dasar pembayaran Provinsi Sumber Daya Hutan (PSDH) dan/atau Dana Reboisasi (DR);

c. membayar PSDH dan/atau DR sesuai ketentuan peraturan perundang-undangan;

d. membayar ganti rugi nilai tegakan kepada pemerintah apabila areal yang dimohon merupakan hutan tanaman hasil rehabilitasi seluas yang digunakan sesuai ketentuan peraturan perundang-undangan;

e. melaksanakan perlindungan hutan pada areal Persetujuan Penggunaan Kawasan Hutan dan areal sekitar persetujuan sesuai dengan ketentuan peraturan perundang-undangan;

f. melakukan pengendalian kebakaran hutan dan lahan, berupa antara lain:

f.1. menempatkan sekurang-kurangnya 1 (satu) Regu Inti Pengendali Kebakaran Hutan;

f.2. merekrut karyawan pada perusahaan sebagai anggota Regu Pendukung Pengendali Kebakaran Hutan;

f.3. menyiapkan Sumberdaya Manusia pengendalian kebakaran hutan dalam Brigade Pengendalian Kebakaran Hutan dan Lahan (Brigdalkarhutla) dalam organisasi kelompok-kelompok Masyarakat Peduli Api;

f.4. menyiapkan sarana dan prasarana (sarpras) untuk menunjang kegiatan Brigdalkarhutla antara lain sarpras pencegahan kebakaran hutan dan pemadaman kebakaran hutan.

g. memberikan kemudahan bagi aparat Kementerian Lingkungan Hidup dan Kehutanan baik pusat maupun daerah pada saat melakukan monitoring dan evaluasi di lapangan;

h. mengkoordinasikan kegiatan kepada instansi Lingkungan Hidup dan Kehutanan setempat;

i. melakukan pemberdayaan masyarakat sekitar areal Persetujuan Penggunaan Kawasan Hutan;

j. melakukan kegiatan persiapan penggunaan kawasan hutan secara bertahap untuk menjaga penurunan emisi karbon sampai dengan 0 % (nol persen) sesuai rencana tahun 2030;

k. melaksanakan kewajiban lain yang ditetapkan oleh Menteri;

l. membuat laporan berkala setiap 6 (enam) bulan sekali secara *online* dan menyampaikan bukti pelaporan kepada Menteri mengenai Penggunaan Kawasan Hutan yang dipergunakan dengan tembusan disampaikan kepada Direktur Jenderal Planologi Kehutanan dan Tata Lingkungan, Direktur Jenderal Pengelolaan Hutan Lestari, Direktur Jenderal Konservasi Sumber Daya Alam dan Ekosistem, Direktur Jenderal Pengendalian Daerah Aliran Sungai dan Rehabilitasi Hutan, Kepala Dinas Kehutanan Provinsi Sulawesi Tengah, Kepala Balai Pemantapan Kawasan Hutan Wilayah XVI Palu, dan Kepala Balai Pengelolaan Daerah Aliran Sungai dan Hutan Lindung Palu Poso.

KELIMA : PT. Hengjaya Mineralindo dilarang :

a. memindahtangankan Persetujuan Penggunaan Kawasan Hutan kepada pihak lain atau melakukan perubahan nama pemegang Persetujuan Penggunaan Kawasan Hutan tanpa persetujuan Menteri Lingkungan Hidup dan Kehutanan;
b. menjaminkan atau mengagunkan areal Persetujuan Penggunaan Kawasan Hutan kepada pihak lain;
c. menggunakan merkuri dalam kegiatan pertambangan;
d. melakukan kegiatan lainnya yang dilarang sesuai ketentuan peraturan perundang-undangan.

KEENAM : PT. Hengjaya Mineralindo wajib menyelesaikan hak-hak pihak ketiga, apabila terdapat hak-hak pihak ketiga di dalam areal Persetujuan Penggunaan Kawasan Hutan dengan meminta bimbingan dan fasilitasi Pemerintah Daerah setempat.

KETUJUH : Persetujuan Penggunaan Kawasan Hutan untuk Kegiatan Eksplorasi Lanjutan pada Tahap Operasi Produksi Bijih Nikel ini dicabut dan pemegang Persetujuan dikenakan sanksi sesuai ketentuan peraturan perundang-undangan, apabila pemegang persetujuan tidak memenuhi kewajiban dan/atau melakukan pelanggaran atas ketentuan-ketentuan sebagaimana dimaksud dalam Keputusan ini.

KEDELAPAN : Perpanjangan Persetujuan Penggunaan Kawasan Hutan diberikan dengan mempertimbangkan hasil evaluasi terhadap pemenuhan kewajiban dalam Persetujuan Penggunaan Kawasan Hutan dan diajukan oleh pemegang Persetujuan Penggunaan Kawasan Hutan sebelum Persetujuan Penggunaan Kawasan Hutan berakhir.

KESEMBILAN : Keputusan ini mulai berlaku pada tanggal ditetapkan untuk jangka waktu paling lama selama 2 (dua) tahun, kecuali apabila dicabut oleh Menteri Lingkungan Hidup dan Kehutanan.

Ditetapkan di Jakarta
pada tanggal 9 September 2021

Salinan sesuai dengan aslinya
Plt. KEPALA BIRO HUKUM,

MENTERI LINGKUNGAN HIDUP DAN KEHUTANAN REPUBLIK INDONESIA,

ttd.

MAMAN KUSNANDAR

SITI NURBAYA

Salinan Keputusan ini disampaikan kepada Yth :
1. Menteri Koordinator Bidang Kemaritiman dan Investasi;
2. Gubernur Sulawesi Tengah;
3. Sekretaris Jenderal Kementerian Lingkungan Hidup dan Kehutanan;

4. Direktur Jenderal Planologi Kehutanan dan Tata Lingkungan;
5. Direktur Jenderal Pengelolaan Hutan Lestari;
6. Direktur Jenderal Pengendalian Daerah Aliran Sungai dan Rehabilitasi Hutan;
7. Direktur Jenderal Konservasi Sumber Daya Alam dan Ekosistem;
8. Direktur Jenderal Penegakan Hukum Lingkungan Hidup dan Kehutanan;
9. Direktur Jenderal Mineral dan Batubara, Kementerian Energi dan Sumber Daya Mineral;
10. Bupati Morowali;
11. Kepala Dinas Kehutanan Provinsi Sulawesi Tengah;
12. Kepala Balai Pemantapan Kawasan Hutan Wilayah XVI Palu;
13. Kepala Balai Pengelolaan Hutan Produksi Wilayah XII Palu;
14. Kepala Balai Pengelolaan Daerah Aliran Sungai dan Hutan Lindung Palu Poso;
15. Kepala Wilayah Pengelolaan Unit XIV-KPHP Tepe Asa Moroso, Provinsi Sulawesi Tengah;
16. Direktur PT. Hengjaya Mineralindo.

PETA
PERSETUJUAN PENGGUNAAN KAWASAN HUTAN UNTUK KEGIATAN EKSPLORASI LANJUTAN PADA TAHAP OPERASI PRODUKSI BIJIH NIKEL PADA KAWASAN HUTAN PRODUKSI TERBATAS (HPT)

a.n. PT. HENGJAYA MINERALINDO

DI KABUPATEN MOROWALI
PROVINSI SULAWESI TENGAH
LUAS : ± 984,0 Ha
SKALA 1 : 25.000

U

LAMPIRAN KEPUTUSAN MENTERI LINGKUNGAN HIDUP DAN KEHUTANAN REPUBLIK INDONESIA

NOMOR : SK.676/MENLHK/SETJEN/PLA.0/9/2021
TANGGAL : 9 September 2021

MENTERI LINGKUNGAN HIDUP DAN KEHUTANAN REPUBLIK INDONESIA

SITI NURBAYA

KETERANGAN :

- Batas sebagian areal Izin Usaha Pertambangan a.n. PT. Hengjaya Mineralindo
- Batas areal Persetujuan Penggunaan Kawasan Hutan untuk kegiatan eksplorasi lanjutan pada tahap operasi produksi bijih nikel a.n. PT. Hengjaya Mineralindo seluas ± 984,0 Ha, meliputi kegiatan :
  - Rencana pengeboran (drilling) sebanyak 208 titik bor, dengan rincian :
    - Kedalaman titik bor : 20 m
    - Jarak antar titik bor : 200 m
    - Diameter titik bor : 10 - 15 cm
- HL — Hutan Lindung
- HPT — Hutan Produksi Terbatas
- HPK — Hutan Produksi yang Dapat Dikonversi
- Batas areal persetujuan penggunaan kawasan hutan lainnya
- Sungai dan anak sungai
- Jalan

Catatan :
- Batas areal persetujuan penggunaan kawasan hutan lain dan batas areal izin pemanfaatan hutan yang tergambar dalam peta tidak sepenuhnya dapat dijadikan acuan batas di lapangan.
- Berdasarkan Pasal 394 huruf b Peraturan Pemerintah Nomor 23 Tahun 2021 tentang Penyelenggaraan Kehutanan bahwa Kawasan Hutan Produksi Terbatas sebelum berlakunya Peraturan Pemerintah ini, dinyatakan tetap berlaku sesuai dengan tahap pengukuhannya serta ditetapkan peruntukan dan fungsinya sebagai Hutan Produksi Tetap

DASAR :
- Instruksi Presiden RI Nomor 5 Tahun 2019 tanggal 7 Agustus 2019
- Keputusan Menteri Kehutanan Nomor SK.869/Menhut-II/2014 tanggal 29 September 2014 sebagaimana telah diubah dengan Keputusan Menteri Lingkungan Hidup dan Kehutanan Nomor SK.452/MENLHK/SETJEN/PLA.0/11/2020 tanggal 30 November 2020
- Keputusan Bupati Morowali Nomor 540.3/SK.001/DESDM/VI/2011 tanggal 16 Juni 2011
- Surat Kepala Dinas Kehutanan Provinsi Sulawesi Tengah Nomor 522/32.61/Bid.P2H tanggal 17 November 2020
- Keputusan Kepala Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu Provinsi Sulawesi Tengah a.n. Gubernur Sulawesi Tengah Nomor 540/34/IUP-OP-PENCIUTAN/DPMPTSP/2020 tanggal 10 Juli 2020
- Surat Direktur Jenderal Mineral dan Batubara Nomor 328/MB.04/DJB/2021 tanggal 10 Februari 2021
- Surat Direktur PT. Hengjaya Mineralindo Nomor 011/LGD.DIR-HM/II/2021 tanggal 23 Februari 2021

SUMBER :
- Peta Rupa Bumi Indonesia (RBI), skala 1 : 50.000
- Peta Kawasan Hutan dan Konservasi Perairan di Provinsi Sulawesi Tengah, skala 1:250.000 (Lampiran Keputusan Menteri Kehutanan Nomor SK.869/Menhut-II/2014 tanggal 29 September 2014 sebagaimana telah diubah dengan Keputusan Menteri Lingkungan Hidup dan Kehutanan Nomor SK.452/MENLHK/SETJEN/PLA.0/11/2020 tanggal 30 November 2020)
- Peta lampiran surat Direktur Jenderal Mineral dan Batubara Nomor 328/MB.04/DJB/2021 tanggal 10 Februari 2021
- Peta lampiran surat Direktur PT. Hengjaya Mineralindo Nomor 011/LGD.DIR-HM/II/2021 tanggal 23 Februari 2021

Sumber : Peta Kawasan Hutan dan Konservasi Perairan di Provinsi Sulawesi Tengah, skala 1:250.000

KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN

Appendix 3
ESG Reports

NICKEL INDUSTRIES

NICKEL INDUSTRIES LIMITED
and its controlled entities
A.B.N. 44 127 510 589

Incorporating Our Values

2021 SUSTAINABILITY REPORT

Contents

Table of Contents	3
About This Report	3
Sustainability Performance Highlight	4
Message from the Chairman	8
Sustainability at Nickel Industries: Incorporating Our Values	10
Stakeholder Engagement & Material Topics	13
Company Profile	19
Sustainability Performance	23
Economic Performance	24
Environmental Performance	29
Our Environmental Policy	29
Water and Effluents	30
Biodiversity	32
Climate Risk and Resilience	34
Energy	39
Waste	42
Social Performance	44
Occupational Health and Safety (OHS)	44
Human Capital Development	52
Diversity and Equal Opportunity	52
Local Communities	55
Human Rights	56
CSR Collaboration at the IMIP	56
Sustainability Governance	57
Governance Structure	57
Good Mining Practices	58
Anti-corruption	61
GRI Standard Content Index	66
SASB: Metals and Mining	70
Feedback Form	71

About this Report

This is Nickel Industries Limited's (the 'Company', 'Nickel Industries', or 'we') inaugural Sustainability Report ('Report'), which showcases our commitment and intentions towards our employees, investors, stakeholders, the environment and the communities in which we operate. Consequently, this report contains no restatement of information. The performance disclosures in the report pertain to the period from 1 January to 31 December 2021. We approach the subject of sustainability very seriously and have taken great care in determining a unified framework to ensure consistent long-term sustainability performance. We are committed to publishing a report every year. [102-48, 102-49, 102-50, 102-51, 102-52]

This inaugural Report has been prepared in accordance with the Global Reporting Initiative (GRI) Standards: Core Option, with Metals and Mining (MM) Supplement Sector, Sustainability Accounting Standards Board (SASB) for Metals and Mining Standard and the Task Force on Climate-Related Financial Disclosures (TCFD) for selected disclosure indicators. [102-54]

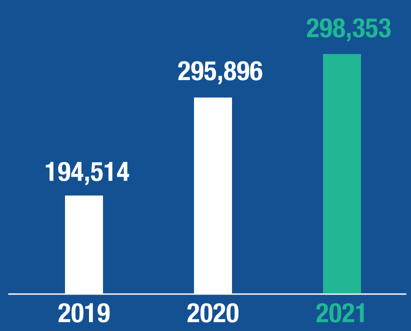
This Report has been prepared based on relevant reporting principles (stakeholder inclusiveness, materiality, completeness, accuracy, balance, clarity, comparability, reliability, timeliness) and stages through collaborative discussions during 2021. The material topics were chosen in line with the Company's corporate strategy and have been approved by the Board of Directors. The report includes financial information based on the Consolidated Financial Statements audited by KPMG as an independent auditor. The Social Responsibility (SR) Asia, a leading sustainability assurance provider in the region, has independently assured the Report's compliance with regards to selected information concerning the Company's sustainability performance. [102-45, 102-46, 102-56]

Contact information regarding the Report: [102-53]
Nickel Industries Limited
Level 2, 66 Hunter Street,
Sydney, NSW, 2000, Australia
Phone : +61 (2) 9300 3311
Email : info@nickelmines.com.au
Website : https://nickelmines.com.au/

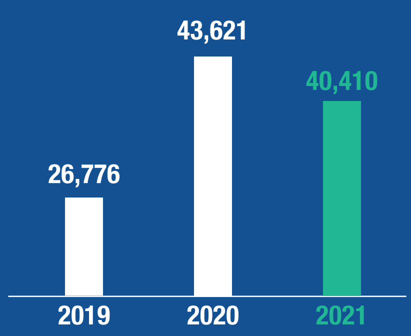
Sustainability Performance Highlights

Economic Performance

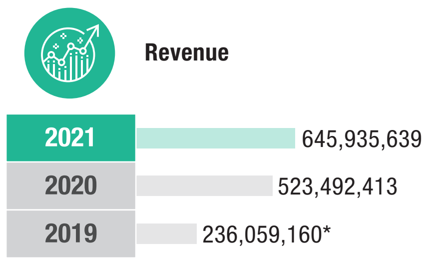
Production Performance
Nickel Pig Iron (NPI) Production (Tonnes)

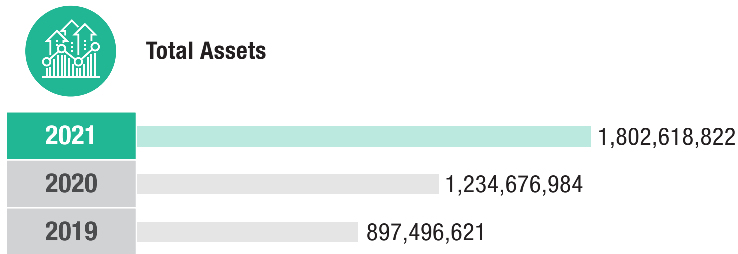


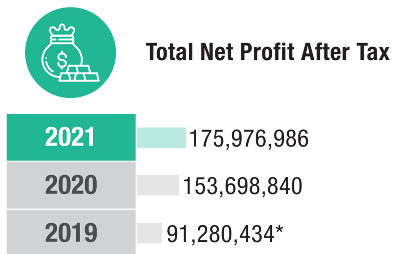
Nickel Metal Production (Tonnes)



Financial Performance (USD)



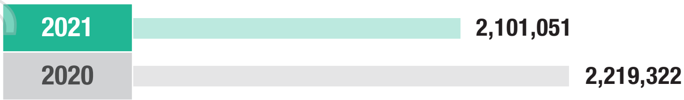




*6 months to 31 December 2019

Environmental Performance

Green House Gas (GHG) Emissions (Scope 1 & 2 plus partial data from the Scope 3) (tonnes of CO_2eq)



2021

Blue PROPER ratings achievement for a second consecutive year, which means 100% environmental regulations compliance in the operational area of **Hengjaya Mine.** Only two mining companies in Central Sulawesi Province received this acknowledgment from the Indonesia Ministry of Environment and Forestry in the last year.

- Black: Not in compliance (negligence)
- Red: Not in compliance
- Blue: In compliance
- Green: Beyond compliance
- Gold: Beyond compliance (consistent performance)

Social Performance

Number of Occupational Accidents

Description	2019	2020	2021
Hengjaya Nickel	6	13	10
Ranger Nickel	-	11	10
Hengjaya Mine	8	3	8

Total Training Participants by Employee Category and Gender*

Employee Category	2020		2021	
	Male	Female	Male	Female
Permanent	4	1	42	6
Contract	0	0	0	0
Total	4	1	42	6

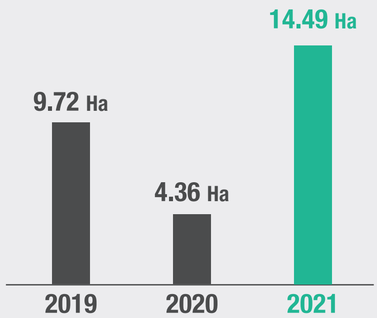
*Data from Hengjaya Mineralindo

Average Hours of Training*

Year	Total Training Hours	Average per Participant		Average per Employee	
		Total	Average	Total	Average
2021	1,288	48	26.83	263	4.90
2020	320	5	64	234	1.37

*Data from Hengjaya Mineralindo

Rehabilitated Land Area at Hengjaya Mine



Since 2019

We have supported mangrove and watershed rehabilitation in Central Sulawesi with a total area of **1,781 Ha** and planted more than **2 million trees.** These efforts will stimulate economic development of our local community, with a projected income of USD 535 per hectare which will begin eight years after the trees' plantation.

Pillar	Sub-Pillar	Achievement(s)
Economic Development	Financial Performance	Continued strong production and EBITDA, with operations set to triple in size over the next 12 months.
	Procurement Practices	Hiring 100% local and national suppliers at the mining site that sustainably contribute to the livelihoods and wellbeing of the communities around our areas of operations.
	Indirect Economic Impacts	Collectively contributes to the total growth of 4.9% of Central Sulawesi Province in 2020, while the Indonesian economy contracted by 2.1% in the same year. Over the past decade, the District of Morowali in Central Sulawesi, where our Hengjaya Mine, Hengjaya Nickel, and Ranger Nickel operations are located, grew by 1,200% versus the whole province's growth of 161%.
Environmental Stewardship	Biodiversity	Supporting mangrove and watershed rehabilitation in Central Sulawesi with a total area of 1,781 Ha and planted more than two million trees since 2019. These efforts will stimulate the community's economy, with a projected income of USD 535 per hectare which will begin eight years after the trees' plantation. The related forestry institutions have acknowledged that PT Hengjaya Mineralindo's watershed rehabilitation programme is one of the best in the region. A coaching clinic was held at the end of November 2021 in our watershed rehabilitation areas, attended by various forestry and environmental agencies so that they can adopt PT Hengjaya Mineralindo's watershed rehabilitation methods and processes. Absorbed 9,392 tonnes of CO_2eq from reforestation projects in 2020. Some of the types of planted trees in the area were pine, rattan, hazelnut, and durian. Preparing to survey a potential biodiversity zone in 2022 with a total area of 62 Ha inside our operational border of Hengjaya Mine.
	Energy	Through our collaboration at Indonesia Morowali Industrial Park ('IMIP'), we have supported: • the establishment of nickel processing facilities near the mine sites which could reduce the energy consumption of nickel ore transportation; • the construction of waste heat boiler of 2×25 MW in the coke power plant and the use of high-temperature coke oven flue gas to generate electricity which could save the use of energy in the operations; • the installation of waste to heat power generation with the capacity of 7 MW to recover and utilise low calorific value flue gas of sintering machine to produce electric power, decreasing the use of coal in the process; and • the improvement of enterprise heat energy utilisation ratio to conserve our energy consumption.
	Emissions	Working with Hatch and Pertiwi Consulting, professional carbon consulting firms, to calculate our emissions in 2021 and to develop a decarbonisation roadmap. Also, in the last year, the Company and Shanghai Decent launched its 'Future Energy' collaboration framework, aimed at exploring to transition current energy sources utilised across the Company's operations to renewable energy and other lower carbon-emitting solutions. Discussions are already well advanced on collaborations involving solar and LNG-based energy solutions to begin the transition away from current coalfired power sources. One of the early implementations was the installation of 450 KWp solar panels at our Hengjaya Mine to reduce the amount of fossil fuel usage in our mine site. It is anticipated that the Hengjaya Mine solar project will reduce diesel consumption by approximately 31 million litres over the 25-year projected project life. At IMIP, the nickel-iron hot metal and blast furnace hot metal are sent direct to steelmaking production, while billet steel is sent directly to hot rolling, which avoids the need to re-melt the nickel in the steelmaking process and thereby greatly reduces energy consumption and carbon emissions. Controlling the level of air particles at our operations at IMIP, such as: • the installation of dust screen on both sides of the dust retaining wall of the coal yard, and more than 20 sets of atomisation spray equipment at the hopper of the door crane, as well as the belt transfer station and the material outlet of the belt at the wharf to effectively control the coal ash floating during the loading and unloading process; and • the improvement of dust collecting covers to effectively reduce the dust produced in the production process.

Pillar	Sub-Pillar	Achievement(s)
	Waste	Supporting Morowali Regency and Indonesia Free of Waste visions in 2025 (70% waste handling and 30% waste reduction) by providing 20 motorcycle carts and one truck for waste collection activities.
	Water and Effluents	Meeting water effluent standards in its operations following Indonesia's regulations. The Hengjaya Mine received Blue PROPER from the Indonesia Ministry of Environment in 2021 which means full compliance with environmental regulations in the country. Only two mining companies in Central Sulawesi Province received this acknowledgment from the Indonesia Ministry of Environment and Forestry in the last year. The use of automatic continuous monitoring system for water effluent, advanced circulating water and sewage treatment facilities at IMIP, which greatly improve the utilisation rate of water resources and realise zero water discharge.
Social Responsibility	Community Relations and Development	PT Hengjaya Mineralindo is committed to encouraging economic growth and providing quality welfare to the communities around its mining activities. The Company is fully aware that active mining activities are expected to have positive impacts on the communities and the surrounding environment, including for internal and external stakeholders. Working to fulfil the Corporate social and environmental responsibility law as mandated by the Indonesia Limited Company Law No. 40/2007 and Indonesia Government Regulation no. 47/2012. Supported various education, health services, infrastructure, social, cultural and religious programs in 2021. Funded 18 projects from eight surrounding villages, including local port rehabilitation and community health facility development. Distributing groceries to local villagers and many other beneficial programmes. Preparing to initiate three flagship programs in 2022: • coral reef conservation; • community-based waste management; and • regional library/community reading park to increase reading interest, reduce illiteracy and meet the educational needs of the community, especially the young generation. Supporting the teachers at the local schools near the IMIP. Waste management support for the Bahodopi District via collaboration with the IMIP.
	Anti-Corruption	Published its Anti-Bribery and Corruption Policy.
	Health and Safety	Providing free health clinic for local villagers around the IMIP. Achieved five million working hours without a lost-time injury in Hengjaya Mine operations until October 2021.

Message from the Chairman [102-14]

Dear Fellow Shareholders

I am very pleased to be able to present to you Nickel Industries' inaugural Sustainability Report for the calendar year ended 31 December 2021.

The COVID-19 pandemic has a residual effect in the countries and markets in which we operate. The pandemic revealed enormous social and economic disparities and dramatically demonstrated the vulnerability of our societies and individual selves. At the same time, we must never underestimate the profound resilience and tenacity of humans in the face of adversity, that has resulted in the world's rapid recovery. As a result, the global economy continues to recover, even as the pandemic resurfaces.

Despite the pandemic's unpredictable nature, our response has remained robust. We were able to safeguard our employees' health and safety and adapt the Company's business processes and operations effectively to the current reality and situation. I can confidently state that COVID-19 has had no material adverse effect on the Company's operating or financial performance in 2021; in fact, we have continued to grow.

Simultaneously, the Company is conscious of the responsibilities of being a globally significant nickel producer. We have always operated in a responsible manner, and take pride in our significant contribution to the sustainable development of the regions in which we operate.

With this, our first-ever Sustainability Report, we hope to take a step forward in demonstrating accountability for our business activities by taking an ever-more sustainable and responsible approach. As you will read in the following pages, sustainability has always been ingrained in our operations and is a crucial component of our business.

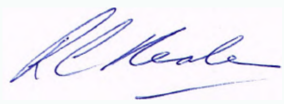
The report's key topics have been carefully considered and selected due to extensive research and consultations with internal and external stakeholders. This multi-stakeholder approach ensures that we are all collectively moving towards a more sustainable future in every way possible.

I invite you to read our report and learn how we incorporate environmental, social, and governance (ESG) best practices into every aspect of our business. Please read about our commitments, initiatives, progress to date, the challenges and barriers we encountered, as well as our path forward.

Our three sustainability pillars of economic development, environmental stewardship, and social responsibility direct our decisions and actions toward long-term value creation for our stakeholders and the planet.

Last but not least, I would like to take this opportunity to thank you for your continued interest in the Company's sustainability-related performance. This would not be possible without all those who work for and with us, whose continued efforts ensure the success and sustainability of the Company.

Yours sincerely,



Rob Neale
Chairman

Vision, Mission, and Values [102-16]

Vision
To become a global leader in low-cost nickel production

Mission
To deliver value to our shareholders, employees, businesses and local communities over the long-term through safe and responsible operations.

Values
Nickel Industries instils a culture of acting professionally, ethically and responsibly. It seeks to operate in line with the values set out below to ensure all employees within the Company and its subsidiaries work to reinforce these values.

Safety, environment and community
The Company prioritises safety, health, community and the environment. Operating safely with due regard to the environment and communities in which the Company operates enhances the sustainability and performance of the Company's business.

Performance
The Company is a results and performance-driven company striving to generate returns for shareholders by meeting strategy and targets developed to drive continuous improvement for all stakeholders.

Team work
The Company encourages its people to work together as a high performing team and values rewarding team success.

Respect
The Company encourages and values strong, open and inclusive communication and treats all people, within and outside the Company, ethically and with dignity and mutual respect.

Governance
The Company manages business risks through sound business processes and high-quality decision making. The Company is committed to following all applicable rules, regulations and standards.

Sustainability at Nickel Industries: Incorporating Our Values

Sustainability Policy

The Sustainability Policy represents Nickel Industries' commitment to implementing sustainable development through its non-financial objectives and priorities that result in long-term value creation for the Company, local community, and other stakeholders. The policy acts as a precursor for the Company's sustainability strategy and future targets, and is evaluated, adjusted or expanded accordingly each year.

As this year is the Company's first sustainability report, the theme is aptly named 'Incorporating Our Values', signaling the Company's commitment to incorporate sustainability values across the life cycle of our activities and to continuously improving disclosure of our sustainability performance.

We believe that sustainable development is core to our existence and we aspire to responsibly supply a critical base metal for the future of our planet while also promoting environmental protection, social empowerment, and improving the health and safety of our workers, host communities and regional neighbours.

Performing at a world-class level in sustainability is critical to our business success. Meeting our commitments in these areas contributes to sustainable development in our operational areas and, more broadly, worldwide, and is critical to our continued access to resources, capital, and engaged employees.

Hence, the core sustainability policy is rooted in three realms of influence, which are increasingly broad in nature: 1) sustainable operations; 2) stimulation of local development; and 3) contribution to global sustainability. These policies act as a foundation and are guiding principles in developing our sustainability strategy.

Policy
Sustainable operations

Description
Nickel Industries recognises the important role that we play in addressing shared global challenges. We will contribute to the dialogue and confrontation of the challenges in terms of sustainable development, as appropriate to our scope of activities.

Commitments
- To meet or exceed the standards where we operate and continuously improve performance.
- To achieve zero harm towards our employees, contractors and local communities, promoting active genuine care inside and outside the Company.
- To continuously improve our activities, seeking increased efficiency in the use of natural resources.
- To manage risks and impacts, adopting elimination, mitigation, compensation and monitoring measures, and maximising the positive benefits of our activities.
- To work with responsibility, ethics and transparency, engaging with our stakeholders.

Policy
Stimulation of local development

Description
Beyond the management of our activities, Nickel Industries seeks to stimulate local socioeconomic development that sustainably contributes to the livelihoods and wellbeing of the communities and environment around our areas of operation.

Commitments
- To support the development and hiring of local workforce and suppliers.
- To understand and monitor the key social and environmental indicators for the regions where we operate, and make conscious decisions to improve social and environmental wellbeing in the most appropriate and meaningful ways.
- To develop programmes related to social needs, according to the long-term economic development vision, while avoiding reactive social investments.
- To respect indigenous and local communities' connections to lands, waters and the environment and seek to develop mutually beneficial agreements with land connected peoples, promoting engagement, free, prior and informed consultation and risk and impact evaluation.

SUSTAINABLE DEVELOPMENT GOALS

Policy
Contribution to global sustainability

Description
We recognise the important role that we play in addressing shared global challenges. Nickel Industries will contribute to the dialogue and confrontation of the challenges in terms of sustainable development, as appropriate to our scope of activities.

Commitments
- To be transparent in terms of governance, policy, procedures, practices and the Company's performance to our stakeholders.
- To contribute towards global targets related to our business, by continuously improving our operations and seeking partnerships, solutions and technology for challenges to sustainable development.
- To contribute to creating a positive legacy for future generations, balancing the social, environmental and economic aspects of our business.
- To work together with colleagues, partners and communities globally to deliver the products our customers need, and to learn from each other to improve our performance.
- To promote active partnerships at international, national, regional, and local levels, based on mutual commitment and trust.
- To engage with our joint venture partners to share our practices and insights, and learn from theirs.
- To recognise and respect diverse cultures, communities, and points of view.
- To respect human rights and work with communities and organisations to create mutual value throughout and beyond the life of our operations.
- To strive to contribute to the United Nations' Sustainable Development Goals.

Sustainability Strategy

The Company's commitment to sustainability is reflected through its strategy. We are constantly engaging with stakeholders to ensure our strategy and activities align with society's evolving expectations.

Our sustainability strategy focuses on three core pillars, each with its own set of sub-pillars that are chosen based on existing sustainability policies and international best practices. We believe the pillars that we have chosen are the most relevant to our operations.

Pillar
Economic Development

Sub-Pillar
- Financial performance
- Indirect economic impacts
- Procurement practices

We recognise that we are part of the community in the regions where we operate, and our presence has a significant positive social impact. We have a long term vision, and strive to continue to grow our business in a way that provides an optimum benefit to the lives of people in the community. Hence, the Company strives to continuously improve its financial performance that generates indirect economic impacts to the surrounding areas of our operational sites and helps thousands of people and local suppliers to grow simultaneously with the Company.

Pillar
Environmental Stewardship

Sub-Pillar
- Climate change
- Biodiversity
- Energy
- Emissions
- Waste
- Water and effluents

We believe that environmental sustainability is a core part of our existence. Our products are essential for the global energy transition and the stability of our operating environment is critical to the long term success of our operations. As a company, we are committed to seeking zero harm for our environment and establishing a positive legacy in our operational regions wherever and whenever we operate, from exploration, to rehabilitation and closure.

Pillar
Social Responsibility

Sub-Pillar
- Anti-corruption
- Community relations and development
- Donation and sponsorship
- Education
- Gender and Diversity
- Health and Safety
- Human rights
- Infrastructure

We are committed to stimulating local socioeconomic development that sustainably contributes to the livelihoods and wellbeing of the communities and environment around our areas of operation as parts of our social responsibility; we will also respect the local people and customs wherever we operate.

Furthermore, we are committed to strive to contribute to the United Nations Sustainable Development Goals (SDGs), by supporting the implementation of the SDGs at local, national, and global scales, as appropriate to our scope of activities.

Stakeholder Engagement & Material Topics

Starting from this year, the Company will conduct an annual materiality assessment to ensure our sustainability strategy is focused appropriately, to assess the changing sustainability landscape, and to better understand and prioritise the issues that matter to our business and stakeholders. The reporting of our sustainability performance focuses on topics that the Company and its stakeholders have identified as material to the Company's progress and future as a nickel producing company, based on the results of this materiality assessment.

The materiality assessment determines which ESG issues need to be included and reported in our publication. Our materiality assessment includes extensive consultations with our internal and external stakeholders, and accommodates information regarding our business and the broader nickel sector both at a local and global level. Each stakeholder has been contacted and given the opportunity to express their opinions and concerns via the channels of communication that are most appropriate for them. Below is a full list of the stakeholders involved in our materiality assessment.

Identification of Stakeholder Needs and Approach [102-40] [102-42] [102-43] [102-44]

Stakeholders	Identification Base	Engagement Method	Key Concerns
Internal Stakeholders			
Investors and Shareholders	D, R, I, P	Meeting and electronic communication	Economic performance, energy and emission, diversity and equal opportunity, anti-corruption, human rights
Employees	D, R, T, I, P		Occupational health and safety, diversity and equal opportunity, human capital development
External Stakeholders			
Customers	D, R, I, P	Meeting and electronic communication	Economic performance
Contractors	D, R, T, I, P		Occupational health and safety, energy and emission, good mining practices, human capital development
Business Partners	D, R, T, I, P		Economic performance, local communities, energy and emission
Governments	R, T, I, DP	Meeting	Good mining practices, local communities, water and effluent, biodiversity, waste, energy, occupational health and safety, indirect economic impact, anti-corruption, human rights
Local Communities	D, R, T, I, DP, P		Indirect economic impact, local communities

Explanation of Identification Base

Dependency (D)
Nickel Industries' dependence on someone or an organisation, or vice versa

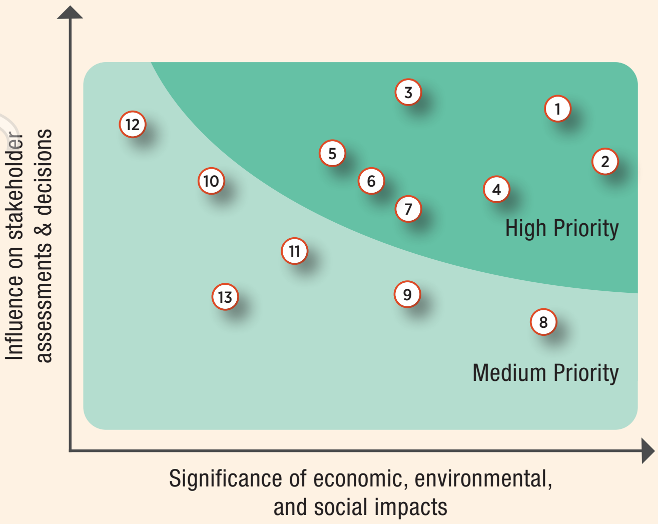
Tension (T)
Someone or an organisation has an influence on the Company regarding certain economic, social or environmental issues

Proximity (P)
Someone or an organisation has a geographical and operational closeness with the Company

Responsibility (R)
The existence of legal, commercial or ethical responsibility towards someone or an organisation

Influence (I)
Someone or an organisation has an influence on the Company or other stakeholder strategies or policies

Diverse Perspective (DP)
Someone or an organisation has different views that can influence the situation and encourage actions that did not exist before



1. Local Communities
2. Occupational Health and Safety
3. Economic Performance
4. Human Capital Development
5. Energy & Emission
6. Diversity and Equal Opportunity
7. Good Mining Practices
8. Anti-corruption
9. Human Rights
10. Water and Effluent
11. Biodiversity
12. Waste
13. Indirect Economic Impact

Based on the results of materiality assessment in 2021, we will focus on the high priority topics as listed below:

High Priority [102-47]

Material Topics	Support for SDGs
Local Communities	1, 8, 10
Occupational Health and Safety	3, 4
Economic Performance	8, 10
Human Capital Development	3, 4, 8
Energy & Emission	12, 13
Diversity and Equal Opportunity	10, 5
Good Mining Practices	3, 4, 15, 16

Medium Priority [102-47]

Material Topics	Support for SDGs
Anti-corruption	16
Human Rights	5, 10, 16
Water and Effluent	6, 12, 15
Biodiversity	15
Waste	13, 15
Indirect Economic Impact	1, 3, 4, 6, 8, 10

Local Communities Management Approach [103-1, 103-2, 103-3]

Key Disclosures
Operations with local community engagement, impact assessments, and development programmes [413-1]

Importance
The communities in which our business operate are our stakeholders and, as such, we are mindful of the value we create for those communities. The Company is committed to responsible corporate citizenship, which includes meeting the social, socioeconomic, and enterprise development needs of the communities in which it operates.

Scope, Initiatives, and Achievements
Performance Target:
At a minimum, we aim to fulfill the obligations of the Company according to the regulations on local community development in our operational areas.

Achievement Strategy:
We have identified eight focuses for our community relations and development programmes to achieve their targets: education, health, real income & job creation, economic independence, social-cultural & religious support, life environment, civil society organisation, and infrastructure.

Achievements:
The Company is being referred as a role model in Morowali City, our operational area in 2021.

Person in Charge and Form of Evaluation
Person in Charge: CSR Department
Evaluation: The evaluation is conducted on a regular basis and the team provides a monthly newsletter on community relations and development to the management.

Impacted Stakeholders
- Internal: Management
- External: Local Communities, Government, Business Partner

Occupational Health and Safety (OHS) Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Occupational Health and Safety Management System [403-1, 403-3]
- Hazard Identification, Risk Assessment, and Incident Investigation [403-2]
- Occupational Health Services [403-3]
- Worker Participation, Consultation, and Communication on Occupational Health and Safety [403-4]
- Worker Training on Occupational Health and Safety [403-5]
- Promotion of Worker Health [403-6]
- Prevention and Mitigation of Occupational Health and Safety Impacts Directly Linked by Business Relationships [403-7]
- Workers Covered by an Occupational Health and Safety Management System [403-8]
- Work-Related Injuries & Work-Related Ill Health [403-9] [403-10]

Importance
OHS is a material topic because it is necessary to protect the health and safety of employees as well as the Company's assets. OHS management ensures that employees are healthy and safe on the job, allowing them to perform at their best.

Scope, Initiatives, and Achievements
Performance Target:
- Zero Fatality and Zero Loss Time Injury ('LTI');
- Preventing Accidents, Occupational Diseases, Accidents Due to Labour Diseases, Dangerous Events; and
- Realising a Mining Safety culture.

Achievement Strategy:
- All content of the OHS policy is granulated into work programmes;
- Commitment in implementing OHS Policy at all levels of our operations;
- Evaluating the OHS programmes on a regular basis;
- Conduct management reviews by involving stakeholders.

Achievements:
The Hengjaya Mine recorded over five million hours of work without a fatality or LTI from November 2019 to October 2021.

Person in Charge and Form of Evaluation
Evaluation: OHS Management Audit, Contractor Compliance Check, planned and unplanned inspections.
Person in Charge: Safety Department

Impacted Stakeholders
- Internal: Management, Employees
- External: Contractors, Government

Economic Performance Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Economic Value Generated and Distributed [201-1]
- Financial implications and other risks and opportunities due to climate change [201-2]
- Defined Benefit Plan Obligations and Other Retirement Plans [201-3]

Importance
Economic performance is significant as it relates to business continuity and the distribution of added value to stakeholders.

Scope, Initiatives, and Achievements
The scope of reporting includes all of our operating subsidiaries in 2021, based on the Consolidated Financial Statement in the same year.

Person in Charge and Form of Evaluation
The Board of Directors is responsible for the Company's economic performance data and are audited by KPMG.

Impacted Stakeholders
- Internal: Shareholders, Management
- External: Customers, Business Partners

Good Mining Practices
Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Total amounts of overburden, rock, tailings and sludge and their associated risks [MM3]

Importance
Mining requires prudence and industry-standard best practices as it has the propensity to significantly impact the environment. We always exercise due diligence and planning to ensure that our operations are reasonable, safe, and appropriate in accordance with all applicable laws, regulations, and permits.

Scope, Initiatives, and Achievements
Performance Target:
At a minimum, we aim to fulfill the obligations of the Company according to the regulations on mining operations in our operational areas.

Achievement Strategy:
The team works closely with the contractors and business partners to make sure that the mining operations are conducted responsibly.

Achievements:
The Hengjaya Mine received Blue PROPER from the Indonesia Ministry of Environment in 2021 as the proof of regulatory compliance from the authority. Only two mining companies in Central Sulawesi Province received this acknowledgment from the Indonesia Ministry of Environment and Forestry in the last year. In terms of production, a record annual result of 2,457,694 wmt of mined saprolite ore was achieved in 2021, an increase of 182% from the production of totalled 870,503 wmt mined ore in 2020.

Person in Charge and Form of Evaluation
Persons in Charge: Mining Operations Department
Evaluation: Weekly, monthly, and annually.

Impacted Stakeholders
- Internal: Management
- External: Contractors, Governments

Emissions
Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Governance
- Direct (Scope 1) GHG emissions [305-1]
- Electricity indirect (Scope 2) GHG emissions [305-2]
- Other indirect (Scope 3) GHG emissions [305-3]
- GHG emissions intensity [305-4]

Importance
Global warming and climate change are understood to be a result of GHG emissions, putting human survival in jeopardy. Given the mining industry's propensity to generate GHG emissions, the Company's emissions must be reduced in order to contribute to global efforts to combat climate change.

Person in Charge and Form of Evaluation
The sustainability manager is responsible for the reporting of Green House Gas (GHG) emissions and the figures are evaluated on a regular basis.

Scope, Initiatives, and Achievements
The report identifies organisational and operational boundaries for which the GHG inventory is confined, for inventory data to be gathered for the Hengjaya Nickel and Ranger Nickel projects and the Hengjaya Mine and associated facilities and services (project). The emissions intensity in 2021 decreased by 6% in comparison with the previous year.

The Company also works to define its decarbonisation roadmap in the upcoming years with the support of climate experts and professionals.

Impacted Stakeholders
- Internal: Management, Investors and Shareholders
- External: Contractors, Business Partners

Energy
Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Energy consumption within the organisation [302-1]
- Energy consumption outside of the organisation [302-2]
- Energy intensity [302-3]
- Reduction of energy consumption [302-4]

Importance
Energy use in large quantities has a direct effect on the life of all living things on the planet and the viability of businesses, emphasising the vital nature of energy use that is responsible and efficient.

Person in Charge and Form of Evaluation
Energy management is the responsibility of the Operations Department and is supported by the Environmental Department.

Scope, Initiatives, and Achievements
The Scope of this Report includes all of the Company's subsidiaries: Hengjaya Mine, Hengjaya Nickel, and Ranger Nickel. In 2021, we reduced our energy consumption by 830,028 GJ in comparison with the previous year.

In 2021, Nickel Industries and Shanghai Decent launched their 'Future Energy' collaboration framework to jointly explore opportunities to transition current energy sources utilised across the Company's operations to renewable energy and other lower carbon-emitting solutions.

One of the early implementations was the installation of 450KWp solar panels at our Hengjaya Mine to reduce the amount of fossil fuel usage in our mine site.

Impacted Stakeholders
- Internal: Investors and Shareholders
- External: Contractors, Business Partners, Governments

Diversity and Equal Opportunity Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Diversity of governance bodies and employees [405-1]
- Ratio of basic salary and remuneration of women to men [405-2]

Importance
Diversity and equal opportunity enable the Company to recruit solely on the basis of merit and contribute to the development of an inclusive culture. As a result, the Company is able to recruit and retain the best talent.

Person in Charge and Form of Evaluation
Persons in Charge: Human Resource Department
Evaluation: The evaluation is conducted on a regular basis.

Scope, Initiatives, and Achievements
Performance Target:
The Company offers equal opportunity for anyone who meets our job and service qualifications to work and collaborate with the Company.

Achievement Strategy:
The Company communicates its commitment to diversity and equal opportunity publicly on its corporate website. The management will consider targets for this aspect in the upcoming period.

Achievements:
No report was received about any violation against this commitment in 2021. Also, male and female employees on the same work level received equal payment in 2021.

Impacted Stakeholders
- Internal: Investors and Shareholders, Employees
- External: -

Human Capital Development Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Hours of Training per Year per Employee [404-1]
- Programmes for Upgrading Employee Skills and Transition Assistance Programmes [404-2]

Scope, Initiatives, and Achievements
By implementing received training materials, employees and workers can avoid making errors while performing their jobs. Achievements include employees and workers who have passed certification/training, as well as how they apply it in their respective functions. These development programs contribute for the low turnover rate in the company. At Hengjaya Mine, the rate was 11% in 2021.

Achievement
The total training hours at Hengjaya Mine were increased by more than 300% in 2021 in comparison with the 2020.

Importance
Training and education are necessary for optimal job performance, and provides a deeper understanding for employees to perform their job properly and correctly. Our programmes and initiatives are part of our wider human capital development plan. Furthermore, certifications are required for some positions.

Person in Charge and Form of Evaluation
Evaluations are carried out by an individual's respective superiors, and are overseen by Human Resources and Department Heads.

Impacted Stakeholders
- Internal: Management, Employees
- External: Contractors

Water and Effluents Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Water process [303-1]
- Management of water discharge-related impacts [303-2]
- Water withdrawal [303-3]

Importance
Water and effluents is a material topic as without the proper management and use of water, it can lead to devastating effects for the Company and its surrounding environments such as land subsidence, empty space and seawater intrusion.

Person in Charge and Form of Evaluation
Water and effluent management are overseen by Environmental Department.

Scope, Initiatives, and Achievements
The scope of the reporting period encompasses our nickel mining site: the Hengjaya Mine and our RKEF lines at IMIP: Hengjaya Nickel and Ranger Nickel.

Impacted Stakeholders
- Internal: Management
- External: Government

Waste Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Waste generation and significant waste-related impacts [306-1]
- Management of significant waste-related impacts [306-2]
- Waste generated [306-3]
- Waste diverted from disposal [306-4]
- Waste directed to disposal [306-5]

Importance
Waste management is essential to minimise pollution's impact on the environment and avoid the spread of disease to surrounding areas.

Person in Charge and Form of Evaluation
Waste management is the responsibility of the Environmental Department.

Scope, Initiatives, and Achievements
The scope of the reporting period encompasses our nickel mining site: the Hengjaya Mine and our operations at IMIP: Hengjaya Nickel and Ranger Nickel.

In 2021, more than 3,100 kg of waste at our RKEF Plants was recovered and diverted from landfill.

Impacted Stakeholders
- Internal: Management
- External: Governments

Biodiversity Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Significant impacts of activities, products, and services on biodiversity [304-2]

Importance
Biodiversity provides functioning ecosystems that are necessary for the Earth and its inhabitants. Failure to do so would result in the deterioration of the quality of life on Earth.

Person in Charge and Form of Evaluation
The conservation and protection of biodiversity is overseen by the Environmental Department.

Scope, Initiatives, and Achievements
The scope of the reporting period encompasses our nickel mining site: the Hengjaya Mine. Since 2019, we have supported the rehabilitation of 1,781 Ha in Central Sulawesi and more than 2 million trees have been planted in the same period.

These efforts will stimulate the community's economy, with a projected income of USD 535 per hectare which will begin eight years after the trees' plantation.

Impacted Stakeholders
- Internal: Management
- External: Governments

Anti-Corruption Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Operations assessed for risks related to corruption [205-1]
- Confirmed incidents of corruption and actions taken [205-3]

Importance
Corruption pervades every facet of society. Preventing corruption accelerates progress toward greater human advancement, contributes to the protection of our planet, generates jobs, advances gender equality, and ensures greater access to essential services such as healthcare and education.

Person in Charge and Form of Evaluation
Person in Charge: Corporate Secretary

Scope, Initiatives, and Achievements
Performance Target:
Zero corruption cases for the Company.

Achievement Strategy:
The Company communicates its commitment to anti-corruption publicly on its corporate website.

Achievements:
No report was received about the violation against this commitment in 2021.

Impacted Stakeholders
- Internal: Management, Investors and Shareholders
- External: Governments

Indirect Economic Impact Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Infrastructure Investments and Services Supported [203-1]
- Significant Indirect Economic Impacts [203-2]

Importance
Indirect economic performance is a material topic because it impacts the Company's sustainability through community support. Support is derived from the perceived benefits and increased welfare of the community.

Person in Charge and Form of Evaluation
The sustainability manager is responsible to find data about the indirect economic impact from the Company to its operational areas.

Scope, Initiatives, and Achievements
The scope of the reporting period encompasses all of our operating subsidiaries in Morowali city. Collectively, we have contributed for the growth of 1,200% of the city in the last decade.

Impacted Stakeholders
- Internal: Management
- External: Governments, Local Communities

Human Rights Management Approach [103-1, 103-2, 103-3]

Key Disclosures
- Operations that have been subject to human rights reviews or impact assessments [412-1]

Importance
Human rights are fundamental rights that all humans possess simply by virtue of being human. They are vital safeguards for everyone, but especially for those who may face abuse, neglect, and isolation. We are committed to ensuring that our society embodies fundamental values such as justice, dignity, equality, and respect.

Person in Charge and Form of Evaluation
Person in Charge: Sustainability Department, CSR Department, HR Department.

Scope, Initiatives, and Achievements
Performance Target:
Compliance with human rights regulations in its operational areas.

Achievement Strategy:
Working together with its contractors and business partners to respect human rights along the value chain.

Achievements:
No report was received about the violation against this commitment in 2021.

Impacted Stakeholders
- Internal: Management, Investors and Shareholders
- External: Governments

Company Profile

History [102-1] [102-3] [102-4] [102-5]

Nickel Industries is an Australian public company which is a globally significant, low-cost producer of nickel pig iron ('NPI'), a key ingredient in the production of stainless steel. Nickel Industries was incorporated on 12 September 2007, under the laws of the State of New South Wales, Australia, and is involved in the acquisition, exploration and development of nickel mining projects. The Company's Head Office is located at 66 Hunter Street, Sydney, NSW, 2000, Australia.

In 2009, the Company acquired an 80% stake in the Hengjaya Mineralindo Nickel Mine ('Hengjaya Mine'), located in the Morowali Regency of Central Sulawesi, Indonesia, from which nickel ore was exported until the Indonesian government banned unprocessed mineral exports in January 2014. The export ban on unprocessed minerals was imposed to encourage the development of an Indonesian downstream processing industry that would allow Indonesians to benefit more from their country's vast mineral wealth.

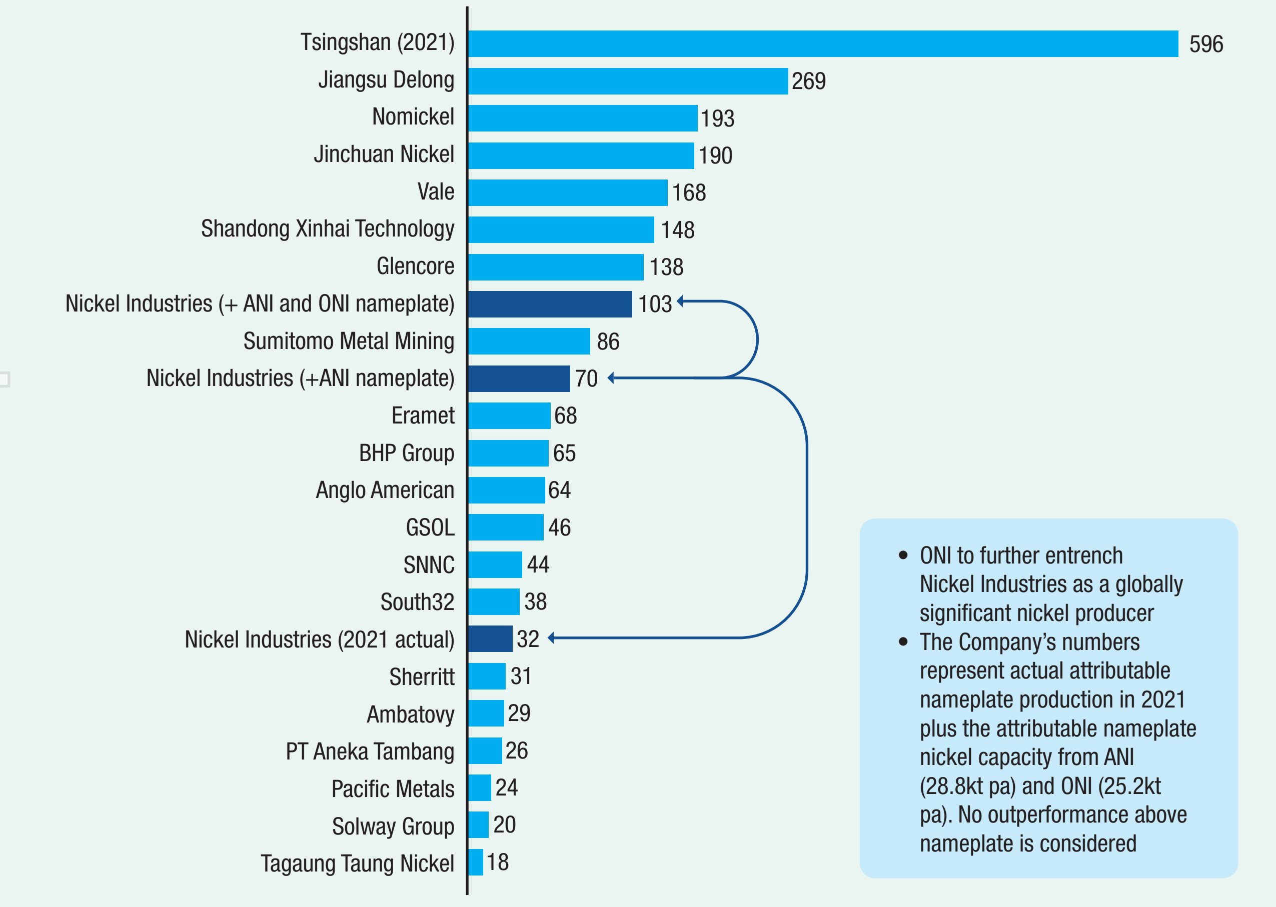
Tsingshan, one of the first companies that committed to the Indonesian government's vision of local processing, began construction of its world-class Indonesia Morowali Industrial Park ('IMIP') in July 2013. As Tsingshan required additional nickel ore as feedstock for its expanded NPI and stainless-steel capacity within IMIP, Nickel Industries resumed operations in October 2015 and entered into an offtake agreement with Tsingshan for high-grade saprolite ore.

Nickel Industries now holds 80% economic interest in the Hengjaya Nickel and Ranger Nickel projects, both of which operate rotary kiln electric furnace ('RKEF') plants producing NPI within the IMIP. In 2021, Nickel Industries acquired an 80% interest in the Angel Nickel project, comprising four 54KVA RKEF lines and a 380MW power plant within the Indonesia Weda Bay Industrial Park ('IWIP'). In 2021, the Company entered into a definitive agreement to acquire a 70% interest in the Oracle Nickel Project ('ONI' or 'ONI Project'), a new development project that has commenced construction within the IMIP comprising four next-generation RKEF lines with an annual nameplate production capacity of 36,000 tonnes of nickel-metal (in nickel pig iron). Nickel Industries' 70% interest in ONI represents 25,200 tonnes per annum ('tpa') of attributable nameplate nickel-metal capacity which will increase the Company's total attributable nameplate capacity to 78,000 tpa of nickel metal.

		IMIP	IMIP	IMIP	IWIP	Total
Annual Capacity		**HNI**	**RNI**	**ONI**	**ANI**	
Nameplate	Ni tonnes	15,000	15,000	36,000	36,000	102,000
Nickel Industries attributable	Ni tonnes	12,000	12,000	25,200	28,800	78,000

As illustrated in the chart below, the ONI Project will further cement Nickel Industries as a globally significant nickel producer.

Processed Nickel Production (Kt Ni)



Milestones in 2021

03 May

The Company signed an MoU with its collaboration partner, Shanghai Decent, for two of its four 80% owned operating RKEF lines to undergo the necessary modifications to allow them to produce a nickel matte product suitable for sale into the electric vehicle battery market.

22 November

Nickel Industries and Shanghai Decent agreed to establish a "Future Energy" collaboration framework to optimise the transition to renewable energy sources across the Company's operations and announce the signing of a further MoU to acquire a 70% interest in the Oracle Nickel Project.

24 December

Nickel Industries' 80% owned subsidiary, PT Hengjaya Mineralindo, received Blue PROPER from the Indonesia Ministry of Environment and Forestry, confirming 100% compliance with environmental regulations in our operational area.

External Initiatives & Memberships [102-13]

Nickel Industries is a member of numerous national, regional, and international organisations. These organisations help develop and implement industry safety and environmental standards at the Company. They are also a great way to engage governments, regulators, and communities on energy, climate, and trade issues. The Company participates in industry associations and consortiums to learn more about issues, share knowledge, help develop standards, and represent the industry before regulators.

During 2021, the Company joined several external initiatives, including: [102-12]

- Uniting Business LIVE, hosted by the UN Global Compact;
- Nickel Industries, through its operating subsidiaries at IMIP (Hengjaya Nickel Industry and Ranger Nickel Industry), was registered as a member of Forum Industri Nikel Indonesia ('FINI'); and
- Asosiasi Penambang Nikel Indonesia ('APNI').

Association Membership [102-13]

Association Name	Role	Scope
APNI	Member	National
FINI	Member	National

External Awards and Appreciation

100% regulatory compliance

2020 Blue PROPER Award (awarded in 2021)

2021 Blue PROPER Award

Sustainability
Performance

Economic Performance

Economic development is fundamental to the Company's sustainability goals and objectives. We produce some of the lowest capital-intensive and most profitable NPI in the global market, in partnership with Tsingshan, the world's largest, lowest cost stainless steel producer. This allows us to continuously improve our financial performance, enabling us to generate increased indirect economic impacts to the surrounding areas of our operational sites and help thousands of people and local suppliers to grow simultaneously with the Company.

Our principal operations in Central Sulawesi, Indonesia, are the Hengjaya Nickel and Ranger Nickel projects located within the IMIP, and the Hengjaya Mine. At year-end, the Company held an 80% interest in each RKEF project and the Hengjaya Mine, a large tonnage, high-grade nickel laterite deposit close to the IMIP.

The Company has acquired an 80% interest in an additional four RKEF lines and a 380MW power plant ('Angel Nickel' / 'ANI') within the IWIP in October 2021. The ANI plant commenced commissioning in January 2022, ahead of the October 2022 contractual delivery date, with the ANI project utilising power from the existing IWIP electricity grid in the interim.

The Company has also signed a multi-faceted MoU with Shanghai Decent Investment (Group) Co., Ltd ('SDI') setting out a framework for future collaborations between the parties over the next several years. This includes the Company's purchase of a 70% interest in the Oracle Nickel Project ('ONI' or 'ONI Project'), a new development project that has commenced construction within the IMIP comprising four next-generation RKEF lines with an annual nameplate production capacity of 36,000 tonnes of nickel metal (in NPI) and a 380MW power plant.

NPI production raw materials include nickel ore acquired by PT Hengjaya Nickel Industry and PT Ranger Nickel Industry from PT Hengjaya Mineralindo, operator of the Hengjaya Mine, as well as other third-party mines. [102-2]

Operational Areas [102-4]

5,963
Hengjaya Mine (Ha)

27
Hengjaya Nickel (Ha)

30
Ranger Nickel (Ha)

Markets Served [102-6]

Geographic location	Indonesia and China
Sectors served	Metals and mining
Types of customers	Business
Beneficiaries	Metals processing companies

Nickel ore and NPI sales revenue are measured based on the consideration specified in a contract with each customer. The Company recognises revenue by transferring control over goods or a service to a customer.

All NPI sales during the year were to Tsingshan-related entities located in either Indonesia or China. All nickel ore sales during the year ended 31 December 2021 were to the Company's 80% owned subsidiaries PT Hengjaya Nickel Industry and PT Ranger Nickel Industry, under a series of offtake agreements to supply 100,000 WMT per month between each entity, and to the Huayue Nickel Cobalt project located within the IMIP. [102-2]

Financial Implications and Other Risks and Opportunities Due to Climate Change [201-2]

Nickel Industries is committed to evidence-based climate change preparedness and mitigation targets. Our sustainability team is responsible for developing the Company's climate change strategy, collaborating with all departments and the Board of Directors to develop a holistically integrated strategy that is reviewed and adjusted annually further to strengthen the Company's resilience against its effects.

Economic Value Generated

In 2021, The Company's Hengjaya Nickel and Ranger Nickel projects at the IMIP produced a combined 298,353 tonnes of NPI.

The total revenue of Nickel Industries and its controlled entities (together 'the Group') for the year ended 31 December 2021 was $645,935,639.

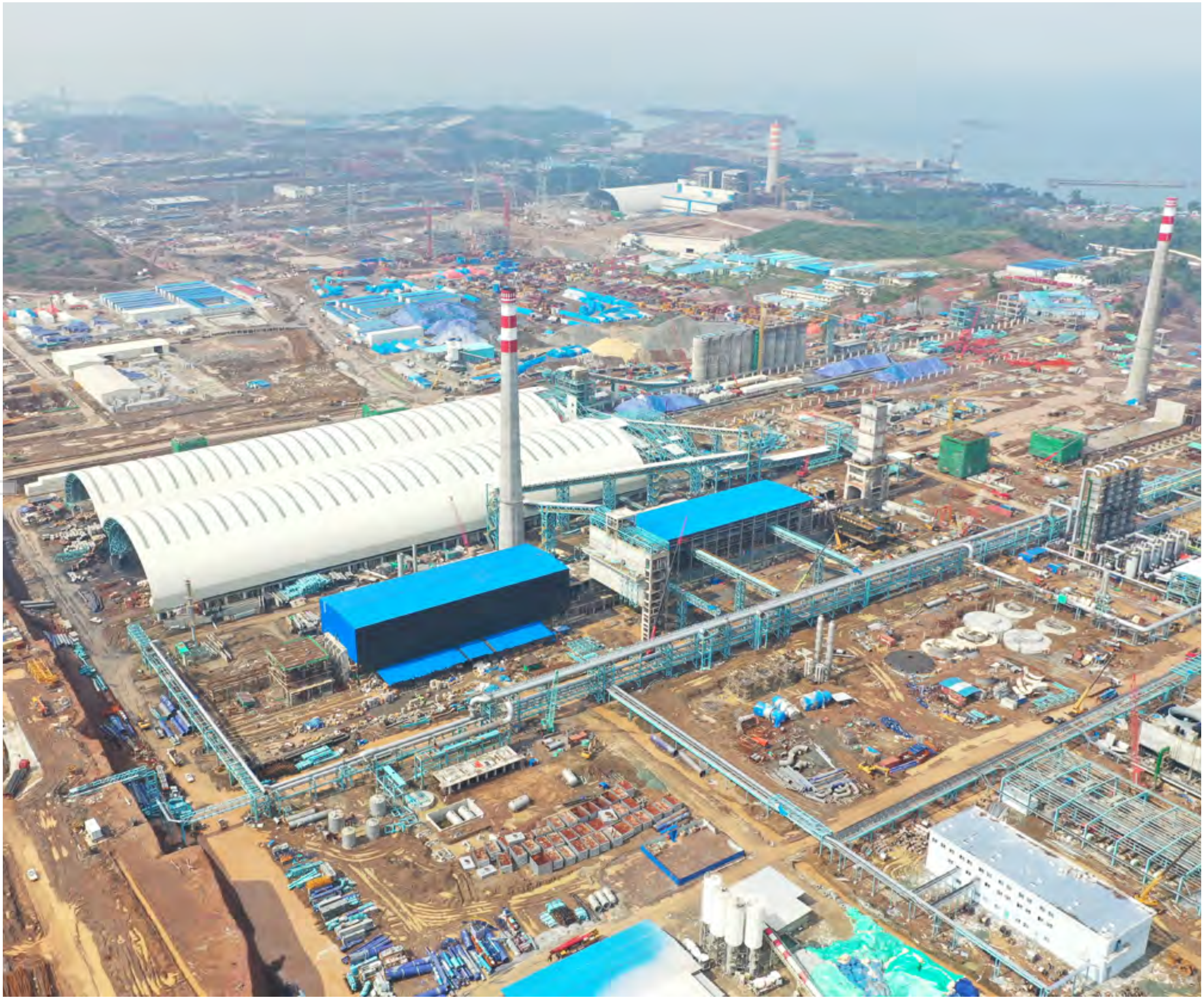
Production Performance

Production Performance

Description	Unit	2019	2020	2021
NPI Production	Tonnes	194,514	295,896	298,353
NPI Grade	%	13.8	14.7	13.5
Nickel Metal Production	Tonnes	7,885	43,621	40,410

Growth of NPI Production

Description	2019	2020	2021	Δ%	
	1	2	3	1:2	2:3
Nickel Industries Limited	194,514	295,896	298,353	52	1



Supply Chain [102-9]

Suppliers Type

Description	2019		2020		2021	
	Total	%	Total	%	Total	%
Local Suppliers	18	9	15	8	9	5
National Suppliers	182	91	179	92	183	95
International Suppliers	0	0	0	0	0	0
Total	200	100	194	100	192	100

Contract Value by Supplier (IDR)

Description	2019		2020		2021	
	Total	%	Total	%	Total	%
Local Suppliers	832,100,000	3	2,024,388,998	5	1,665,397,000	3
National Suppliers	28,768,567,194	97	36,263,784,552	95	55,279,170,314	97
International Suppliers	0	0	0	0	0	0
Total	29,600,667,194	100	38,288,173,549	100	56,944,567,314	100

Notes: Supplier data refers to the Hengjaya Mine operations

Significant Changes to the Organisation and Its Supply Chain [102-10]

In 2021, Nickel Industries increased the ownership for Angel Nickel to 80%. Subsequent to year end, two RKEF lines have been modified and now have the ability to continue to produce NPI or when required, a nickel matte product. However, there were no significant changes to the supply chain during the reporting period. Various stakeholders (including suppliers, vendors, contractors, and consultants) are involved in various business operations at Morowali City. [102-9, 102-10]

Organisational Scale (USD) [102-7]

Description		2019	2020	2021
Revenue		236,059,160*	523,492,413	645,935,639
Total Capitalisation	Total Liabilities	175,377,516	148,448,076	472,706,783
	Total Equity	722,119,105	1,086,228,908	1,329,912,039
Total Assets		897,496,621	1,234,676,984	1,802,618,822
Total Net Profit After Tax		91,280,434*	153,698,840	175,976,986

*6 months to 31 December 2019

In 2021, Nickel Industries has a Head Office in Sydney, Australia and three operating subsidiaries: Hengjaya Mine, Hengjaya Nickel, and Ranger Nickel.

Economic Value Generated (USD) [201-1]

Description	2019*	2020	2021
Economic Value Generated			
Revenue	236,059,160	523,492,413	645,935,639
Other Income	13,035,913	2,166,484	2,786,467
Total	**249,095,073**	**525,658,897**	**648,722,106**

*6 months to 31 December 2019

Defined Benefit Plan Obligations and Other Retirement Plans [201-3]

Liabilities for employee benefits for wages, salaries, annual leave and sick leave that are expected to be settled within 12 months of the reporting date represent obligations resulting from employees' services provided to the reporting date, are calculated at undiscounted amounts based on remuneration wage and salary rates that the Company expects to pay as at reporting date including related on-costs, such as workers compensation insurance and payroll tax.

Indirect Economic Impact

We are committed to contributing to sustainable development in our operational areas, and more broadly across the globe to create a positive legacy for future generations. We help and stimulate economic development in our operational areas by prioritising the hiring of local workforces and suppliers. Additionally, we create programmes that are connected and relevant to the needs of residents and our long-term economic development strategy, avoiding reactive social investments.

Our operations in Central Sulawesi indirectly contributed to the total growth of 4.9% of this province in 2020, while the Indonesian economy contracted by 2.1% in the same year. As a background note, the District of Morowali in Central Sulawesi (where our Hengjaya Mine, Hengjaya Nickel, and Ranger Nickel are located) grew by 1,200% versus the whole province's growth of 161% over the past decade.

Significant Indirect Economic Impacts [203-2]

Infrastructure is a fundamental need of the communities in which we operate. The Company recognises the critical role we play in addressing these issues and will continue to support these needs as they arise within the scope of our operations.

In 2021, our infrastructure developments included school renovations and improved water infrastructure quality for Bete-Bete Village. Further information regarding the infrastructure investments provided by the Company can be found in the Social Performance section of the report. [203-1]

Environmental Performance

Our Environmental Policy

We believe that environmental sustainability is a core part of why we exist. As a Company, we are committed to seeking zero harm to our environment and establishing a positive legacy in our operational regions wherever and whenever we operate, from exploration, rehabilitation and closure. We realise that environmental management is an important part of our operations. For this reason, we are committed to managing all aspects of effective and efficient environmental performance by:

1. complying with all Indonesian laws and regulations related to the environment and anticipate through ongoing consultation with the authorities, as well as any changes in the future that can affect the continuity of the project;
2. setting environmental goals and evaluate the performance of the achievement of those goals, and be determined to continue to improve environmental performance and evaluate targets in response to changing needs and expectations;
3. designing and operating projects in accordance with the Company's Environmental Management System;
4. carrying out environmental inspections, audits, and performance appraisal programmes to measure the effectiveness of the environmental management system and the implementation of policies;
5. developing and maintaining an environmentally conscious culture through management concern and responsibility, education and training for all employees and contractors;
6. involving stakeholders for their attention, and aspirations relating to aspects of the development, operation and closure of the mine, and recognise the close links between environmental, economic, social, and cultural issues; and
7. communicating our performance openly, accurately, and transparently.

Our policy is reviewed regularly, documented, implemented, and communicated to all employees, contractors, visitors, and other stakeholders.

Our commitment to environmental sustainability has been recognised by the Indonesian Ministry of Energy and Natural Resources, which in 2021 awarded the Company's Hengjaya Mine a 'Blue PROPER' rating to confirm full compliance with the mine's operating license of associated rehabilitation programmes and commitments. Only two mining companies in Central Sulawesi Province received this acknowledgment from the Indonesia Ministry of Environment and Forestry in the last year.

The Company intends to improve its 'Blue PROPER' rating to 'Green PROPER' and possibly 'Gold PROPER', the highest level that could be achieved by an operating entity in Indonesia, as a commitment from the management to become a role model in the nickel sector for the sustainability aspects.

Water and Effluents

Water and Effluent Usage

The Company is committed to continuously improving water efficiency and meeting or exceeding local effluent standards. We continually identify and assess water-related risks and implement continuous improvement plans to manage the risks. We respect indigenous and local communities' rights to safe and clean water, and we work to develop active partnerships at the international, national, regional, and local levels to safeguard and conserve water for future generations. With regards to indigenous and local communities' connections to land, water, and the environment, we seek to develop mutually beneficial agreements with land-connected peoples by promoting engagement, free, prior, and informed consultation, as well as risk and impact assessment. [303-1]

It is crucial to maintain the availability and quality of surface and groundwater sources through efficient use and prevention of water pollution. The Company maintains a continuous effluent monitoring system at the Hengjaya Mine as a commitment to safeguarding the access and quality of the area's water resources.

The Company adheres to prevailing Indonesian laws such as Decree of the State Minister of the Environment No. 51 of 2004 concerning Standard Quality of Seawater; and Government Regulation No. 82 of 2001 concerning Water Quality Management and Water Pollution Control. These regulations allow us to anticipate any potential impacts through ongoing consultation with the relevant authorities, meeting water effluent standards in its operations by the local standards. [303-2]

To ensure water quality in our mining areas, we conduct the following activities before, during, and after our operations:

- land clearing is limited to the development of supporting facilities on the site;
- managing runoff water by constructing drainage channels and channelling runoff water into sediment pond systems;
- avoiding the disposal of solid and liquid waste into bodies of water;
- avoiding the discharge of water used to wash construction equipment into bodies of water;
- continuous water monitoring and a thorough analysis of all discharges to ensure that they will have no adverse effect on the environment and comply with water effluent standards in our operational areas;
- avoiding land clearing activities adjacent to rivers, river borders, or water springs; and
- plant and/or maintain vegetation along the river's banks and water-courses.

To avoid potential degradation of water quality due to soil erosion at the mining sites, we implement the following activities:

- conduct mining gradually and immediately follow up with reclamation and revegetation following each mining operation;
- no mining on land with a slope greater than 35%;
- no mining within a radius of 250 metres of a river;
- design and install terraces to increase sediment capacities in proportion to land clearing area and therefore minimise erosion potential;
- plant cover crops and timber plants on former mining sites to prevent soil erosion;
- cover excavated nickel ore piles with tarpaulins to prevent gully erosion, migration of ore; and
- construct drainage diversions to control external runoff water from entering the mine site, the stockpile, and the mine road.

In our RKEF lines at IMIP, we monitor water quality regularly by a certified laboratory at a predetermined monitoring point. The results of this water quality monitoring are then compared with the applicable quality standards and the residual water produced is processed by circulating it and then reused for the production process so that nothing is discharged into the environment. The water source for production and domestic activities comes from the Water Treatment Plant ('WTP') Department as the water provider in the area with the quantity in the table below: [303-3]

Source of Water	Unit	Hengjaya Nickel's Water Withdrawal (All Areas)		
		2019	2020	2021
Surface water	m^3	0	0	0
Groundwater		0	0	0
Produced water		0	0	0
Third-party water		766,042	1,105,545	751,345

Source of Water	Unit	Ranger Nickel's Water Withdrawal (All Areas)		
		2019	2020	2021
Surface water	m^3	0	0	0
Groundwater		0	0	0
Produced water		0	0	0
Third-party water		618,115	1,105,545	751,345

Water Consumption [303-5]

Description
Domestic water used in office and basecamp of Hengjaya Mine (m^3)

2020	2021
5,597	39,350

Remarks
In 2020, the operations at Hengjaya Mine were affected by the transmission of COVID-19 virus while in 2021 the operations at the mining site have recovered and thus, consumed more water than the previous year.

Biodiversity

Biodiversity Policy and Protection

We acknowledge the importance of biodiversity in our operations and projects and commit to implementing biodiversity management programmes as a part of our good mining practices. We are committed to making conscious decisions to improve biodiversity levels in the most appropriate and meaningful ways and to comply with the local biodiversity regulations wherever we operate.

We implement biodiversity conservation strategies to positively impact the presence of high-value biodiversity in our project areas. We ensure that mine closure activities are well planned and carried out as soon as possible after our operational phase. This process is communicated with all relevant stakeholders to ensure an integrated approach to the final land-use plan. Our biodiversity management adheres to Indonesia Government Regulation No. 28 of 2011 as amended by Indonesia Government Regulation No. 108 of 2015 concerning Conservation of Biological Natural Resources and Their Ecosystems. [EM-MM-160a.1]

Our technological approach for biodiversity conservation entails the following:

- land clearing is limited to mining areas only;
- reclaiming and replanting each mined area;
- optimising the impact management for the disturbances to the animal habitat and vegetation; and
- preserving wild animal habitats by limiting land clearing only to areas used for mining infrastructure development.

Additionally, we have developed a socioeconomic strategy to protect biodiversity across all of our operations, which includes the following:

- counselling employees and society on the prohibition of and disturbance of endemic and protected vegetation;
- establishing a bulletin board of hunting prohibition. The ban board is primarily located in the forest area and is designed to be informative, with the sanctions listed for each offence; and
- counselling employees and the general public on the prohibition of disturbing wildlife.

Counselling is provided to employees and residents in the vicinity of the mining site. The material delivered is primarily information about the types of protected wildlife and the importance of preserving their sustainability and existence. Additionally, it explains the sanctions and violations that extend to the entire mining area.

Our principal biodiversity programme is to support mangrove and watershed rehabilitation in Central Sulawesi with a total area of 1,781 Ha. More than two million trees have been planted since 2019 with the potential of an additional one million trees to be planted. These efforts will stimulate the community's economy, with a projected income of USD 535 per hectare which will begin eight years after planting with sap from the trees being the main source of income. If the price at the collectors is used, the income will reach USD 800 per hectare per month. Additionally, after forty years, the sap price per hectare can reach USD 3,200 per hectare per month. The projected economic income is the main reason why Forest Management Unit Tepeasa Maroso (Poso District) and PT Hengjaya Mineralindo chose to plant pine trees. It is hoped that a sustainable source of income can be generated through this watershed rehabilitation project.

Through its subsidiary, PT Hengjaya Mineralindo, the Company held a four-day rehabilitation training programme in November 2021, which was attended by representatives from local villages and the local forestry institutions. The program aimed to educate participants about forest rehabilitation and how to plant indigenous pine trees in Ensa Village. The related forestry institutions have acknowledged that PT Hengjaya Mineralindo's watershed rehabilitation program is one of the best in the region. The initiative is one of many efforts made by the Company to protect the biodiversity of local areas, which aligns with our Environmental Stewardship pillar.

In December 2021, PT Hengjaya Mineralindo repurposed 1,094 hectares of land into rehabilitation planting areas in Ensa and Bomba villages, North Morowali Regency as an extension of its commitment towards environmental stewardship.

Significant Impacts of Activities, Products, and Services on Biodiversity

[304-2] [MM2]

Direct Impact
Land conversion for nickel mining activities

Indirect Impact
Species migration

Climate Risk and Resilience

Climate Change is fundamentally altering the risks that people, businesses, and the financial sector face throughout the world. The direct impact of climate change already affects businesses, via extreme weather events, such as floods and droughts and shortages of raw materials owing to severe weather conditions. In addition, many companies also face substantial indirect climate risks, such as shifting market trends, increased legislation and financial and public policies that accelerate a global transition to a low-carbon economy.

Nickel Industries recognises its responsibility to support the global efforts to transition to a low-carbon economy, while at the same time ensuring that its operations reduce its exposure to climate risks. Climate change aspects need to be addressed via two components: Accounting for Greenhouse Gas ('GHG') emissions and second to understanding the financial related risks coming from Climate change. For reporting purpose, the guideline for Climate-related Financial Disclosure ('TCFD') is followed. It starts via the set-up on Climate change analysis within the business, then looks at existing or possible strategies that include climate change aspects to provide further information on the risks the business is exposed to and then reports on the data analysis of the Company's GHG inventory via the Metrics and Targets section.

Recognising the challenge to address the requirements, the Company engaged external consultants to build capacity in house and start with important data collection to understand the risks and opportunities that climate change can pose towards our business. A three-year roadmap was developed and for the first year, the Company investigated climate-related governance, the development of its GHG inventory and GHG emission reduction strategies.

Core elements of recommended climate-related financial disclosure

Governance
The organization's governance around climate-relate risks and opportunities.

Strategy
The actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning.

Risk Management
The processes used by the organization to identify, assess, and manage climate-related risks.

Metrics and Targets
The metrics and targets used to assess and manage relevant climate-related risks and opportunities.

Governance

Since 2020, the Company has engaged third parties to assist to develop a GHG inventory and GHG decarbonisation strategy. The supervision lies with the national sustainability team, but local monitoring and data collection is carried out by the local environment teams at Hengjaya Mine and IMIP.

	2021	2022	2023	2030
Governance	Identification for internal & external stakeholders	Strengthen cross-departmental working groups on climate related issues	Climate specific expert/ unit High level position aware of climate risks & opportunities	Climate specific expert/unit High level position aware of climate risks & opportunities
Strategy	Internal communication & coordination with higher level management	Adopt GHG reduction targets into strategies	Present climate impact analysis & discuss strategic decisions	Revise and update targets & have regular (biannual meetings) External communication & coordination
Risk Management	Exposure to GHGs	Capacity building & data collection	Climate scenario Fiscal and transition risk identification Evaluate business impacts Adapt risk management	Institutionalisation/ Monitoring/ Implementation & Evaluation
Metrics & Targets	Develop internal database GHG inventory Scope 1, 2 and 3 GHG reduction targets for operations		Screen for climate related risks Climate risk priorities	Institutionalisation/ Monitoring/ Implementation & Evaluation

Metrics and Targets - GHG Inventory

The Company's greenhouse gas emissions were calculated according to the principles of ISO 14064-1:2018 and the Greenhouse Gas Protocol Standard.

The source of emissions has been collected for the different parts of Nickel Industries:

- the mining operations by Hengjaya Mine (HM) and its main subcontractors (PT RJS, PT STM, PT Buana, PT Danmar and PT Monalisa); and
- the RKEF operations in IMIP by Hengjaya Nickel ('HNI') and Ranger Nickel ('RNI').

The reduction of emissions through tree planting have also been computed at:

- the Hengjaya Mine area; and
- DAS Bomba and Ensa.

The equity approach was used to define the organizational boundaries of the GHG inventory, as Nickel Industries owns the majority of the reported business units (80% of HM, HNI and RNI) and has control over them.

Most of the emission factors ('EF') used for the computation of the GHG inventory 2021 are local EF (Tier 2); the ones related to combustion (Scope 1) are published by the Indonesian Ministry of Energy and Mineral Resources and the ones related to deforestation and reforestation are mainly based on field observations and Indonesian literature.

The Tier 1 EF of the Intergovernmental Panel on Climate Change ('IPCC') guidelines have been used when local EF were not available. These are the main factors as to why we have chosen 2021 as our baseline for benchmarking GHG emissions.

In the case of the electricity consumption of HNI and RNI, there is no EF specific to the electricity grid of IMIP (constituted of a group of 8 providers, independent from the external PLN grid) and it could not be computed because of the lack of data. For that reason, a market-based approach has been used, and the considered EF is an average grid factor for Indonesia. The impact of the Scope 2 emissions will be reevaluated in the future, when a more accurate EF for IMIP grid is available.

The GHG Inventory 2020 has been computed based solely on Tier 1 EF from IPCC, which explains some disparities in results while the consumption values are similar.

Some assumptions and extrapolations have been carried out to gather incomplete datasets, however this should not have any significant impact on the overall results. The complete methodology and these assumptions are described in the GHG inventory report.

GHG Emissions of Nickel Industries in 2020-2021*

GHG Emissions (tCO_2e)	2020	2021
Scope 1 - Direct Emissions Category [305-1]		
Stationary Fuel Combustion	1,209,108	951,666
Mobile Fuel Combustion	22,917	13,968
Carbon fraction in the NPI	-24,737	-24,942
Refrigerants	138	116
Total Scope 1 (tCO_2e) [EM-MM-110a.1]	1,207,426	940,808
Scope 2 - Indirect Electricity Emissions Category [305-2]		
Total Scope 2 (tCO_2e)	975,078	1,086,944
Scope 3 - Other Indirect Emissions Category [305-3]		
Purchased Goods and Services	-not available-	20,182
Transportation	-not available-	645
Total Scope 3 (tCO_2e)	-	20,828
Biogenic Emissions		
Combustion of Biofuel (tCO_2e)	274	4,682
Land use change		
Deforestation	44,058	55,888
Reforestation	-7,514	-8,098
Total Land Use Change (tCO_2e)	36,545	47,790
Total Emissions and Removals (tCO_2e)	2,219,322	2,101,051

*Data from Hengjaya Mine, Ranger Nickel Project, and Hengjaya Nickel Project. The emission figures were counted based on equity-share approach in which the Company own 80% of interest in each subsidiary.

Direct (Scope 1) GHG Emissions [305-1]

The direct emissions considered in the inventory 2021 are:

- HM: all significant fuel combustion sources (stationary and mobile) and the main fugitive emissions; and
- HNI and RNI: the main fuel combustion emissions (stationary and mobile).

The vast majority (98%) of the Scope 1 emissions is due to the coal combustion in the RKEF processes of HNI and RNI.

Energy Indirect (Scope 2) GHG Emissions [305-2]

As previously stated, the EF of the IMIP electricity grid that supplies HNI and RNI is not available. Additional analyses have helped to limit the probable range for the emission factor and a provisional EF of 0.864 has been chosen for this analysis as it is the default low value indicated by the analysis; this value is in line with regular electrical Indonesian grids like the Java-Bali grid (JAMALI: 0.87 ex-post 2019).

Ini 2021, the electricity from a grid provider is exclusively by HNI and RNI, as HM and its contractors are producing their electricity by genset.

Other Indirect (Scope 3) GHG Emissions [305-3]

The most significant indirect emissions for the Hengjaya Mine have been computed:

- all the fuel combustion and fugitive emissions resulting from the mining activities of the main subcontractors (PT STM, PT RJS, PT Buana, PT Monalisa, PT Danmar) have been recorded under the Purchased goods and services Scope 3 category; and
- the staff commuting and business travels of HM and its subcontractors have been recorded under the Transportation Scope 3 category.

Biogenic GHG Emissions

As per the ISO standard requirements, the biogenic emissions from the combustion of biofuels have been separated from the rest of the fuel combustion reporting. A total of 8.8 million litres of B30 biodiesel have been consumed in 2021 by HM and its contractors, representing an emission for Nickel Industries of 4,682 tons of CO_2-e.

GHG Emissions due to Land Use Change

The land clearing operations in view of the exploitation of new mining areas in 2021 have led to the deforestation of tropical rainforest representing 55,888 tons of CO_2-e emissions for the Company.

Other parts of the pits which have already been exploited are benefiting from a reforestation program with the fast-growing sengon trees (Paraserianthes falcataria) and local grass as pioneer species. The first areas have been replanted in 2014 and the total currently accounts for 45.96 ha.

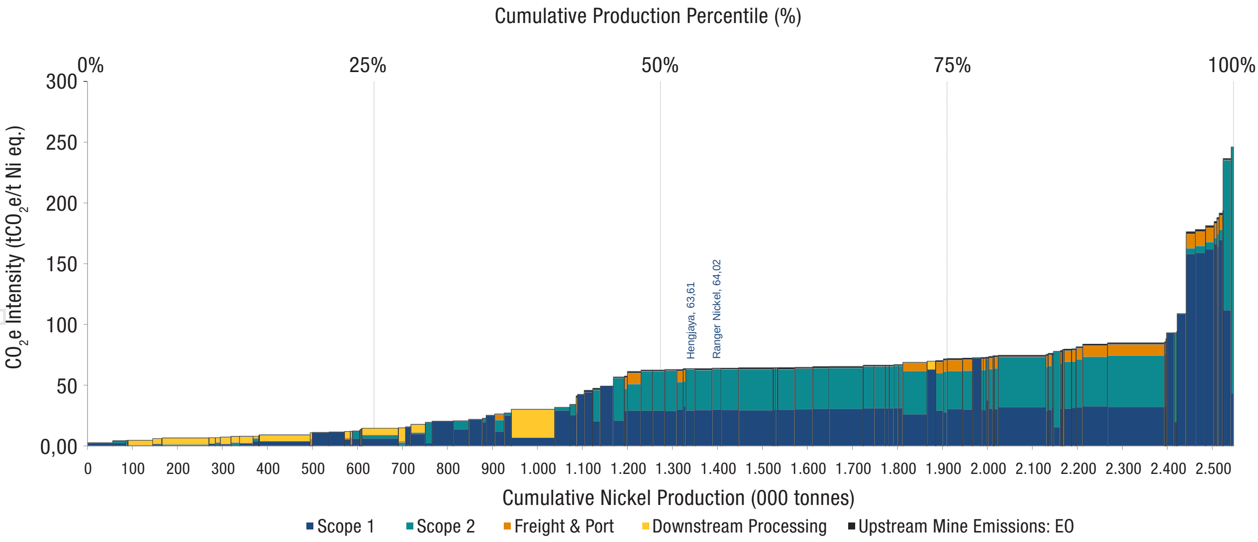
We also support two rehabilitation projects in Central Sulawesi (DAS Bomba and Ensa) where pine trees (Pinus merkusii) have already been planted in degraded areas. Overall, these reforestation projects represent a reduction of 8,098 tons of the CO_2-e emissions for the Company.

GHG Emissions Intensity [305-4]

For the purpose of the characterisation of the GHG emission intensity, the following values are computed on considering 100% of the emissions of the Organisation (Scope 1, 2 and 3), hence not following the equity share approach. The biogenic emissions and the impact of deforestation and reforestation have also been included.

Description	Unit	2020	2021
Total Emissions	tCO_2e	2,774,153	2,626,314
Nickel Metal Production	t Ni eq.	43,621	40,410
Carbon Intensity of the nickel production	tCO_2e / t Ni eq.	63.60	64.99

Nickel Industries' GHG Intensity Based on the Third-party Data



Source: Skarn's GHG Intensity Curves

Our carbon intensity in the last year was slightly higher than in 2020 due to a lower nickel content from our NPI production in 2021. Nevertheless, the Company still ranked close to the second quartile to Skarn's GHG intensity Curves for the nickel sector globally and was in a better position than many nickel producers, especially in Indonesia and other ASEAN countries.

As a side note, Skarn used different approaches in calculating the Company's carbon footprint and that was why there are small gaps between their figures and the results of our GHG inventory. As an example, Skarn does not consider Scope 3 emissions in the calculation while the Company includes some elements of this scope in the GHG inventory. Nevertheless, the Company is committed to decarbonising its value chain and pushing its operations to be included in the first quartile of Skarn's curves in the future.

Strategies for GHG emission reductions

Nickel Industries is continuously improving our activities, seeking increased efficiency in using natural resources and reducing carbon footprint in our projects and operations. We have diversified our product range by producing nickel matte products that can be used to make battery-grade nickel for use in electric vehicles and other low carbon technologies.

The Company increases energy use efficiency through the identification, assessment and application of energy efficiency of the project to reduce greenhouse gas emissions and operational costs. We adhere to comply with the emission standards and, regularly evaluate these achievements in response to changing needs and expectations. Also, we worked with Hatch and Pertiwi Consulting, professional carbon consulting firms, to develop a decarbonisation roadmap for the Company.

Nickel Industries ensures that its emissions and particulates do not exceed the quality standards stipulated in Indonesia Government Regulation Number 41 of 1999 concerning Air Pollution Control. Our technological approach focuses on using appropriate vehicles and heavy equipment, watering the roads in the mobilisation path three to four times daily or whenever there is evidence of an impact, tree planting along the mobilisation path and transport route, securing vehicle bodies when transporting construction materials, and installation of solar cells in the camp to reduce diesel fuel for power generation. [EM-MM-120a.1]

In 2021, Nickel Industries and Shanghai Decent launched its ‘Future Energy’ collaboration framework, aimed to jointly explore opportunities to transition current energy sources utilised across the Company’s operations to renewable energy and other lower carbon-emitting solutions. Discussions are already well advanced on collaborations involving solar and LNG-based energy solutions to begin the transition away from current coal-fired power sources.

‘Future Energy’ projects that are under discussion include but are not limited to:

- the collaboration with PT Sumber Energi Surya Nusantara (‘SESNA’) on the installation of 200MWp solar capacity, becoming the first tenant at IMIP to participate in this initiative, with electricity generated to contribute to the power requirements of the Company’s RKEF lines. This project would mark a larger foray into solar power for the Company with its 80%-owned HM Mine commissioning its 450 KWp solar project that will significantly reduce the requirement for diesel-fired generators to power the mine and camp facilities. It is estimated that every kWh generated from this solar cell could reduce the number of carbon emissions by 0.864 kg of CO_2e; and
- the development of an LNG-to-power solution for IMIP utilising a parcel of land within the HM Mine IUP whereby LNG receiving jetty, storage, and regasification facilities, auxiliary pipelines and transmission lines could fuel a 180MW combined-cycle gas turbine power plant.

The ‘Future Energy’ projects identified above represent two of the more immediate opportunities, with both parties committed to exploring other opportunities to reduce carbon emissions from the Indonesian nickel industry significantly.

Energy

Energy Policy and Statistics

Delivering world-class sustainability performance is essential to our business success. Meeting our commitments in the energy aspect contributes to sustainable development in our operational areas and more broadly across the globe, and is essential to our continued access to resources, capital and engaged people. Thus, we are always committed to continuously improving our activities, seeking increased efficiency in energy in our projects and operations.

Nickel Industries increases energy use efficiency through the identification, assessment and application of energy efficiency of the project to reduce greenhouse gas emissions and operational costs. We implement energy identification and assessment in all operations to reduce energy use, and design and operate our projects by energy reduction targets.

As of the reporting period, our joint contributions at IMIP have resulted in many improvements in energy use and emissions:

- exploring new technology and new methods of energy-saving and recycling;
- the establishment of smelters near the mine greatly saves the energy consumption of nickel ore transportation;
- a 225MW energy-efficient waste heat boiler was installed in the coke power plant, and electricity is generated using the high-temperature coke oven flue gas;
- blast furnace sintering equipped with waste to heat power generation with a 7MW capacity, recovery and utilisation of low calorific value flue gas of sintering machine to produce electric power, increasing burning and efficiency; and
- high knot and enterprise heat energy utilisation ratios result in significant energy savings. At IMIP, nickel-iron hot metal and blast furnace hot metal are sent directly to steelmaking. In contrast, billets are sent directly to hot rolling, resulting in significant energy savings and a reduction of carbon dioxide emissions.

Energy Consumption

Total Energy Consumption

In view of the reporting of 2021, a comprehensive audit of the sources of energy consumption has been carried out in HM and its main contractors, which will explain some disparities between the consumptions of 2020 and 2021. Some dataset was not available for HNI and RNI, hence only the most significant ones have been included in this table.

This year, we began a more thorough monitoring of our energy consumption both within and outside the organization, as well as an examination of every aspect of energy use. As a result, the baseline year for future reporting will follow 2021.

Total Energy Consumption [302-1] [EM-MM-130a.1]

Type of Non-Renewable Energy	Energy Consumption (GJ)	
	2020	2021
Anthracite coal	1,579,857	1,787,439
Bituminous coal	7,675,421	7,070,786
Semi-coke coal	3,566,376	2,994,990
Electrode paste	93,834	93,655
Electricity	5,765,901	5,661,165
Gasoline	69	61
Biodiesel (B30)	23,477	304,995
Diesel	373,283	334,898
LPG	213	409
Acetylene	-not available-	4
Total	**19,078,431**	**18,248,403**

Note: The energy content factor is from Table 1.2 from Volume 2 (Energy), Chapter 1 (Introduction) of the 2006 IPCC Guidelines. The conversion factors are from the GHG Protocol tool for stationary combustion, Version 4.1. of the World Resources Institute (2015).

Energy Consumption within The Organisation

Type of Non-Renewable Energy	Energy Consumption (GJ)
	2021
Anthracite coal	1,787,439
Bituminous coal	7,070,786
Semi-coke coal	2,994,990
Electrode paste	93,655
Electricity	5,661,165
Gasoline	61
Biodiesel (B30)	62,202
Diesel	227,880
LPG	362
Acetylene	4
Total	**17,898,545**

The source data has been collected for the purpose of the GHG Inventory. The energy content factor is from Table 1.2 from Volume 2 (Energy), Chapter 1 (Introduction) of the 2006 IPCC Guidelines. The conversion factors are from the GHG Protocol tool for stationary combustion, Version 4.1. of the World Resources Institute (2015).

The source data has been collected for the purpose of the GHG Inventory: the energy reported as consumed outside of the Organisation was consumed by the main subcontractors of the mining site (PT STM, PT RJS, PT BUANA). The energy content factor is from Table 1.2 from Volume 2 (Energy), Chapter 1 (Introduction) of the 2006 IPCC Guidelines. The conversion factors are from the GHG Protocol tool for stationary combustion, Version 4.1. of the World Resources Institute (2015).

Energy Consumption outside of The Organisation [302-2]

Type of Non-Renewable Energy	Unit	Energy Consumption 2021
Biodiesel (B30)	GJ	242,793
Diesel	GJ	108,574
LPG	GJ	47
Total	**GJ**	**351,414**

Energy Intensity [302-3]

Total Energy Usage (GJ)

2020	2021
19,078,431	18,248,403

Nickel Metal Production (tonnes of nickel equivalent)

2020	2021
43,621	40,410

Energy Intensity of the Nickel production (GJ/tonne of nickel equivalent)

2020	2021
437.36	451.58

Reduction of Energy Consumption [302-4]

At the end of 2021, HM had installed solar panels on the camp buildings' roofs in view of shifting a significant part of the electricity produced by diesel generators to renewable energy. More panels have also been installed on each of the six guard posts in the mining area. It is anticipated that the Hengjaya Mine solar project will reduce diesel consumption by approximately 31 million litres over the 25-year projected project life. HM and some of its subcontractors (PT STM and PT Buana) are using biodiesel (B30) to shift 48% of the total diesel consumption towards more renewable energy.

Waste

Waste Treatment Policy & Statistics

Nickel Industries acts responsibly across the life cycle of our activities, from project conception, through to execution and operation, till the closure of our activities, to manage risks and impacts related to waste generation by promoting the '4R' principles: reduce, reuse, recycle, and recovery. In addition, we are also working collectively with the local stakeholders in our sites and project areas to promote responsible waste management as part of our long-term sustainability commitments. [306-1] [306-2]

By implementing the 4R concept and ensuring the safe storage and disposal of waste and process residues. We manage overburden in our disposal areas to ensure that drainage issues can be identified, organised and rehabilitated to support stable and safe structures. Our hazardous waste storage areas adhere to applicable laws and regulations, including Indonesia Minister of Environment and Forestry Regulation No. P.12/Menlhk/Secretary-General/PLB.3/5/2020 on Hazardous Waste Storage and Indonesia Government Regulation No. 101 of 2014 on Hazardous Waste Management. The Company coordinates and collaborates with relevant agencies to manage generated hazardous waste through accepted waste processing methods in our operational areas.

Our technological approach to waste management entails the following activities:

- establishing sufficient temporary waste storage around the project site;
- collecting waste from temporary waste storage periodically and transporting it to the landfill;
- establishing a garbage disposal area around the activity site to prevent workers from throwing garbage carelessly and polluting the surrounding waters;
- establishing a location for workers to dispose of faeces (septic tank); and
- accommodating remnants of lubricating oil, fuel, and or other hazardous waste that may pollute the waters.

Meanwhile, our socioeconomic approach entails the following measures:

- instilling the discipline of properly disposing of waste in the entire workforce;
- implementing healthy behaviour principles in the corporate environment;
- completing permits for hazardous waste; and
- conducting specialised training for hazardous waste management workers.

At Hengjaya Nickel and Ranger Nickel, waste is sorted into three types: organic waste, inorganic waste, and hazardous waste. Domestic waste generation is recorded by IMIP while the hazardous waste is handed over to the licensed carriers of hazardous waste. We ensure that the carriers and processors of hazardous waste have permits according to the regulations, in which every transportation of this waste is equipped with a manifest so that every transportation data is always recorded in accordance with regulations. The amount of waste generated in 2021 is listed below: [306-3] [306-4] [306-5]

Hengjaya Nickel	Waste Generated	Waste Diverted from Disposal	Waste Directed to Disposal
Waste Composition			
Organic Waste	169.90 tonnes	-	169.90 tonnes
Inorganic waste	90.89 tonnes	-	90.89 tonnes
Slag Nickel Pig Iron	2,043,673 tonnes	-	2,043,673 tonnes
Used oil	1.08 tonnes	0.9 tonnes	0.18 tonnes
Used Battery	1.46 tonnes	1.28 tonnes	0.18 tonnes
Used filter	0.05 tonnes	0.04 tonnes	0.01 tonnes
Used clot/majun	0.04 tonnes	-	0.04 tonnes

Ranger Nickel	Waste Generated	Waste Diverted from Disposal	Waste Directed to Disposal
Waste Composition			
Organic Waste	209.66 tonnes	-	209.66 tonnes
Inorganic Waste	112.15 tonnes	-	112.15 tonnes
Slag Nickel Pig Iron	2,052,886 tonnes	-	2,052,886 tonnes
Used oil	0.90 tonnes	0.72 tonnes	0.18 tonnes
Used Battery	0.45 tonnes	0.13 tonnes	0.32 tonnes
Used filter	0.05 tonnes	0.04 tonnes	0.01 tonnes
Used clot/majun	-	-	-

Additionally, Hazardous and Toxic waste at Hengjaya Mine is managed and processed by third parties. [306-3]

Type of Hazardous and Toxic Waste	Management Method	2020	2021
Used oil	Processed by the third parties	13.90 tonnes	4.98 tonnes
Contaminated clot		0.13 tonnes	0.02 tonnes
Used filter		0.14 tonnes	0.23 tonnes
Used battery		0.35 tonnes	0.07 tonnes

Social Performance

Nickel Industries seeks to contribute positively to the places we operate. We are driven by an intrinsic sense of duty and have long believed that we must emphasise human well-being and societal advancement to be a sustainable business. We work to create a harmonious society and strengthen communities through our operations, activities, initiatives, and other resources that improve people's livelihoods.

Occupational Health and Safety (OHS)

OHS Policy and Statistics

The Company regards health and safety as a top priority; it is paramount in our industry. We are committed to upholding rigorous health and safety standards, striving to keep our workplaces injury- and illness-free, and actively promoting a zero-accident work culture in every aspect of our operations. Our objective is to achieve 'Zero-Harm' for our employees, contractors, and the surrounding communities in which we operate.

Our commitment to a safe work environment is reflected in our Occupational Health and Safety (OHS) policies that were designed to protect our employees, contractors, suppliers, and other workers. Effective implementation of OHS policies demonstrate our commitment as a mining company. OHS in the Company itself is achieved by cultivating employee habits that prioritise OHS; when good habits are practised repeatedly and continuously, they become ingrained in our behaviour and culture.

The implementation of an OHS management system in a company is a requirement under Article 87 of Law 13 of 2003 on Manpower, which states that companies must implement an Occupational Health and Safety Management System that is integrated with a company's management system. HNI and RNI have implemented an Occupational Health and Safety Management System by adhering to applicable OHS laws and regulations, implementing risk management procedures, and adhering to OHS standards. HNI and RNI will implement the OHS Management System in the future, and it is hoped that by implementing this system, the Company will be able to maintain a healthy work environment that is also safe, efficient, and productive. Additionally, implementing an OHS and Environmental Management System can assist the Company's leaders in implementing OHS standards.

Occupational Health and Safety Management System [403-1][403-3] [403-8]

We maintain a compliant occupational health and safety management system for all employees, contractors, visitors, and other stakeholders. Our OHS management system is based on the following seven principles: Policy; Planning; Organisation and Personnel; Implementation; Evaluation and Follow-up; Documentation; and Management Review. The implementation of the OHS management system aims to ensure the safety and health of all employees and contractor/supplier workers and mining operations.

Our operations in Indonesia comply with Indonesia Law No. 1 of 1970 – on Occupational Safety and Health; Decree of the Director General of Indonesia Minister of Energy and Mineral Resources (MEMR) no 185.K37.04 DJB 2019 concerning Technical Guidelines for Mining Safety and OHS Management System; Indonesia MEMR Decree No. 1827 K 30 MEM 2018 regarding Guidelines for the Implementation of Good Mining Engineering Rules; Indonesia MEMR Regulation No. 26 2018 concerning the Implementation of Good Mining Rules and Supervision of Mineral and Coal; and Indonesia Ministerial Regulation No. 38 of 2014 concerning the Implementation of the Mining Safety Management System for Mineral and Coal.

Additionally, we develop and implement occupational health and safety management system standards in line with mine safety management systems.

Our OHS policies include the following:

1. conducting hazard identification and risk assessment for all Company activities and determining risk controls to reduce risk to the accepted levels;
2. determining occupational health and safety targets objectives and regularly evaluating their achievement;
3. developing and implementing mine occupational health and safety as well as operational safety programmes by involving all employees to prevent occupational health and safety incidents, including occupational illness;
4. developing safe work procedures, providing appropriate personal protective equipment and safety equipment, and facilitating training and capacity development for our employees in every aspect of OHS;
5. reporting unsafe events and conditions and 'stop the job' until corrective actions have been made;
6. enforcing continuous improvement by evaluating Occupational Health and Safety Management system performance through internal and external audits and follow up of any non-conformances; and
7. implementing the emergency response and preparedness procedures, providing resources and regular testing to ensure their effectiveness.

We practise our 7 Golden Rules policy that applies to all employees, contractors, visitors, and other stakeholders:

7 Golden Rules

- It is forbidden to work if you are not healthy/fit and not using the correct Personal Protective Equipment ('PPE')
- It is forbidden to use the equipment without following the working procedures or procedures for use
- It is forbidden to work at height without using the required personal fall protection device
- It is forbidden to operate or modify the equipment unless by the competent workers who have the authority to do so
- Do not remove, bypass or modify the safety protection device without permission
- Do not use lifting equipment beyond the criteria for using the tool or place yourself under the lifting process
- Do not enter restricted areas or areas without permission

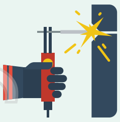
Our policies are reviewed regularly, documented, implemented, and communicated to all employees, contractors, visitors, and other stakeholders.

To assess OHS execution, the Company periodically performs an internal audit of the Mining Safety Management System ('MSMS'). This is a shared responsibility for all companies operating in the mining industry.

The MSMS audit is a systematic and independent review of the Company's compliance with predetermined criteria to quantify the results of planned and implemented activities in the execution of MSMS.

This MSMS audit is conducted to verify compliance with the seven elements of MSMS by analysing the system's ability to ensure compliance with applicable laws and regulations, as specified in the Indonesian Director General of Minerals and Coal Decree 185/7.04/DJB/2019.

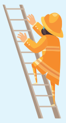
Hazard Identification, Risk Assessment, and Incident Investigation [403-2]



Types of High-Risk Jobs
Working with heat

Description of Activities and Risks
Welding, cutting, grinding

Mitigation
Implementing Hazard Identification and Risk Assessment Determining Control (HIRADC) process, enacting Standard Operational Procedures (SOPs) and Job Safety Analysis (JSA), inspection and observation, promoting Near-Miss Report (NMR), training & education (internal), issuing permit to work, provision of Personal Protective Equipment (PPE) according to the type of work (face shield, apron, special hand gloves, welding screen, etc.)



Types of High-Risk Jobs
Working at height

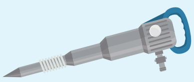
Description of Activities and Risks
All work carried out at height (minimum 1.8 metres from ground/floor level)

Mitigation
Implementing Hazard Identification and Risk Assessment Determining Control (HIRADC) process, enacting Standard Operational Procedures (SOPs) and Job Safety Analysis (JSA), inspection and observation, promoting Near-Miss Report (NMR), training & education (internal), issuing permit to work, provision of Personal Protective Equipment (PPE) according to the type of work (full body harness with shock absorber, static line, etc.)

Types of High-Risk Jobs
Working near water

Description of Activities and Risks
Activities around water (barging activity, water sampling, etc.)

Mitigation
Implementing Hazard Identification and Risk Assessment Determining Control (HIRADC) process, enacting Standard Operational Procedures (SOPs) and Job Safety Analysis (JSA), inspection and observation, promoting Near-Miss Report (NMR), training & education (internal), issuing permit to work, provision of Personal Protective Equipment (PPE) according to the type of work (ring buoy, life jacket, etc.)



Types of High-Risk Jobs
Work using electric tools

Description of Activities and Risks
Use of Electrical Tools (hand grinding, hand drill, etc.)

Mitigation
Implementing Hazard Identification and Risk Assessment Determining Control (HIRADC) process, enacting Standard Operational Procedures (SOPs) and Job Safety Analysis (JSA), inspection and observation, promoting Near-Miss Report (NMR), training & education (internal), issuing permit to work, electrical tagging, provision of Personal Protective Equipment (PPE) according to the type of work (face shield)

Types of High-Risk Jobs
Work Using Lifting Equipment and Transport

Description of Activities and Risks
Lifting using lifting equipment (Manitou Forklift) and Transport (heavy equipment, dump truck, etc.)

Mitigation
Implementing Hazard Identification and Risk Assessment Determining Control (HIRADC) process, enacting Standard Operational Procedures (SOPs) and Job Safety Analysis (JSA), inspection and observation, promoting Near-Miss Report (NMR), training & education (internal), issuing permit to work, electrical tagging, provision of safety signs, provision of Personal Protective Equipment (PPE) according to the type of work, providing Licenses of Competency.

Occupational Health Services [403-3]

Some of the health services and facilities provided by the Company to employees:

- provision of First Aid Station facilities according to standards;
- health facilities: one doctor and four nurses;
- medical checkup: for all employees; and
- COVID-19 vaccination;
- every month, all employees are given vitamins;
- 1x24 hour Health Service for all employees in need (sick/unfit);
- conducting annual Health Risk Assessments (HRAs) by MKK Doctors (Master of Occupational Medicine); and
- conducting canteen inspections.

Worker Participation, Consultation, and Communication on Occupational Health and Safety [403-4]

- We established a Mining Safety Committee which is responsible for managing OHS performance;
- The Head of Mining Engineering leads the safety committee on site with the participation of members (Operational Supervisor, Technical Supervisor, Competent Mining Technical Personnel, Mining OHS and Mining Operational Safety) who have been appointed by Company management and approved by the committee and employee representatives;
- The Safety committee meeting is held at least once a month; and
- The General Safety Tool Box Meeting is held once a week (Monday).

HNI and RNI's participation, communication, and consultation processes include the following:

1. conducting Safety Talks prior to the beginning of work activities;
2. safety patrols to conduct OHS Inspections;
3. Safety signs/OHS banners;
4. emergency response procedure;
5. reviewing applicable laws and regulations;
6. investigation of accidents and follow-up evaluation;
7. reporting of workplace accidents and occupational health diseases;
8. internal/external OHS consultations; and
9. OHS meetings.

OHS Training and Education

We provided OHS training to both employees and contractors throughout the reporting period as part of our human capital development programme. Due to the COVID-19 pandemic, some training was conducted online, while face-to-face training adhered to strict health protocols.

One of our additional initiatives to maintain a strong OHS culture in in our operations was the adoption of weekly Safety Talks to share knowledge about OHS culture with all employees. The sharing opportunity is rotated amongst departments, with each meeting focusing on a different aspect of OHS. Regular safety meetings serve as an excellent reminder to all employees of the critical nature of implementing OHS.

For example, on January 11, 2021, our project in Hengjaya Mine participated in the 2021 National OHS Month by hosting an opening ceremony with the topic 'Optimising Community Self-Reliance Cultivated OHS in the Industrial. Revolution 4.0-Based Era Information Technology.' that served as the kick-off for Hengjaya Mine's series of OHS competitions, aiming to further increase employee understanding of OHS implementation.

Nickel Industries also provides programmes for Basic Life Support Training. This programme equips participants with the knowledge and skills necessary to maintain life when confronted with life-threatening situations. This course focuses on performing CPR (Cardiac Pulmonary Resuscitation) and is designed to educate individuals who encounter cases/incidents of cardiac arrest or respiratory arrest on the job or in the surrounding region. This CPR serves as a reminder to all employees of the critical nature of OHS.

In the last three years, staff at HNI and RNI have undertaken relevant training and workshops on OHS, such as first-aid simulation, firefighter skills, safety of handling chemical substances, and many others, to make sure that our personnel have sufficient knowledge and skills to run our operations safely.

Worker Training on Occupational Health and Safety [403-5]

OHS Training for Employee at Hengjaya Mine

Type of Training	2019		2020		2021	
	Number of participants	Number of Training Hours	Number of participants	Number of Training Hours	Number of participants	Number of Training Hours
Working at Height	25 HM 9 Contractor	4 Hours	5 Contractor	4 Hours	0	0
Near Miss Report	68 HM 4 Contractor	2 Hours	12 HM	2 Hours	27 HM 9 Contractor	2 Hours
HIRADC	0	0	0	0	4 Contractor	4 Hours
Incident Investigation (ICAM Method)	3 HM	4 Hours	0	0	0	0
ERT Training (Basic Life Support)	15 HM 2 Contractor	4 Hours	15 HM 3 Contractor	4 Hours	28 HM 1 Contractor	4 Hours
ERT Training (Fire Fighting)	9 HM 21 Contractor	4 Hours	62 HM 12 Contractor	4 Hours	0	0
ERT Training (Kendrick Extrication Devices)	9 HM	4 Hours	0	0	8 HM	4 Hours
ERT Training (Emergency Reporting)	8 HM	4 Hours	0	0	0	0
Confined Spaces	4 HM	4 Hours	0	0	0	0
Lock Out Tag Out (LOTO)	8 HM 6 Contractor	4 Hours	0	0	0	0

Employee Health Promotion
[403-6]

Health promotion activities carried out:

- banner installations;
- socialisation in internal meetings/general safety toolbox meetings; and
- sharing videos related to health protocols via a Whatsapp group.

Additionally, through our collaboration at IMIP, we provide an emergency clinic where employees who are ill or have work-related accidents can be picked up and transported to the clinic via an ambulance, to receive medical treatment. This clinic is a 24-hour health care facility that offers outpatient polyclinic, inpatient, and emergency unit services.

Prevention and Mitigation of OHS Impacts Directly Related to Operations [403-7]

Efforts to prevent and handle COVID-19:

- temperature measurement for all employees who will enter the mining work area;
- implementation of strict health protocols;
- distributing masks to all employees;
- conducting rapid tests on each employee returning home, entering the site, or returning from a visit/outside the Morowali area;
- employees who are infected with COVID will receive treatment in accordance with the SOP, which may include self-isolation; and
- carrying out fatigue checks and alcohol/drug testing. [403-10]

The Company's approach to preventing and mitigating the Negative Impact of OHS is to educate employees about OHS standards in order to protect their health, increase work efficiency, and prevent workplace accidents and diseases. The benefits include the ability to anticipate the presence of hazard-causing factors and take preventive measures in advance, to comprehend the various types of hazards present in the workplace, to assess the level of hazards present, and to control the occurrence of hazards, including Business Relations within the scope of HNI and RNI.

Work-Related Injuries & Work-Related Ill Health [403-9] [EM-MM-320a.1]

Number of Occupational Accidents at Hengjaya Mine

Description	2019	2020	2021*
Occupational Accident			
• Light	6	3	7
• Heavy	1	0	0
• Fatal	1	0	1
Lost Time Injury Frequency Rate (LTIFR)	1.07	0.00	2.75
Total Injury Frequency Rate (TIFR)	4.27	1.47	20.30
Total	8	3	8

Calculation of work accidents based on 1,000,000 hours worked
*There were changes in the calculation methods in 2021 to comply with the Indonesia Ministry of Energy and Mineral Resource's new standard.

Number of Occupational Accidents at Hengjaya Nickel

Description	2019	2020	2021
Fatality	-	-	-
Loss Time Injury	-	-	-
Restricted Work Day Case	-	-	-
Medical Treatment Injury	2	4	1
First Aid Treatment	4	9	9
Total	6	13	10

Number of Occupational Accidents at Ranger Nickel

Description	2019	2020	2021
Fatality	-	-	-
Loss Time Injury	-	-	-
Restricted Work Day Case	-	-	-
Medical Treatment Injury	-	-	-
First Aid Treatment	-	11	10
Total	-	11	10

Our commitment to occupational health and safety management is paramount, and we believe that all injuries, fatalities, and occupational diseases are preventable. However, we are deeply saddened to report that one fatality occurred in November 2021 at Hengjaya Mine. Before this, we recorded over five million hours of work without LTIs or fatalities at the mine site. We believe that any loss of life is intolerable and are committed to eliminating fatalities across our organisation. The Company has taken this incident seriously and with utmost care, working together with authorities to develop mitigation procedures to avoid a repeat of this accident in the future.

COVID-19 Response

Additionally, to mitigate the effect and spread of COVID-19, we made modifications to our procedures to make our project sites safer for our employees, contractors, visitors, and other stakeholders to work in. The Company complies with and refers to Morowali Bupati Regulation No. 25 of 2020 Concerning Guidelines for the Implementation of a New Normal in Handling COVID-19. This is accomplished by implementing our Standard Operating Procedures for COVID-19 prevention—early detection and screening.

Preventive measures include disinfection actions to avoid the spread of COVID-19 in the office area, dormitory, canteen, security posts, preparations, prayer rooms, transportation equipment entering and exiting the area, and other locations where our staff conduct business.

Additionally, our health protocol is put in place to prevent the spread of infection, which includes frequent hand washing, covering of the mouth and nose while coughing or sneezing, fully cooking meat and eggs in the canteen, maintaining a safe distance, avoiding crowds, and restricting mobilisation and engagement where necessary.

Protocols and procedures for early detection include the distribution of questionnaires to assess health, body temperature checks at entry/exit checkpoints, mask mandates, medical examinations, and patient referrals to hospitals and public health facilities in the event of COVID-19-related symptoms. We assist our employees in regularly conducting antigen and polymerase chain reaction ('PCR') swab tests for personnel who travel to and from the site.

With regular use of these principles, the Covid-19 pandemic in our operational sites may be correctly anticipated, and our personnel can maintain a healthy and safe environment.

Human Capital Development

Training and Education Policy and Statistics

Nickel Industries continues to design and invest in human capital development programmes that help our employees develop the skills and knowledge they need to advance within our Company.

Despite the challenges posed by the COVID 19 pandemic throughout the reporting period we still held various training and education programmes, including in person and virtual sessions.

Average Hours of Training per Year per Employee* [404-1]

Total Training Participants by Employee Category and Gender

Employee Category	2020		2021	
	Male	Female	Male	Female
Permanent	4	1	42	6
Contract	0	0	0	0
Total	4	1	42	6

Average Hours of Training

Year	Total Training Hours	Average per Participant		Average per Employee	
		Total	Average	Total	Average
2021	1,288	48	26.83	263	4.90
2020	320	5	64	234	1.37

Programmes for Upgrading Employee Skills in 2021* [404-2]

Training Programme	Participants	Training Hours
OHS management system implementation	1	40
OHS management system auditor	1	152

*Notes: Data from Hengjaya Mineralindo

Diversity and Equal Opportunity

Diversity and Inclusion Policy

The Company has a strong commitment to diversity and recognises the value of attracting and retaining personnel with different backgrounds, knowledge, and expertise. We are focused on fostering an inclusive culture and creating a more diverse, inclusive team at every level. We aim to set the tone at the top through a diverse board and executive team.

The Company recognises that diversity not only encompasses gender but extends to age, ethnicity, religious or cultural background, language, marital or family status, and disability.

The Board of Directors is responsible for designing and overseeing the implementation of its diversity policy. The directors of the Company are responsible for promoting diversity within the Company's culture and monitoring the effectiveness of this diversity policy.

The Company recognises that it needs to provide management with appropriate guidance to foster a value for diversity within its management culture. To achieve this, the Company is committed to providing its management with the appropriate training and resources to understand the benefits of diversity in recruitment strategies and day-to-day management strategies. The Board are also required to develop initiatives that will promote and achieve diversity goals.

Meanwhile, all personnel are required to act in a manner that supports diversity within the workplace and promotes the objectives set out in this diversity policy.

Employees are encouraged to provide feedback to management regarding programmes or initiatives which will improve the Company's approach to diversity and inclusion in the workplace.

Diversity of Governance Bodies and Employees* [405-1]

Age Group	Total Employees					
	2019		2020		2021	
	Male	Female	Male	Female	Male	Female
< 30 years old	88	9	80	10	106	16
30-50 years old	100	15	121	12	122	9
> 50 years old	11	2	11	0	9	1
Total	199	26	212	22	237	26

Ratio of Basic Salary and Remuneration of Women to Men [405-2]

There is no difference in the basic salary and remuneration earned by women and men **(1:1 ratio).**

Maternity Leave

Information regarding maternity leave provided by the Company to employees in 2021.

Number of Maternity Leave* [405-1]

Number of employees entitled to maternity leave	19
Number of employees who took maternity leave	1
Number of employees who returned to work in the reporting period after maternity leave ended	1

Turnover Rate* (%)

2020	2021
13 employees = 6%	28 employees = 11 %

*Data from Hengjaya Mineralindo

Employee Statistics [102-8][102-41]

Up until the end of 2021, based on the Hengjaya Mine's data, the Company employs 263 people, consisting of 237 or 90% male employees and 26 or 10% female employees. All employees are protected under Indonesia's Law No.13 of 2003 concerning Manpower and Law No.11 of 2020 on Job Creation, and we do not have any part-time employees.

Employee Profile [102-8]

Number of Employees in 2021 Based on Employment Status and Gender

Employment Status	Male		Female		Total	
	Total	%	Total	%	Total	%
Permanent Employees	203	77	24	9	227	86
Temporary Employees	34	13	2	1	36	14
Total	237	90	26	10	263	100

Number of Employees in 2021 Based on Employment Status and Placement

Placement	Permanent Employees		Temporary Employees		Total	
	Total	%	Total	%	Total	%
Site	213	86	36	15	249	100
Head Office	14	5	0	0	14	100
Total	227	91	36	15	263	100

Number of Employees Based on Position and Gender

Position	2019		2020		2021	
	Male	Female	Male	Female	Male	Female
Director	2	0	2	0	2	0
Manager	4	0	4	0	5	0
Superintendent	8	0	13	1	13	1
Supervisor	20	2	26	4	28	4
Staff	35	15	42	17	52	21
Non-staff	126	13	125	0	137	0
Total	195	30	212	22	237	26
	225		234		263	

Local Communities

Local Communities Policy and Statistics

Nickel Industries is committed to encouraging economic growth and providing quality welfare to the communities around the mining activities. The Company is fully aware that mining activities are expected to have positive impacts on the communities and the surrounding environment, including for internal and external stakeholders.

The Company believes that it is very important to contribute to improving the wellbeing of communities around our projects in the most appropriate and meaningful ways. We seek to develop programmes related to the communities' needs, with a long-term economic development vision, to avoid reactive social investments to create mutual value throughout and beyond the life of our operations.

We base our corporate social and environmental responsibility programmes according to Indonesia Minister of Energy and Resource Regulation No. 11/2018 on Procedures for Granting Licensing and Reporting Areas on Mining Business Activities, Indonesia Law No. 40/2007 and Indonesia Government Regulation No. 47 of 2012. Our programmes aim to encourage the development of economy, education, socio-culture, health, the environment, welfare, and community independence around our area of operations in a sustainable manner.

Flagship CSR Programmes [413-1]

The Company provides many flagship CSR initiatives that contribute indirectly to the achievement of the SDGs while also directly benefiting the communities in which we operate. In 2021, the priority areas for our social empowerment programmes focused mainly on waste, clean water resources, and COVID-19-related donations.

The Company routinely contributes to charitable causes, including through charitable grants or donations, financial or other assistance, or sponsorship of a person or activity on a charitable basis, without expecting or accepting favourable action or the exercise of influence. We promote genuine care both within and outside the Company to develop mutually beneficial relationships with the communities in which we operate.

Our charitable donations included the following:

- provisions for earthquake victims in West Sulawesi, working directly with the provincial Ministry of Energy and Natural Resources and Governor's office;
- staple food donations at One Ete Village;
- staple food donation at Lafeu Village;
- donating sacrificial cows on the Feast of Idul Adha (Islamic festival);

- donation of waste truck units to eight villages within two districts around Hengjaya Mine' operational area; and
- donation to Mount Semeru victims in Lumajang, West Java.

We believe that clean water access is a fundamental human right and that waste management is inextricably linked to this. Recognising this, we have aided communities with facilities and infrastructure necessary for clean water. These efforts include the following:

- monitoring Water Reservoirs Construction at Bete-Bete; and
- monetary donation for Bete-Bete Village to support Clean Water Infrastructure.

Although the COVID-19 pandemic is a hard hit to public health, the epidemic's effect extends to the economic and social sectors. We believe we must participate in and contribute to the prevention and control of epidemics, and the mitigation of their effects, by launching the COVID-19 Disaster Care Programme.

The Company is committed to assisting the Government in its efforts to minimise the effects of COVID-19 through the following efforts:

- donation of 2750 masks;
- donation of 25 Oxygen Tanks to North Morowali Hospital;
- donation of 25 Oxygen Tanks to Morowali Hospital; and
- provision of dozens of food packages to impoverished residents in the Tangofa and Puungkeu villages.

Education is one of the priority areas for our social empowerment. We implement various initiatives to enhance the educational level in our areas of operation. We believe these activities in the long-term will help improve the quality of human capital of our local communities. Our contributions in the field of education include the renovation and construction of new facilities at TK Kartini Kindergarten.

Human Rights

Human Rights Policy

Nickel Industries commits to respect human rights and the interests of cultures, customs and values of employees and communities affected by our activities. We believe that all individuals are born equal and have certain inherent rights.

While governments are responsible for protecting human rights, we and other companies uphold those rights. In other words, responsibility for human rights is shared. Respect for human rights is fundamental for the Company to establish and maintain confidence with its customers, colleagues, and other stakeholders, and to minimise risk to individuals and enterprises.

We respect the rights of workers by not employing child or forced labour; avoiding human trafficking; eliminating harassment and discrimination; respecting freedom of association and collective bargaining; and providing a mechanism to address workers grievances. As a result, given the absence of such violation of human rights, these topics have relatively lower priorities for this Report. Whilst, the Company acknowledges the importance of these topics and continually strives to improve and uphold human rights where possible.

Operations that Have Been Subject to Human Rights Reviews or Impact Assessments [412-1]

Indonesia
Country of operations

1
Total Number

33%
Percentage

CSR Collaboration at the IMIP

In addition, our operational activities at the IMIP have allowed us to jointly collaborate with our neighbouring companies and industries in the development and implementation of CSR activities within the surrounding area through PT IMIP. Together, our efforts have allowed us to create a more significant impact in communities in education and training, provision of infrastructure, environmental conservation, healthcare, religious donations and activities, and COVID-19 related donations.

Sustainability Governance

Governance Structure

Corporate Governance is about having a set of core values and behaviours that underpin the Company's activities and ensure transparency, fair dealing and protection of stakeholders' interests. Since its incorporation, the Company has set a corporate governance framework in compliance with regulatory requirements and international best practices.

Nickel Industries is committed to conducting its business activities and governing the Company by best practices of corporate governance to the appropriate extent to the size and nature of the Company's operations. As a publicly-listed company, the Company complies with the recommendations set out in the Corporate Governance Principles and Recommendations of the ASX Corporate Governance Council.

A complete description of the Company's current corporate governance practises is set out in the Company's Corporate Governance Statement which can be viewed on our website.

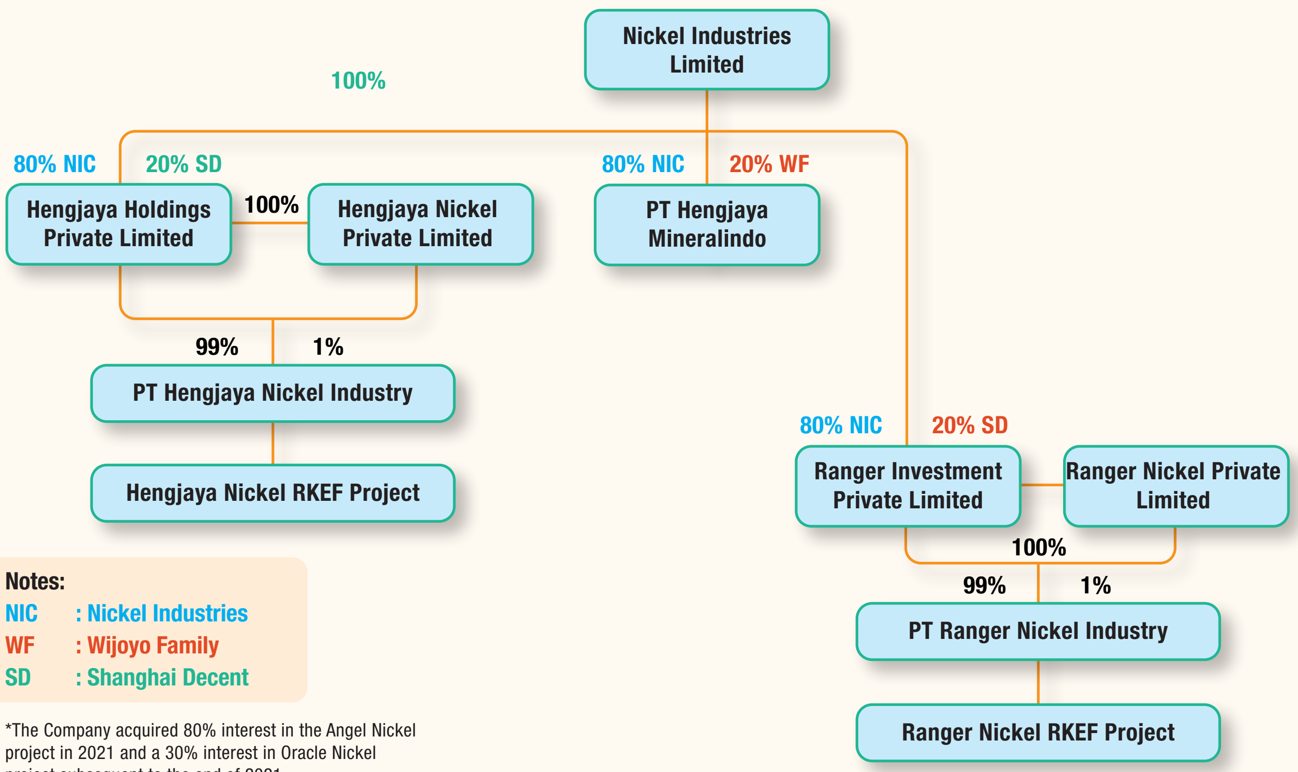
Furthermore, the Company, primarily through its operating subsidiaries, is exposed to a range of economic, environmental and social sustainability risks. The Company has inherent exposure to market volatility and operational risks which can have potentially adverse impacts on the Group.

The Company manages these risks through the following means:

- maintaining adequate funding where possible and monitoring of future rolling cash flow forecasts of our operations, which reflect expectations of financial returns, assets and liabilities;
- dealing with regulated financial entities in Australia and Indonesia;
- seeking experts' advice on environmental issues and adopting appropriate environmental management programmes; and
- seeking to foster appropriate community relations with stakeholders, both present and future.

In 2021, Nickel Industries appointed its first ever sustainability manager in Indonesia to manage the environmental, social, and governance ('ESG') aspects of the Company's operations, helping to ensure the Company delivers on its ESG commitments and align the organisation's business model with its sustainability strategy and to assist the implementation of this strategy with a direct reporting line to our Chief Operating Officer ('COO'). Moreover, sustainability is a collective responsibility for all of the board and directors of the Company. [102-18]

Organisational Structure*



Notes:
NIC : Nickel Industries
WF : Wijoyo Family
SD : Shanghai Decent

*The Company acquired 80% interest in the Angel Nickel project in 2021 and a 30% interest in Oracle Nickel project subsequent to the end of 2021.

Good Mining Practices

Precautionary Principle [102-11]

Nickel Industries always follows a mining process in compliance with Good Mining Practices at our Hengjaya Mine, which is carried out comprehensively through planning, staged implementation, and periodic evaluations. The Good Mining Practices implemented by the Hengjaya Mine are in accordance with the obligations stated in the Indonesia Minister of Energy and Mineral Resources (MEMER) Regulation No. 26 of 2018 and Indonesia MEMR Ministerial Decree 1827K/30/MEM/2018.

In its implementation, the following activities are carried out:

1. good mining technical implementation;
2. implementation of mineral conservation that utilises all minerals by the specified level limits;
3. implementation of mining activities by the principles of Occupational Health and Safety; and
4. implementation of environmental management, including reclamation activities.

Hengjaya Mine's Business Permit is located in Morowali District, Central Sulawesi Province. There were excavation activities in two blocks in 2021, namely Bete-Bete Block and Central Block. The mining process is carried out independently in both blocks, according to the characteristics of the nickel laterite deposits.

Our mining activities include
- preliminary exploration;
- advanced exploration, resource drilling and geological modelling;
- geotechnical studies;
- land clearing;
- topsoil stripping and storage;
- material transfer cover;
- ore excavation and quarrying;
- ore transport to temporary storage;
- ore testing in laboratories;
- ore shipping to end users for processing;
- rehabilitation planning, monitoring and operations;
- community relations;
- technical support;
- medical services; and
- compliance and financial reporting.

To supervise mining activities, a comprehensive MSMS is implemented, which encompasses policies, planning, organisation, and personnel, implementation, monitoring, evaluation, follow up, management review, workplace improvement and risk management.

Our planning occurs periodically, beginning with five-year planning and progressing through annual, quarterly, monthly, weekly, and daily planning. This planning entails geological modelling of the exploration results, preparation and approval of the optimal pit designs, provision of auxiliary digging-transport equipment, and schedule according to project requirements.

Our Mine Planning Department is responsible for the preparation of these activities through initiatives detailed below:
1. conducting daily, weekly, and monthly coordination meetings with mining contractors to discuss the achievement of periodic targets;
2. reviewing the plans submitted by the mining contractors so that they are in line with the annual targets and in compliance with licensing regulations;
3. conducting daily internal meetings for the implementation of routine and additional tasks; and
4. periodic reviews of actual results versus planned production.

Summary of mined materials and their management [MM3]

Description	Related environmental risk	Management
Overburden	Landslide, sedimentation when it rains	• Management of overburden disposal by geotechnical studies; and • Regular monitoring to reduce the risk of landslides.
Rock	Landslide, sedimentation when it rains	Utilisation of rock for road lining in the pits
Tailing	No tailings are produced in the PT Hengjaya Mineralindo IUP	No tailings are produced in the PT Hengjaya Mineralindo IUP
Sludge	No sludge is produced in the PT Hengjaya Mineralindo IUP	No sludge is produced in the PT Hengjaya Mineralindo IUP

Minimising and optimisation of land clearing is carried out in the following ways:

1. by optimising the stripping ratio based on available geological information so that only the cleared land in an area that actually contains ore body material or an amount of land required for mine infrastructure;
2. optimising the selection of mining location, especially avoiding areas with waterways, such as rivers and lakes, to reduce the potential of water flow contamination and allow successful rehabilitation;
3. observing the administrative boundaries given by the government and providing certain distances between pits and boundaries to reduce the risk of land clearing in areas that are not allowed by the permits; and
4. demarcate, design and install various controls to minimize soil erosion, sediment run off from all active mine areas.

Designing pits by the Mine's life requires consideration of the surrounding natural topography, water flow, and ore requirements within-grade limits and detailed final rehabilitation and landform.

In instances when mine pits are located adjacent to the license boundary, a pit design boundary and final landform is determined to ensure sufficient distance from the permitted limit is maintained.

With the progression of time and the growing market demand for nickel, plans have been made and reviewed periodically to expand mining production and optimise the project's resources. Apart from utilising saprolite nickel ore for RKEF production, Hengjaya Mine has begun to supply nickel limonite ore in 2021 to end-users for hydrometallurgical processing to produce products for electric vehicle battery market. Both types of ore materials are hauled or shipped to the industrial park factories for final metallurgical processing.

Optimisation of limonite conservation is carried out in the following ways:

1. collecting data on areas that have reserves of low-grade ore (limonite) according to the specified grade limit;
2. plan mining sequence so low-grade ore (limonite) materials can be easily identified and mined and can be utilised for metallurgical processing; and
3. coordinating departments to separate low-grade ore (limonite) from saprolite ore according to the nickel grade and mineral elements so that it is separated from overburden material and sent to intermediate stockpiles.

Following the increase in production, we continue to expand the exploration and ore storage areas, and the ore stockpiles storage area was excavated and covered. Additionally, we are well advanced in the construction of an 18-kilometre-long special haul road connecting the Hengjaya Mine area to the Industrial Park processing factory, this will reduce ore transport time by replacing barge transport with truck transport.

Significant efforts have been made to improve the quality of mining processes. Among other things, this includes reusing material from open pits for access construction, designing material storage areas that follow the natural topography of the site, creating settling ponds that are proportional to the catchment area and rate of deposition, optimising excavation to meet specified level limits, and optimising material mixing to obtain the appropriate grade of ore. Other mine optimisations have been a result of more detailed mine planning and scheduling, therefore, reducing ore and waste rehandling.

Efforts for medium-term mining operations:

1. collecting data on available resources and reserves by level limits;
2. identifying new areas that are increasing the project's resources and reserves;
3. planning the drilling activities with a certain drilling spacing to better understand the volume of resources and reserves;
4. scheduling the mining process and sequencing in accordance to the capacity of the production equipment;
5. developing a pit design by the optimisation of the stripping ratio and content values; and
6. carrying out periodic control and reconciliations over the mine's plans so that accurate adjustments can be made to the schedule or design of the mining pit.

Anti-corruption

The Company is committed to complying with the laws and regulations of the countries in which it operates. These laws include the Criminal Code Act 1995 (Australia) and any other anti-corruption law of a country or a state, territory or province of a country in which the Company operates, or which otherwise applies to the Company by its partners or third parties operating on the Company's behalf. The Company has not yet conducted an internal assessment and analysis of its anti-corruption policy for 2021, owing to the fact that this is the Company's first Sustainability Report and the material topics that are prioritised. Nevertheless, efforts are being made to continuously improve and broaden the scope of anti-corruption measures in order to bolster governance. The Company intends to implement a more robust policy, combined with anti-corruption training for relevant employees in 2022. [205-1]

We have placed safeguards in our internal policies that minimise the Company's exposure to corruption, strengthened our internal training and communications to ensure effective anti-corruption policies for all employees, and upheld integrity as a core element in our corporate culture. We strive to continuously improve our efforts to mitigate and prevent corruption and will do better at demonstrating our commitment.

Specifically, the Company is committed to:

a. not engage in corrupt business practices;
b. implement measures to prevent bribery and corruption by all personnel;
c. at a minimum, endeavour to comply with all applicable laws, regulations and standards, including Anti-Bribery and Corruption Laws; and
d. when dealing with third parties, undertake reasonable due diligence to ensure that such parties are suitable for the Company to associate with and will not take bribes or perform corrupt acts on the Company's behalf or for which the Company may be or become responsible for, or otherwise liable.

The Company has adopted a Code of Conduct, Anti-Bribery and Corruption Policy, Whistleblower Policy and a Securities Trading Policy that applies to all directors, officers, employees, consultants, contractors and advisors of the Company. The Company is committed to acting ethically and responsibly. The policies are available on the Website.

In 2021, the Company did not receive any report where the interests and responsibilities of the employees conflicted with the Company nor our anti-bribery and corruption policy. [205-3]

SR Asia sustainability defined | GREAT Global Responsibility and Accountability | AA1000 Licensed Report 000-174/V3-4LCMM

Independent Assurance Statement

The 2021 Sustainability Report of Nickel Industries Limited

Number : 03/000-174/II/2022/SR-Asia/Indonesia

Assurance Type : Type 1 assurance
Assurance Level : Moderate
Reporting Standards : GRI Standard 2020 Consolidated, GRI G4 Mining and Metals (MMSS)

Dear stakeholders,

Nickel Industries Limited ("the Company" or the "Reporting Organization") has engaged **Social Responsibility Asia** ("SR Asia") in the evaluation of its **2021 Sustainability Report** ("the Report") for the reporting periodof **January 1st to December 31st, 2021.** The Reporting Organization is a publicly listed Australian companythat manufactures nickel pig iron (NPI), a key ingredient in the production of stainless steel. This is the Independent Assurance Statement ("the Statement") indicating the results of assurance work following specific methods and approaches as agreed by the "Management[1]".

Intended User and Purpose

The purpose of the Statement is to present our opinion including the findings and recommendations based on the results of assurance work to the Company's stakeholders. The Assurance Team in accordance with specific procedures and a specific scope of work carried out the assessment. Except for the areas covered in the scope of the assurance, we encourage all NOT to solely interpret the Statement as the basis to conclude the Company's overall performance or sustainability.

Responsibilities

As agreed with Management, SR Asia is responsible for conducting an assessment, NOT an audit, of the Report content and developing recommendations as well as the Statement as described in the scope of assurance. The Management is exclusively responsible for presenting data, figures, and information in the content of the Report. in As stated in the Non-Disclosure Agreement and the Engagement Agreement, SR Asia is responsible for presenting assurance results only to Management. We accept NO responsibility for any other reason or to any other individual or organization. Any third-party reliance on the Report is entirely at their own risk.

Independence, Impartiality, and Competency

To ensure its independence, SR Asia adheres to a strict assurance protocol as well as an ethical code of conduct. We also performed a pre-engagement assessment prior to the assurance work to evaluate the risks of engagement as well as the independence and impartiality of the experts leading the assurance work. We confirm that the assurance experts do not have any relationships with the Company that can influence their ability to produce unbiased and objective reviews and statements. SR Asia also certifies

[1] *Management refers to the management of the Company who was in charge for the sustainability report assurance project*

that The Assurance Team have sufficient work experience and knowledge of sustainability report writing, AA1000 AccountAbility principles and standards, ISO 26000 projects, SUSBA, TCFD, SASB, GRI Standards, and POJK 51/POJK.03/2017.

Type and Level of Assurance Service

1. **Type 1 assurance** on the Report content with respect to the AA1000 Assurance Standard v3 and AA1000APS (2018) AccountAbility Principles.
2. A **moderate level of assurance** to address **risks of information and conclusions of the Report being error is reduced, meaning not reduced to very low, but not zero**.

Scope and Limitation of Assurance Service

1. Data and information in the Report for the period of **January 1st to December 31st, 2021**.
2. Material topics presented in the Report: **Local Communities; Occupational Health and Safety; Economic Performance; Human Capital Development; Energy & Emission; Diversity and Equal Opportunity; Good Mining Practices.**
3. Adherence to the Consolidated set of GRI Sustainability Reporting Standards 2020 ("GRI Standard") and GRI G4 Mining and Metals Sector Disclosure ("GRI-G4 MM") issued by the Global Reporting Initiative;
4. Evaluation of publicly disclosed information, system, and process of the Company to ensure adherence of the Report content to the reporting principles.
5. SR Asia does NOT include financial data, information, and figures in the Report content. We assumed that the Company, independent parties, or other parties associated with the Company have verified and/or audited financial statements, data, and information.

Exclusion

1. Stakeholders' engagement, which may be involved in developing the Report.
2. Financial data and information from the Company's documents other than those mentioned in the Report.
3. Aspects of the Report other than those mentioned under the defining materiality section and discussion on defining Report content.
4. Data and information outside the reporting period and/or in the public domain not covered in the reporting period.
5. Forward-looking statements and claims describe opinion, belief, expectation, advertisement, and future planning.
6. Evaluation of the adherence of the Report content to the Task Force on Climate-Related Financial Disclosures (TCFD) and Sustainability Accounting Standard Board (SASB) standards and disclosures.

Methodology and Source of Disclosure

1. Form an Assurance Team whose members are the experts in sustainability report development and assurance
2. Perform pre-engagement phase to ensure the independence and impartiality of the Assurance Team
3. Carry out initial analysis on the Report document submitted by the Company
4. Evaluate data and information against the standards, principles, and indicators of AA1000AS v3, AA1000APS (2018), GRI Standards, GRI-G4 FS, and POJK 51

5. Assess indicators data, including tracing back data to the sources, especially those related to material aspects
6. Review inline information relevant and significant to the sustainability context of the Company
7. Discuss online the results of the analysis with the Management and data contributors
8. Apply SR Asia Protocol on Assurance Analysis and use SR Asia Great Assurance Tool digital platform
9. Release the Independent Assurance Statement that SR Asia International has approved
10. Issue the Management Letter

Adherence to AA1000AP (2018) and GRI Standards

***Inclusivity* –** Presentation of the Company's stakeholders is inclusive. The Reporting Organization has stated its commitment to conduct responsible business operations. The Reporting Organization also has included sustainability aspects into its risk management and business strategy, such as accommodating climate change as part of risk and opportunity concerns.

***Materiality* –** The content of the Report includes material topics that are relevant to the business entity operating in the extractive industry. The Report identified and fairly represented topics from all three aspects of sustainability: economics, social, and environmental. The Company conducted a materiality assessment process, but no specific criteria with a minimum threshold were recorded.

***Responsiveness* –** The Company has indicated sufficient responses to its sustainability aspects and sustainable development. The Company already has the whistleblower policy to accommodate complaints and grievances or reporting of unethical conducts. The Company is going to developing carbon reduction roadmap in the upcoming year. In over all, procedures and initiatives for developing responses are integrated across management functions and practices, supported by ongoing and continuous communication with the stakeholders.

***Impact* –** The Company has sufficiently presented quantitative data and qualitative information on the economic, environmental, and social impacts of its business operations and decisions. However, the Reporting Organization is expected to engage third party to perform an impact assessment, mainly on its social aspects, including human rights.

***In "Accordance" with Core Option* –** Based on the assurance work and findings, the SR Asia team concluded that the Report has been prepared and adheres to the Core Option of GRI Standards. At least one disclosure of each material topic is adequately presented in the Report. The DMA disclosure, if applicable, is well presented. However, we encourage the Company to disclose more indicators of the Mining and Metals sector's (MMSS) performance in future reporting.

GRI Standards Principles – The Report follows the Principles for Determining Report Content (stakeholder inclusiveness, sustainability context, materiality, and completeness) as well as the Principles for Determining Report Quality (balance, timeliness, comparability, accuracy, clarity, and reliability). During the assurance work, the Management provided excellent support by submitting evidence documents as requested.

SR Asia sustainability defined | GREAT Global Responsibility and Accountability | AA1000 Licensed Report 000-174/V3-4LCMM

Recommendation

1. To conduct a more strategic and well-documented stakeholder engagement management as indicated by the AA1000 Stakeholder Engagement Standard (AA1000SES 2015).
2. To strengthen alignment of sustainability commitments with the Sustainable Development Goals (SDGs) when applicable with certain indicators and targets.
3. To improve and disclose more comprehensive and detail the method of each stakeholder engagement following the topic concerns.
4. To create an integrated management system across functions that covers sustainability performance data and information from various units or functions while adhering to sustainability reporting standards, approaches, and methodologies.
5. To identify and measure social impacts by engaging the third parties and using the globally-accepted impacts assessment methods, approaches, and standards.

The assurance provider,

Jakarta, 21th of February 2022

Birendra Raturi
International Director
Social Responsibility Asia

AA1000 Licensed Report 000-174/V3-4LCMM

Dr.Se[illegible]aka
Country Director for Indonesia
Social Responsibility Asia

Social Responsibility Asia (SR Asia)

International
4F-CS-25, Ansal Plaza, Vaishali, Ghaziabad (NCR Region Delhi), Uttar Pradesh 201010, INDIA
Landline / Mobile: +91-120-4103023; +91-120-6452020 / +91-9810059109
E-mail: info@sr-asia.org, Website: www.sr-asia.org

Indonesia
PT Sejahtera Rambah Asia, #1607 Splendor Tower, Soho Pancoran,
Jl. MT Haryono Kav.2-3, Jakarta 12810, INDONESIA
Landline: +62-21-5010 1504, E-mail: services@srasia-indo.com, Website: www.srasia-indo.com

GRI Standard Content Index [102-55]

GRI Standard		Disclosure	Page
GRI 102: General Disclosures 2016	102-1	Name of the organisation	19
	102-2	Activities, brands, products, & services	24-25
	102-3	Location of headquarters	19
	102-4	Location of operations	19,24
	102-5	Ownership and legal form	19
	102-6	Markets served	25
	102-7	Organisation scale	28
	102-8	Information employees	54
	102-9	Supply chain	27
	102-10	Significant changes	27
	102-11	Precautionary Principle or approach	58
	102-12	External initiatives	22
	102-13	Membership of associations	22
	102-14	Statement from senior decision-maker	8
	102-16	Values, principles, standards, and norms of behaviour	9
	102-18	Governance structure	58
	102-40	List of stakeholder groups	13
	102-41	Collective bargaining agreements	54
	102-42	Identifying and selecting stakeholders	13
	102-43	Approach to stakeholder engagement	13
	102-44	Key topics and concerns	13
	102-45	Entities included in the consolidated financial statements	3
	102-46	Defining report content and topic Boundaries	3
	102-47	List of material topics	14
	102-48	Restatements of information	3
	102-49	Changes in reporting	3
	102-50	Reporting period	3
	102-51	Date of the most recent report	3
	102-52	Reporting cycle	3
	102-53	Contact point for questions regarding the report	3
	102-54	Claims of reporting in accordance with the GRI Standards	3
	102-55	GRI content index	66-69
	102-56	External assurance for the report	3, 62-65

GRI Standard		Disclosure	Page
Material Topics			
Economic Performance			
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	15
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 201: Economic Performance 2016	201-1	Direct economic value generated and distributed	28
	201-2	Financial implications and other risks and opportunities due to climate change	25
	201-3	Defined benefit plan obligations and other retirement plans	28
Indirect Economic Impact			
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	18
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
Indirect Economic Impacts 2016	203-1	Infrastructure investments and services supported	28
	203-2	Significant indirect economic impacts	28
Anti-Corruption			
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	18
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 205: Anti-corruption 2016	205-1	Operations assessed for risks related to corruption	61
	205-3	Confirmed incidents of corruption and actions taken	
Energy			
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	16
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 302: Energy 2016	302-1	Energy consumption within the organisation	40
	302-2	Energy consumption outside of the organization	41
	302-3	Energy intensity	41
	302-4	Reduction of energy consumption	41
Water and Effluent			
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	17
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 303: Water and Effluent 2018	303-1	Interactions with water as a shared resource	30
	303-2	Management of water discharge-related impacts	30
	303-3	Water withdrawal	31

GRI Standard		Disclosure	Page
Biodiversity			
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	18
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 304: Biodiversity 2016	304-2	Significant impacts of activities, products, and services on biodiversity	32
GRI Metals and Mining Supplement Sector 2013	MM2	The number and percentage of total sites identified as requiring biodiversity management plans according to stated criteria and the number (percentage) of those sites with plans in place	33
Emission			
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	16
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 305: Emission 2016	305-1	Direct (Scope 1) GHG emissions	36
	305-2	Energy indirect (Scope 2) GHG emissions	36
	305-4	GHG emission intensity	37
Waste			
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	18
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 306: Waste 2020	306-1	Waste generation and significant waste-related impacts	42
	306-2	Management of significant waste-related impacts	
	306-3	Waste generated	43
	306-4	Waste diverted from disposal	43
	306-5	Waste directed to disposal	43
Occupational Health and Safety			
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	15
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 403: Occupational Health and Safety 2018	403-1	Occupational health and safety management system	45
	403-2	Hazard identification, risk assessment, and incident investigation	47
	403-3	Occupational health services	45, 47
	403-4	Worker participation, consultation, and communication on occupational health and safety	48
	403-5	Worker training on occupational health and safety	49
	403-6	Promotion of worker health	50
	403-7	Prevention and mitigation of occupational health and safety impacts directly linked by business relationships	50

GRI Standard		Disclosure	Page
GRI 403: Occupational Health and Safety 2018	403-8	Workers covered by an occupational health and safety management system	45
	403-9	Work-related injuries	50
	403-10	Work-related ill health	50
		Human Capital Development	
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	17
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 404: Training and Education 2016	404-1	Average hours of training per year per employee	52
	404-2	Programme for upgrading employee skils	52
		Diversity and Equal Opportunity	
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	17
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 405: Diversity and Equal Opportunity 2016	405-1	Diversity of governance bodies and employees	53
	405-2	Ratio of basic salary and remuneration of women to men	53
		Human Rights	
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	19
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 412 : Human Rights Assessment 2016	412-1	Operations that have been subject to human rights reviews or impact assessments	56
		Local Communities	
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	15
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI 413 : Local Communities 2016	413-1	Operations with local community engagement, impact assessments, and development programmes	55-56
		Good Mining Practices	
GRI 103: Management Approach 2016	103-1	Explanation of topic material's and boundaries	16
	103-2	Management approach and its components	
	103-3	Evaluation of management approach	
GRI Metals and Mining Supplement Sector 2013	MM3	Total amounts of overburden, rock, tailings and sludge and their associated risks	59

SASB: Metals and Mining

Topic		Description	Page
Greenhouse Gas Emissions	EM-MM-110a.1	Gross global Scope 1 emissions, percentage covered under emissions-limiting regulations	36
Air Quality	EM-MM-120a.1	Air emissions of the following pollutants: (1) CO, (2) NOx (excluding N_2O), (3) SOx, (4) particulate matter (PM10), (5) mercury (Hg), (6) lead (Pb), and (7) volatile organic compounds (VOCs)	38
Energy Management	EM-MM-130a.1	(1) Total energy consumed, (2) percentage grid electricity, (3) percentage renewable	40
Biodiversity Impacts	EM-MM-160a.1	Description of environmental management policies and practices for active sites	32
Workforce Health & Safety	EM-MM-320a.1	(1) MSHA all-incidence rate, (2) fatality rate, (3) near miss frequency rate (NMFR) and (4) average hours of health, safety, and emergency response training for (a) full-time employees and (b) contract employees	50

Feedback Form

Nickel Industries' Sustainability Report 2021 provides an overview of our sustainability performance. We look forward to receiving any input from you regarding this Sustainability Report by sending an email, or completing this form.

Your Profile

Name (if you wish) : ....
Institution/Company : ....
Email : ....
Telephone/Mobile : ....

1. This report is easy to understand

☐ Disagree ☐ Neutral ☐ Agree

2. The report has described positive and negative information concerning the Company:

☐ Disagree ☐ Neutral ☐ Agree

3. Material topic(s) which is(are) the most important to you:
(score 1 = most important; score 13 = least important)

- Local Communities ( )
- Occupational Health and Safety ( )
- Economic Performance ( )
- Good Mining Practices ( )
- Emission and Energy ( )
- Diversity and Equal Opportunity ( )
- Anti-corruption ( )
- Human Rights ( )
- Training and Education ( )
- Water and Effluent ( )
- Waste ( )
- Biodiversity ( )
- Indirect Economic Impact ( )

4. Kindly provide your input/suggestions/comments about this report:

....
....
....

Stakeholders Group

☐ Investor and Shareholder
☐ Employee
☐ Customer
☐ Contractor
☐ Business Partner
☐ Government
☐ Local Community
☐ Other, please state: ....

Thank you for your feedback. Please send this feedback form to the contact listed in this report or directly to:

Nickel Industries Limited
Level 2, 66 Hunter Street,
Sydney, NSW, 2000, Australia
Phone : +61 (2) 9300 3311
Email : info@nickelmines.com.au
Website : https://nickelmines.com.au/

NICKEL INDUSTRIES

www.nickelmines.com.au

KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN
REPUBLIK INDONESIA

MENGANUGERAHKAN PENGHARGAAN
PROGRAM PENILAIAN PERINGKAT KINERJA PERUSAHAAN
DALAM PENGELOLAAN LINGKUNGAN HIDUP

PROPER

PERINGKAT

BIRU

KEPADA

PT. Hengjaya Mineralindo

PERIODE 2019 - 2020

Ir. Sigit Reliantoro, M.Sc.
Sekretaris Direktorat Jenderal Pengendalian Pencemaran dan Kerusakan Lingkungan

KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN
REPUBLIK INDONESIA

MENGANUGERAHKAN PENGHARGAAN
PROGRAM PENILAIAN PERINGKAT KINERJA PERUSAHAAN
DALAM PENGELOLAAN LINGKUNGAN HIDUP

PROPER

PERINGKAT

BIRU

KEPADA

PT Hengjaya Mineralindo

PERIODE 2020 - 2021

Ir. Sigit Reliantoro, M.Sc.
Direktur Jenderal Pengendalian Pencemaran
dan Kerusakan Lingkungan

PEDULI

PT. HENGJAYA MINERALINDO

PPM Report

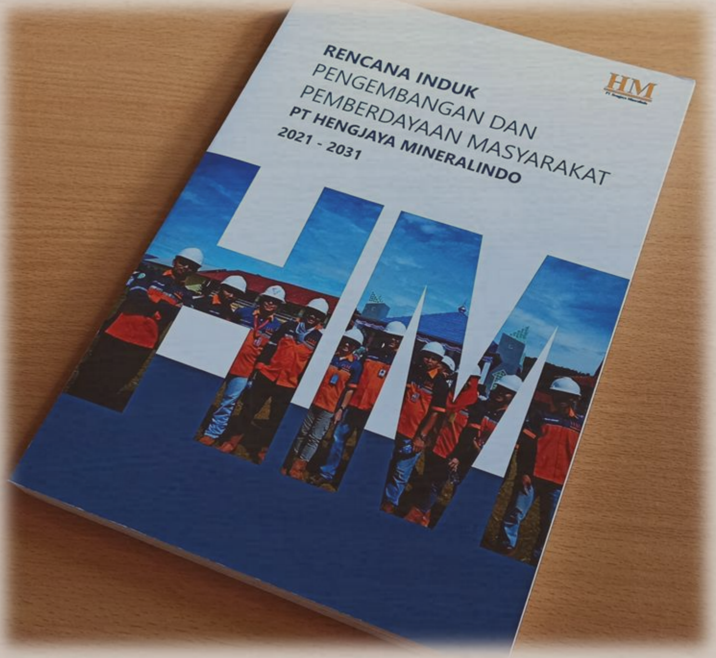
July 2022

In accordance with Government Regulation No. 47/2012 and the Minister of Energy and Mineral Resources Regulation No. 41 of 2016 regarding company obligations and Central Sulawesi Governor Regulation Number 38 of 2019. Therefore, PT Hengjaya Mineralindo (PT. HM) is fully committed to encouraging economic growth and the welfare of the community around mining area.

PT. HM is fully aware that the existence of mining is expected to have a positive impact on the community and the surrounding environment as stated in *the Blueprint for the Community Empowerment Development of Central Sulawesi Province for 2020 - 2024*

Through corporate social and environmental responsibility, the company is obliged to arrange and implement a Community Empowerment Development (PPM) program which includes 8 aspects as a form of the company’s commitment to realizing the concept of Corporate Social Responsibility (CSR) to further encourage the Economy, Education, Social Culture, Health, Environment, Welfare and Self-reliance of communities around mining in a sustainable manner.

Based on the Main Plan for Community Development and Empowerment (RI PPM) which was approved by the Department of Energy and Mineral Resources of Central Sulawesi Province on December 4, 2020. There are 8 main PPM PT HM programs and its derivatives.



1. **EDUCATION**
   - Preschool development facilities
   - Islamic Boarding School development facilities (MI, MTs, MA and Pesantren)
   - E-learning and *Kejar Paket A, B and C*
   - Scholarship
   - Cooperation with local governments in the Certification of Junior High School Teacher Competencies.
   - Competency Training for Educators
   - Vocational Training
   - Internship collaboration
2. **HEALTH**
   - Integrated Healthcare Center Facility
   - Stunting prevention and treatment
   - Health worker training
   - Community-based total sanitation (providing healthy latrines)
   - Facilities for providing public health infrastructure (*Puskesmas* and Pustu)
3. **REAL INCOME AND EMPLOYMENT**
   - PT HM's policy on the utilization of local workers
   - PT HM partnership with *BUM Desa*, Cooperatives and MSMEs
   - Entrepreneurship programs in agriculture, fisheries, plantations and home industries
4. **ECONOMIC INDEPENDENCE**
   - Increasing the added value of plant commodities (food, plantation, horticulture)
   - Plant revitalization (food, plantation, horticulture)
   - Post-harvest management
   - Marker access
   - Fisheries development
   - Optimization of Fishery Processing and Production
   - Fish marketing access
   - Tourism area development
5. **SOCIAL CULTURE AND RELIGION**
   - Mosque and Islamic School-based empowerment facilities
   - Providing worship facilities
   - Local arts and culture development facilities
   - PT HM's participation in Indonesian and regional independence day activities
   - Sports activity facilities
   - Mainstreaming of disaster in the implementation of PPM
   - Emergency and disaster response programs (floods, forest fires, social conflicts, etc.)
6. **ENVIRONMENT**
   - Environmental conservation around the coast
   - Arrangement of residential neighborhoods around the coast
   - Domestic waste management
   - Post-mining land use for the PPM program
7. **INSTITUTIONAL**
   - Alignment of PPM programs and regional and village development plans
   - Community institutional capacity enhancement (*Karang Taruna, Kelompok Perempuan, LKMD, OMS,* etc.)
8. **INFRASTRUCTURE**
   - Development facilities and rehabilitation of integrated service units in the village (population, education and health)
   - Facilities for construction and rehabilitation of farm roads and village markets
   - Agricultural production infrastructure development facilities
   - Tourism supporting infrastructure development facilities
   - Facilities for improving information and communication networks (village internet)

On April 30, 2021 at the Morowali Regent's office hall is a historic day for the villages surrounding the mines of PT Hengjaya Mineralindo and Morowali Regency in general because the Socialization Event of PT Hengjaya Mineralindo's Community Development & Empowerment (PPM) Program in 2020 has been held. The event was attended by elements of regional leadership deliberations including the Head of the Regional Development Planning Agency, related agencies, the Bahodopi Sub-district and representatives of the Bungku Pesisir Sub-district as well as the Village Heads and and the Head of BPD of all villages surrounding the mines of PT Hengjaya Mineralindo.

The event was opened by the Regent of Morowali and also announced that the 2021 PT Hengjaya Mineralindo PPM Program has started. The Regents said that the PPM program is the obligation of all mining companies, where the regulations have been determined so that all parties involved in it must follow according to their respective duties, principals and functions. The Regent also hopes that every village will make good use of the PPM program which will be start because it will be a collaborative development program in villages around the mines of PT Hengjaya Mineralindo. The regent thanked PT Hengjaya Mineralindo for investing in Morowali and always implementing the principles of Good Mining Practice in its activities.

PT. HENGJAYA MINERALINDO

PPM Activity Proposal

Citizens' Aspiration

Exploring community needs, community
Problems and community barriers to
Village potential

Education
Health
Work
Economy
Social Culture
Institutional
Environment
Infrastructure

RPJMDes

6 years

RPJMDes contains a
Longlist of Planned Solutions to Settle
Residents' needs from various sources of funds
(APBD, APBD Provinsi, APBN,
Swadaya, other sources of funds)

PerDes

1 year

Village funds
Swadaya
Third Party (PPM Hengjaya)

PPM Implementation

Reviewing the implementation of a Year of activities
Are the citizens' needs being satisfied or not?

Explore the aspirations of the residents
For the following year

PT HENGJAYA MINERALINDO PPM PROGRAM FLOW

PT. HENGJAYA MINERALINDO

Approved TPK, submitted to HM
For Disbursement

Regency PPM Control Team
Morowali

PT. HENGJAYA MINERALINDO

HM only disburses the TPK that has been
Approved by the Regency

Each TPK Prepares Proposals, submitted to ---->

Disbursement of funds directly to
The TPK account

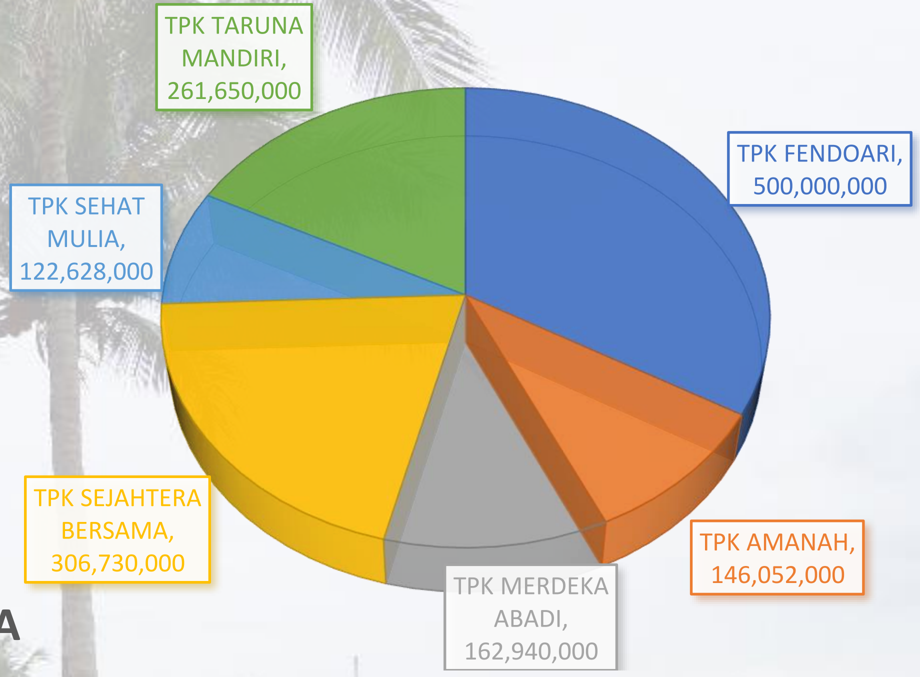
Lafeu	Tandaoleo	One ete	Tangofa	Pu'ungkeu	Bete-bete	Padabaho	Makarti Jaya
250 Juta	250 Juta	250 Juta	1.5 M	500 Juta	4.7 M	500 Juta	250 Juta
Boleh 1 TPK	Boleh 1 TPK	Boleh 1 TPK	Min 3 TPK	Min 2 TPK	Min 9 TPK	Min 2 TPK	Boleh 1 TPK
Education Health Economy Social Culture Institutional Environment Infrastructure	Education Health Economy Social Culture Institutional Environment Infrastructure	Education Health Economy Social Culture Institutional Environment Infrastructure	Education Health Economy Social Culture Institutional Environment Infrastructure	Education Health Economy Social Culture Institutional Environment Infrastructure	Education Health Economy Social Culture Institutional Environment Infrastructure	Education Health Economy Social Culture Institutional Environment Infrastructure	Education Health Economy Social Culture Institutional Environment Infrastructure

PPM 2021 REALIZATION

PERIOD JULY 2022

Desa TANGOFA

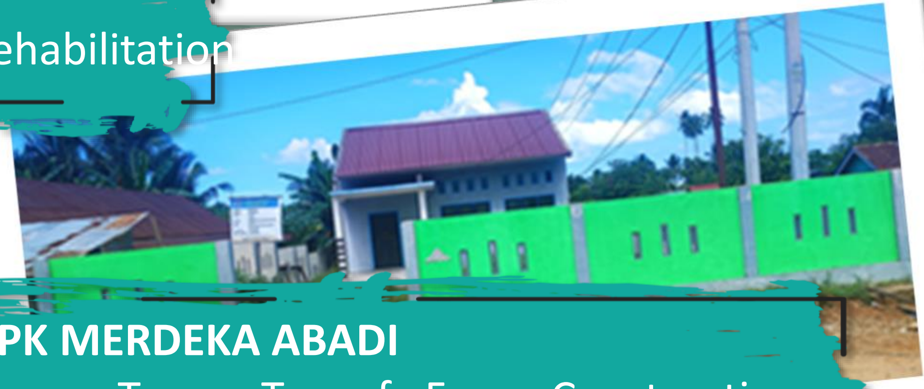
TPK DESA TANGOFA



PROGRESS PPM DESA TANGOFA

TPK FENDOARI
Tangofa Mosque Rehabilitation

TPK AMANAH
Construction of Ablution Place in Tangofa Mosque



TPK MERDEKA ABADI
Karang Taruna Tangofa Fence Construction

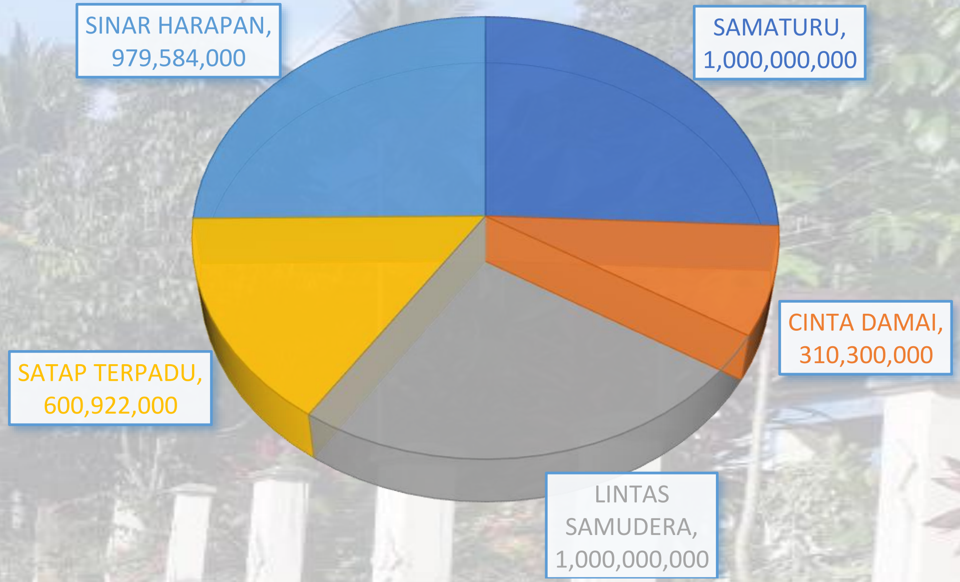
TPK SEJAHTERA BERSAMA
Tangofa Mosque Fence Construction

TPK SEHAT MULIA
Tangofa Elementary School Fence Construction

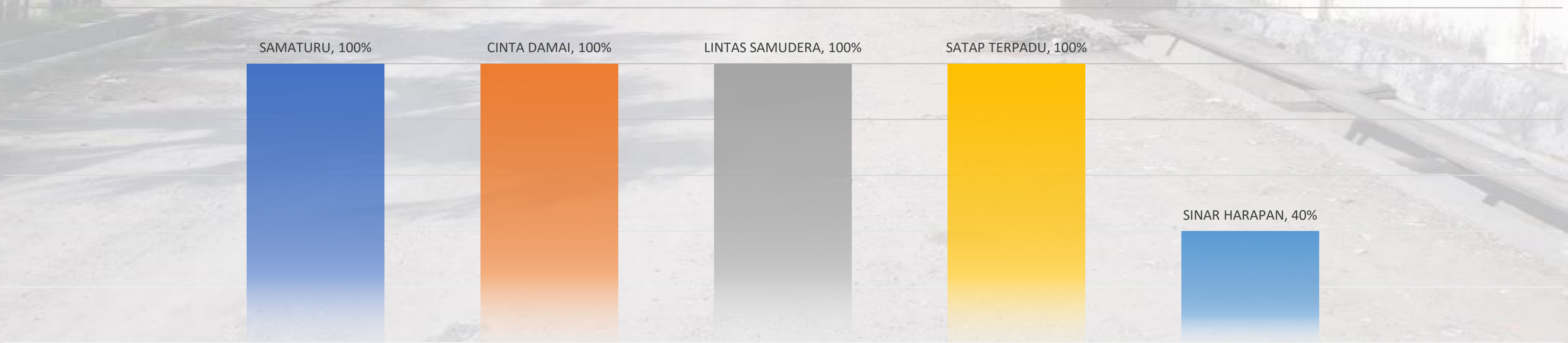
TPK TARUNA MANDIRI
Construction of Drainage and Plat Duiker

Desa BETE BETE

TPK DESA BETE BETE



PROGRESS PPM DESA BETE BETE



TPK SAMATURU
Rabat Concrete Construction

TPK LINTAS SAMUDERA
Dock Rehabilitation

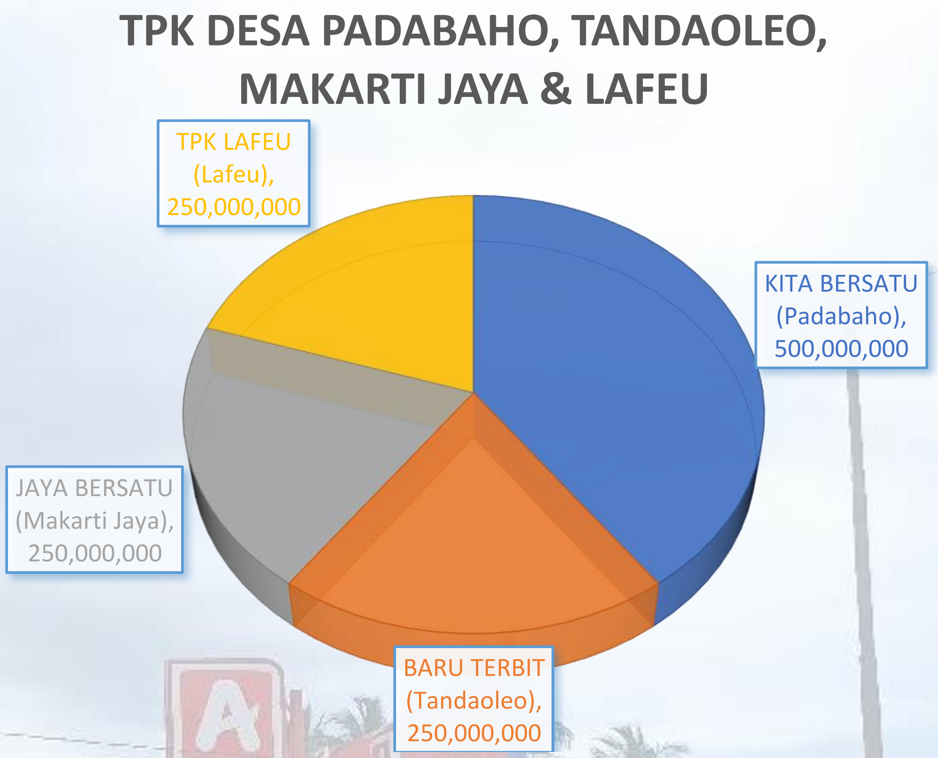
TPK SATAP TERPADU
Construction of Paving Blocks for the countryard of Satu Junior High School

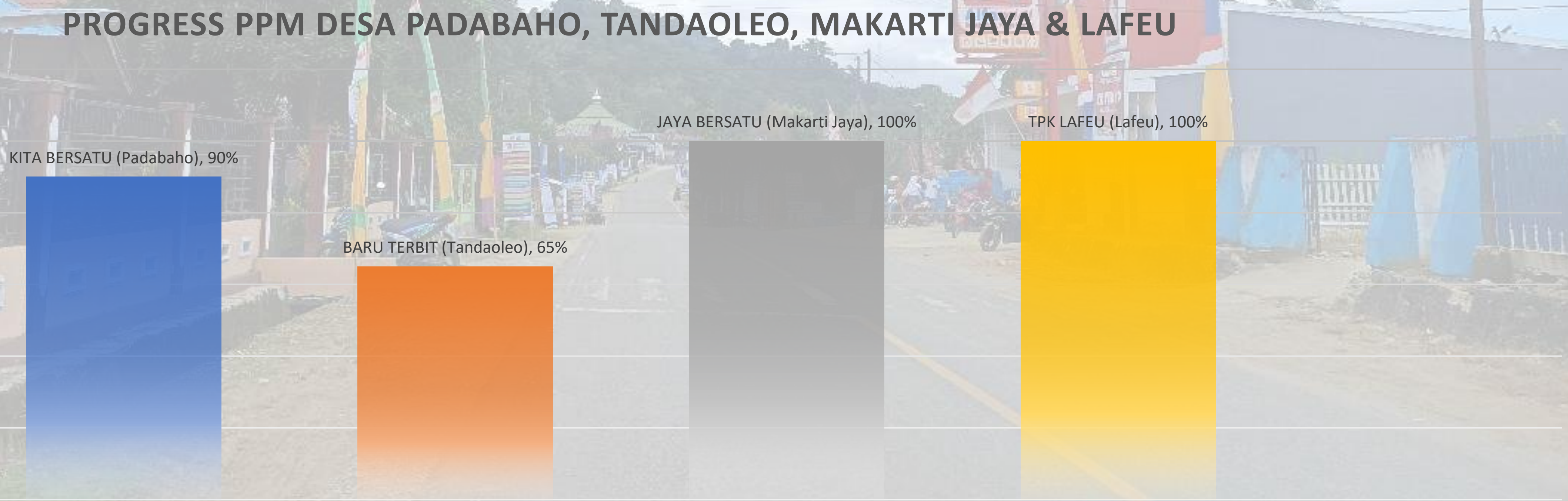
TPK CINTA DAMAI
Providing of Fiber Boats and Katinting Machines for Fishermen

TPK SATAP TERPADU
Satu Junior High School Fence Construction

TPK SINAR HARAPAN
Village market construction

Desa PADABAHO TANDAOLEO MAKARTI JAYA LAFEU





TPK KITA BERSATU
Drainage/Aqueduct

TPK BARU TERBIT
Construction of Islamic School Teacher's House

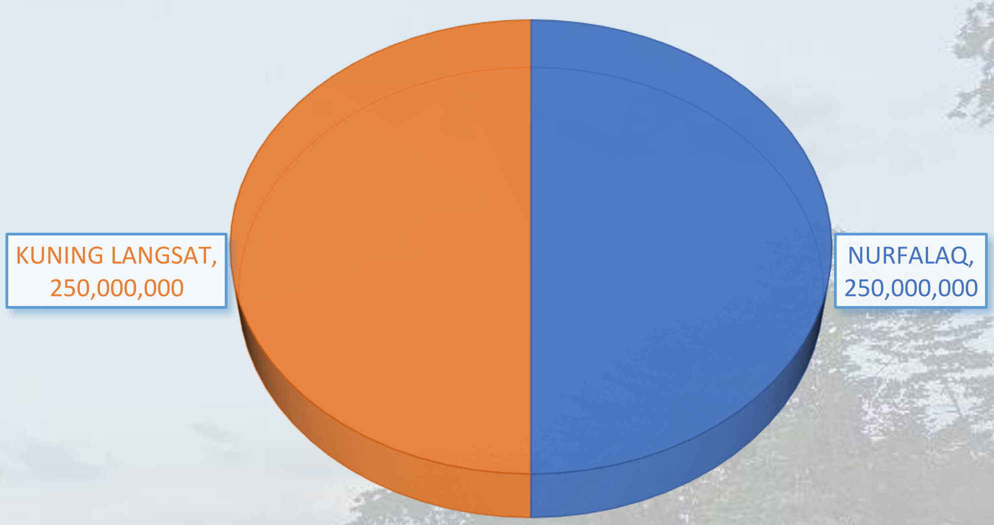
TPK BARU TERBIT
Community Health Center Rehabilitation

TPK KITA BERSATU
Construction of TPA AL Quran

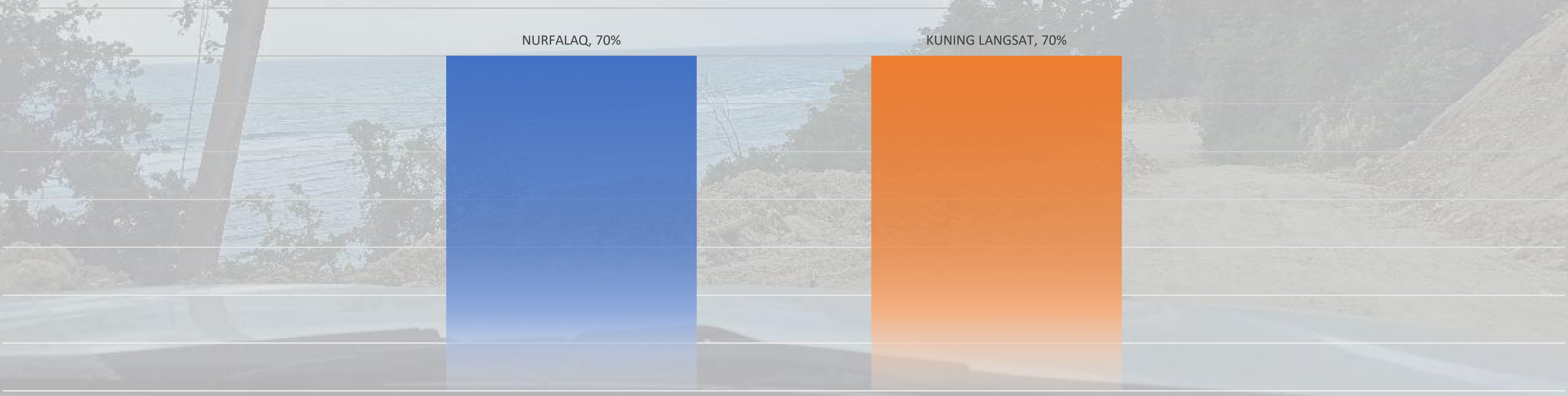
TPK JAYA BERSATU
Football Field Hoarding

Desa PUUNGKEU

TPK DESA PUUNGKEU



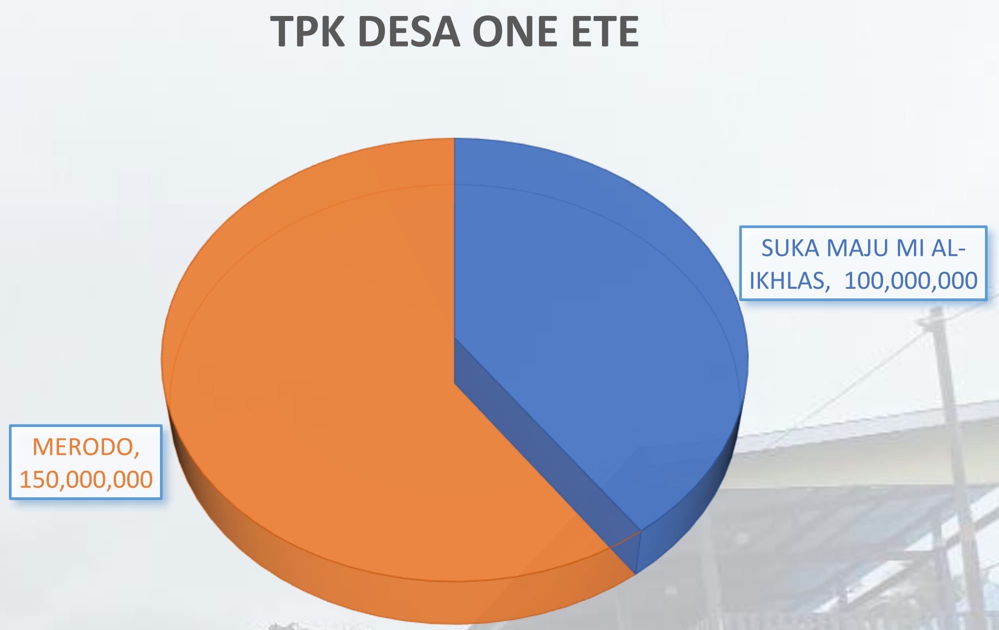
PROGRESS PPM DESA PUUNGKEU

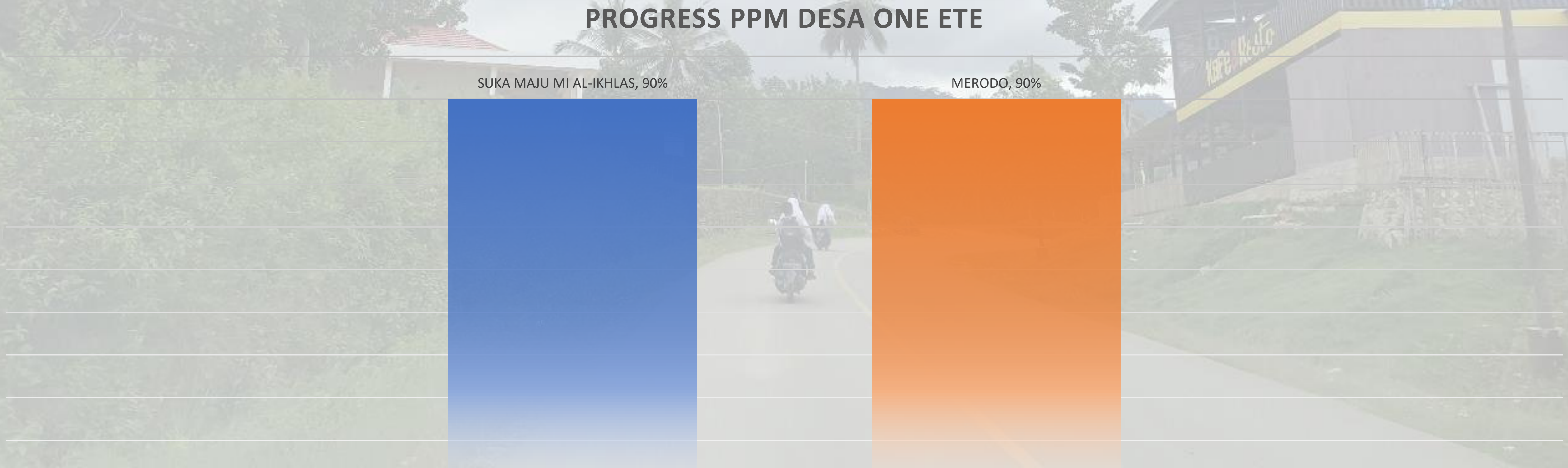


TPK NURFALAQ
Construction of Ablution Place in Puungkeu Mosque

TPK KUNING LANGSAT
Preschool Construction

Desa ONE ETE


TPK DESA ONE ETE
SUKA MAJU MI AL-IKHLAS, 100,000,000
MERODO, 150,000,000


PROGRESS PPM DESA ONE ETE
SUKA MAJU MI AL-IKHLAS, 90%
MERODO, 90%

TPK SUKA MAJU MI AL-IKHLAS
Construction of Ablution Place in Puungkeu Mosque

TPK MERODO
Construction of lavatory and mosque roof terraces

PPM 2021 RECAPITULATION

DESA	RENCANA ALOKASI DANA	NAMA TPK	NAMA KEGIATAN	RENCANA ANGGARAN BIAYA	REALISASI PENCAIRAN DANA	PROGRESS PELAKSANAAN KEGIATAN		SISA DANA	SISA ALOKASI DANA PPM
						Financially	Phisically		
TANGOFA	1,500,000,000	TPK FENDOARI	Rehabilitasi Mesjid Tangofa	500,000,000	500,000,000	100%	100%	-	-
		TPK AMANAH	Pembangunan Tempat Wudhu Mesjid Tangofa	146,052,000	146,052,000	100%	100%	-	
		TPK MERDEKA ABADI	Pembangunan Pagar Karang Taruna Tangofa	162,940,000	162,940,000	100%	100%	-	
		TPK SEJAHTERA BERSAMA	Pembangunan Pagar Mesjid Tangofa	306,730,000	306,730,000	100%	100%	-	
		TPK SEHAT MULIA	Pembangunan Pagar SDN Tangofa	122,628,000	122,628,000	100%	100%	-	
		TPK TARUNA MANDIRI	Pembangunan Drainase dan Plat Duiker	261,650,000	183,155,000	70%	70%	78,495,000	
	1,500,000,000		Jumlah Serapan Dana	1,500,000,000	1,421,505,000	95%	95%	78,495,000	-

PPM 2021 RECAPITULATION

DESA	RENCANA ALOKASI DANA	NAMA TPK	NAMA KEGIATAN	RENCANA ANGGARAN BIAYA	REALISASI PENCAIRAN DANA	PROGRESS PELAKSANAAN KEGIATAN		SISA DANA	SISA ALOKASI DANA PPM
						Financially	Phisically		
BETE-BETE	4,700,000,000	SAMATURU	Pembangunan Rabat Beton	1,000,000,000	1,000,000,000	100%	100%	-	1,175,625,000
		CINTA DAMAI	Pengadaan Perahu Fiber dan Mesin Katinting Kelompok Nelayan	310,300,000	310,300,000	100%	100%	-	
		LINTAS SAMUDERA	Rehabilitasi Dermaga	1,000,000,000	1,000,000,000	100%	100%	-	
		SATAP TERPADU	Pembangunan Paving Block Pelataran SMP Satu Atap	234,491,000	234,491,000	100%	100%	-	
			Pembangunan Pagar SMP Satu Atap	366,431,000	366,431,000	100%	100%	-	
		SINAR HARAPAN	Pembangunan Pasar Desa	613,153,000	245,261,000	40%	40%	367,892,000	
	4,700,000,000		**Jumlah Serapan Dana**	**3,524,375,000**	**3,156,483,000**	**90%**	**90%**	**367,892,000**	**1,175,625,000**

PPM 2021 RECAPITULATION

DESA	RENCANA ALOKASI DANA	NAMA TPK	NAMA KEGIATAN	RENCANA ANGGARAN BIAYA	REALISASI PENCAIRAN DANA	PROGRESS PELAKSANAAN KEGIATAN		SISA DANA	SISA ALOKASI DANA PPM
						Financially	Phisically		
PADABAHO	500,000,000	**KITA BERSATU**	Drainase/Saluran Air	56,927,000	56,927,000	100%	90%	-	-
			Pembangunan TPA AL Quran	443,073,000	443,073,000	100%	90%	-	
	500,000,000		**Jumlah Serapan Dana**	**500,000,000**	**500,000,000**	**100%**	**90%**	**-**	**-**
TANDAOLEO	250,000,000	**BARU TERBIT**	Pembangunan Rumah Guru Pesantren	200,000,000	140,000,000	70%	60%	60,000,000	-
			Rehabilitasi Puskesdes	50,000,000	35,000,000	70%	70%	15,000,000	
	250,000,000		**Jumlah Serapan Dana**	**250,000,000**	**175,000,000**	**70%**	**65%**	**75,000,000**	**-**
MAKARTIJAYA	250,000,000	**JAYA BERSATU**	Penimbunan Lapangan Sepak Bola	250,000,000	250,000,000	100%	100%	-	-
	250,000,000		**Jumlah Serapan Dana**	**250,000,000**	**250,000,000**	**100%**	**100%**	**-**	**-**

PPM 2021 RECAPITULATION

DESA	RENCANA ALOKASI DANA	NAMA TPK	NAMA KEGIATAN	RENCANA ANGGARAN BIAYA	REALISASI PENCAIRAN DANA	PROGRESS PELAKSANAAN KEGIATAN		SISA DANA	SISA ALOKASI DANA PPM
						Financially	Phirically		
PU'UNGKEU	500,000,000	NURFALAQ	Pembangunan Tempat Wudhu Masjid Puungkeu	250,000,000	175,000,000	70%	70%	75,000,000	-
		KUNING LANGSAT	Pembangunan Gedung PAUD	250,000,000	175,000,000	70%	70%	75,000,000	
	500,000,000		Jumlah Serapan Dana	500,000,000	350,000,000	70%	70%	150,000,000	-
LAFEU	250,000,000	TPK LAFEU	Pembuatan Lapangan Bola	250,000,000	250,000,000	100%	100%	-	-
	250,000,000		Jumlah Serapan Dana	250,000,000	250,000,000	100%	100%	-	-
ONE ETE	250,000,000	SUKA MAJU MI AL-IKHLAS	Pembangunan Pagar Sekolah Madrasah	100,000,000	100,000,000	100%	90%	-	-
		MERODO	Pembangunan WC dan atap teras Masjid	150,000,000	150,000,000	100%	90%	-	
	250,000,000		Jumlah Serapan Dana	250,000,000	250,000,000	100%	90%	-	-
	8,200,000,000	Jumlah TPK 19	J U M L A H	7,024,375,000	6,352,988,000	91%	88%	671,387,000	1,175,625,000

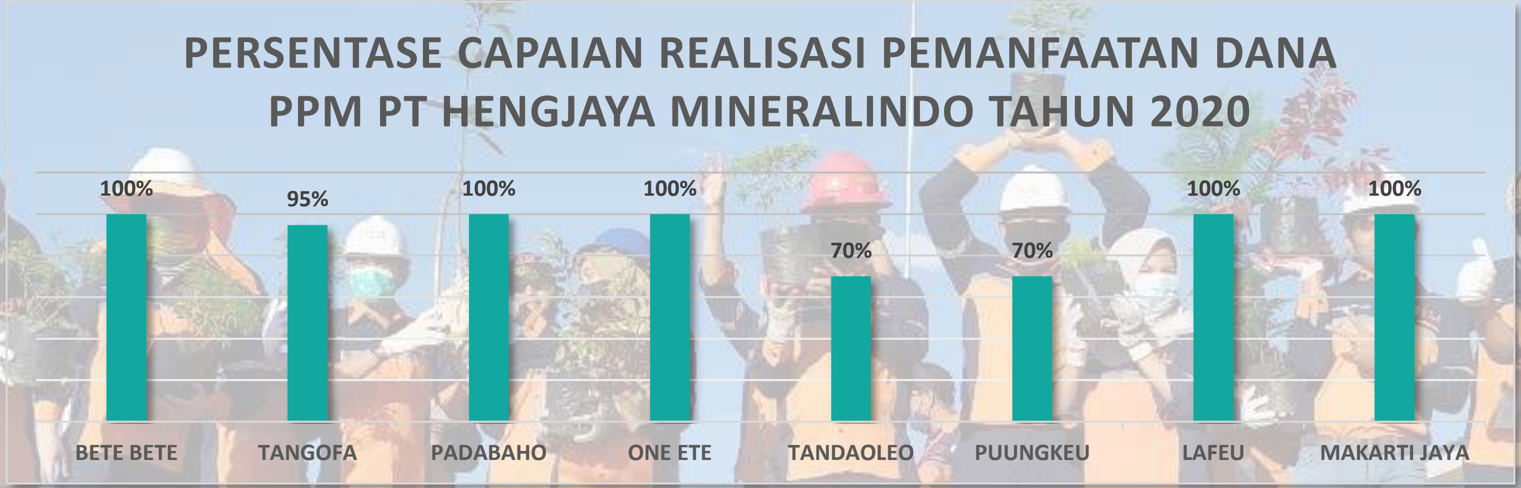
PPM 2021 RECAPITULATION

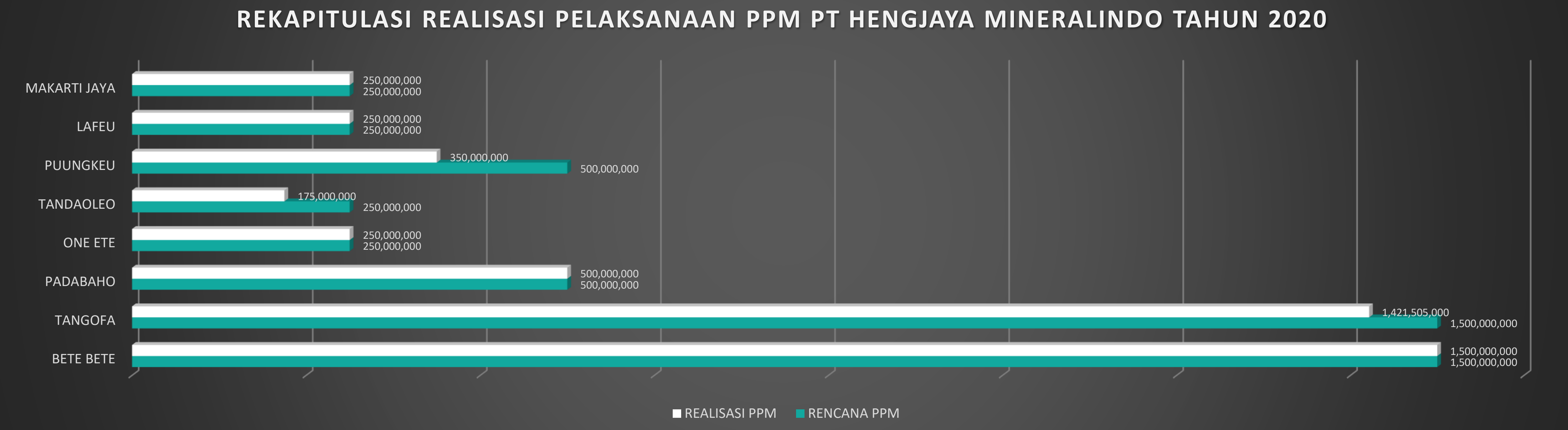
REKAPITULASI LAPORAN PELAKSANAAN PPM PT HENGJAYA MINERALINDO TAHUN 2020

Horizontal (Value) Axis Major Gridlines

NAMA DESA	JUMLAH TPK	JUMLAH PROPOSAL	RENCANA ALOKASI DANA			REALISASI DANA			PERSENTASE REALISASI JUMLAH DANA BANDING SERAPAN DANA DI MASYARAKAT	SISA ALOKASI DANA	KETERANGAN
			PPM	PEMBERDAYAAN DESA (FEE 2017-2019)	JUMLAH	PPM	PEMBERDAYAAN DESA (FEE 2017-2019)	SERAPAN DANA DI MASYARAKAT			
BETE BETE	5	6	1,500,000,000	3,200,000,000	4,700,000,000	1,500,000,000	2,024,375,000	3,156,483,000	67%	1,543,517,000	
TANGOFA	6	6	1,500,000,000	-	1,500,000,000	1,500,000,000	-	1,421,505,000	95%	78,495,000	sisa Termyn 3
PADABAHO	1	2	500,000,000	-	500,000,000	500,000,000	-	500,000,000	100%	-	
ONE ETE	2	2	250,000,000	-	250,000,000	250,000,000	-	250,000,000	100%	-	
TANDAOLEO	1	2	250,000,000	-	250,000,000	250,000,000	-	175,000,000	70%	75,000,000	sisa Termyn 3
PUUNGKEU	2	2	500,000,000	-	500,000,000	500,000,000	-	350,000,000	70%	150,000,000	sisa Termyn 3
LAFEU	1	1	250,000,000	-	250,000,000	250,000,000	-	250,000,000	100%	-	
MAKARTI JAYA	1	1	250,000,000	-	250,000,000	250,000,000	-	250,000,000	100%	-	
	19	22	5,000,000,000	3,200,000,000	8,200,000,000	5,000,000,000	2,024,375,000	6,352,988,000	88%	1,847,012,000	

PPM 2021 RECAPITULATION





Terima Kasih

PT. HENGJAYA MINERALINDO

Head Office	:	Noble House Building, 20nd Floor-Unit No.6 Jl. DR Ide Anak Agung Gde Agung Kav.E.4.2 No.2, Mega Kuningan -Jakarta Selatan, 12950
Telp/Fax	:	021-29183191, 29183192 / 021-29183194
Site Tangofa	:	Desa Tangofa, Kec. Bungku Pesisir, Kab. Morowali, Sulawesi Tengah

HSE – SAFETY STATS 2020

Safety Statistics (Last LTI - November 2019)

PT. HENGJAYA MINERALINDO

Nickel Mines Limited
MONTHLY REPORT
Nickel Mine Project - Tangofa
Agu-20

MAN HOURS RECORD 2020

Year 2020

Month	PT. HM	Yr Cum	Proj Cum	Contractor's	Yr Cum	Proj Cum	Total Yr Cum	Total Proj Cum	Start Jan 2020
Jan-20	44,176	44,176	516,860	140,553	140,553	1,542,189	184,729	2,059,049	Jan 01-31
Feb-20	44,176	88,352	561,036	136,375	276,928	1,678,564	365,280	2,239,600	Feb 01-29
Mar-20	43,975	132,327	605,011	164,455	441,383	1,843,019	573,710	2,448,030	Mar 01-31
Apr-20	36,344	168,671	641,355	84,473	525,856	1,927,492	694,527	2,568,847	Apr 01-30
Mei-20	35,300	203,971	676,655	94,157	620,013	2,021,649	823,984	2,698,304	May 01-31
Jun-20	38,276	242,247	714,931	105,978	725,991	2,127,627	968,238	2,842,558	Jun 01-30
Jul-20	36,752	278,999	751,683	73,420	799,411	2,201,047	1,078,410	2,952,730	Jul 01-31
Agu-20	38,248	317,247	789,931	122,015	921,426	2,323,062	1,238,673	3,112,993	Aug 01-31
Sep-20		317,247	789,931		921,426	2,323,062	1,238,673	3,112,993	
Okt-20		317,247	789,931		921,426	2,323,062	1,238,673	3,112,993	
Nov-20		317,247	789,931		921,426	2,323,062	1,238,673	3,112,993	
Des-20		317,247	789,931		921,426	2,323,062	1,238,673	3,112,993	
Hrs Year 2020	**317,247**			**921,426**			**1,238,673**		
Hrs Since LTI	**379,385**			**1,114,258**			**1,493,643**		

Last LTI date: 12-Nov-19 18-Nov-19
First LTI on 2019: 03-Jun-19
Report date: 31-Aug-20
Safe days on 2020: 244
Safe days since last LTI: 287
Start Project: 01-Jan-19
Number of safe days lost before LTI: 161
Number of safe hours lost before LTI: 1,681,091

PT. HENGJAYA MINERALINDO

Nickel Mines Limited
MONTHLY REPORT
Nickel Mining Project - Tangofa
Agu-20

OHSE PERFORMANCE STATISTIC PROJECT TO DATE

Safety Statistics (Project to Date from 01 Jan 2019)

ACCIDENT / INCIDENT CLASSIFICATION	HM (Project to Date) (Incl. mgmt/Admin/Superv / Direct Labour)		CONTRACTOR (Project to Date) (Incl. mgmt/Admin/Superv / Direct Labour)		PROJECT TOTALS (Project to Date) (Incl. mgmt/Admin/Superv / Direct Labour)	
	This Period	Cumulative	This Period	Cumulative	This Period	Cumulative
Hours Worked	38,248	789,931	122,015	2,323,062	160,263	3,112,993
Average No. of Workers	217		580		797	
Fatalities	0	0	0	1	0	1
Number of Lost Time Injuries (LTI)	0	1	0	2	0	3
Number of safe days lost before LTI	0	154	0	161	0	315
Number of Hours Since Last LTI (12 Nov 2019)	38,248	379,385	122,015	1,114,258	160,263	1,493,643
FATALITIES	0	0	0	1	0	1
LTI	0	1	0	0	0	1
AWI	0	0	0	0	0	0
MTI	0	0	0	1	0	1
FAI	0	0	1	2	1	2
Non Injury Incident Potential Class #1	0	0	0	5	0	5
Non Injury Incident Potential Class #2	0	0	0	0	0	0
Non Injury Incident Potential Class #3	0	0	0	0	0	0
Lost Time Injury Frequency Rate (LTIFR):						
No. of Lost Time Injuries x 1,000,000	0.00	1.27	0.00	1.29	0.00	1.28
No. of Hours Worked						
Total Incident Frequency Rate (TIFR):						
Fatal + LTI + AWI + MTI + FAI + PC1 + PC2 + PC3 x 1,000,000	0.00	1.27	8.20	3.87	6.24	3.21
Hours Worked						
Severity Rate (SR):						
No. of LTD x 1,000,000	0.00	194.95	0.00	69.31	0.00	101.19
Hours Worked						

MAN POWER & MAN HOURS

The total project hours worked, start 2019 to date, reached 3.112.993 hours. Since the last LTI (November 12th, 2019) we have accumulated 1.493.643 safe worked hours with 287 days LTI free.

In 2020, we strive for zero LTI.

HSE – SAFETY STATS 2021

Safety Statistics (Last LTI - November 2021)

PT. HENGJAYA MINERALINDO

Nickel Mines Limited
MONTHLY REPORT
Nickel Mine Project - Tangofa
Des-21

MAN HOURS RECORD 2021

Year 2021

Month	PT. HM	Yr Cum	Proj Cum	Contractor's	Yr Cum	Proj Cum	Total Yr Cum	Total Proj Cum	Start Jan 2021
Jan-21	41,458	41,458	997,351	205,031	205,031	3,169,479	246,489	4,166,830	Jan 01 - 31
Feb-21	39,174	80,632	1,036,525	212,869	417,900	3,382,348	498,532	4,418,873	Feb 01 - 28
Mar-21	44,298	124,930	1,080,823	207,076	624,976	3,589,424	749,906	4,670,247	Mar 01 - 31
Apr-21	43,038	167,968	1,123,861	229,719	854,695	3,819,143	1,022,663	4,943,004	Apr 01 - 30
Mei-21	37,514	205,482	1,161,375	224,867	1,079,562	4,044,010	1,285,044	5,205,385	Mei 01 - 31
Jun-21	45,302	250,784	1,206,677	247,514	1,327,075	4,291,523	1,577,859	5,498,200	Juni 01 - 30
Jul-21	43,392	294,176	1,250,069	261,871	1,588,946	4,553,394	1,883,122	5,803,463	Juli 01 - 31
Agu-21	42,282	336,458	1,292,351	261,928	1,850,874	4,815,322	2,187,332	6,107,673	Aug 01 - 31
Sep-21	47,132	383,590	1,339,483	271,210	2,122,084	5,086,532	2,505,674	6,426,015	Sept 01 - 30
Okt-21	48,067	431,657	1,387,550	294,497	2,416,581	5,381,029	2,848,238	6,768,579	Oct 01 - 31
Nov-21	7,712	439,369	1,395,262	47,590	2,464,170	5,428,618	2,903,539	6,823,880	Nov 26 - 30
Des-21	43,036	482,405	1,438,298	265,865	2,730,035	5,694,483	3,212,440	7,132,781	Dec 01 - 31
Hrs Year 2021	**509,495**			**2,899,604**			**3,409,099**		
Hrs Since LTI	**50,748**			**313,455**			**364,203**		

Last LTI date:	19-Nov-21
Report date:	31-Dec-21
Safe days on 2021 since last LTI:	**36**
Safe days since last LTI:	**36**
Start Project:	01-Jan-19
Number of safe days lost before LTI:	**737**
Number of safe hours lost before LTI:	**5,345,888**

PT. HENGJAYA MINERALINDO

Nickel Mines Limited
MONTHLY REPORT
Nickel Mining Project - Tangofa
Des-21

SHEQ PERFORMANCE STATISTIC PROJECT TO DATE

Safety Statistics (Project to Date from 01 Jan 2019)

ACCIDENT / INCIDENT CLASSIFICATION	HM (Project to Date) (Incl. mgmt/Admin/Superv / Direct Labour)		CONTRACTOR (Project to Date) (Incl. mgmt/Admin/Superv / Direct Labour)		PROJECT TOTALS (Project to Date) (Incl. mgmt/Admin/Superv / Direct Labour)	
	This Period	Cumulative	This Period	Cumulative	This Period	Cumulative
Hours Worked	43,036	1,438,298	265,865	5,694,483	308,901	7,132,781
Average No. of Workers	249		1,120		1,369	
Number of safe days lost before LTI	18	737	18	737	18	737
Number of safe days lost cause Fatality			6,000			
Number of Hours Since Last LTI (26 Nov 2021)	43,036	50,748	265,865	313,455	308,901	364,203
FATALITIES	0	0	0	2	0	2
LTI	0	1	0	0	0	1
AWI	0	0	0	0	0	0
MTI	0	1	0	2	0	3
FAI	0	2	0	7	0	9
Non Injury Incident Potential Class #1	0	0	0	5	0	5
Non Injury Incident Potential Class #2	0	0	0	0	0	0
Non Injury Incident Potential Class #3	0	0	0	0	0	0
Lost Time Injury Frequency Rate (LTIFR): No. of Lost Time Injuries x 1,000,000 / No. of Hours Worked	0.00	0.70	0.00	0.35	0.00	0.42
Total Incident Frequency Rate (TIFR): Fatal + LTI + AWI + MTI + FAI + PC1 + PC2 + PC3 x 1,000,000 / Hours Worked	0.00	2.78	0.00	2.81	0.00	2.80
Severity Rate (SR): No. of LTD x 1,000,000 / Hours Worked	139418.16	4171.60	22567.84	1053.65	19423.70	841.19

MAN POWER & MAN HOURS

The total project hours worked, start 2019 to date, reached 7.132.781 hours. Since the last LTI (November 26th, 2021) we have accumulated 364.203 safe worked hours with 36 days LTI free.

In 2021, we strive for zero LTI.

HSE – SAFETY STATS - 2022

Safety Statistics (Last LTI - November 2021)

PT. HENGJAYA MINERALINDO

Nickel Mines Limited
MONTHLY REPORT
Nickel Mine Project - Tangofa
Jun-22

MAN HOURS RECORD 2022

Year 2022

Month	PT. HM	Yr Cum	Proj Cum	Contractor's	Yr Cum	Proj Cum	Total Yr Cum	Total Proj Cum	Start Jan 2022
Jan-22	45,454	45,454	554,949	281,526	281,526	3,181,130	326,980	7,459,761	Jan 01 - 31
Feb-22	40,800	86,254	595,749	253,819	535,345	3,434,949	621,599	7,754,380	Feb 01 - 28
Mar-22	47,610	133,864	643,359	285,003	820,348	3,719,952	954,212	8,086,993	Mar 01 - 31
Apr-22	48,928	182,792	692,287	269,821	1,090,169	3,989,773	1,272,961	8,405,742	Apr 01 - 30
Mei-22	44,670	227,462	736,957	277,152	1,367,321	4,266,925	1,594,783	8,727,564	May 01 - 31
Jun-22	49,060	276,522	786,017	310,323	1,677,644	4,577,248	1,954,166	9,086,947	Jun 01 - 30
Jul-22		276,522	786,017		1,677,644	4,577,248	1,954,166	9,086,947	
Agu-22		276,522	786,017		1,677,644	4,577,248	1,954,166	9,086,947	
Sep-22		276,522	786,017		1,677,644	4,577,248	1,954,166	9,086,947	
Okt-22		276,522	786,017		1,677,644	4,577,248	1,954,166	9,086,947	
Nov-22		276,522	786,017		1,677,644	4,577,248	1,954,166	9,086,947	
Des-22		276,522	786,017		1,677,644	4,577,248	1,954,166	9,086,947	
Hrs Year 2022	**276,522**			**1,677,644**			**1,954,166**		
Hrs Since LTI	**327,270**			**1,991,098**			**2,318,368**		

Last LTI date:	19-Nov-21
Report date:	30-Jun-22
Safe days on 2022:	**181**
Safe days since last LTI:	**217**
Start Project:	01-Jan-19
Number of safe days lost before LTI:	**737**
Number of safe hours lost before LTI:	**5,345,888**

MAN POWER & MAN HOURS

The total project hours worked, start 2019 to date, reached 9.086.947 hours. Since the last LTI (November 26th, 2021) we have accumulated 2.318.368 safe worked hours with 217 days LTI free.

In 2022, we strive for zero LTI.

PT. HENGJAYA MINERALINDO

Nickel Mines Limited
MONTHLY REPORT
Nickel Mining Project - Tangofa
Jun-22

SHQ PERFORMANCE STATISTIC PROJECT TO DATE

Safety Statistics (Project to Date from 01 Jan 2019)

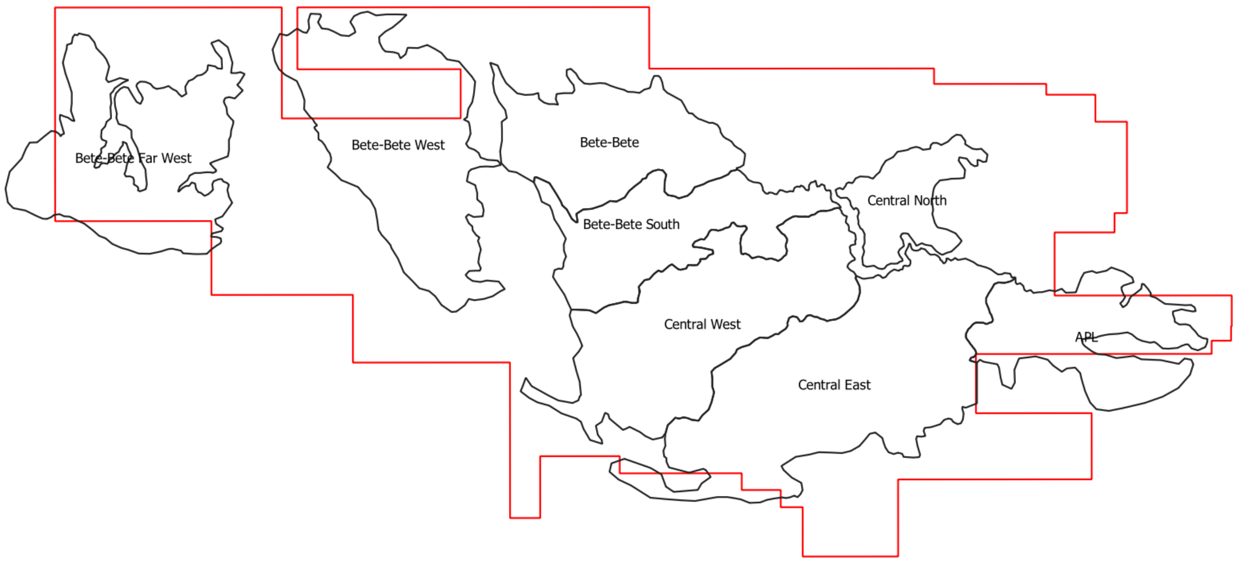
ACCIDENT / INCIDENT CLASSIFICATION	HM (Project to Date) (Incl. mgmt/Admin/Superv/ Direct Labour)		CONTRACTOR (Project to Date) (Incl. mgmt/Admin/Superv/ Direct Labour)		PROJECT TOTALS (Project to Date) (Incl. mgmt/Admin/Superv/ Direct Labour)	
	This Period	Cumulative	This Period	Cumulative	This Period	Cumulative
Hours Worked	49,060	786,017	310,323	4,577,248	359,383	5,363,265
Average No. of Workers	263		1,301		1,564	
Number of safe days lost before LTI		737		737		737
Number of safe days lost cause Fatality			6,000			
Number of Hours Since Last LTI (26 Nov 2021)	49,060	327,270	310,323	1,991,098	359,383	2,318,368
FATALITIES	0	0	0	2	0	2
LTI	0	1	0	0	0	1
AWI	0	0	0	0	0	0
MTI	0	1	0	2	0	3
FAI	0	2	0	8	0	10
Nearmiss	0	0	0	5	0	5
Lost Time Injury Frequency Rate (LTIFR):						
No. of Lost Time Injuries x 1,000,000	0.00	1.27	0.00	0.44	0.00	0.56
No. of Hours Worked						
Total Incident Frequency Rate (TIFR):						
Fatal + LTI + AWI + MTI + FAI + Nearmiss x 1,000,000	0.00	5.09	0.00	3.71	0.00	3.92
Hours Worked						
Severity Rate (SR):						
No. of LTD x 1,000,000	122299.23	7633.42	19334.69	1310.83	16695.28	1118.72
Hours Worked						

Appendix 4
Descriptive Statistics and Swath plots

Hengjaya Mineralindo

Descriptive Statistics

JORC 2022



WEIGHTED AVERAGE BY DOMAIN

Domain	Genlith	Thick	Weighted Average				
			% Ni	% Co	% Fe	% MgO	% SiO2
Bete-Bete	Limonite	6.85	0.95	0.13	46.67	1.96	5.73
	Saprolite	8.39	1.51	0.04	15.23	21.43	36.77
Bete-Bete South	Limonite	11.67	1.06	0.13	43.06	1.62	7.42
	Saprolite	9.18	1.24	0.04	16.96	18.77	34.25
Central West	Limonite	12.23	1.10	0.14	44.80	1.49	7.81
	Saprolite	9.88	1.46	0.04	15.16	21.12	36.25
Central East	Limonite	11.07	1.03	0.12	42.53	1.43	11.37
	Saprolite	11.09	1.36	0.04	15.10	18.50	40.40
Bete-Bete West	Limonite	5.69	0.86	0.11	41.85	1.64	14.47
	Saprolite	5.92	1.31	0.03	15.95	18.81	38.20
Bete-Bete Far West	Limonite	5.31	0.89	0.14	44.12	2.66	10.48
	Saprolite	7.33	1.06	0.03	12.58	23.09	37.20
APL	Limonite	8.78	0.91	0.11	37.99	1.50	17.48
	Saprolite	12.43	1.13	0.04	14.15	17.44	46.61

ALL DOMAIN STATISTICS

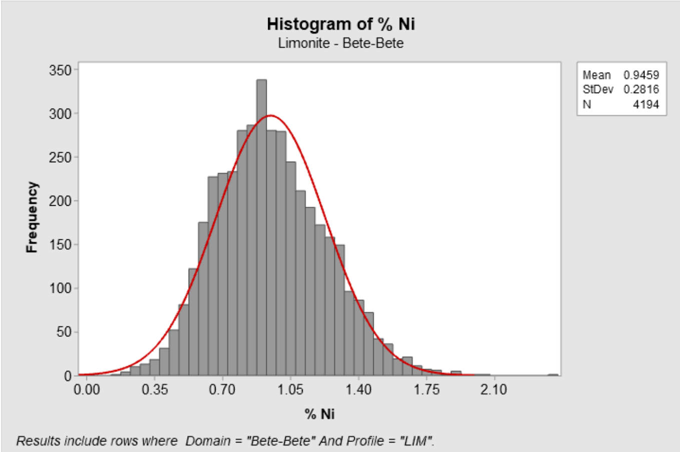
Variable	Profile	Samples	Mean	Median	StDev	Variance	CoefVar	Minimum	Maximum	Skewness	Kurtosis
Ni	SED	270	0.09	0.03	0.13	0.02	141.32	0.01	0.76	2.36	6.59
	LIM	53739	1.05	1.06	0.29	0.09	28.05	0.00	3.38	0.06	0.03
	SAP	52509	1.36	1.30	0.62	0.38	45.61	0.02	6.36	0.65	0.68
	BRK	15108	0.36	0.34	0.13	0.02	34.76	0.03	1.66	1.46	4.58
Co	SED	270	0.01	0.01	0.01	0.00	147.01	0.00	0.20	11.03	156.76
	LIM	53739	0.13	0.12	0.07	0.00	54.02	0.00	1.36	2.40	16.89
	SAP	52509	0.04	0.03	0.05	0.00	113.28	0.00	1.51	6.46	106.08
	BRK	15108	0.01	0.01	0.01	0.00	61.36	0.00	0.13	2.52	21.73
Fe	SED	270	3.02	2.24	2.56	6.56	84.91	0.16	17.74	2.19	8.18
	LIM	53739	43.73	44.68	7.22	52.11	16.51	0.00	69.80	-1.38	3.82
	SAP	52509	14.84	11.87	8.54	72.86	57.51	1.00	64.80	1.53	2.22
	BRK	15108	7.13	6.89	1.78	3.17	24.96	0.34	54.86	6.19	88.69
MgO	SED	270	6.94	2.66	8.37	70.08	120.68	0.10	30.63	1.53	0.94
	LIM	53739	1.54	1.00	2.07	4.28	134.59	0.00	42.06	8.35	108.06
	SAP	52509	20.37	21.80	9.60	92.17	47.14	0.00	46.63	-0.33	-0.85
	BRK	15080	31.69	32.98	7.06	49.81	22.27	0.00	49.11	-2.33	7.03
SiO2	SED	270	25.97	25.03	15.54	241.60	59.85	2.23	68.42	0.32	-0.83
	LIM	53739	9.14	5.30	10.05	101.01	110.01	0.00	99.00	3.10	13.51
	SAP	52509	38.49	39.12	10.40	108.21	27.02	0.00	99.00	0.53	4.10
	BRK	15080	42.03	40.50	7.78	60.57	18.52	0.00	96.17	3.20	14.41

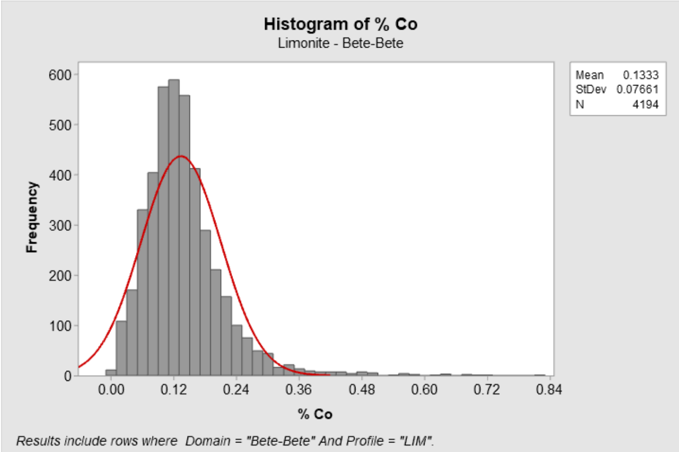
BETE-BETE

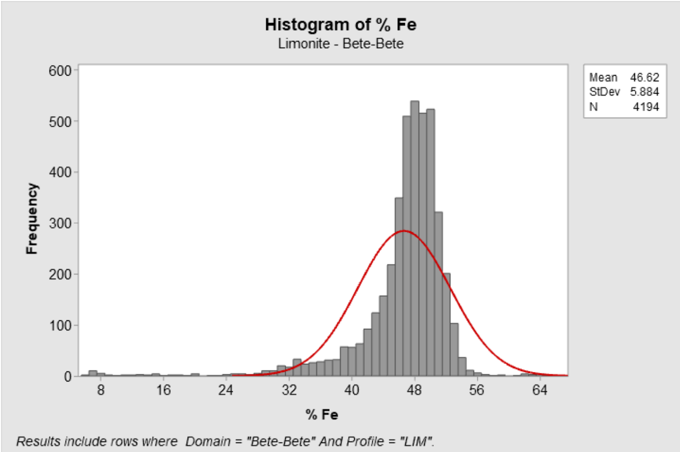
STATISTICS

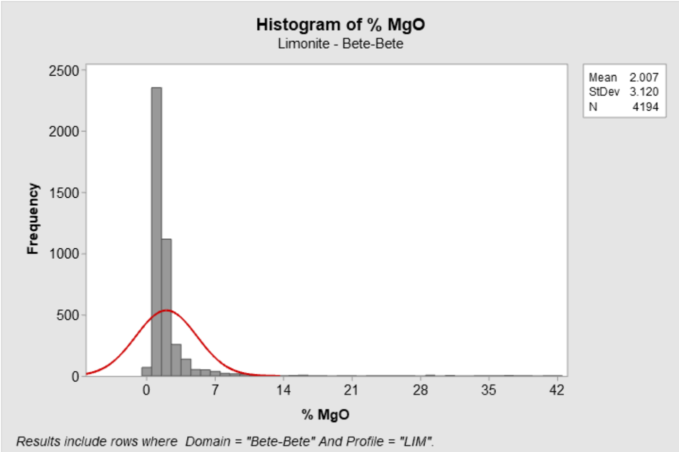
Variable	Profile	Samples	Mean	Median	StDev	Variance	CoefVar	Minimum	Maximum	Skewness	Kurtosis
Ni	SED	28	0.07	0.04	0.05	0.00	67.81	0.02	0.18	0.98	-0.05
	LIM	4194	0.95	0.92	0.28	0.08	29.78	0.01	2.39	0.34	0.12
	SAP	5425	1.48	1.47	0.61	0.37	41.16	0.09	4.23	0.21	-0.38
	BRK	2020	0.37	0.31	0.16	0.02	42.95	0.10	1.29	1.46	2.43
Co	SED	28	0.01	0.01	0.00	0.00	44.92	0.00	0.02	0.27	1.31
	LIM	4194	0.13	0.12	0.08	0.01	57.47	0.00	0.83	2.03	8.91
	SAP	5425	0.04	0.03	0.04	0.00	110.49	0.00	1.12	6.68	109.66
	BRK	2020	0.02	0.01	0.01	0.00	61.26	0.00	0.06	0.09	-1.08
Fe	SED	28	3.69	3.36	2.02	4.07	54.68	0.17	7.38	0.16	-1.05
	LIM	4194	46.62	47.80	5.88	34.62	12.62	6.43	66.30	-2.87	13.56
	SAP	5425	14.69	11.67	8.37	70.08	57.01	4.73	51.40	1.60	2.43
	BRK	2020	7.16	6.89	1.32	1.75	18.48	3.89	21.13	3.02	19.46
MgO	SED	28	5.54	2.57	6.05	36.64	109.27	0.83	24.56	1.64	2.37
	LIM	4194	2.01	1.28	3.12	9.74	155.47	0.20	42.06	7.80	75.33
	SAP	5425	22.21	23.79	9.21	84.72	41.44	0.01	42.27	-0.41	-0.70
	BRK	2020	32.71	33.27	5.09	25.88	15.55	0.60	47.12	-2.53	12.01
SiO2	SED	28	25.69	26.99	19.44	377.87	75.66	2.40	53.49	0.10	-1.74
	LIM	4194	5.79	3.77	5.76	33.20	99.52	0.00	52.46	2.98	11.78
	SAP	5425	37.05	39.10	6.94	48.10	18.72	2.45	52.51	-2.01	4.79
	BRK	2020	39.50	39.75	3.34	11.14	8.45	20.11	61.46	1.27	8.92

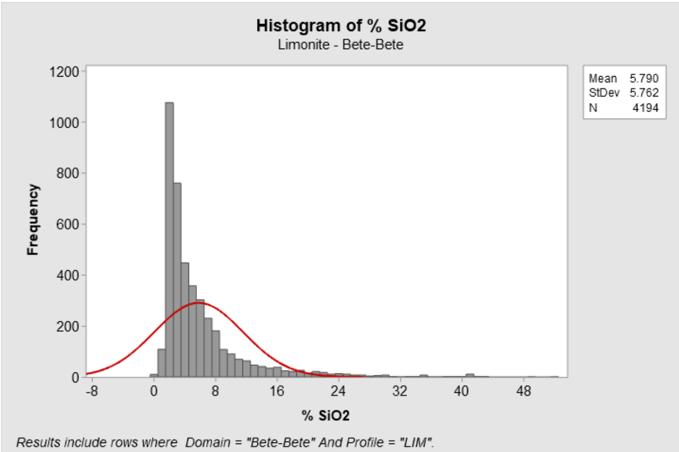
HISTOGRAM: LIM



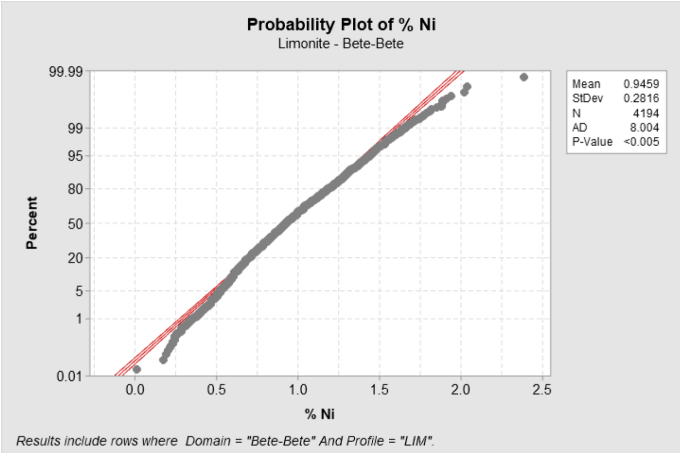


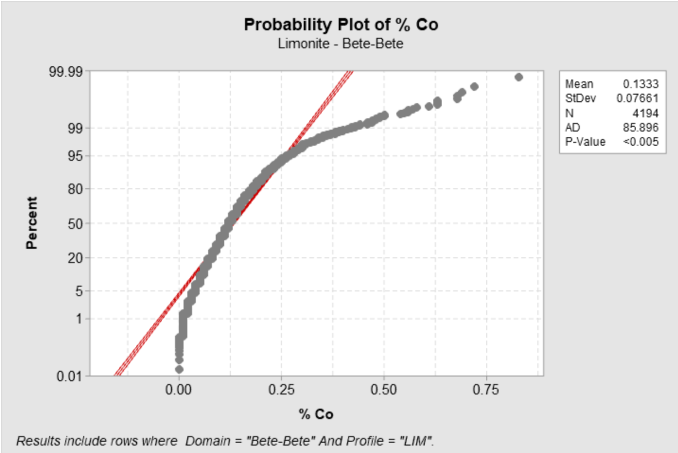


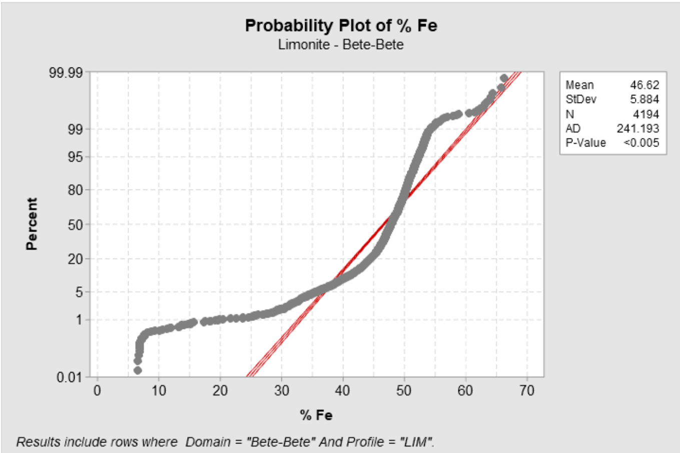


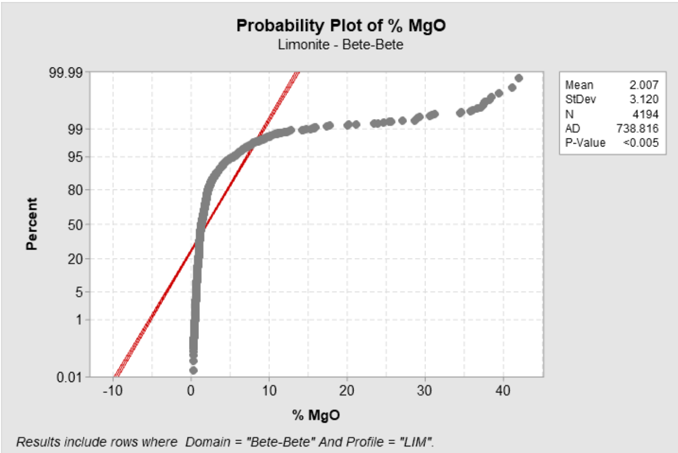


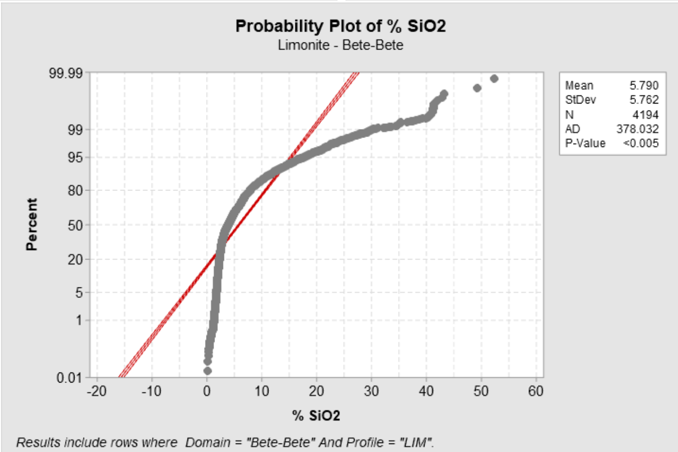
PROBABILITY PLOT: LIM



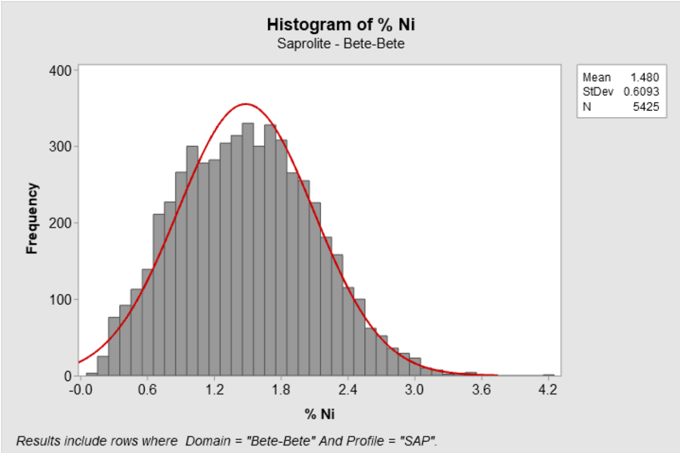


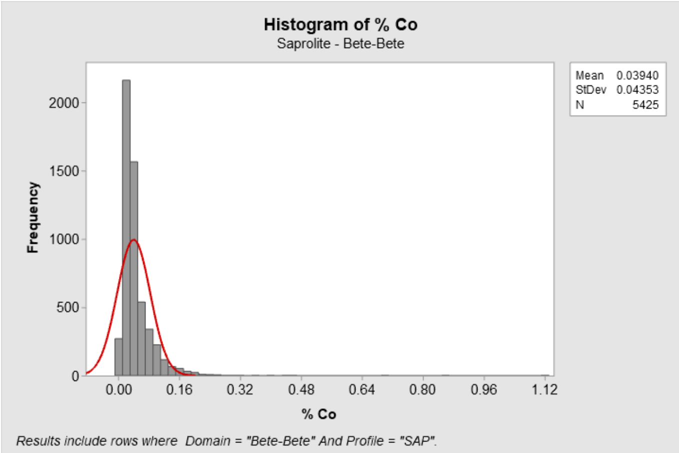


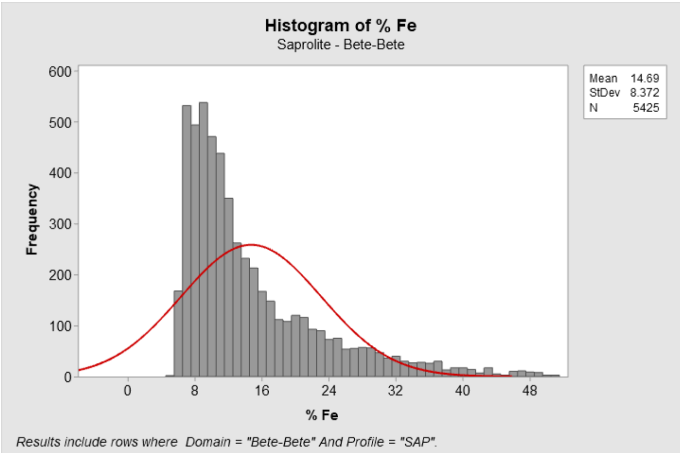


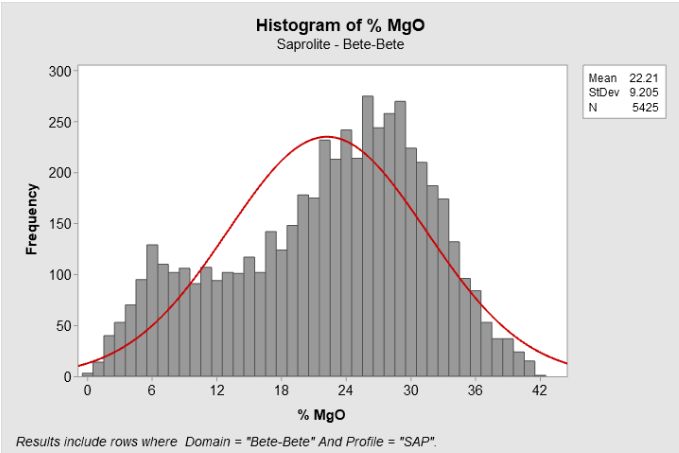


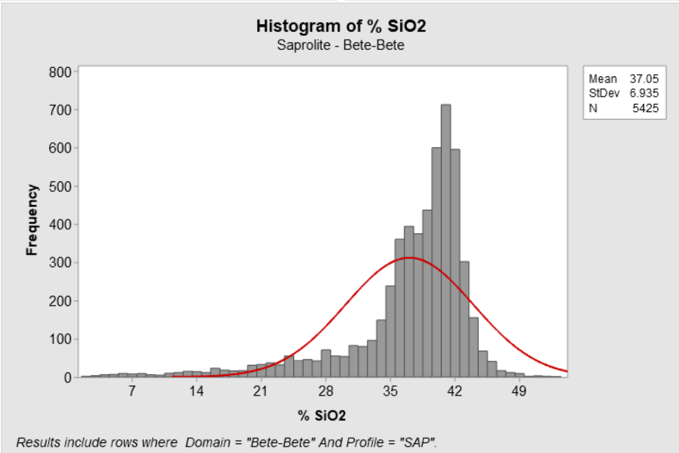
HISTOGRAM: SAP



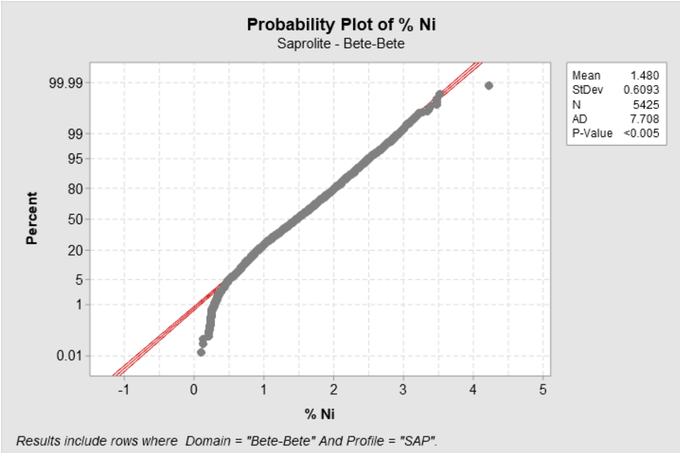


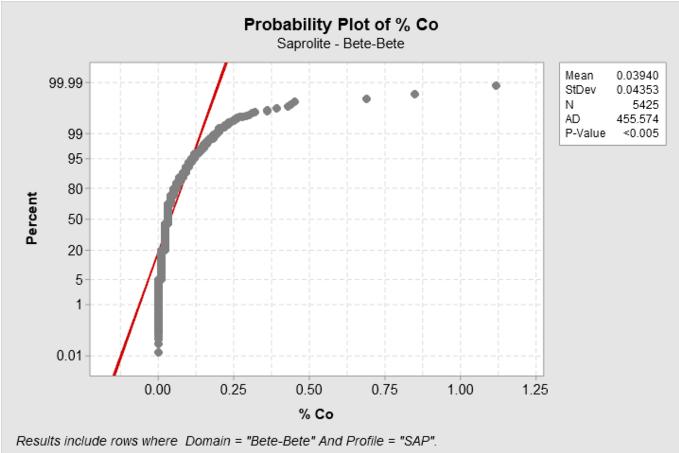


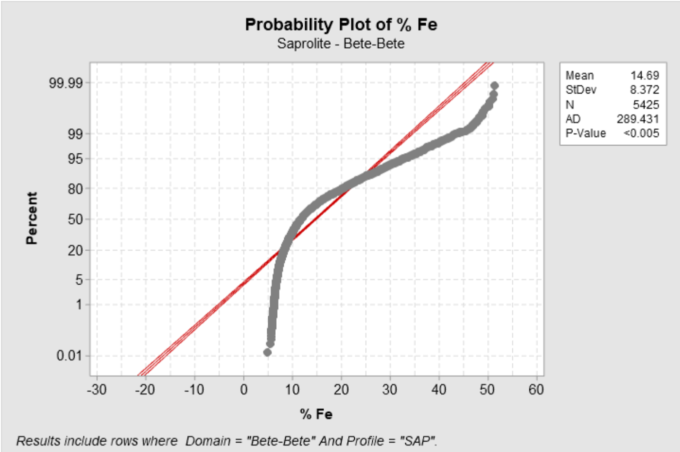


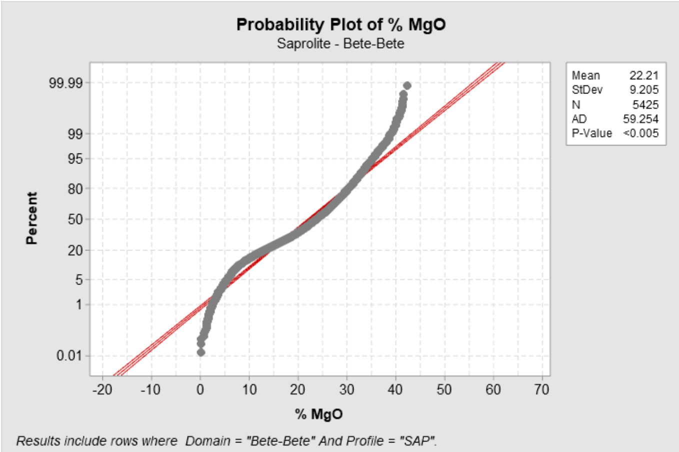


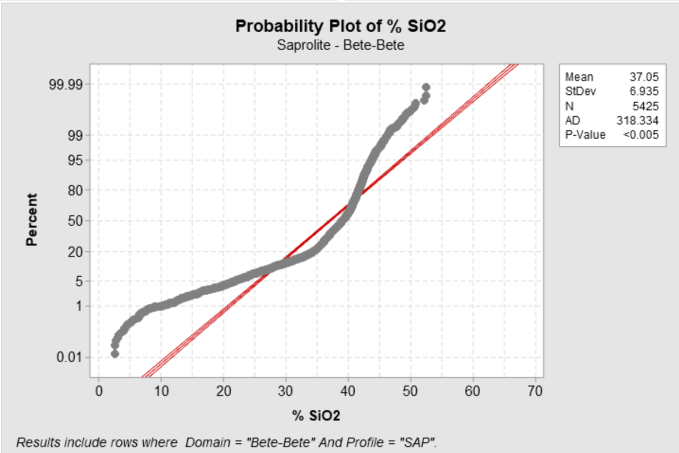
PROBABILITY PLOT: SAP



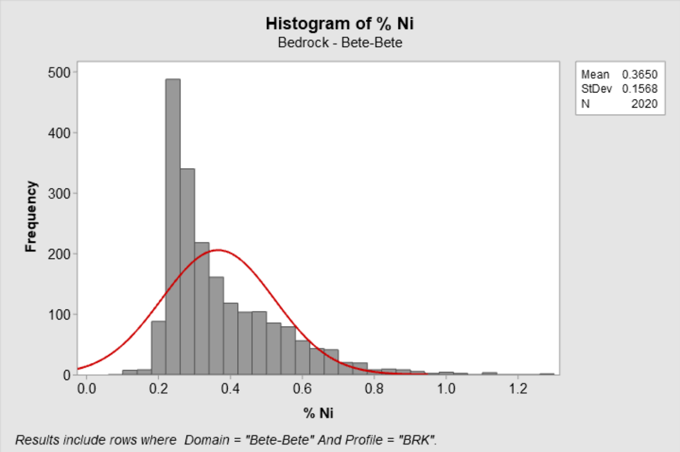


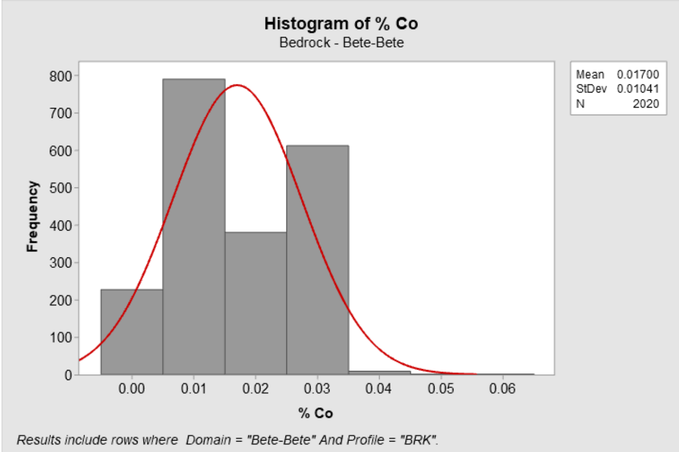


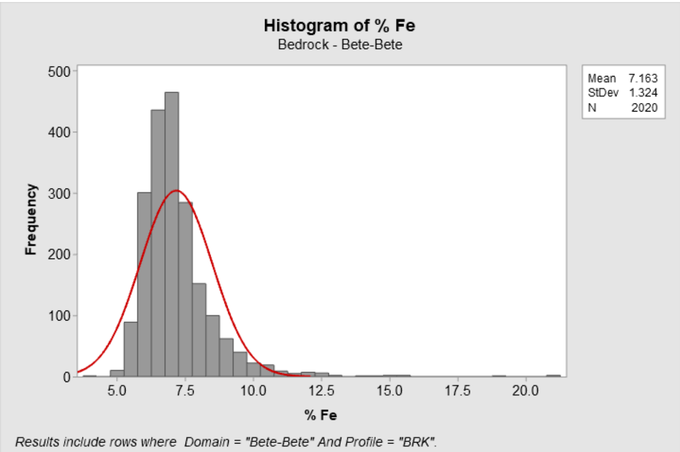


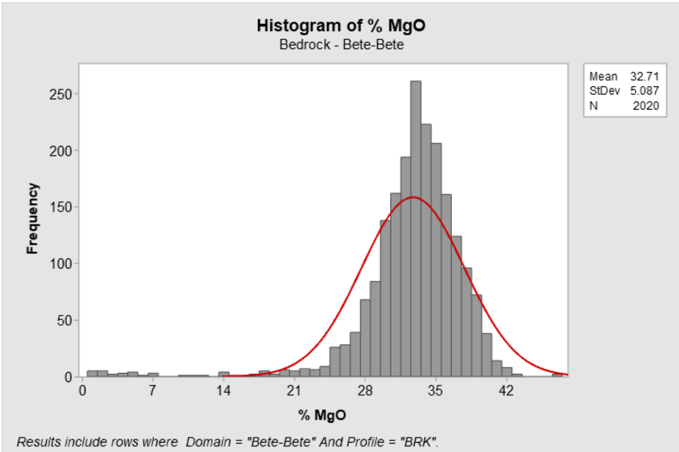


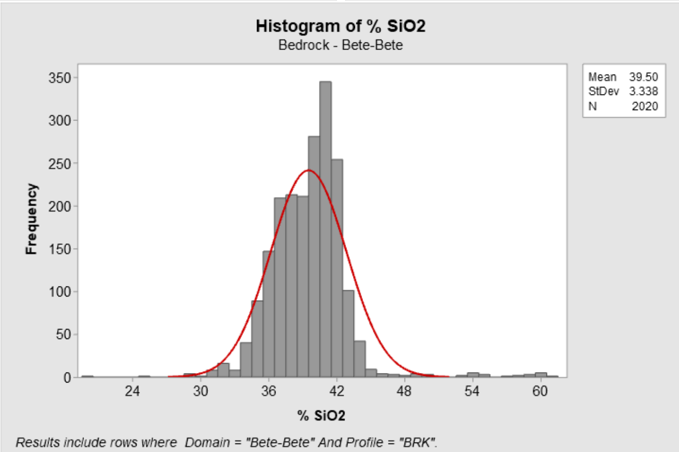
HISTOGRAM: BRK



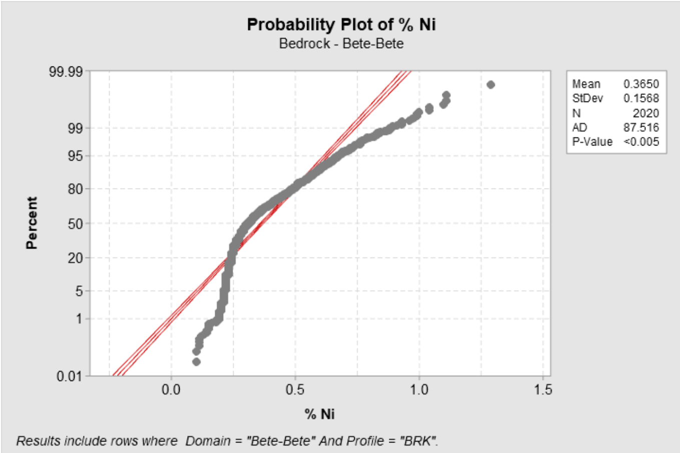


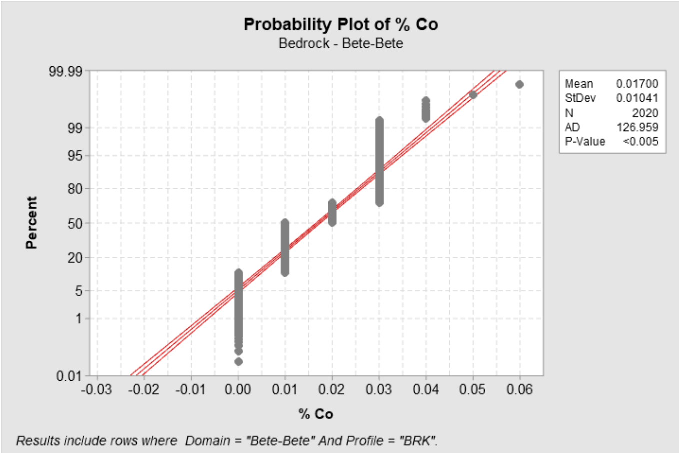


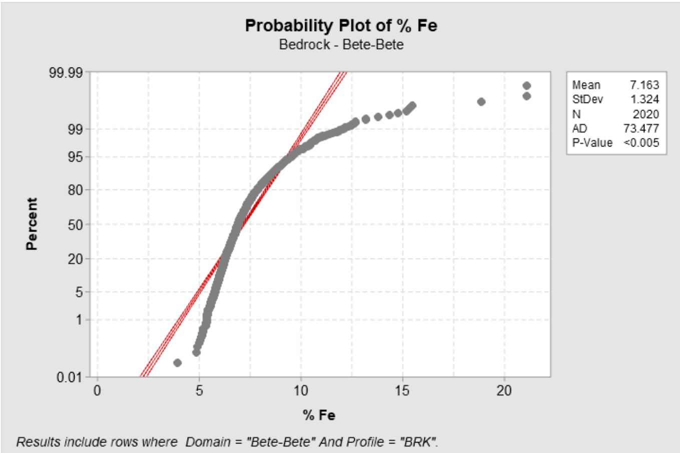


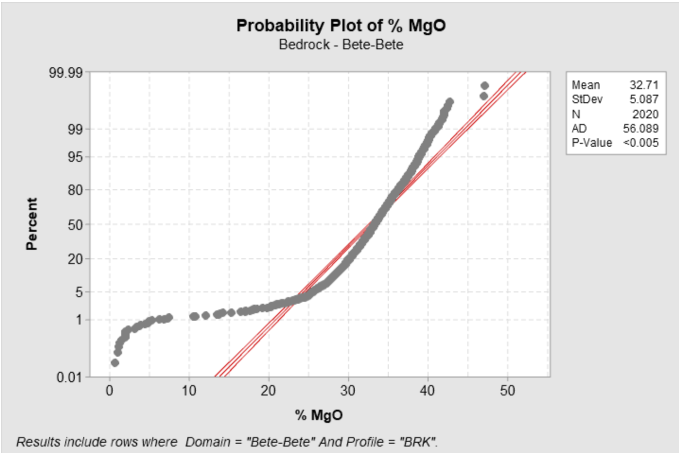


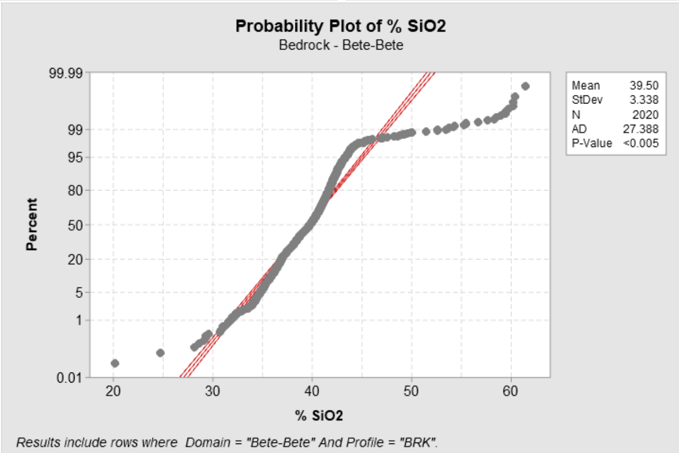
PROBABILITY PLOT: BRK









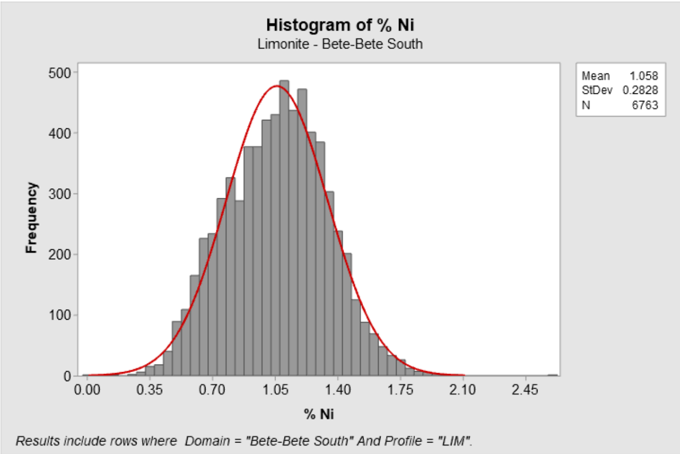


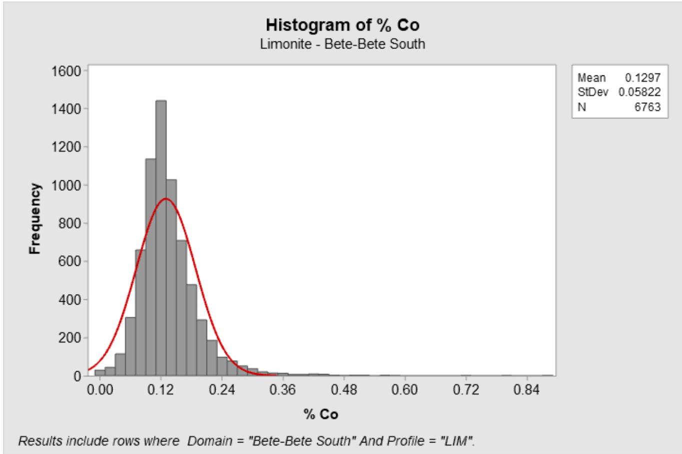
BETE-BETE SOUTH

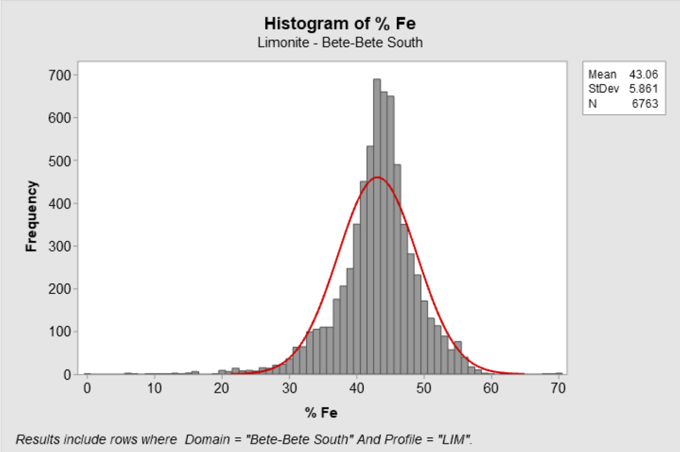
STATISTICS

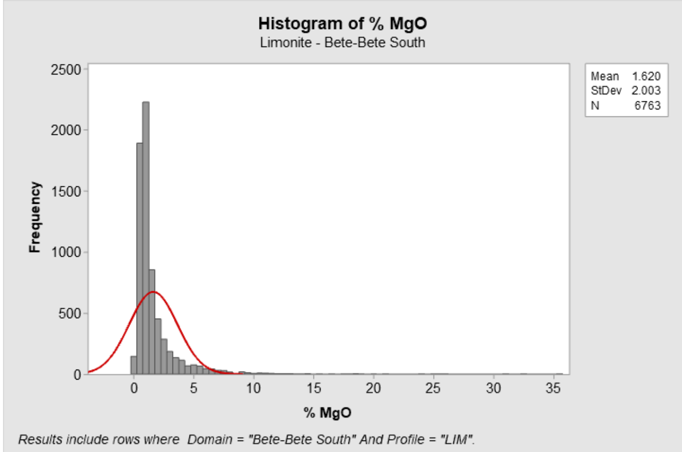
Variable	Profile	Samples	Mean	Median	StDev	Variance	CoefVar	Minimum	Maximum	Skewness	Kurtosis
Ni	SED	3	0.25	0.25	0.10	0.01	38.53	0.15	0.34	-0.16	
	LIM	6763	1.06	1.07	0.28	0.08	26.72	0.00	2.59	0.01	-0.18
	SAP	5524	1.22	1.18	0.47	0.22	38.22	0.16	3.88	0.71	1.16
	BRK	1373	0.38	0.36	0.13	0.02	33.02	0.16	1.17	1.01	1.56
Co	SED	3	0.02	0.02	0.01	0.00	34.64	0.01	0.02	-1.73	
	LIM	6763	0.13	0.12	0.06	0.00	44.90	0.00	0.87	2.21	13.54
	SAP	5524	0.04	0.03	0.04	0.00	91.63	0.00	0.96	5.33	79.18
	BRK	1373	0.02	0.01	0.01	0.00	52.38	0.00	0.12	2.12	18.46
Fe	SED	3	6.66	7.02	1.32	1.74	19.78	5.20	7.76	-1.14	
	LIM	6763	43.06	43.49	5.86	34.35	13.61	0.00	69.80	-0.86	3.49
	SAP	5524	16.51	13.75	8.87	78.64	53.72	3.47	55.26	1.16	0.95
	BRK	1373	7.14	6.98	1.77	3.13	24.78	4.09	54.86	16.31	406.77
MgO	SED	3	22.91	25.94	5.45	29.72	23.79	16.62	26.18	-1.73	
	LIM	6763	1.62	1.02	2.00	4.01	123.59	0.00	35.53	5.42	51.26
	SAP	5524	19.33	19.37	9.07	82.33	46.95	0.27	44.46	-0.05	-0.95
	BRK	1373	33.19	33.54	3.82	14.59	11.51	1.24	46.68	-1.32	6.87
SiO2	SED	3	40.19	39.97	0.88	0.78	2.19	39.44	41.16	1.05	
	LIM	6763	7.42	4.70	6.66	44.30	89.65	0.00	56.03	2.22	6.80
	SAP	5524	34.54	36.65	8.48	71.84	24.54	2.66	78.82	-0.64	0.78
	BRK	1373	39.25	38.96	3.41	11.60	8.68	3.30	61.50	0.06	12.52

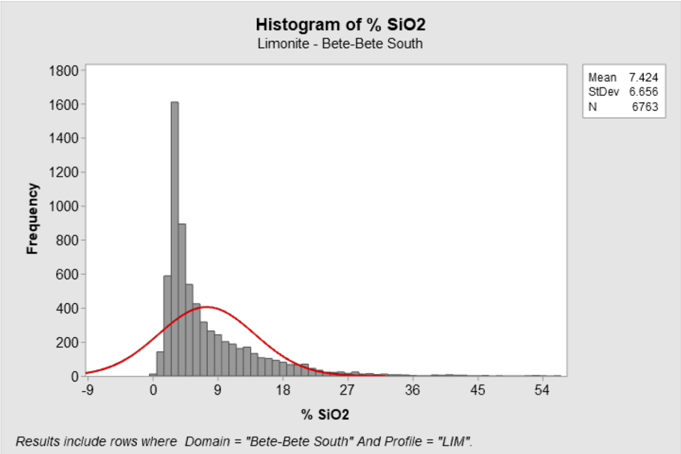
HISTOGRAM: LIM



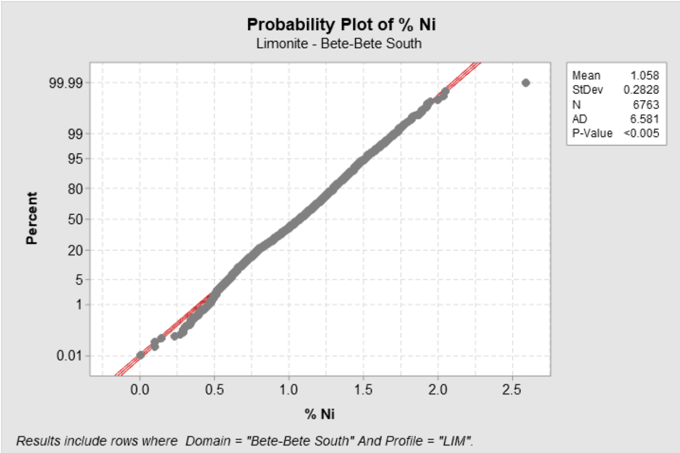


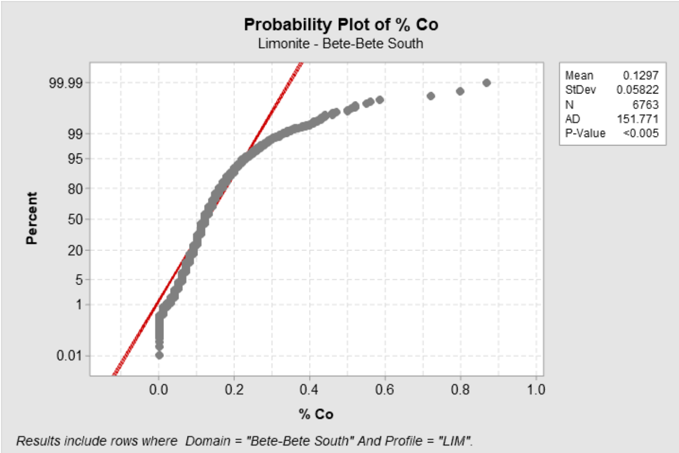


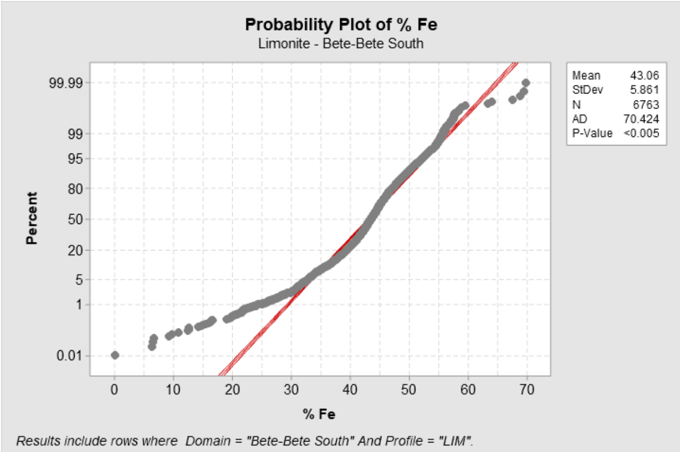


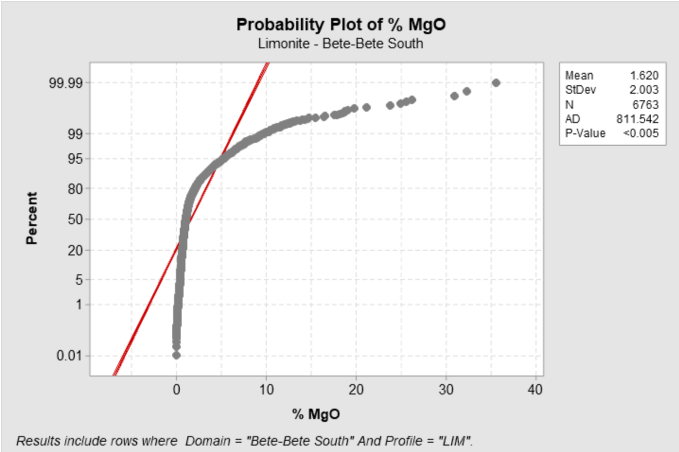


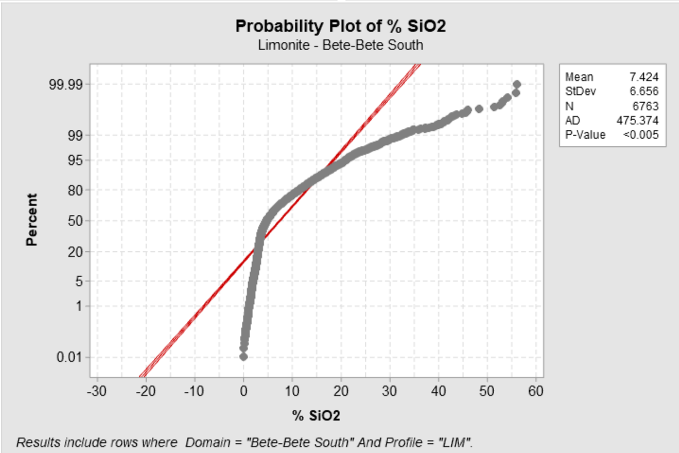
PROBABILITY PLOT: LIM



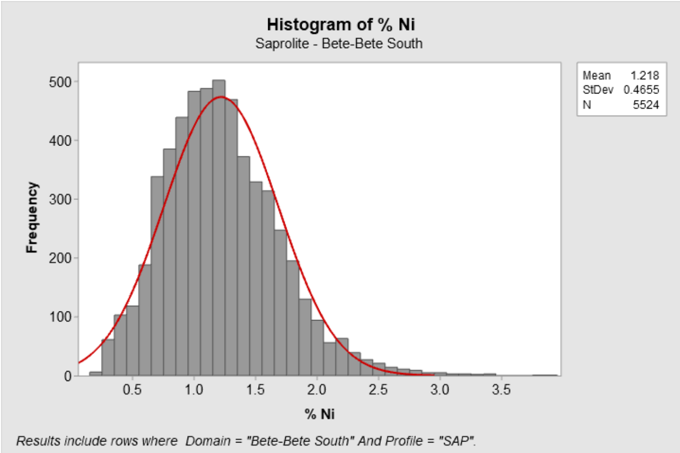


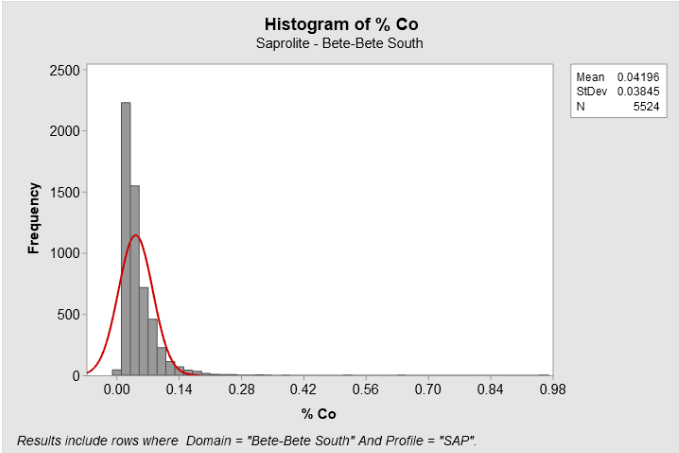


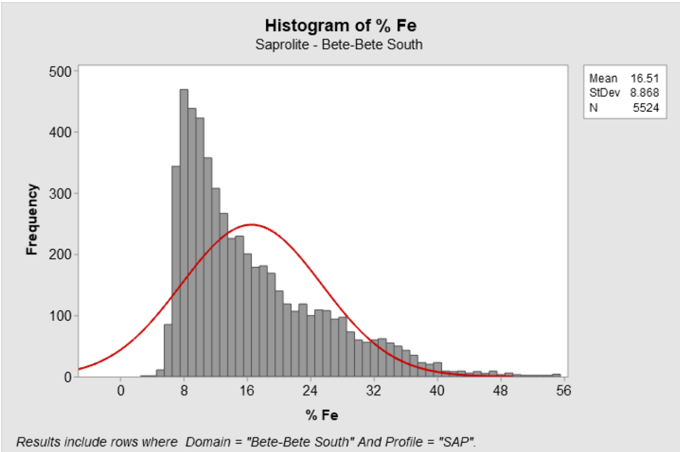


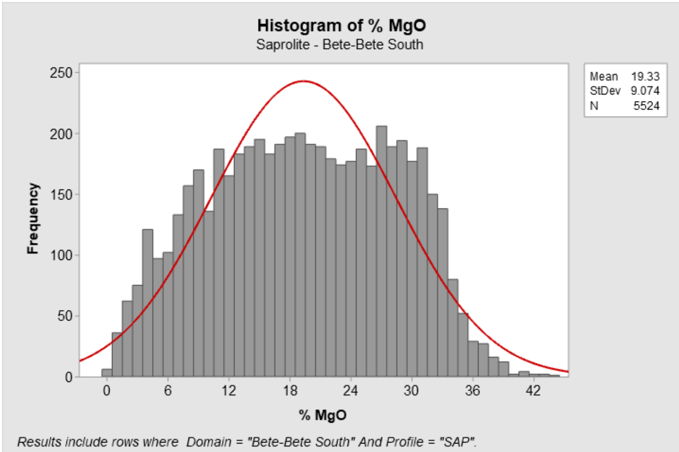


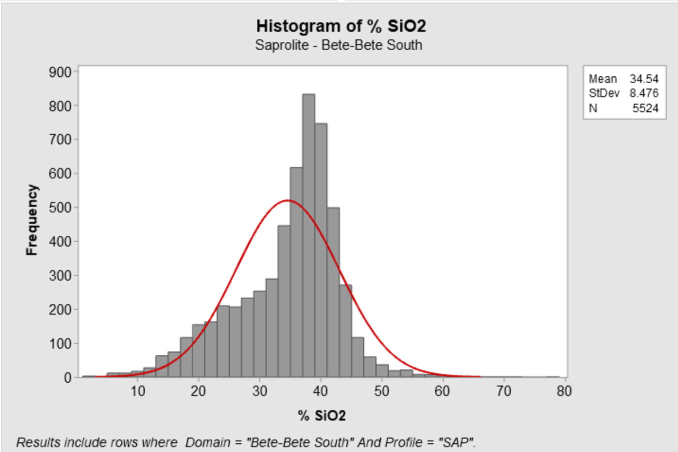
HISTOGRAM: SAP



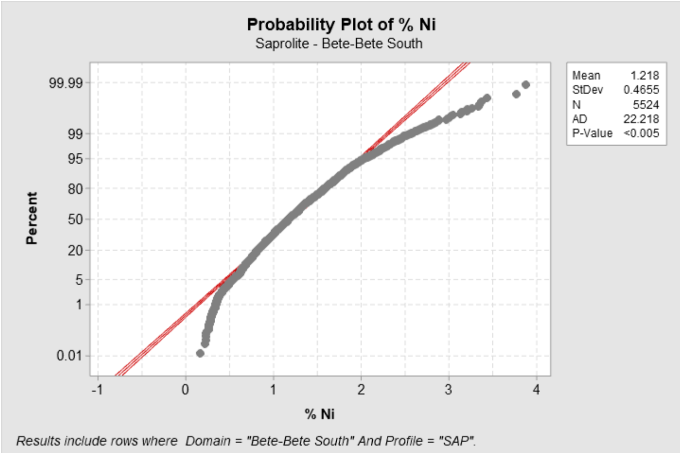


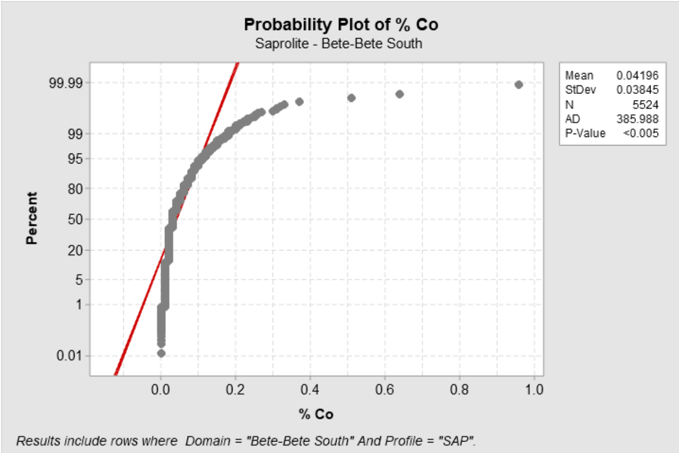


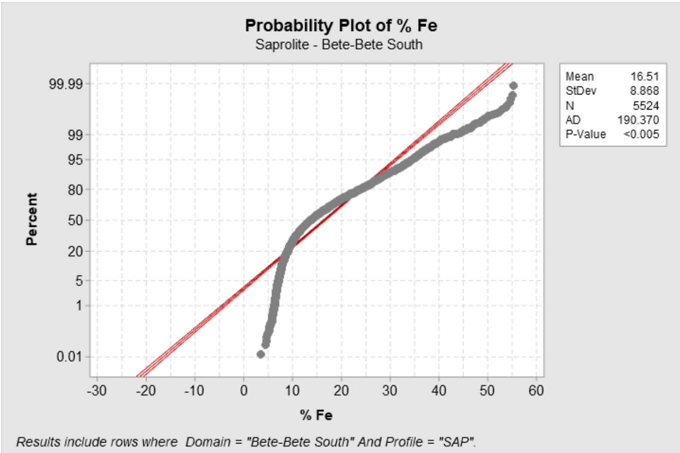


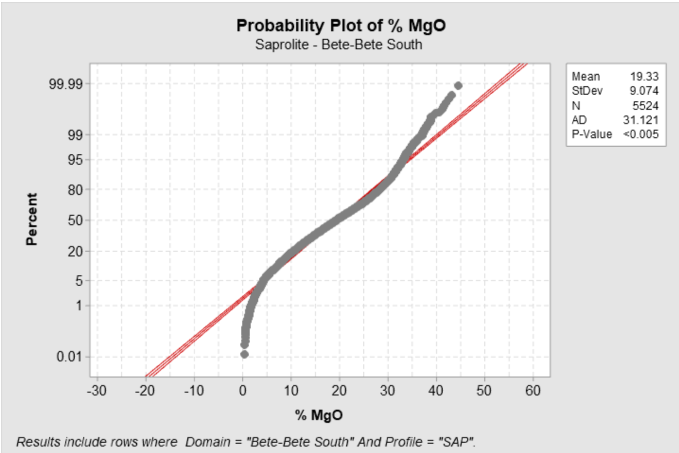


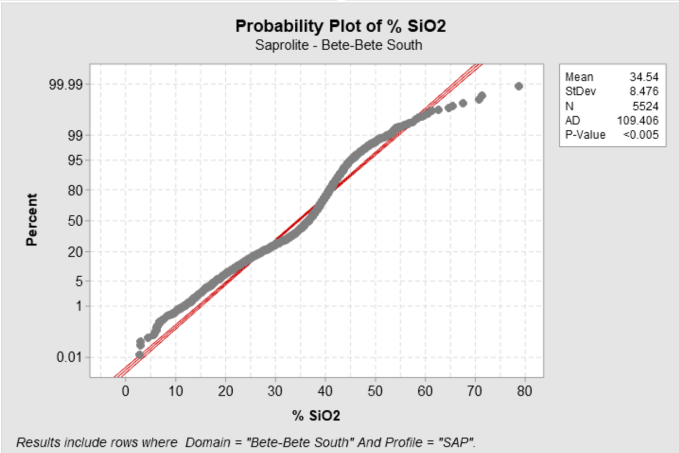
PROBABILITY PLOT: SAP



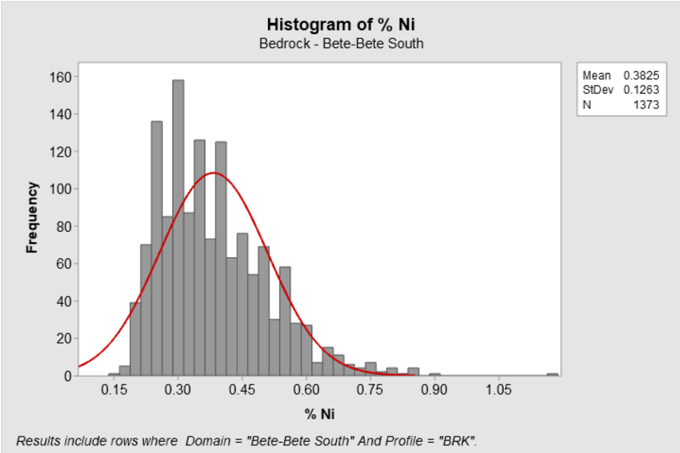


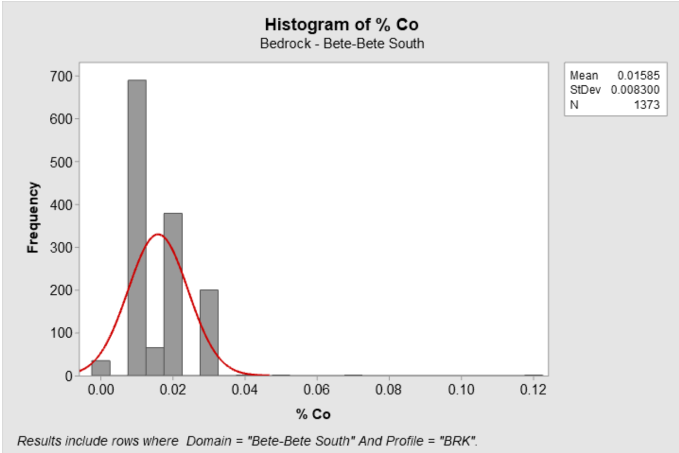


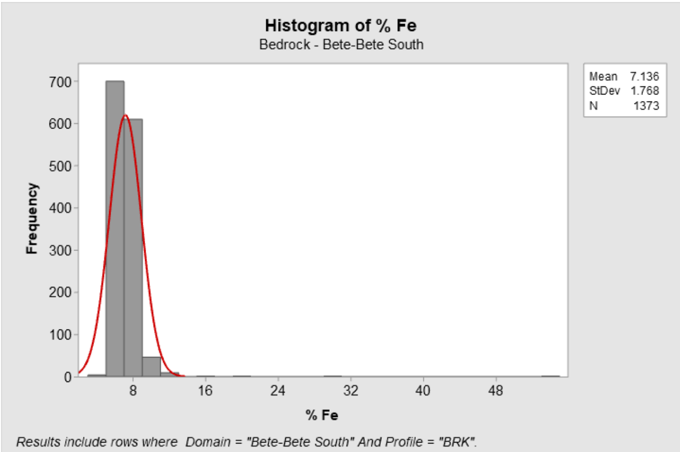


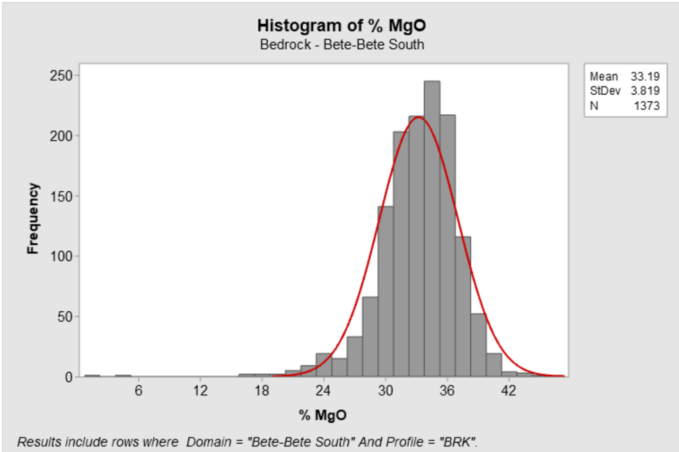


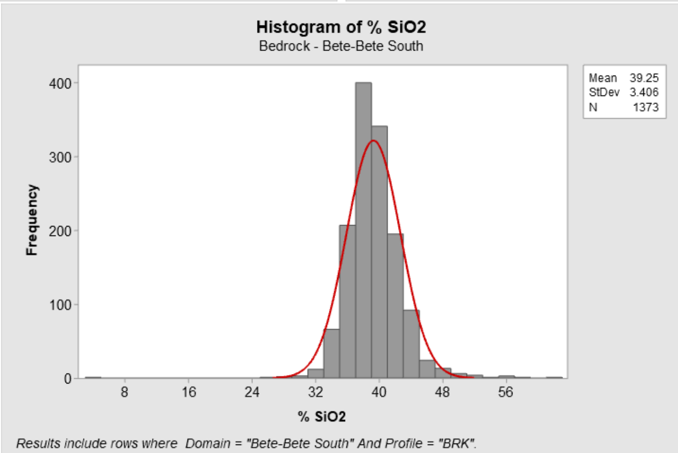
HISTOGRAM: BRK



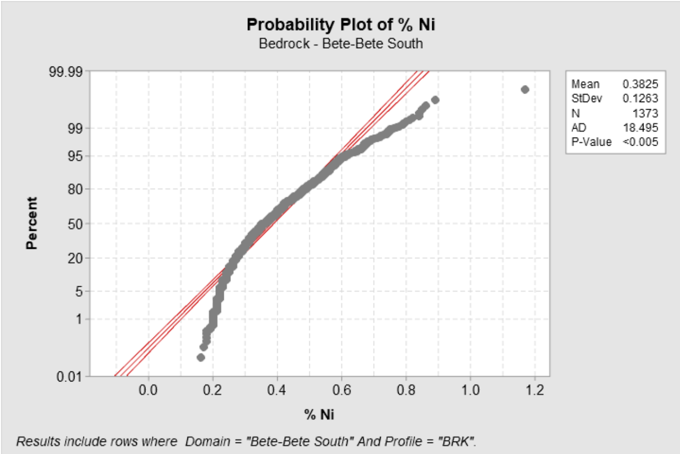


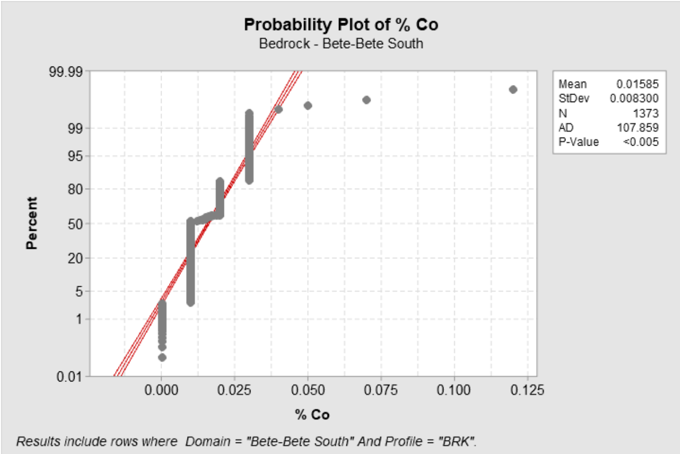


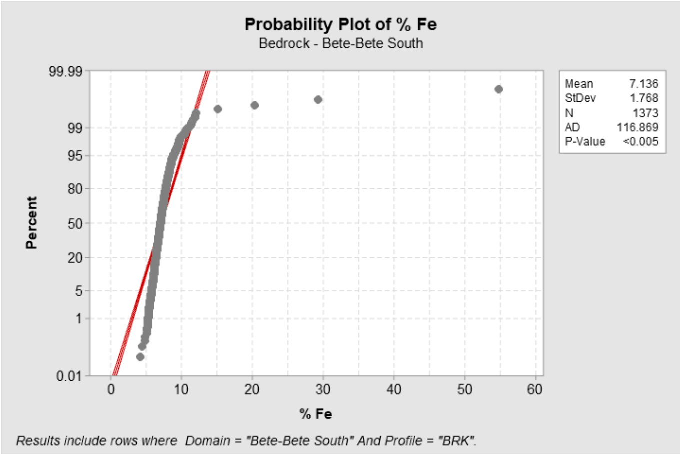


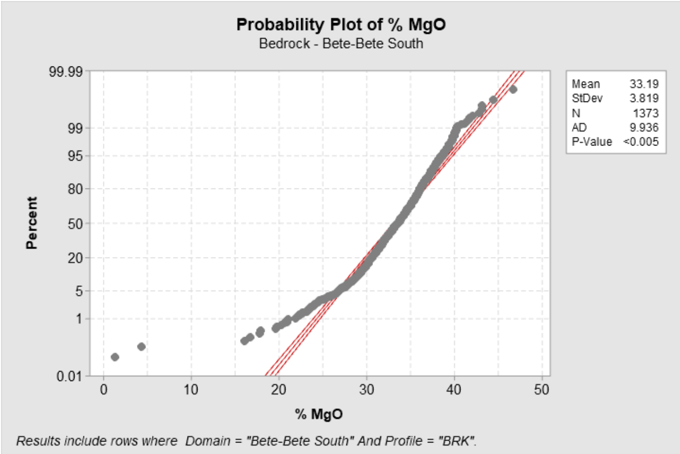


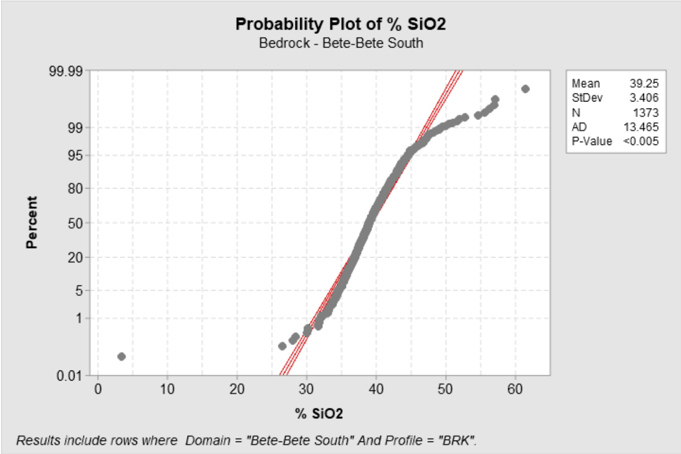
PROBABILITY PLOT: BRK







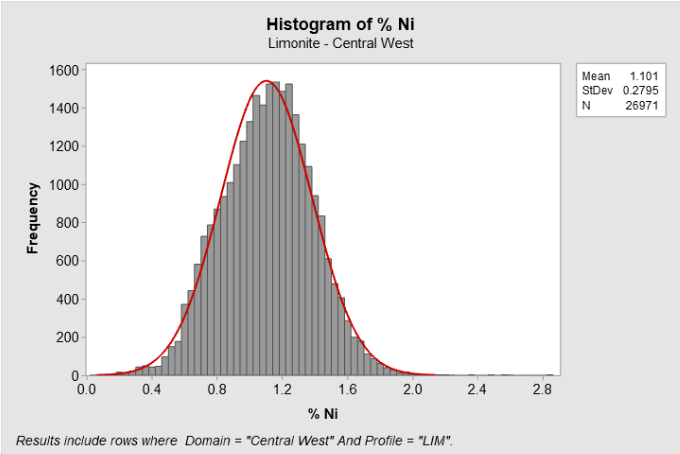


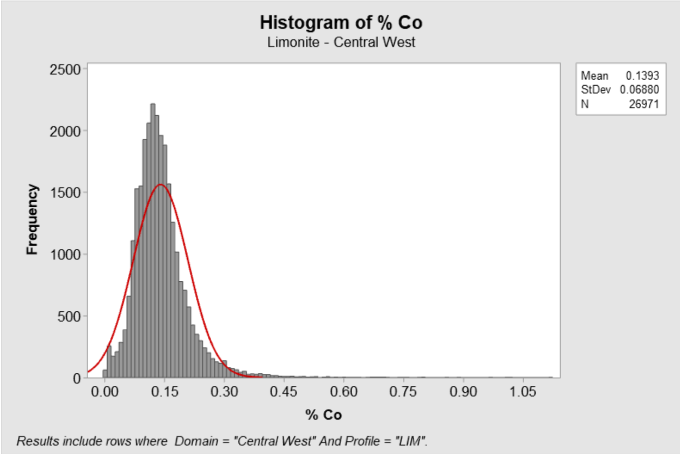


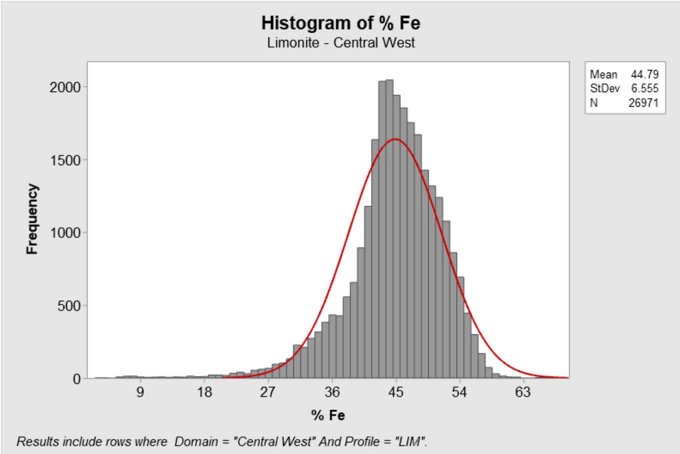
CENTRAL WEST
STATISTICS

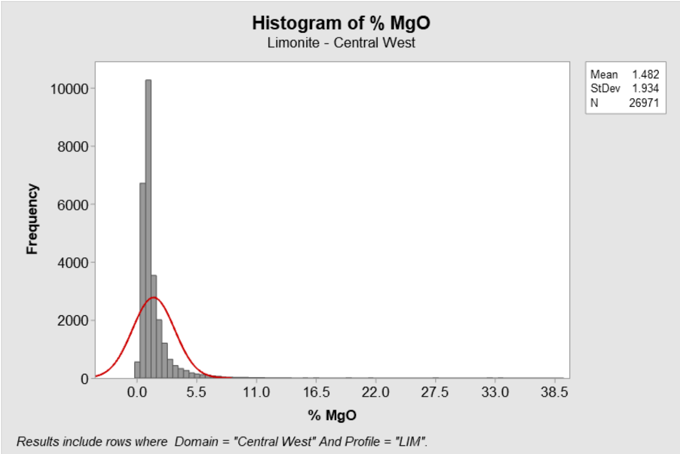
Variable	Profile	Samples	Mean	Median	StDev	Variance	CoefVar	Minimum	Maximum	Skewness	Kurtosis
Ni	SED	7	0.14	0.16	0.07	0.00	48.45	0.03	0.21	-0.69	-0.85
	LIM	26971	1.10	1.11	0.28	0.08	25.39	0.05	2.85	0.01	0.20
	SAP	22704	1.45	1.41	0.64	0.41	44.18	0.16	6.36	0.49	0.23
	BRK	5582	0.37	0.35	0.11	0.01	29.79	0.09	1.66	1.49	7.02
Co	SED	7	0.01	0.01	0.00	0.00	44.10	0.00	0.01	-2.65	7.00
	LIM	26971	0.14	0.13	0.07	0.00	49.38	0.00	1.12	2.23	13.61
	SAP	22704	0.04	0.03	0.05	0.00	116.88	0.00	1.51	5.98	90.33
	BRK	5582	0.01	0.01	0.01	0.00	50.40	0.00	0.12	0.85	13.82
Fe	SED	7	3.92	4.89	1.84	3.38	46.94	0.82	5.42	-1.03	-0.54
	LIM	26971	44.79	45.21	6.56	42.97	14.63	2.82	68.10	-1.10	3.22
	SAP	22704	14.86	11.72	8.80	77.47	59.22	3.12	64.80	1.61	2.46
	BRK	5582	7.03	6.90	1.25	1.56	17.79	2.19	29.16	5.29	74.40
MgO	SED	7	17.94	25.17	12.42	154.26	69.22	0.70	28.13	-0.87	-1.38
	LIM	26971	1.48	0.97	1.93	3.74	130.48	0.00	39.03	8.52	113.79
	SAP	22704	21.49	23.20	9.08	82.41	42.25	0.00	44.01	-0.47	-0.76
	BRK	5582	32.88	33.16	4.10	16.79	12.46	0.00	47.40	-2.36	14.92
SiO2	SED	7	31.08	38.26	15.73	247.31	50.60	6.01	47.26	-1.06	-0.63
	LIM	26971	7.82	4.74	7.59	57.63	97.01	0.00	80.52	2.52	8.57
	SAP	22704	36.37	38.28	8.35	69.68	22.95	1.26	78.51	-0.95	1.88
	BRK	5582	39.72	39.35	3.85	14.86	9.70	0.00	74.66	1.47	11.97

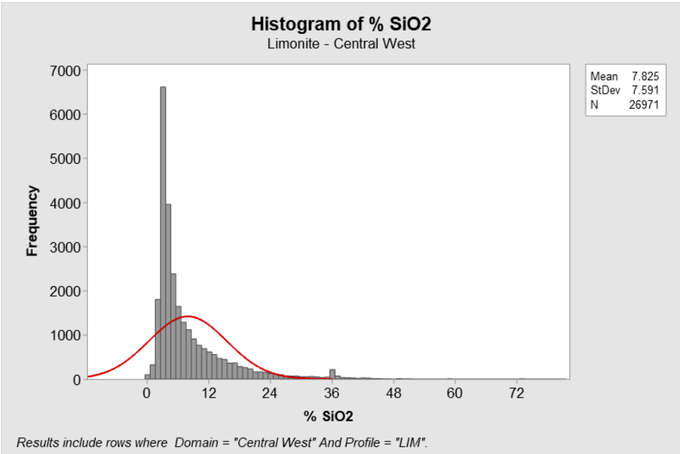
HISTOGRAM: LIM



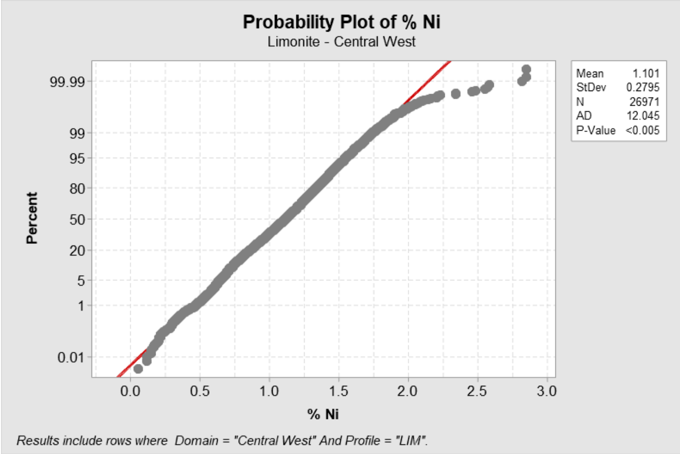


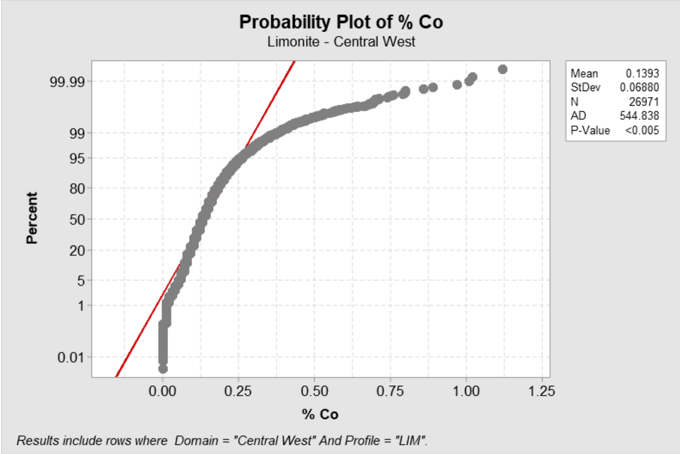


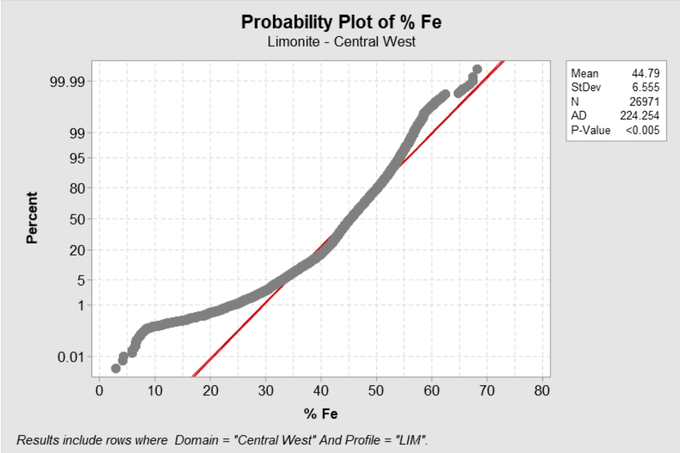


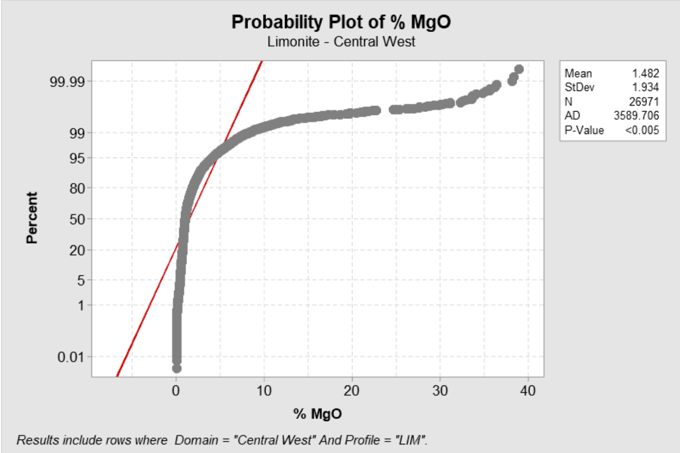


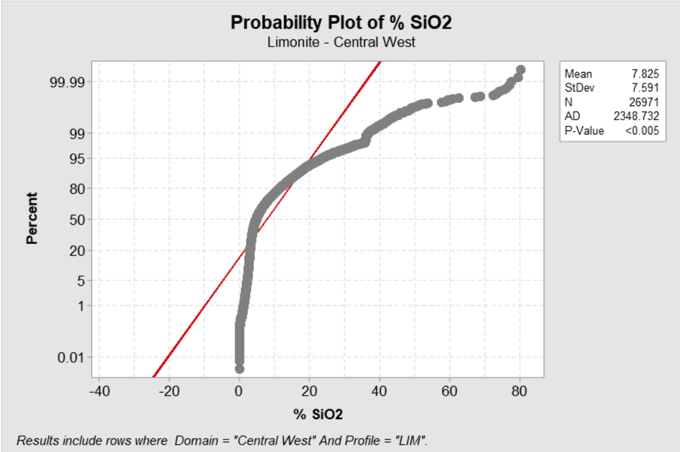
PROBABILITY PLOT: LIM



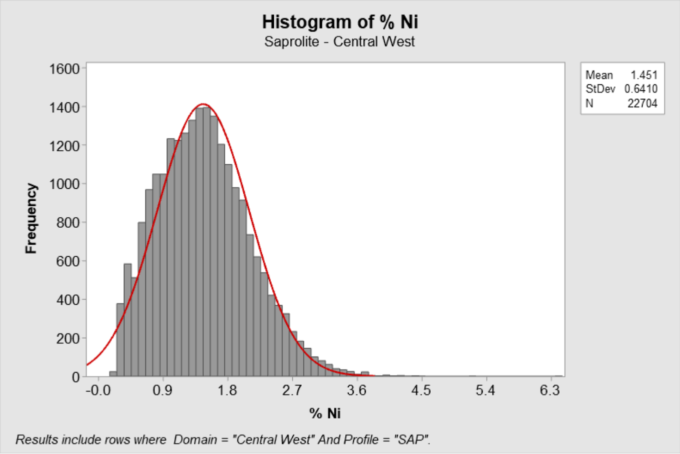


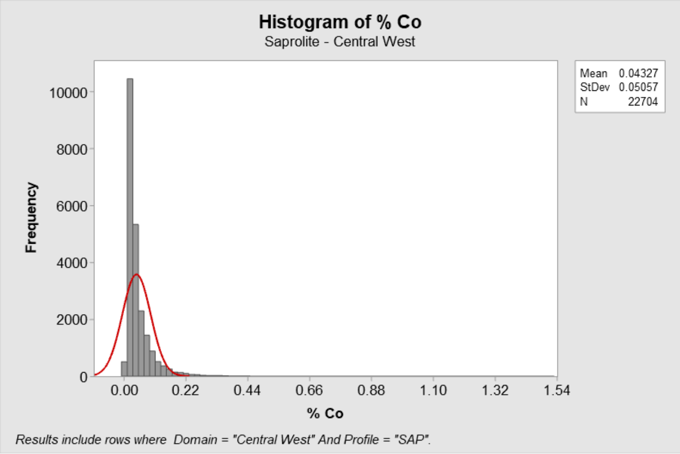


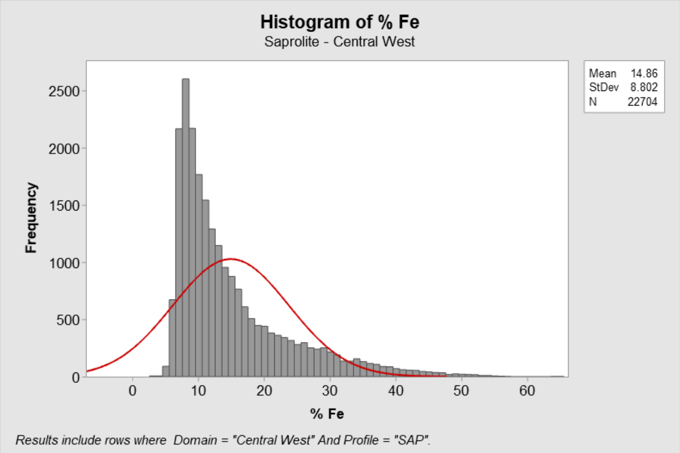


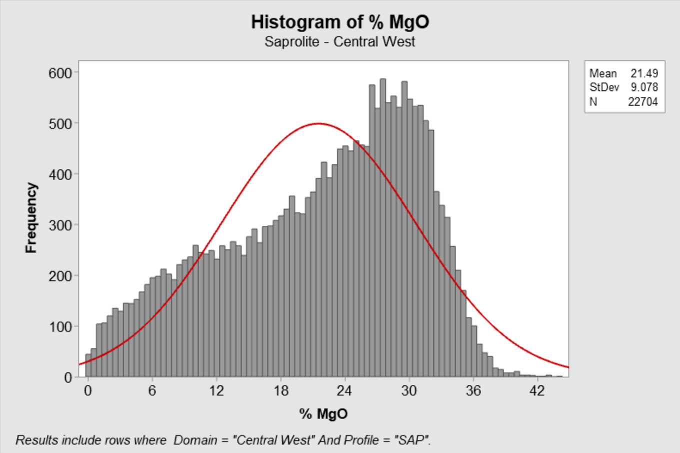


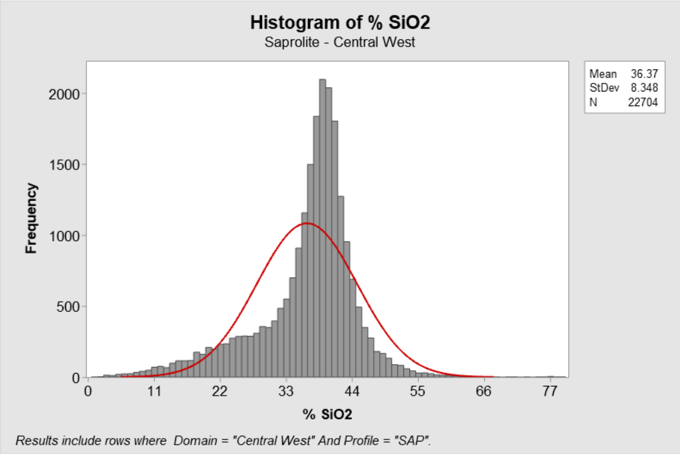
HISTOGRAM: SAP



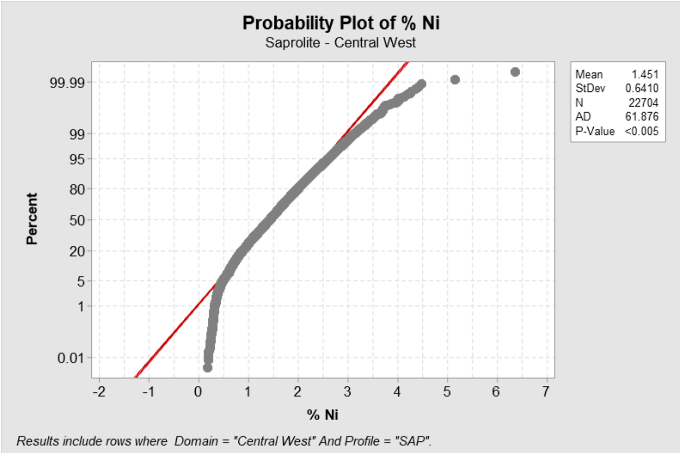


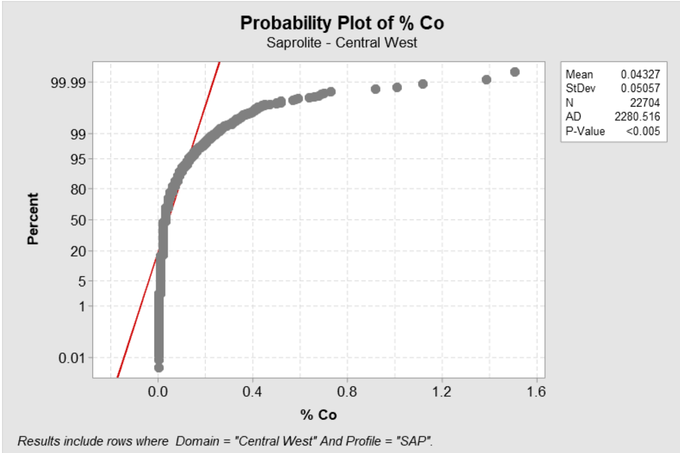


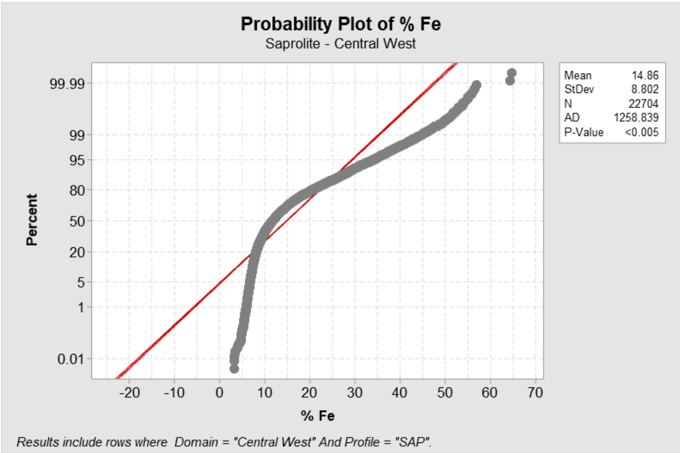


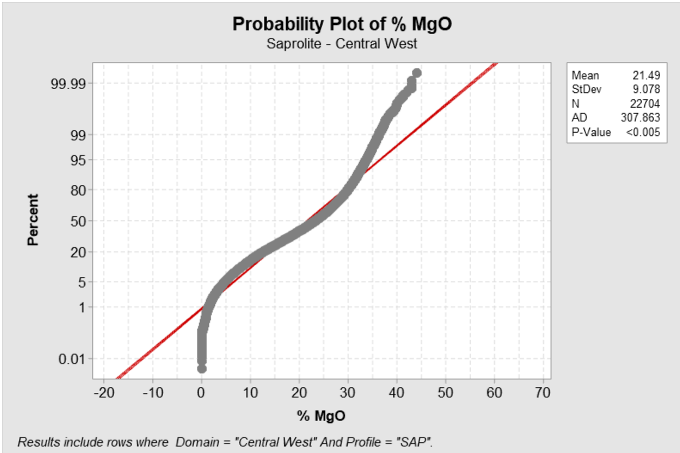


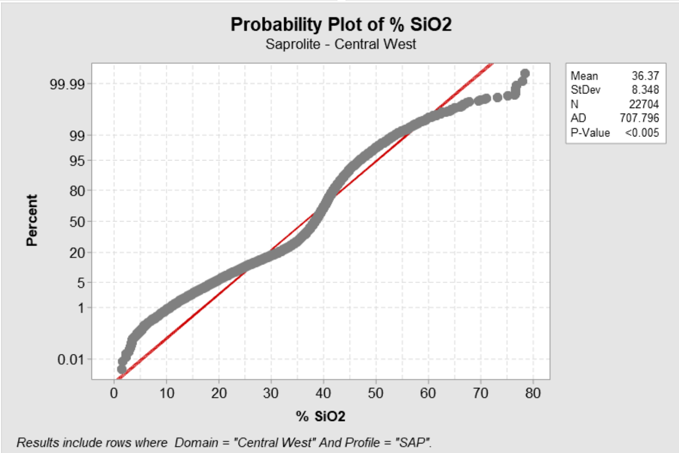
PROBABILITY PLOT: SAP



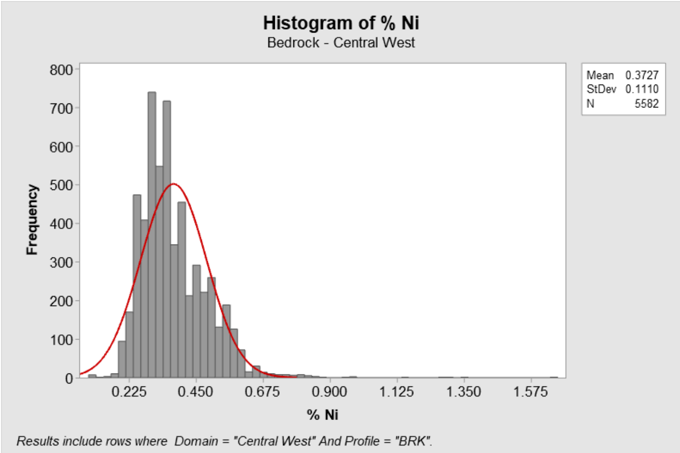


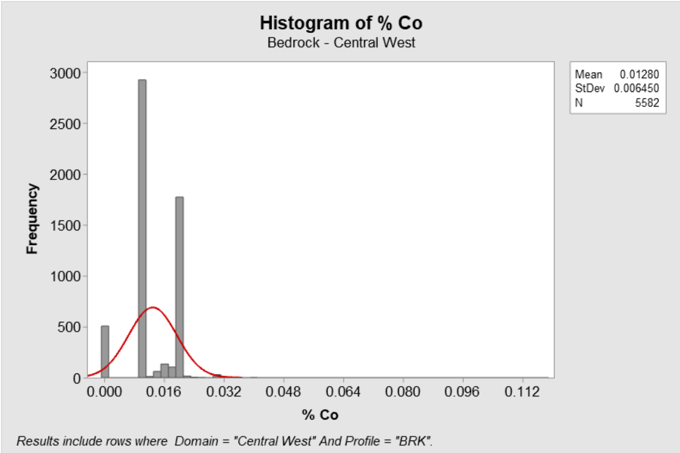


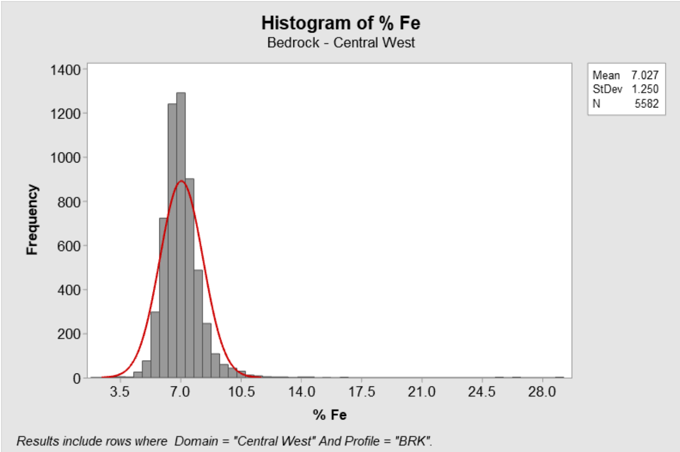


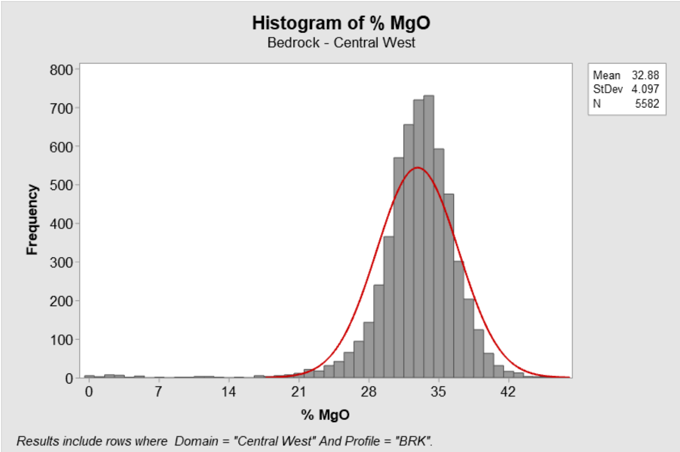


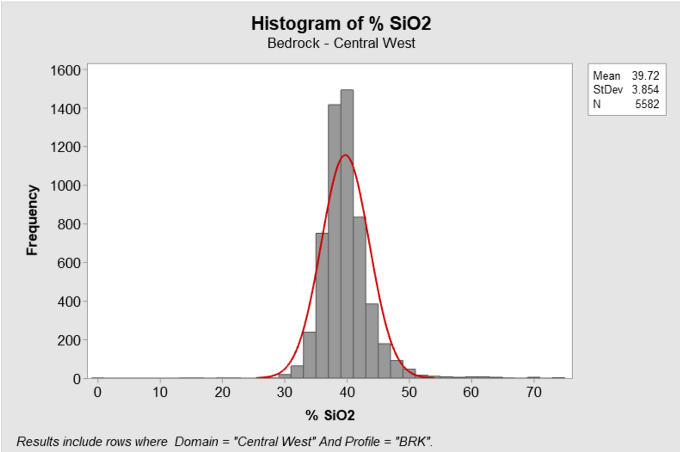
HISTOGRAM: BRK



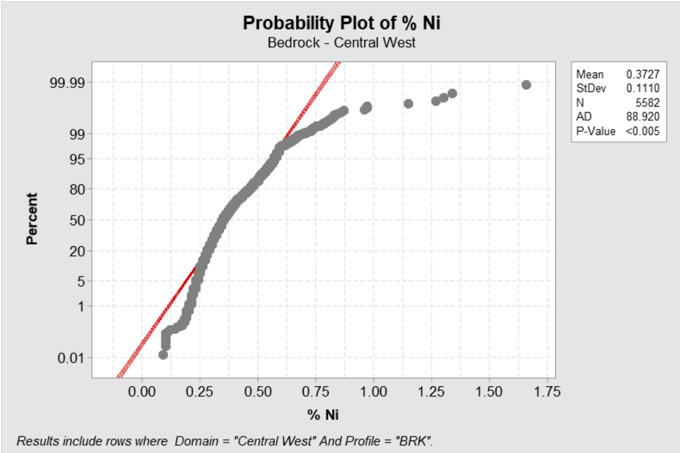


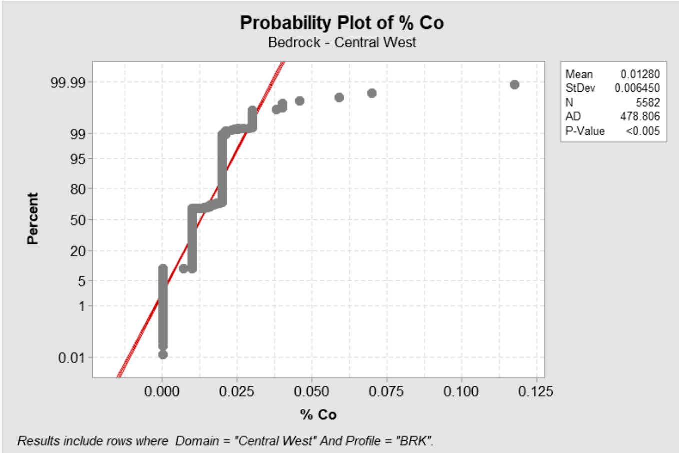


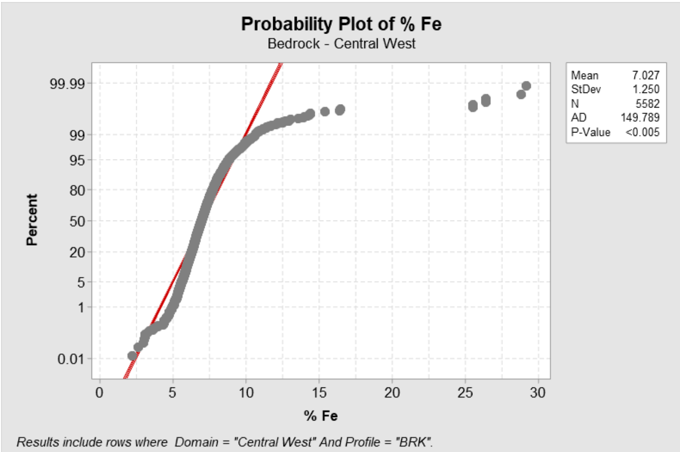


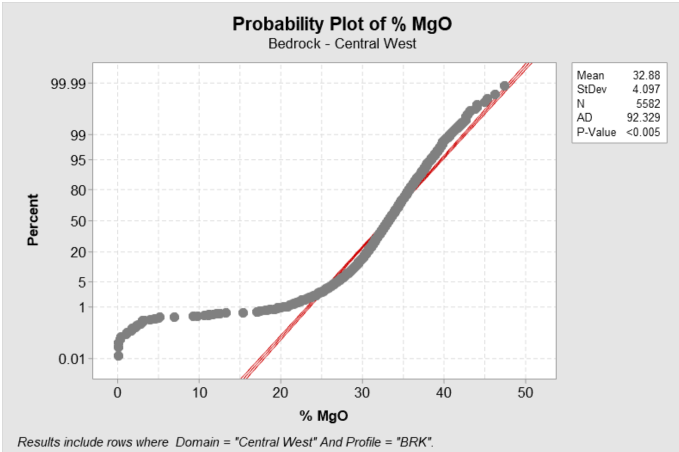


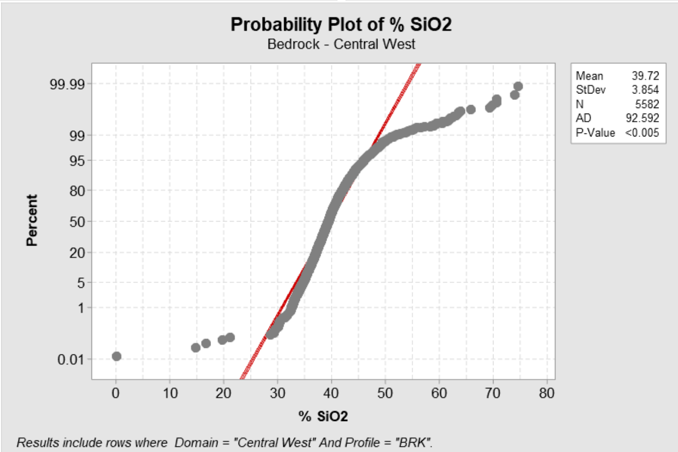
PROBABILITY PLOT: BRK







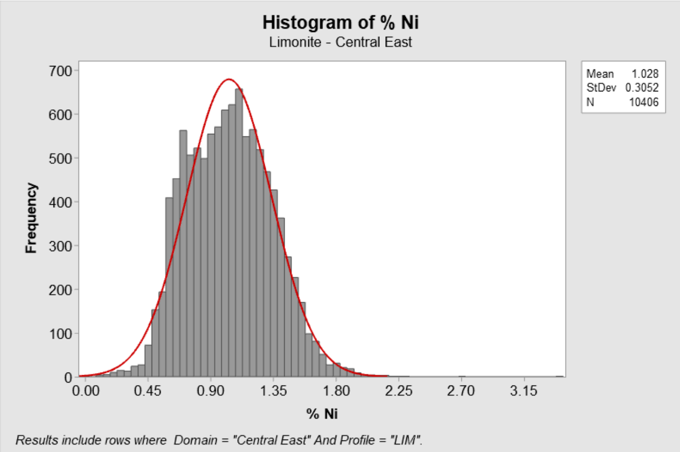


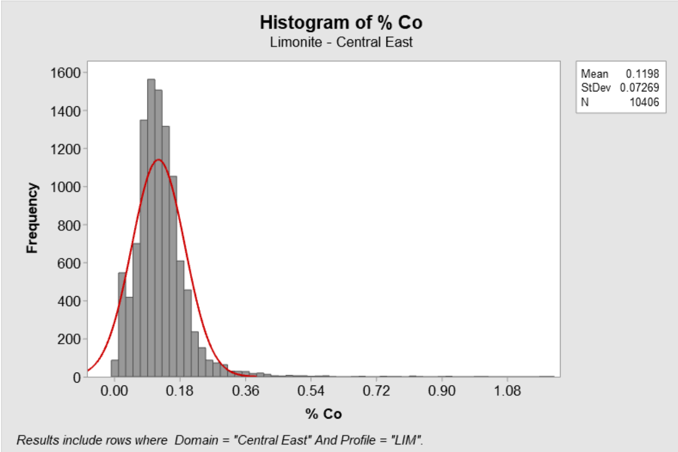


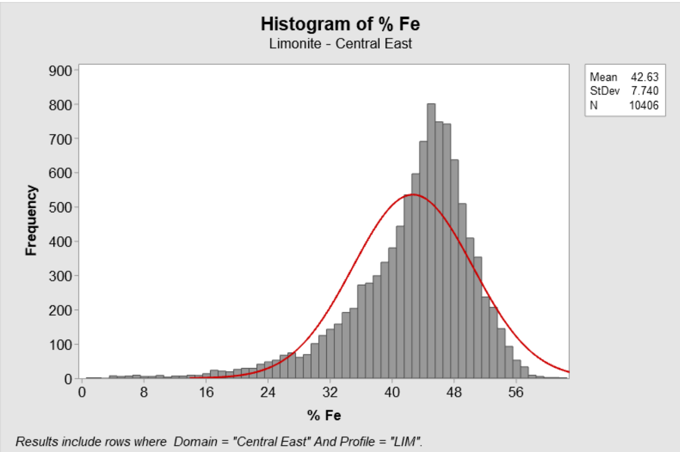
CENTRAL EAST
STATISTICS

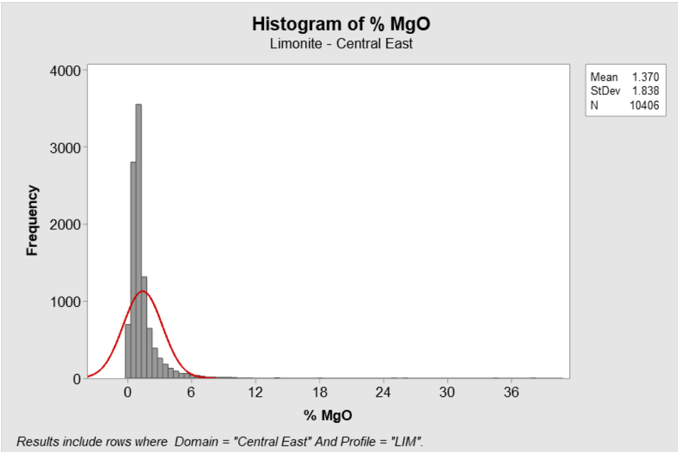
Variable	Profile	Samples	Mean	Median	StDev	Variance	CoefVar	Minimum	Maximum	Skewness	Kurtosis
Ni	SED	1	0.05	0.05				0.05	0.05		
	LIM	10406	1.03	1.02	0.31	0.09	29.69	0.02	3.38	0.25	0.13
	SAP	10688	1.35	1.28	0.62	0.39	46.18	0.02	6.02	0.82	1.46
	BRK	2439	0.38	0.36	0.12	0.02	32.99	0.07	1.37	1.50	5.38
Co	SED	1	0.01	0.01				0.01	0.01		
	LIM	10406	0.12	0.11	0.07	0.01	60.68	0.00	1.20	3.03	26.07
	SAP	10688	0.04	0.03	0.04	0.00	113.20	0.00	1.35	7.64	139.38
	BRK	2439	0.01	0.01	0.01	0.00	56.06	0.00	0.11	3.80	34.00
Fe	SED	1	1.96	1.96				1.96	1.96		
	LIM	10406	42.63	44.19	7.74	59.90	18.16	0.80	61.50	-1.29	2.68
	SAP	10688	14.79	12.08	8.22	67.53	55.56	1.84	54.09	1.51	2.19
	BRK	2439	7.37	7.03	2.06	4.25	27.99	0.94	38.13	4.39	38.24
MgO	SED	1	0.95	0.95				0.95	0.95		
	LIM	10406	1.37	0.91	1.84	3.38	134.12	0.00	40.59	9.12	137.81
	SAP	10688	18.92	20.30	9.91	98.25	52.39	0.00	46.27	-0.23	-0.89
	BRK	2439	30.35	32.20	8.51	72.46	28.05	0.00	49.11	-1.74	3.42
SiO2	SED	1	5.46	5.46				5.46	5.46		
	LIM	10406	11.28	6.67	11.75	138.15	104.25	0.00	94.65	2.38	7.17
	SAP	10688	40.59	40.64	10.81	116.90	26.64	0.00	99.00	0.46	3.20
	BRK	2439	43.86	42.00	8.83	77.94	20.13	17.64	93.00	2.31	6.80

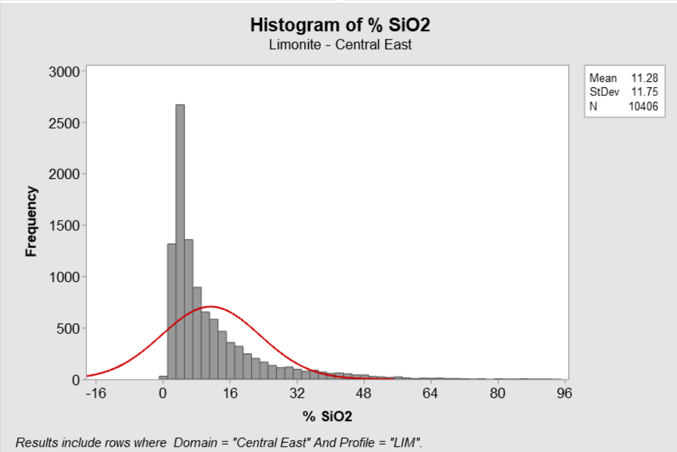
HISTOGRAM: LIM



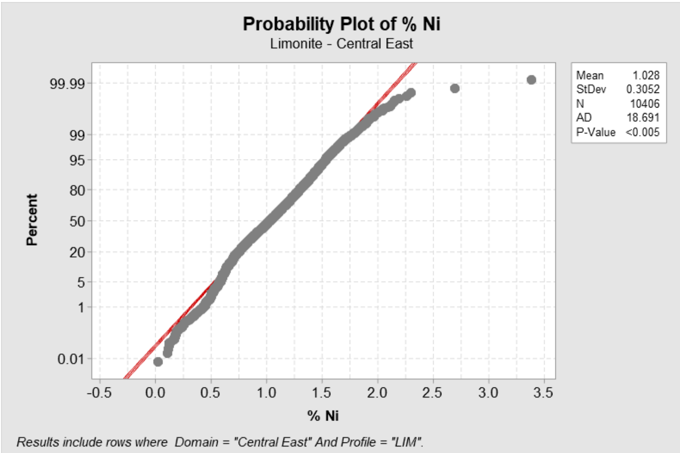


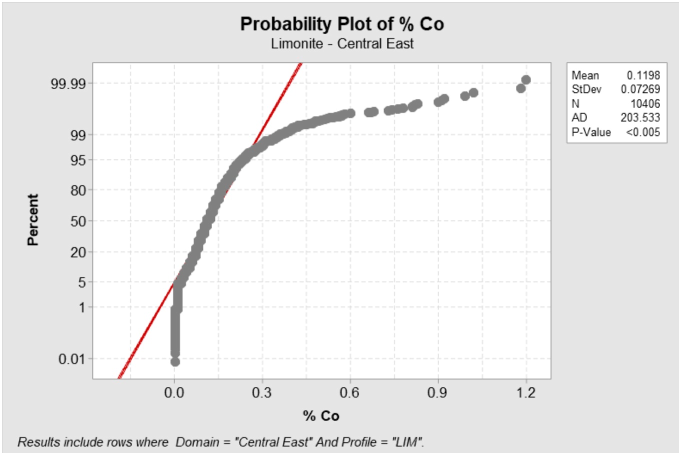


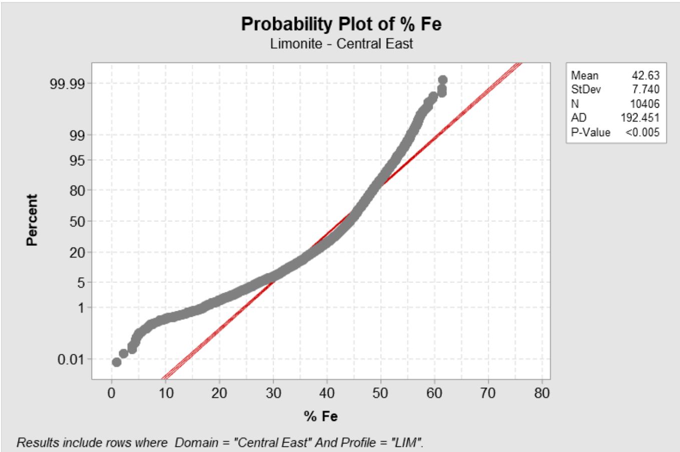


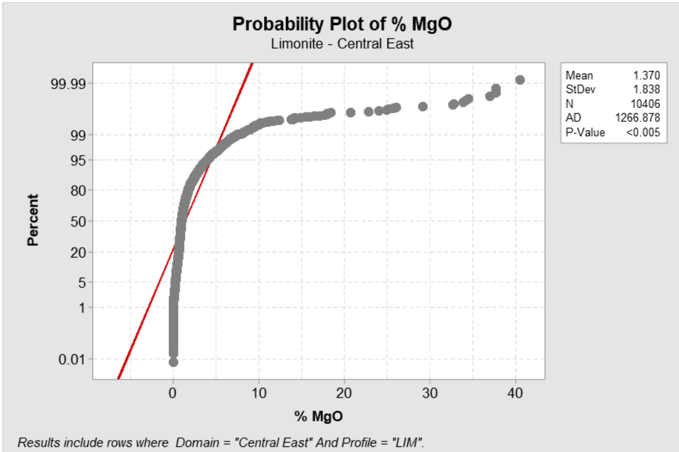


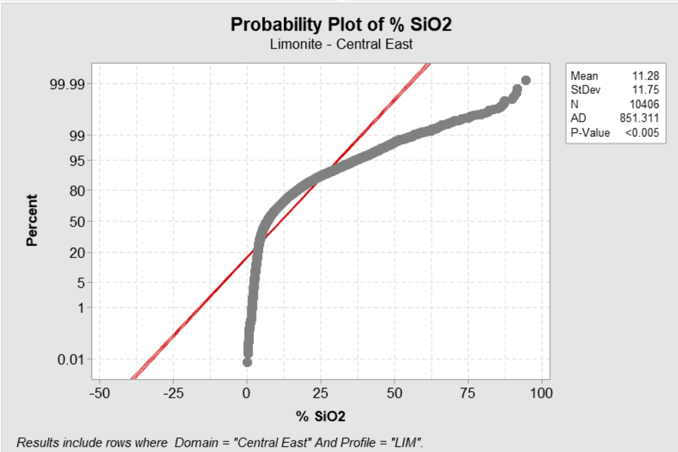
PROBABILITY PLOT: LIM



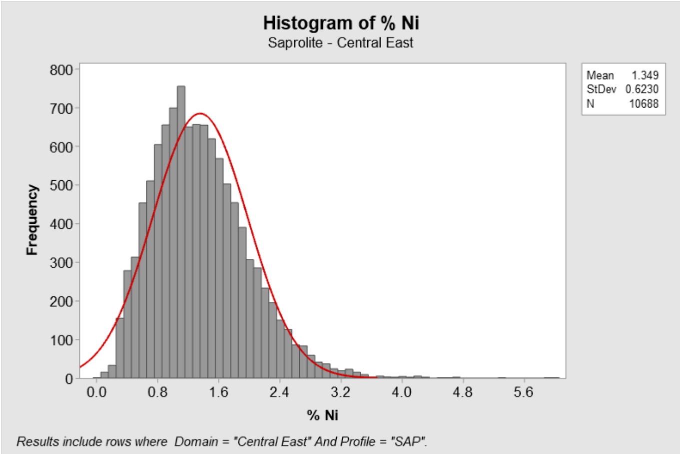


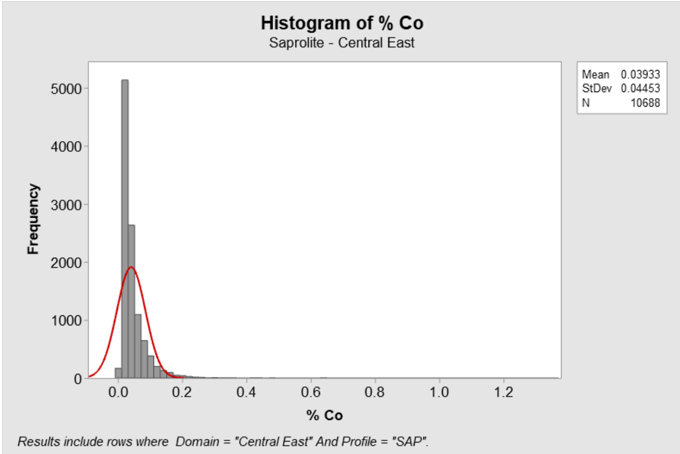


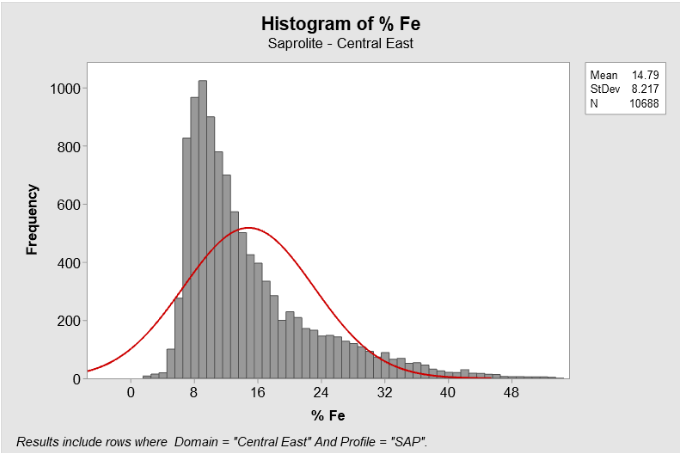


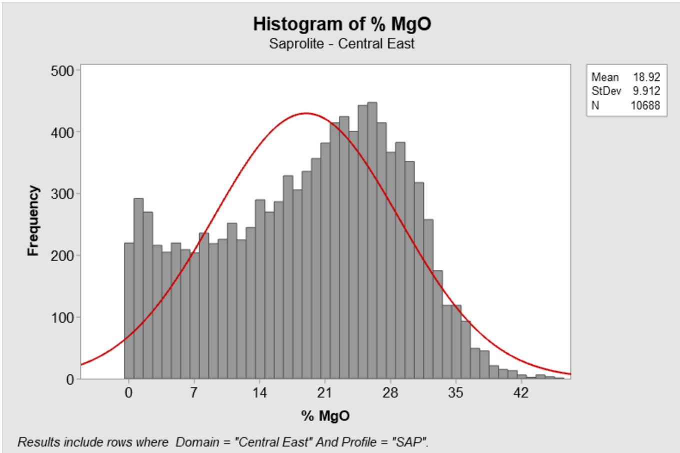


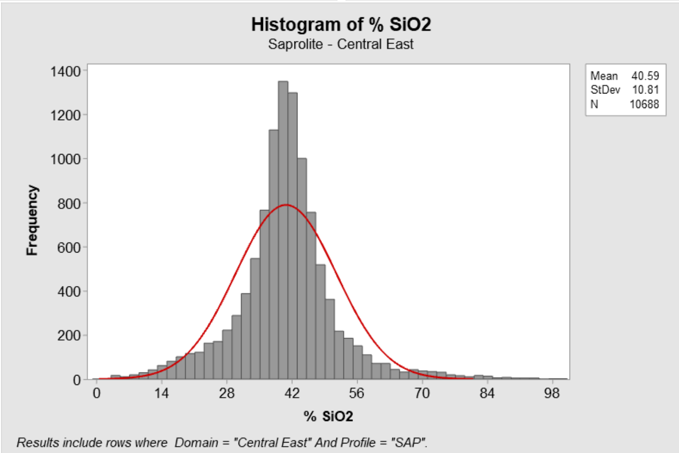
HISTOGRAM: SAP



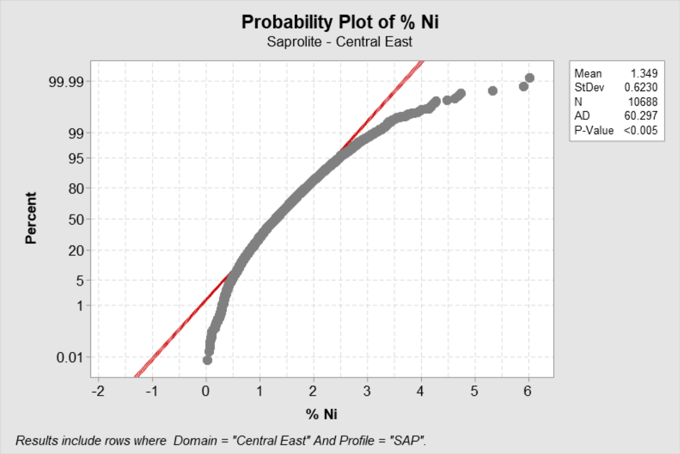


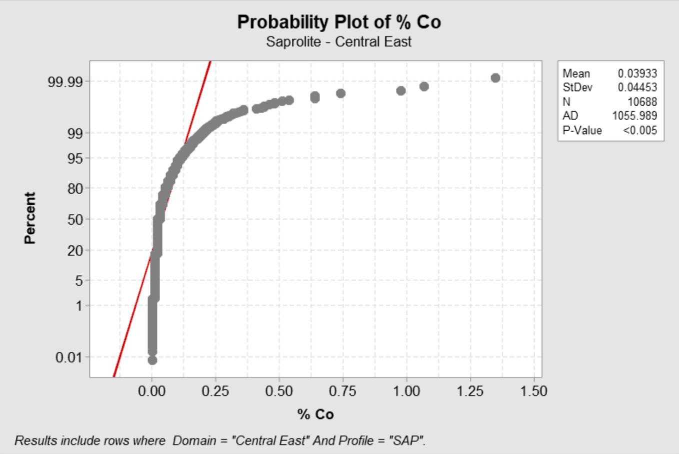


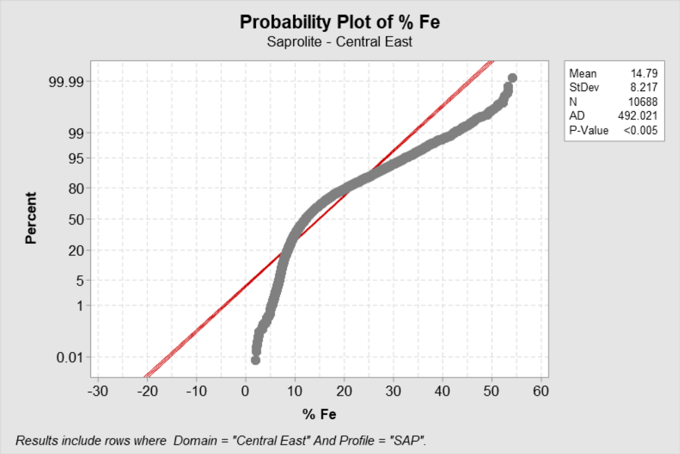


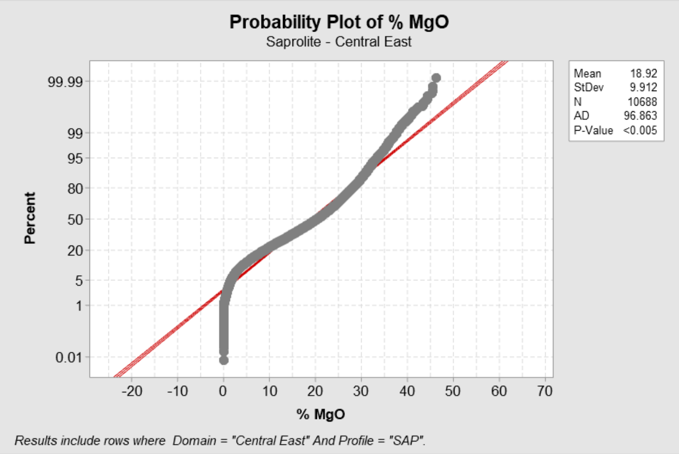


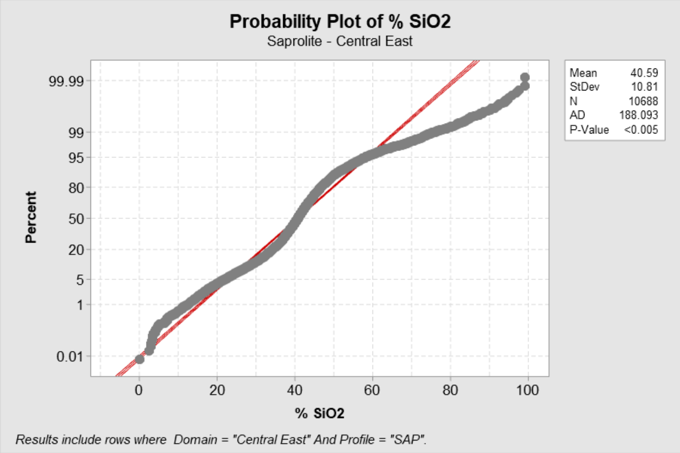
PROBABILITY PLOT: SAP



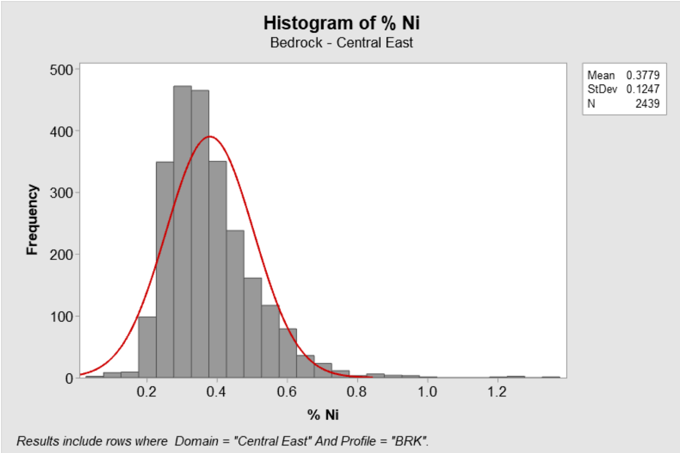


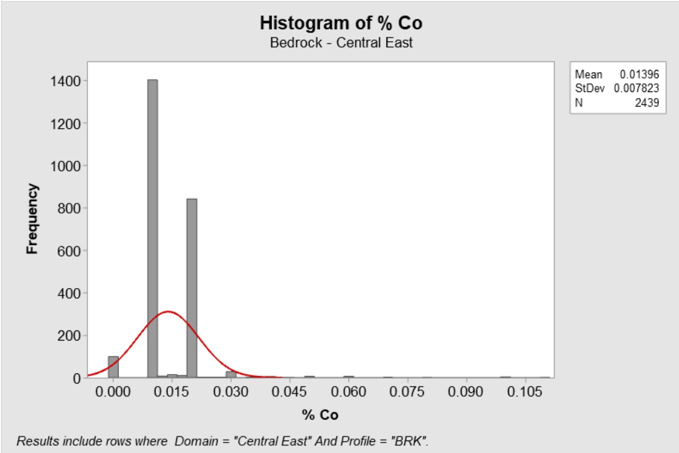


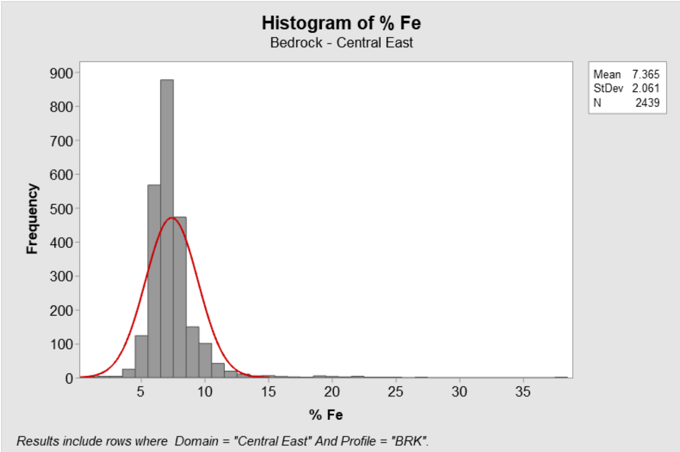


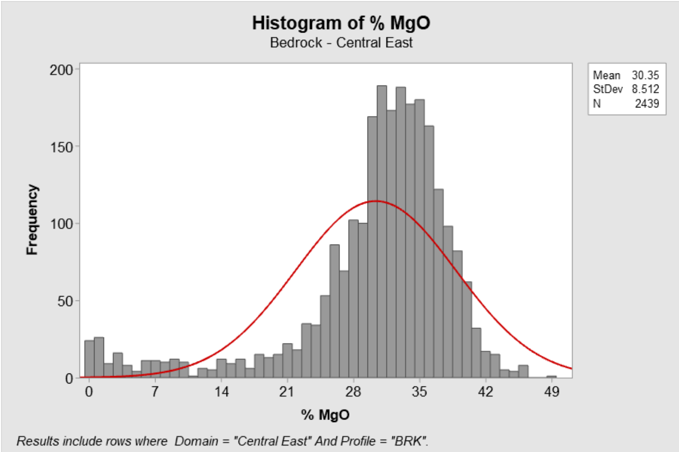


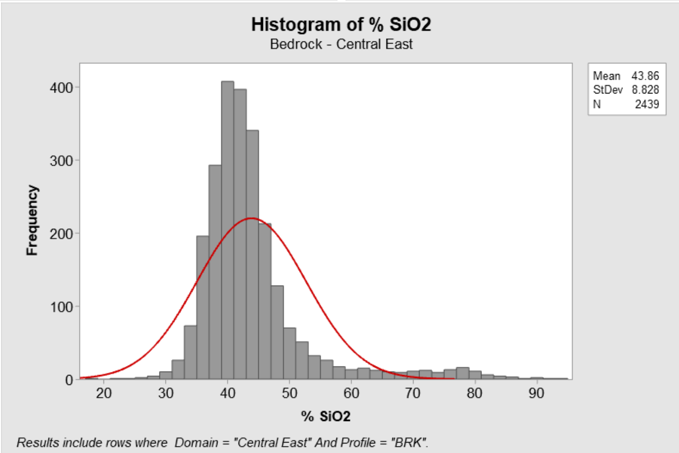
HISTOGRAM: BRK



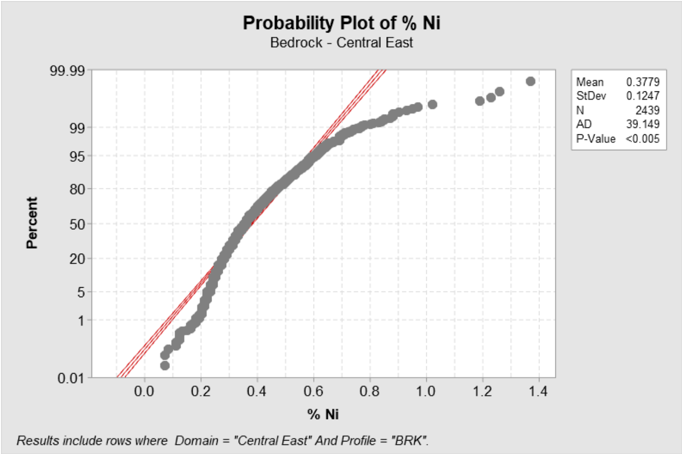


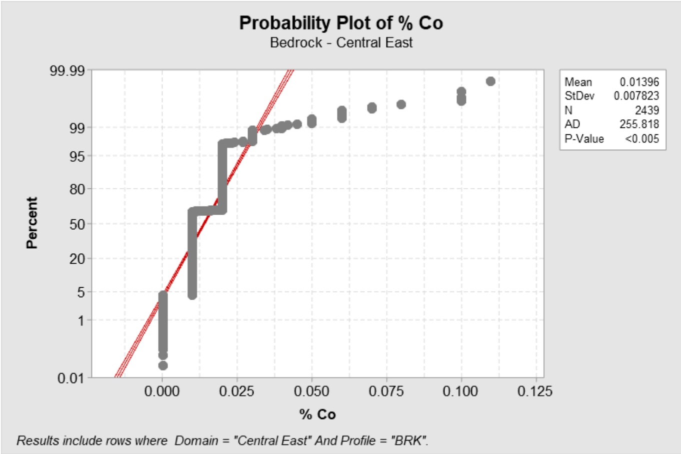


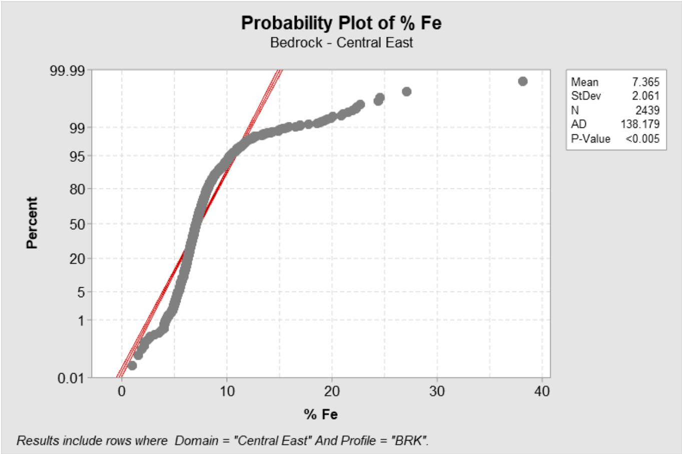


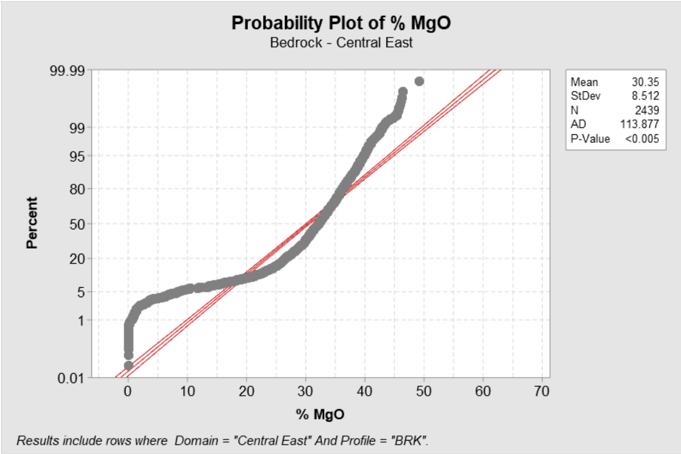


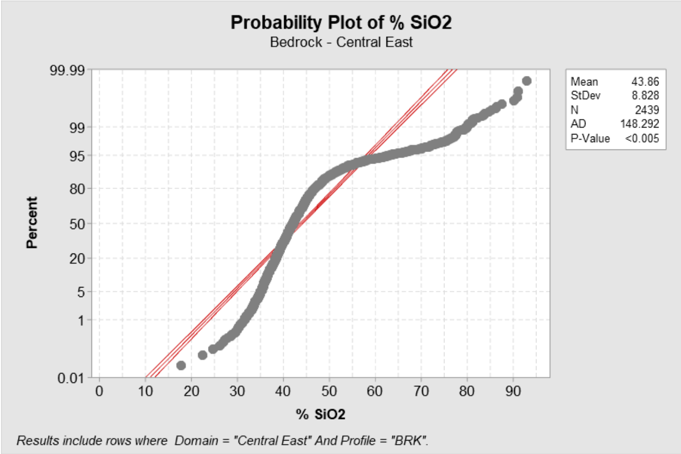
PROBABILITY PLOT: BRK







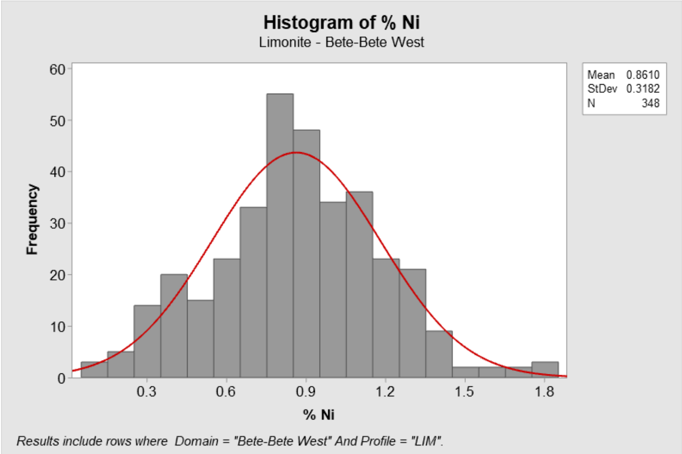


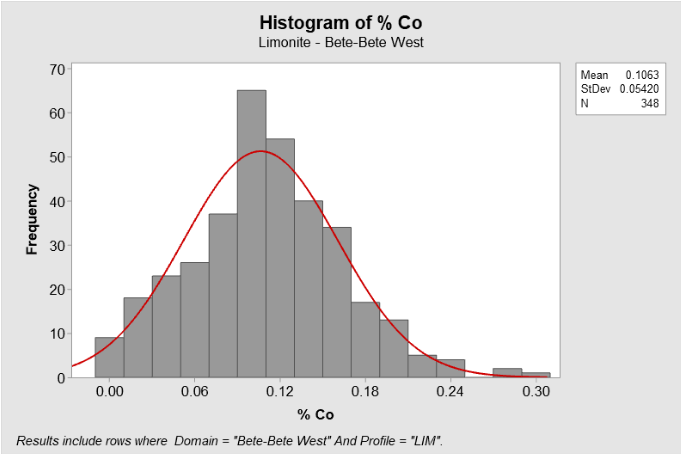


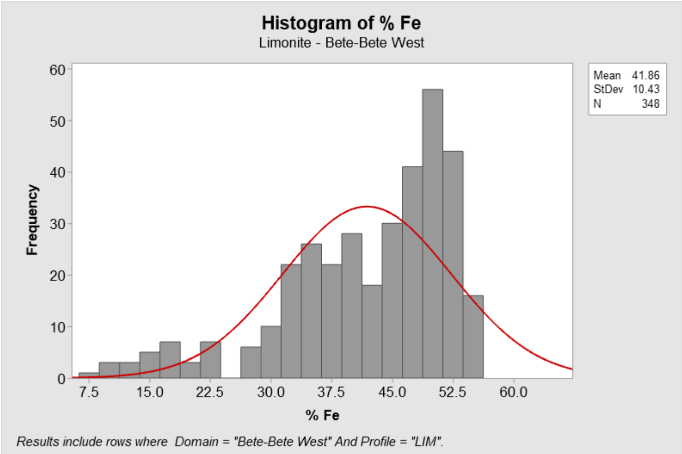
BETE-BETE WEST
STATISTICS

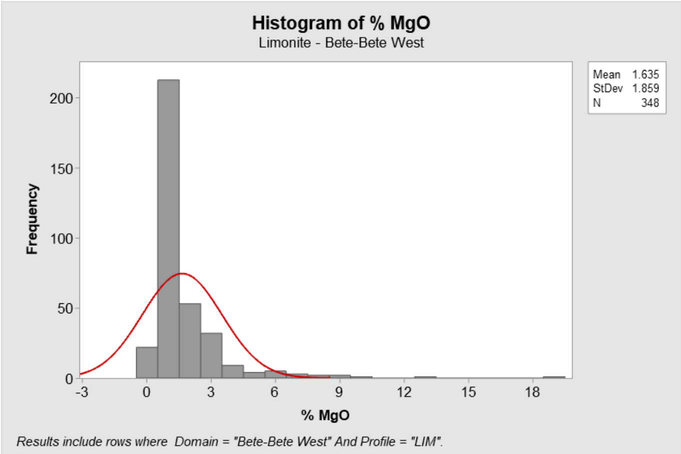
Variable	Profile	Samples	Mean	Median	StDev	Variance	CoefVar	Minimum	Maximum	Skewness	Kurtosis
Ni	SED	27	0.23	0.20	0.09	0.01	41.56	0.09	0.49	1.39	2.58
	LIM	348	0.86	0.85	0.32	0.10	36.95	0.08	1.80	0.07	0.05
	SAP	384	1.33	1.31	0.54	0.29	40.66	0.12	3.75	0.53	1.55
	BRK	226	0.35	0.30	0.16	0.02	44.84	0.07	0.93	1.16	1.11
Co	SED	27	0.01	0.01	0.01	0.00	34.37	0.01	0.02	0.08	-2.16
	LIM	348	0.11	0.10	0.05	0.00	50.99	0.00	0.31	0.30	0.44
	SAP	384	0.03	0.02	0.03	0.00	99.09	0.00	0.19	1.94	4.24
	BRK	226	0.02	0.01	0.01	0.00	67.02	0.00	0.10	3.28	20.98
Fe	SED	27	5.88	5.59	1.64	2.68	27.87	3.38	11.17	1.42	3.49
	LIM	348	41.86	44.90	10.43	108.85	24.92	8.72	55.30	-1.08	0.68
	SAP	384	16.14	13.05	8.90	79.21	55.14	6.30	54.94	1.74	3.27
	BRK	226	8.70	7.45	3.30	10.90	37.93	4.99	18.83	1.28	0.71
MgO	SED	27	20.29	18.64	7.64	58.40	37.66	3.02	30.63	-0.24	-0.85
	LIM	348	1.64	1.00	1.86	3.46	113.70	0.01	19.17	4.36	28.56
	SAP	384	20.03	21.17	10.60	112.37	52.93	0.01	38.76	-0.29	-1.07
	BRK	226	26.16	33.77	14.31	204.77	54.70	0.09	42.51	-0.81	-1.09
SiO2	SED	27	29.91	32.72	6.84	46.76	22.86	16.39	43.25	-0.35	-0.79
	LIM	348	14.46	9.94	12.35	152.43	85.36	2.64	72.52	1.85	3.53
	SAP	384	39.59	41.85	8.43	71.03	21.29	4.09	60.30	-1.57	3.98
	BRK	226	43.53	42.42	4.77	22.72	10.95	34.99	62.27	1.83	3.74

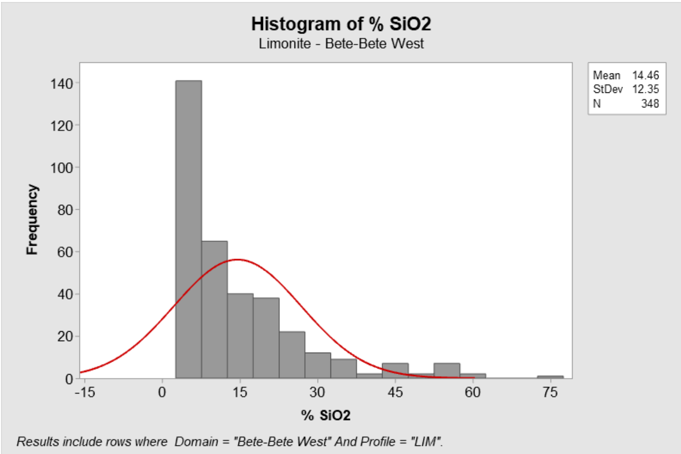
HISTOGRAM: LIM



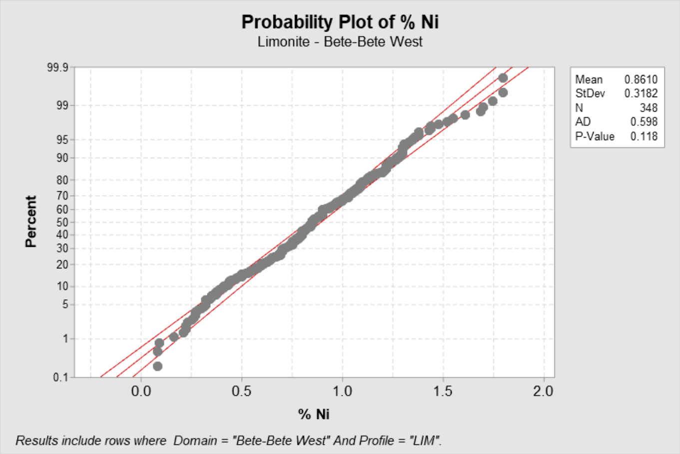


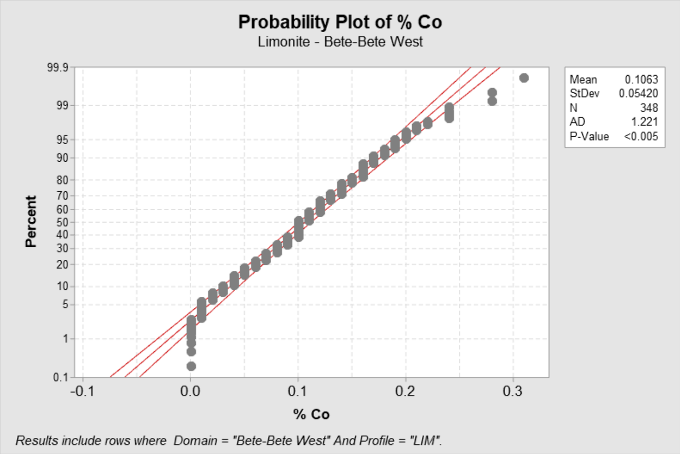


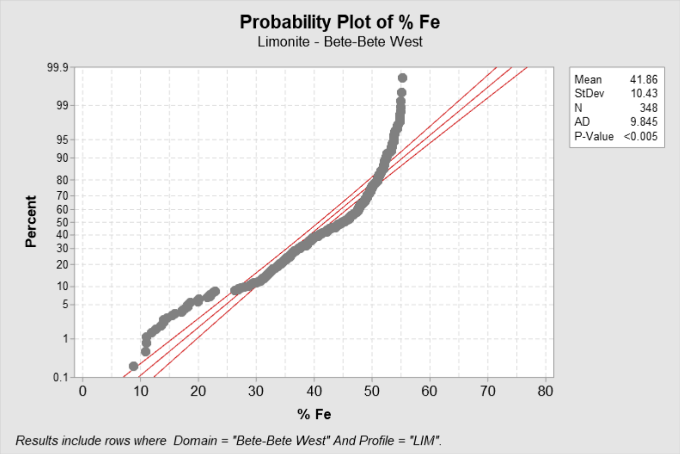


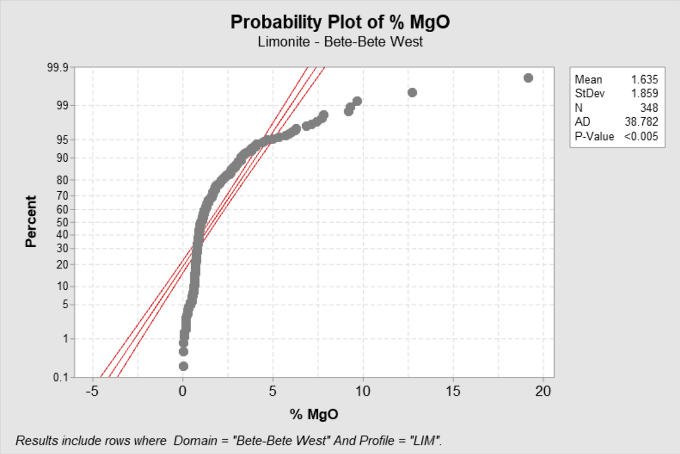


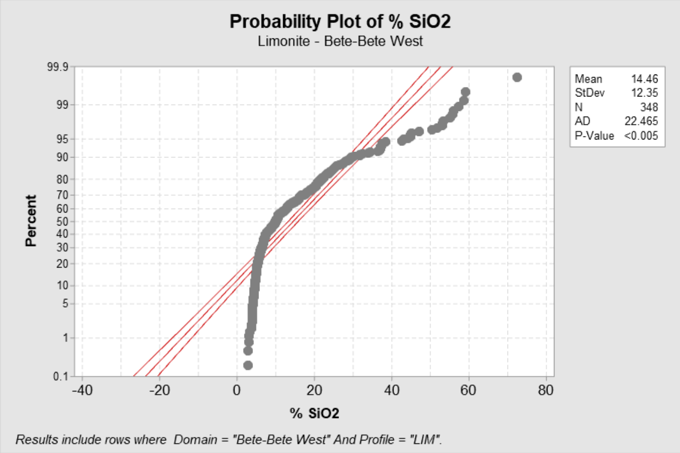
PROBABILITY PLOT: LIM



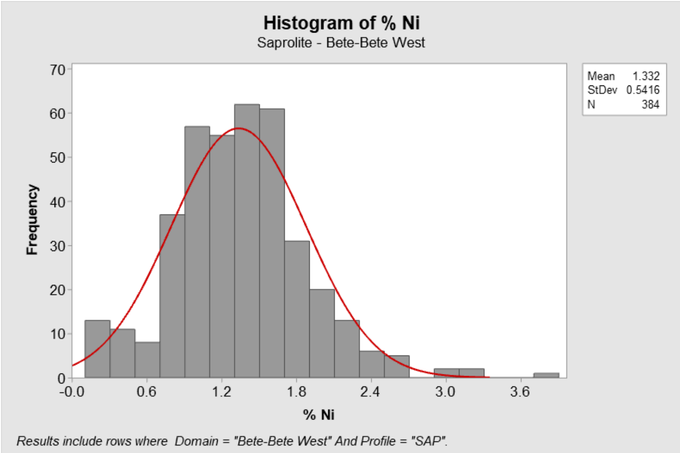


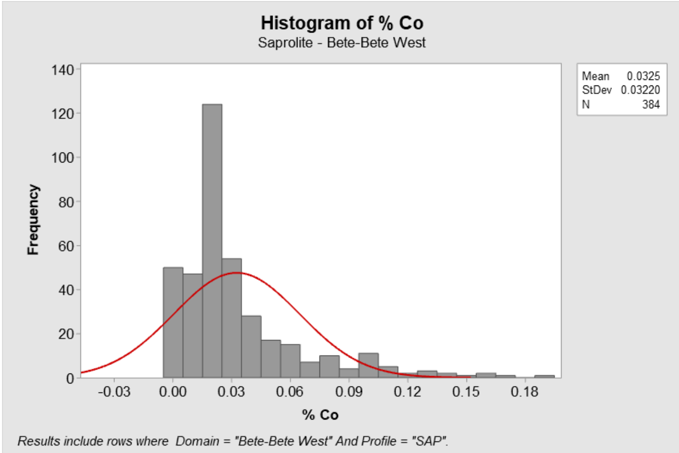


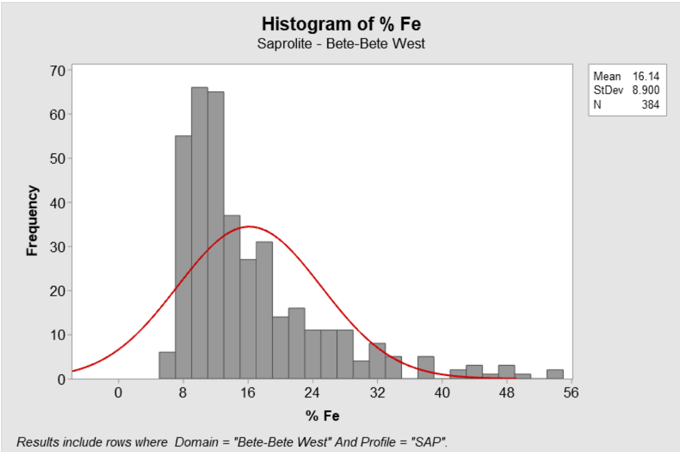


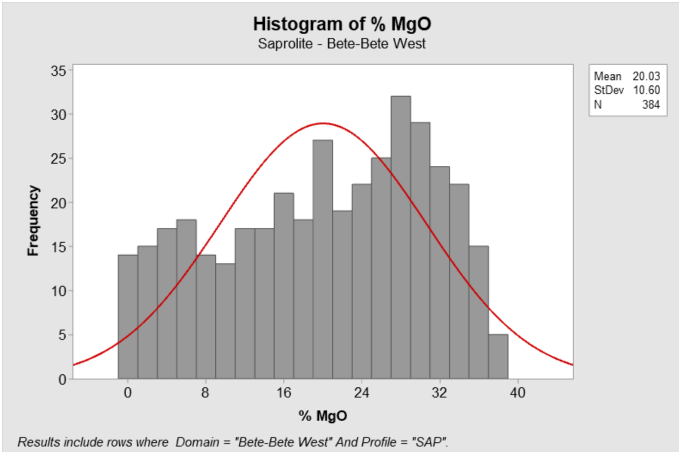


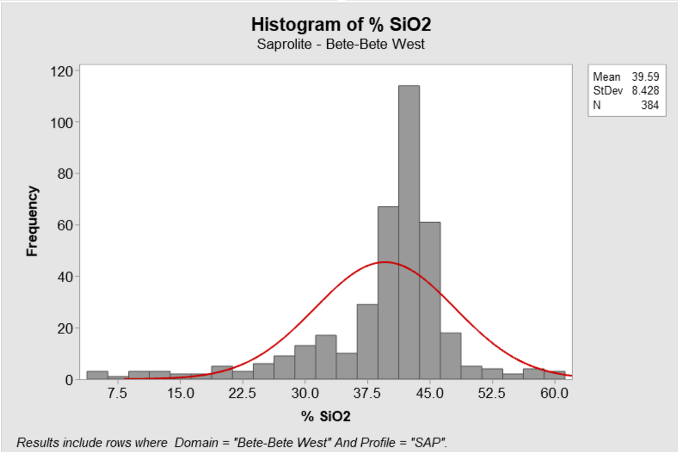
HISTOGRAM: SAP



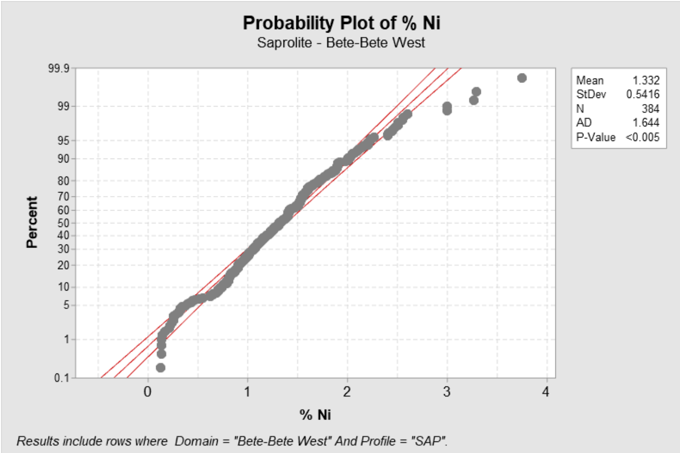


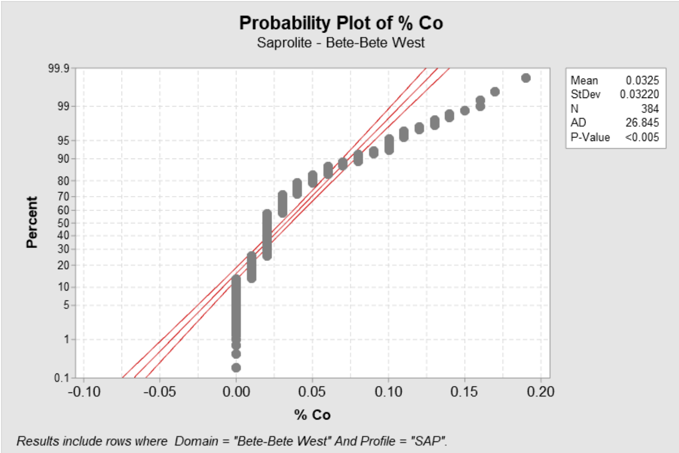


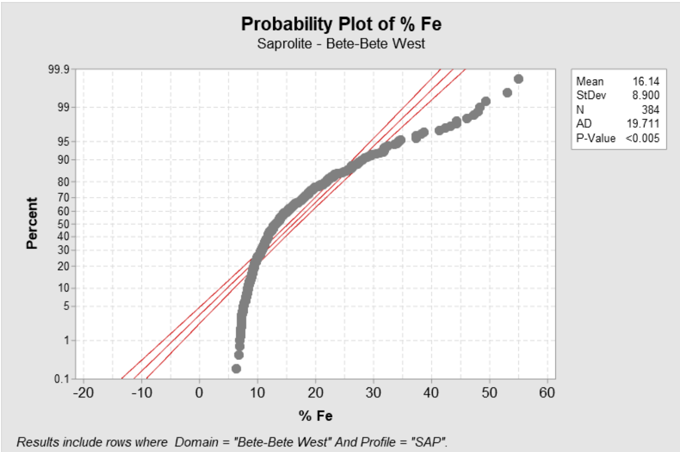


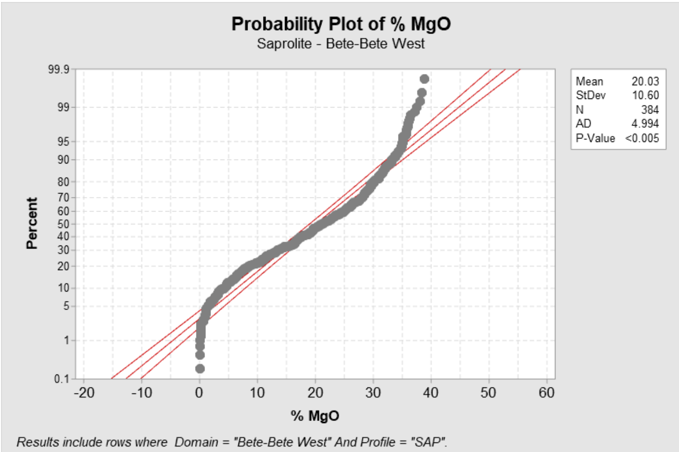


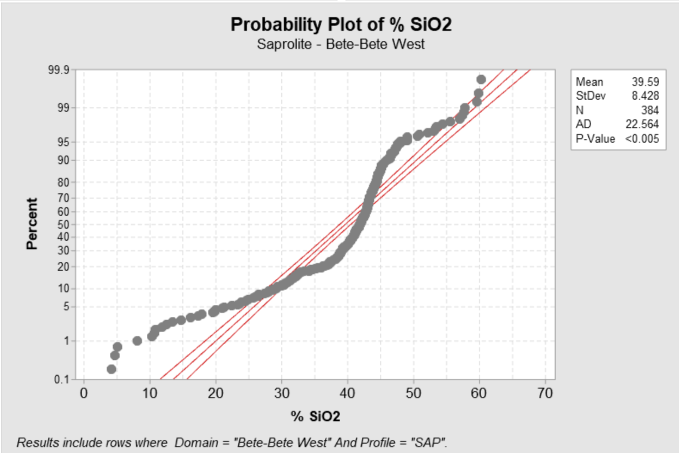
PROBABILITY PLOT: SAP



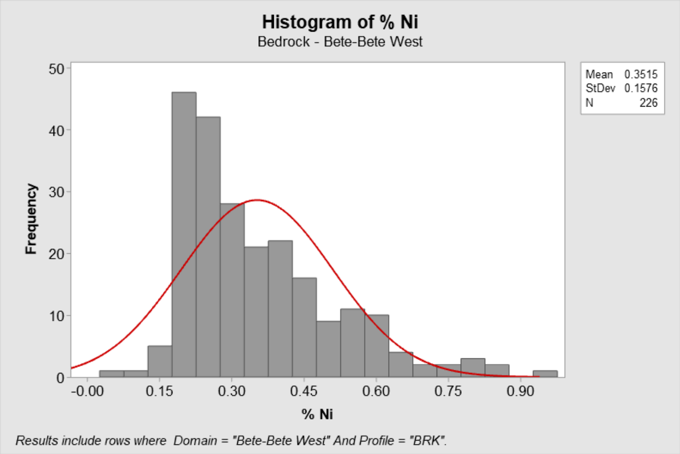


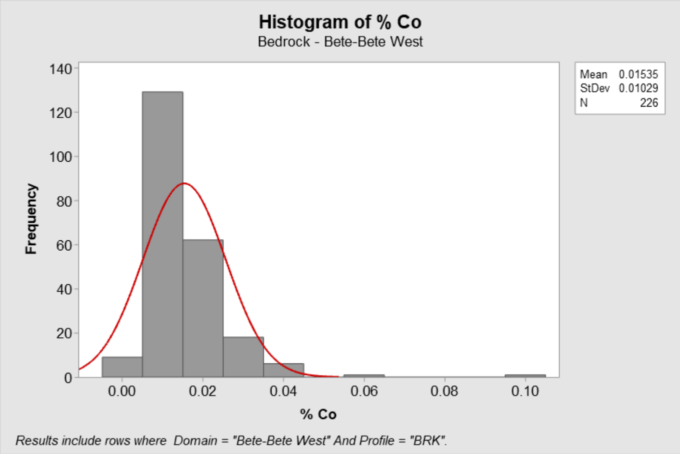


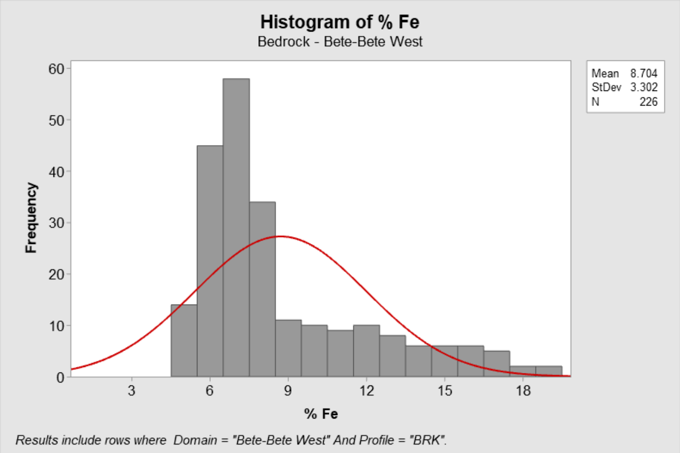


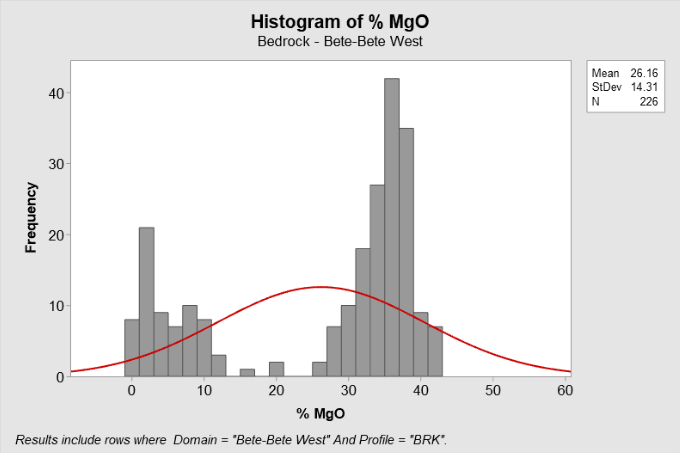


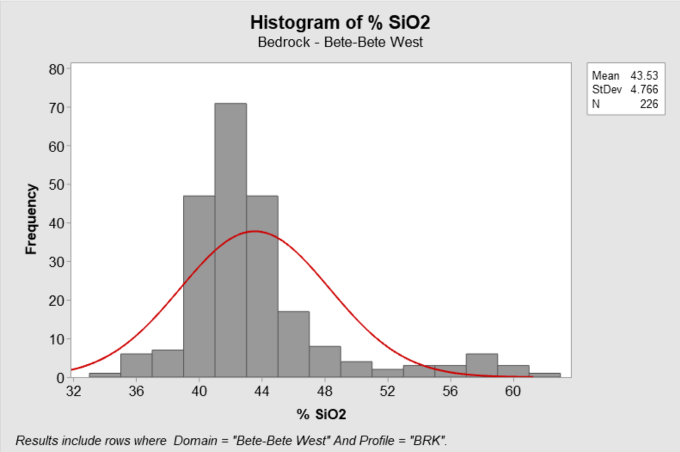
HISTOGRAM: BRK



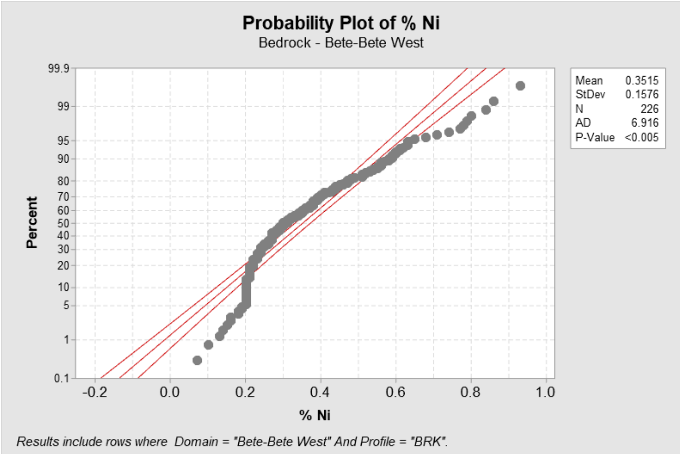


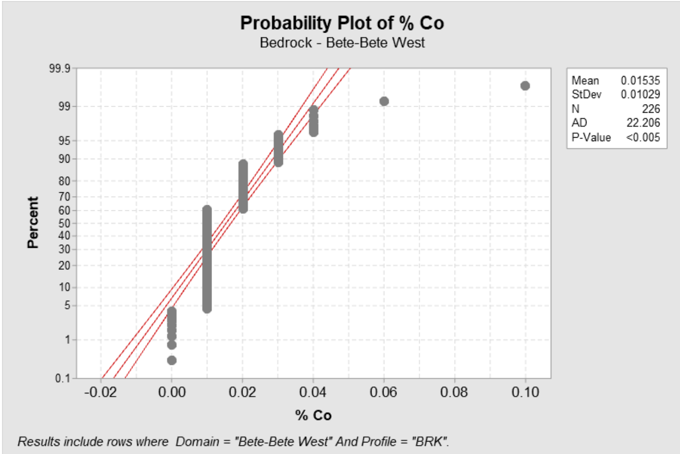


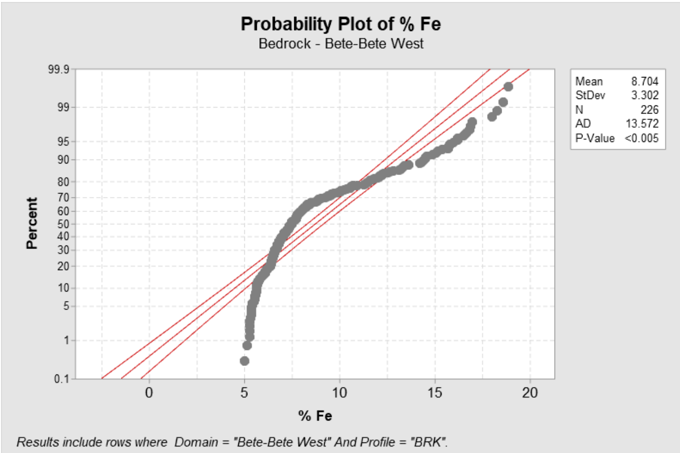


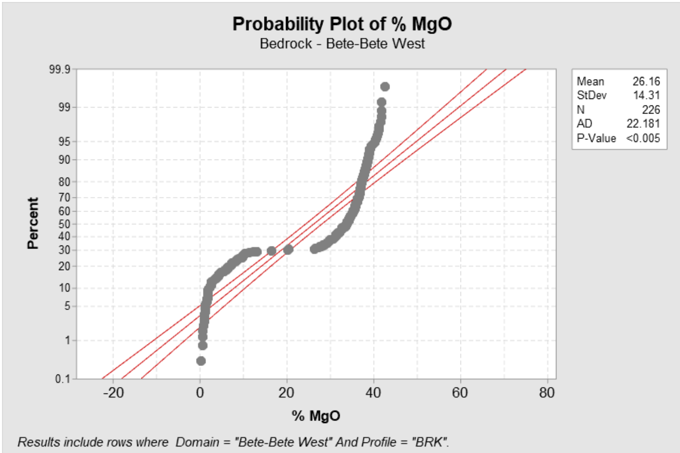


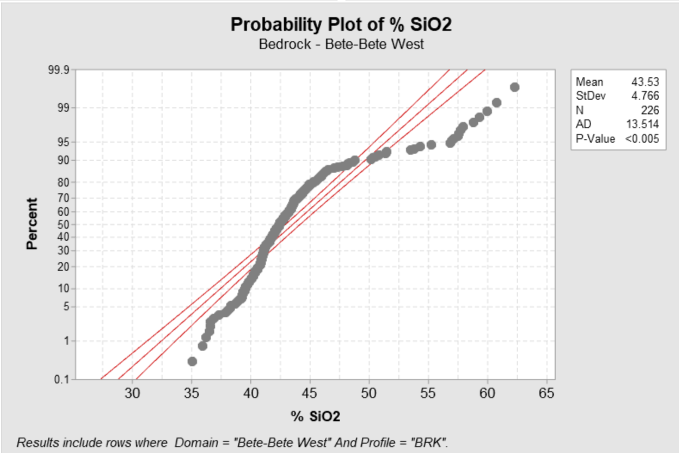
PROBABILITY PLOT: BRK









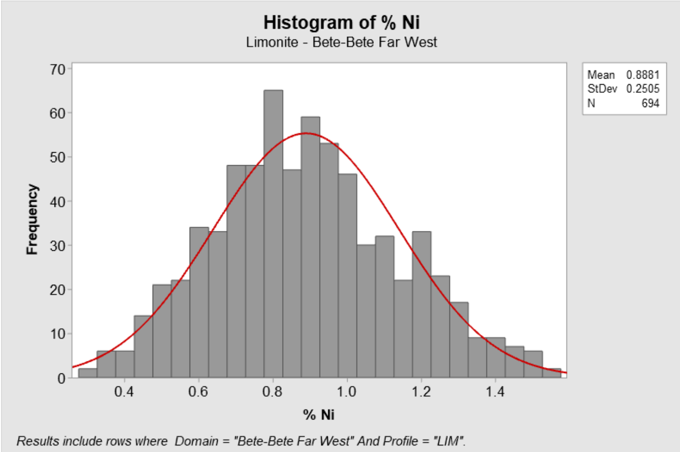


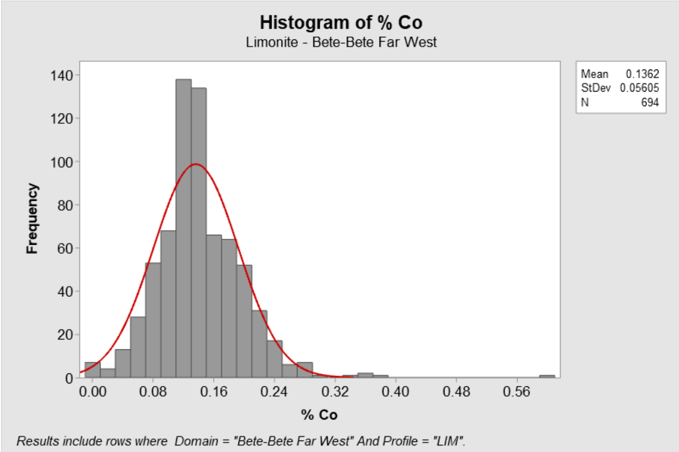
BETE-BETE FAR WEST

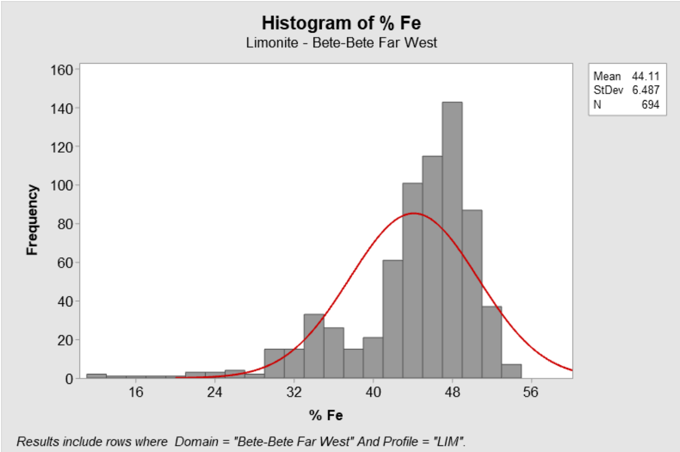
STATISTICS

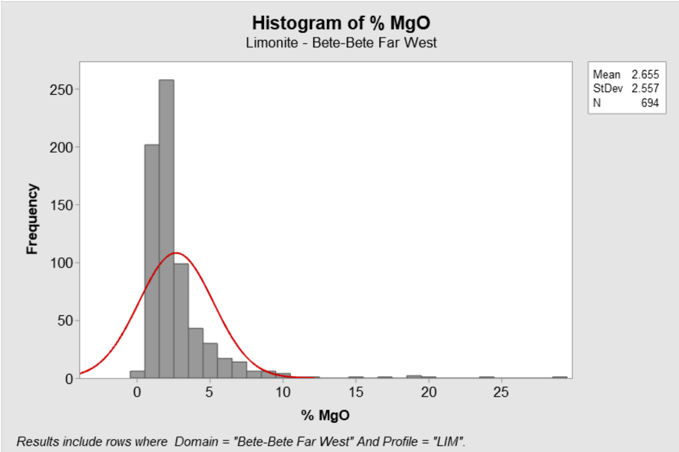
Variable	Profile	Samples	Mean	Median	StDev	Variance	CoefVar	Minimum	Maximum	Skewness	Kurtosis
Ni	SED	23	0.32	0.31	0.17	0.03	52.11	0.01	0.74	0.61	0.67
	LIM	694	0.89	0.88	0.25	0.06	28.21	0.31	1.56	0.22	-0.38
	SAP	995	1.06	0.97	0.49	0.24	46.33	0.22	2.95	0.89	0.93
	BRK	520	0.34	0.32	0.10	0.01	30.64	0.15	0.69	0.84	0.16
Co	SED	23	0.01	0.01	0.01	0.00	74.67	0.00	0.04	1.26	1.78
	LIM	694	0.14	0.13	0.06	0.00	41.16	0.00	0.60	1.25	7.37
	SAP	995	0.03	0.02	0.03	0.00	107.01	0.00	0.33	2.45	10.90
	BRK	520	0.01	0.01	0.01	0.00	133.47	0.00	0.10	4.00	23.09
Fe	SED	23	6.54	5.85	3.70	13.70	56.62	1.53	17.68	1.51	2.92
	LIM	694	44.11	45.88	6.49	42.08	14.71	11.59	54.11	-1.62	3.43
	SAP	995	12.50	9.83	7.03	49.45	56.25	3.82	49.48	1.96	4.17
	BRK	520	7.39	6.90	2.46	6.03	33.22	4.66	25.70	4.84	26.38
MgO	SED	23	15.71	20.51	8.60	73.96	54.73	2.04	25.11	-0.50	-1.56
	LIM	694	2.66	2.03	2.56	6.54	96.30	0.41	28.94	4.64	32.34
	SAP	995	23.32	25.68	7.96	63.29	34.12	1.12	36.03	-0.96	0.03
	BRK	520	30.33	31.67	6.43	41.29	21.19	1.80	38.30	-3.44	12.20
SiO2	SED	23	31.60	32.86	11.06	122.31	35.00	7.88	56.43	-0.57	1.61
	LIM	694	10.50	8.90	7.46	55.66	71.03	2.33	43.13	1.80	3.62
	SAP	995	37.21	37.85	6.80	46.17	18.26	7.83	76.31	0.06	5.89
	BRK	520	38.37	37.77	4.13	17.02	10.75	31.80	64.86	2.23	9.52

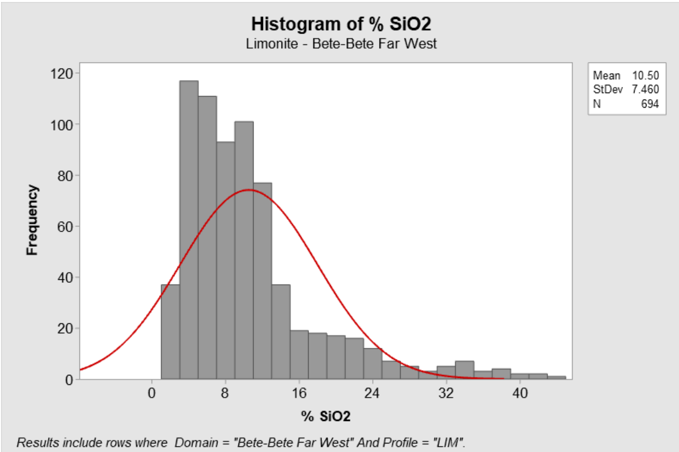
HISTOGRAM: LIM



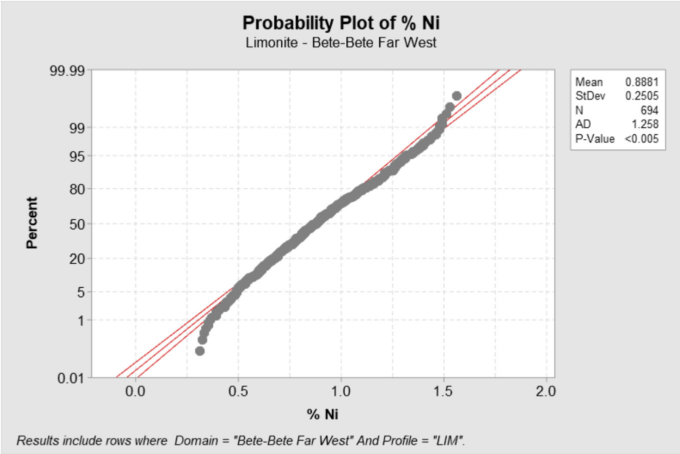


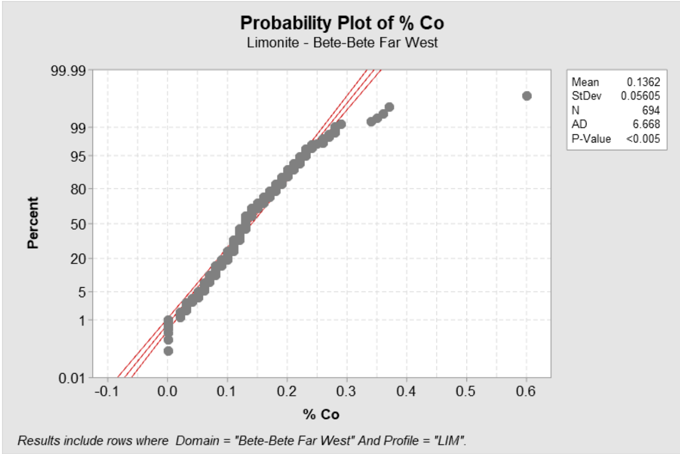


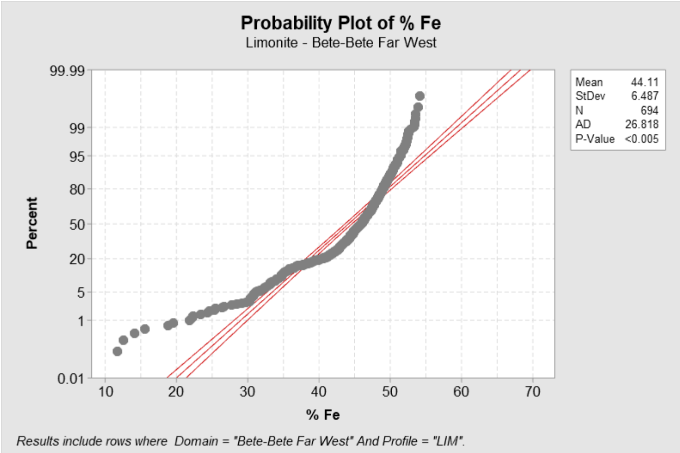


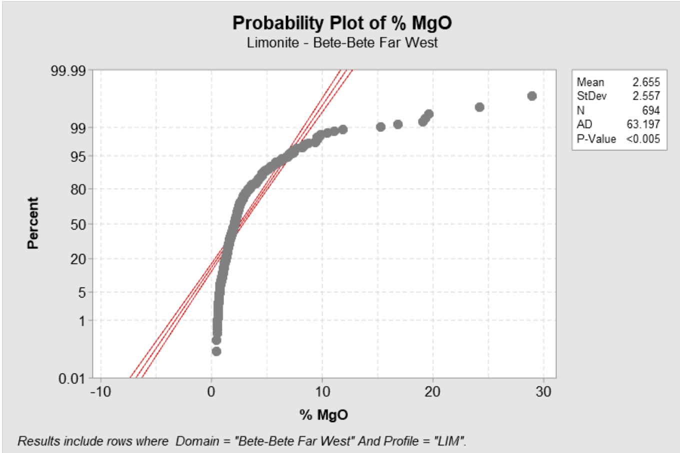


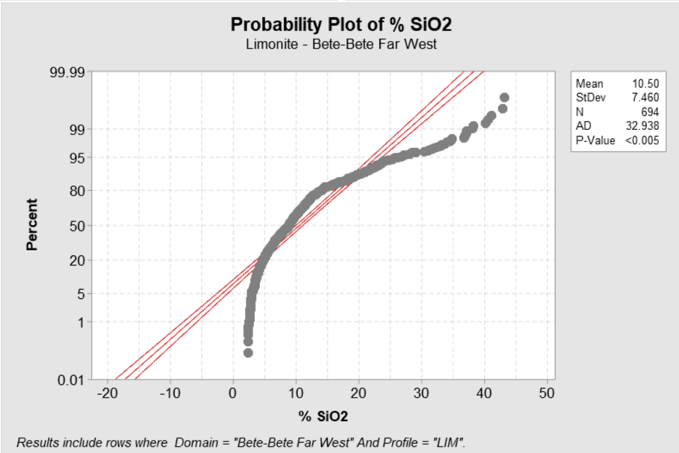
PROBABILITY PLOT: LIM



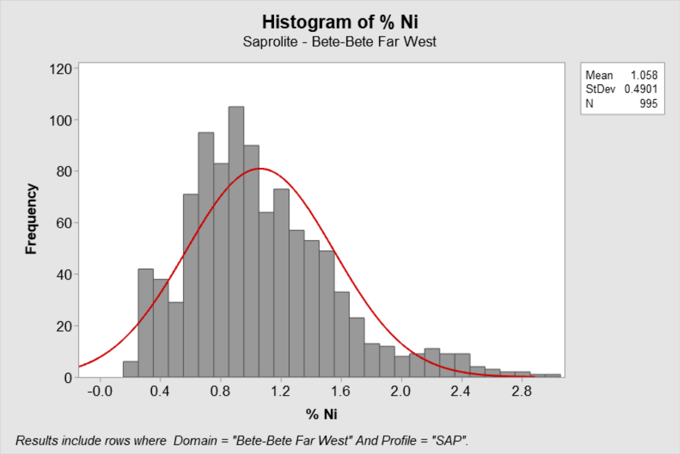


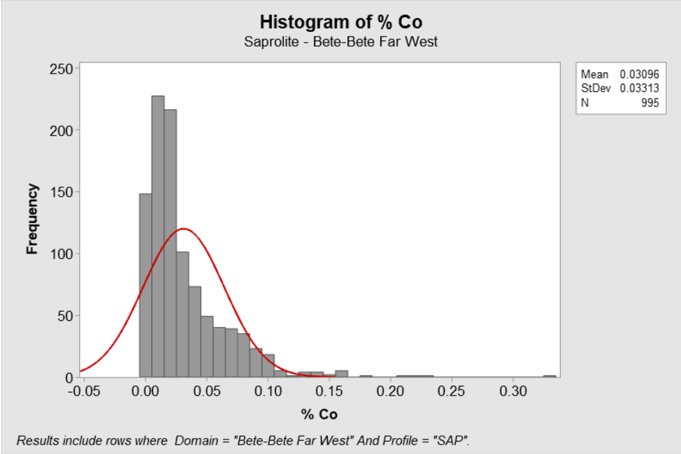


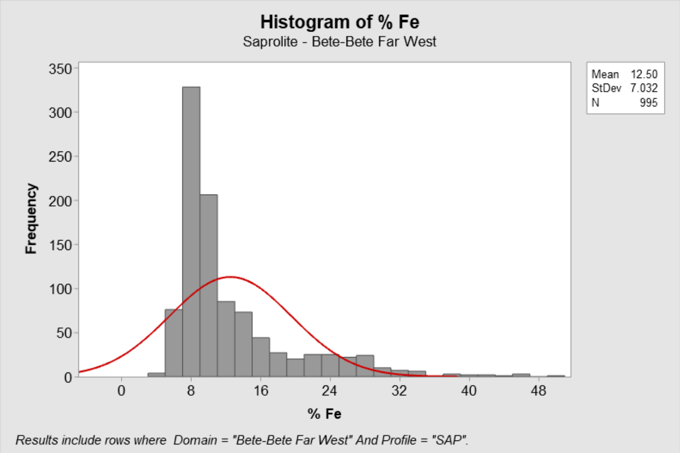


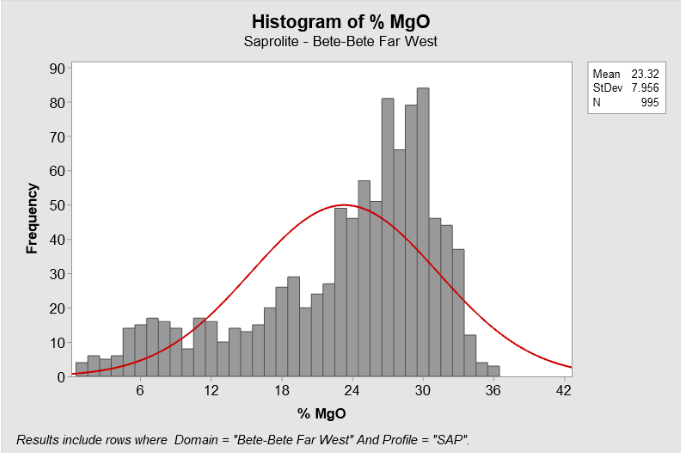


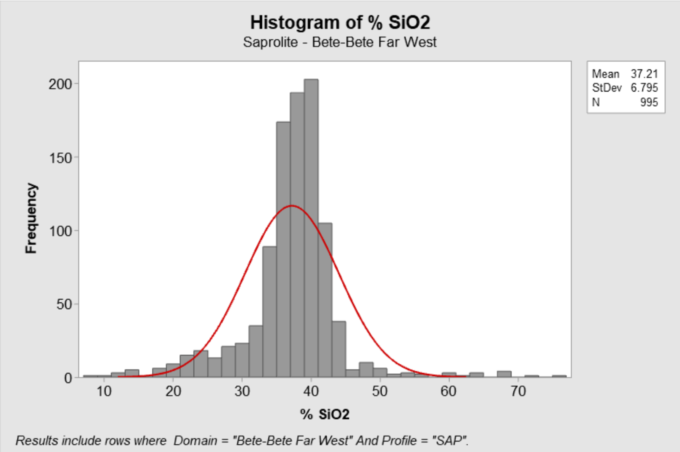
HISTOGRAM: SAP



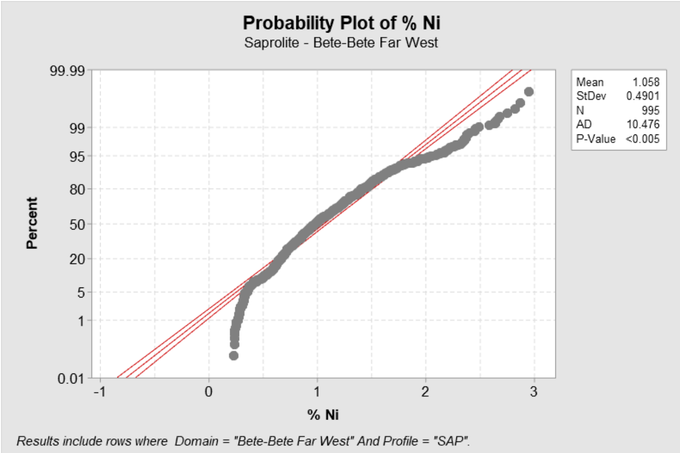


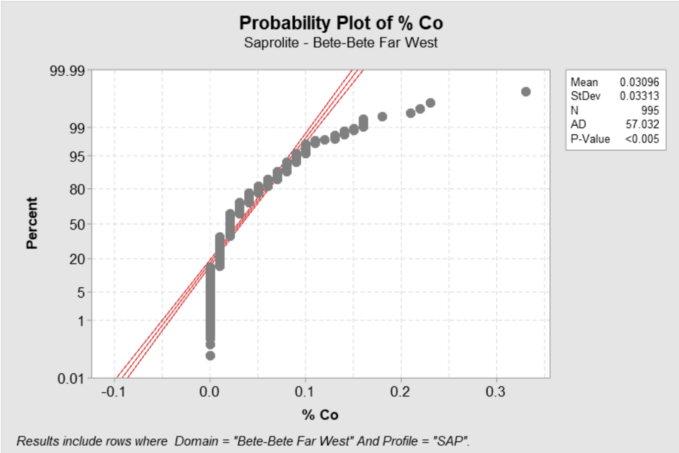


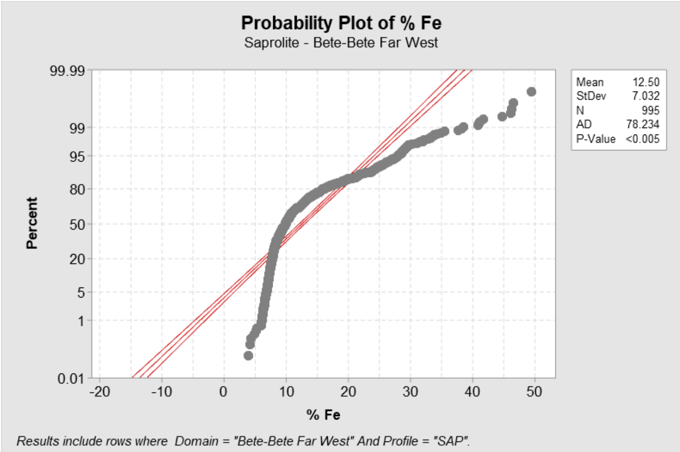


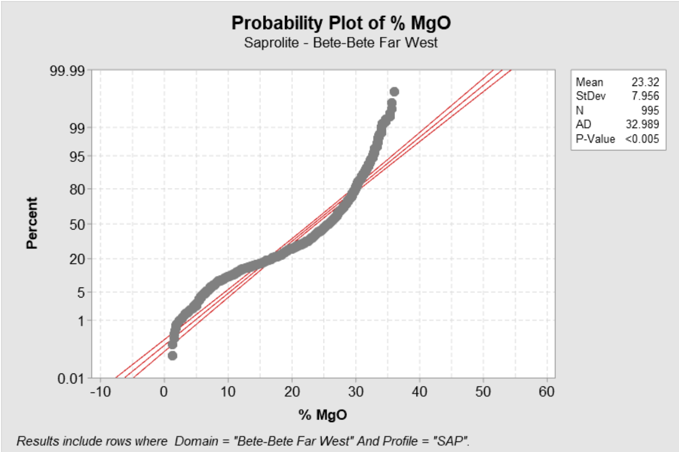


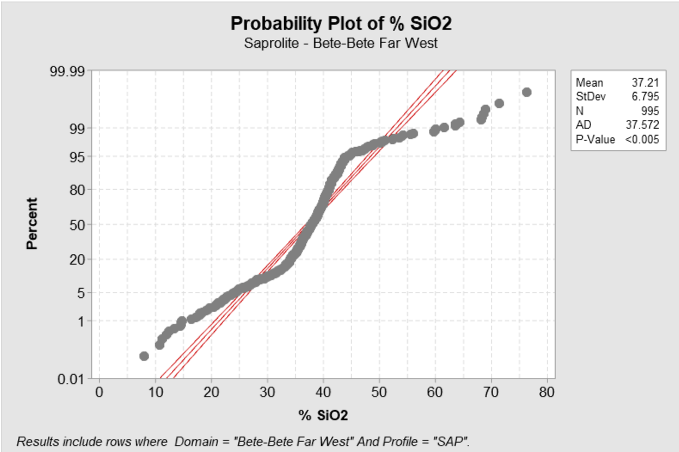
PROBABILITY PLOT: SAP



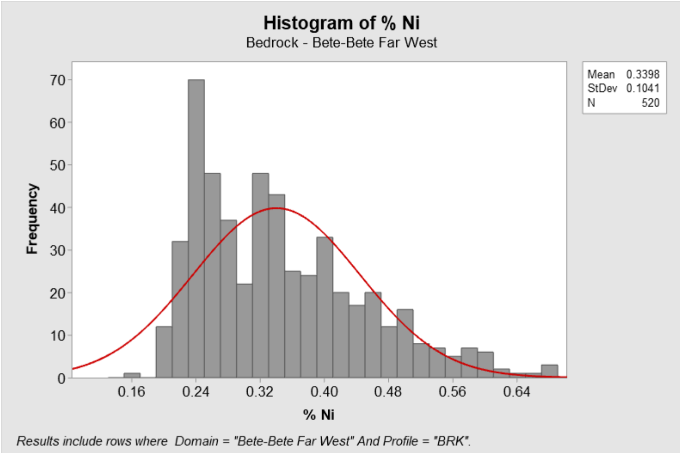


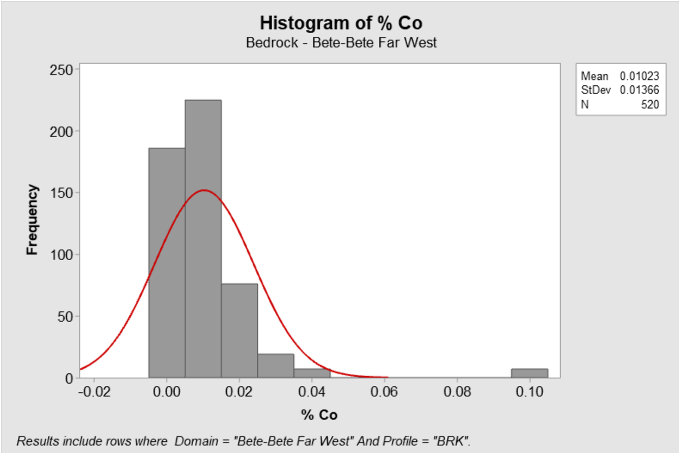


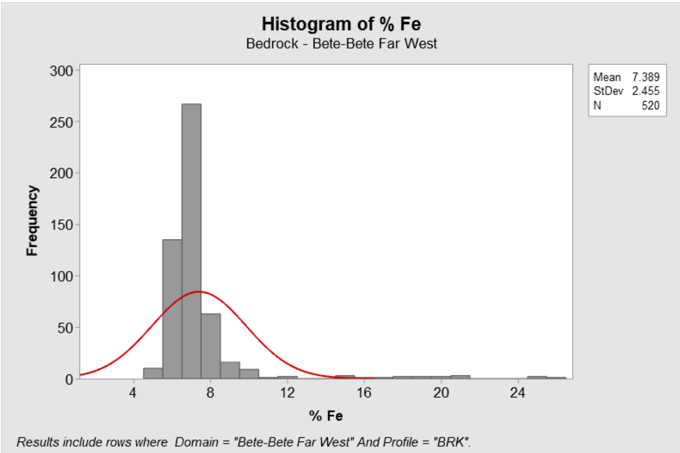


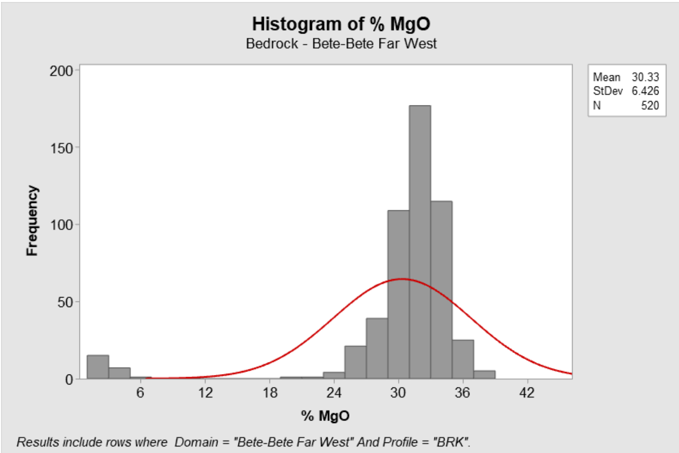


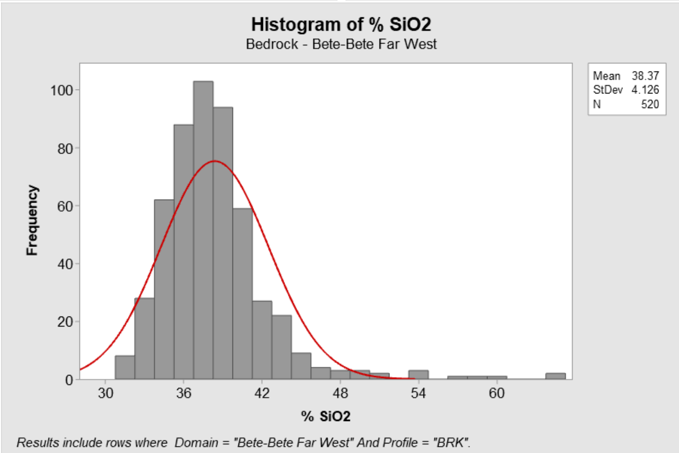
HISTOGRAM: BRK



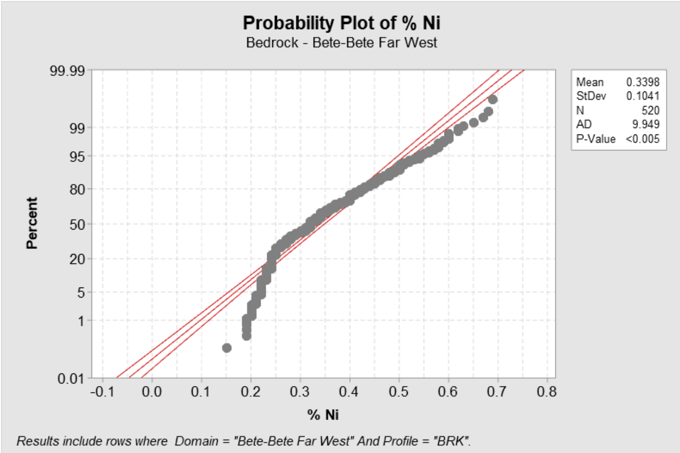


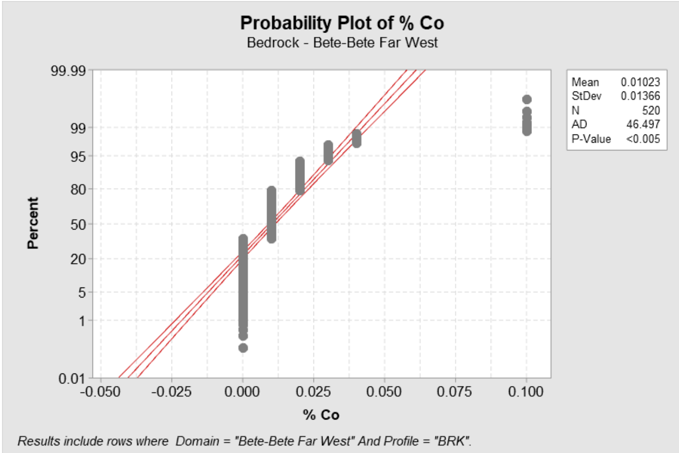


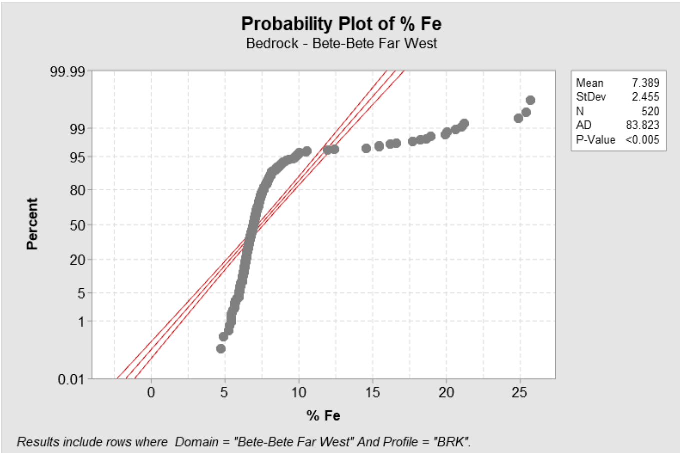


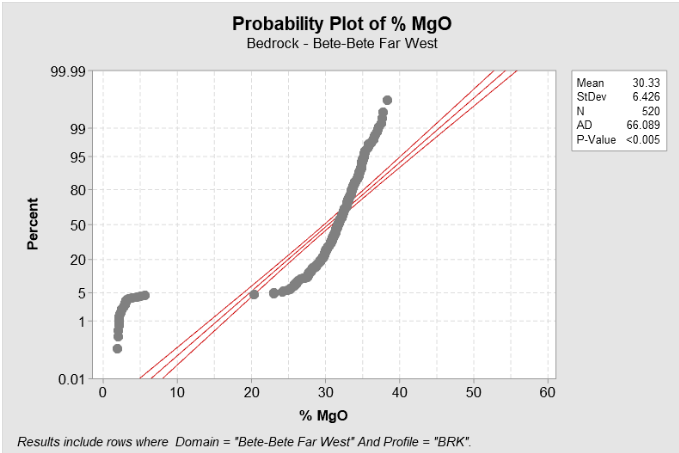


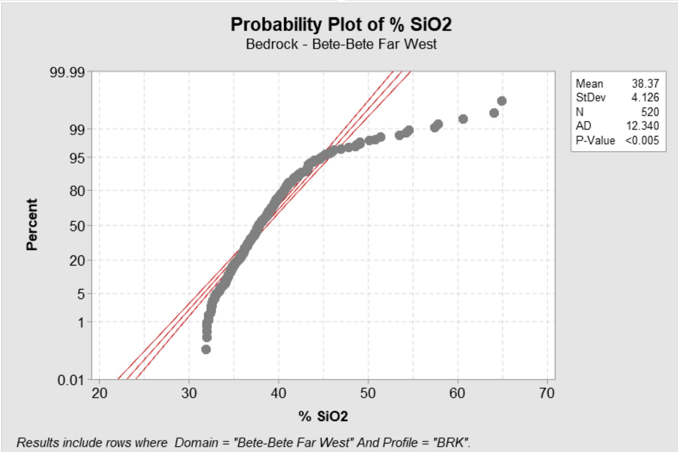
PROBABILITY PLOT: BRK









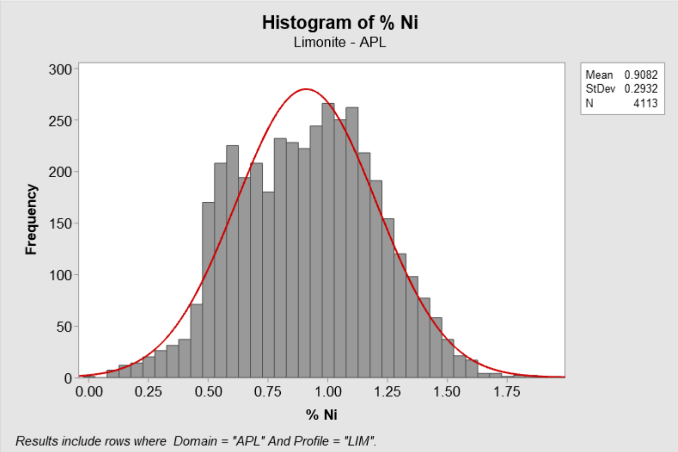


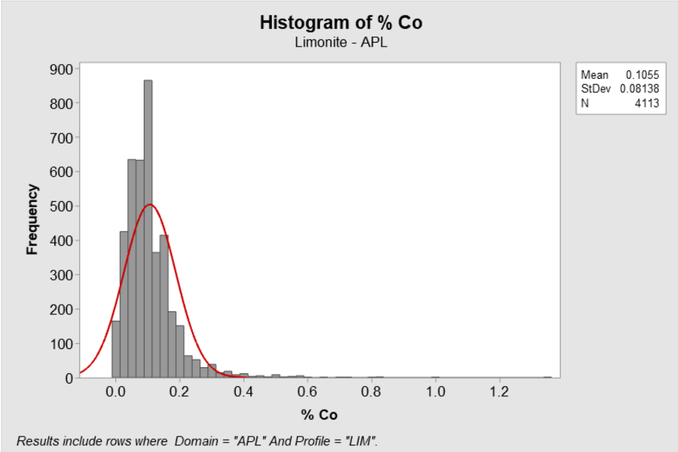
APL

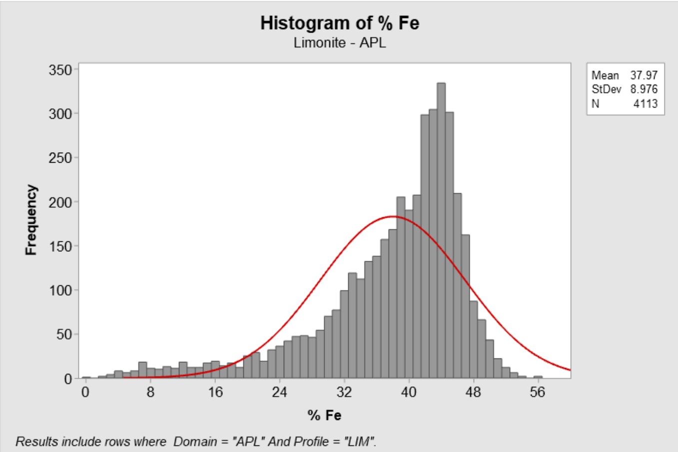
STATISTICS

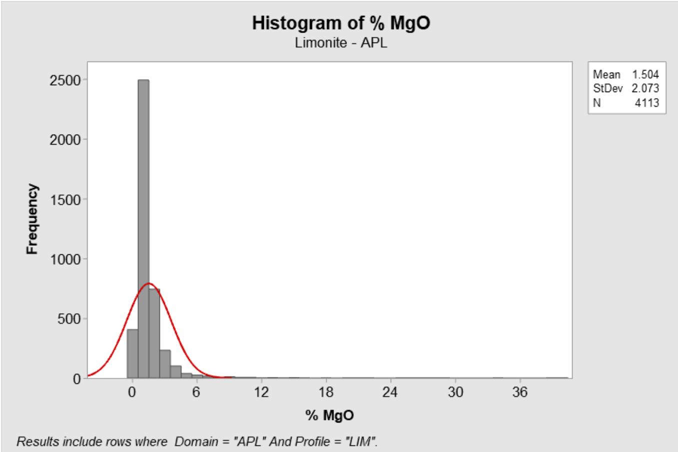
Variable	Profile	Samples	Mean	Median	StDev	Variance	CoefVar	Minimum	Maximum	Skewness	Kurtosis
Ni	SED	173	0.04	0.02	0.08	0.01	201.35	0.01	0.76	6.08	46.27
	LIM	4113	0.91	0.92	0.29	0.09	32.29	0.01	1.93	0.00	-0.43
	SAP	6619	1.13	1.04	0.58	0.34	51.65	0.05	5.20	1.19	2.94
	BRK	2744	0.33	0.30	0.12	0.02	37.28	0.03	1.28	1.93	6.72
Co	SED	173	0.01	0.01	0.02	0.00	218.31	0.00	0.20	10.99	135.86
	LIM	4113	0.11	0.09	0.08	0.01	77.13	0.00	1.36	3.41	27.24
	SAP	6619	0.04	0.02	0.04	0.00	117.41	0.00	1.28	7.13	127.07
	BRK	2744	0.01	0.01	0.01	0.00	62.86	0.00	0.13	5.06	54.20
Fe	SED	173	1.95	1.73	1.65	2.71	84.24	0.16	17.74	5.31	48.49
	LIM	4113	37.97	40.49	8.98	80.56	23.64	0.27	55.80	-1.44	2.20
	SAP	6619	13.86	11.17	7.88	62.06	56.85	1.00	50.40	1.48	2.03
	BRK	2744	6.90	6.64	1.99	3.95	28.81	0.34	43.60	6.02	82.46
MgO	SED	173	3.19	2.34	3.41	11.59	106.85	0.53	28.31	4.43	23.91
	LIM	4113	1.50	1.04	2.07	4.30	137.81	0.00	39.50	9.00	117.12
	SAP	6619	17.82	18.45	10.65	113.38	59.74	0.00	46.63	0.03	-1.00
	BRK	2716	30.51	33.14	9.47	89.62	31.03	0.00	46.17	-1.44	1.82
SiO2	SED	173	23.95	21.88	15.62	243.94	65.22	3.06	61.23	0.61	-0.73
	LIM	4113	17.54	10.86	18.23	332.40	103.93	0.00	99.00	1.94	3.61
	SAP	6619	46.88	44.55	14.41	207.73	30.75	2.84	99.00	0.66	1.44
	BRK	2716	47.94	44.35	10.83	117.24	22.59	6.71	96.17	2.26	5.58

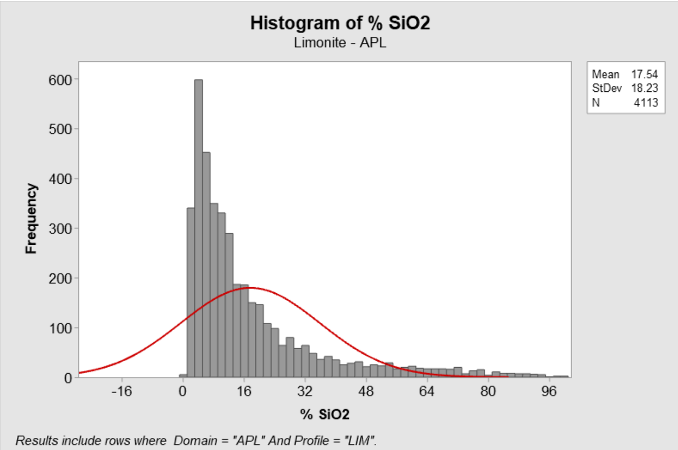
HISTOGRAM: LIM



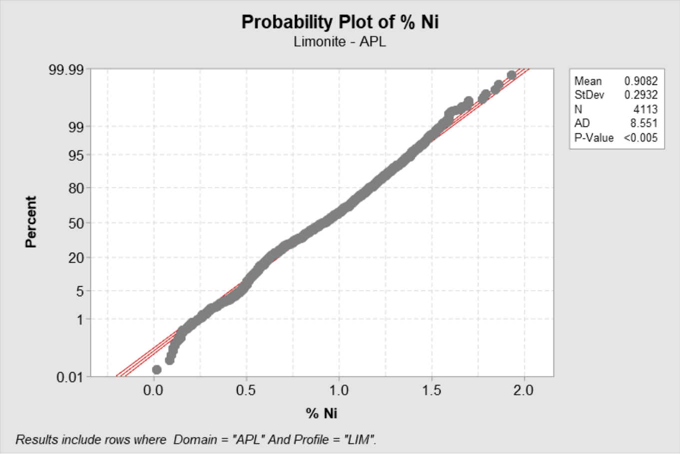


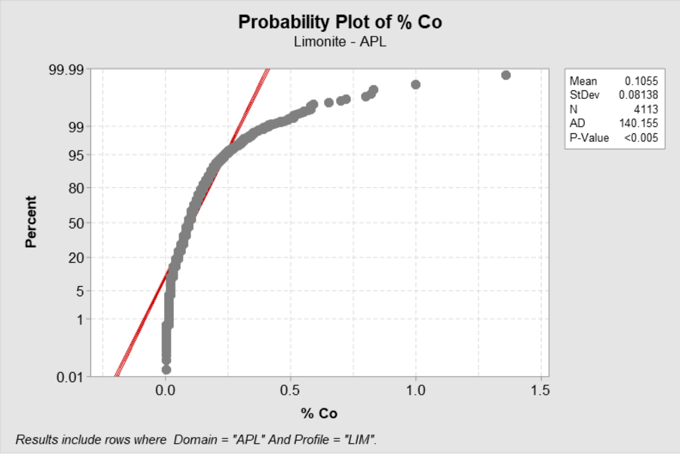


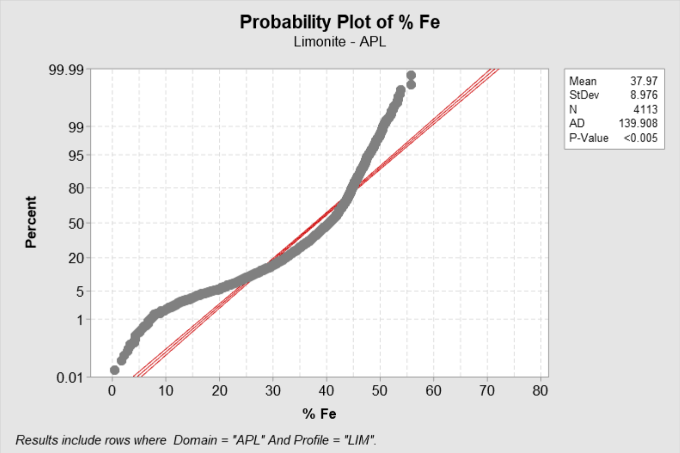


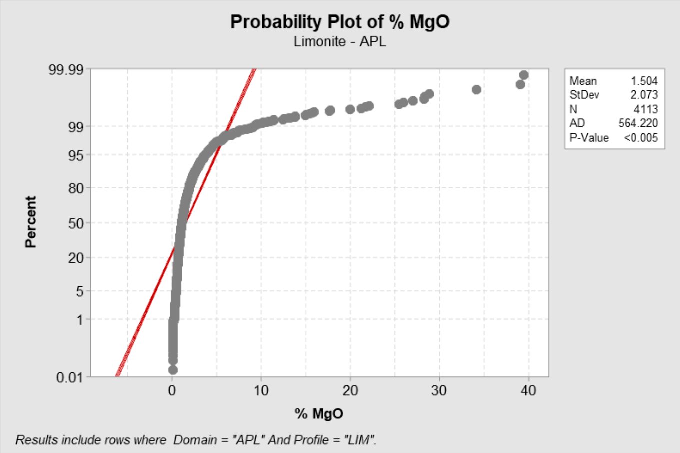


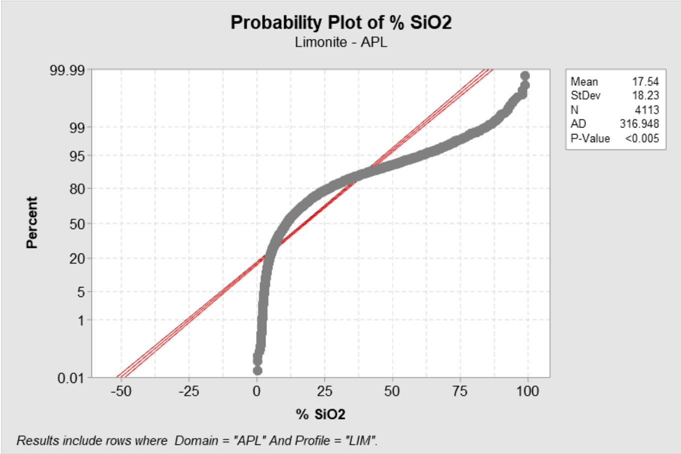
PROBABILITY PLOT: LIM



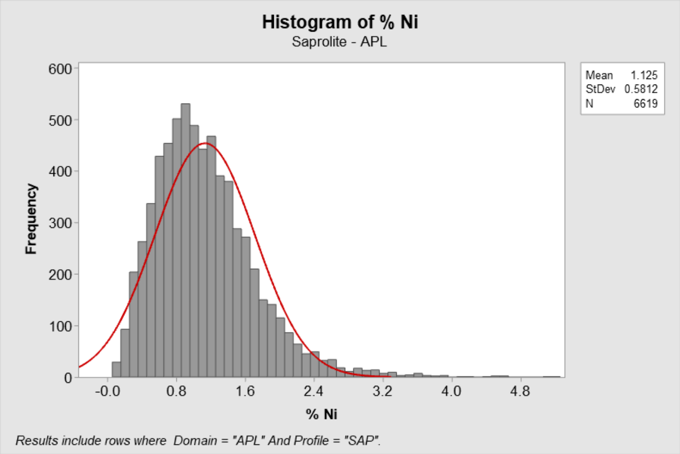


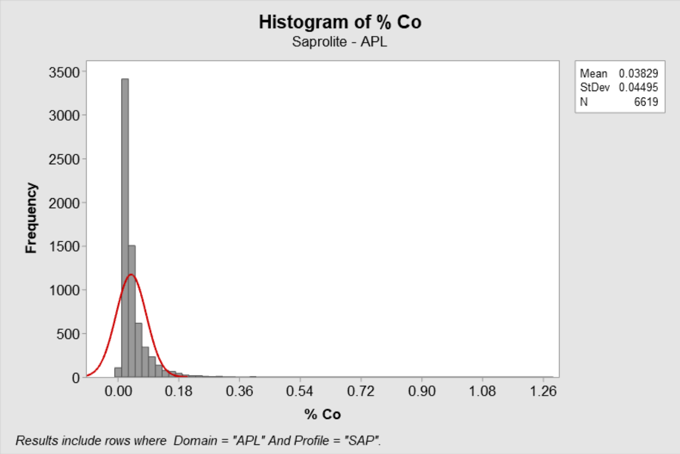


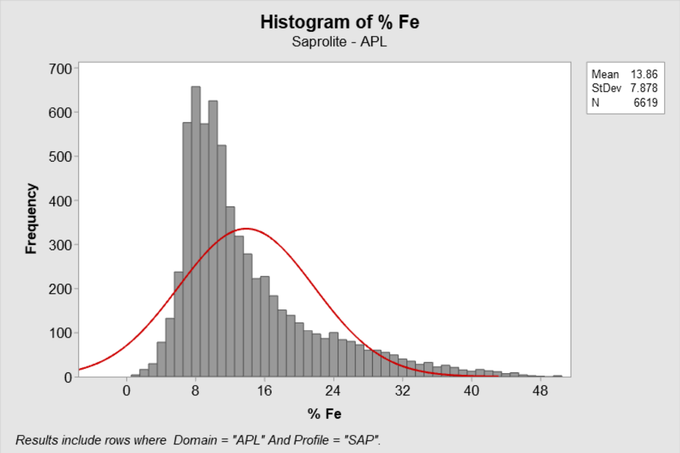


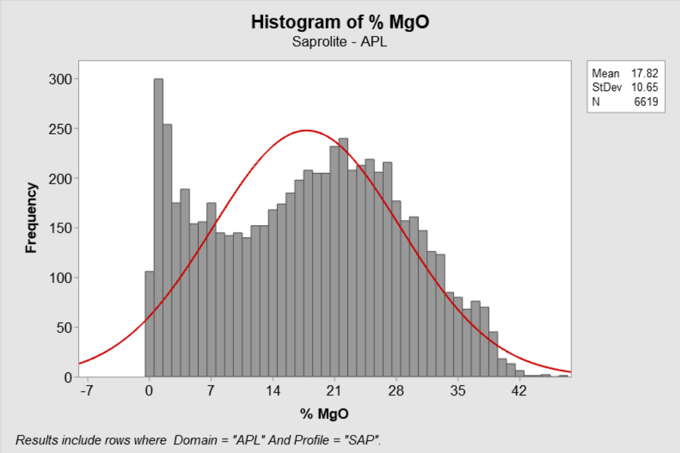


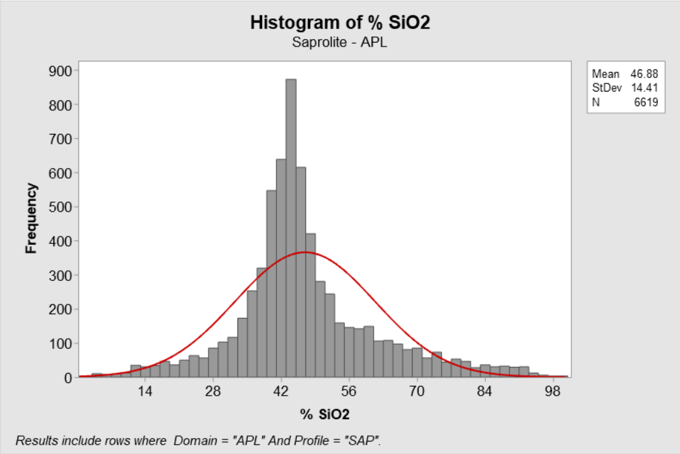
HISTOGRAM: SAP



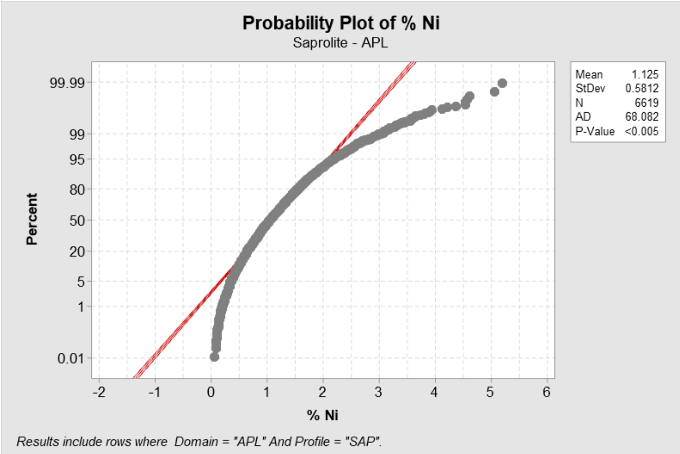


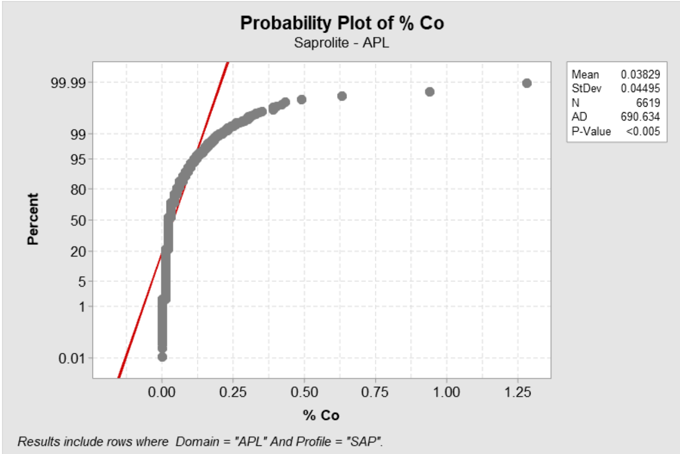


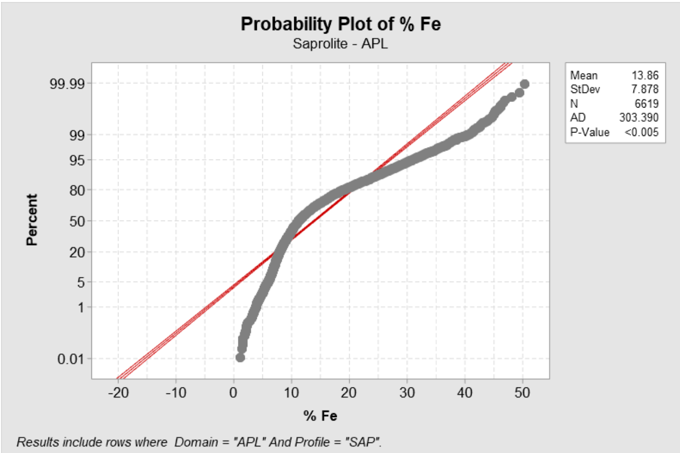


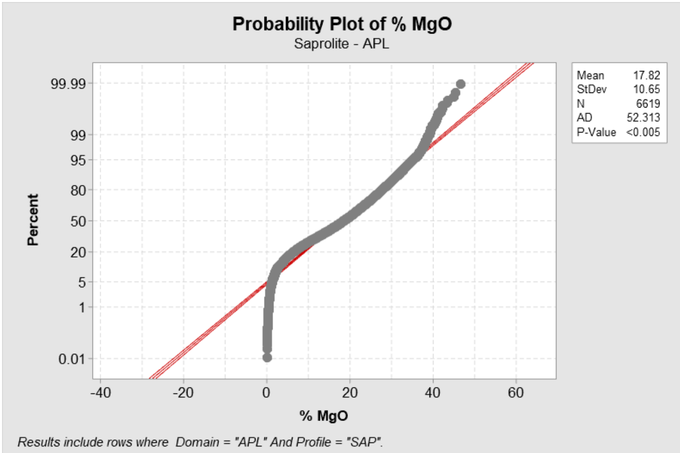


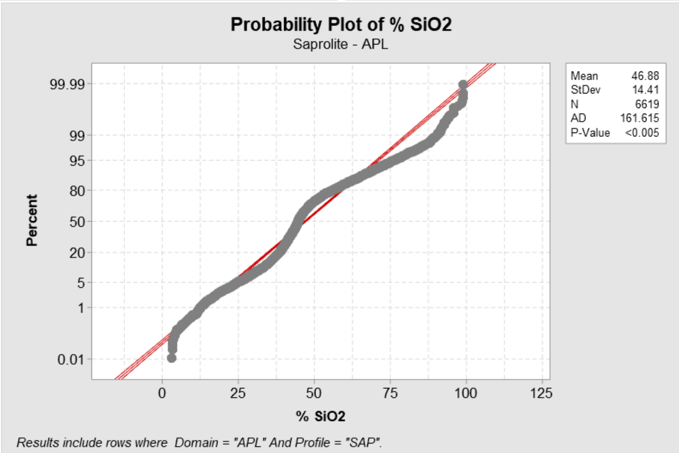
PROBABILITY PLOT: SAP



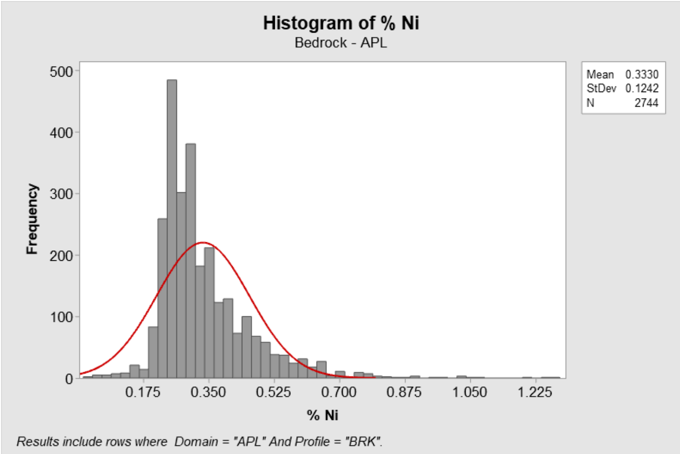


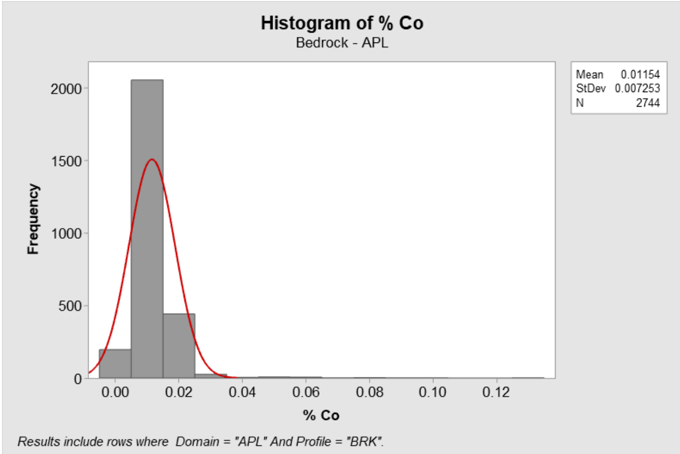


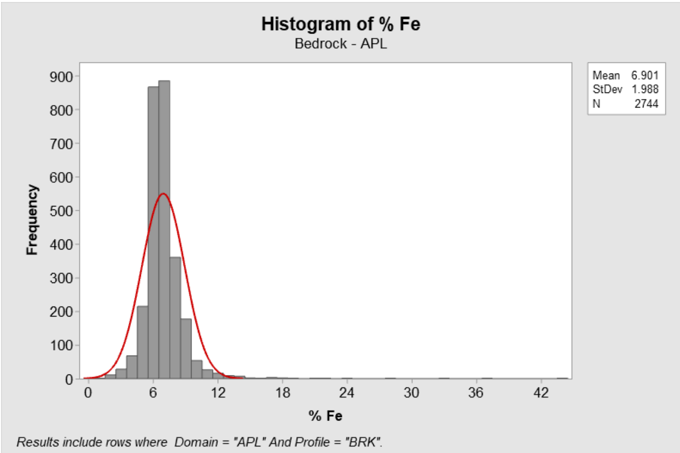


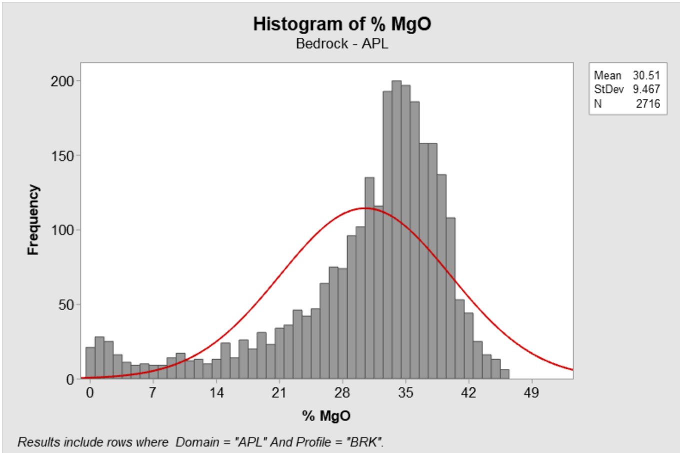


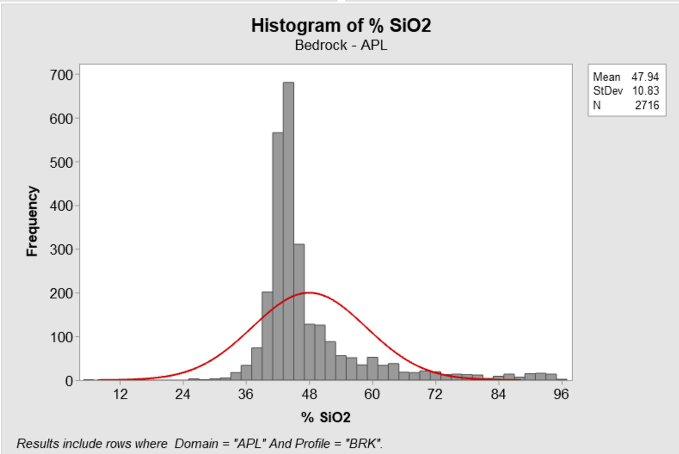
HISTOGRAM: BRK



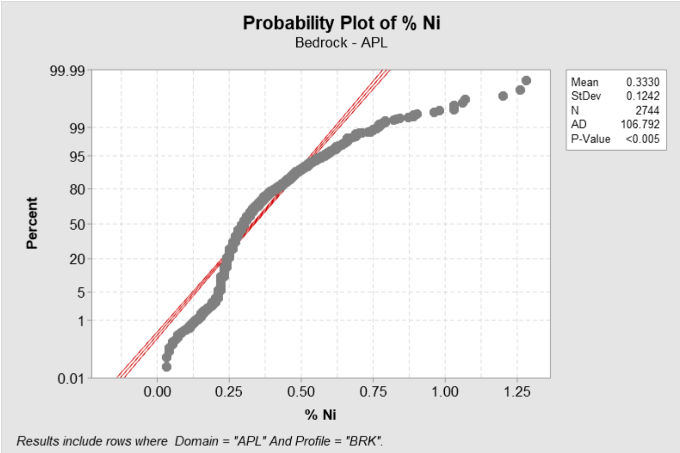


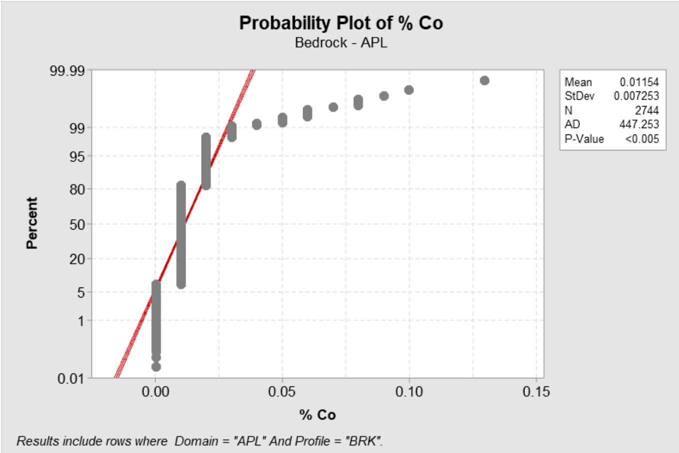


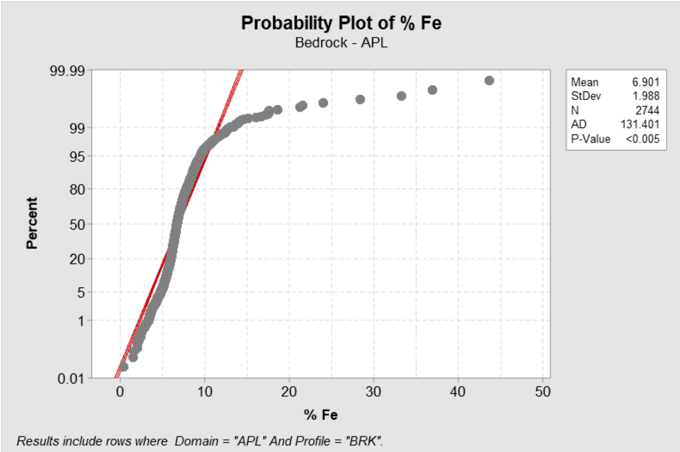


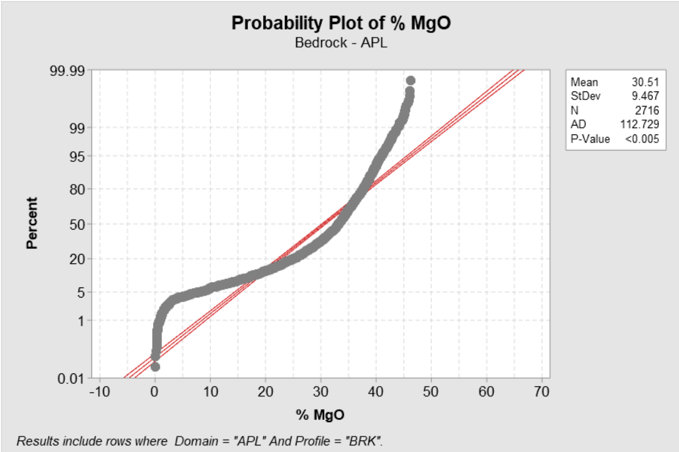


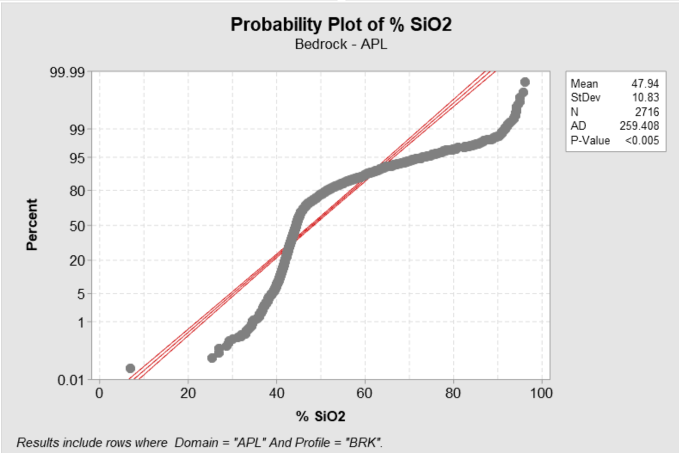
PROBABILITY PLOT: BRK





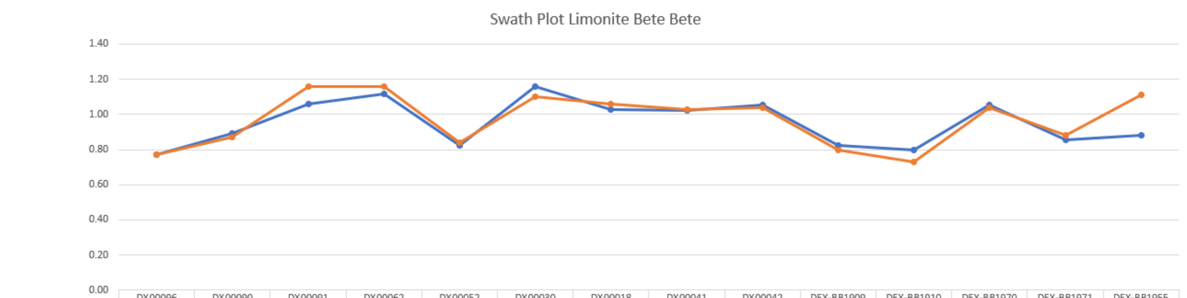






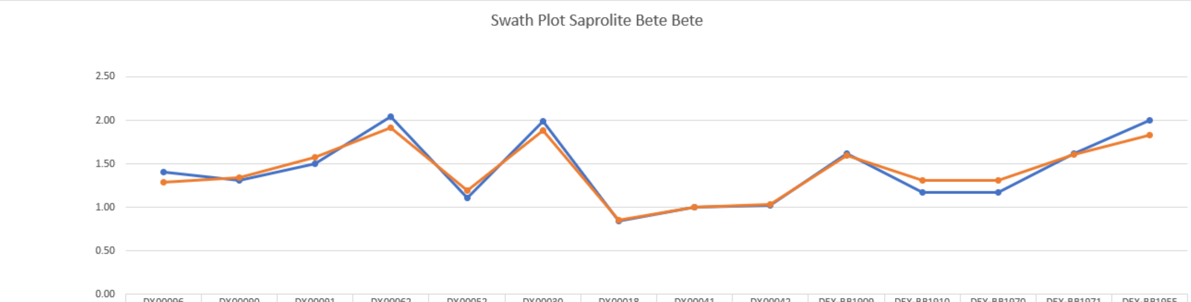
SWATH PLOTS

Bete Bete Limonite



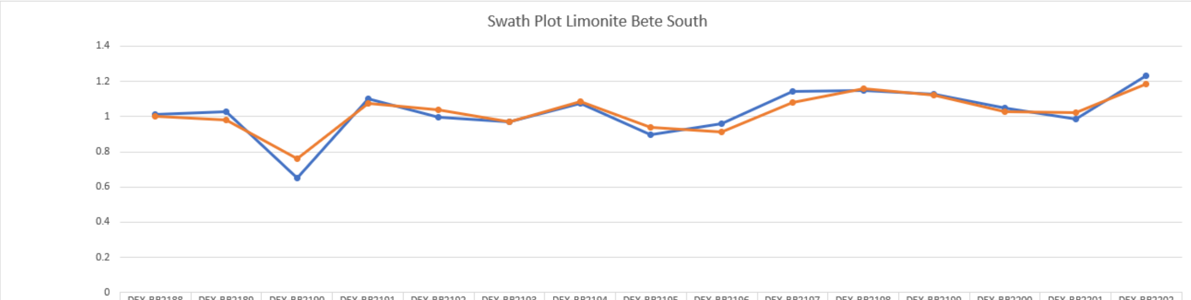
	DX00096	DX00090	DX00091	DX00062	DX00052	DX00030	DX00018	DX00041	DX00042	DEX-BB1909	DEX-BB1910	DEX-BB1970	DEX-BB1971	DEX-BB1955
DH Composite	0.77	0.89	1.06	1.12	0.83	1.16	1.03	1.03	1.05	0.82	0.80	1.05	0.86	0.88
BM Composite	0.77	0.87	1.16	1.16	0.84	1.10	1.06	1.03	1.04	0.80	0.73	1.04	0.88	1.11

Bete Bete Saprolite



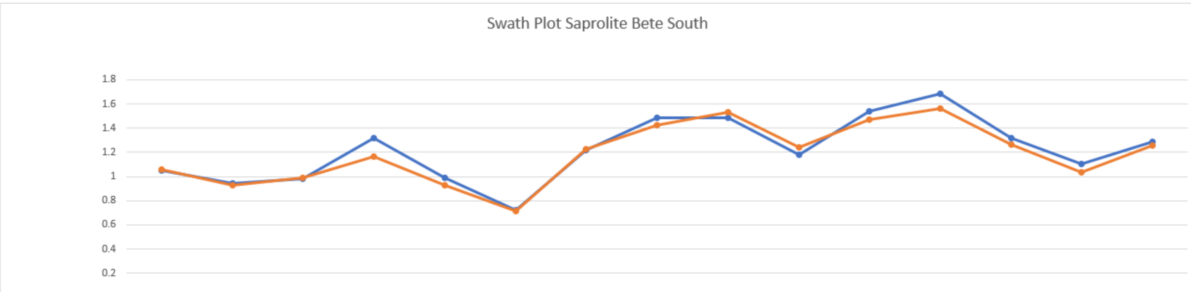
	DX00096	DX00090	DX00091	DX00062	DX00052	DX00030	DX00018	DX00041	DX00042	DEX-BB1909	DEX-BB1910	DEX-BB1970	DEX-BB1971	DEX-BB1955
DH Composite	1.41	1.31	1.50	2.04	1.11	1.99	0.85	1.00	1.03	1.62	1.17	1.18	1.61	2.00
BM Composite	1.29	1.34	1.58	1.92	1.19	1.88	0.85	1.00	1.03	1.60	1.31	1.31	1.61	1.83

Bete South Limonite



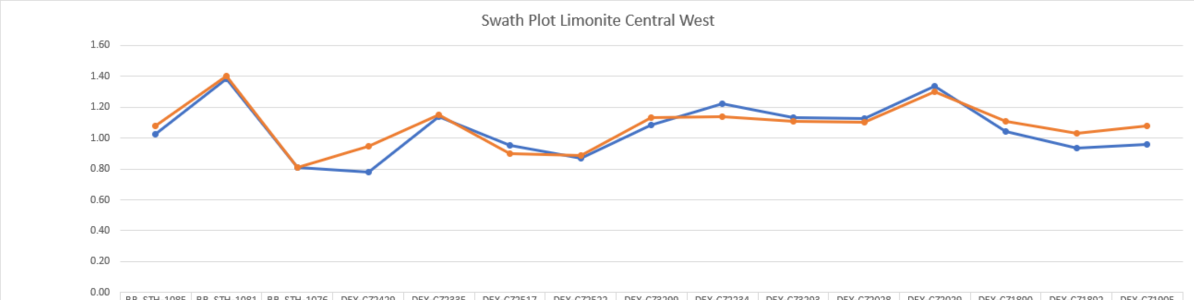
	DEX-BB2188	DEX-BB2189	DEX-BB2190	DEX-BB2191	DEX-BB2192	DEX-BB2193	DEX-BB2194	DEX-BB2195	DEX-BB2196	DEX-BB2197	DEX-BB2198	DEX-BB2199	DEX-BB2200	DEX-BB2201	DEX-BB2202
DH Composite	1.014	1.0267	0.65	1.1012	0.9975	0.968	1.0767	0.8953	0.9608	1.1425	1.1496	1.1258	1.051	0.987	1.2333
BM Composite	1	0.98	0.76	1.075	1.038	0.969	1.083	0.939	0.913	1.078	1.161	1.123	1.026	1.025	1.185

Bete South Saprolite



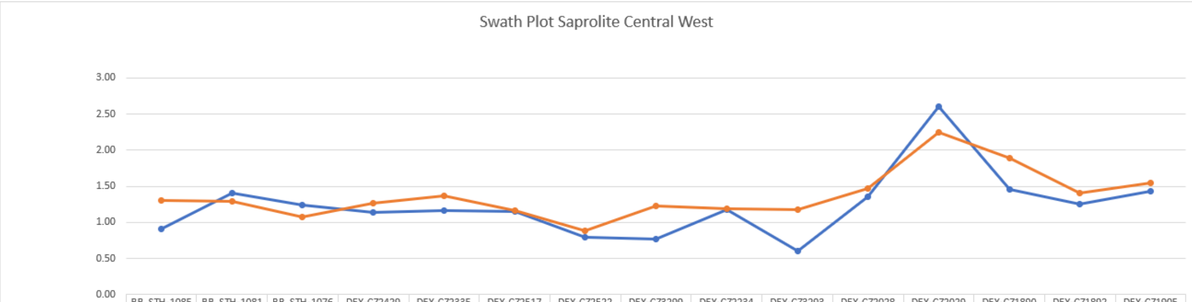
	DEX-BB2188	DEX-BB2189	DEX-BB2190	DEX-BB2191	DEX-BB2192	DEX-BB2193	DEX-BB2194	DEX-BB2195	DEX-BB2196	DEX-BB2197	DEX-BB2198	DEX-BB2199	DEX-BB2200	DEX-BB2201	DEX-BB2202
DH Composite	1.0533	0.945	0.9798	1.3167	0.9882	0.7182	1.2156	1.485	1.4891	1.1782	1.5367	1.6831	1.3164	1.1	1.2867
BM Composite	1.057	0.924	0.99	1.164	0.924	0.717	1.223	1.423	1.53	1.239	1.468	1.565	1.267	1.036	1.253

Central West Limonite



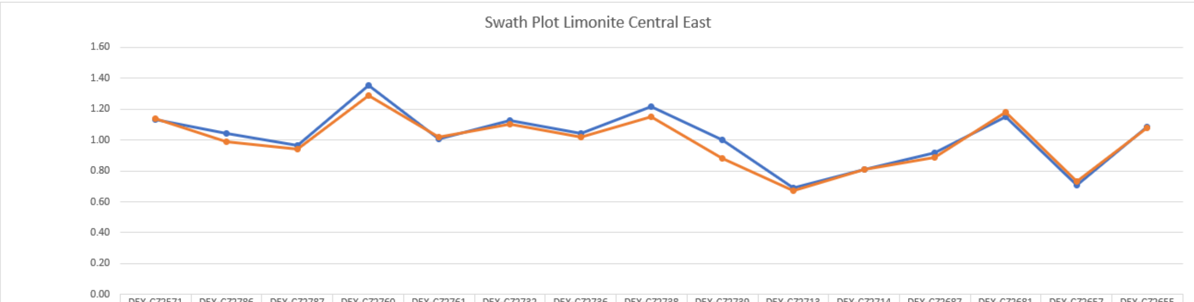
	BB_STH-1085	BB_STH-1081	BB_STH-1076	DEX-CZ2429	DEX-CZ2335	DEX-CZ2517	DEX-CZ2522	DEX-CZ3299	DEX-CZ2234	DEX-CZ3293	DEX-CZ2028	DEX-CZ2029	DEX-CZ1890	DEX-CZ1892	DEX-CZ1905
DH Composite	1.02	1.38	0.81	0.78	1.14	0.96	0.87	1.09	1.22	1.13	1.13	1.33	1.04	0.94	0.96
BM Composite	1.08	1.4	0.81	0.95	1.15	0.9	0.89	1.13	1.14	1.11	1.1	1.3	1.11	1.03	1.08

Central West Saprolite



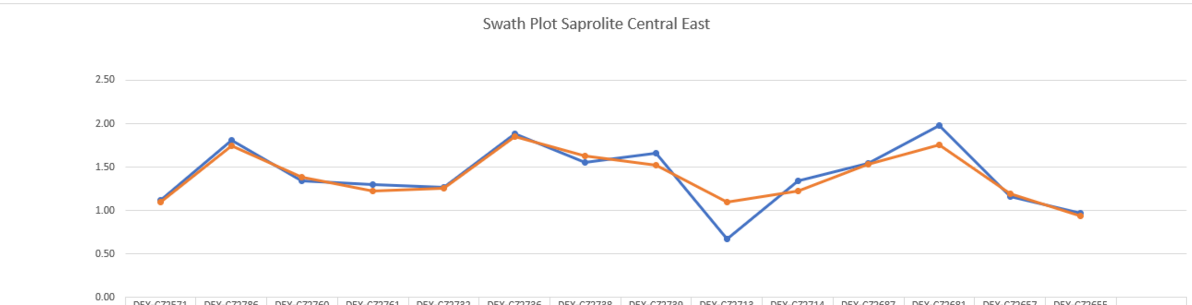
	BB_STH-1085	BB_STH-1081	BB_STH-1076	DEX-CZ2429	DEX-CZ2335	DEX-CZ2517	DEX-CZ2522	DEX-CZ3299	DEX-CZ2234	DEX-CZ3293	DEX-CZ2028	DEX-CZ2029	DEX-CZ1890	DEX-CZ1892	DEX-CZ1905
DH Composite	0.91	1.40	1.24	1.14	1.16	1.16	0.80	0.76	1.17	0.60	1.36	2.61	1.46	1.25	1.43
BM Composite	1.31	1.29	1.07	1.27	1.37	1.17	0.89	1.23	1.19	1.18	1.47	2.25	1.89	1.4	1.55

Central East Limonite



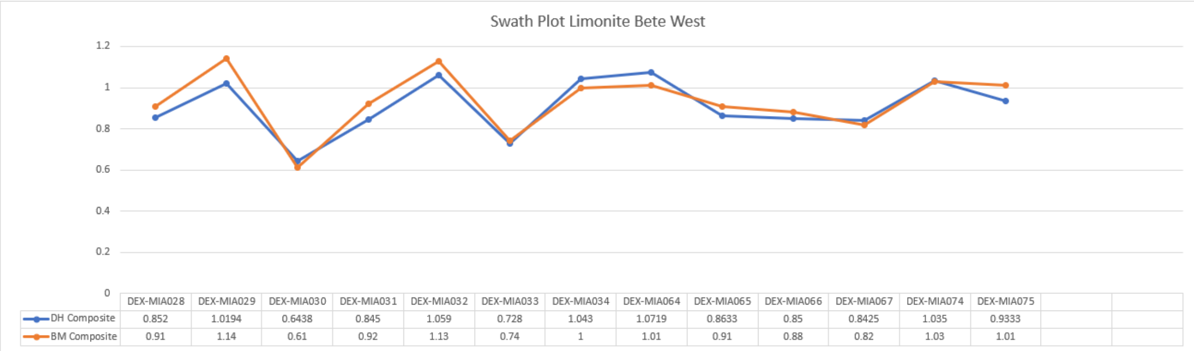
	DEX-CZ2571	DEX-CZ2786	DEX-CZ2787	DEX-CZ2760	DEX-CZ2761	DEX-CZ2732	DEX-CZ2736	DEX-CZ2738	DEX-CZ2739	DEX-CZ2713	DEX-CZ2714	DEX-CZ2687	DEX-CZ2681	DEX-CZ2657	DEX-CZ2655
DH Composite	1.13	1.05	0.96	1.35	1.01	1.13	1.04	1.22	1.00	0.69	0.81	0.92	1.15	0.71	1.08
BM Composite	1.14	0.99	0.94	1.29	1.02	1.10	1.02	1.15	0.88	0.67	0.81	0.89	1.18	0.73	1.08

Central East Saprolite



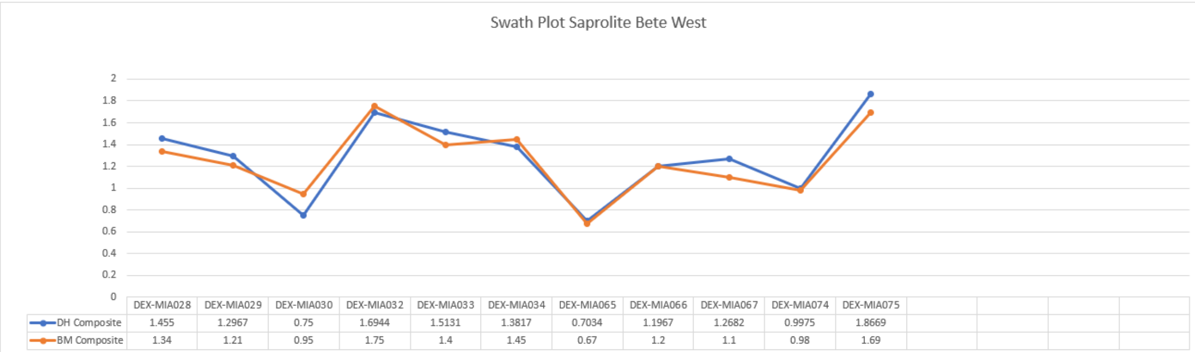
	DEX-CZ2571	DEX-CZ2786	DEX-CZ2760	DEX-CZ2761	DEX-CZ2732	DEX-CZ2736	DEX-CZ2738	DEX-CZ2739	DEX-CZ2713	DEX-CZ2714	DEX-CZ2687	DEX-CZ2681	DEX-CZ2657	DEX-CZ2655	
DH Composite	1.11	1.81	1.34	1.29	1.27	1.88	1.55	1.66	0.67	1.34	1.55	1.97	1.16	0.97	
BM Composite	1.10	1.74	1.38	1.23	1.26	1.85	1.63	1.52	1.10	1.23	1.53	1.76	1.19	0.94	

Bete West Limonite



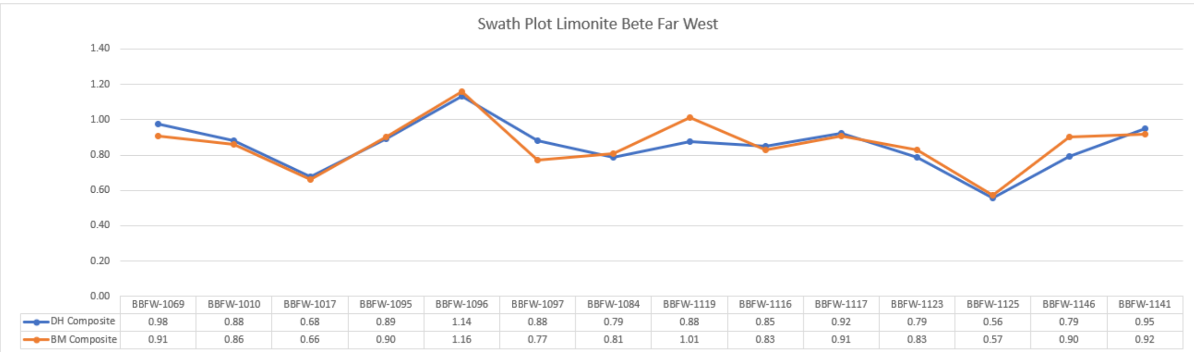
	DEX-MIA028	DEX-MIA029	DEX-MIA030	DEX-MIA031	DEX-MIA032	DEX-MIA033	DEX-MIA034	DEX-MIA064	DEX-MIA065	DEX-MIA066	DEX-MIA067	DEX-MIA074	DEX-MIA075
DH Composite	0.852	1.0194	0.6438	0.845	1.059	0.728	1.043	1.0719	0.8633	0.85	0.8425	1.035	0.9333
BM Composite	0.91	1.14	0.61	0.92	1.13	0.74	1	1.01	0.91	0.88	0.82	1.03	1.01

Bete West Saprolite



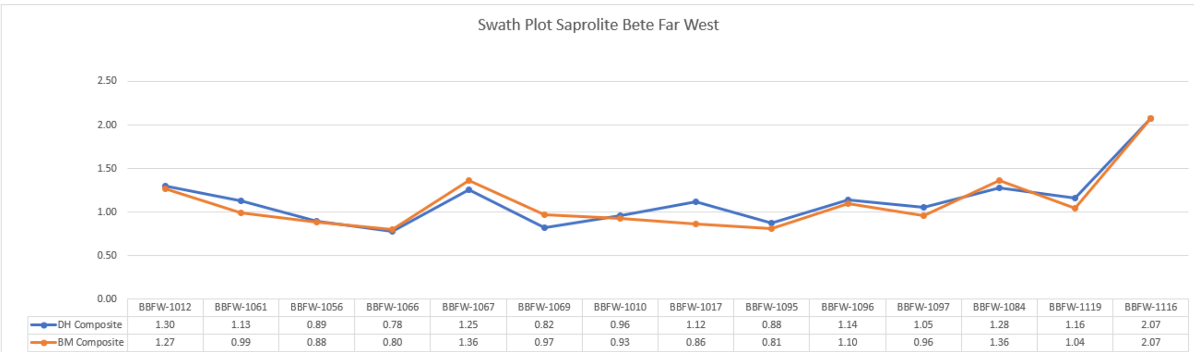
	DEX-MIA028	DEX-MIA029	DEX-MIA030	DEX-MIA032	DEX-MIA033	DEX-MIA034	DEX-MIA065	DEX-MIA066	DEX-MIA067	DEX-MIA074	DEX-MIA075
DH Composite	1.455	1.2967	0.75	1.6944	1.5131	1.3817	0.7034	1.1967	1.2682	0.9975	1.8669
BM Composite	1.34	1.21	0.95	1.75	1.4	1.45	0.67	1.2	1.1	0.98	1.69

Bete Far West Limonite



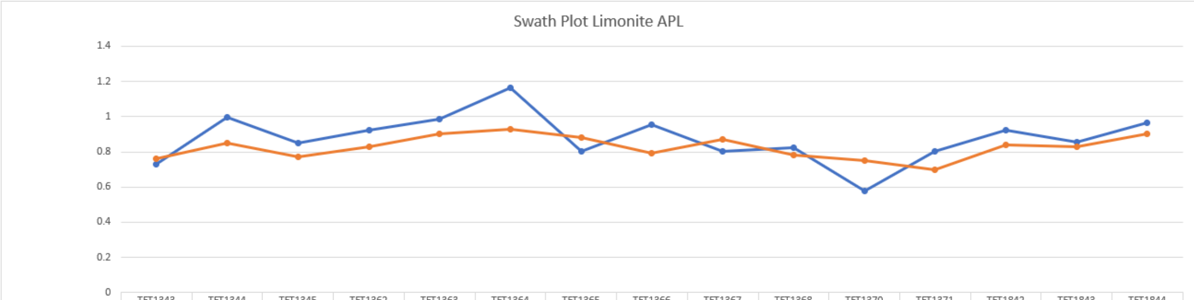
	BBFW-1069	BBFW-1010	BBFW-1017	BBFW-1095	BBFW-1096	BBFW-1097	BBFW-1084	BBFW-1119	BBFW-1116	BBFW-1117	BBFW-1123	BBFW-1125	BBFW-1146	BBFW-1141
DH Composite	0.98	0.88	0.68	0.89	1.14	0.88	0.79	0.88	0.85	0.92	0.79	0.56	0.79	0.95
BM Composite	0.91	0.86	0.66	0.90	1.16	0.77	0.81	1.01	0.83	0.91	0.83	0.57	0.90	0.92

Bete Far West Saprolite



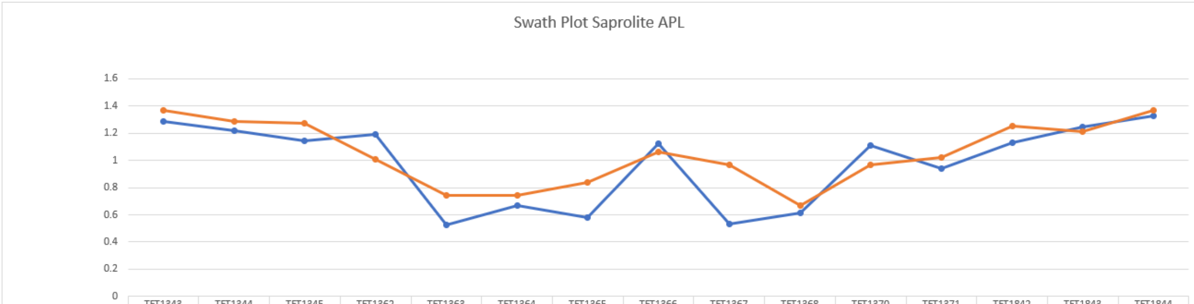
	BBFW-1012	BBFW-1061	BBFW-1056	BBFW-1066	BBFW-1067	BBFW-1069	BBFW-1010	BBFW-1017	BBFW-1095	BBFW-1096	BBFW-1097	BBFW-1084	BBFW-1119	BBFW-1116
DH Composite	1.30	1.13	0.89	0.78	1.25	0.82	0.96	1.12	0.88	1.14	1.05	1.28	1.16	2.07
BM Composite	1.27	0.99	0.88	0.80	1.36	0.97	0.93	0.86	0.81	1.10	0.96	1.36	1.04	2.07

APL Limonite



	TFT1343	TFT1344	TFT1345	TFT1362	TFT1363	TFT1364	TFT1365	TFT1366	TFT1367	TFT1368	TFT1370	TFT1371	TFT1842	TFT1843	TFT1844
DH Composite	0.7295	0.9958	0.8483	0.9242	0.9883	1.1638	0.804	0.9533	0.8032	0.8213	0.58	0.8039	0.9252	0.853	0.9637
BM Composite	0.76	0.85	0.77	0.83	0.9	0.93	0.88	0.79	0.87	0.78	0.75	0.7	0.84	0.83	0.9

APL Saprolite



	TFT1343	TFT1344	TFT1345	TFT1362	TFT1363	TFT1364	TFT1365	TFT1366	TFT1367	TFT1368	TFT1370	TFT1371	TFT1842	TFT1843	TFT1844
DH Composite	1.288	1.2197	1.1467	1.1905	0.529	0.6667	0.5829	1.1227	0.5325	0.6148	1.1131	0.9413	1.1324	1.2446	1.325
BM Composite	1.37	1.29	1.27	1.01	0.74	0.74	0.84	1.06	0.97	0.67	0.97	1.02	1.25	1.21	1.37

Appendix 5
Laboratory QAQC Reports

Laboratory and Sample Analysis Procedures at the HM Laboratories JORC Compliant Report

C.E. Watson

August 2022

For:
Tony Green – Chief Operations Officer
Willem Dique – Operations Manager
Daniel Madre - Danmar

Contents Page

	Introduction	1
1	**Quality Assurance and Quality Control**	**1**
	1.1 Quality Assurance at PT HM	2
	1.2 Quality Control at PT HM	2
	1.2.1 First Lab Split Stage	2
	1.2.2 Drying Stage	2
	1.2.3 First Crushing Stage	3
	1.2.4 First Splitting Stage	3
	1.2.5 Second Crushing Stage	3
	1.2.6 Second Splitting Stage	3
	1.2.7 Pulverising Stage	3
	1.2.8 Third Splitting Stage	3
	1.3 Particle Sizing Test	4
	1.4 Specific Gravity Measurement	4
	1.5 Moisture Content	4
2	**Quality Control at PT HM Assay Laboratory**	5
	2.1 Coarse Blanks	5
	2.2 Coarse Rejects	5
	2.3 Particle Sizing Test	7
3	**Sample Assay Quality Control**	8
	3.1 Pulp Duplicates/Duplicate Assays	8
	3.2 Accuracy	9
	3.3 Check Standards/CRM’s	10/11
	3.4 Replicate Samples	12
	3.5 Inter Laboratory Check Samples	13
	3.6.1 PT HM & PT Geoservices	13/14
	3.6.2 PT HM & COA’s	14/15
4	**Control Sample Insertion Rates**	15/16
5	**Reporting, Review and Continuous Improvement**	16/18
6	**Conclusions**	18/19
7	**References**	

Table of Figures

		page
1	Scatterplot showing results for Coarse Reject or Coarse Duplicates	6
2	200# Screen Test results March 2022	7
3	Scatterplot showing results for Pulp Duplicate assays	8/9
4	Oreas Standard 182 Control Chart	10
5	Oreas Standard 187 Control Chart	11
6	Oreas Standard 192 Control Chart	11
7	Oreas Standard 195 Control Chart	11
8	Scatterplot showing results for Replicate assays	12
9	Scatterplot showing results for Interlaboratory Geoservices	13/14
10	Scatterplot showing results for Interlaboratory COAS vs HM	14/15

Table of Tables

1	Exploration Control Sample Insertion Rates	16
2	JORC Table 1 – Sample Prep and Assay	21

PT Hengjaya Mineralindo
Laboratory and Sample Analysis Procedures at the HM Laboratories
JORC Compliant Report - August 2022

Introduction

This report on the QAQC Department's activities at the PT Hengjaya Mineralindo (HM) preparation and assay laboratories at their Tangofa Camp in Sulawesi, Indonesia, has been compiled as part of a JORC Compliant Report and according to the guiding principles of the JORC Code, 2012 Edition, which states: *"Transparency and Materiality are the guiding principles of the Code, and the Competent Person must provide explanatory commentary on the material assumptions underlying the declaration of Exploration Results, Mineral Resources or Ore Reserves."* This report endeavours to address the sections on Sub-sampling techniques and sample preparation and the Quality of assay data and laboratory tests in JORC TABLE 1, Section 1, Sampling Techniques and Data, a copy of which is attached.

PT Hengjaya Mineralindo (HM) has two separate facilities at the Tangofa Camp site for processing and assaying samples collected in the exploration (drilling) programme and mining (production) operations at the site. These two facilities are the Sample Preparation Laboratory (Prep Lab), where the samples are converted from raw samples into 200# (75 micron) pulp samples, and the Assay Laboratory, where the 200# pulp samples are assayed using XRF Spectrometers to provide the elemental composition of the drill and mine samples, in particular, the weight percent of nickel, iron, silicon dioxide and magnesium oxide, and the grade of the valuable elements, nickel and iron.

The purpose of sampling and sample preparation is described in the AusIMM Field Geologists Manual, Fifth Edition , 2011, as being *"…the reduction in particle size, through crushing and pulverising, and its sample size, through splitting, while retaining the representativeness of the medium being sampled."*

Roden & Smith describe three elements essential for a satisfactory assay and sampling system, these being: maintaining the integrity of the sample in the field, selecting the appropriate assay method and monitoring the complete sampling and assay process on a continuous basis.

At HM, mining samples of as much as 400 – 600 tons are mined and sampled (STP), and these samples processed at the Prep Lab to produce a 60 gm pulp sample from which a 10 gm pressed powder pellet is produced for XRF analysis.Exploration samples are submitted from the Danmar drill programme in batches of 100 samples, each sample representing a 1 meter advance in the drill hole and weighs approximately 8 kgs, wet, on its arrival at the prep lab. As with the mine samples, the drill samples are reduced in volume and sample particle size to produce a 60 gm pulp sample, from which a 10 gm sample is taken for a pressed pellet, or a fused bead, for XRF. The expectation is that the results obtained on the 10 gm pressed powder pellets or fused beads are produced from the 600 ton mine or 8 kg drill sample are, within acceptable limits, representative of the original samples. It is the primary responsibility of the HM QAQC Department to ensure that this is the case.

1.Quality Assurance and Quality Control

Quality Assurance and Quality Control (QAQC) are two separate processes, but are often combined and referred to as QAQC. The purpose of QAQC is determining the quantity and concentration of the economic element of interest and providing the confidence we have in these numbers to allow us to put them in context with where we are in the mining value chain. It ensures that the data we are going to collect and the data we are collecting are of suitable quality (Sterk, 2019).

Quality Assurance means assuring the quality of the data by having a set of standard operating procedures (SOPs) in place, aiming to prevent errors being made in the sampling or measuring process. Wikipedia describes QA as including two principles, the first being "fit for purpose", the product needs to be suitable for the intended purpose, and the second being "right first time", where mistakes should be eliminated. Sterk summarizes the above by saying Quality Assurance is about the prevention of errors, and it occurs before sampling or measurement, while Quality Control is about the detection and correction/rejection of errors as they occur during the sampling or measurement process.

1.1 Quality Assurance at PT HM

The primary Standard Operating Procedure (SOP) for the samples submitted by the exploration and mining operations at PT HM is the "JIS Method for Sampling and Method of Determination of Moisture Content of Garnierite Nickel Ore" JIS M-8109-1996, by H.Kanazawa, August 1996. This Japanese industrial Standard specifies the following methods for this purpose of determination of the average grade and moisture content of a lot of garnierite nickel ore as follows:

1. Method of taking the sample
2. Method of sample preparation for moisture test sample and quality sample.
3. Method of measuring the moisture content
4. Method of determination of the moisture content and dry mass of the lot.

The JIS standard addresses the reduction in particle size and of the sample size through incremental sample reduction according to different sized scoops depending upon the particle size of the material being sampled. This SOP is used in reducing the size of the sample in the mining operations and in the sample preparation laboratory at the sample receival area, after drying, after jaw crushing, Roll Crushing and pulverising, and at the assay laboratory prior to the production of a pressed pellet or fused bead prior to XRF spectroscopy.

1.2 Quality Control at PT HM Sample Prep Lab

Quality Control is ensuring that checks and balances are implemented and are constantly reviewed and assessed, in order to identify whether the sampling /measuring systems and the laboratory are providing quality assays, ie are "in control". In the minerals industry, the checks and balances commonly used to monitor the sample preparation and assaying processes includes standards, blanks and duplicates.

Sterk discusses how geoscientists should be aware of variance, and QA,QC and Acceptance Testing (Reporting and Review) are relevant at every stage of the sample collection, sample preparation and assaying treatment. This is important, and we should assess the QA, QC and AT at each and every one of our sample treatment stages. At HM, these could are considered as Primary Sample, 1st Split, 2nd Split, 3rd Split etc., and Analytical, and a short summary of these different stages is given below. These samples are collected at the HM Sample Prep Lab.

1.2.1 First Lab Split Stage Prior to Drying - Both the reduction in particle size and the reduction in sample size take place at the Sample Preparation Laboratory (the Prep Lab), where the mining samples and the exploration samples are submitted, checked, and the mining samples split according to the JIS standard.

The exploration samples have not been split at this stage, only the mining samples have been incrementally split as per the standard, with the objective of reducing the sample size before drying.

1.2.2.Drying Stage - Samples are dried as the first stage of in sample preparation at temperatures 105° or 110°, for different durations, depending on the source material:

Exploration samples	- 8 to 12 hrs at 105° to 110° C
Mining samples	- 6 to 8 hrs at 105° to 115° C

Moisture Content - 24 hrs at 105° C

Once the drying is complete, the samples are removed from the oven and weighed, and the weights recorded for data entry, the Moisture Content being the difference between the wet weight and the dry weight divided by the wet weight and shown as a % figure. The average figure for the saprolite samples recovered in the HM drill programme is around 40% moisture.

1.2.3 First Crushing Stage – Jaw Crusher - The first crushing stage of the oven dried drill sample occurs at the Jaw Crusher, where the two trays of dried sample are poured into the jaw crusher and reduced in size to a -10 mm product which is collected underneath the Jaw Crusher.

1.2.4 First Splitting Stage – Jones Riffle Splitter - The Jaw crusher product is now poured into a Jones Riffle Splitter which produces two similar products, one of which is taken forward to the next crushing stage, while the second Riffle Splitter product is discarded.

The first crushing stage and the first splitting stage are now complete, all part of the incremental crushing and splitting process in reducing the grain size and sample size of the original dried sample. These two stages continue to follow the details provided in the JIS standard, part of the HM Quality Assurance programme.

1.2.5 Second Crushing Stage – Roll Crusher - The second crushing stage comprises the Jones Riffle split product being poured into a Double Roll Crusher which reduces the -10 mm jaw crusher product into a – 3 mm product which is collected beneath the double roll crusher.

1.2.6 Second Splitting Stage – Manual Incremental Reduction - As described in the JIS M 8109 – 1996 standard, the second splitting stage consists of the - 3 mm double roll crusher product being reduced by manual incremental reduction into two incremental split samples weighing approximately 500 gms each, one is labelled and sent to sample storage, while the other sample will be sent to the next stage in the processing cycle, the pulveriser. In addition to the split samples collected above, before discarding the remaining double roll crusher product, a further sample is collected, one approximately every 20 samples, and placed in a brown paper envelope and numbered with a DR suffix, this being a Double Roll Crusher product sample that will be sent for assay to test the performance of the two crushing and splitting stages, often referred to as the Course Reject sample, or at HM, the Double Roll (DR) sample. This is the first of the Laboratory check samples to be collected as part of the HM Quality Control programme, and will be used to monitor the quality of the jaw crushing and roll crushing stages in reducing the particle size and the sample size during the sample preparation programme.

1.2.7 Pulverising Stage - The fifth stage consists of the 500 gm -3 mm double roll sample being placed into a pulverizing bowl, a puck added, the lid is replaced and this unit placed inside the Essa Pulverizer using a cradle. The cradle is removed and the machine turned on and run for 5 minutes, after which the pulverizer bowl is removed from the machine using the cradle, the lid removed, the puck taken out, and the pulverised sample, the "pulp", placed onto a tray, and passed on to the next stage of incremental splitting.

This pulverising stage is third stage in the reduction in particle size in the sample preparation process, where the dried exploration sample of approximately >20 mm was reduced in size to -10 mm at the Jaw Crusher, and then to -3 mm at the Roll crusher, and finally to -200# at the pulverising stage

1.2.8 Third Splitting Stage – Manual Incremental Reduction - The sixth stage of sample preparation is where the pulp sample is incrementally reduced with enough pulp to place into two brown paper envelopes, one of which goes to the Assay Lab, and the second sample goes to storage.

A further check sample is taken from the residual pulp remaining from this second incremental splitting before being discarded to waste, and is placed into a brown sample bag and given the sample number with a DA suffix. This is the second check sample taken to monitor the pulverising quality at the HM Prep Lab and is referred to as the DA check sample, or Pulp Reject sample. This is part of the Quality Control programme to test the quality of the pulverising process.

1.3 Particle Sizing Test (PST) – Checking the Quality of the Pulverizing Process – A PST is taken on one in every ten of the pulverised product, the pulps, to ensure the pulverisation has been done properly. A small sample of material is weighed and then placed on a 200# (75 micron) stainless steel screen and screened until all the sample that can pass the 75 micron screen has passed The weights of the – 75 micron material and the+ 75 micron products are both weighed and recorded. If the weight of the – 75 micron product is more than 95% of the total pulp sample weight, then the pulverisation process is acceptable. If the weight of the – 75 micron product is less than 95% of the total weight then this is not acceptable and the process is repeated.

Other Sample Preparations - In addition to the standard sample processing procedures described above, two further sample processing techniques are performed at the PT HM sample preparation laboratory to provide additional information for the geological and mining databases, these being Specific Gravity (density) testing and the measurement of the Moisture Content of selected samples.

1.4 Specific Gravity Measurement

At the Sample Prep. Lab the specific gravity of the four different lithological samples, collected from the drilling operations, eg the soil or overburden, limonite, saprolite and bedrock are measured by the displacement method.

1.5 Moisture Content - Nickel ore is hygroscopic and it is important to ensure that all moisture is removed from the sample to prevent the assay results showing a low bias by an amount equivalent to the weight percent residual moisture. This has the potential to affect its behaviour during smelting, which in turn can result in a lower price received per ton of smelted ore. For this reason, accurate measurement of moisture content of the mining samples before the ore is shipped to the IMIP smelter is one of the important tasks undertaken at the Sample Prep Lab.

The moisture content of the drill samples is calculated through weighing the drill samples wet, before they are placed in the ovens for drying, and again when they have been removed from the ovens and prior to the first stage of crushing. The difference in weight between the weights of the samples before and after drying, divided by the original wet weight of the sample gives the moisture content as a percentage figure.

2. Quality Control at the PT HM Assay Lab

The pulp samples of 50 – 60 gms from each consignment completed at the sample prep lab are sent to the Assay Lab where they are recorded into the production register and then placed into an oven to protect the samples from absorbing atmospheric moisture. This is the analytical stage of the sample treatment, where the samples collected at the Prep Lab are snet to the Assay Lab for analysis.

A new assay lab number is assigned to each pulp sample packet, this is undertaken at the same time as Certified Reference Materials (CRMs), pulp duplicate samples, coarse rejects, blank check and replicate check samples are inserted into the sample streams as part of the Quality Control procedures. After checking that the renumbering of these samples has been completed correctly, the samples are then taken through to the preparation room and placed in a dessicator to await the production of pressed pellets or go to the room where they will be processed into fused beads using the Bruker xrFuse6 equipment.

Roden & Smith mention how XRF assay procedures have not changed significantly but the use of fused beads instead of pressed powder pellets have resulted in better precision and lower detection limits. They go on to say that XRF is an analytical method capable of producing very precise assays over wide concentration ranges and is therefore widely used for assaying nickel laterite ores and iron ores, a similar statement being made by Bruker claiming the S2 Puma XRF offers high accuracy and precision in determining the elemental composition of nickel laterite ores.

HM presently have two XRF Spectrometers at their Tangofa Assay Lab, one a Malvern Panalytical Epsilon 4 XRF, the other a Bruker S2 Puma XRF. These are compact energy dispersive spectrometers that are capable of undertaking elemental analysis and configured with dedicated software specifically for the nickel laterite suite of elements. Both the Epsilon 4 and the Puma S2 XEF's use a Nickel XRF 12 Element Suite for Ni, Fe, Co, MgO, SiO2, CaO, Al2O3, Cr2O3, MnO, P2O5, SO3 and TiO2.

Sample preparation quality, reflecting sub-sampling precision and contamination during sample preparation, are measured by the insertion of coarse grained control samples that are placed in the sample stream prior to or during the sample preparation phase. Samples used for these tests are coarse blanks and coarse duplicates.

2.1 Coarse Blanks

Contamination is assessed by using coarse blank samples, these being barren samples in which the elements being tested, at HM these are Ni and Fe. In order to be effective, coarse blank samples are inserted into the exploration sample batch streams at the rate of 4 coarse blanks, 4 CRM's and 92 original samples, prior to submission of the samples to the Prep Lab.

2.2 Coarse Duplicates

Coarse duplicate samples, often referred to as coarse rejects, and by HM QA/QC staff as DR samples. They are collected from the Double Roll crusher product, during the incremental splitting of this product, by the same operator, and at the same time and place as the sample is split to provide material for pulverising, and a representative sample of material is collected for storage. Coarse duplicate samples are used to test the sub-sampling precision of the first crushing and incremental splitting stages.

Figure 1: Scatterplot showing results of 1020 Coarse Reject original vs duplicate assays

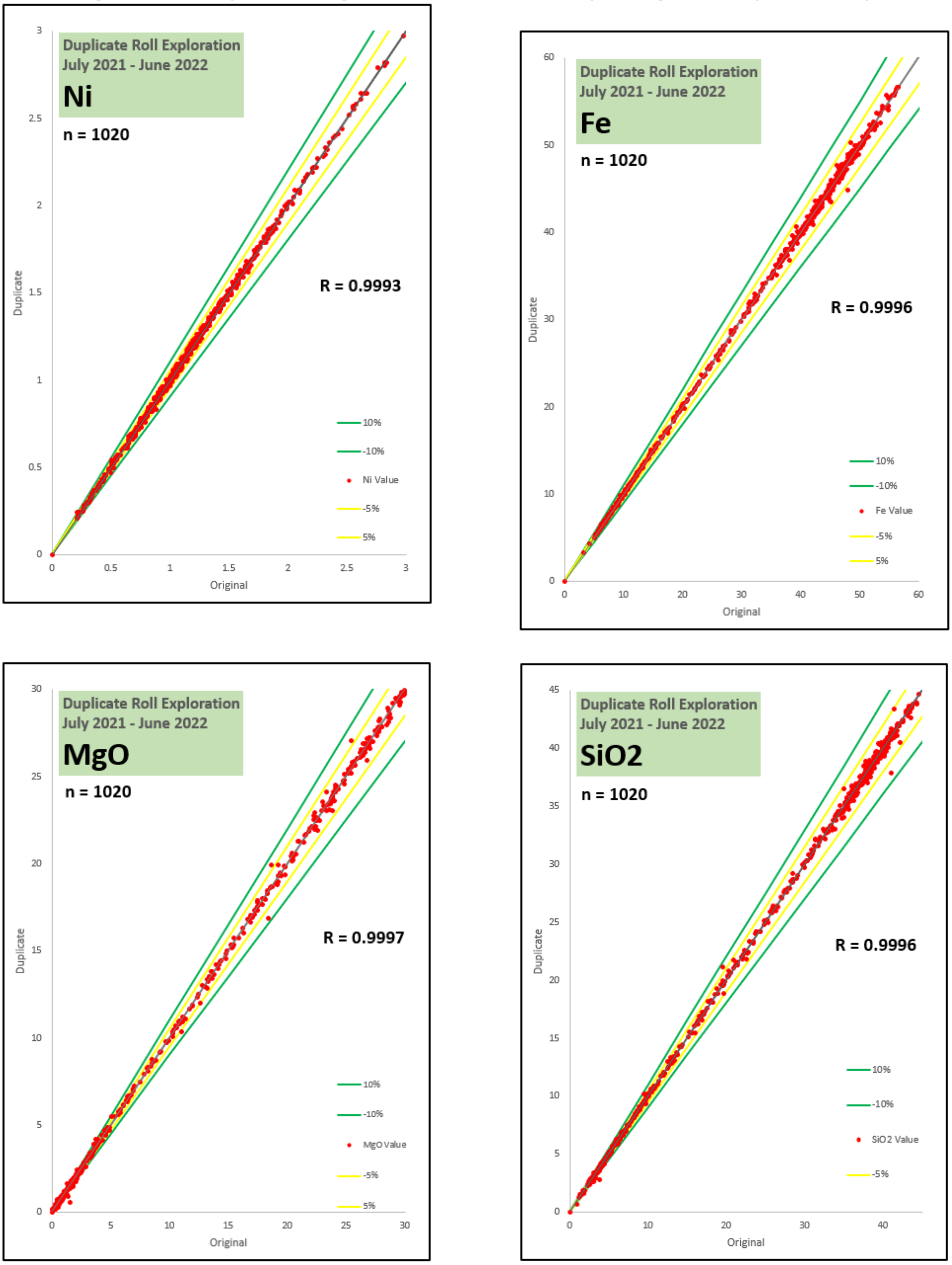


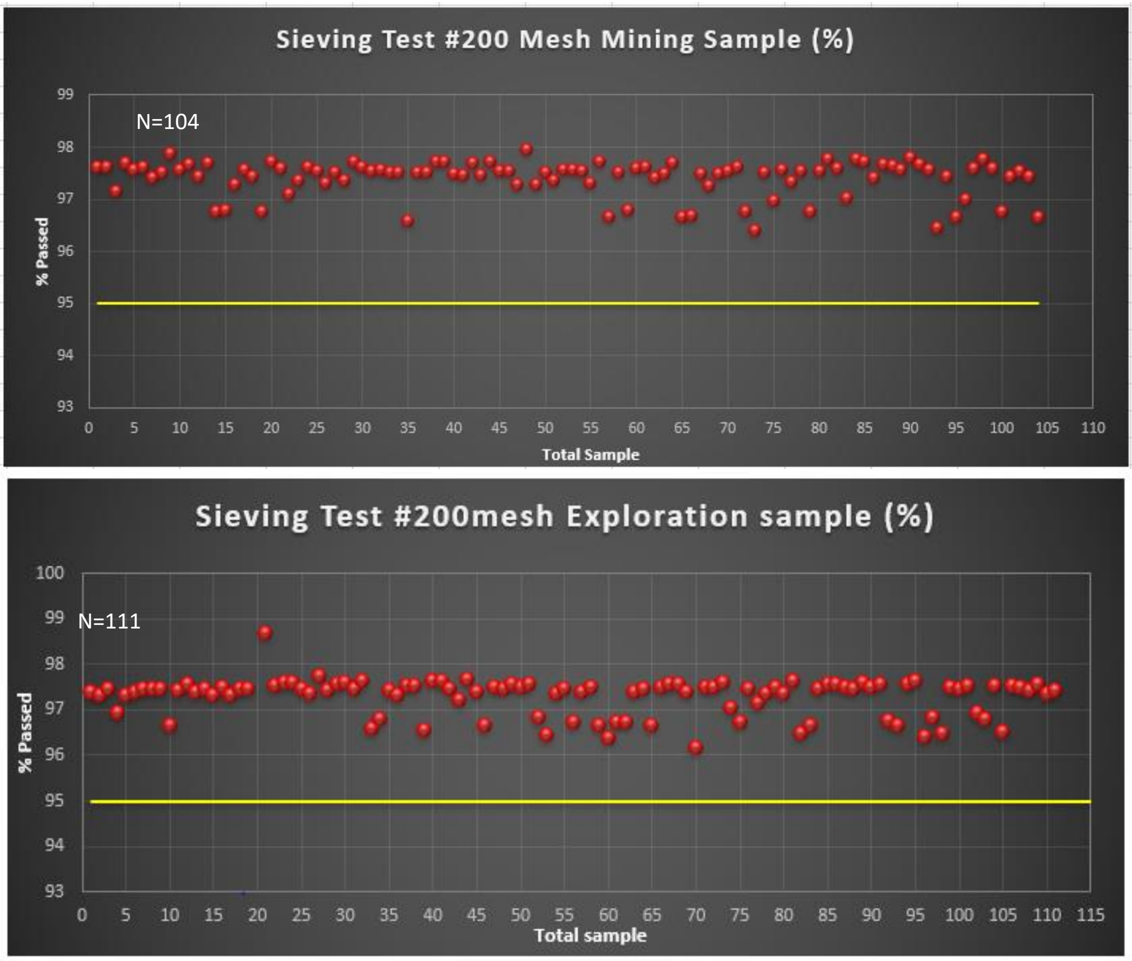
Figure 1 is a scatterplot showing the results for the four elements Ni, Fe, MgO and SiO2 from the original and duplicate roll sample results from 1,020 exploration assays undertaken over the period July 2021 to March 2022. The graphs show the original and duplicate elemental values in red plotted on a middle grey line representing the mean elemental values of these samples. The two yellow lines above and below the mean line represent the correlation between the assay variables with a variance of +5% and -5%, and the outer green lines represent the variance between the assay variables of +10% and -10%. Scatterplots where the results slope from the lower left to upper right indicate a positive correlation.

Figure 1 shows that with all four elements the red dots plot within the +10% and -10% variance lines. In fact, the majority plotting between the +5% and -5% yellow lines, showing there is a high correlation between the original and the duplicate assay values. This is further confirmed with the correlation coefficient (R^2) values of > 0.999 for the elements being assayed. These figures confirm the high precision of the jaw crushing, the first splitting and roll crushing stages and supports the use of the Coarse Duplicate assay data for resource estimation purposes.

2.3 Particle Sizing Test- -200# Screen Test

Figure 2 shows two graphs showing the results of the particles sizing tests undertaken on 111 exploration samples and 104 mining samples at the HM Prep Lab during March 2022. The yellow line is for 95% of the pulverised material passing the 200# screen, and shows the majority of the samples returning a figure of between 97% and 98% for both the exploration samples and the mining samples. These results show the repeatability precision of the pulverizing process in reducing the particle size of the samples to be high

Figure 2 : Screen Test Results – March 2022



3 Sample Assay Quality

What is quality, and how do we define it?

Sample assay quality is defined through analytical accuracy, analytical precision and contamination during assaying. It is assessed using fine grained, pulverised samples that are inserted into the sample stream after the preparation stage and before the assaying stage. Samples used in testing assay quality include pulp duplicates, Certified Reference Materials (CRMs) and fine blanks.

The AusIMM Field Geologists' Manual, (2011) defines accuracy as *"…the closeness of agreement between a test result and the 'true' value or accepted reference value."* Similarly, it defines precision as *"…the closeness of agreement between independent test results under stipulated conditions."*

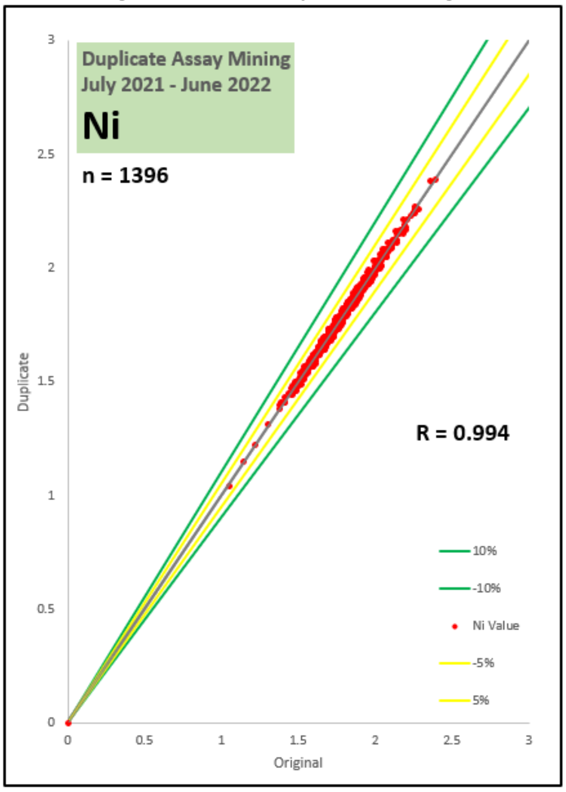
Accuracy and precision are the two key elements in understanding data quality, and are illustrated with the dartboard diagram. We need to quantify the precision and accuracy (bias). Sampling or analysis is said to be accurate when the mean error approaches zero. Sampling or analysis is said to be precise when there is a small spread of errors around the mean sampling error.

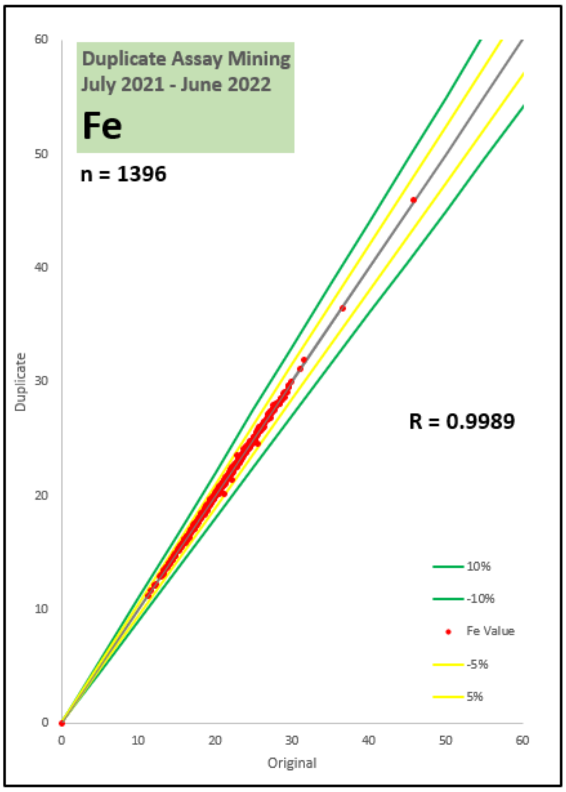
Date with "good" accuracy and "good" precision can be regarded as "Good Quality" and as such, will be "fit for purpose". We also use the terminology "representative", when the precision and accuracy are within acceptable tolerances.

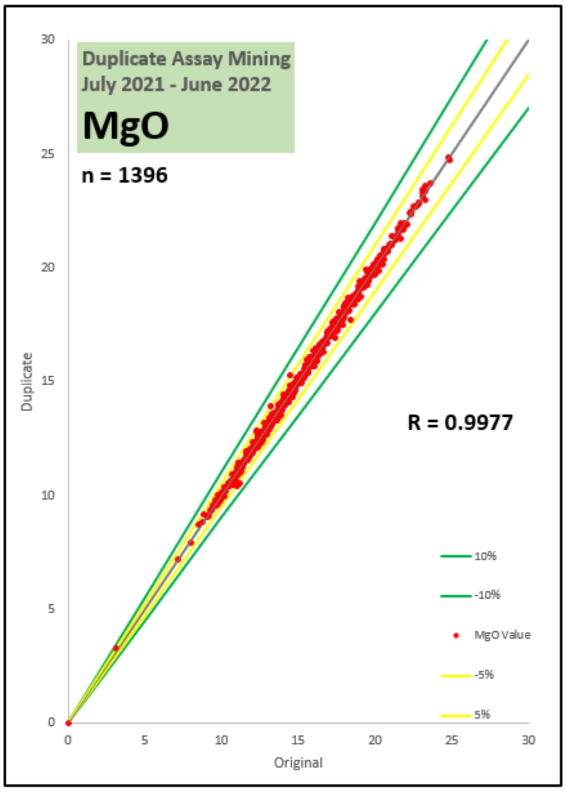
3.1 Pulp Duplicates, or Duplicate Assay

Pulp duplicates, or Duplicate Assays (DA) as they are called at HM, are second splits of the fine grained pulp samples that are collected in the final incremental splitting of the samples after pulverising. Along with the incremental split sample that is taken and bagged for XRF assay at the HM assay lab, and the sample taken for storage and future reference if required, a third sample is collected from each batch and analysed at the same time as the original sample, but with a different sample number. The pulp duplicates are indicators of the analytical precision, which can be affected by the quality of the pulverisation process and the homogenisation of the sample.

Figure 3: Scatterplot showing results of 1,396 plots for Pulp original vs duplicate assays







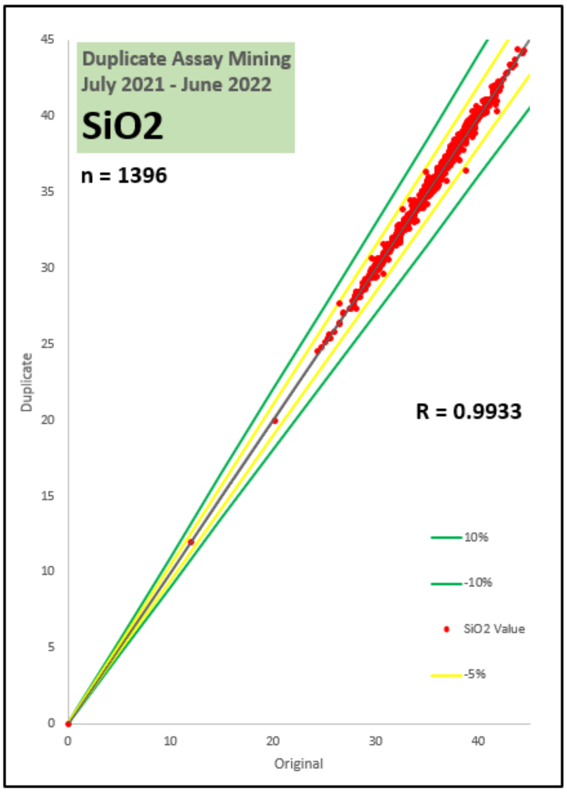


Figure 3 shows scatterplots for the elements Ni, Fe, MgO and SiO2 from original and duplicate assays from 1,396 pulp samples analysed between July 2021 and June 2022. The scatterplots are similar to those shown in Figure 1 for the Coarse Reject assays, with the majority of the Ni and Fe falling within the two yellow lines representing a +/- 5% variance from the assay, a high precision, and reflected with correlation coefficients of 0.994 and 0.9989 respectively.

One difference between the Pulp Duplicate and the Duplicate Roll Graphs shown in Figure 1 is the lack of data points for the lower values of Ni, Fe MgO and SiO2. The reason for this is that Figure 1 shows the wider range of elemental results for exploration samples, while Figure 3 shows results from mining samples with cut-off grades of 1.5% Ni reflected in the average saprolite grades of around 1.75% Ni. Similalrly, average saprolite Fe results are around 20%, for MgO an average of 23%, and for SiO2, around 38%.

3.2 Accuracy

Accuracy refers to the component of the measurement error that in replicate measurements remains constant or varies in a predictable manner. It is assessed by using Certified Reference Materials, eg OREAS 193, and by inserting these CRMs into the sample stream, it is possible to assess the performance of the assay lab undertaking the assay work for internal control. When sent to commercial laboratories with Interlaboratory Check samples it allows comparison of the HM Aassay Lab performance against commercial laboratories and assess for any bias.

Accuracy is treated as a qualitative attribute, ie low or lower accuracy, high or higher accuracy, and should not be given a quantitative value. Accuracy is measured through the bias, which is the difference between the expectation of the test results and an accepted reference value. There is an inverse relationship between accuracy and bias, the higher the absolute value of the bias, the lower the accuracy, and vice versa.

3.3 Check Standards, or Certified Reference Materials (CRM's)

Certified Reference Materials, CRM's, are samples with certified grades, prepared under specially controlled conditions and have a certified mean value for the contained elements in that standard, along with associated confidence and tolerance limits. They are used in Quality Control to monitor the values of the standard against those of the unknown samples being assayed and allow the accuracy of the assay process to be monitored. HM use CRMs produced by OREAS (Ore Research & Exploration P/L, from Victoria, Australia. OREAS CRMs currently used are Standards 182, 187, 192, 193, 194 and 195 with certified Nickel values of 0.707, 1.37, 1.77, 1.93, 2.13 and 2.94 respectively. In addition, these standards have certified standard deviations and state the 95% Confidence and Tolerance Limits with low and high values.

CRMs are generally placed into the sample stream at a frequency of one in 20 samples with mine samples and higher frequency of one in 10 exploration samples, this higher value due to the first sample in each run on the Epsilon 4 and Puma S2 XRF spectrometers being a standard as described in the Standard Operating Procedure.

Figures 4, 5, 6, 7 and 8 are Shewart Control Charts for the results of assays using the OREAS standards 182, 187, 192 and 195 over an eight month period from November 2021 to June 2022. The assay results obtained over a period of time are plotted on a chart of showing certified values against the number of samples assayed, with one line showing the certified mean value, and two green lines showing the expected value plus/minus two standard deviations, also referred to as Upper and Lower Warning Limits, and two red lines representing the Upper and Lower Control Limits at three standard deviations.

Abzalov describes how specific analytical problems have recognizable patterns on certain diagrams , the different distribution patterns of the analytical results being indicative of the error sources and types, being most effective when applied to certified standards such as the OREAS CRM's. Good quality analyses will be characterised by a random distribution points around the certified mean value, with 95% of the data points lying within two standard deviations of the mean. The same number of analyses should fall above and below the mean.

Figure 4: CRM OREAS 182 - 537 Exploration Sample Analyses

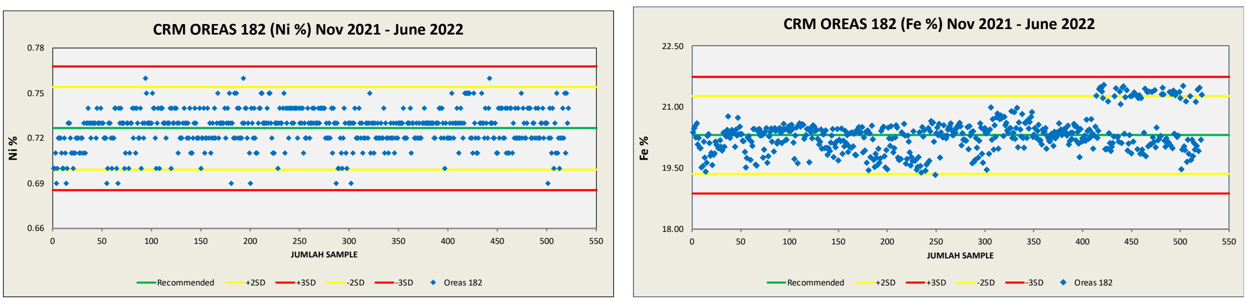


Figure 4, the OREAS Standard 182 shows the results plotting with 95% within two standard deviations of the mean for both Ni and Fe and showing good precision. However, with the Fe graph, the accuracy is not as good on the right hand side of the graph.

Figure 5: CRM OREAS 187 – 582 Exploration Analyses

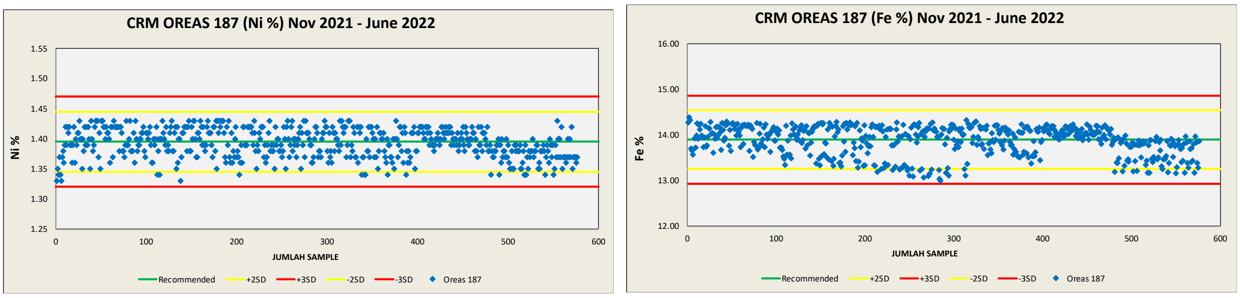


Figure 5 shows the results for 582 exploration samples for Ni and Fe, with both elements showing good precision, 95% of the results plotting within two standard deviations of the mean, and similar numbers of samples above and below the mean. Accuracy in the Fe graph is not as good, with the appearance of more samples below the mean value.

Figure 6: CRM OREAS 192 – 339 Exploration Analyses

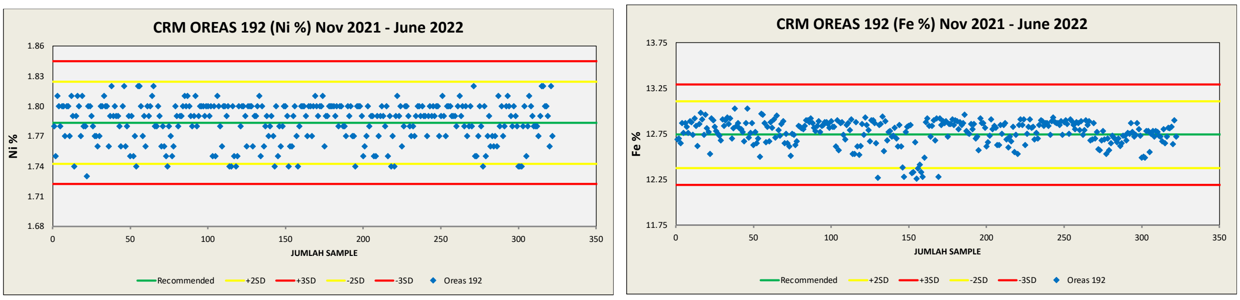


Figure 6 shows good distribution of 339 exploration data results, with 95% of the data points plotting within two standard deviations of the mean, and similar numbers of data points above and below the mean for excellent precision, but the Fe graph shows a number of data points close to the negative -10% warning line which reduces the accuracy in this graph.

Figure 7: CRM OREAS 195 – 193 Exploration Analyses

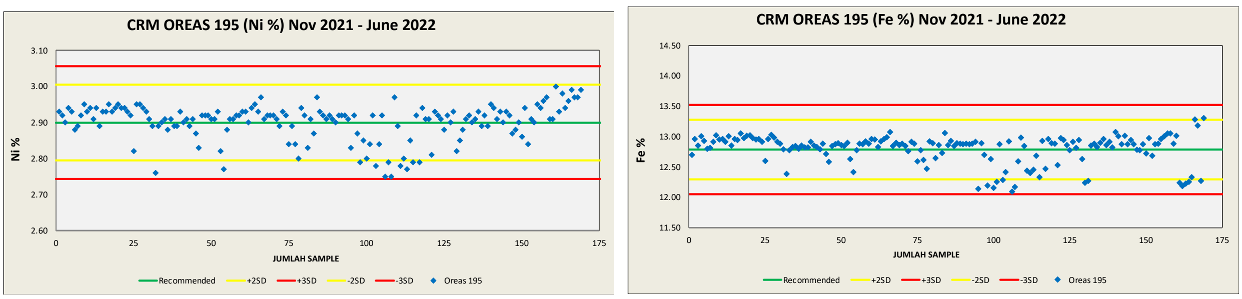


Figure 7 shows a good distribution of the 193 exploration data points with 95% of the results plotting within two standard deviations of the mean for both Ni and Fe, but as with the previous graphs, the accuracy appears to drop around the 100 sample mark for approximately 10 samples which indicates less accuracy.

These graphs show that for the 1,651 exploration samples assayed using 4 different OREAS Laterite Suite CRM's the precision between the original and the CRM values are generally excellent, whilst the accuracy for the Ni is good to excellent whilst for the Fe it is of lower quality.

3.4 Replicate Samples

These are two portions of the same pulp samples that are used to produce two separate pressed pellets or fused beads, that are given different sample numbers before being inserted into the same batch, or Job Sheet. At HM they are taken as part of the standard package of check samples, these being one DA or pulp assay, one DR or coarse reject assay, one REP or replicate sample and one CRM.

Figure 8: Scatterplot showing results of 2,130 plots for original vs replicate assays

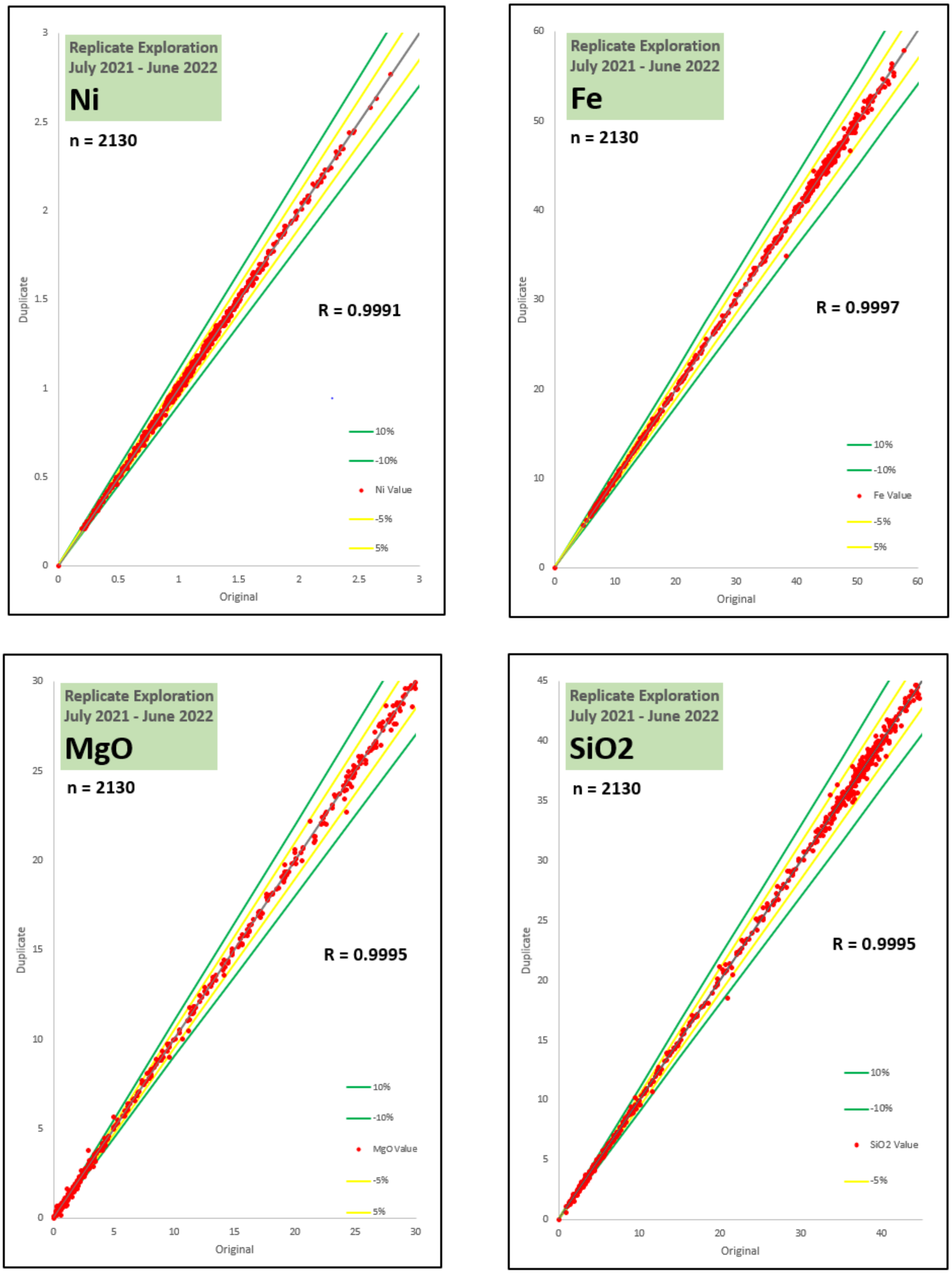


Figure 8 shows scatterplots for 2,130 replicate analyses undertaken between July 2021 and June 2022. The format of the scatterplots is the same as for the previous scatterplots for the Coarse Rejects (DR) and the Pulp Duplicates (DA), with these results showing the wider range in values for the elements due to the samples being tested originating from exploration samples.

The scatterplots for replicate sample assays show the majority of the results plotting within the two yellow lines indicating a 95% confidence in the result plotting withing these limits, and is considered an excellent result. The graphs also show correlation coefficients of more than 0.999, indicating high precision. Spreadsheet data shows there is also an even spread of the replicate assay being both similar to, higher than, and lower than the primary assay in the case of Ni, whilst for Fe, MgO and SiO2 there are slightly more duplicate assays in the Assay<Original category with a corresponding lower figure in the Assay=Original category. This confirms a normal distribution of assay values for these elements and indicates there is little evidence of systematic bias occurring in this replicate check assay programme.

3.5 Interlaboratory Check Samples

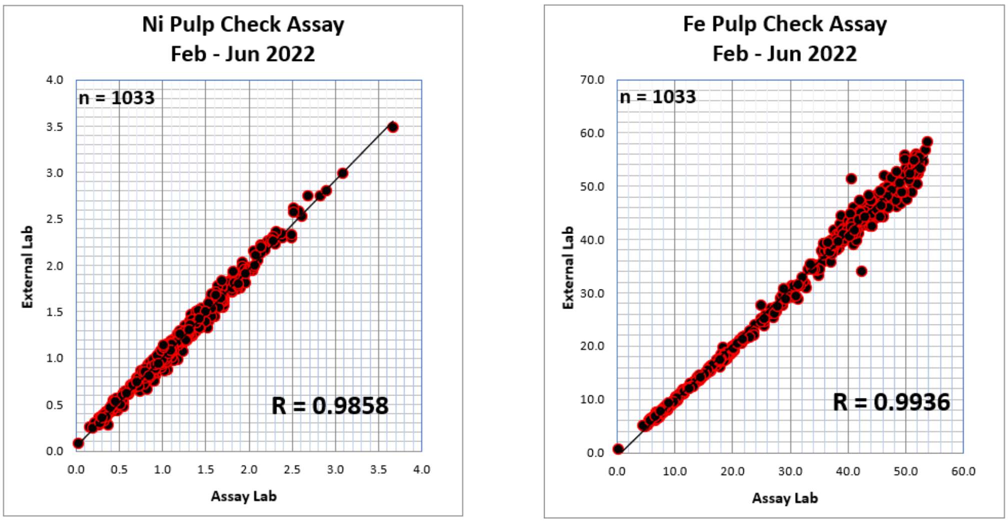
3.5.1 HM Lab vs PT Geoservices Lab

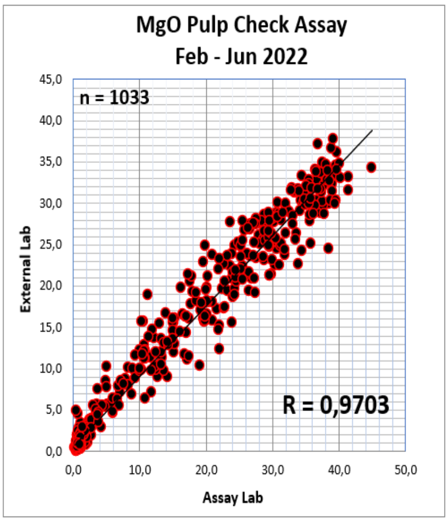
Interlaboratory Check samples are second splits of both the coarse reject samples and the finer 200 # pulp samples that are routinely assayed at the HM Assay Lab and submitted to second, commercial, laboratories under a different sample number. These samples are used to assess the assay accuracy of the HM laboratory relative to the secondary, Geoservices Laboratory.

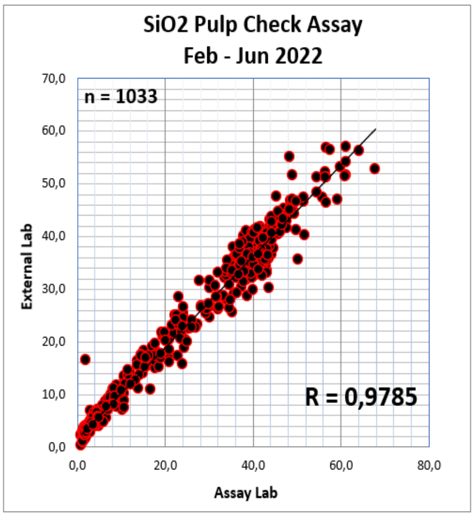
Batches of Exploration samples were sent to the Geoservices Laboratory in Kendari on a periodic basis where the coarse reject samples underwent pulverising and incremental splitting, to be sent off for XRF assay at the Geoservices Analytical Laboratory in Bandung, along with duplicate pulp assay samples. Geoservices then forwarded the HM pulp sample checks to their analytical lab as a different consignment, and once assayed, the results were returned to the Assay Laboratory at the Tangofa site.

Figure 9 shows the results of the inter laboratory check sample tests comparing the results of 1033 split Exploration coarse reject and 200# pulp samples assayed at the original HM assay laboratory with samples sent to the Gesoservices assay Laboratory in Bandung.

Figure 9: Scatterplot showing results of 1033 plots of HM original vs Geoservices duplicate assays







The scatterplots show differing precision for the different elements, with the best correlation shown between the results for Fe and Ni, 0.9936 and 0.9858 respectively, SiO2 and SiO2 have lower correlations at 0.9785 and 0.9703.

Data for the results for the two laboratories shows a difference between the mean for the Ni and Fe values for the HM Lab as 1.15 % Ni and 27.52 % Fe against 1.13 % Ni and 26.93 % Fe for Geoservices, a difference of 1.74% for Ni and 2.14% for Fe. These represent a +/- 5% variance from the assay, a high precision, and reflected with correlation coefficients of 0.9858 and 0.9936.

These results show lesser precision than was the case with the internal checks using Coarse Rejects, Pulp Assays and Replicate Assays at the HM Lab. This indicates the difference is likely to be due to different sample processing procedures at the two laboratories, and different accuracies and precision due to different equipment. There is a difference between the pressed powder pellets used at the HM Lab with the Fused Bead system used at Geoservices. Similalrly, the HM Assay Lab uses a Malvern Panalytical Epsilon 4 XRF and a Buker Puma S2 XRF that was brought into operation in 2021 and any differences between these XRF Units and those used at Geoservices could result in small differences being recorded.

3.5.2 Comparison PT HM Assay Lab vs IMIP Smelter Results

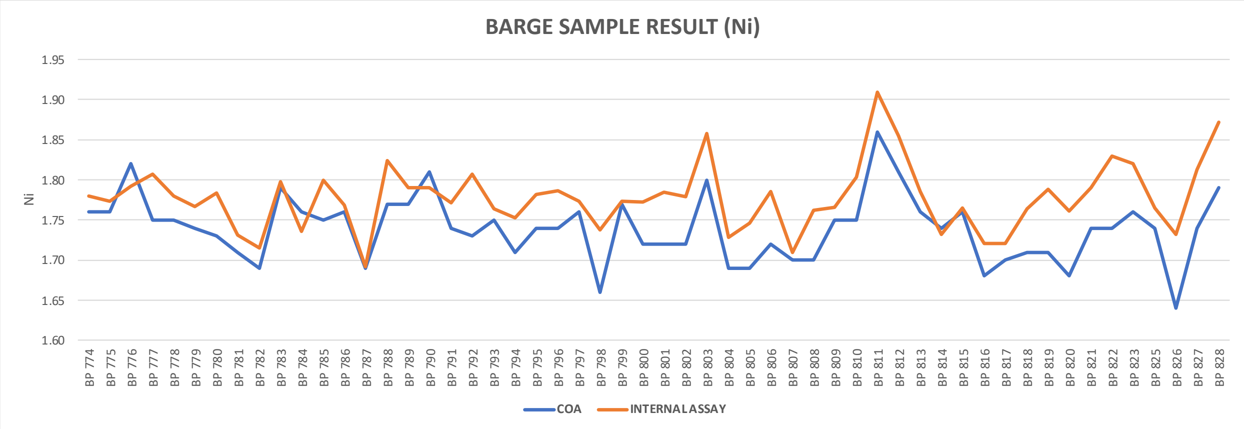
When the barges carrying ore from the HM Jetty to the IMIP smelter arrive, samples are collected from the saprolite ore and assayed at the IMIP facility. These results are used to determine the price paid for the nickel laterite ore. These results are provided in a Certificate of Assay (COA) and Certificate of Quality by PT Intertek Utama Services, Indonesia.

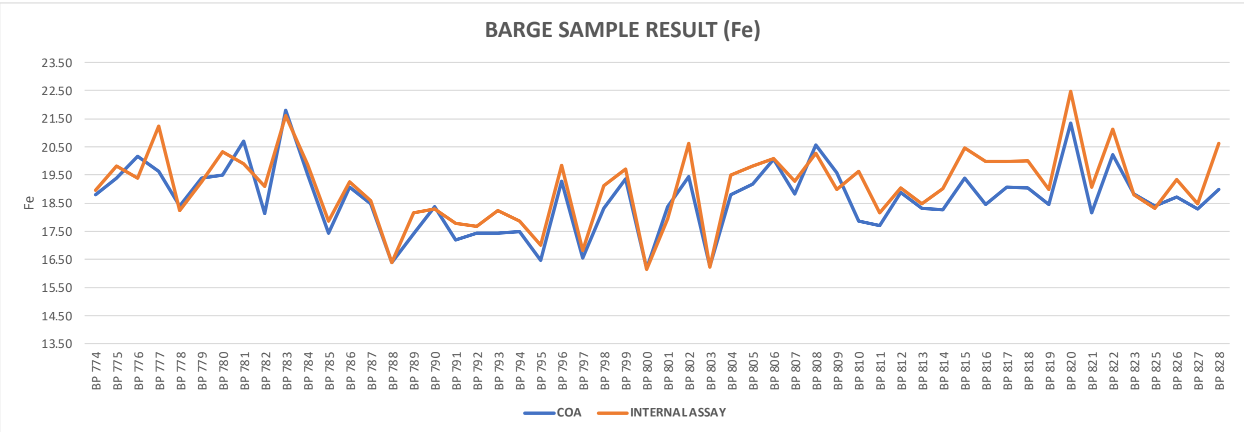
Figure 10 shows graphics of the plots of the Ni and Fe results from the HM Assay Lab and the IMIP COA for 54 samples from barge numbers BP 774 and BP 828 which delivered saprolite ore from the HM Mining Operations to the IMIP Smelter between May 2022 and July 2022.

These graphs represent HM assay results with means of 1.78% Ni and 19.10 % Fe, standard deviations of 0.04 and 1.30, and variances of 0.0016 and 1.6834 respectively. Similar results of 1.74% Ni and 18.66% Fe, standard deviations of 0.04 and 1.20, and variances of 0.0017 and 1.4441 were recorded on the IMIP COA's. Interestingly, the difference between the two sets of data shows a mean difference of 0.04, or 2.2% for the Ni values, with 50 of the 54 COA values being less than the HM assay values. With the Fe values, there is a 2.3% difference between the HM and COA values, with 41 of the 54 COA's returning lower values than HM.

The consistency of results from these 54 samples is interesting, and as before, can be the result of sample processing differences, eg pressed pellet vs fused bead, different equipment and calibration issues.The other problem is the hygroscopic nature of nickel ore, and how the increase in moisture content of the saprolite between leaving the HM stockpiles and being fed into the smelter is likely to result in differences in the Ni values, and may explain the variation between the Ni and Fe graphs.

Figure 10: Graphic showing results of 54 saprolite samples assayed at HM and IMIP Smelter





4. Control Sample Insertion Rates

HM operates a quality control programme at its Tangofa Laboratories where different types and sub-types of control samples are inserted into the sample stream in order to monitor precision, accuracy and possible contamination at the different stages in the sampling, sample preparation and sample assaying sequence.

Sample collection is usually controlled through the use of twin samples and field duplicates, but due to all the Jackro triple barrel drill core being sent for sample preparation and assay, these control samples are not sent for checking.

Sample preparation is controlled through the use of coarse blanks, coarse rejects (DR) and 200# particle sizing tests at the HM Prep Lab.

Sample assay is controlled through the use of pulp duplicates (DA), CRM's, Replicate samples and Interlaboratory check samples.

Mendez (2011) described the frequency of control samples using information from International QA/QC consultants, Exploration and Mining Companies, various authors and the Toronto Stock Exchange and found that a figure of 20% (1 in 5) of the total samples assayed comprise control samples of various types.

During the period July 2021 to June 2022 a total of 50,102 exploration samples were processed at the HM Sample Prep and Assay Labs. The following check samples were added into this original sample stream:

Table 1:
Exploration Control Sample Insertion Rates
July 2021 - June 2022

Period	Exploration Samples	Coarse Rejects/DR		Pulp Duplicates/DA		Replicates		CRM's		Interlab Checks	
		No.	%	No.	%	No.	%	No.	%	Checks	%
May - July 2022	50,102	1,020	2.0%	1,110	2.2%	2,130	4.2%	1,997	4.0%	1,951	3.9%

The Coarse Reject and Pulp Duplicate samples comprise 2.0% and 2.2% of the samples submitted. These figures correspond to those proposed by Mendez, of 2% and 2% respectively.

Replicate samples and CRMs comprise 4.2% and 3.98% respectively of the samples submitted. Although Mendez does not appear to specifically include replicates, this figure of 4.2% allows an additional measurement of the Assay Quality at the HM labs, and is due to two replicate samples being inserted into the sample stream instead of the one coarse reject and one pulp duplicate sample per batch.

The differences between the % of check samples proposed by Mendez, 1 in 5, or 20%, and the 12.5% at HM is due to the lack of Twin Samples collected at the sample collection stage, 2%, because the whole drill core is sent for sample preparation and assay, and a further 2% by way of pulp blanks are also not collected at HM. With 4% of the samples being CRM's this is less than the 6% CRM's suggested by Mendez, but 1,951 Interlaboratory Check samples were sent for assay at Geoservices, 3.9% of the total exploration samples, and in line with the 4% suggested by Mendez.

In summary, a total of 8,208 check samples were inserted into the sample stream of 50,102 exploration samples and submitted for assay ay the Geoservices Assay Laboratory, a total of 16.4% as compared to the 20% suggested by Mendez.

5.Review, Reporting and Continuous Improvement

This section covers three aspects of of the activities undertaken at the QAQC Department thatdeserve a mention.

The Review section is similar to the Acceptance Testing that Sterk discusses, and which he believes should accompany each QA and QC stage in the sample collection, preparation and analysis stages of the sample processing stream. At present, the HM QC team undertake the following:

- Receive printout of assay results for the batches/consignments of exploration samples.
- Check results to confirm check samples inserted into sample stream by HM staff/client.
- Identify check samples and compare CRM results with original results to confirm acceptable precision and accuracy, and present to Supervisor to confirm acceptability of results, and whether or not samples need to be re-assayed in the event of contamination, bias or poor precision.
- If CRM results not acceptable, the analyst and Foreman will consult and clean the Tube Filter and repeat the analysis. If the next analysis is in order the sample assaying will continue.
- If the repeat assay is not acceptable, the next assay will be conducted with a different CRM. If this assay produces an acceptable result, the assay sampling will continue. If this assay produces an unacceptable result, the Supervisor will inform the Lab Superintendent and the Supervisor will undertake recalibration of the unit.
- Lab Foreman then decides and approves circulation of results internally.
- Lab Superintendent decides and approves results going out to client.
- Lab Foream decides and approves entry of sample results data onto HM database.
- Lab Supervisor checks and confirms data entry is correct and in order.

In addressing any issues with Interlaboratory Check Samples, Sterk emphasises the importance of communicating with the commercial laboratory which undertook the assaying of check samples, and discussing what may have caused any serious differences in precision or accuracy.

Reporting of the analysis of the Quaity Control samples is continual, ongoing process and the HM QAQC Department issues a Monthly Report detailing the activities of the department for each calendar month. Sections covered in the QAQC Laboratory Monthly Report for June 2022 are:

- Health & Safety – Near Miss Report
- Accident Report
- Radiation Accident Report
- Preparation Lab Production Report
- Assay Lab Production Report
- Sample Type Statistics
- Monthly Sample Split eg Mining, Exploration, Barging, QAQC
- Quality Control – Sieving Test
- Precision
- Accuracy
- CRM's
- InterLaboratory Check Samples
- Personnel
- Planning, Implementation and Constraints
- Photos

Continuous Improvement is an ongoing procedure that is necessary to maintain the quality of the sample preparation and assay at the HM Laboratories in response to the increase in production at the PT HM Tangofa Mine, from 75,000 wmt per month during 2019 to 300,000 wmt per month in June 2022. Accompanying this three fold increase in the production of saprolite ore, Nickel Industries is now commencing the mining of limonite to feed an HAPAL Plant at IMIP to produce batteries for electric vehicles in Sulawesi. This increase in production has seen a corresponding increase in the staffing levels at the Sample Prep and Assay laboratories, as well as the purchase of additional equipment to meet the increased production with upgrading the equipment at the sample prep lab, the assay lab and associated storage.Nickel Industries have signed MOU's and other agreements in order to acquire additional resources to provide additional feedstock for additional RKEF lines at IMIP at Morowali and IWIP at Halmahera.

To meet the challenges of the increased production and implementation of additional technologies and equipment to handle these increases it will be important to upgrade the skill sets of the staff to ensure that the increase in production will see a corresponding increase in the quality of the data generated at the labs, and continue to seek higher standards of precision and accuracy through improved techniques.

Current international standards for the reporting of exploration and mining results, such as JORC Code 2012 and Canadian NI43-101, require that a programme of data verification is included with any exploration programme to confirm the validity of the exploration data, and this is normally done by inclusion of JORC Code , 2012 Edition – Table 1 Report Template, a copy of which is attached as Table 2.

6. Conclusions

This report has been submitted as part of a JORC Code 2012 Edition Compliant report following the guiding principles of Transparency, Materiality and Competence with the author providing details of the QAQC activities at the HM operations at their Tangofa Camp.

The purpose of Quality Assurance and Quality Control is to determine the quantity and concentration of Ni and Fe and associated lateritic nickel elements and provide confidence in the numbers to allow us to use these numbers in resource estimation, and ensuring that the data we are going to collect and the data we are collecting are of suitable quality. Quality Assurance is about the prevention of errors occurring before the sampling or measurement and Quality Control is about the detection/correction of errors as they occur during the sampling or measurement process (Sterk, 2019).

The Standard Operating Procedure (SOP) for the samples submitted by the exploration and mining operations at PT HM is the “JIS Method for Sampling and Method of Determination of Moisture Content of Garnierite Nickel Ore” JIS M-8109-1996, by H.Kanazawa, August 1996. Other SOP’s are added as new equipment and technologies are introduced into the Sample Prep and Sample Assay Labs.

Descriptions of the various splitting, drying, crushing and pulverising stages are given and what check samples are collected from and introduced into the sample stream at those times. This is where *“…the reduction in particle size, through crushing and pulverising, and its sample size, through splitting, while retaining the representativeness of the medium being sampled”* is our mantra.

Sample preparation quality is measured using Coarse Blanks, Coarse Rejects/Coarse Duolicates and Sample Sizing Tests: Figure 1 shows plots for the four elements with the majority of the data points plotting between the +5% and -5% yellow lines, showing there is a high correlation between the original and the duplicate assay values, with correlation coefficient (R^2) values of > 0.999 for the elements being assayed. These figures confirm the high precision of the jaw crushing, the first splitting and roll crushing stages and supports the use of the Coarse Duplicate assay data for resource estimation purposes.

Figure 2 shows two graphs showing the results of the particle sizing tests undertaken on 111 exploration samples and 104 mining samples at the HM Prep Lab during March 2022. The yellow line is for 95% of the pulverised material passing the 200# screen, and shows the majority of the samples returning a figure of between 97% and 98% for both the exploration samples and the mining samples. These results show the repeatability precision of the pulverizing process in reducing the particle size of the samples to be high.

Sample assay quality is measured using Pulp Duplicate/DA’s, CRM’s, Replicates and Inter Laboratory Checks. Figure 3 shows scatterplots for the elements Ni, Fe, MgO and SiO2 from original and duplicate assays from 1,396 pulp samples analysed between July 2021 and June 2022. The scatterplots show the majority of the Ni and Fe falling within the two yellow lines representing a +/- 5% variance from the assay, a high precision, and reflected with correlation coefficients of 0.994 and 0.9989 respectively.

Figures 4, 5, 6 and 7 are Shewart Control Charts for the results of assays undertaken using OREAS Standards 18, 187, 192 and 195 for Ni and Fe. They show the data points falling within the 2 SD and 3 SD lines, with generally 95% of the Ni and Fe assays falling within 2 standard deviations of the mean, and similar numbers of assays faling above and below the mean line, indicating good precision and accuracy. The results for Fe also show good precision, but the accuracy is not as good for some of the Fe assay results, where we believe some calibration issues occurred following the installation of a new XRF machine.

Figure 8 shows scatterplots for replicate sample assays show the majority of the results plotting within the two yellow lines indicating a 95% confidence in the result plotting withing these limits, and is considered an excellent result. The graphs also show correlation coefficients of more than 0.999, indicating high precision. Spreadsheet data shows there is also an even spread of the replicate assay being both similar to, higher than, and lower than the primary assay for Ni, an excellent result.

Figure 9 shows the results of Inter Laboratory checks between HM Assay Lab and Geoservices.The scatterplots show excellent precision for Ni and good precision for Fe, with the best correlation shown between the results for Fe and Ni, 0.9936 and 0.9858 respectively, SiO2 and SiO2 have lower correlations at 0.9785 and 0.9703.Data for the results for the two laboratories shows a difference between the mean for the Ni and Fe values for the HM Lab as 1.15 % Ni and 27.52 % Fe against 1.13 % Ni and 26.93 % Fe for Geoservices, a difference of 1.74% for Ni and 2.14% for Fe. These represent a +/- 5% variance from the assay, a high precision, and reflected with correlation coefficients of 0.9858 and 0.9936.

Figure 10 shows graphics of the plots of the Ni and Fe results from the HM Assay Lab and the IMIP COA for 54 samples from barge numbers BP 774 and BP 828 which delivered saprolite ore from the HM Mining Operations to the IMIP Smelter between May 2022 and July 2022.These graphs represent HM assay results with means of 1.78% Ni and 19.10 % Fe, standard deviations of 0.04 and 1.30, and variances of 0.0016 and 1.6834 respectively. Similar results of 1.74% Ni and 18.66% Fe, standard deviations of 0.04 and 1.20, and variances of 0.0017 and 1.4441 were recorded on the IMIP COA's. Interestingly, the difference between the two sets of data shows a mean difference of 0.04, or 2.2% for the Ni values, with 50 of the 54 COA values being less than the HM assay values. With the Fe values, there is a 2.3% difference between the HM and COA values, with 41 of the 54 COA's returning lower values than HM.

Table 1. is a summary showing a total of 8,208 check samples were inserted into the sample stream of 50,102 exploration samples and submitted for assay ay the Geoservices Assay Laboratory, a total of 16.4% as compared to the 20% suggested by Mendez. The difference is due to the lack of Twin Samples from the drill site, due to the complete drill core being submitted for sample prep and assay, and 4% CRM's as opposed to the 6% suggested by Mendez.

It was suggested that data with "good" accuracy and "good" precision can be regarded as "Good Quality" and as such, will be "fit for purpose" when the precision and accuracy are within acceptable tolerances. It is the author's belief that the Quality Assurance and Quality Control team at the HM Sample Prep Lab and Assay Lab have shown in the work described in this report that the data generated from the labs is of Good Quality and Fit for Purpose, with the precision and accuracy within acceptable limits and is suitable for inclusion in the calculation of mineral resources for the JORC Compliant Report for PT Hengjaya Mineralindo.

Charles Watson
24th August 2022

References:

Abzalov, M, 2008, Quality Control of Assay Data: A Review of Procedures for Measuring and Monitoring Precision and Accuracy, Exploration and Mining Geology, Vol. 17, Nos. 3-4, p 131-144

Abzalov, M, 2011, Sampling Errors and Control of Assay Data Quality in Exploration and Mining Geology

AusIMM, 2011, Field Geologists' Manual, Fifth Edition, Monograph 9.

JIS, August 1996, Method for Sampling and Method of Determination of Moisture Content of Garnierite Nickel Ore, JIS M-8109-1996 H.Kanazawa, Private Translation

Armando Simon Mendez (2011), A Discussion on Current Quality-Control Practices in mineral Exploration Applications and Experience of Quality Control, Prof. Ognyan Ivanov (Ed.), ISBN:978-953-307-236-4,InTech.

Roden, S. and Smith, T., 2014, Sampling and Analysis Protocols and Their Role in Mineral Exploration and New Resource Development, Monograph 30 – Mineral Resource and Ore Reserve Estimation, the AusIMM Guide to Good Practice, Second Edition, 2014.

Sterk,R., 2015, Quality control on assays: addressing some issues, 2015 AusIMM New Zealand Branch Annual Conference, Dunedin

Sterk, R., Nov. 2019, Beating a Dead Horse

C.E.Watson
August 2022

Table 2: JORC Table 1 - Sample Prep & Assay

Criteria	JORC Code explanation	Commentary
	• *Whether logging is qualitative or quantitative in nature. Core (or costean, channel, etc) photography.* • *The total length and percentage of the relevant intersections logged.*	
Sub-sampling techniques and sample preparation	• *If core, whether cut or sawn and whether quarter, half or all core taken.* • *If non-core, whether riffled, tube sampled, rotary split, etc and whether sampled wet or dry.* • *For all sample types, the nature, quality and appropriateness of the sample preparation technique.* • *Quality control procedures adopted for all sub-sampling stages to maximise representivity of samples.* • *Measures taken to ensure that the sampling is representative of the in situ material collected, including for instance results for field duplicate/second-half sampling.* • *Whether sample sizes are appropriate to the grain size of the material being sampled.*	• With the exception of a small density sample of approximately 700 to 800 gms taken from each of the four geological horizons observed in each drill hole, all the drill core submitted to the lab for analysis • Reduction in size of large primary drill sample to small pulp sample used in pressed powder pellet for XRF assay without affecting accuracy or precision follows JIS Method for Sampling and Method of Determination of Moisture Content of Garnierite Nickel Ore, JIS M-8109-1996,with drill core submitted to HM Prep Lab where it is dried for 12 hrs at 105 °C and then crushed, riffle split, crushed again, split and pulverized to a particle size that corresponds to 95% passing 75 micron Test Screen. Pulp samples of approx. 50 gms are taken from the pulverized samples for assay. Coarse reject and pulp duplicates taken after splitting to monitor precision of products; 200# Screen tests indicate precision of pulverising in reducing sample size is high.
Quality of assay data and laboratory tests	• *The nature, quality and appropriateness of the assaying and laboratory procedures used and whether the technique is considered partial or total.* • *For geophysical tools, spectrometers, handheld XRF instruments, etc, the parameters used in determining the analysis including instrument make and model, reading times, calibrations factors applied and their derivation, etc.* • *Nature of quality control procedures adopted (eg standards, blanks, duplicates, external laboratory checks) and whether acceptable levels of accuracy (ie lack of bias) and precision have been established.*	• Assaying and lab procedures follow JIS M-8109-1996 SOP to ensure representivity of the sample presented for XRF analysis. Pressed pellets comprising 10 gm sample pulp used for assay using Bruker and Panalytical EDXRF Spectrometers to determine 12 most important elements in Nickel laterite ores. XRF the preferred assay method for nickel laterite ores, capable of very high degree of accuracy and precision. • No field duplicates are submitted as all sample core submitted for sample prep and assay. • Sub-sampling precision and contamination controlled during sample preparation with coarse blanks, coarse rejects and 200# screen tests. • Sub-sampling analytical accuracy, analytical precision and contamination during assaying controlled by pulp duplicates, OREAS CRM's, replicates and checks by external laboratories. • Scatterplots and comparative statistics for coarse rejects confirm high precision of crushing & splitting stages and 200# screen tests show repeatability of pulverising stages to be high. • Scatterplots and comparative statistics for pulp duplicate assays and replicate assays confirm high precision repeatability and no systemic bias in these check analyses programmes.

		• OREAS CRM's 182, 187,192, 193 and 194 yielded Control charts with high precision but less accuracy, and with 95% of analyses plotting within 2 standard deviations of the mean which is acceptable. • Check samples sent to Geoservices for Interlab Checks showed a high correlation between the results for Ni and Fe, with differences of 1.74% for Ni and 2.14% for Fe between the two labs, an approx. 5% variance from the assay.
Verification of sampling and	• *The verification of significant intersections by either independent or alternative company personnel.* • *The use of twinned holes.*	

Appendix 6

Hengjaya Geotechnical & Hydrogeological Report

KAJIAN GEOTEKNIK DAN HIDROLOGI/HIDROGEOLOGI DEPOSIT NIKEL TAMBANG HENGJAYA MINERALINDO

PT. HENGJAYA MINERALINDO

Disiapkan Untuk

PT HENGJAYA MINERALINDO

Desember 2021

GEOMINE

MINING AND GEOTECHNICAL CONSULTANT

DAFTAR ISI

DAFTAR ISI .... **ii**
DAFTAR GAMBAR .... **v**
DAFTAR TABEL .... **xiv**
LAMPIRAN .... **xvii**
EXECUTIVE SUMMARY .... **xviii**

1. PENDAHULUAN **1-1**
1.1. Latar Belakang 1-1
1.2. Lingkup Kerja 1-1
1.3. Metode Kerja 1-1
1.3.1. Kajian Geoteknik 1-1
1.3.2. Kajian Hidrologi/Hidrogeologi 1-3
1.4. Kesampaian Lokasi 1-4

2. KONDISI GEOLOGI **2-1**
2.1. Geologi Regional 2-1
2.2. Geologi Lokal 2-3
2.3. Struktur Geologi 2-6

3. KAJIAN HIDROLOGI DAN HIDROGEOLOGI **3-1**
3.1. Akuisisi Data 3-1
3.1.1. Jenis, Jumlah, dan Sebaran Data 3-1
3.1.2. Data Hujan 3-2
3.1.3. Data Level Muka Airtanah 3-7
3.1.4. Data Konduktivitas Hidraulik 3-8
3.1.5. Kondisi Hidrologi dan Hidrogeologi Umum 3-11
3.1.5.1. Daerah Aliran Sungai 3-11
3.1.5.2. Hidrogeologi Umum 3-13
3.2. Analisis Hidrologi 3-14
3.2.1. Analisis *Catchment* 3-14

3.2.1.1. *Catchment Area* Rencana Tambang 3-14
3.2.1.2. Catchment Area Rencana Pond 3-16
3.2.2. Desain Hujan Puncak 3-18
3.2.3. Koefisien Limpasan 3-22
3.2.4. Debit Puncak Air Permukaan 3-24
3.3. Analisis Hidrogeologi... 3-26
3.3.1. Latar Belakang Geologi 3-26
3.3.2. Sistem Hidrogeologi 3-27
3.3.3. Pola Aliran dan Muka Airtanah 3-29
3.3.4. Model Hidrogeologi 3-30
3.3.4.1. Model Kalibrasi (Steady State)............................... 3-33
3.3.4.2. Model Prediksi Rencana Pengembangan Tambang 3-34
3.4. Rekomendasi Teknis 3-39
3.4.1. Saluran Drainase 3-39
3.4.2. *Sump* dan Pemompaan 3-43
3.4.3. Sediment Pond.. 3-45

4. KAJIAN GEOTEKNIK 4-1
4.1. Data Geoteknik 4-1
4.1.1. Pengeboran Geoteknik 4-1
4.1.2. *Logging Geoteknik* dan *Foto Core* 4-2
4.1.3. Pengujian Laboratorium 4-4
4.1.3.1. Sifat Fisik Soil (Soil Physical Properties) 4-5
4.1.3.2. Uji Sifat Fisik Batuan (*Rock Physical Properties*) 4-6
4.1.3.3. Uji Sifat Mekanik Tanah (*Limonite Mechanical Properties*).. 4-8
4.1.3.4. Uji Sifat Mekanik Batuan (Rock Mechanical Properties) 4-9
4.2. Karakteristik Geoteknik.. 4-10
4.2.1. *Limonite* 4-10
4.2.2. *Saprolite* 4-11

4.2.3. *Bedrock* 4-12
4.3. Evaluasi Properties Massa Batuan 4-12
4.4. Model Litologi 4-13
4.5. Metode Analisis Kestabilan Lereng 4-18
4.5.1. Kondisi Muka Air Tanah dalam Pemodelan 4-18
4.5.2. Kondisi Beban Seismik 4-18
4.5.3. Metode Kesetimbangan Batas (*Limit Equilibrium Method*) 4-19
4.5.4. Kriteria Standar Faktor Keamanan (FK) 4-20
4.5.5. Validasi Properties Material 4-21
4.5.6. Analisis Balik *Waste Dump* 4-23
4.6. Analisis Kestabilan Lereng 4-27
4.6.1. Analisa Kestabilan Lereng Tunggal (Bench Face Angle) 4-27
4.6.2. Analisa Kestabilan Lereng Keseluruhan (Overall Slope Angle) ... 4-30
4.7. Analisis Kemampugalian dan Kemampugaruan 4-33
4.7.1. Kekuatan Tekan Batuan (*Uniaxial Compressive Strength*) 4-33
4.7.2. Spasi Kekar (Discontinuity Spacing) 4-36
4.7.3. Hasil Analisis Kemampugalian dan Kemampugaruan 4-37

5. KESIMPULAN DAN REKOMENDASI 5-1
5.1. Kesimpulan 5-1
5.1.1. Kesimpulan Kajian Hidrologi dan Hidrogeologi 5-1
5.1.2. Kesimpulan Kajian Geoteknik 5-1
5.2. Rekomendasi 5-4
5.2.1. Rekomendasi Hidrologi dan Hidrogeologi 5-4
5.2.2. Rekomendasi Geoteknik 5-10

DAFTAR GAMBAR

Gambar 1.1 Letak Konsesi PT Hengjaya Mineralindo ... 1-5
Gambar 2.1 Peta geologi regional lembar Bungku, Sulawesi (Simandjuntak dkk., 1993) yang telah ditambahkan dengan batas IUP ... 2-2
Gambar 2.2 Korelasi unit stratigrafi pada peta geologi lembar Bungku (Simandjuntak dkk., 1993) ... 2-3
Gambar 2.3 Peta morfologi lokal ... 2-4
Gambar 2.4 Peta geologi lokal ... 2-5
Gambar 2.5 Peta geologi Sulawesi (Van Leeuwen dkk., 2011) ... 2-7
Gambar 3.1 Peta distribusi ketersediaan stasiun hujan di sekitar IUP HM ... 3-3
Gambar 3.2 Data produk hujan Satelit TRMM versi 3B42 pada titik Stasiun Routa ... 3-4
Gambar 3.3 Perbandingan *time series* antara hujan Stasiun Routa dan hujan satelit (TRMM) ... 3-5
Gambar 3.4 Diagram *scatter* dari data hujan Stasiun Routa dan hujan satelit (TRMM) ... 3-5
Gambar 3.5 Rekapitulasi hujan bulanan wilayah studi (kombinasi data Stasiun Routa dengan data hujan produk Satelit TRMM) ... 3-6
Gambar 3.6 Grafik rata-rata curah hujan bulanan daerah studi ... 3-7
Gambar 3.7 Praktik lapangan *slug test* menggunakan metode *falling head* ... 3-8
Gambar 3.8 Peta distribusi lokasi pengukuran muka airtanah dan titik pengujian konduktivitas hidraulik lapangan ... 3-10
Gambar 3.9 Peta daerah aliran sungai dan aliran air permukaan regional daerah studi ... 3-12
Gambar 3.10 Peta cekungan air tanah regional lokasi studi ... 3-13
Gambar 3.11 *Sub-catchment* area rencana tambang HM ... 3-15
Gambar 3.12 *Sub-catchment area* rencana *settling pond* ... 3-17
Gambar 3.13 Grafik hujan maksimum harian (*annual maximum*) lokasi studi. ... 3-19
Gambar 3.14 Grafik probabilitas analisis hujan rencana (hujan puncak). ... 3-20
Gambar 3.15 Kurva *Intensity Duration Frequency* (IDF) lokasi rencana tambang HM ... 3-22
Gambar 3.16 Konseptual sistem hidrogeologi lokasi IUP HM ... 3-28
Gambar 3.17 Representatif penampang hidrostratigrafi lokasi IUP HM ... 3-29

Gambar 3.18 Pola umum aliran airtanah lokasi studi 3-30
Gambar 3.19 Gambaran model hidrogeologi pada bidang tiga dimensi 3-32
Gambar 3.20 Kalibrasi model kondisi *steady state*, perbandingan *head* airtanah model dengan data observasi lapangan 3-34
Gambar 3.21 Pola aliran *head* airtanah *existing* (atas) dan akhir tambang (bawah)........ 3-36
Gambar 3.22 Representatif penampang airtanah kondisi *existing* dan akhir tambang 3-37
Gambar 3.23 Representasi grafis debit *groundwater inflow* ke dalam pit 3-38
Gambar 3.24 Rekomendasi sistem penyaliran rencana tambang PT HM........ 3-40
Gambar 3.25 Spesifikasi pompa berdasarkan kemampuan *head* dan *discharge* (contoh dari produk Sultzer) 3-44
Gambar 3.26 Tipikal rekomendasi *Sediment Pond-01* 3-48
Gambar 3.27 Tipikal rekomendasi *Sediment Pond*-02 3-48
Gambar 3.28 Tipikal rekomendasi *Sediment Pond-03* 3-49
Gambar 3.29 Tipikal rekomendasi *Sediment Pond-0* 3-49
Gambar 3.30 Tipikal rekomendasi *Sediment Pond-05* 3-50
Gambar 4.1 Lokasi Lubang Bor Geoteknik PT HM........ 4-2
Gambar 4.2 Contoh Foto *Core* untuk Lubang Bor DHG-01 4-3
Gambar 4.3 Contoh *Logging* Geoteknik di Lubang Bor DHG-01 4-4
Gambar 4.4 Distribusi Statistik Pengujian *Trixial Test* (UU) 4-8
Gambar 4.5 Distribusi Statistik Pengujian *Uniaxial Compressive Strength* (UCS)........ 4-10
Gambar 4.6 Contoh Material *Limonite*........ 4-11
Gambar 4.7 Contoh Material *Saprolite* 4-11
Gambar 4.8 Contoh Material *Bedrock (Dunite)*........ 4-12
Gambar 4.9 *Section Line* untuk Analisis Kestabilan Lereng........ 4-14
Gambar 4.10 *Section Actual* 01 4-14
Gambar 4.11 *Section Actual* 02 4-14
Gambar 4.12 *Section Actual* 03 4-15
Gambar 4.13 *Section* AA' 4-15
Gambar 4.14 *Section* BB' 4-15
Gambar 4.15 *Section* CC' 4-15
Gambar 4.16 *Section* DD'........ 4-16
Gambar 4.17 *Section* EE'........ 4-16

Gambar 4.18 *Section* FF’ 4-16
Gambar 4.19 *Section* GG’ 4-16
Gambar 4.20 *Section* HH’ 4-17
Gambar 4.21 *Section* II’ 4-17
Gambar 4.22 *Section* JJ’ 4-17
Gambar 4.23 *Section* KK’ 4-18
Gambar 4.24 Peta Sumber dan Bahaya Gempa Indonesia (Pusat Kajian Gempa Nasional, 2017) 4-19
Gambar 4.25 Hasil Validasi Properties pada *Section Actual* 01 4-22
Gambar 4.26 Hasil Validasi Properties pada *Section Actual* 02 4-22
Gambar 4.27 Hasil Validasi Properties pada *Section Actual* 03 4-23
Gambar 4.28 Hasil Pengukuran Muka Air Tanah DHG-02 4-24
Gambar 4.29 *Section Line Waste Dump* Aktual 4-24
Gambar 4.30 Hasil analisis properties material awal pada *section* 1 4-25
Gambar 4.31 Hasil analisis properties material awal pada *section* 2 4-25
Gambar 4.32 Analisis Balik *Section* 1 4-26
Gambar 4.33 Analisis Balik *Section* 2 4-27
Gambar 4.34 Hasil Analisis Kestabilan Lereng Tunggal pada Domain *Limonite* 4-29
Gambar 4.35 Hasil Analisis Kestabilan Lereng Tunggal pada Domain *Saprolite* 4-29
Gambar 4.36 Hasil Analisis Kestabilan Lereng Tunggal pada Domain *Bedrock* 4-30
Gambar 4.37 Hasil Analisis Kestabilan Lereng *Section* BB’ Area Bete-Bete (Sisi Utara) 4-32
Gambar 4.38 Hasil Analisis Kestabilan Lereng *Section* FF’ Area Central West (Sisi Barat Daya) 4-32
Gambar 4.39 Hasil Analisis Kestabilan Lereng *Section* KK’ Area Central East (Sisi Barat Daya) 4-33
Gambar 4.40 Contoh Data Logging Limonite 4-34
Gambar 4.41 Hubungan Domain dengan Nilai UCS 4-36
Gambar 4.42 Hubungan Domain dengan Spasi Kekar 4-37
Gambar 4.43 Hubungan Nilai Kuat Tekan Batuan dengan Spasi Kekar 4-37
Gambar 4.44 Kemampugalian dan Kemampugaruan Berdasarkan Pettifer-Fookes 4-38
Gambar 5.1 Kemampugalian dan Kemampugaruan Berdasarkan Pettifer-Fookes 5-4
Gambar 5.2 Rekomendasi sistem penyaliran rencana tambang PT HM 5-5

Gambar 5.3 Spesifikasi pompa berdasarkan kemampuan *head* dan *discharge* (contoh dari produk Sultzer) 5-7
Gambar 5.4 Hasil Analisis Kestabilan Lereng Section KK' Lereng B (*Overall Slope* 29^{o}).... 5-11
Gambar 5.5 Hasil Analisis Kestabilan Lereng Section KK' Lereng B (GW -6m Model) 5-12

DAFTAR TABEL

Tabel A Properties Material Hasil Analisis Balik xx
Tabel B Kemampugalian dan Kemampugaruan per Litologi xx
Tabel 3.1 Jenis dan jumlah ketersediaan data PT HM, pelengkapan, dan data *gap* terkait analisis hidrologi dan hidrogeologi 3-1
Tabel 3.2 Evaluasi ketersediaan data dari stasiun klimatologi terdekat dan stasiun hujan di sekitar lokasi studi (data BMKG dan PUSAIR)................................. 3-3
Tabel 3.3 Hasil pengukuran kedalaman muka airtanah 3-7
Tabel 3.4 Resume nilai konduktivitas hidraulik hasil uji lapangan dan uji laboratorium 3-9
Tabel 3.5 Luas dan karakteristik fisik *sub-catchment area* rencana bukaan tambang 3-15
Tabel 3.6 Luas dan karakteristik fisik *sub-catchment area* rencana *settling pond* 3-17
Tabel 3.7 Nilai hujan maksimum harian (*annual maximum*) lokasi studi 3-18
Tabel 3.8 Hasil uji kecocokan distribusi data hujan maksimum 3-19
Tabel 3.9 Hasil perhitungan hujan puncak pada periode ulang tertentu 3-20
Tabel 3.10 Hasil perhitungan intensitas periode ulang hujan (*Intensity Duration Frequency*) lokasi rencana tambang HM 3-21
Tabel 3.11 Kurva perhitungan koefisien limpasan (*Hydraulic Design Manual*, TxDOT, 2016) 3-23
Tabel 3.12 Estimasi nilai koefisien limpasan pada *catchment* tambang HM 3-23
Tabel 3.13 Estimasi debit dan volume maksimum aliran air permukaan pada masing-masing *sub-catchment* rencana bukaan tambang HM 3-25
Tabel 3.14 Estimasi debit dan volume maksimum aliran air permukaan pada masing-masing *sub-catchment* rencana *settling pond* 3-26
Tabel 3.15 Dimensi dan ukuran *grid* dari model fisik hidrogeologi 3-31
Tabel 3.16 *Input* parameter hidraulik untuk model airtanah 3-33
Tabel 3.17 Estimasi *groundwater inflow* 3-38
Tabel 3.18 Rekomendasi dimensi drainase rencana tambang PT HM........................... 3-41
Tabel 3.19 Kapasitas *inflow* maksimum dan *head* dari masing-masing rencana pit 3-43

Tabel 3.20 Rekomendasi spesifikasi jenis pompa (sejenis) untuk mengantisipasi aliran puncak pada tambang PT HM 3-44
Tabel 3.21 Karakteristik *sub-catchment* beserta besar *head* untuk dialirkan ke perimeter 3-45
Tabel 3.22 Perhitungan *fall velocity* dan luas permukaan *sediment pond* 3-46
Tabel 3.23 Perhitungan jumlah dan dimensi *settling pond* 3-47
Tabel 3.24 Perhitungan sedimen yang terendapkan tiap tahun........ 3-52
Tabel 4.1 Lokasi dan Titik Koordinat Lubang Bor Geoteknik........ 4-2
Tabel 4.2 Rekapitulasi Jumlah Sampel Untuk Pengujian Sifat Fisik dan Mekanik 4-4
Tabel 4.3 *Summary* Pengujian Sifat Fisik *Limonite* 4-6
Tabel 4.4 *Summary* Pengujian Sifat Fisik Batuan *Saprolite* 4-6
Tabel 4.5 *Summary* Pengujian Sifat Fisik Batuan *Bedrock* 4-7
Tabel 4.6 *Summary* Hasil Pengujian Sifat Mekanik *Limonite* 4-8
Tabel 4.7 Rekapitulasi Hasil Pengujian Sifat Mekanik *Saprolite*........ 4-9
Tabel 4.8 Rekapitulasi Hasil Pengujian Sifat Mekanik *Bedrock* 4-9
Tabel 4.9 *Properties* Massa Batuan PT. Hengjaya Mineralindo (PT HM) 4-13
Tabel 4.10 Data untuk Interpretasi dan validasi Model Litologi 4-13
Tabel 4.11 Perbandingan kondisi kesetimbangan dan asumsi metode *Limit Equilibrium* (Krahn, 2003) 4-19
Tabel 4.12 Kriteria Faktor Keamanan Minimum (Kepmen ESDM No. 1827 Tahun 2018)........ 4-20
Tabel 4.13 *Properties* Awal Massa Batuan PT. Hengjaya Mineralindo (PT HM) 4-21
Tabel 4.14 Rekapitulasi Analisis Validasi Properties Material........ 4-21
Tabel 4.15 *Properties* Awal *Waste* Material........ 4-24
Tabel 4.16 Properties Material Analisis Balik........ 4-26
Tabel 4.17 Hasil Analisis Kestabilan Lereng Tunggal 4-28
Tabel 4.18 Hasil Analisis Kestabilan Lereng Keseluruhan 4-31
Tabel 4.19 Estimasi Kekuatan *Soil* berdasarkan ISRM 1981........ 4-34
Tabel 4.20 Kuat Tekan Batuan masing-masing Domain........ 4-35
Tabel 4.21 Spasi Kekar masing-masing Domain 4-36
Tabel 4.22 Kemampugalian dan Kemampugaruan per Litologi 4-38
Tabel 5.1 Hasil Analisis Kestabilan Lereng Tunggal 5-2

Tabel 5.2 Hasil Analisis Kestabilan Lereng Keseluruhan 5-3
Tabel 5.3 Kemampugalian dan Kemampugaruan per Litologi 5-3
Tabel 5.4 Kapasitas *inflow* maksimum dan *head* dari masing-masing rencana pit 5-6
Tabel 5.5 Rekomendasi spesifikasi jenis pompa (sejenis) untuk mengantisipasi aliran puncak pada tambang PT HM 5-7
Tabel 5.6 Karakteristik *sub-catchment* beserta besar *head* untuk dialirkan ke perimeter 5-8
Tabel 5.7 Perhitungan *fall velocity* dan luas permukaan *sediment pond* 5-9
Tabel 5.8 Perhitungan jumlah dan dimensi *settling pond* 5-10
Tabel 5.9 Rekomendasi Analisis Kestabilan Lereng Tunggal 5-10
Tabel 5.10 Hasil Analisis Rekomendasi Kestabilan Lereng *Waste Dump* 5-12

LAMPIRAN

Lampiran A Field Drilling Report PT HM A-1
Lampiran B Foto Core B-1
Lampiran C Slugtest Result PT HM C-1
Lampiran D Hasil Uji Lab PT HM D-1
Lampiran E Hasil Analisis Kestabilan Lereng E-1

EXECUTIVE SUMMARY

PT Hengjaya Mineralindo (“HM”) saat ini sedang melakukan pengkinian terhadap laporan Studi Kelayakan terkait dengan rencana untuk melakukan peningkatan kapasitas produksi nikel dan untuk pengembangan area tambang. Untuk mendukung pengkinian studi tersebut, salah satu aspek yang diidentifikasi memerlukan studi lanjutan adalah kajian yang terkait geoteknik dan hidrologi/hidrogeologi. Untuk keperluan tersebut HM telah meminta Geomine Mining and Geotechnical Consultant (“GEOMINE”) untuk melakukan kajian geoteknik dan hidrologi/hidrogeologi. Laporan ini menampilkan data-data yang dikumpulkan, analisis dan hasil kajian geoteknik dan hidrologi/hidrogeologi, serta rekomendasi terkait kedua kajian tersebut.

Kajian Hidrologi dan Hidrogeologi

Berdasarkan hasil interpretasi kondisi hidrogeologi di PT Hengjaya Mineralindo diketahui bahwa lapisan penyusun hidrostratigrafi sistem airtanah ini dibagi menjadi tiga, yaitu tanah laterit berukuran lempung (laterit atas), laterit bawah dan batuan ultramafik terkekarkan, serta batuan ultramafik tidak terkekarkan. Lapisan yang membentuk zona akuifer utama pada sistem airtanah ini adalah laterit bawah dan batuan ultramafik terkekarkan. Lapisan laterit bawah dan batuan ultramafik terkekarkan dikelompokkan menjadi satu zona akuifer utama dengan ketebalan berkisar 10-30 m. Tanah laterit berukuran lempung (limonit) berfungsi sebagai lapisan akuiklud. Lapisan batuan ultramafik yang tidak terkekarkan bertindak sebagai lapisan akuifug, diasumsikan kontinu hingga ketebalan lebih dari 100 meter.

Kebutuhan data untuk keperluan muka airtanah dan konduktivitas hidraulik dianggap telah memenuhi kebutuhan data minimal untuk analisis, data tersebut didapatkan dari pengukuran lapangan pada sembilan lubang bor geoteknik dan dari data-data yang dikumpulkan pada lubang eksplorasi dan sumber referensi lainnya untuk daerah tersebut.

Berdasarkan model prediksi, didapatkan hasil estimasi *groundwater inflow* pada tahun pertama sebesar 22.19 liter/detik dan berangsur turun menuju garis konstan (*steady*) di sekitar 19.00 liter/detik pada tahun-tahun berikutnya. Debit *groundwater inflow* secara umum cenderung kecil karena posisi muka airtanah yang relatif telah turun, sehingga sedikit yang berpotongan dengan bukaan tambang.

Rekomendasi teknis terkait rencana penyaliran meliputi desain saluran drainase, sump dan pemompaan, serta sediment pond telah diberikan di dalam laporan ini.

Kajian Geoteknik

Pengumpulan data properties material HM dilakukan melalui logging geoteknik terhadap core-core dari sembilan lubang pengeboran geoteknik dan hasil pengujian sifat fisik dan mekanik. Validasi terhadap properties menggunakan geometri aktual dan analisis balik menggunakan indikasi ketidakstabilan dilakukan untuk menentukan properties yang merepresentasikan karakteristik domain geoteknik di area HM.

Analisis kestabilan lereng tunggal menunjukkan mayoritas geometri lereng tunggal memenuhi kriteria Faktor Keamanan minimum terutama untuk domain *saprolite* dan *bedrock*. Untuk domain *limonite* tinggi jenjang 3 meter dengan kondisi *saturated* memenuhi kriteria, namun untuk tinggi jenjang 5 meter perlu berada pada kondisi *dry* untuk dapat memenuhi kriteria.

Analisa kestabilan lereng keseluruhan menunjukkan *design* akhir *pit* PT Hengjaya Mineralindo telah memenuhi kriteria dan menunjukkan kondisi yang stabil dengan nilai Faktor Keamanan (FK) di atas 1.3 untuk kondisi statik dan di atas 1.05, kecuali pada Sec_KK' yang berlokasi di Central East. Hasil analisis pada Sec_KK' menunjukkan nilai FK dan PoF berada di bawah batas kriteria minimum dan menunjukkan kondisi *marginally stable*. Untuk membuat kondisi *stable* pada Sec_KK perlu dilakukan pelandaian sudut *overall* menjadi 29° atau penurunan muka air tanah sedalam 6 m dengan pemasangan *drain hole*.

Analisis kestabilan lereng juga dilakukan pada waste dump yang berlokasi di Bete-bete (titik bor geoteknik DHG-02). Berdasarkan kondisi *waste dump* aktual di area DHG-02 yang terpantau mengalami ketidakstabilan, dilakukan analisis balik untuk mendapatkan properties material *waste* yang sedekat mungkin untuk merepresentasikan kondisi aktual yang diamati dan dapat digunakan dalam analisis selanjutnya. Hasil analisis balik terhadap properties *waste* menghasilkan properties *waste* pada Tabel A. Dengan properties *waste* dari hasil analisis balik, untuk menjaga kestabilan lereng pada area *waste dump*, perlu dilakukan penurunan sudut *overall* sekitar 2° dari kondisi aktual untuk memperoleh nilai FK yang sesuai dengan ketentuan. Sudut *overall slope* yang menunjukkan nilai FK aman adalah sebesar 18° dengan tinggi 33 m.

Tabel A Properties Material Hasil Analisis Balik

Litologi	*Unit Weight* (kN/m^3)	Mohr Coloumb	
		C (KPa)	Phi (Degree)
Limonite	18.77	11	27
Saprolite	20.21	61	18
Bedrock	26.71	217	35
Waste	21.9	9	20

Analisis kemampugalian dan kemampugaruan dilakukan pada masing-masing domain berdasarkan data parameter nilai kuat tekan batuan dan spasi kekar yang di-*plot* ke dalam grafik Pettifer-Fookes. Dari grafik dapat disimpulkan bahwa karakteristik setiap domain terdistribusi dalam kategori yang relatif homogen sehingga perlakuan penggalian atau penggaruan juga relatif sama untuk masing-masing domain tersebut seperti pada Tabel B.

Tabel B Kemampugalian dan Kemampugaruan per Litologi

Litologi	Metode
Limonite	*Easy Digging*
Saprolite	*Hard Digging*
Bedrock	*Easy-Hard Ripping*

1. PENDAHULUAN

1.1. Latar Belakang

PT Hengjaya Mineralindo ("HM") merupakan salah satu perusahaan yang bergerak di bidang usaha pertambangan nikel laterit di Morowali, Sulawesi Tengah. HM telah melakukan kegiatan penambangan nikel dengan sistem tambang terbuka (open pit mining) sejak tahun 2011.

Saat ini HM sedang melakukan pengkinian terhadap laporan Studi Kelayakan terkait dengan rencana untuk melakukan peningkatan kapasitas produksi nikel dan untuk pengembangan area tambang. Untuk mendukung pengkinian studi tersebut, salah satu aspek yang diidentifikasi memerlukan studi lanjutan adalah kajian yang terkait geoteknik dan hidrologi/hidrogeologi.

Untuk keperluan tersebut HM telah meminta Geomine Mining and Geotechnical Consultant ("GEOMINE") untuk melakukan kajian geoteknik dan hidrologi/hidrogeologi. Laporan ini menampilkan data-data yang dikumpulkan, analisis dan hasil kajian geoteknik dan hidrologi/hidrogeologi, serta rekomendasi terkait kedua kajian tersebut.

1.2. Lingkup Kerja

Ruang lingkup kerja adalah melakukan kajian geoteknik dan kajian hidrologi/hidrogeologi untuk deposit nikel PT Hengjaya Mineralindo.

1.3. Metode Kerja

1.3.1. Kajian Geoteknik

Keperluan kajian geoteknik ini adalah untuk melakukan karakterisasi terhadap massa batuan, melakukan analisa kestabilan terhadap lereng pit dan waste dump, mengidentifikasi resiko dan memberikan saran/rekomendasi terhadap desain tambang. Kajian geoteknik akan dilakukan melalui tahapan berikut:

- **Studi Literatur**

  Studi literatur dilakukan terhadap laporan-laporan dan data yang ada sebelumnya termasuk studi geologi, model geologi dan struktur, rencana tambang, dan data dari program pemboran yang sudah dilakukan.

- **Planning Pengeboran/Pengumpulan Data Lapangan untuk Karakterisasi Massa Batuan**

  Planning pengeboran geoteknik dan pengumpulan data lapangan akan dilakukan berdasarkan lokasi yang akan disepakati antara GEOMINE dan HM. Rekomendasi pengeboran geoteknik dilakukan di beberapa titik yang berlokasi di sekitar area rencana pit PT Hengjaya Mineralindo untuk mengetahui karakteristik material yang ada. Pemilihan titik bor tersebut disesuaikan dengan rencana pengeboran eksplorasi yang akan dilakukan oleh PT HM, rencana penambangan 5 tahun ke depan, lokasi *waste dump* dan area IPPKH tahap III, dengan pertimbangkan titik bor meng-cover domain dan seluruh area tambang.

- **Standard Penetration Test (SPT)**

  Standard Penetration Test (SPT) bertujuan untuk mendapatkan nilai N-SPT, yang dapat memberikan nilai densitas relatif dari granular material yang secara virtual sulit didapatkan dari sampel undisturbed. SPT perlu dilakukan apabila kondisi material pada waste dump terdiri dari kombinasi boulder dan rock. Apabila material waste dump cenderung kepada soil dan limonit, maka hanya perlu dilakukan pengambilan sampel untuk di uji laboratorium.

- **Uji Geoteknik di Laboratorium**

  Kebutuhan uji geoteknik terhadap sampel coring akan dipilih untuk memberikan gambaran yang cukup mengenai properti dari masing-masing domain. Domain dalam geoteknik didefinisikan sebagai batuan yang mempunyai karakter atau behavior yang sama. Umumnya di deposit nikel, domain ini dikontrol oleh tipe deposit limonit, saprolite, dan bedrock.

- **Analisa Kestabilan Pit dan Waste Dump**

  Analisa kestabilan dilakukan dengan mempertimbangkan properti dari masing-masing domain dan dilakukan terhadap existing pit dan waste dump plan dan geometri.

Nilai kekuatan *rockmass* dari masing-masing domain akan diestimasi berdasarkan (i) evaluasi hasil data uji laboratorium, (ii) evaluasi data karakterisasi dari lapangan dan (iii) analisa balik terhadap pit atau waste dump failure yang pernah terjadi. Analisa akan dilakukan mengacu kepada Kepmen ESDM No 1827.k/30/MEM/2018. Final rekomendasi untuk pit dan waste dump geometri akan dihasilkan.

1.3.2. Kajian Hidrologi/Hidrogeologi

Kajian hidrologi/hidrogeologi dilakukan dengan tujuan sebagai berikut:

- Merangkum pemahaman mengenai kondisi dan karakteristik hidrologi-hidrogeologi di lokasi studi, berdasarkan data-data studi terdahulu.
- Memprediksi potensi jumlah aliran air permukaan dan aliran air tanah yang masuk ke dalam tambang, serta yang mempengaruhi area sekitar tambang.
- Memprediksi perubahan sistem air permukaan dan airtanah yang disebabkan oleh proses penambangan.

Perencanaan dan Pengumpulan Data

Melakukan pengumpulan data-data yang dibutuhkan terkait studi, berdasarkan data dari penelitian sebelumnya dan data lain yang tersedia, dan melakukan analisis kesenjangan terhadap kebutuhan dan keterbatasan data. Jika terdapat kekurangan data utama yang diperlukan untuk analisis, rekomendasi pengambilan data dan atau pengujian akan disarankan.

Analisis Hidrologi Air Permukaan

- Mendeskripsikan kondisi dan karakteristik hidrologi daerah studi dan sekitarnya berdasarkan data-data studi terdahulu dan data lapangan.
- Melakukan analisis perubahan sistem dan pola air permukaan akibat kegiatan penambangan yang direncanakan.
- Melakukan analisis debit puncak air permukaan yang mungkin mempengaruhi rencana tambang, dan area sekitar tambang, serta dampak yang mungkin disebabkan.

Analisis Hidrogeologi

- Mendeskripsikan kondisi dan karakteristik hidrogeologi daerah studi dan sekitarnya berdasarkan data-data terdahulu dan data lapangan.

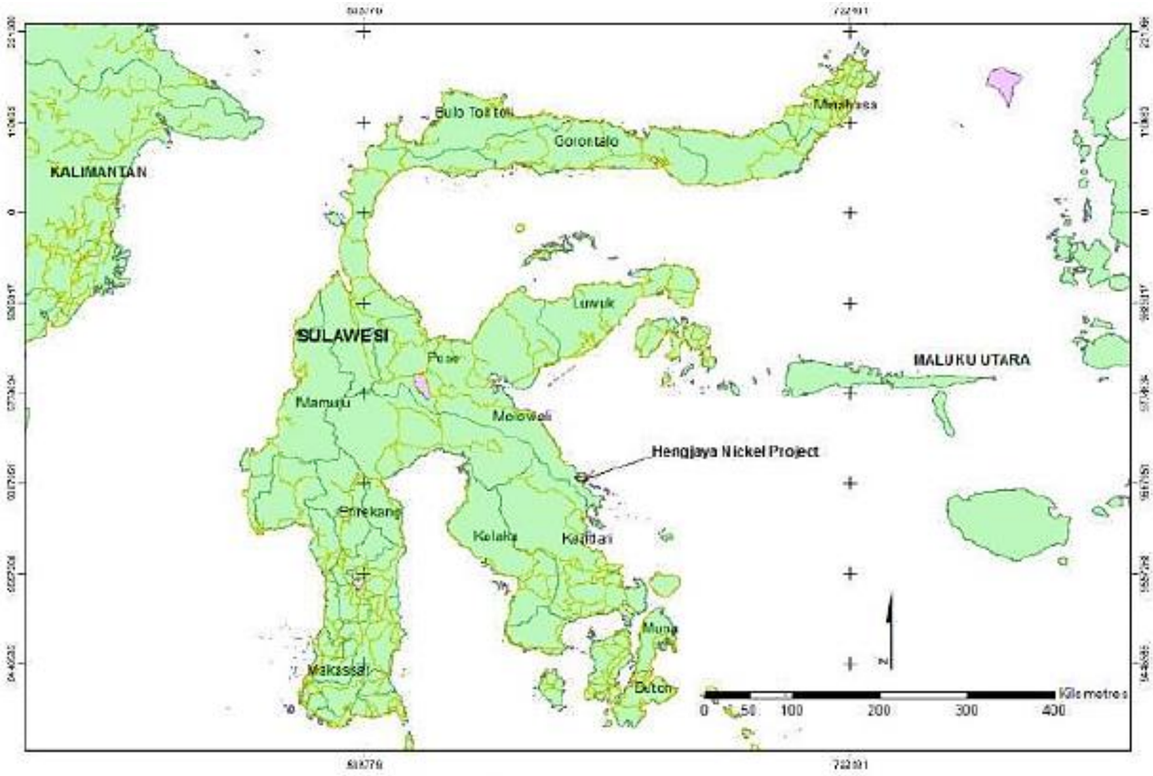
- Membuat model konseptual dan model numerik dari kondisi hidrogeologi dan aliran air tanah di sekitar lokasi studi.
- Melakukan analisis perubahan sistem dan pola airtanah akibat kegiatan penambangan yang direncanakan berdasarkan model hidrogeologi dan air tanah.
- Melakukan analisis debit maksimum airtanah yang mungkin masuk ke dalam tambang, dan area sekitar tambang berdasarkan model hidrogeologi dan air tanah.

Penulisan Laporan dan Rekomendasi

- Memberikan rekomendasi teknis terkait aspek hidrologi dan hidrogeologi berdasarkan hasil analisis yang dilakukan.

1.4. Kesampaian Lokasi

Area penambangan milik PT Hengjaya Mineralindo berada di Desa Tangofa Kecamatan Bungku Pesisir dan Desa Bete – Bete Kecamatan Bahodopi Kabupaten Morowali, Provinsi Sulawesi Tengah dimana untuk menuju lokasi konsesi ini di tempuh dengan menggunakan pesawat terbang dari Jakarta menuju Kota Kendari atau penerbangan dari Jakarta transit Makassar dan diteruskan ke Morowali. Kemudian diteruskan dengan perjalanan darat selama ± 6 jam melewati Kabupaten Konawe Utara (Asera) namun apabila melewati Morowali maka hanya dibutuhkan waktu ± 3 jam yang melintasi PT Bintang Delapan Mineral hingga menuju ke Desa Tangofa, Kecamatan Bungku Pesisir, Kabupaten Morowali, Provinsi Sulawesi Tengah.



Gambar 1.1 Letak Konsesi PT Hengjaya Mineralindo

Untuk menuju ke lokasi kegiatan penambangan atau Lokasi Izin Usaha Pertambangan PT Hengjaya Mineralindo dari Desa Tangofa diperlukan waktu ± 30 menit dengan kendaraan roda empat (disarankan *double* gardan, 4 x 4). Sementara untuk lokasi dermaga yang digunakan sebagai *entry point* dimana kebutuhan alat berat akan masuk dan juga sebagai dermaga saat pengapalan material *ore* yang akan dikapalkan berada di Desa Tangofa yang terdapat di tepi pantai bagian timur laut wilayah IUP PT Hengjaya Mineralindo.

2. KONDISI GEOLOGI

2.1. Geologi Regional

Peta geologi regional yang digunakan dalam laporan ini adalah Peta Geologi Lembar Bungku, Sulawesi (Simandjuntak dkk., 1993). Morfologi di daerah Lembar Bungku dapat dibagi menjadi lima satuan, yaitu:

A. Dataran rendah

   Morfologi dataran rendah umumnya mempunyai ketinggian 0 – 50 mdpl.

B. Dataran menengah

   Morfologi dataran menengah menempati daerah sekitar Desa Tokolimbu dan Tosea, memiliki ketinggian 50 – 100 mdpl.

C. Perbukitan menggelombang

   Morfologi perbukitan menggelombang memiliki ketinggian 100 – 400 mdpl.

D. Karst

   Morfologi karst memiliki ketinggian 400 – 800 mdpl yang dicirikan oleh adanya perbukitan kasar, sungai bawah tanah, maupun dolina.

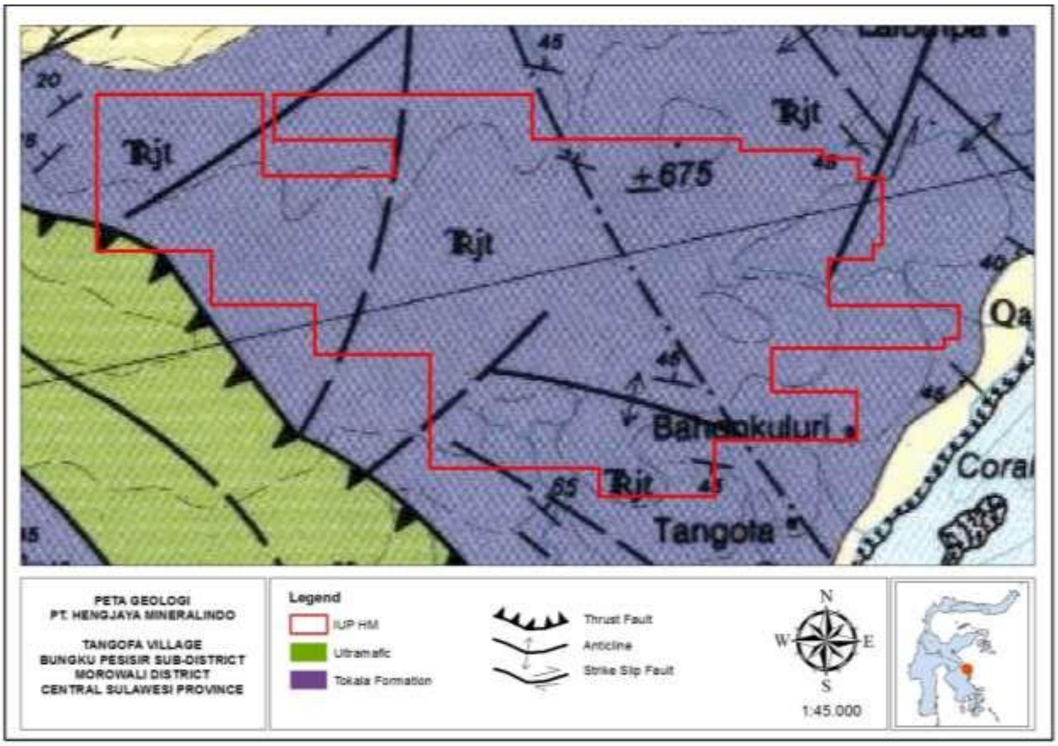
E. Pegunungan

F. Morfologi pegunungan memiliki ketinggian lebih dari 800 mdpl.

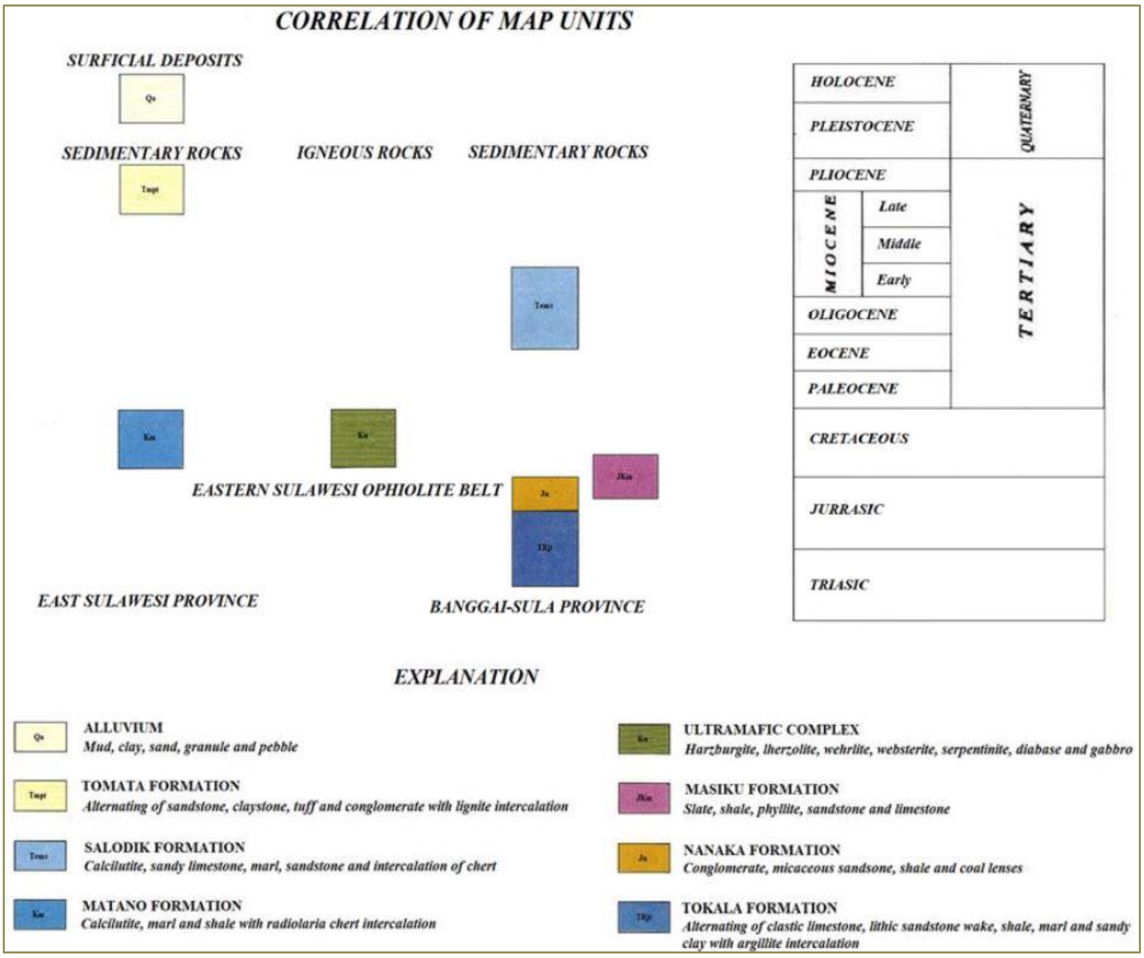
Satuan batuan di Peta Geologi Lembar Bungku (Simandjuntak dkk., 1993) (Gambar 2.1), satuan batuan dapat dikelompokkan dalam dua mandala geologi, yaitu Mandala Banggai-Sula dan Mandala Sulawesi Timur (Sukamto, 1975). Pembagian stratigrafinya berturut-turut dari muda ke tua adalah sebagai berikut (Gambar 2.2):

1. ALUVIUM (Qa) : lumpur, lempung, pasir, kerikil, serta kerakal.
2. FORMASI TOMATA (Tmpt) : perselingan batupasir konglomerat, batulempung, tufa dengan sisipan lignit.
3. FORMASI SALODIK (Tems) : kalsilutit, batugamping pasiran, napal, batupasir juga rijang.
4. FORMASI MATANO (Km) : kalsilutit, napal, serpih dan rijang. Kalsilutit, berbutir halus, berwarna kelabu, padat-keras, lapisannya baik, tebal lapisan berkisar antara 10 – 15 cm.

5. KOMPLEKS ULTRAMAFIK (Ku) : harzburgit, lherzolit, wehrlit, websterit, serpentinit, dunit, diabas dan batuan gabro.
6. FORMASI MASIKU (JKm) : batusabak, serpih, flit, batupasir, batugamping dengan buncak rijang. Batusabak, berwarna kelabu sampai coklat kehitaman, berlapis baik, padat.
7. FORMASI NANAKA (Jn) : konglomerat, batupasir mikaan, serpih dan lensa batubara.
8. FORMASI TOKALA (TRJt) : perselingan batugamping klastika, batu pasir sela, wake, serpih, napal, lempung pasiran dengan sisipan argilit.



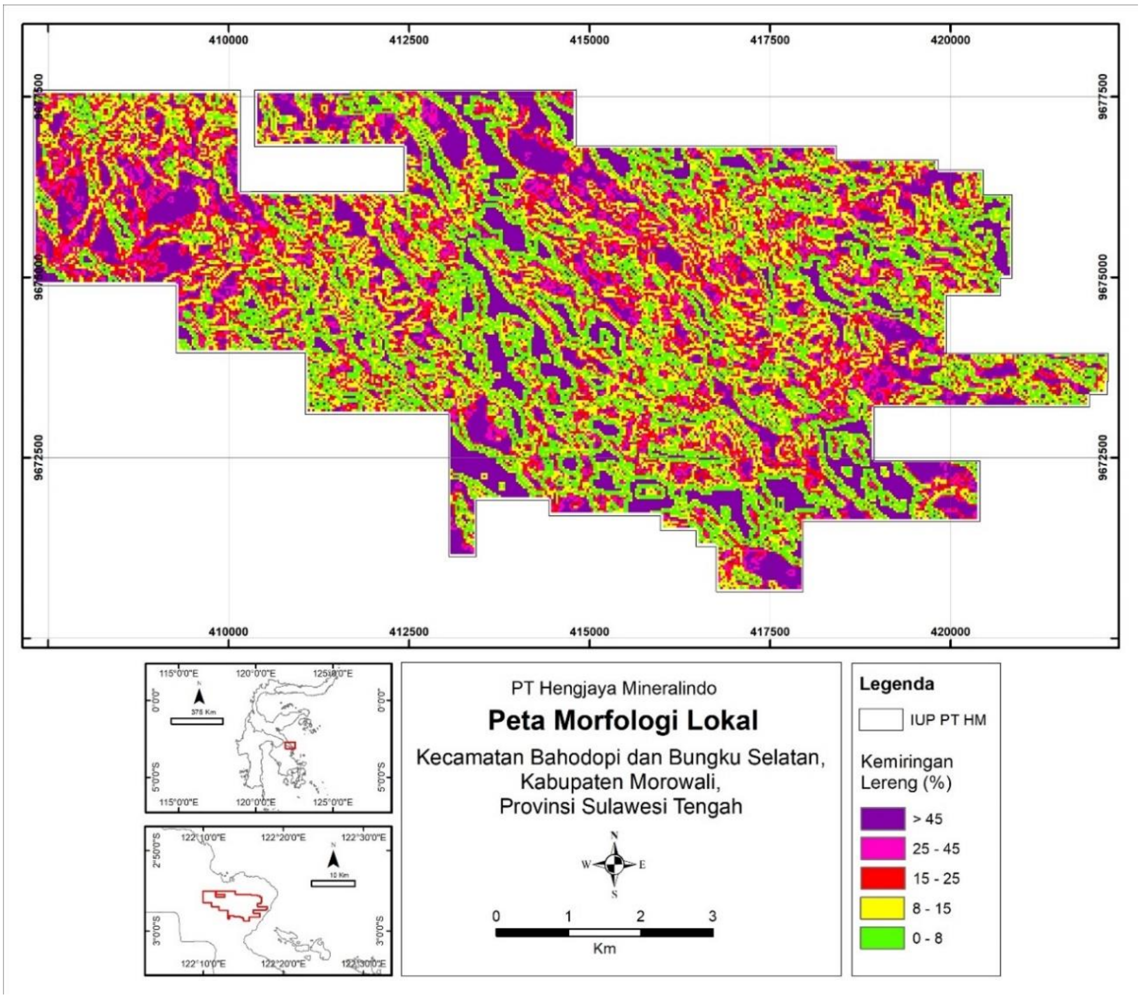
Gambar 2.1 Peta geologi regional lembar Bungku, Sulawesi (Simandjuntak dkk., 1993) yang telah ditambahkan dengan batas IUP



Gambar 2.2 Korelasi unit stratigrafi pada peta geologi lembar Bungku (Simandjuntak dkk., 1993)

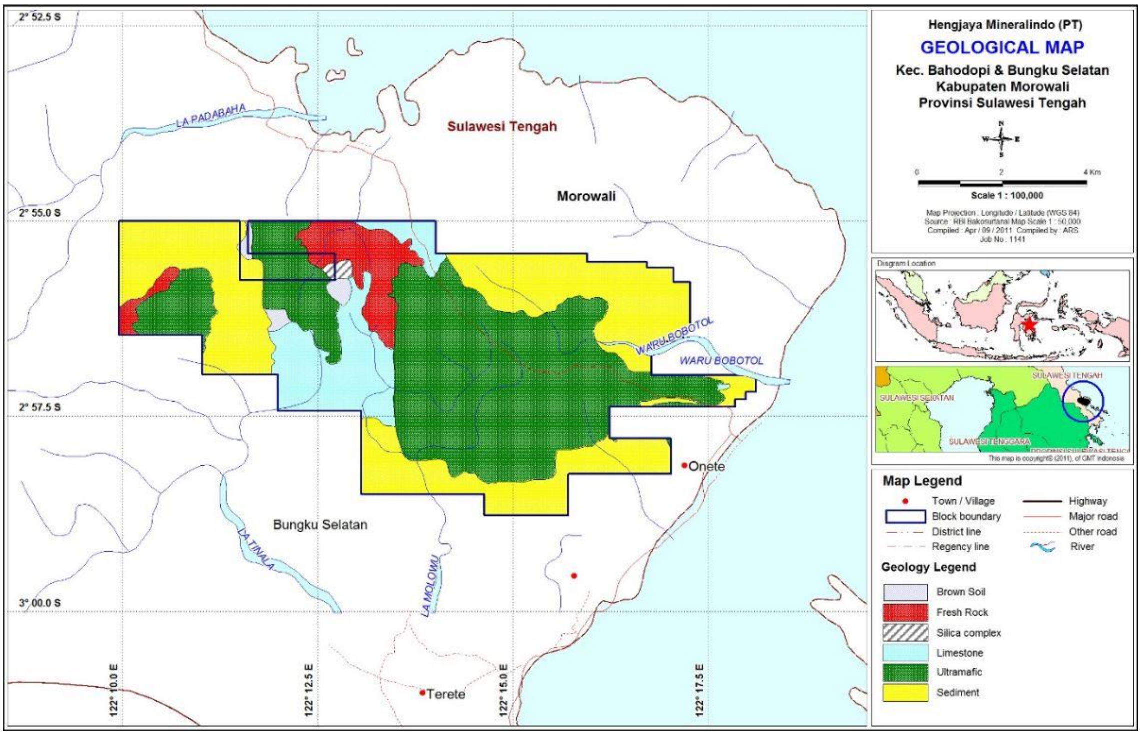
2.2. Geologi Lokal

Secara deskripsi kuantitatif/morfometri, morfologi masing-masing daerah wilayah penelitian dengan wilayah sekitarnya dapat dikelompokkan berdasarkan arah umum kemiringan lereng menjadi lima satuan morfologi, yaitu datar (0 – 8%) ditunjukkan dengan warna hijau, landai (8 – 15%) ditunjukkan dengan warna kuning, agak curam (15 – 25%) ditunjukkan dengan warna merah, curam (25 – 45%) ditunjukkan dengan warna merah muda, dan sangat curam (> 45%) ditunjukkan dengan warna ungu (Gambar 2.3).



Gambar 2.3 Peta morfologi lokal

Peta geologi lokal yang digunakan dibuat oleh HM sebagai acuan untuk melihat kondisi geologi permukaan selama program eksplorasi berlangsung saat ini (Gambar 2.4). Reliabilitas data yang digunakan sudah dikonfirmasi pada Desember 2019 selama pemetaan yang dilakukan oleh ahli geologi PT Danmar Eksplorindo dalam pencarian batugamping dan agregat untuk pembangunan proyek jalan. Pada peta geologi lokal, terdapat perbedaan yang signifikan dengan Peta Geologi Regional Lembar Bungku (lihat Gambar 2.1) yang memperlihatkan wilayah konsesi HM seluruhnya disusun oleh Formasi Tokala. Faktanya, Kompleks Ultramafik adalah batuan penyusun dominan di kawasan HM dan menyebar lebih dari 60% wilayah konsesi. Formasi Tokala adalah batuan yang lebih tua dan secara stratigrafi terdapat di bawah Kompleks Ultramafik.



Gambar 2.4 Peta geologi lokal

Lapisan yang kaya akan bijih nikel umumnya terdapat di bawah zona pelapukan dan di atas batuan dasar. Di bagian atas zona pelapukan ini umumnya ditumbuhi pepohonan (hutan) yang mengindikasikan bahwa lapisan tersebut cukup subur.

Pada daerah penelitian di wilayah IUP dari hasil pengamatan survei geologi banyak dijumpai blok-blok/spot area yang merupakan zona laterit, dengan ketebalan rata-rata ± 10 meter. Penampakan laterit secara visual terutama dari sisi warna permukaan memiliki perubahan-perubahan yang cukup drastis, hal ini sebagai akibat adanya perbedaan derajat serpentinisasi pada batuan ultramafik di wilayah tersebut. Sedangkan keberadaan mineral pembawa nikel seperti garnierit dan krisopras berada pada bongkah-bongkah dan membentuk zona serta jalur-jalur tertentu dalam satu zona *vein*. Kondisi ini menyebabkan tingginya kandungan silika (SiO_2). Kondisi ini dapat dilihat pada lereng sepanjang jalan Trans Sulawesi yang melintasi wilayah IUP Produksi PT Hengjaya Mineralindo.

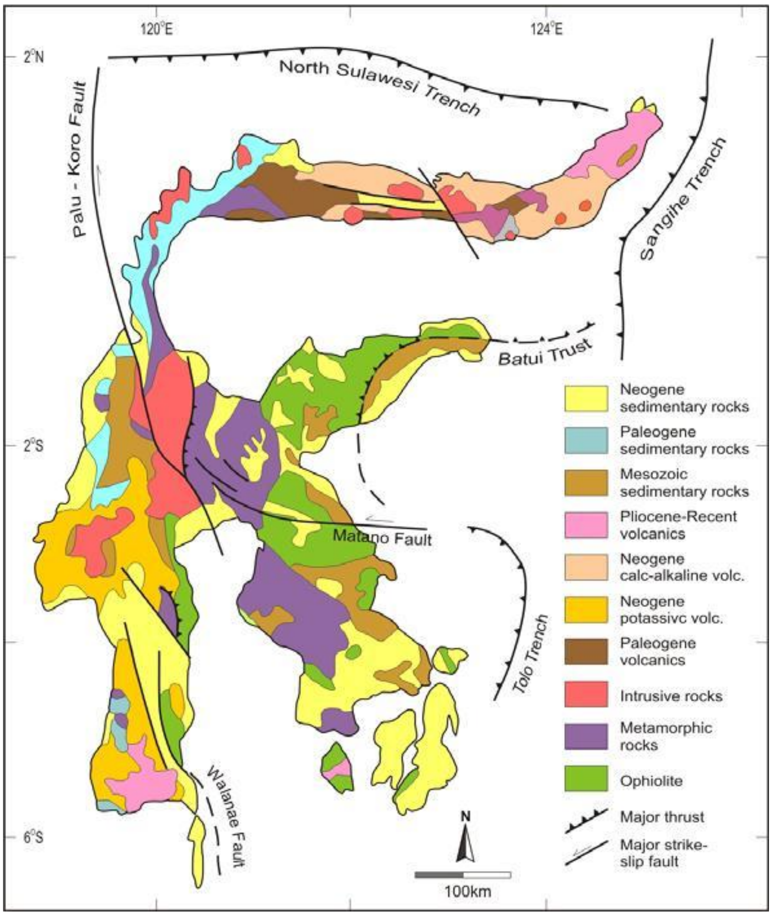
Pada blok-blok daerah penelitian di wilayah IUP sudah dilakukan pengeboran detail dengan *grid* 100 – 25 m, terdapat singkapan saprolit yang cukup meyakinkan, adanya indikasi mineral-mineral garnierit yang berkembang ke arah utara dan selebihnya perkembangan ke arah timur, terjadi perubahan kualitas menjadi batuan ultramafik (serpentinit) yang masih segar.

Beberapa bagian terutama di sisi utara-timurlaut dari konsesi wilayah IUP Produksi PT Hengjaya Mineralindo, terdapat zona serpentinisasi yang sangat dangkal lateritnya, namun kaya akan mineral garnierit yang terdapat pada rekahan batuannya, memungkinkan kandungan unsur nikel yang sangat tinggi dan memungkinkan bisa menjadi sebuah *injector* pada saat pengapalan dengan hasil penambangan yang memiliki kandungan kadar nikel yang rendah.

Berdasarkan hasil analisis singkapan endapan nikel dan korelasi terhadap penampang bor dangkal dan data sumur uji, tebal endapan bijih berkisar 1,20 – 20,00 m yang di bagian atasnya terkadang ditutupi oleh lapisan oksida besi atau goetit-aluminiun setebal 15 – 30 cm, atau disebut juga *iron capping*.

2.3. Struktur Geologi

Sulawesi secara tektonik merupakan wilayah yang disusun oleh benturan dua massa kerak benua, yaitu Sundaland yang menyusun Sulawesi Barat dan Australoid yang menyusun sebagian Sulawesi sebelah timur (Banggai-Sula) dan tenggara (Buton) (Gambar 2.5). Terjepit di tengahnya adalah kerak samudera yang kini menjadi ofiolit dan terangkat ke permukaan melalui mekanisme obduksi. Ofiolit yang naik ke permukaan tersebut menjadi sumber batuan utama penghasil mineral logam dasar nikel dan besi.



Gambar 2.5 Peta geologi Sulawesi (Van Leeuwen dkk., 2011)

Pada periode 70 – 15 juta tahun yag lalu (Ma), hanya ada Sulawesi Barat yang masih menjadi bagian Sundaland dan tambahan massa kerak Bumi di sebelah timurnya. Sulawesi Barat kala itu adalah sebuah busur kepulauan/busur magmatik-vulkanik hasil subduksi kerak samudera terhadapnya yang menghasilkan beberapa periode magmatik dan volkanik di Sulawesi bagian barat. Perubahan-perubahan tektonik seperti pembukaan Selat Makassar, pembukaan Teluk Bone, pembukaan Teluk Tomini/Cekungan Gorontalo, subduksi Laut Sulawesi pada 50 – 15 Ma menyebabkan perubahan arah/polaritas busur magmatik dan subduksi Sulawesi dari cembung ke arah samudera menjadi agak lurus

Pada periode 15 – 5 Ma, Sulawesi mengalami collision dan docking dua mikrokontinen Australia ke arah Sulawesi dari sebelah tenggara (mikrokontinen Buton-Tukangbesi) dan dari sebelah timur (mikrokontinen Banggai-Sula). Pada periode ini diperkirakan terjadi pembalikan utama arah/polaritas busur-busur Sulawesi dari semula cembung ke arah samudera menjadi cekung ke arah samudera (ke arah timur pada kala ini).

Pembalikan polaritas busur-busur Sulawesi ini secara frontal adalah akibat benturan mikrokontinen d Banggai-Sula yang membenturnya di titik pusat Sulawesi. Yang mengakibatkan rotasi. Lengan Tenggara berotasi melawan arah jarum jam sehingga membuka melebarkan Teluk Bone di sebelah baratnya, Lengan Utara berotasi searah jarum jam sehingga menutup Cekungan Gorontalo.

Periode 5 – 0 Ma adalah finalisasi pembalikan busur-busur Sulawesi dan periode tectonic escape di Sulawesi. Setelah benturan Buton-Tukangbesi dan benturan Banggai-Sula, terjadilah tectonic escape berupa sesar-sesar mendatar besar yang meretakkan dan menggeser-geser Sulawesi. Sesar-sesar ini mengarah ke timur umumnya, yaitu ke arah free oceanic edge saat itu. Sesar-sesar mendatar besar Palu-Koro, Matano, Lawanopo, Kolaka, dan Balantak terjadi melalui mekanisme post-collision tectonic escape.

Namun faktanya, jika dilihat dari peta geologi lokal yang dibuat oleh HM (Gambar 2.4), struktur geologi tidak begitu berkembang seperti yang diinterpretasikan pada peta geologi regional. Hal tersebut kemungkinan karena wilayah IUP yang sudah mengalami pelapukan dan lateritisasi, sehingga sulit untuk menemukan bukti-bukti keberadaan jejak struktur geologi di lapangan.

3. KAJIAN HIDROLOGI DAN HIDROGEOLOGI

3.1. Akuisisi Data

Kebutuhan data terkait analisis hidrologi dan hidrogeologi sangat bergantung pada tujuan, ketersediaan data yang dimiliki, dan tingkat ketelitian hasil yang diharapkan. PT Hengjaya Mineralindo ("HM") memiliki beberapa data primer yang dibutuhkan untuk melakukan analisis dasar hidrologi dan hidrogeologi. Namun tidak semua data yang dimiliki HM cukup untuk memenuhi kebutuhan dasar analisis. *Gap* data analisis dilakukan terhadap ketersediaan data yang dimiliki HM. Hasil tersebut selanjutnya menentukan bagaimana kekurangan terhadap data dapat dipenuhi, dan pendekatan metode ilmiah yang digunakan sesuai dengan jumlah dan ketersediaan data.

3.1.1. Jenis, Jumlah, dan Sebaran Data

Tabel 3.1 memperlihatkan rekapitulasi ketersediaan data yang dimiliki HM terkait kebutuhan analisis hidrologi dan hidrogeologi, resume dari data gap, dan bagaimana pelengkapan terhadap gap data dipenuhi. Penjelasan rinci dari Tabel 3.1 mengenai jenis, jumlah, dan persebaran data yang dimiliki HM, serta pelengkapan data sekunder/literatur dibahas selanjutnya pada subbab 3.1.2 hingga subbab 3.1.4.

Tabel 3.1 Jenis dan jumlah ketersediaan data PT HM, pelengkapan, dan data *gap* terkait analisis hidrologi dan hidrogeologi

Jenis Data	Jumlah/Keterangan	Kelengkapan Data/ *Gap* Data Analisis	Pelengkapan *Gap* Data/ Keterangan
Data Hujan	Tidak ada data rekaman hujan yang diperoleh dari HM	Data curah hujan harian kontinu minimal 10 tahun diperlukan untuk menentukan persentil-95 (*95th percentile*) kejadian hujan pada suatu lokasi.	Pelengkapan data hujan menggunakan data sekunder dari stasiun terdekat milik BMKG atau PUSAIR. Pelengkapan data juga didekati dengan data hujan satelit (TRMM)
Data Topografi	Hasil Survei Topografi, HM 2021	Data topografi terbatas pada area IUP HM. Kebutuhan analisis *catchment* mencakup area di luar konsesi HM	Data topografi di luar IUP HM menggunakan data DEM Nasional (Badan Informasi Geografis Indonesia)

Jenis Data	Jumlah/Keterangan	Kelengkapan Data/ *Gap* Data Analisis	Pelengkapan *Gap* Data/ Keterangan
Muka Airtanah	Data pengukuran lapangan pada 9 titik bor geoteknik tahun (Geomine, 2021)	Data pengukuran muka airtanah mencerminkan *total head* dari semua litologi yang hadir	Kebutuhan data muka airtanah dianggap telah memenuhi kebutuhan data minimal untuk analisis lanjutan.
Parameter Hidraulik	1. Uji akuifer lapangan dilakukan pada 9 sumur bor geoteknik (Geomine, 2021) 2. Uji permeabilitas laboratorium pada 6 sampel batuan dari hasil core pengeboran (Geomine, 2021)	Data konduktivitas hidraulik dianggap telah memenuhi kebutuhan data untuk analisis lanjutan, di mana nilai konduktivitas hidraulik didapatkan pada masing-masing litologi	Selain data konduktivitas hidraulik, data parameter hidraulik lainnya, seperti storativitas dan porositas dibutuhkan untuk kepentingan analisis selanjutnya. Pelengkapan data nilai stortativitas dan porositas menggunakan data literatur pada litologi sejenis.
Data Kondisi Umum Hidrologi dan Hidrogeologi	Kondisi umum hidrologi dan hidrogeologi, seperti: batas DAS, jaringan sungai, batas Cekungan Airtanah, Peta hidrogeologi regional	Pengambilan Data Sekunder dari instansi terkait	Untuk mendapatkan gambaran umum kondisi hidrologi dan hidrogeologi daerah studi data sekunder diambil dari instansi terkait, seperti: - Batas DAS regional: Sistem Informasi Pengelolaan DAS KLHK - Peta jaringan sungai: Badan Informasi Geografis (BIG) - Peta Batas CAT

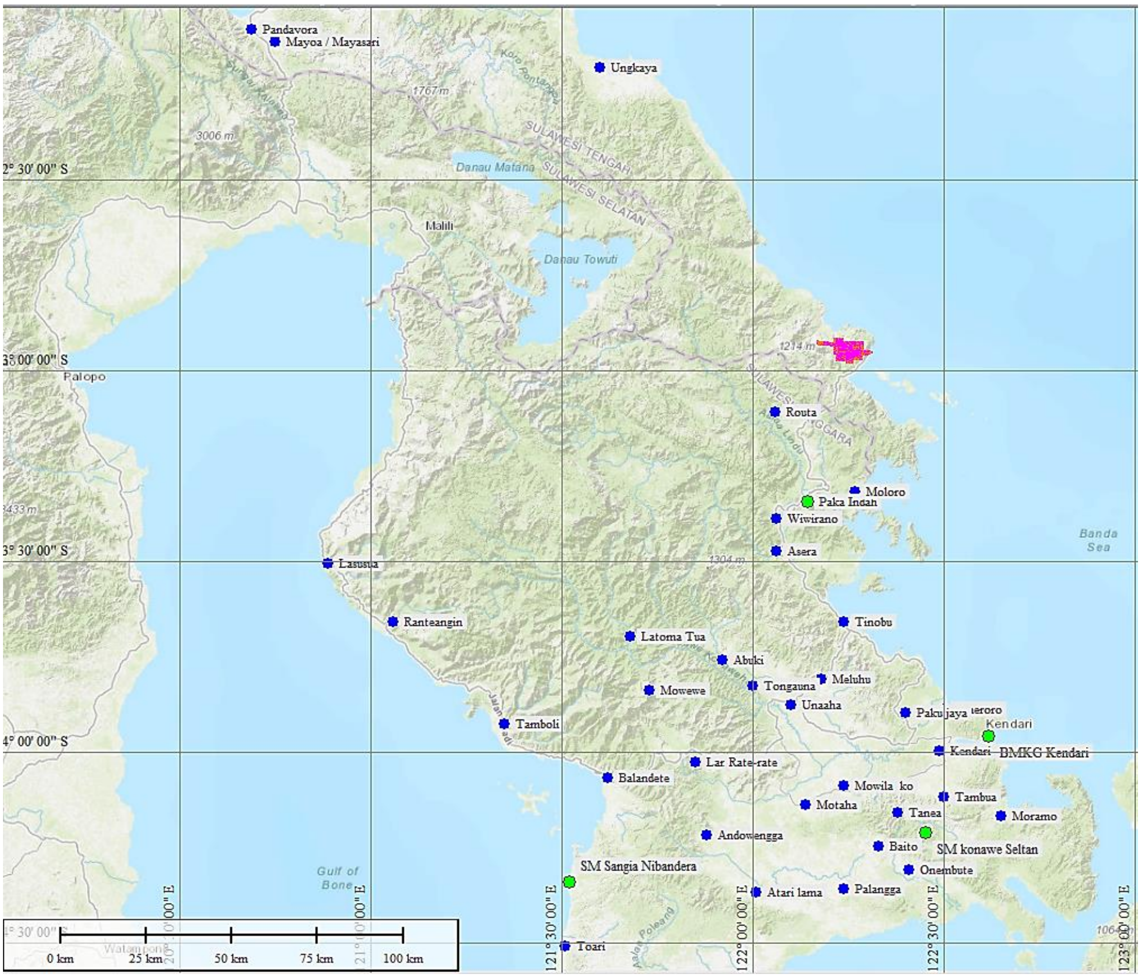
3.1.2. Data Hujan

Tidak ada data pencatatan hujan yang dimiliki HM. Data curah hujan yang panjang, yaitu minimal data 10 tahun kontinu diperlukan untuk menentukan persentil-95 (95th percentile) kejadian hujan pada suatu lokasi. Data pemantauan tiga puluh tahun atau lebih sangat diharapkan untuk melakukan analisis statistik yang tidak bias (US EPA, Technical Guidance on Implementing the Stormwater Runoff Requirements, 2009). Untuk melengkapi data hujan yang akan digunakan dalam analisis selanjutnya, pengambilan data dilakukan melalui Badan Meteorologi Klimatologi dan Geofisika (BMKG) serta Badan Penelitian dan Pengembangan Sumber Daya Air (PUSAIR).

Evaluasi ketersediaan data stasiun BMKG dan PUSAIR di sekitar area lokasi studi ditunjukkan pada Tabel 3.2. Peta lokasi stasiun klimatologi di sekitar wilayah studi dapat dilihat pada Gambar 3.1.

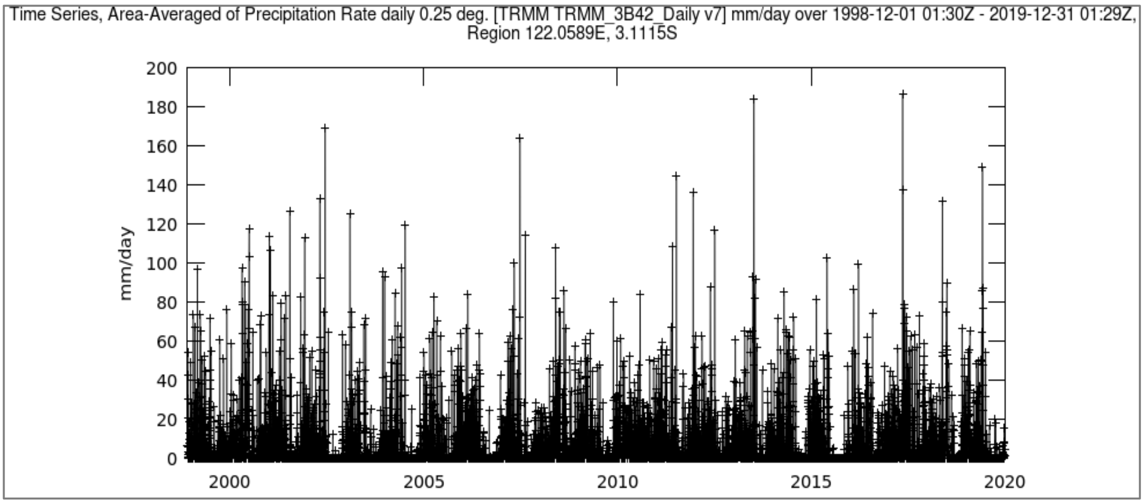
Tabel 3.2 Evaluasi ketersediaan data dari stasiun klimatologi terdekat dan stasiun hujan di sekitar lokasi studi (data BMKG dan PUSAIR)

No.	Nama Stasiun	Periode Observasi	Periode Data Lengkap	Jarak	Data Tersedia	Sumber
1	Routa	2014-2019	6 tahun	27 Km	Hujan Harian	PUSAIR
2	Moloro	2018-2019	2 tahun	35 Km	Hujan Harian	PUSAIR
3	Paka Indah	1991-2019	2 tahun	45 Km	Klimatologi Harian	PUSAIR
4	Wiwirano	2010-2019	10 tahun	53 Km	Hujan Harian	PUSAIR
5	Asera	1995-2019	12 tahun	62 Km	Hujan Harian	PUSAIR
6	Ungkaya	2007-2017	11 tahun	109 Km	Hujan Harian	PUSAIR



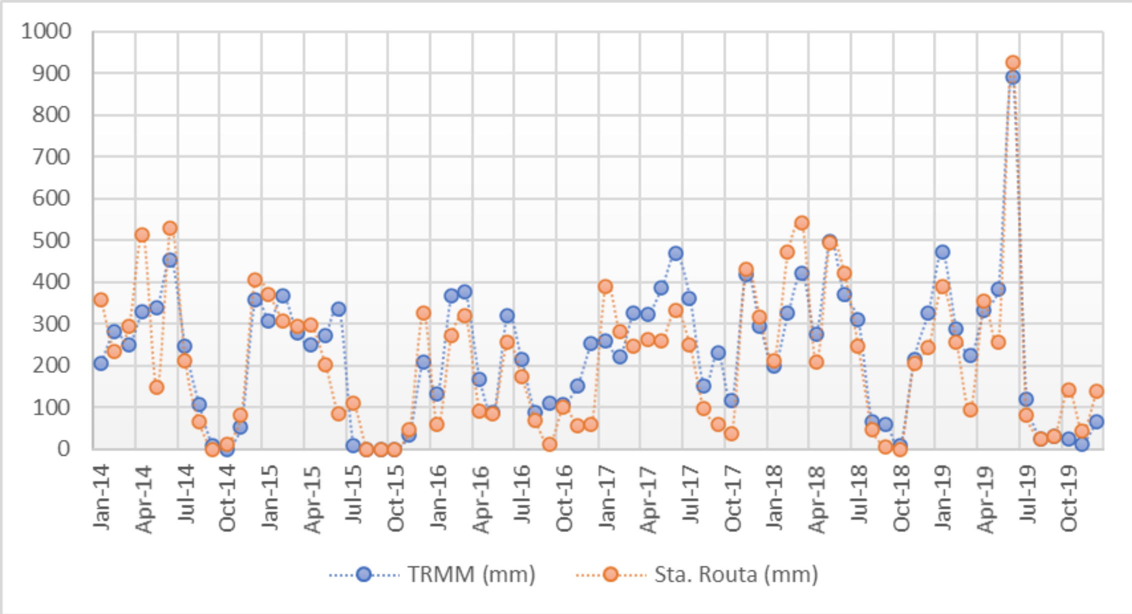
Gambar 3.1 Peta distribusi ketersediaan stasiun hujan di sekitar IUP HM

Berdasarkan data yang tersedia dari BMKG dan PUSAIR, stasiun terdekat dengan lokasi studi adalah Stasiun Routa. Namun seperti dapat dilihat pada Tabel 3.2, data hujan pada stasiun Routa hanya meliputi data untuk 6 tahun periode (2014-2019). Untuk melengkapi data hujan lebih panjang, pengambilan data hujan satelit dilakukan. Data curah hujan satelit diperoleh dari produk penelitian Tropical Rainfall Measuring Mission (TRMM) yang diambil dari produk opensource NASA, GES DISC. Data curah hujan dari TRMM yang diperoleh merupakan data hujan harian (versi 3B42), dengan grid resolusi spasial 0,25°, dan tersedia sepanjang periode 1999-2019 (Gambar 3.2).

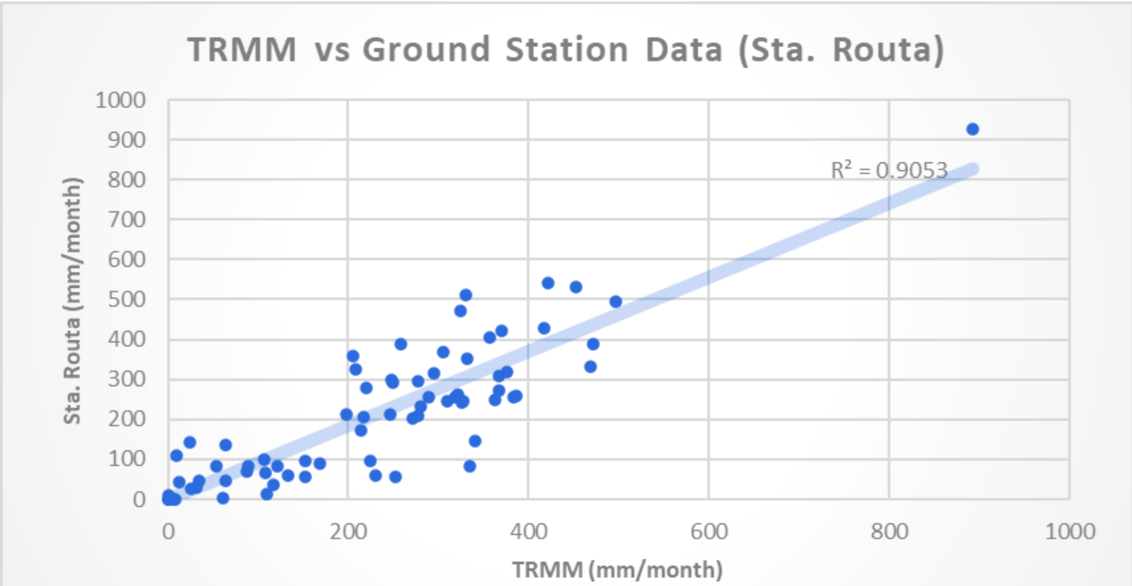


Gambar 3.2 Data produk hujan Satelit TRMM versi 3B42 pada titik Stasiun Routa

Untuk memverifikasi keakuratan data curah hujan satelit, dilakukan uji komparasi antara data satelit dan data Stasiun Routa pada tahun yang sama. Perbandingan data hujan bulanan antara Stasiun Routa dan data satelit pada *time series* dan *scatter plot* ditunjukkan pada **Error! Reference source not found.** dan **Error! Reference source not found.**. Berdasarkan hasil komparasi dapat terlihat bahwa pola *series* grafik hujan bulanan dari Satelit TRMM memiliki keseragaman dengan data hujan stasiun Routa (**Error! Reference source not found.**). Selain itu nilai hasil perbandingan memperlihatkan koefisien korelasi antara data curah hujan satelit dan data Stasiun Routa memiliki nilai sebesar 0.9 (**Error! Reference source not found.**). Hasil ini menunjukkan data curah hujan produk satelit berkorelasi sangat baik dengan data hujan Stasiun Routa, sehingga dapat digunakan untuk kepentingan analisis selanjutnya.

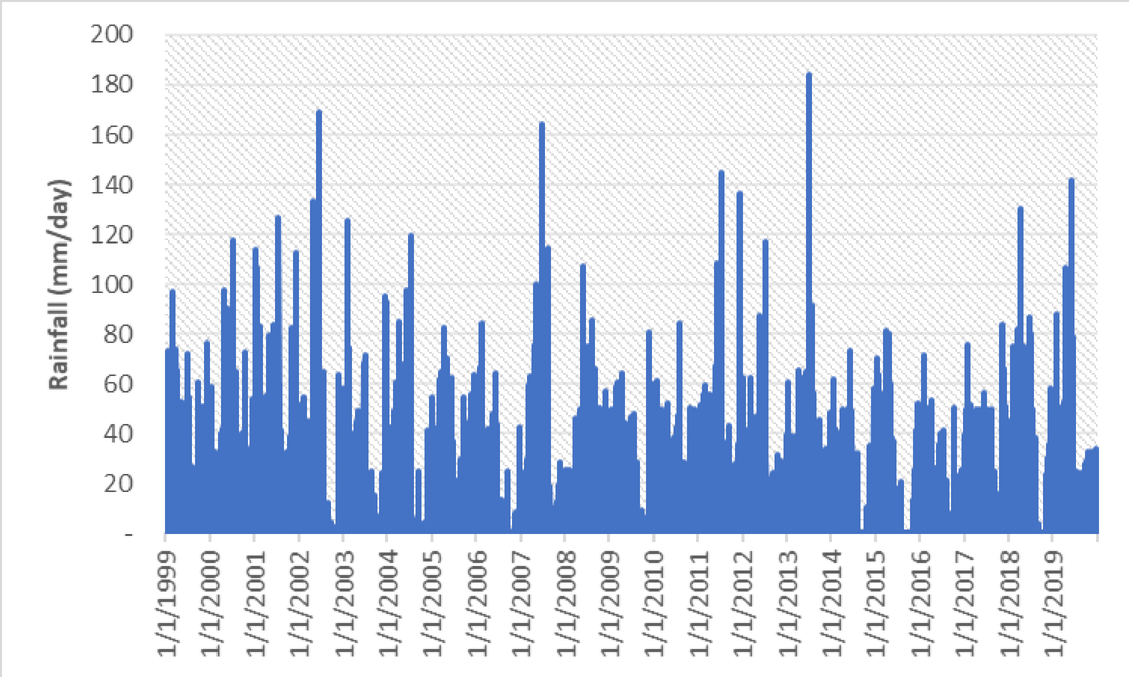


Gambar 3.3 Perbandingan *time series* antara hujan Stasiun Routa dan hujan satelit (TRMM)



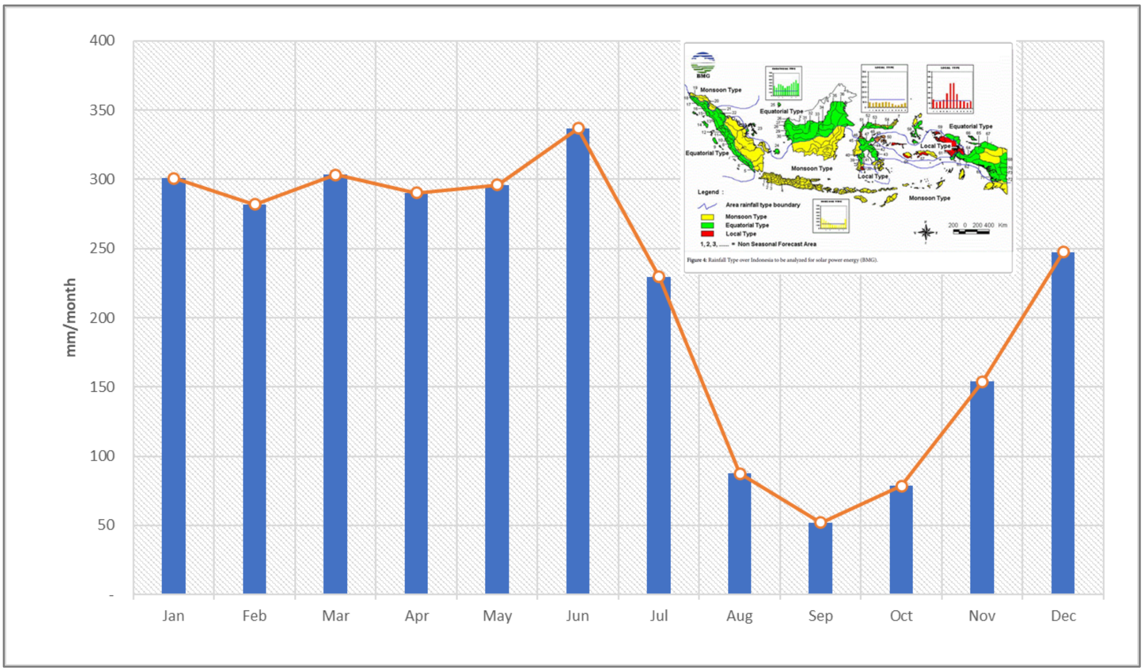
Gambar 3.4 Diagram *scatter* dari data hujan Stasiun Routa dan hujan satelit (TRMM)

Setelah data ter-verifikasi dan dinyatakan berkorelasi dengan baik, selanjutnya data curah hujan satelit akan digunakan untuk mengisi kekosongan data pada stasiun darat tersedia. Sehingga data hujan selanjutnya menggunakan data Satelit TRMM untuk periode tahun 1999-2013 dan rata-rata data Stasiun Routa untuk periode tahun 2004-2019. Plot data hujan harian dari stasiun PUSAIR dikombinasikan dengan data hujan produk satelit TRMM dapat dilihat pada Gambar 3.5.



Gambar 3.5 Rekapitulasi hujan bulanan wilayah studi (kombinasi data Stasiun Routa dengan data hujan produk Satelit TRMM)

Berdasarkan data akuisisi diketahui jumlah rata-rata curah hujan tahunan daerah studi selama periode tahun 1999-2019 (20 tahun) adalah sebesar 2658 mm/tahun. Curah hujan harian rata-rata selama 20 tahun (1999-2019) adalah 7,27 mm dengan curah hujan harian maksimum selama 20 tahun adalah 184 mm yang terjadi pada 10 Juli 2013. Berdasarkan pola data hujan klasifikasi BMKG, jenis pola hujan di daerah studi masuk dalam tipe lokal. Tipe Lokal umumnya merupakan kebalikan dari pola hujan monsun, yaitu jika di daerah dengan pola monsun mengalami musim hujan maka daerah dengan pola lokal mengalami musim kemarau atau sebaliknya. Grafik rata-rata hujan bulanan daerah studi selama 20 tahun (1999-2009) dapat dilihat pada Gambar 3.6 yang memperlihatkan tipe pola hujan di daerah studi.



Gambar 3.6 Grafik rata-rata curah hujan bulanan daerah studi

3.1.3. Data Level Muka Airtanah

Pengukuran kedalaman muka air tanah dilakukan pada 9 lokasi lubang bor geoteknik yang tersebar pada lokasi rencana pengembangan tambang HM. Berdasarkan hasil pengukuran lapangan, diketahui kedalaman muka airtanah di lokasi penambangan HM berkisar antara 6,15 s/d 23,78 meter di bawah permukaan, dengan rata-rata sebesar 16 meter kedalaman di bawah permukaan. Data hasil pengamatan kedalaman muka air tanah hasil investigasi lapangan tahun 2021 dapat dilihat pada Tabel 3.3, dengan sebaran data pengukuran yang dapat dilihat pada Gambar 3.8.

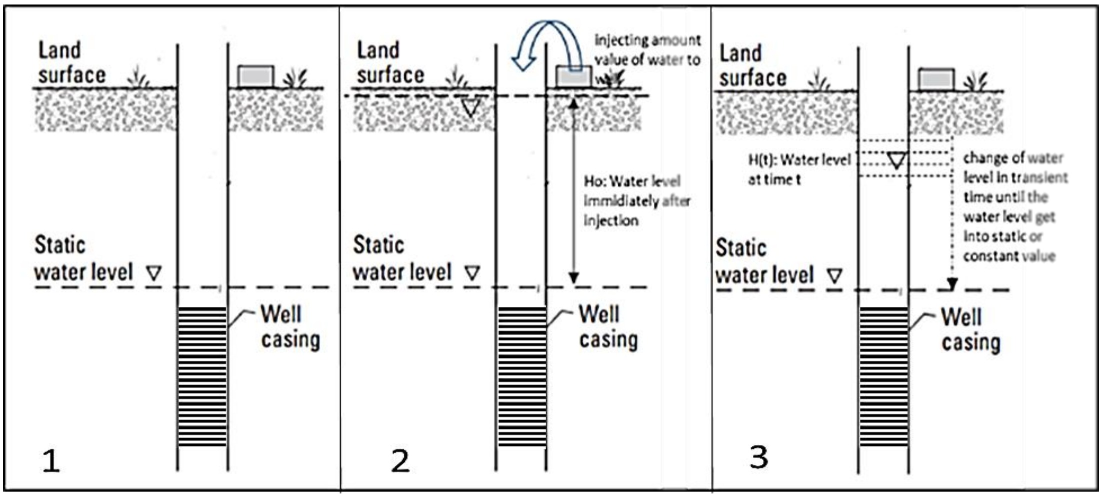
Tabel 3.3 Hasil pengukuran kedalaman muka airtanah

Hole ID	Easting	Northing	Elevation (m RL)	Total Depth (m)	GWL Depth (m)	GWL Elevation (m RL)
DHG-01	413455	9675637	380.127	17	13	367.127
DHG-02	414147	9675839	519	14	8.58	510.42
DHG-03	415011	9675627	445.292	31	6.15	439.142
DHG-04	414243	9674697	402.991	35	27	375.991
DHG-05	415969	9674988	433.43	23	8.7	424.73
DHG-06	415447	9673487	329	35	23.78	305.22
DHG-07	416755	9674354	407.194	15	14.2	392.994

Hole ID	Easting	Northing	Elevation (m RL)	Total Depth (m)	GWL Depth (m)	GWL Elevation (m RL)
DHG-08	417317	9673539	358.125	20	19.2	338.925
DHG-09	418482.3	9673633	411.148	30	23.2	387.948

3.1.4. Data Konduktivitas Hidraulik

Data konduktivitas hidraulik didapatkan dari hasil pengujian langsung di lapangan dan hasil uji laboratorium yang diambil dari lubang pengeboran. Uji akuifer di lapangan dilakukan pada 8 sumur bor menggunakan metode *slug test* (*falling head*). *Slug test* (dalam Bouwer dan Rice, 1976) diterapkan untuk menentukan konduktivitas hidraulik dari tes sumur tunggal menggunakan metode *falling head*. Dalam metode ini, level airtanah statis di dalam sumur diukur sebelum pengujian. Sejumlah air kemudian dimasukkan ke dalam sumur. Pengukuran level air dilakukan secara berkala oleh *level logger* dan setiap perubahan level air dicatat sampai level air mencapai nilai statis/konstan kembali. Ilustrasi *slug test* menggunakan metode *falling head* dapat dilihat pada Gambar 3.7.



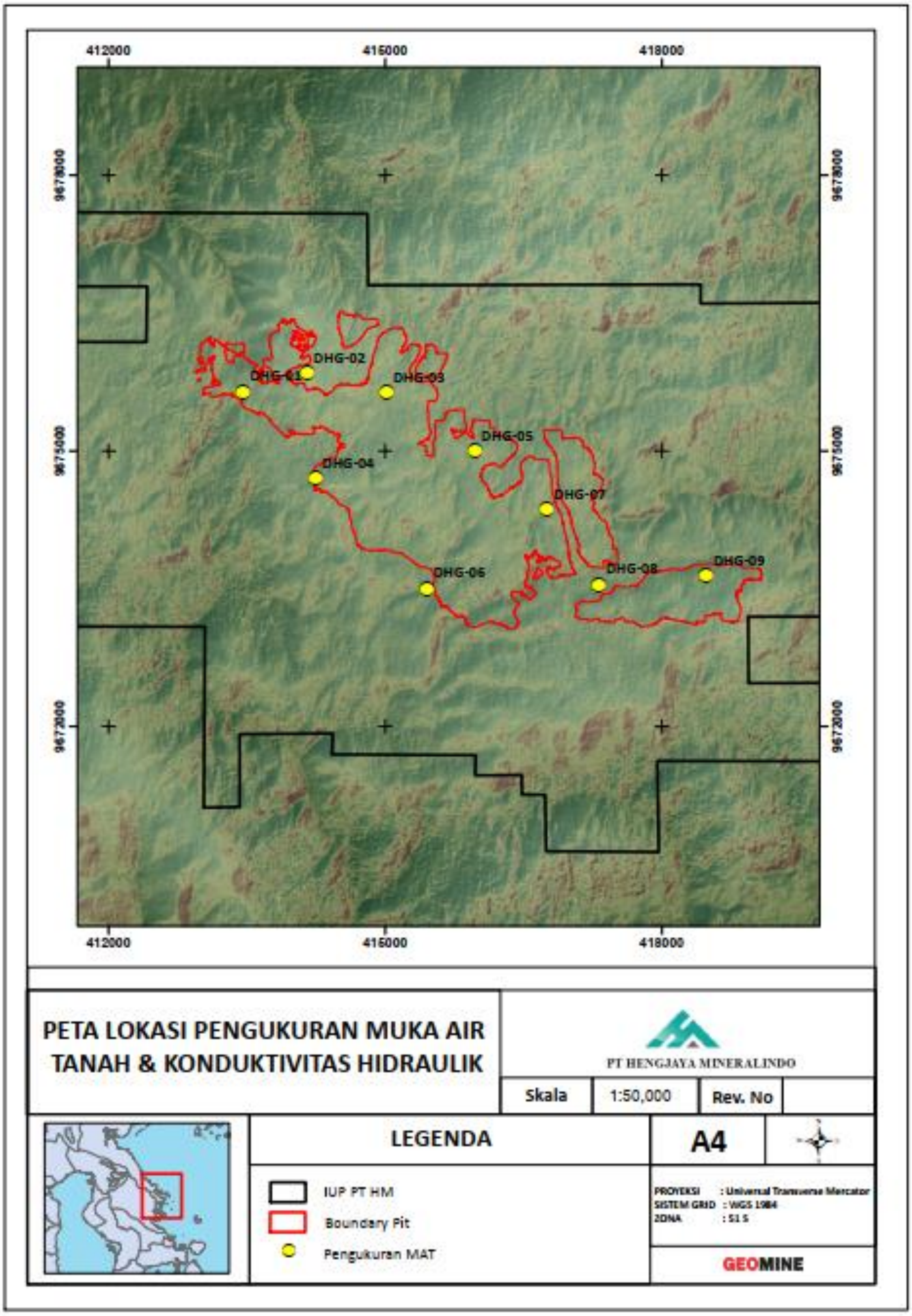
Gambar 3.7 Praktik lapangan *slug test* menggunakan metode *falling head*

Data dari hasil uji lapangan selanjutnya diproses untuk mendapatkan parameter konduktivitas hidraulik menggunakan metode Hvorslev. Resume nilai konduktivitas hidraulik hasil slug test dapat dilihat pada Tabel 3.4, dengan sebaran titik data yang dapat dilihat pada Gambar 3.8.

Selain itu untuk melengkapi data konduktivitas hidraulik, pengujian laboratorium juga dilakukan pada beberapa sampel tanah dan litologi batuan yang hadir. Uji konduktivitas hidraulik laboratorium dilakukan di laboratorium hidrogeologi dan hidrogeokimia Institut Teknologi Bandung, menggunakan vacuum permeameter constant head, dengan standar pengujian mengacu pada ASTM D 5084. Rekapitulasi hasil uji konduktivitas hidraulik laboratorium dapat dilihat pada Tabel 3.4.

Tabel 3.4 Resume nilai konduktivitas hidraulik hasil uji lapangan dan uji laboratorium

Method	Hole ID / Sample ID	Coordinate UTM 51S		Hydraulic Conductivity (m/s)	Lithology
		Easting	Northing		
Uji Lapangan-Slug test	DHG-01	413400.4	9675826	2.52E-05	Saprolit
	DHG-02	414146	9675839	9.50E-05	Saprolit
	DHG-03	415097.6	9675904	4.48E-06	Saprolit
	DHG-04	414286.9	9674645	1.15E-05	Saprolit
	DHG-05	415735.3	9674946	4.35E-06	Saprolit
	DHG-06	415097	9673413	1.26E-04	Saprolit
	DHG-07	416875.6	9674311	3.33E-05	Saprolit
	DHG-08	417733	9673383	2.82E-05	Saprolit
Laboratorium Permeability Test	DHG-01	413400.4	9675826	1.06E-06	Saprolit
	DHG-05	415735.3	9674946	7.18E-04	Saprolit
	DHG-06	415097	9673413	1.83E-05	Saprolit
	DHG-08	417733	9673383	<1.00E-12	Dunit



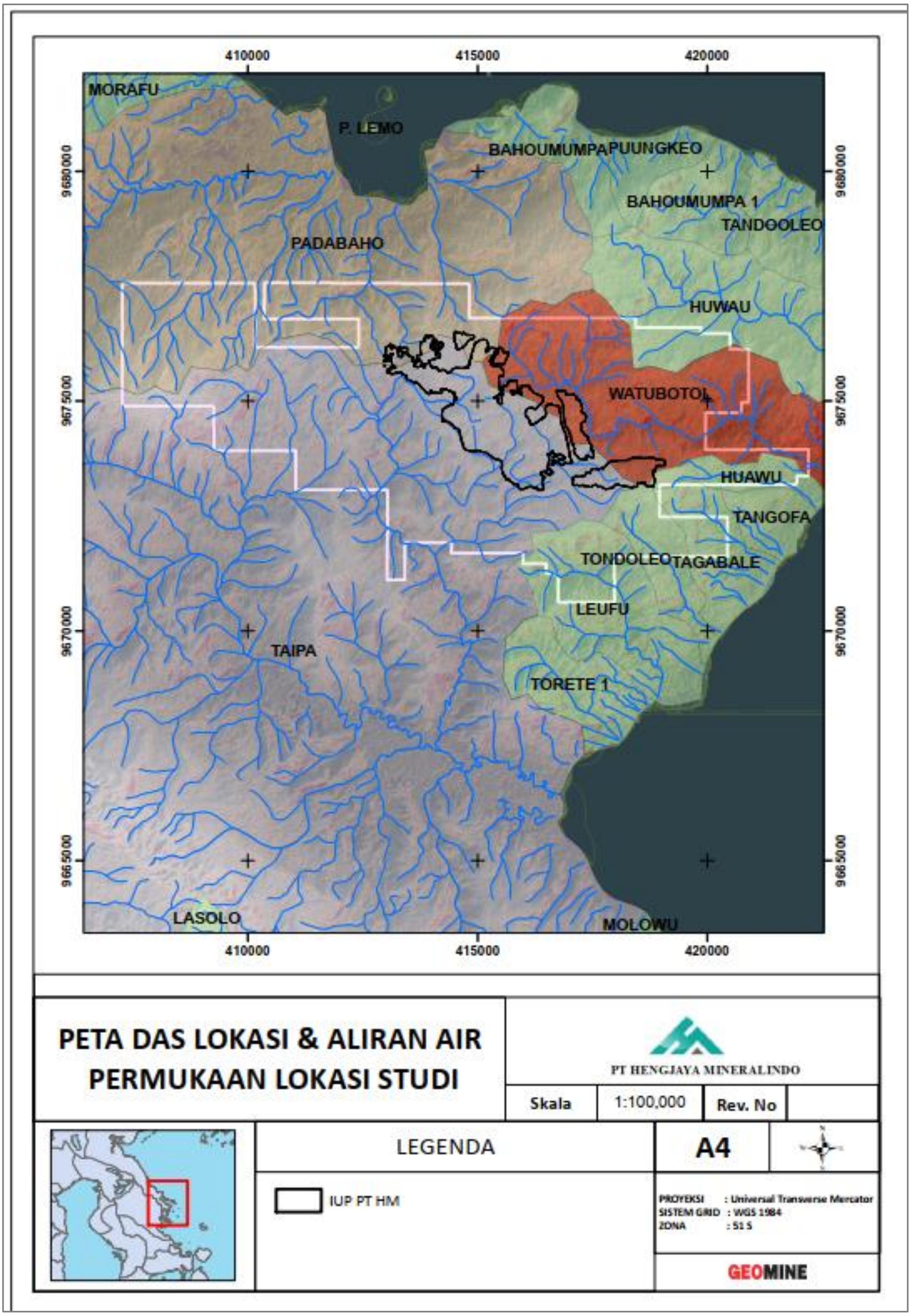
Gambar 3.8 Peta distribusi lokasi pengukuran muka airtanah dan titik pengujian konduktivitas hidraulik lapangan

3.1.5. Kondisi Hidrologi dan Hidrogeologi Umum

3.1.5.1. Daerah Aliran Sungai

Berdasarkan data Sistem Informasi Pengelolaan DAS Kementerian Lingkungan Hidup dan Kehutanan, lokasi rencana pengembangan tambang HM masuk ke dalam 2 Daerah Aliran Sungai (DAS), yaitu DAS Taipa (Kode DAS= DAS530815) dan DAS Watubotol (Kode DAS= DAS 510808). Luas DAS Taipa adalah sebesar 204,37 Km2, dengan aliran sungai utama yang mengalir pada DAS ini adalah Sungai La Tinala. Luas DAS Taipa adalah sebesar 18,24 Km2, dengan aliran sungai utama yang mengalir pada DAS ini adalah Sungai La Watubotol.

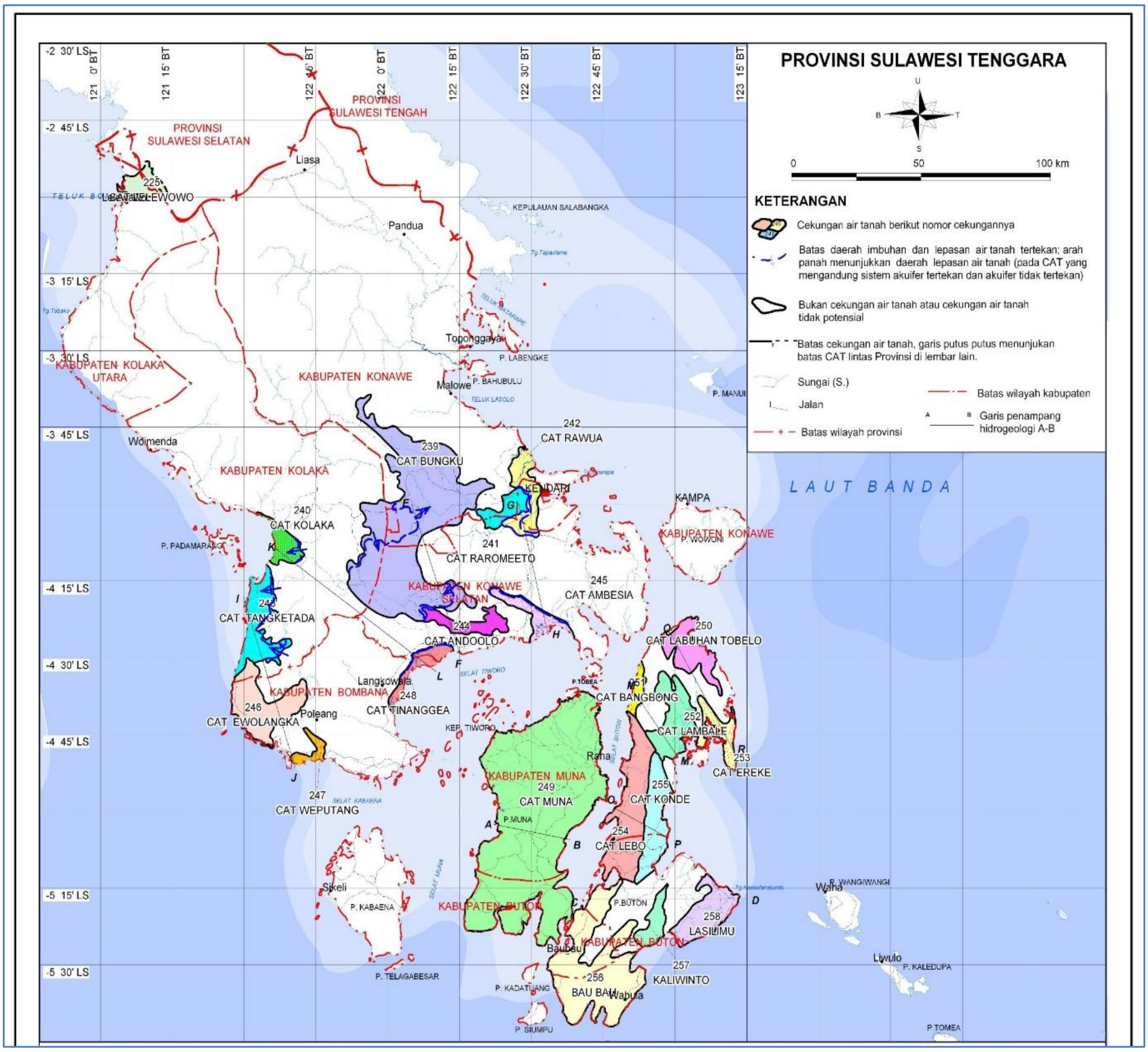
Secara posisi, rencana lokasi pengembangan tambang HM terletak pada bagian paling hulu dari salah satu lembah DAS Taipa dan DAS Watubotol. Lokasi aliran sungai terdekat dan terkait rencana pengembangan tambang HM antara lain anak sungai Molowu yang merupakan anak-anak sungai Tinala, serta La Watubotol. Peta batas DAS dan aliran air permukaan daerah studi dapat dilihat pada Gambar 3.9.



Gambar 3.9 Peta daerah aliran sungai dan aliran air permukaan regional daerah studi

3.1.5.2. Hidrogeologi Umum

Cekungan Air Tanah (CAT) diartikan sebagai suatu wilayah yang dibatasi oleh batas hidrogeologi di mana semua kejadian hidrogeologi seperti terjadinya proses pengimbuhan, pengaliran, dan pelepasan airtanah berlangsung. CAT mempunyai batas yang secara langsung dikontrol oleh kondisi geologi dan hidraulik, CAT mempunyai daerah imbuhan airtanah dan daerah lepasan airtanah serta memiliki satu kesatuan sistem akuifer berdasarkan peta cekungan air tanah daerah Sulawesi Tenggara. Daerah lokasi studi berada pada daerah yang bukan merupakan cekungan air tanah atau cekungan air tanah yang tidak potensial (Gambar 3.10).



Gambar 3.10 Peta cekungan air tanah regional lokasi studi

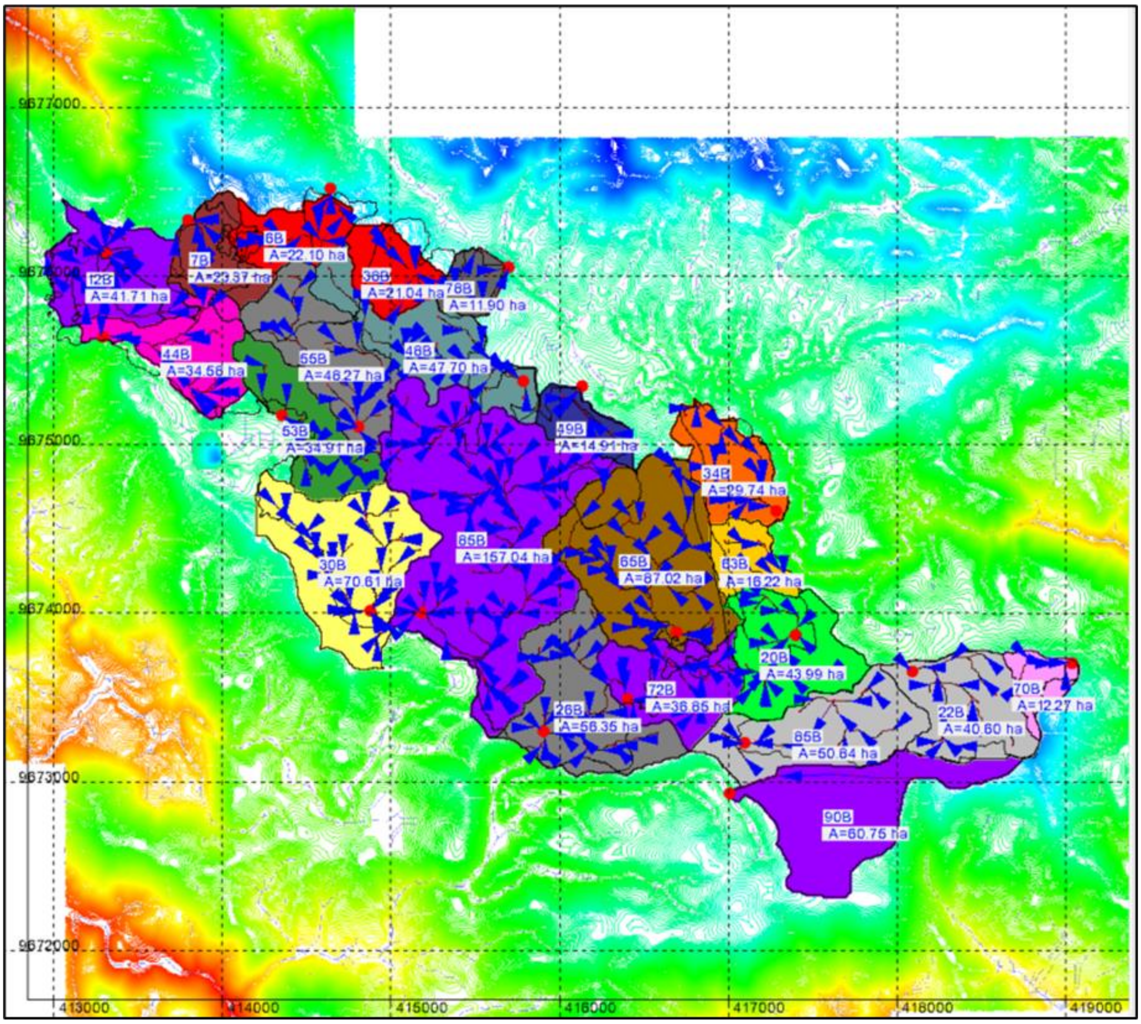
3.2. Analisis Hidrologi

3.2.1. Analisis *Catchment*

3.2.1.1. *Catchment Area* Rencana Tambang

Perubahan morfologi akibat bukaan tambang akan mengubah aliran air permukaan alami khususnya pada lokasi rencana bukaan tambang. Pada kondisi tambang, air permukaan secara dominan mengalir menuju titik terendah menuju lubang bukaan tambang, dengan terdapat sebagian kecil aliran air permukaan yang tetap mengalir mengikuti aliran alaminya. Delineasi *catchment* rencana bukaan tambang dilakukan menggunakan desain bukaan tambang kondisi akhir. Pada kondisi aktualnya, perubahan *sub-catchment* perlu disesuaikan mengikuti *sequence* dari kemajuan tambang.

Catchment area yang terbentuk dari rencana bukaan tambang HM dapat dilihat pada Gambar 3.11. Berdasarkan hasil delineasi, aliran air permukaan pada rencana bukaan tambang HM dapat dibagi menjadi 18 *sub-catchment*. Beberapa *sub-catchment* memiliki aliran yang cukup besar dari luar pit, sehingga perimeter *drainage* dibutuhkan pada beberapa area untuk mencegah aliran dan mengurangi jumlah air permukaan yang masuk ke dalam pit. Luas masing-masing *sub-catchment* dan karakteristik fisik aliran dari rencana bukaan tambang HM dapat dilihat pada Tabel 3.5.



Gambar 3.11 *Sub-catchment* area rencana tambang HM

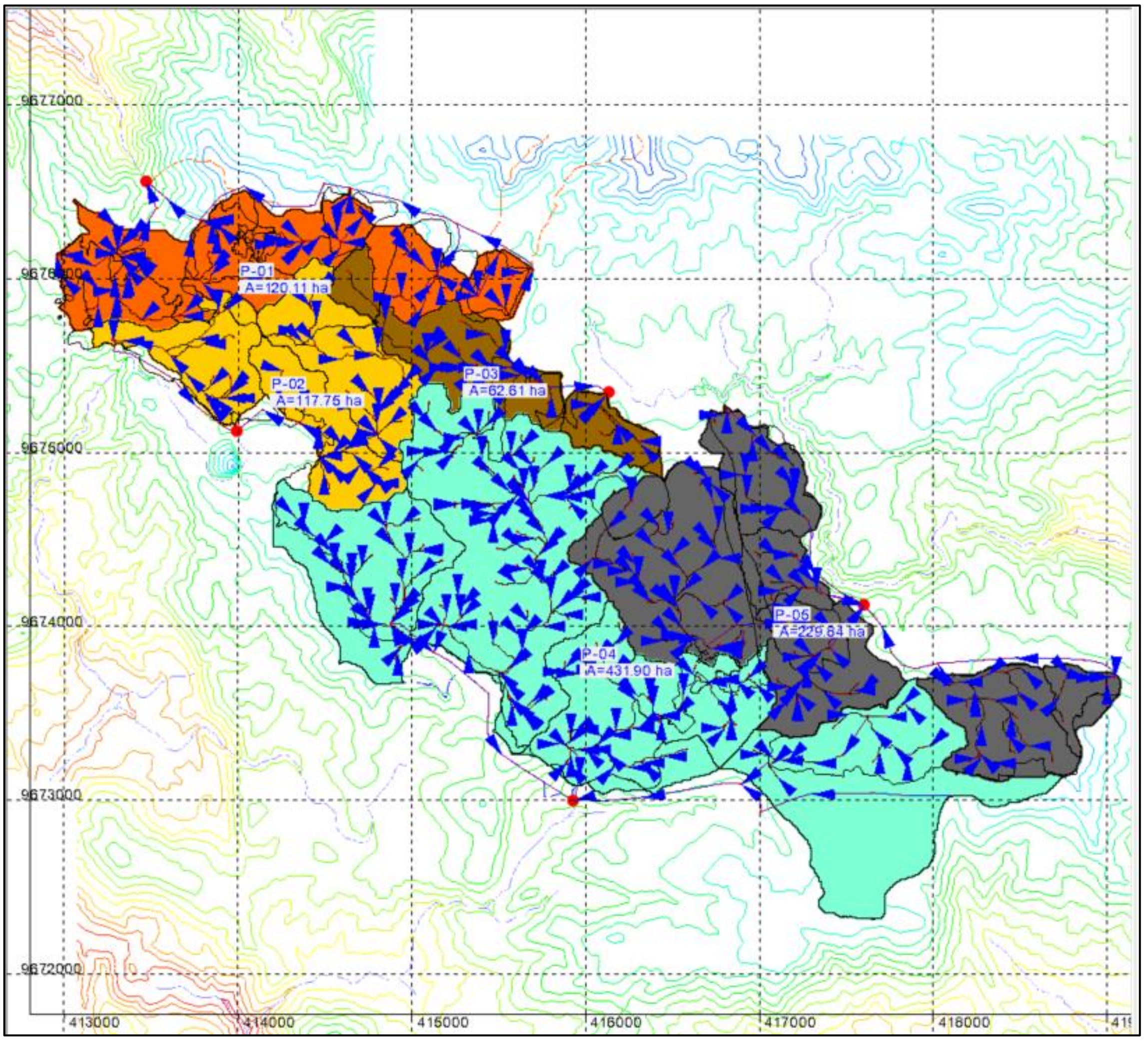
Tabel 3.5 Luas dan karakteristik fisik *sub-catchment area* rencana bukaan tambang

Sub-Catch	Basin Area (A)	Basin Slope (BS)	Basin Length (L)	Basin Perimeter (P)	Maximum Flow Disctance (MFD)	Maximum Flow Slope (MFS)
	Ha	m/m	m	m	m	m
90B	60.75	0.1677	1763.837	5831.0201	1922.19	0.0638
72B	36.85	0.2684	767.7083	4031.4898	1139.84	0.0474
70B	12.27	0.3989	496.3386	2194.1339	856.8	0.171
65B	87.02	0.2605	1067.7	5507.2013	1687.2	0.0744
63B	16.22	0.2826	572.8804	2494.0209	719.72	0.1265
55B	48.27	0.2162	1081.961	4704.3886	1765.09	0.0646
53B	34.91	0.2321	724.6296	4291.2807	981.7	0.0451
49B	14.91	0.2277	612.6794	2438.9548	709.53	0.0791
48B	47.7	0.1976	1401.445	5854.7629	1801.59	0.0677
44B	34.58	0.3007	910.1121	4516.9167	1170.39	0.1251

Sub-Catch	Basin Area (A)	Basin Slope (BS)	Basin Length (L)	Basin Perimeter (P)	Maximum Flow Disctance (MFD)	Maximum Flow Slope (MFS)
	Ha	m/m	m	m	m	m
38B	21.04	0.1707	458.1703	2473.4198	794.25	0.0733
34B	29.74	0.2517	846.7632	3370.16	1362.28	0.0521
78B	11.9	0.1932	478.2803	1784.6887	723.36	0.0484
30B	70.61	0.2994	1036.378	5122.3505	1272.68	0.0966
26B	56.35	0.256	879.6818	5425.3145	1426.41	0.0736
22B	40.6	0.3551	873.1552	3794.3871	1062.01	0.1411
20B	43.99	0.1977	620.8768	4111.5782	948.35	0.059
12B	41.71	0.3281	645.6748	4117.9297	1021.62	0.1496
7B	23.37	0.2437	636.088	3190.1908	1143.23	0.0701
6B	22.1	0.1827	680.2941	3150.7921	1179.8	0.0695
85B	50.84	0.3086	1108.52	4602.3301	1556.96	0.0556
85B	157.04	0.2427	1504.766	9670.0309	3120.85	0.0423

3.2.1.2. Catchment Area Rencana Pond

Catchment area dari *settling pond* dihitung sebagai titik akhir penyaliran dari lokasi tambang (pit dan *disposal*) sebelum dibuang ke perairan bebas. Secara umum konsep rencana *settling pond* terdiri dari lima lokasi utama, seperti dapat dilihat pada Gambar 3.12. Hasil delineasi luas masing-masing *sub-catchment* dan karakteristik fisik dari rencana *pond* dapat dilihat pada Tabel 3.6.



Gambar 3.12 *Sub-catchment area* rencana *settling pond*

Tabel 3.6 Luas dan karakteristik fisik *sub-catchment area* rencana *settling pond*

Sub-Catch	Basin Area (A)	Basin Slope (BS)	Basin Length (L)	Basin Perimeter (P)	Maximum Flow Disctance (MFD)	Maximum Stream Slope (MSS)
	Ha	m/m	m	m	m	m
P-01	120.11	0.2437	2307.6915	14708.4894	3352.18	0.1353
P-02	117.75	0.2455	1117.2108	13507.1236	2903.71	0.1739
P-03	62.61	0.2048	1724.464	8289.3021	2160.32	0.0543
P-04	431.9	0.2532	2820.4794	31951.1715	4548.61	0.0972
P-05	229.84	0.2726	1690.3491	21418.362	2971.23	0.1507

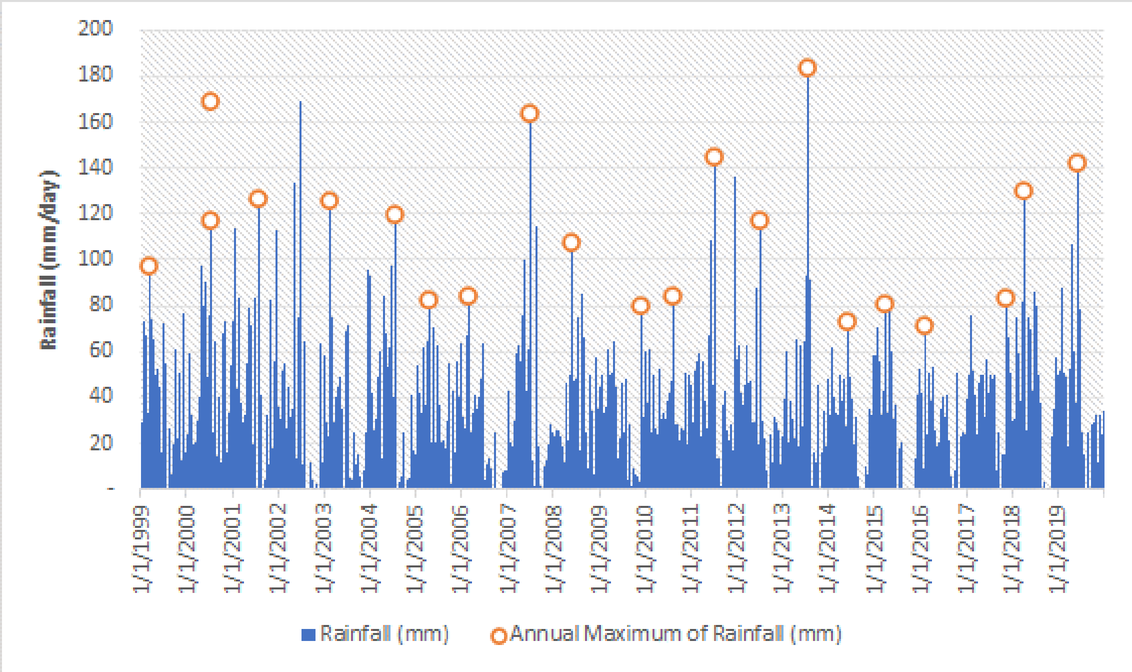
3.2.2. Desain Hujan Puncak

Desain hujan puncak diprediksi melalui analisis frekuensi. Analisis frekuensi bertujuan untuk mencari hubungan antara besarnya suatu kejadian (maksimum atau minimum) dan frekuensinya berdasarkan distribusi probabilitas. Hubungan antara besarnya kejadian dan frekuensinya, atau peluang kejadiannya adalah berbanding terbalik. Pengambilan seri data untuk tujuan analisis frekuensi dilakukan terhadap data maksimum tahunan (*annual maximum series*).

Data hujan maksimum tahunan diambil dari hasil data akuisisi yang diambil satu data maksimum untuk setiap tahunnya. Tabel 3.7 dan Gambar 3.13 memaparkan nilai curah hujan harian maksimum tahunan (*annual maximum*) untuk lokasi studi.

Tabel 3.7 Nilai hujan maksimum harian (*annual maximum*) lokasi studi

Tahun	Annual Maximum of Rainfall (mm)	Tanggal Kejadian
1999	97.05	4-Mar-99
2000	117.38	4-Jul-00
2001	126.76	22-Jul-01
2002	168.87	5-Jul-00
2003	125.50	8-Feb-03
2004	119.67	12-Jul-04
2005	82.65	9-Apr-05
2006	83.98	22-Feb-06
2007	164.11	28-Jun-07
2008	107.55	29-May-08
2009	80.34	24-Nov-09
2010	84.21	3-Aug-10
2011	144.88	11-Jul-11
2012	117.06	6-Jul-12
2013	184.07	10-Jul-13
2014	73.30	4-Jun-14
2015	81.10	31-Mar-15
2016	71.70	6-Feb-16
2017	83.50	15-Nov-17
2018	130.00	10-Apr-18
2019	142.00	7-Jun-19



Gambar 3.13 Grafik hujan maksimum harian (*annual maximum*) lokasi studi.

Frekuensi data hujan dapat diartikan sebagai suatu cara untuk memprediksi suatu besaran curah hujan di masa yang akan datang dengan menggunakan data curah hujan di masa yang lalu berdasarkan distribusi frekuensi. Dalam studi ini fungsi distribusi yang dianalisis menggunakan fungsi distribusi normal, distribusi log-normal, distribusi log Pearson III, dan distribusi Gumbel. Untuk mendapatkan fungsi distribusi yang sesuai digunakan, uji kompatibilitas dilakukan dengan metode Kolmogorov Smirnov dan Chi-Square. Hasil uji kesesuaian distribusi ditunjukkan pada Tabel 3.8. Hasil analisis distribusi yang paling mendekati adalah distribusi Normal.

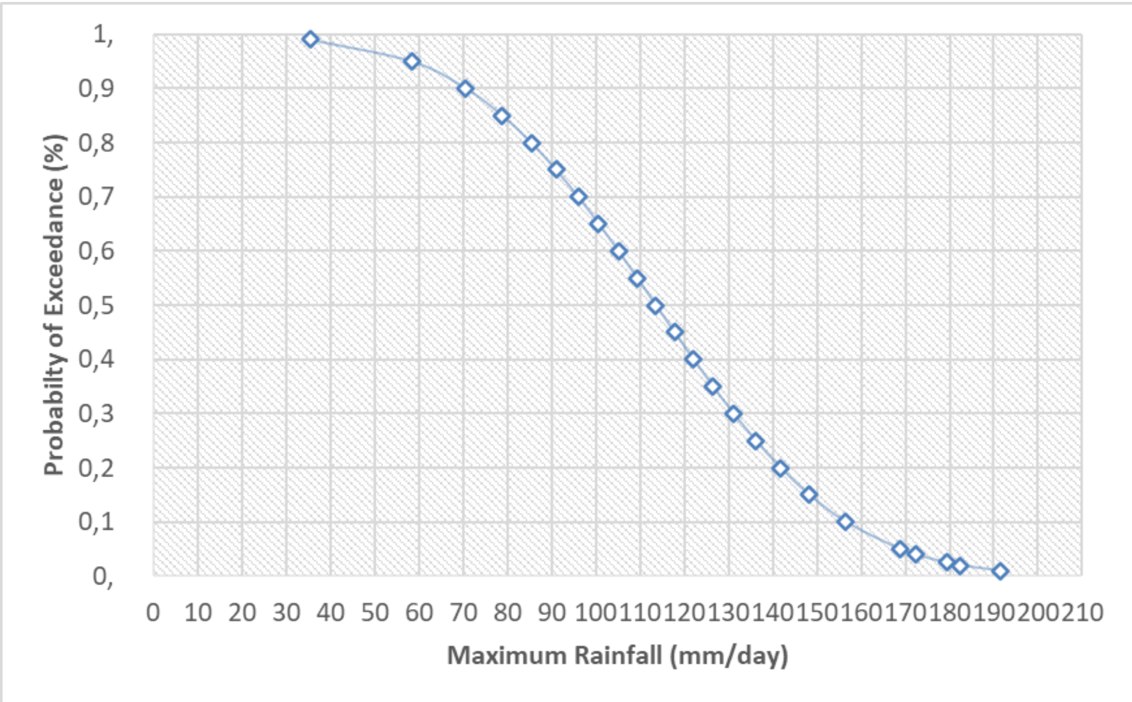
Tabel 3.8 Hasil uji kecocokan distribusi data hujan maksimum

Kolmogorov-Smirnov Test	**Normal**	**Log Normal**	**Gumbel**	**Log Pearson III**
D-value	0.173	0.177	0.186	0.176
D-Critical	0.284	0.284	0.284	0.284
Chi-Square Test	**Normal**	**Log Normal**	**Gumbel**	**Log Pearson III**
Chi-square (Observed value)	4.667	7.333	4.667	7.333
Derajat Kebebasan	4	4	4	3
Chi-square (Critical value)	9.448	9.448	9.448	7.815

Selanjutnya perhitungan hujan rencana (hujan puncak) dihitung dengan menggunakan fungsi distribusi Normal. Resume hasil perhitungan hujan puncak dengan probabilitas atau periode ulang tertentu dapat dilihat pada Tabel 3.9 dan Gambar 3.14.

Tabel 3.9 Hasil perhitungan hujan puncak pada periode ulang tertentu

P(x >= Xm) Probabilitas	Tahun Kala-Ulang	Hujan Puncak (mm/hari)
0.99	1	35.644
0.5	2	113.604
0.2	5	141.809
0.1	10	156.552
0.05	20	168.727
0.04	25	172.273
0.025	40	179.287
0.02	50	182.429
0.01	100	191.565



Gambar 3.14 Grafik probabilitas analisis hujan rencana (hujan puncak).

Intensitas Hujan Maksimum

Hasil yang didapatkan dari analisis frekuensi hujan masih berupa curah hujan harian (akumulasi selama 24 jam). Selanjutnya data hujan harian perlu diubah terlebih dahulu menjadi data intensitas. Intensitas hujan dapat dikatakan sebagai ketinggian atau kederasan hujan per satuan waktu, biasanya dinyatakan dalam satuan yang lebih pendek (mm/jam). Jika volume hujan adalah tetap, maka intensitas hujan akan makin tinggi seiring dengan durasi hujan yang makin singkat, sebaliknya intensitas hujan makin rendah seiring dengan durasi hujan yang makin lama. Nilai intensitas hujan dapat dinyatakan sebagai intensitas pada satu titik, yang dinyatakan melalui kurva IDF (*Intensity Duration Frequency*) atau hujan yang terdistribusi dalam hujan jam-jaman.

Jika data hujan jangka pendek tidak tersedia dan data hujan harian tersedia, maka persamaan regresi kurva IDF diturunkan dengan persamaan:

$$I = \frac{R_{24}}{24}\left(\frac{24}{t}\right)^{m}$$

R_{24} = curah hujan untuk satu hari

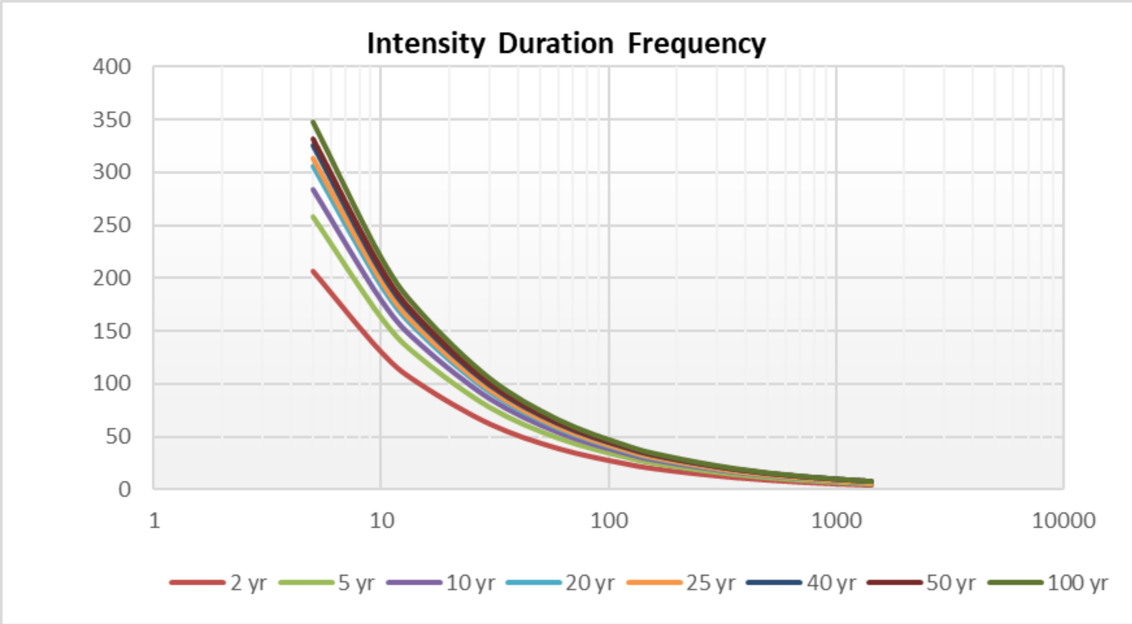
t = periode ulang (2, 5, 10, 15, 20, 25, 40, 50, dan 100 tahun)

m = koefisien hujan

Hasil perhitungan intensitas hujan periode ulang tertentu (*Intensity Duration Frequency*) dapat dilihat pada Tabel 3.10 dan Gambar 3.15.

Tabel 3.10 Hasil perhitungan intensitas periode ulang hujan (*Intensity Duration Frequency*) lokasi rencana tambang HM

Duration (minutes)	Rainfall Intensity (mm/hour)						
	2 yr	5 yr	10 yr	20 yr	25 yr	50 yr	100 yr
5	210.56	266.31	302.97	338.13	349.31	383.97	418.84
10	132.64	167.76	190.86	213.01	220.05	241.89	263.85
15	101.23	128.03	145.65	162.55	167.93	184.60	201.36
30	63.77	80.65	91.76	102.40	105.79	116.29	126.85
60	40.17	50.81	57.80	64.51	66.64	73.26	79.91
120	25.31	32.01	36.41	40.64	41.98	46.15	50.34
180	19.31	24.43	27.79	31.01	32.04	35.22	38.42
360	12.17	15.39	17.51	19.54	20.18	22.19	24.20
720	7.66	9.69	11.03	12.31	12.71	13.98	15.25
1440	4.83	6.11	6.95	7.75	8.01	8.80	9.60



Gambar 3.15 Kurva *Intensity Duration Frequency* (IDF) lokasi rencana tambang HM

3.2.3. Koefisien Limpasan

Koefisien limpasan adalah persentase jumlah air yang dapat melalui permukaan tanah dari keseluruhan air hujan yang jatuh pada suatu daerah. Semakin kedap suatu permukaan, maka semakin tinggi nilai koefisien pengalirannya. Nilai koefisien pengaliran (C) berkisar antara 0 – 1. Nilai C= 0 menunjukkan bahwa semua air hujan terintersepsi dan terinfiltrasi ke dalam tanah, sebaliknya untuk nilai C= 1 menunjukkan bahwa air hujan mengalir sebagai aliran permukaan.

Penentuan nilai faktor C dihitung dengan mengintegrasikan beberapa faktor yang mempengaruhi, yaitu: topografi, kapasitas infiltrasi, tutupan lahan, dan *surface storage*. Nilai koefisien C merupakan kombinasi dari beberapa faktor tersebut, dihitung berdasarkan referensi yang dapat dilihat pada Tabel 3.11 (*Hydraulic Design Manual*, TxDOT, 2016). Hasil perhitungan koefisien pengaliran (C) untuk masing-masing *sub-catchment* yang mempengaruhi tambang HM dapat dilihat pada Tabel 3.12.

Tabel 3.11 Kurva perhitungan koefisien limpasan (*Hydraulic Design Manual*, TxDOT, 2016)

Watershed characteristic	Extreme	High	Normal	Low
Relief - C_r	0.28-0.36	0.20-0.28	0.14-0.20	0.08-0.14
	Steep, rugged terrain with average slopes above 30%	Hilly, with average slopes of 10-30%	Rolling, with average slopes of 5-10%	*Relatifl*y flat land, with average slopes of 0-5%
Soil infiltration - C_i	0.12-0.16	0.08-0.12	0.06-0.08	0.04-0.06
	No effective soil cover; either rock or thin soil mantle of negligible infiltration capacity	Slow to take up water, clay or shallow loam soils of low infiltration capacity or poorly drained	Normal; well drained light or medium textured soils, sandy loams	Deep sand or other soil that takes up water readily; very light, well-drained soils
Vegetal cover - C_v	0.12-0.16	0.08-0.12	0.06-0.08	0.04-0.06
	No effective plant cover, bare or very sparse cover	Poor to fair; clean cultivation, crops or poor natural cover, less than 20% of drainage area has good cover	Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in crops	Good to excellent; about 90% of drainage area in good grassland, woodland
Surface Storage - C_s	0.10-0.12	0.08-0.10	0.06-0.08	0.04-0.06
	Negligible; surface depressions few and shallow, no marshes	Well-defined system of small drainage ways, no ponds or marshes	Normal; considerable surfacedepression, e.g., storage lakes and ponds	Much surface storage, large number of ponds or marshes

Tabel 3.12 Estimasi nilai koefisien limpasan pada *catchment* tambang HM

Parameter	Bukaan Tambang	Rencana Pond
Relief - Cr	0.32	0.28
Soil infiltration - Ci	0.16	0.14
Vegetal cover - Cv	0.16	0.16
Surface Storage - Cs	0.12	0.12
Total	**0.76**	**0.70**

3.2.4. Debit Puncak Air Permukaan

Estimasi debit puncak air permukaan dihitung untuk kepentingan rencana penyaliran tambang. Secara umum debit puncak dihitung untuk kepentingan:

1. Desain *sump* atau sumuran pit pada bukaan tambang
2. Desain saluran
3. Desain *setlling pond*

Berdasarkan data yang diterima, desain tambang merupakan desain pada kondisi tambang akhir, sehingga estimasi debit puncak menghitung kondisi maksimum. Analisis debit puncak air permukaan dihitung dengan menggunakan metode rasional. Berdasarkan SNI 2415:2016 metode rasional dapat digunakan untuk luas DAS yang relatif kecil. Metode rasional adalah metode empiris dari hubungan sederhana antara intensitas curah hujan dengan debit puncak. Persamaan pada metode rasional adalah sebagai berikut:

$$Q = C.I.A$$

Q = debit banjir maksimum (m^3/dtk)

C = koefisien pengaliran/limpasan

I = intensitas curah hujan rata-rata (mm/jam)

A = luas daerah pengaliran (m^2)

Metode rasional pada prinsipnya menggunakan beberapa dasar asumsi, sebagai berikut:

- Curah hujan didistribusikan secara merata ke seluruh area drainase dan konstan sepanjang waktu
- Estimasi debit puncak memiliki probabilitas kejadian yang sama (periode ulang) seperti yang digunakan pada distribusi intensitas hujan (I)
- Estimasi debit puncak dapat direpresentasikan oleh intensitas curah hujan rata-rata selama periode waktu yang sama dengan waktu konsentrasi (Tc)
- Koefisien pengaliran dianggap konstan

Penentuan intensitas hujan yang digunakan mengacu kepada asumsi bahwa hujan terdistribusi merata dengan intensitas hujan terjadi selama periode waktu yang sama dengan waktu konsentrasi.

Dalam hal ini perhitungan waktu konsentrasi menggunakan metode Kirpich dengan persamaan:

$$tc = 0.0195\, L^{0.77}\, S^{-0.385}$$

tc = waktu konsentrasi

L = panjang *basin* (m)

S = *slope* rata-rata *catchment*

Debit Puncak Rencana Bukaan Tambang

Hasil estimasi debit puncak air permukaan dengan metode rasional pada rencana bukaan tambang HM dapat dilihat pada Tabel 3.13. Hasil tersebut merupakan estimasi debit puncak menggunakan periode ulang 25 tahun.

Tabel 3.13 Estimasi debit dan volume maksimum aliran air permukaan pada masing-masing *sub-catchment* rencana bukaan tambang HM

Sub-Catchment	Runoff Coefficient (C)	Rainfall Intensity (mm/hour)	Catchment Area (A) (Ha)	Time of Concentration (minutes)	Peak Flow Rate (m3/sec)
90B	0.76	31.12	60.75	159.39	3.99
72B	0.76	37.71	36.85	119.51	2.93
70B	0.76	60.69	12.27	58.52	1.57
65B	0.76	34.63	87.02	135.82	6.36
63B	0.76	61.43	16.22	57.47	2.10
55B	0.76	32.62	48.27	148.52	3.32
53B	0.76	40.21	34.91	108.52	2.96
49B	0.76	54.85	14.91	68.11	1.73
48B	0.76	32.68	47.70	148.16	3.29
44B	0.76	47.73	34.58	83.93	3.48
38B	0.76	50.77	21.04	76.50	2.25
34B	0.76	35.27	29.74	132.15	2.21
78B	0.76	47.88	11.90	83.53	1.20
30B	0.76	42.79	70.61	98.86	6.38
26B	0.76	0.00	56.35	119.86	0.00
22B	0.76	51.74	40.60	74.35	4.43
20B	0.76	43.85	43.99	95.29	4.07
12B	0.76	53.59	41.71	70.54	4.72
7B	0.76	41.63	23.37	103.02	2.05
6B	0.76	40.87	22.10	105.90	1.91
85B	0.76	30.56	50.84	150.76	3.28

Debit Puncak Rencana *Pond*

Hasil estimasi debit puncak air permukaan dengan metode rasional pada rencana *pond* dapat dilihat pada Tabel 3.14. Hasil tersebut merupakan estimasi debit puncak dengan periode ulang 100 tahun.

Tabel 3.14 Estimasi debit dan volume maksimum aliran air permukaan pada masing-masing *sub-catchment* rencana *settling pond*

Sub-Catchment	Runoff Coefficient	Rainfall Intensity	Catchment Area (A)	Time of Concentration	Peak Flow Rate
	(C)	(mm/hour)	(Ha)	(minutes)	(m3/sec)
P-01	0.7	31.45	120.11	135.56	7.34
P-02	0.7	36.12	117.75	240.27	8.27
P-03	0.7	31.17	62.61	91.89	3.79
P-04	0.7	24.67	431.90	69.02	20.72
P-05	0.7	34.40	229.84	63.96	15.37

3.3. Analisis Hidrogeologi

3.3.1. Latar Belakang Geologi

Lokasi rencana penambangan HM secara keseluruhan terbentuk oleh Kompleks Ultramafik yang terdiri dari litologi peridotit, harzburgit, Iherzolit, wherkit, serpentinit, dan dunit. Unit stratigrafi ini berumur Kapur hingga Oligosen (Simandjuntak dkk., 1991). Pada bagian permukaan, pelapukan batuan ultrabasa di lokasi IUP HM menghasilkan bijih nikel yang dikenal sebagai nikel laterit. Secara umum profil endapan laterit pada lokasi HM adalah sebagai berikut:

1. Lapisan Penutup

   Lapisan ini berwarna coklat kemerahan, merupakan kumpulan massa goetit, hematit, dan limonit, mempunyai kadar besi yang tinggi tetapi kandungan nikel yang relatif rendah.

2. Lapisan Limonit

   Lapisan ini berbutir halus, berwarna coklat muda sampai kekuningan dengan komposisi mineral terdiri dari goetit, limonit, hematit, magnetit, kromit, dan kuarsa sekunder. Kadang-kadang juga dijumpai mineral talk, tremolit, kuarsa, dan maghemit. Pada mineral goetit terikat nikel, krom, kobalt, vanadium, dan aluminium. Lapisan ini umumnya tipis pada daerah yang terjal hingga hilang karena erosi.

3. Zona Saprolit

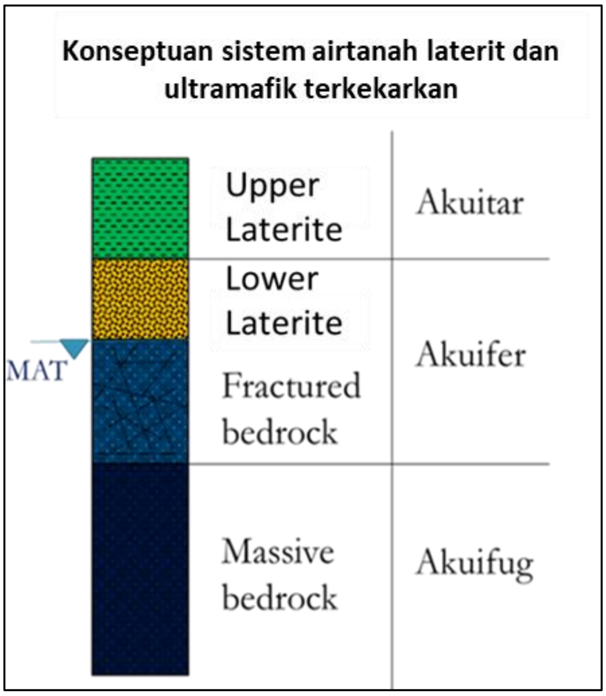
Lapisan ini umumnya berwarna coklat kekuningan sampai kehijauan, merupakan lapisan batuan dasar yang sudah lapuk. Struktur dan tekstur batuan asal masih bisa terlihat. Perubahan geokimia zona ini yang terletak di atas bantuan asal tidak banyak H_2O dan nikel bertambah, sedangkan magnesium dan silika hanya sedikit yang hilang terlindi, zona ini terdiri dari campuran sisa-sisa batuan asal, butiran halus limonit, urat garnierit, kuarsa, mangan, dan kadang-kadang terdapat silika *boxwork*.

4. Zona batuan dasar (*bedrock*)

   Merupakan bagian terbawah dari profil laterit, tersusun dari bongkah-bongkah yang lebih besar dari 75 cm dan blok batuan dasar. Umumnya zona ini berwarna abu-abu kehijauan dan tidak mengandung mineral ekonomis. Kadar mineral logam mendekati atau sama dengan batuan asal.

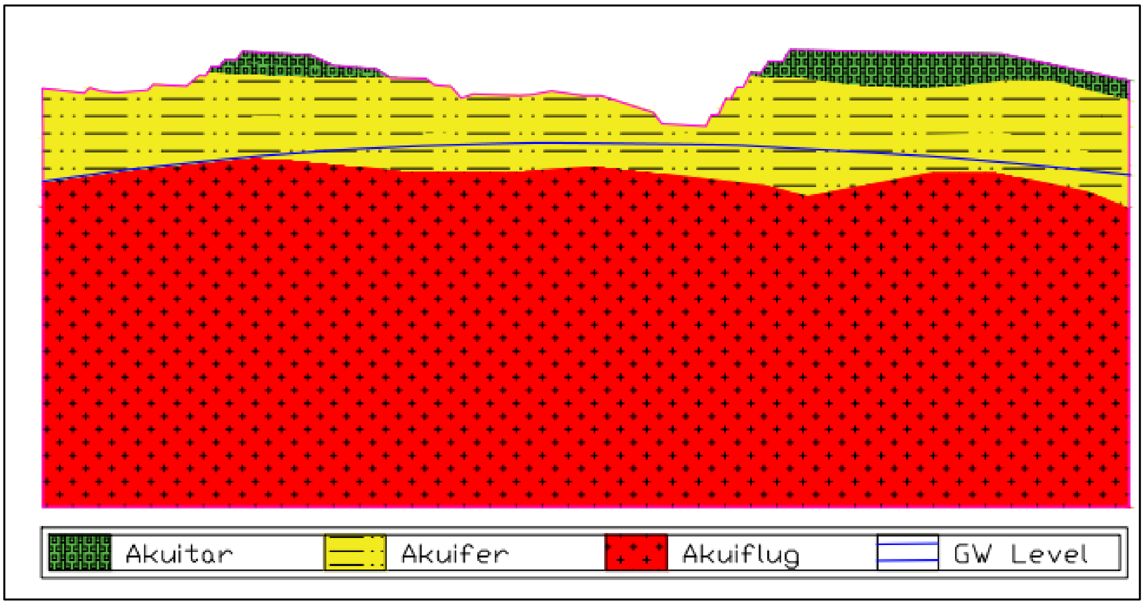
3.3.2. Sistem Hidrogeologi

Sistem airtanah laterit dan ultramafik terkekarkan hadir pada Formasi Ultrabasa, di mana lokasi rencana tambang HM terletak pada sistem airtanah ini. Berdasarkan hasil interpretasi diketahui bahwa lapisan penyusun hidrostratigrafi sistem airtanah ini dibagi menjadi tiga, yaitu tanah laterit berukuran lempung (laterit atas), laterit bawah dan batuan ultramafik terkekarkan, serta batuan ultramafik tidak terkekarkan. Lapisan yang membentuk zona akuifer utama pada sistem airtanah ini adalah laterit bawah dan batuan ultramafik terkekarkan. Lapisan laterit bawah dan batuan ultramafik terkekarkan dikelompokkan menjadi satu zona akuifer utama. Tanah laterit berukuran lempung (limonit) berfungsi sebagai lapisan akuiklud, sedangkan lapisan batuan ultramafik yang tidak terkekarkan bertindak sebagai lapisan akuifug (Gambar 3.16). Ketebalan lapisan akuifer sangat bervariasi yaitu berkisar antara 10-30 m dan lapisan akuifug (batuan dasar yang tidak terkekarkan) diasumsikan kontinu hingga ketebalan lebih dari 100 meter.



Gambar 3.16 Konseptual sistem hidrogeologi lokasi IUP HM

Berdasarkan interpolasi data pengeboran geoteknik, selanjutnya interpretasi hidrostratigrafi di lokasi rencana tambang HM dibuat dengan representatif penampang seperti dapat dilihat pada Gambar 3.17. Lapisan limonit yang berada pada bagian paling atas sangat dipengaruhi oleh aktivitas permukaan yang kuat. Hal ini mengakibatkan lapisan limonit secara umum memiliki ukuran butir yang halus (lempung-lanau) yang membuat lapisan ini diklasifikasikan sebagai akuiklud. Lapisan saprolit atau yang merupakan zona bijih tersusun atas fragmen-fragmen batuan induk yang ter-alterasi, namun pengaruh aktivitas permukaan cenderung minimal. Akibat hasil tersebut maka ukuran butir pada lapisan ini cenderung sangat heterogen, namun berdasarkan hasil uji lapangan lapisan saprolit masuk dalam klasifikasi akuifer. Lapisan terbawah dari nikel laterit merupakan *bedrock*.

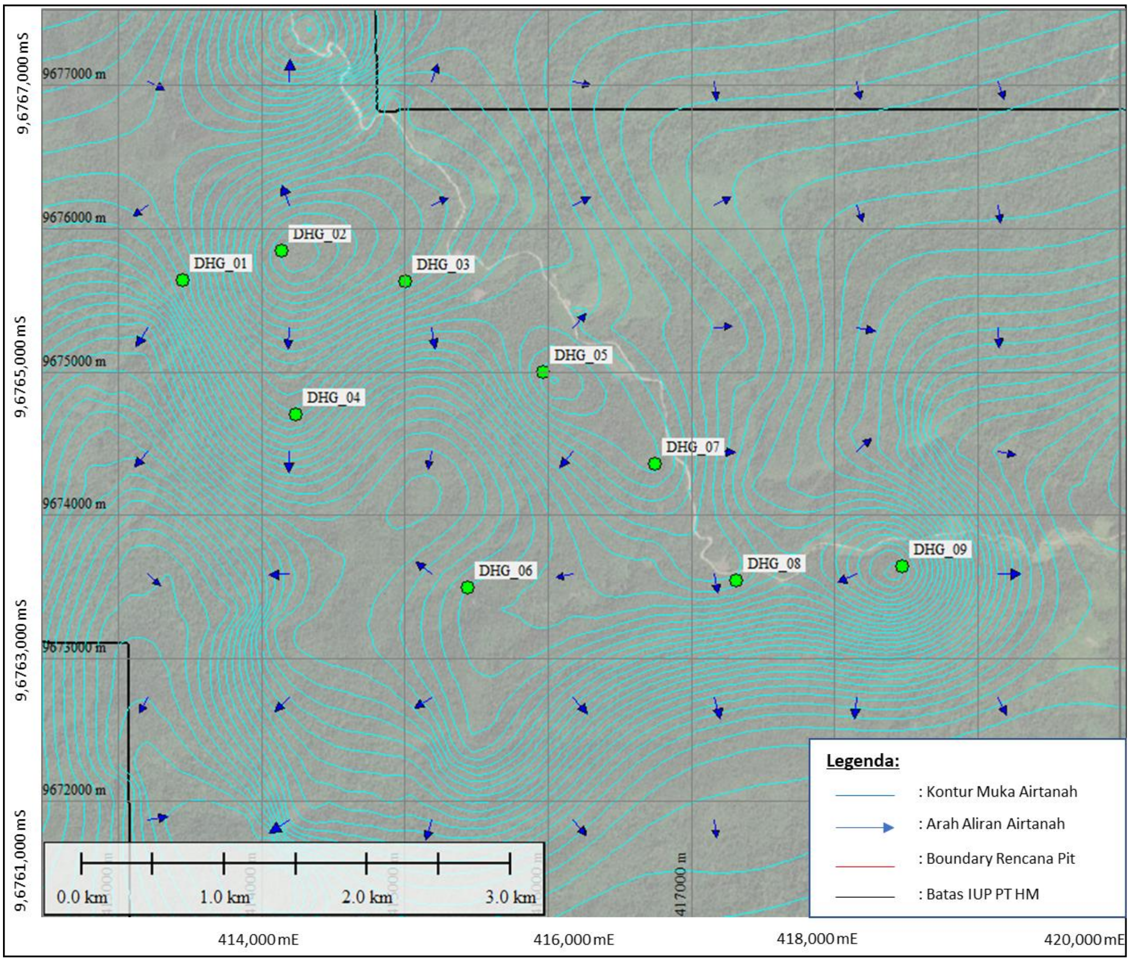


Gambar 3.17 Representatif penampang hidrostratigrafi lokasi IUP HM

Secara umum, berdasarkan hasil pengamatan lapangan, *bedrock* dapat dibagi menjadi dua bagian, yaitu *fractured bedrock* dan *unfractured bedrock*. *Fractured bedrock* hadir dominan pada bagian atas dari *bedrock* yang hadir dengan ketebalan variatif. Kondisi batuan dasar yang terkekarkan membuat zona ini menjadi potensial sebagai zona akuifer dengan medium sistem rekahan. Zona *unfractured bedrock* terletak pada bagian bawah merupakan batuan yang masih segar dan tidak terkekarkan. Zona *unfractured bedrock* diklasifikasikan sebagai akuifug.

3.3.3. Pola Aliran dan Muka Airtanah

Berdasarkan data hasil pengukuran level muka airtanah, interpolasi kontur muka airtanah dilakukan untuk mengetahui gambaran umum pola dan aliran airtanah pada kondisi yang ada saat ini. Selain data muka airtanah, interpretasi juga dibangun berdasarkan fitur hidrologi lainnya, seperti batas sungai dan batas laut. Peta kontur muka airtanah dan interpretasi alirannya dapat dilihat pada Gambar 3.18.



Gambar 3.18 Pola umum aliran airtanah lokasi studi

Berdasarkan hasil interpretasi dapat terlihat bahwa kondisi aliran airtanah saat ini telah terpengaruh oleh aktivitas penambangan yang telah berjalan. Pada area tambang kontur airtanah berada lebih rendah dari daerah sekitarnya dan aliran airtanah cenderung mengarah pada area bukaan tambang. Penurunan atau perubahan aliran airtanah akibat aktivitas tambang berjalan saat ini relatif bersifat lokal, yaitu perubahan tidak memengaruhi aliran secara regional. Airtanah mengalir cenderung dari arah baratlaut menuju tenggara.

3.3.4. Model Hidrogeologi

Model hidrogeologi dibuat untuk dapat memahami kondisi airtanah pada lokasi tambang HM, memprediksi pola perubahan airtanah, serta memprediksi *inflow* airtanah pada kondisi penambangan selanjutnya.

Metode, Pendekatan, dan Asumsi

Pemodelan aliran airtanah (*flow model*) bertujuan untuk mendapatkan gambaran perubahan pola aliran tanah antara kondisi *existing* dan penambangan. Beberapa pendekatan dan asumsi yang digunakan dalam model aliran antara lain:

- Simulasi menggunakan metode *finite difference.*
- Airtanah dianggap sebagai satu sistem besar dengan koneksi hidraulik melalui semua litologi yang hadir.
- *Input* awal parameter hidraulik (K) menggunakan data hasil pengujian lapangan dan penyesuaian nilai parameter hidraulik (K) dilakukan selama proses kalibrasi model.
- Parameter hidraulik lainnya (storativitas, porositas efektif, dan laju infiltrasi aktual) diasumsikan berdasarkan literatur dan merupakan bentuk ketidakpastian.
- *Initial head* menggunakan hasil interpretasi kontur muka airtanah yang telah dijelaskan pada sub-bab sebelumnya.
- Kalibrasi model dilakukan pada kondisi tunak (*steady state*), menggunakan data elevasi airtanah hasil pengukuran lapangan kondisi *existing*.

Model kondisi tunak dijalankan untuk memverifikasi model secara fisik. Model kondisi transien yang dikalibrasi perlu dibangun selanjutnya menggunakan data pemantauan airtanah yang dikumpulkan selanjutnya untuk memberikan hasil yang lebih akurat.

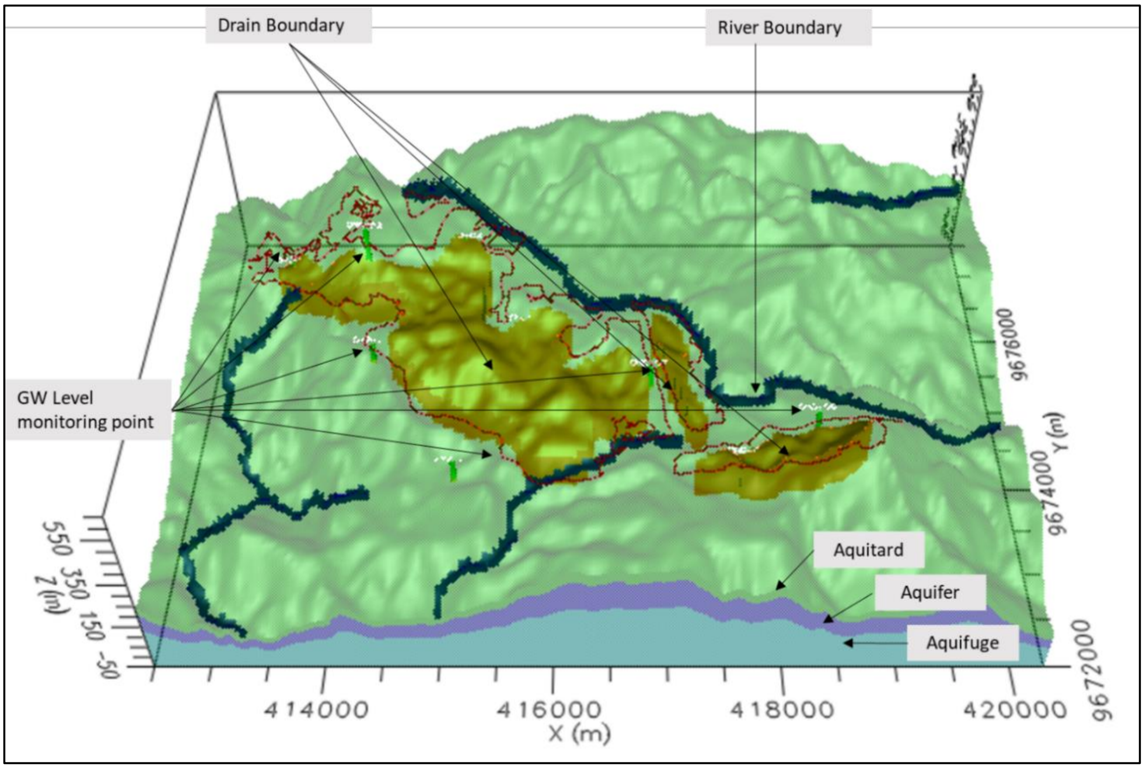
Dimensi Model Fisik

Model hidrogeologi dibangun dengan dimensi 7,8 km pada arah barat-timur dan 5,5 km pada arah utara-selatan dengan luas model sekitar 42,9 km^2. Model dibuat lebih luas dari area *interest* untuk dapat melihat pola perubahan aliran airtanah secara lebih luas. Model ini menggunakan ukuran *grid* berukuran 50 m x 50 m dengan total jumlah sel sebanyak 51.480. Batas dimensi serta ukuran *grid* dari model fisik dapat dilihat pada Tabel 3.15.

Tabel 3.15 Dimensi dan ukuran *grid* dari model fisik hidrogeologi

Dimensi Model			Jarak (m)	Ukuran Grid (m)	Jumlah Grid/Layer
Easting (column)	Min	412500	7800	50	156
	Max	420300			
Northing (row)	Min	9672000	5500	50	110
	Max	9677500			
Elevasi	Min	-50	550	-	3
	Max	500			

Aliran airtanah dimodelkan berdasarkan pendekatan hidrostratigrafi, sehingga layer dibentuk dengan mengikuti hidrostratigrafi berdasarkan interpretasi data bor, atau dengan kata lain masing-masing layer yang terbentuk akan memuat nilai parameter hidraulik tertentu. Selanjutnya data topografi digunakan sebagai batas permukaan dalam pemodelan, sedangkan batas bawah dibatasi pada elevasi -50 mdpl yang diklasifikasikan sebagai lapisan akuifug. Gambaran model fisik hidrogeologi dapat dilihat pada **Error! Reference source not found.**.



Gambar 3.19 Gambaran model hidrogeologi pada bidang tiga dimensi

Initial Head

Distribusi *initial head* airtanah dimodelkan secara spasial berdasarkan pengukuran air tanah yang dilakukan pada tahun 2021. Secara umum, aliran airtanah pada kondisi awal mengalir cenderung berarah barat-timur (lihat Gambar 3.18).

Parameter Hidraulik

Data parameter hidraulik dibuat berdasarkan model konseptual yang telah dijelaskan sebelumnya. Penyesuaian nilai parameter hidraulik dilakukan selama pembuatan model *steady-state*. Data kondisi parameter hidraulik yang digunakan dalam pemodelan dapat dilihat pada Tabel 3.16.

Tabel 3.16 *Input* parameter hidraulik untuk model airtanah

Layer	Litologi	Hidrostratigrafi	K	S			
			(m/s)	Ss	Sy	Eff. Por.	Tot. Por.
1	Limonit	Akuiklud	1.40E-09	3.00E-04	0.12	0.21	0.41
2	Saprolit	Akuifer	5.00E-06	4.90E-03	0.30	0.26	0.53
3	Bedrock	Akuifug	1.00E-12	3.00E-07	0.08	0.03	0.35

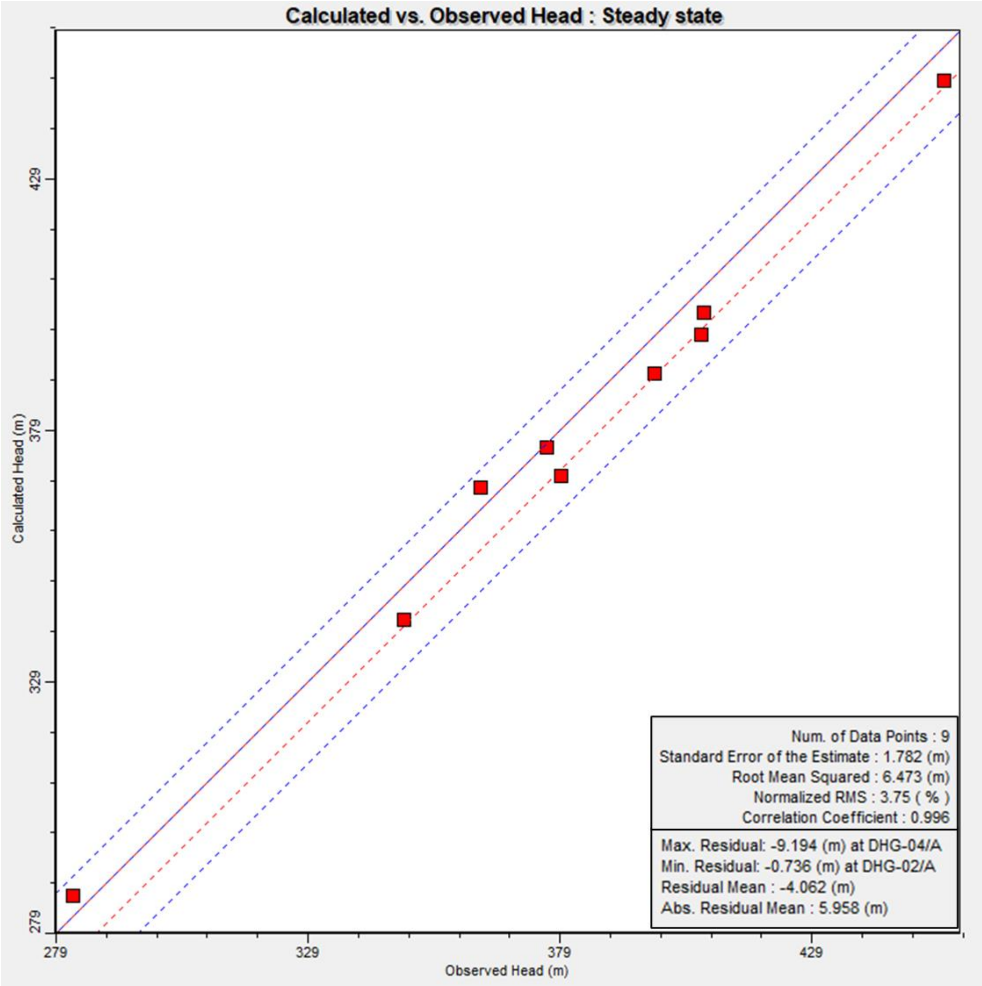
Kondisi Batas

Beberapa penyesuaian ilmiah seperti kondisi batas digunakan pada pembuatan model. Sungai menjadi kondisi batas aliran (*river boundary*) di permukaan dan memiliki hubungan hidraulik dengan akuifer. Untuk “mengisi” kekosongan data muka airtanah, maka digunakan kondisi batas *general head* di bagian tepi model. Rencana bukaan pit yang dibentuk penggalian tambang digunakan sebagai kondisi batas *drain*. Pada batas kedalaman tertentu (-50 mbgs), diasumsikan tidak ada aliran (*no flow boundary*). Skema kondisi batas untuk model aliran airtanah dapat dilihat pada Gambar 3.19.

3.3.4.1. Model Kalibrasi (Steady State)

Kalibrasi model diperlukan untuk memastikan bahwa properti, asumsi, dan metodologi yang digunakan telah mendekati kondisi sebenarnya. Kalibrasi model dalam maknanya yang paling sederhana adalah modifikasi data *input* model untuk tujuan memastikan model lebih sesuai dengan nilai yang diamati (misal *head* dan *flow*). Model pada awalnya dikalibrasi berdasarkan kondisi *steady* yang menggambarkan tatanan/*setting* pemodelan hidrogeologi pada kondisi awal. Kondisi *steady* adalah suatu kondisi di mana jumlah airtanah yang masuk (*recharge*) adalah sama dengan jumlah airtanah yang keluar (*discharge*). Simulasi pada kondisi ini bertujuan untuk mendapatkan gambaran model fisik telah mendekati dengan kondisi sebenarnya.

Grafik kalibrasi antara model dan data yang diukur ditunjukkan pada Gambar 3.20, yang merupakan grafik kalibrasi model pada kondisi *steady state*. Grafik tersebut membandingkan antara kondisi model (*calculated*) dengan kondisi lapangan (*observed*). Model kalibrasi menunjukkan koefisien korelasi sebesar 0,996 dengan *standard error of the estimate* sebesar 1,782 m. Berdasarkan hal tersebut model dianggap sudah mendekati kondisi lapangan dan dapat digunakan untuk memprediksi perubahan *head* dalam kondisi transien dengan perubahan aliran airtanah.



Gambar 3.20 Kalibrasi model kondisi *steady state*, perbandingan *head* airtanah model dengan data observasi lapangan

3.3.4.2. Model Prediksi Rencana Pengembangan Tambang

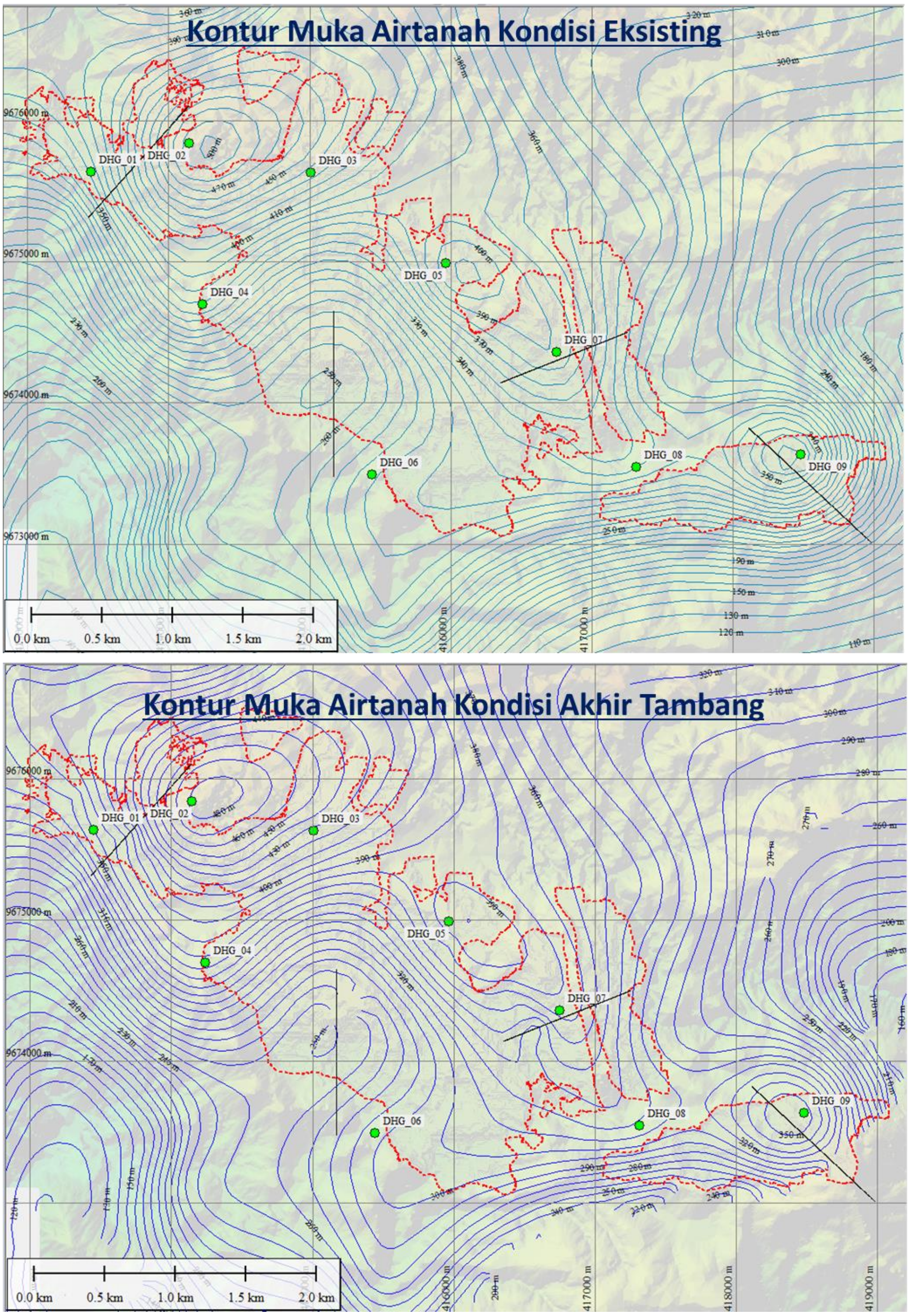
Setelah didapatkan kalibrasi yang diharapkan, dibuat model untuk memprediksi aliran airtanah berdasarkan rencana pit yang diberikan oleh PT HM. Hasil pemodelan airtanah kondisi *steady* akan menjadi dasar model prediksi. *Head* airtanah akan digunakan sebagai *initial head* untuk model transien. Secara umum, asumsi dan parameter yang digunakan pada model prediksi adalah sebagai berikut:

- *Initial head* awal model prediksi adalah *head* airtanah hasil pemodelan *steady state.*
- Air yang keluar melalui dinding bukaan tambang dianggap akan dikeringkan, dalam hal ini kondisi batas *drain* (*drain boundary*) dibuat pada lantai dan dinding tambang dari rencana *open* pit.
- Perubahan morfologi menggunakan data desain bukaan tambang akhir PT HM.

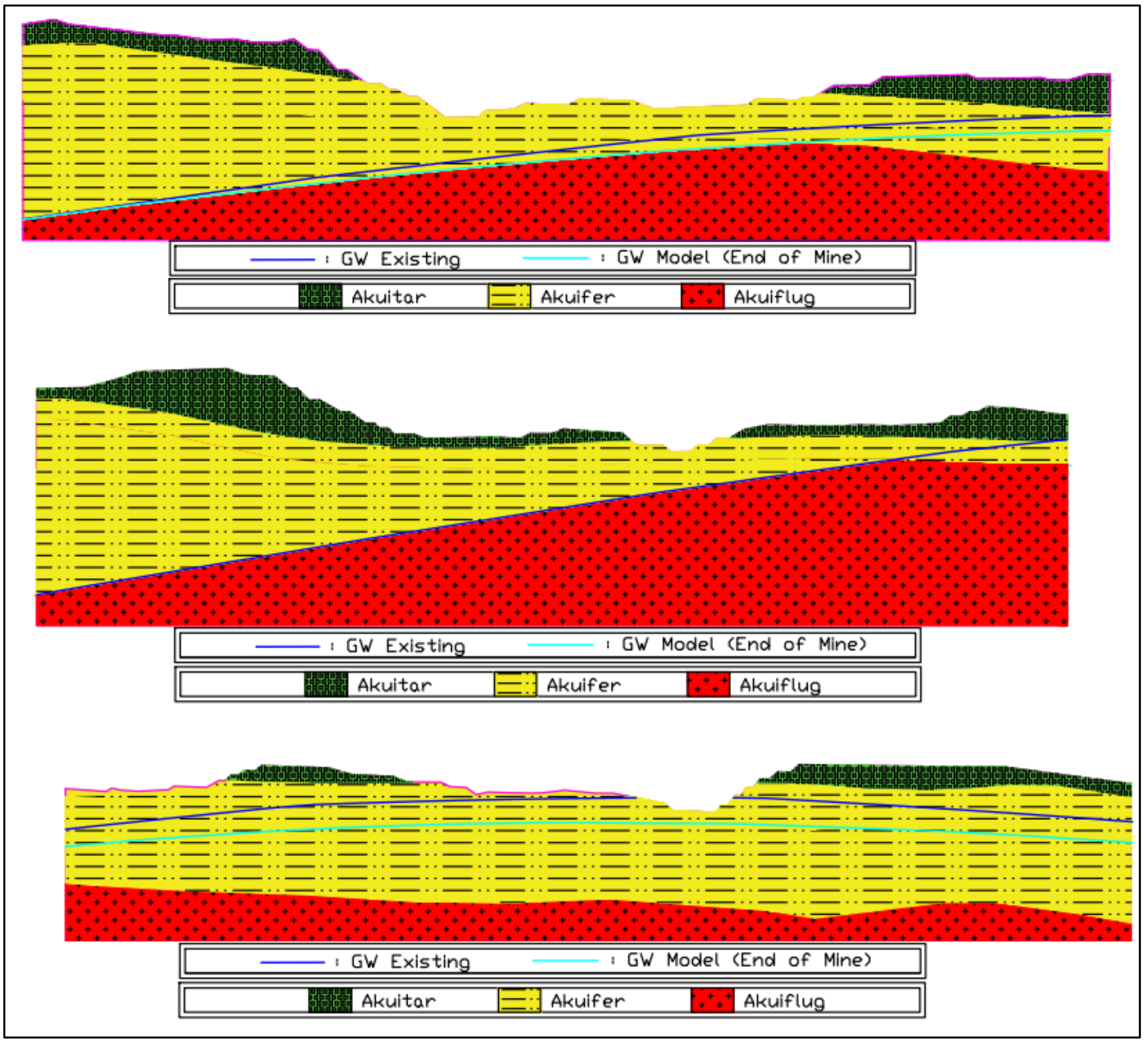
Pola Perubahan *Head* Airtanah

Secara umum, kemajuan penambangan akan berpotensi mengubah pola aliran airtanah, karena operasi penambangan dapat memotong lapisan airtanah alami yang memungkinkan adanya aliran airtanah ke dalam bukaan tambang sehingga menyebabkan terjadinya *drawdown* (penurunan *head* airtanah).

Hasil pemodelan transien menunjukkan bahwa tidak ada perubahan pola aliran airtanah secara regional, namun tampak bahwa ada perubahan kontur airtanah terutama pada daerah-daerah bukaan tambang dengan radius yang terbatas (< 500 meter) (Gambar 3.21). Perubahan muka airtanah pada kondisi akhir tambang dengan kondisi *existing* tidak jauh berbeda secara signifikan, di mana diketahui posisi muka airtanah saat ini sudah relatif mengikuti pola bukaan tambang berjalan. Penampang tipikal perubahan airtanah kondisi *existing* dan kondisi akhir tambang dapat dilihat pada Gambar 3.22.



Gambar 3.21 Pola aliran *head* airtanah *existing* (atas) dan akhir tambang (bawah)



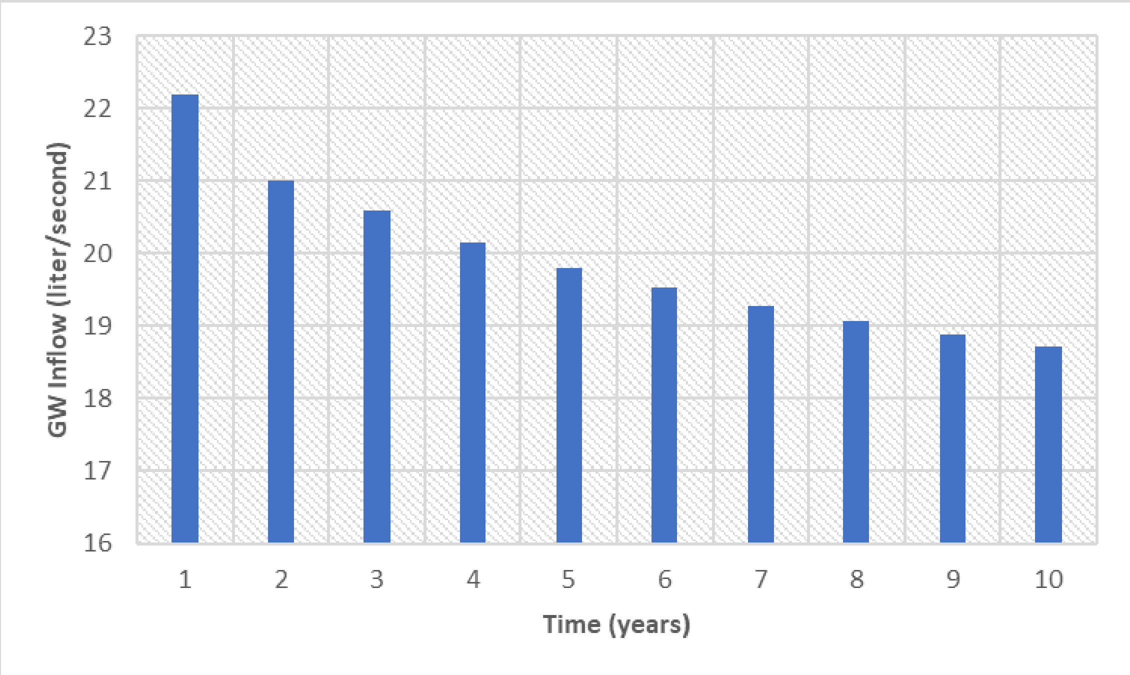
Gambar 3.22 Representatif penampang airtanah kondisi *existing* dan akhir tambang

Estimasi *Groundwater Inflow*

Estimasi debit airtanah yang masuk ke dalam bukaan tambang berdasarkan model prediksi/transien dapat dilihat pada Tabel 3.17 dan direpresentasikan pada grafik di Gambar 3.23. Dari hasil simulasi didapatkan bahwa debit *groundwater inflow* secara umum cenderung kecil. Hal ini disebabkan karena posisi muka airtanah yang relatif telah turun, sehingga sedikit yang berpotongan dengan bukaan tambang. Pola grafik pada Gambar 3.23 menunjukkan debit airtanah yang besar di tahun awal dan berangsur turun menuju garis konstan (*steady*). Pada kondisi aktualnya debit airtanah yang masuk ke dalam tambang dapat bersifat lebih rendah maupun lebih tinggi, menyesuaikan kemajuan tambang (luas dan kedalaman).

Tabel 3.17 Estimasi *groundwater inflow*

Time [years]	Rates [m^3/day]	GW Inflow (liter/second)
1	1917.7	22.19
2	1814.4	21.45
3	1779.5	20.59
4	1740.2	20.14
5	1711.2	19.80
6	1686.8	19.52
7	1665.6	19.27
8	1646.8	19.06
9	1631.6	18.88
10	1616.4	18.70



Gambar 3.23 Representasi grafis debit *groundwater inflow* ke dalam pit

3.4. Rekomendasi Teknis

3.4.1. Saluran Drainase

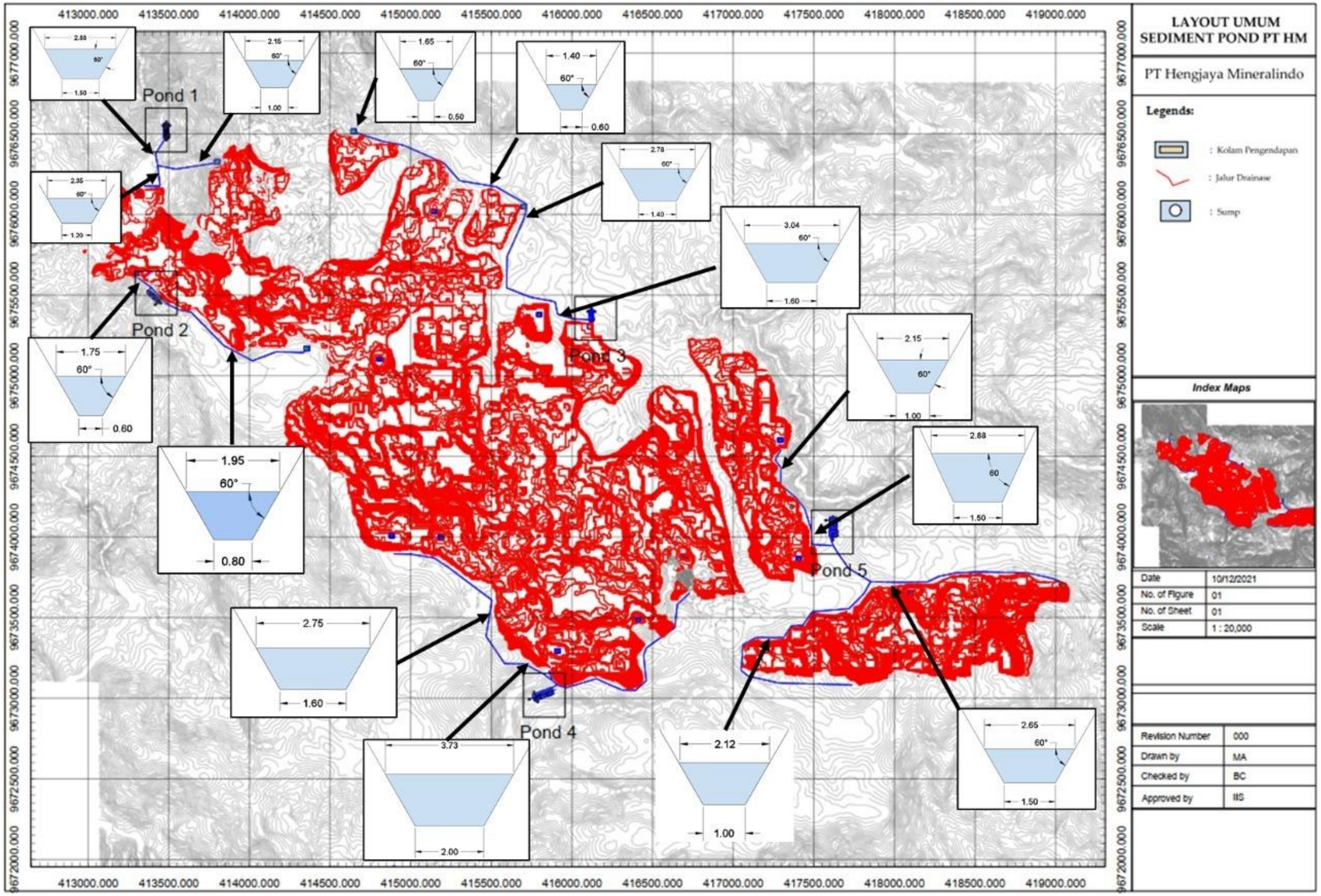
Perimeter Drainase

Saluran perimeter dibutuhkan khususnya pada bagian Selatan dari area pit *central east* (Gambar 3.24). Saluran ini dibuat untuk mencegah masuknya air permukaan yang cukup besar dari luar ke dalam pit.

Rekomendasi dimensi perimeter drainase ditentukan berdasarkan hasil analisis yang dilakukan pada debit rencana yang telah dihitung sebelumnya. Pembuatan perimeter drainase direkomendasikan dengan bentuk saluran berupa trapesium. Dimensi perimeter drainase untuk masing-masing lokasi dapat dilihat pada Tabel 3.18. *Layout* rekomendasi perimeter drainase, serta tipikal dimensi saluran dapat dilihat pada Gambar 3.24.

Drainase Antara

Saluran antara dari lokasi tambang menuju *pond* dibutuhkan untuk mengalirkan air tambang sebelum masuk dan diproses pada *settling pond*. Rekomendasi drainase antara ditentukan berdasarkan hasil analisis yang dilakukan pada debit rencana yang telah dihitung sebelumnya. Pembuatan drainase antara di rekomendasikan dengan bentuk saluran berupa trapesium. Dimensi drainase antara untuk masing-masing lokasi dapat dilihat pada Tabel 3.18. *Layout* rekomendasi perimeter drainase serta tipikal dimensi saluran dapat dilihat pada Gambar 3.24.



Gambar 3.24 Rekomendasi sistem penyaliran rencana tambang PT HM

Tabel 3.18 Rekomendasi dimensi drainase rencana tambang PT HM

Design Parameter	Unit	CD-01	CD-02	CD-03	CD-04	CD-05	CD-06	CD-07
Shape		Trapezium	Trapezium	Trapezium	Trapezium	Trapezium	Trapezium	Trapezium
Discharge Design (Qc)	m^3/sec	4.72	3.96	8.68	2.25	1.20	7.78	9.51
Bottom Width (b)	m	1.20	1.00	1.50	0.50	0.60	1.40	1.60
Top Width (T)	m	2.35	2.15	2.88	1.65	1.41	2.78	3.04
Height (y)	m	1.00	1.00	1.20	1.00	0.70	1.20	1.25
Slope Ratio (z)	m	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Manning coeff.(n)		0.04	0.04	0.04	0.04	0.04	0.04	0.04
Drainage slope (s)		0.03	0.03	0.03	0.03	0.03	0.03	0.03
Angle	°	60	60	60	60	60	60	60
Area (A)	m2	1.78	1.58	2.63	1.08	0.70	2.51	2.90
Wet Perimeter (P)	m	3.51	3.31	4.27	2.81	2.22	4.17	4.49
Radius Hidrolic (R)	m	0.51	0.48	0.62	0.38	0.32	0.60	0.65
Velocity (v)	m/sec	2.87	2.76	3.27	2.38	2.10	3.22	3.38
Discharge (Q)	m^3/sec	5.10	4.34	8.60	2.56	1.47	8.08	9.80

Design Parameter	Unit	CD-01	CD-02	CD-03	CD-04	CD-05	CD-06	CD-07
Shape		Trapezium	Trapezium	Trapezium	Trapezium	Trapezium	Trapezium	Trapezium
Discharge Design (Qc)	m^3/sec	4.32	8.39	5.64	2.96	3.48	6.38	15.67
Bottom Width (b)	m	1.00	1.50	1.50	0.60	0.80	1.60	2.00
Top Width (T)	m	2.15	2.88	2.65	1.75	1.95	2.75	3.73
Height (y)	m	1.00	1.20	1.00	1.00	1.00	1.00	1.50
Slope Ratio (z)	m	0.58	0.58	0.58	0.58	0.58	0.58	0.58

Design Parameter	Unit	CD-01	CD-02	CD-03	CD-04	CD-05	CD-06	CD-07
Shape		Trapezium	Trapezium	Trapezium	Trapezium	Trapezium	Trapezium	Trapezium
Manning coeff.(n)		0.04	0.04	0.04	0.04	0.04	0.04	0.04
Drainage slope (s)		0.03	0.03	0.03	0.03	0.03	0.03	0.03
Angle	°	60	60	60	60	60	60	60
Area (A)	m2	1.58	2.63	2.08	1.18	1.38	2.18	4.30
Wet Perimeter (P)	m	3.31	4.27	3.81	2.91	3.11	3.91	5.46
Radius Hidrolic (R)	m	0.48	0.62	0.55	0.40	0.44	0.56	0.79
Velocity (v)	m/sec	2.76	3.27	3.01	2.47	2.62	3.06	3.85
Discharge (Q)	m^3/sec	4.34	8.60	6.26	2.91	3.61	6.65	16.54

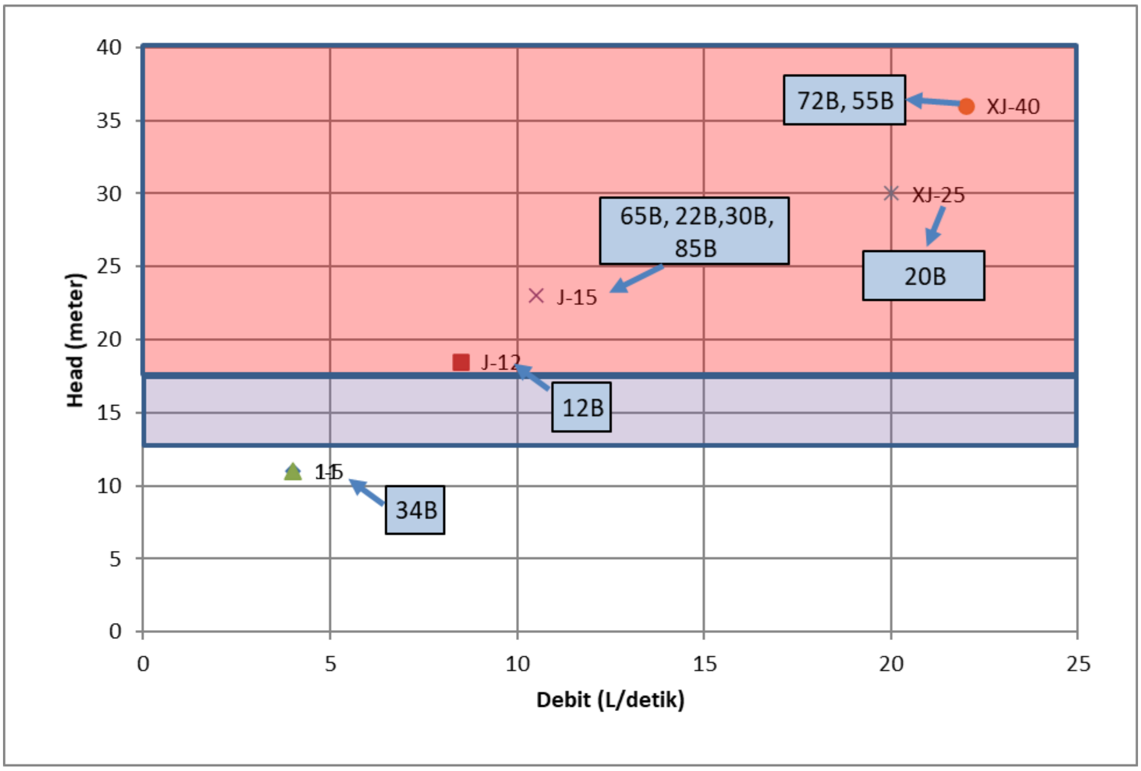
3.4.2. *Sump* dan Pemompaan

Penggunaan pompa di tambang terbuka adalah untuk menjaga agar kapasitas *sump* dapat selalu menahan total limpasan air (airtanah dan air permukaan) yang masuk ke dalam pit. Keseimbangan jumlah air masuk-keluar dilakukan dengan memilih pompa dengan kapasitas yang tepat. Secara teknis, pemilihan pompa dibuat berdasarkan dua faktor utama, yaitu kemampuan dorong pompa (*head*) dan jumlah air yang bisa dipompa (volume/waktu). Dengan mengasumsikan efisiensi *head* 85%, untuk menghilangkan risiko kegagalan maka diperlukan spesifikasi pompa dorong yang mampu mendorong air naik ke lereng dari *sump*. Parameter berikutnya yang harus dipertimbangkan dalam pemilihan pompa adalah kemampuan debit pompa untuk mengeluarkan air dari lokasi tambang. Diperlukan pompa yang mampu mengeringkan secepat mungkin, sehingga *sump* dapat digunakan secara reguler. Kapasitas *inflow* dan *head* maksimum dari masing-masing lokasi rencana pit PT HM dapat dilihat pada Tabel 3.19.

Tabel 3.19 Kapasitas *inflow* maksimum dan *head* dari masing-masing rencana pit

Sub-Catchment	Peak Flow Rate (m3/s)	Head (m)	Head Max (85% Efisiensi) (m)
34B	2.21	6	6.90
65B	6.36	12	13.80
20B	4.07	20	23.00
72B	2.93	30	34.50
22B	4.43	6	6.90
55B	3.32	28	32.20
48B	3.29	8	9.20
30B	6.38	10	11.50
12B	4.72	8	9.20
85B	3.28	4	4.60

Penentuan pompa yang digunakan pada masing-masing pit dihitung berdasarkan potensi maksimum debit *inflow* dan kapasitas *head* maksimum masing-masing rencana pit setelah dikurangi efisiensi sebesar 85%. Gambar 3.25 memperlihatkan spesifikasi pompa yang umum digunakan pada tambang terbuka (contoh dalam produk Sultzer) dengan detail pada Tabel 3.20. Blok biru pada Gambar 3.25 memperlihatkan jenis pompa yang dapat digunakan pada lokasi tambang PT HM.



Gambar 3.25 Spesifikasi pompa berdasarkan kemampuan *head* dan *discharge* (contoh dari produk Sultzer)

Tabel 3.20 Rekomendasi spesifikasi jenis pompa (sejenis) untuk mengantisipasi aliran puncak pada tambang PT HM

Catchment	Jenis Pompa	Discharge (m^3/s)	Head Pompa (m)	Inflow (m^3/s)	Head Max (m)	Ratio
34B	J-5	4	11	2.21	6.90	0.55
65B	J-15	10.5	23	6.36	13.80	0.61
20B	XJ-25	20	30	4.07	23.00	0.39
72B	XJ-40	22	36	2.93	34.50	0.13
22B	J-15	10.5	23	4.43	6.90	0.42
55B	XJ-40	22	36	3.32	32.20	0.17
48B	J-12	8.5	18.5	4.72	9.20	0.56
30B	J-15	10.5	23	6.38	11.50	0.61
12B	J-12	8.5	18.5	4.72	9.20	0.56
85B	J-15	10.5	23	3.28	4.60	0.31

Infrastruktur lain yang dibutuhkan untuk penyaliran di dalam tambang adalah *sump*. *Sump* didefinisikan sebagai kolam untuk mengumpulkan air dan terletak di tingkat terendah level penambangan. Air yang mengalir ke *sump* harus dipompa keluar dari tambang ke kolam pengendapan. Ada dua jenis *sump*, yaitu permanen dan sementara.

Sump permanen dibangun dan digunakan selama kegiatan pertambangan berlangsung, sedangkan *sump* sementara hanya digunakan sementara dan dapat dibangun mengikuti perkembangan dan kebutuhan kegiatan penambangan.

Ukuran *sump* utama harus mampu mengakomodasi jumlah air tanah dan air permukaan yang mengalir ke lubang tambang dan idealnya terletak di titik terendah level penambangan. Ukurannya disesuaikan dengan kemampuan total pemompaan yang tersedia. *Sump* pada pit PT HM berjumlah sesuai dengan *sub-catchment* pada area pertambangan. Dari *sump*, air akan dipompa terlebih dahulu ke perimeter drainase, namun tidak semua *sump* membutuhkan pompa karena tidak memiliki *head* ke lokasi perimeter drainase terdekat. Beberapa *sump* yang membutuhkan pemompaan disajikan pada Tabel 3.21.

Tabel 3.21 Karakteristik *sub-catchment* beserta besar *head* untuk dialirkan ke perimeter

Sub-Catchment	Peak Flow Rate	Head	Head Max
34B	2.21	6	6.90
65B	6.36	12	13.80
20B	4.07	20	23.00
72B	2.93	30	34.50
22B	4.43	6	6.90
55B	3.32	28	32.20
48B	3.29	8	9.20
30B	6.38	10	11.50
12B	4.72	8	9.20
85B	3.28	4	4.60

3.4.3. Sediment Pond

Sediment Pond adalah suatu penyaliran berbentuk kolam yang berfungsi sebagai kolam pengendapan semua air dari areal tambang, baik air tanah maupun air hujan dan bertujuan untuk menjernihkan air yang keluar ke perairan umum. Sebelum menghitung kebutuhan *settling pond*, dibutuhkan perhitungan kecepatan pengendapan sedimen (*Fall Velocity*) yang mengacu pada *Stoke's Law*. Persamaan untuk menghitung *Fall Velocity* adalah sebagai berikut:

$$Vp = \frac{[g\ (\rho p - \ \rho e)\ d^2]}{(18\ h)}$$

Keterangan:

Vp = *vertical fall velocity of particles* (m/s)

g = percepatan gravitasi (9.81 m/s^2)

ρp = densitas partikel tanah (kg/m^3)

ρe = densitas massa air (1000 kg/m^3)

d = diameter partikel untuk sedimentasi (m)

h = kekentalan dinamis air pada suhu 4°C (0.0016 Pa.s)

Selain itu dihitung juga kebutuhan luas permukaan *sediment pond* dengan persamaan:

$$As = \frac{\Theta\, Q}{Vp}$$

Keterangan:

As = minimum luas air pada cekungan (m^2)

Θ = faktor *adjustment* yang berkaitan dengan turbulen (Θ memiliki nilai 1, 1,2, atau 1,5 tergantung pada derajat turbulen pada cekungan sedimentasi)

Q = tingkat debit (m^3/s) sesuai dengan 5% dari aliran puncak (*peak flow*)

Vp = kecepatan sedimentasi (m/s)

Data ukuran butir yang digunakan pada perhitungan menggunakan hasil analisis laboratorium, yaitu ukuran butir dominan pada bagian permukaan di lokasi studi adalah partikel dengan ukuran medium *silt*. Resume perhitungan *Fall Velocity* dan luas permukaan *sediment pond* dapat dilihat pada Tabel 3.22. Perhitungan ini telah memasukkan faktor keselamatan (*factor of safety*) dengan mengalikan debit puncak sebesar 1.25 kali sesuai rekomendasi pada Kepmen 1827 tahun 2018.

Tabel 3.22 Perhitungan *fall velocity* dan luas permukaan *sediment pond*

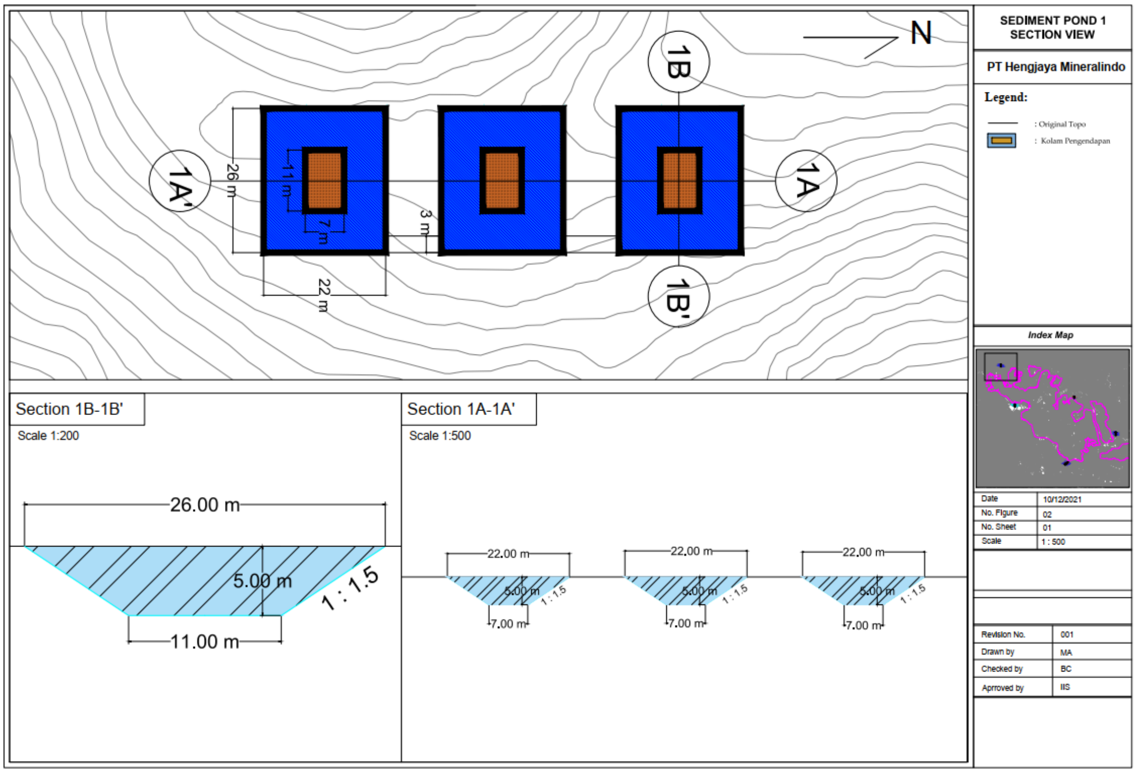
Parameter		Unit	Pond				
			P01	P02	P03	P04	P05
Watershed area	A	ha	120.11	117.75	62.61	431.9	229.84
Peak flow (1,25 x Qp)	Qp	m^3/s	9.175	10.3375	4.7375	25.9	19.2125
Discharge Rate (5% x Qp)	Q	m^3/s	0.37	0.41	0.19	1.04	0.77
Particle size (medium silt)	d	m	2.00E-05	2.00E-05	2.00E-05	2.00E-05	2.00E-05

Parameter		Unit	Pond				
			P01	P02	P03	P04	P05
Soil particle density	pp	kg/m^3	2617	2617	2617	2617	2617
Water density	pe	kg/m^3	1000	1000	1000	1000	1000
Adjusment factor related to turbulence	ϴ		1	1	1	1	1
Fall velocity	**Vp**	**m/s**	**2.20E-04**	**2.20E-04**	**2.20E-04**	**2.20E-04**	**2.20E-04**
Minimum area of sediment pond	**As**	**m^2**	**1665.79**	**1876.85**	**860.13**	**4702.33**	**3488.17**

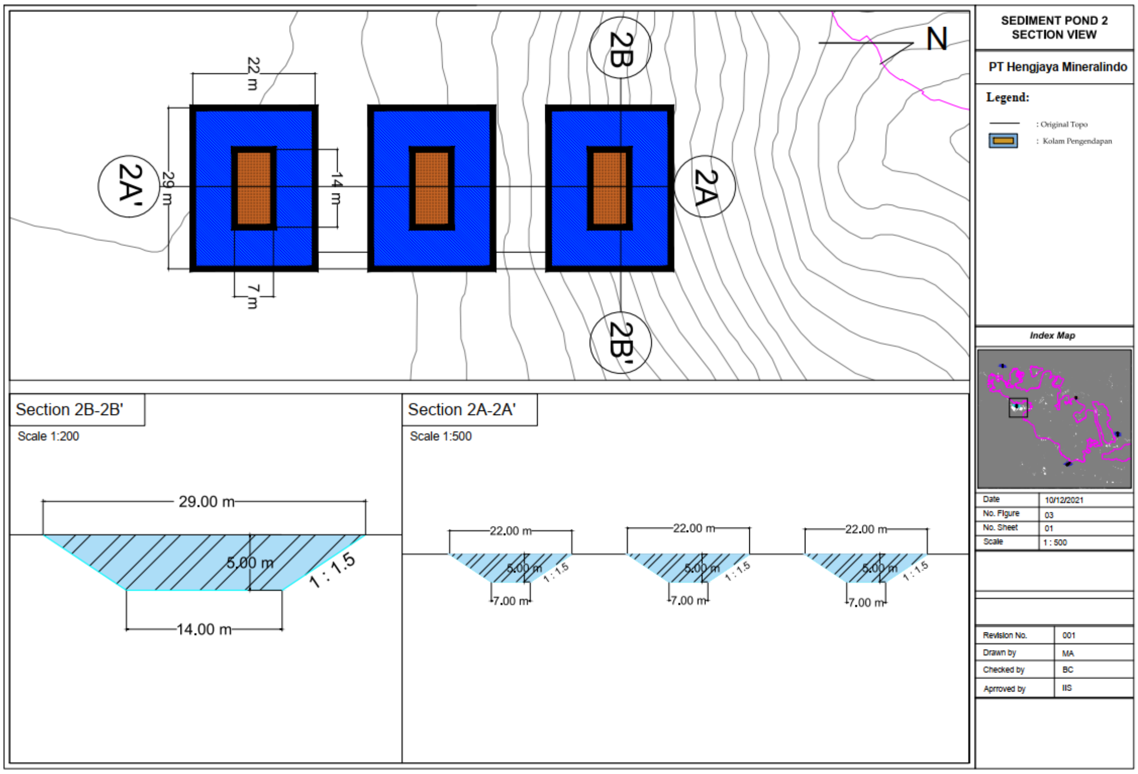
Dengan diketahuinya luas permukaan *sediment pond* yang dibutuhkan, maka dapat diperkirakan dimensi secara keseluruhan. Untuk menjaga kestabilan dinding *sediment pond*, maka kemiringannya dijaga pada angka 1:1.5. Perkiraan dimensi untuk *Pond* 1 hingga 5 dapat dilihat pada Tabel 3.23. Dari perhitungan yang dilakukan, *sediment pond* untuk masing-masing *catchment* (*Pond* 1 hingga *Pond* 5) dibagi menjadi 3 kompartemen, dengan estimasi volume tiap kompartemen berkisar antara 598.5 m^3 hingga 8448 m^3. Konsep desain rekomendasi masing-masing *settling pond* dapat dilihat pada Gambar 3.26 hingga Gambar 3.30.

Tabel 3.23 Perhitungan jumlah dan dimensi *settling pond*

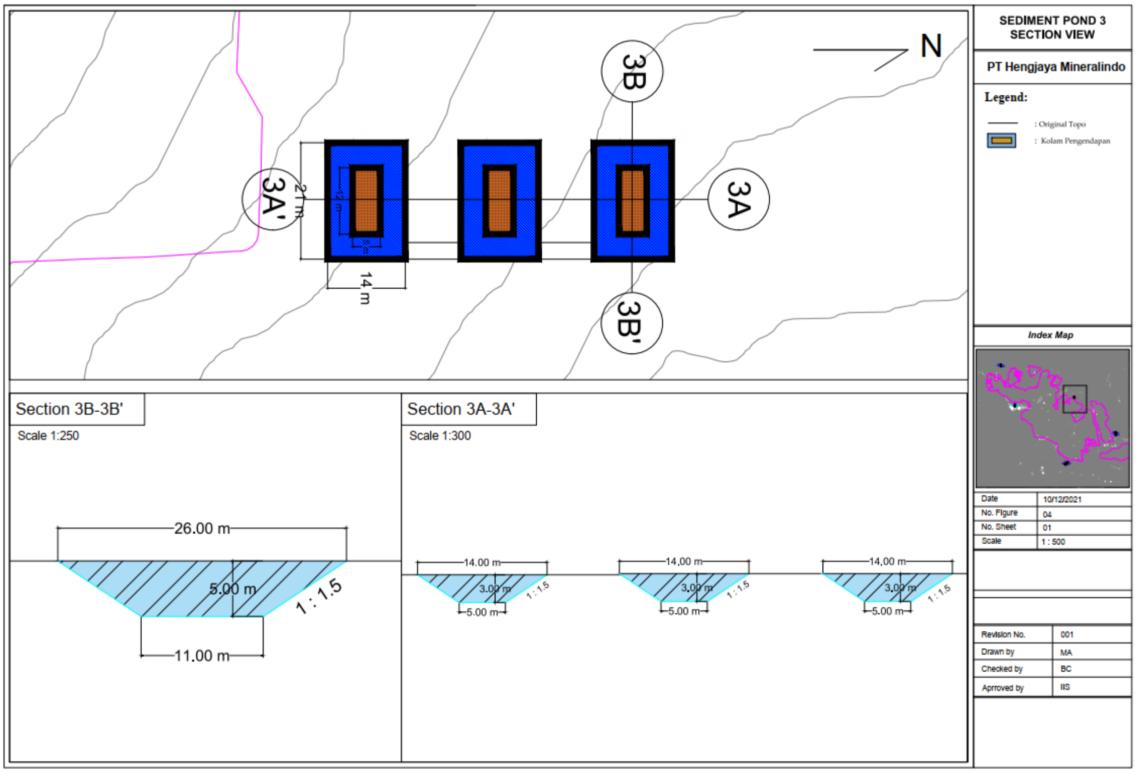
Parameter		Unit	Pond				
			P01	P02	P03	P04	P05
Sediment Pond Dimension							
Slope of sides			1:1.5	1:1.5	1:1.5	1:1.5	1:1.5
Number of sediment pond			3	3	3	3	3
Width at floor of sediment pond	L	m	7	7	5	12	10
Water depth during operation	P	m	5	5	3	8	7
Width of water surface	**W**	**m**	**22**	**22**	**14**	**36**	**31**
Length of sediment pond	**l**	**m**	**26**	**29**	**21**	**44**	**38**
Sediment pond volume (per compartment)		m^3	1885	2102.5	598.5	8448	5453
Total sediment pond volume		m^3	9425	10512.5	1795.5	67584	38171



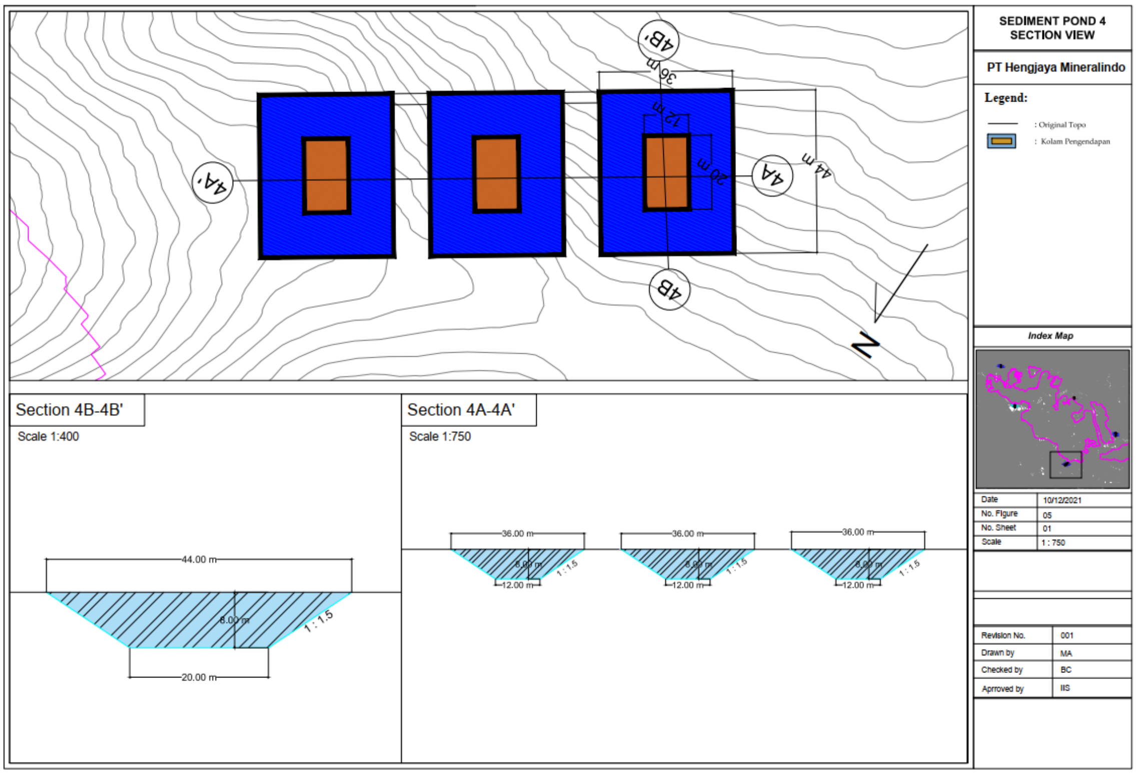
Gambar 3.26 Tipikal rekomendasi *Sediment Pond-01*



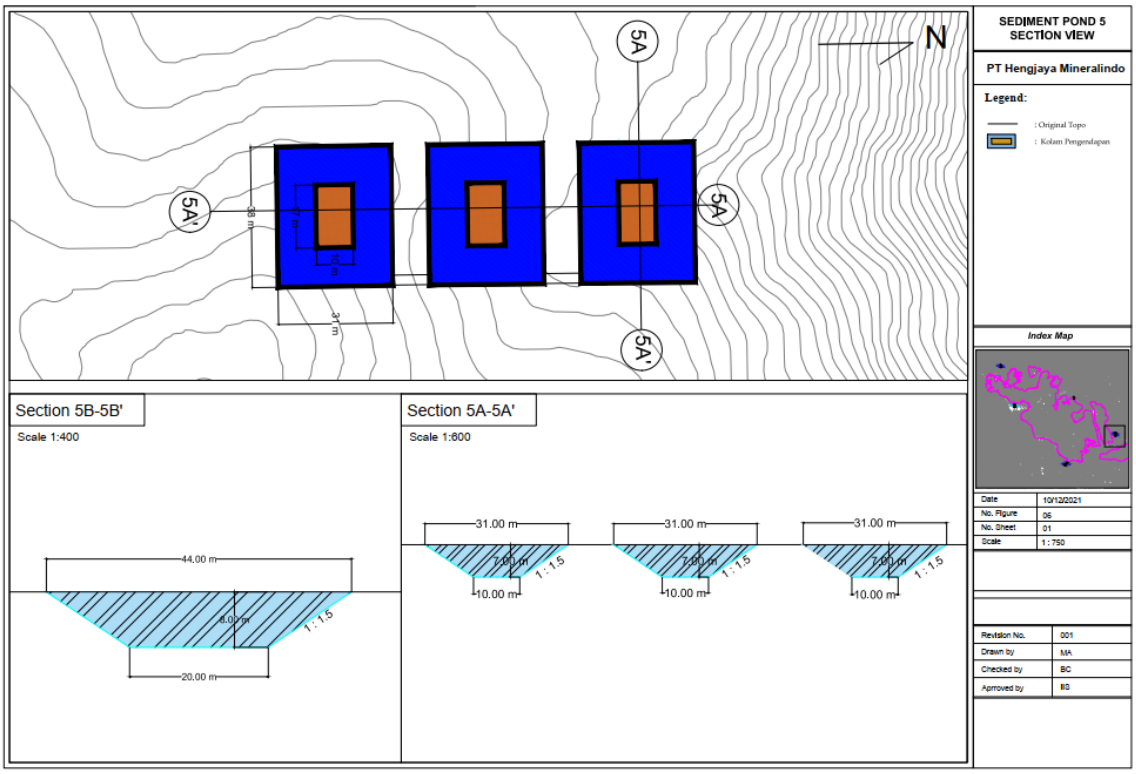
Gambar 3.27 Tipikal rekomendasi *Sediment Pond*-02



Gambar 3.28 Tipikal rekomendasi *Sediment Pond-03*



Gambar 3.29 Tipikal rekomendasi *Sediment Pond-0*



Gambar 3.30 Tipikal rekomendasi *Sediment Pond-05*

Perkiraan partikel yang akan terendapkan pada *sediment pond* dilakukan dengan menggunakan persamaan *Universal Soil Loss Equation* (USLE):

$$A = R\ K\ LS\ C\ P$$

Keterangan:

A = tanah hilang tahunan karena erosi (*annual soil loss due erosion*)

R = indeks erosi hujan

K = faktor kemampuan tanah tererosi

LS = faktor panjang dan *slope*

C = faktor penutup (*cover factor*)

P = faktor pengukuran kontrol erosi

Dengan menggunakan USLE, maka dapat diprediksi jumlah sedimen yang terendapkan tiap tahunnya (Tabel 3.24). Berdasarkan perhitungan ini, didapatkan bahwa massa sedimen yang terendapkan tiap tahun pada tiap *pond* berkisar pada 738 ton (282 m^3) hingga 5798.5 ton (2215.72 m^3).

Dengan asumsi bahwa perawatan atau pengambilan sedimen pada kolam harus dilakukan saat volume sedimen mencapai setengah dari volume kolam, maka perawatan rutin harus dilakukan tiap minimal 1 kali per tahun untuk tiap *pond*.

Tabel 3.24 Perhitungan sedimen yang terendapkan tiap tahun

Parameter		Unit	Pond				
			P01	P02	P03	P04	P05
Annual Deposition Estimation							
Rainfall erosion index	R		100	100	100	100	100
Soil erodibility factor **(silt)**	K		0.6	0.6	0.6	0.6	0.6
Slope steepness	BS	m/m	0.243	0.2455	0.2048	0.2532	0.2726
Slope length	L	m	2307.69	1117.21	1724.46	2820.48	1690.35
The length and slope factor (gradient)	LS		0.19	0.17	0.18	0.20	0.19
Cover factor **(bare soil)**	C		1	1	1	1	1
Erosion control measure factor **(bare soil)**	P		1	1	1	1	1
Annual soil loss due to erosion	**A**	**tonnes/ hectare/year**	**11.62**	**10.07**	**10.70**	**12.18**	**11.13**
Total tons deposited per year		tonnes	1396.25	1185.84	669.98	5260.36	2558.14
		ton	1539.10	1307.17	738.53	5798.55	2819.86
Sediment volume per year		m^3	588.11	499.49	282.20	2215.72	1077.52

4. KAJIAN GEOTEKNIK

4.1. Data Geoteknik

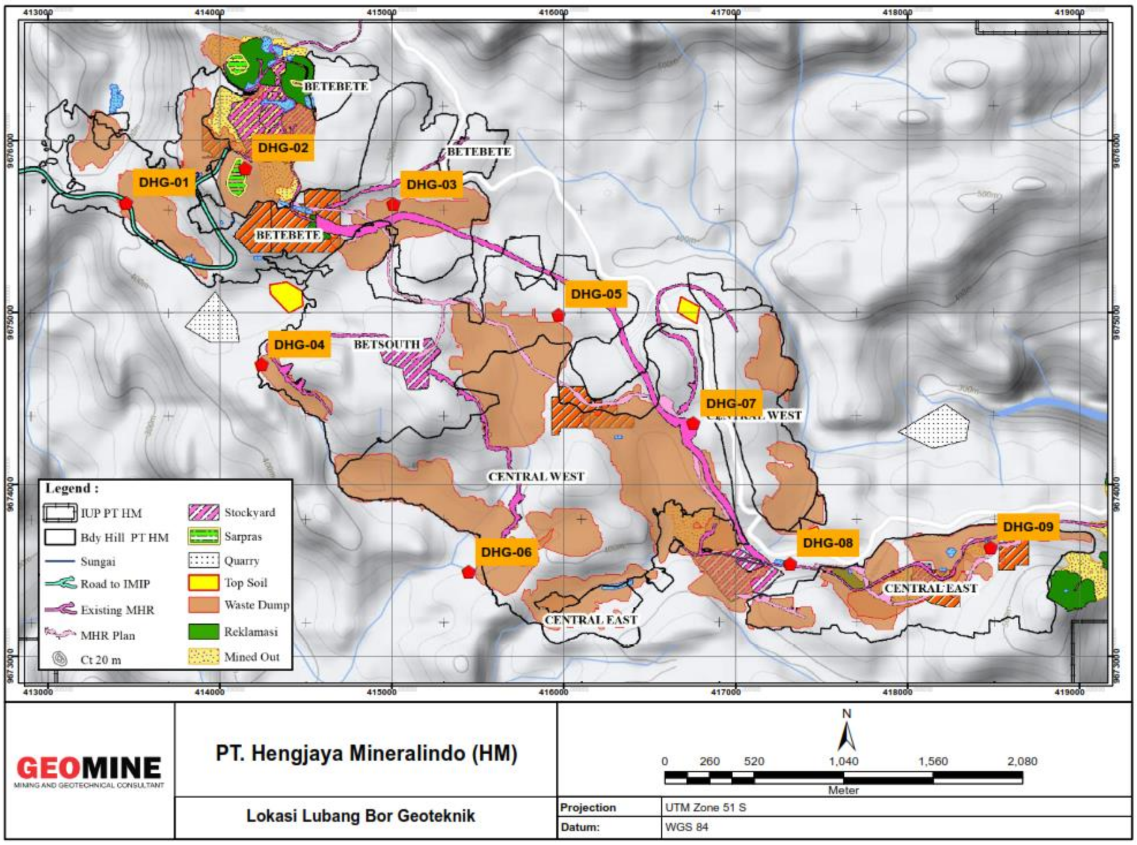
Pengumpulan data untuk kajian geoteknik di area penambangan PT. Hengjaya Mineralindo (HM) yang digunakan pada pembuatan laporan ini bersumber dari data yang diperoleh melalui pengeboran geoteknik, observasi di lapangan yang dilakukan oleh pihak PT. HM, serta dari data kajian yang telah dilakukan sebelumnya di sekitar area tersebut. Adanya kondisi pandemi Covid-19 melimitasi untuk dilakukan *site visit* dan pengambilan data secara langsung oleh pihak GEOMINE. Pengumpulan data ini dilakukan pada bulan September-Oktober 2021 dan data yang diperoleh tersebut adalah sebagai berikut.

- Hasil *logging* geoteknik terhadap *core-core* dari sembilan lubang pengeboran geoteknik yang dilakukan oleh pihak HM pada area rencana penambangan.
- Hasil *slug test* untuk mengetahui nilai hidraulik konduktivitas dan pengukuran muka air tanah pada sembilan lubang pengeboran geoteknik untuk keperluan kajian hidrogeologi.
- Hasil pengujian sifat fisik dan mekanik dari sampel-sampel lubang pengeboran yang dilakukan oleh Laboratorium GWL Bandung.

4.1.1. Pengeboran Geoteknik

Titik pengeboran lubang geoteknik pada area IUP milik PT HM dilakukan berdasarkan memo rekomendasi pengambilan data yang diberikan oleh GEOMINE pada tanggal 2 September 2021. Rekomendasi pengeboran geoteknik ini bertujuan untuk mengumpulkan data dan sampel untuk keperluan kajian geoteknik dan hidrogeologi di area tambang HM.

Pengeboran dilakukan pada bulan September-Oktober 2021 yang terdiri dari sembilan titik lubang bor di sekitar area rencana *pit* dan *waste dump* PT HM. Pemilihan titik bor tersebut disesuaikan dengan rencana pengeboran eksplorasi, rencana penambangan ke depan dan lokasi *waste dump*, dengan pertimbangan titik bor meng-*cover* domain dan seluruh area tambang. Lokasi pengeboran geoteknik dan koordinat dari masing-masing lokasi dapat dilihat pada Gambar 4.1 dan Tabel 4.1 berikut ini.



Gambar 4.1 Lokasi Lubang Bor Geoteknik PT HM

Tabel 4.1 Lokasi dan Titik Koordinat Lubang Bor Geoteknik

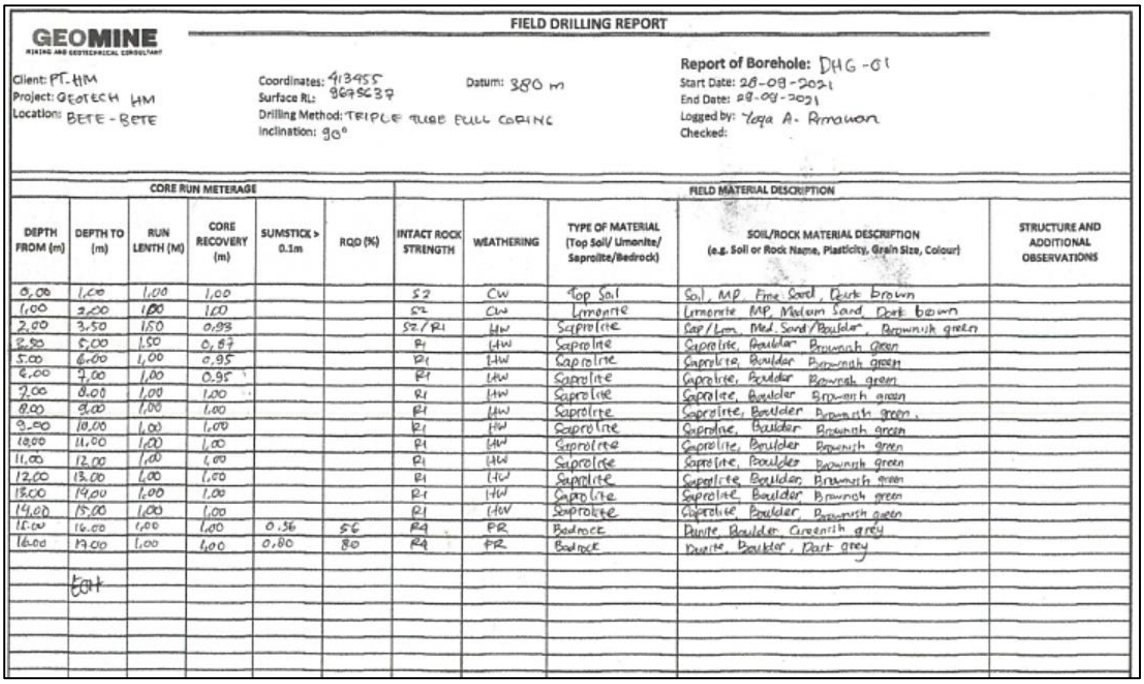
Titik Bor	Domain	Rencana Koordinat *Collar*			Aktual Koordinat *Collar*			*Dip*	*Depth*
		Easting	*Northing*	*Elevation*	*Easting*	*Northing*	*Elevation*		
		(mE)	(mN)	(m)	(mE)	(mN)	(m)	(°)	(m)
DHG-01	Bete Bete	413400	9675826	376	413455	9675637	380	90	17
DHG-02	Bete Bete	414146	9675839	385	414147	9675839	480	90	14
DHG-03	Bete Bete	415097	9675903	461	415011	9675627	445	90	31
DHG-04	Bete South	414286	9674645	406	414243	9674697	423	90	35
DHG-05	Bete South	415735	9674945	416	415969	9674988	452	90	23
DHG-06	Central West	415097	9673413	306	415447	9673487	332	90	35
DHG-07	Central West	416875	9674311	421	416755	9674354	417	90	15
DHG-08	Central East	417733	9673383	417	417317	9673539	361	90	20
DHG-09	Central East	418394	9673864	371	418482.3	9673633	416	90	30

4.1.2. *Logging Geoteknik* dan *Foto Core*

Pengumpulan data *logging* geoteknik dan foto *core* ini bertujuan untuk karakterisasi geoteknik terhadap material *sub-surface* di PT HM.

Sebanyak delapan lubang bor dilakukan di area rencana pit penambangan dan satu lubang bor (DHG 02) yang ditempatkan di area aktual *wastedump*. Gambar 4.2 menampilkan contoh foto *core* yang diperoleh dari aktivitas pengeboran geoteknik dan Gambar 4.3 memperlihatkan contoh hasil *logging* geoteknik yang dilakukan pada core tersebut. Dari data *logging* geoteknik yang dikumpulkan meliputi: i) *depth from-to*, (ii) *core run length*, (iii) *core recovery*, (iv) *sumstick* (*core* dengan panjang lebih dari 10 cm), (v) RQD, (vi) *intact strength*, (vii) *weathering*, (viii) *type of material*, (ix) deskripsi material, dan (x) *structure* dan *additional observations*. Data hasil *logging* geoteknik dan foto *core* selengkapnya dapat ditemukan pada bagian Lampiran A.

Gambar 4.2 Contoh Foto *Core* untuk Lubang Bor DHG-01



GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT. HM
Project: GEOTECH HM
Location: BETE - BETE

Coordinates: 413455
Surface RL: 9675637
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Datum: 380 m

Report of Borehole: DHG - 01
Start Date: 28-08-2021
End Date: 28-08-2021
Logged by: Yoga A. Pramawan
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
0,00	1,00	1,00	1,00			S2	CW	Top Soil	Soil, MP, Fine Sand, Dark brown	
1,00	2,00	1,00	1,00			S2	CW	Limonite	Limonite MP, Medium Sand, Dark brown	
2,00	3,50	1,50	0,93			S2/R1	HW	Saprolite	Sap/Lim, Med. Sand/Boulder, Brownish green	
3,50	5,00	1,50	0,87			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
5.00	6.00	1,00	0,95			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
6,00	7,00	1,00	0.95			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
7,00	8.00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
8.00	9,00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder Brownish green.	
9,00	10,00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
10,00	11,00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
11,00	12,00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
12,00	13.00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder, Brownish green	
13.00	14,00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder, Brownish green	
14,00	15,00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder, Brownish green	
15.00	16.00	1,00	1,00	0.56	56	R4	FR	Bedrock	Dunite, Boulder, Greenish grey	
16.00	17.00	1,00	1,00	0,80	80	R4	FR	Bedrock	Dunite, Boulder, Dark grey	
	EOH									

Gambar 4.3 Contoh *Logging* Geoteknik di Lubang Bor DHG-01

4.1.3. Pengujian Laboratorium

Pengujian sifat fisik dan mekanik material dilakukan oleh pihak Laboratorium GWL di Bandung. Jenis pengujian yang dilakukan adalah Uji Sifat Fisik Batuan/Tanah, Uji *Uniaxial Compressive Strength* (UCS), *Unconfined Compression Test* (UCT), *Triaxial* UU, *Triaxial* CU, dan Uji Permeabilitas. Jumlah sampel dan jenis pengujian yang diuji di laboratorium adalah sebagai berikut:

Tabel 4.2 Rekapitulasi Jumlah Sampel Untuk Pengujian Sifat Fisik dan Mekanik

No.	Tipe Pengujian	Jumlah Sampel Teruji
1	*Atterberg Limit*	9
2	*Falling Head*	5
3	*Moisture Content*	7
4	*Particle Size Distribution*	9
5	*Specific Gravity*	9
6	*Triaxial CU*	1
7	*Triaxial UU*	9
8	*UCS Poisson*	10
9	*UCT*	5
10	*Unit Weight*	7

4.1.3.1. Sifat Fisik Soil (Soil Physical Properties)

Pengujian sifat fisik *soil*/ tanah dilakukan pada masing-masing lubang bor geoteknik untuk material *Limonite*. Tujuan dari pengujian ini adalah untuk mengetahui karakteristik dari *soil* material *insitu*. Jenis pengujian yang dilakukan adalah pengukuran *moisture content*, batas plastis, *specific gravity*, dan uji saringan. Uji saringan dilakukan untuk mendapatkan data kuantitatif mengenai distribusi ukuran partikel di dalam tanah. Distribusi partikel lebih besar dari 75 mm (tertahan oleh ayakan nomor 200) dapat diketahui melalui analisa *screen*, sementara distribusi partikel yang lebih kecil dari 75 mm didapatkan melalui proses sedimentasi menggunakan *hydrometer. Hydrometer* dilakukan pada material yang berukuran lebih kecil dari pasir untuk mengetahui komposisi lempung dan lanau. *Summary* hasil pengujian untuk sifat fisik *soil* dapat dilihat pada Tabel 4.3.

Tabel 4.3 *Summary* Pengujian Sifat Fisik *Limonite*

Statistik	Classification													
	MC (%)	Normal Density (kN/m³)	Dry Density (kN/m³)	Void Ratio	Porosity	Saturation	SG	LL	PL	PI	Gravel	Sand	Silt	Clay	Fines (#200)
Min	46.08	17.40	11.20	1.53	0.61	100.00	2.67	50.80	16.80	18.30	0.00	4.07	41.44	23.20	78.00
Q2	56.55	18.77	12.35	1.81	0.64	100.00	3.30	65.00	33.60	37.10	0.00	12.88	79.13	38.85	83.27
Q3	62.46	19.55	12.40	2.06	0.67	100.00	3.54	78.80	41.00	44.70	0.00	20.64	83.27	46.67	87.84
Max	91.92	22.34	13.80	2.73	0.73	100.00	3.61	110.70	51.50	61.80	9.13	21.42	87.84	54.49	95.93
Mean	60.93	19.21	12.32	1.91	0.65	100.00	3.31	70.90	34.91	35.97	1.01	14.69	75.66	38.85	84.29
Stdev	14.90	1.58	0.86	0.43	0.05	0.00	0.30	20.66	10.90	13.71	3.04	5.76	14.31	22.13	6.19

Keterangan: Q2 = Kuartal 2, Q3 = Kuartal 3, Stdev= Standar Deviasi, MC = *Moisture Content*, SG = *Specific Gravity*, LL = *Liquid Limit*, PL = *Plastic Limit*, PI = *Plasticity Index*, #200 = Ayakan nomor 200

4.1.3.2. Uji Sifat Fisik Batuan (*Rock Physical Properties*)

Tujuan dari pengujian ini adalah untuk menentukan densitas, kandungan air, dan porositas sampel batuan. Hasil pengujian untuk sifat fisik batuan dapat dilihat pada Tabel 4.4 dan 4.5 berikut ini.

Tabel 4.4 *Summary* Pengujian Sifat Fisik Batuan *Saprolite*

Litologi	Statistik	Physical Properties								
		Natural Density (kN/m³)	Dry Density (kN/m³)	Saturated Density (kN/m3)	Spesific Gravity	Natural Moisture Content (%)	Absorption (%)	Saturation (%)	Porosity Rock	Void Ratio Rock
Saprolite	Min	10.23	16.99	12.07	1.84	9.86	11.54	75.01	0.23	0.31
	Q2	10.67	18.67	12.39	1.97	51.65	140.36	76.13	0.72	2.62
	Q3	20.21	19.51	20.51	2.62	54.39	158.99	85.49	0.75	3.06
	Max	22.36	20.35	22.70	2.66	55.67	166.20	91.65	0.76	3.13
	Mean	14.78	18.67	16.00	2.19	38.10	99.55	80.76	0.56	1.93
	Stdev	5.99	2.37	5.17	0.41	21.92	76.83	7.46	0.25	1.39

Keterangan: Q2 = Kuartal 2, Q3 = Kuartal 3, Stdev= Standar Deviasi

Tabel 4.5 *Summary* Pengujian Sifat Fisik Batuan *Bedrock*

Litologi	Statistik	Physical Properties								
		Natural Density (kN/m3)	Rock Dry Density (kN/m3)	Saturated Density (kN/m3)	Spesific Gravity	Natural Moisture Content (%)	Absorption (%)	Saturation (%)	Porosity Rock	Void Ratio Rock
Bedrock	Min	22.60	21.19	23.00	2.41	0.46	1.70	24.92	0.05	0.06
	Q2	27.35	26.98	27.72	2.78	3.01	4.36	63.74	0.11	0.12
	Q3	28.73	28.60	29.13	2.99	6.16	7.88	78.16	0.17	0.20
	Max	30.90	30.75	31.27	3.25	66.21	84.01	78.81	0.67	2.03
	Mean	26.71	26.08	27.08	2.80	13.30	17.46	56.30	0.19	0.43
	Stdev	3.41	3.97	3.42	0.31	26.04	32.71	25.54	0.24	0.78

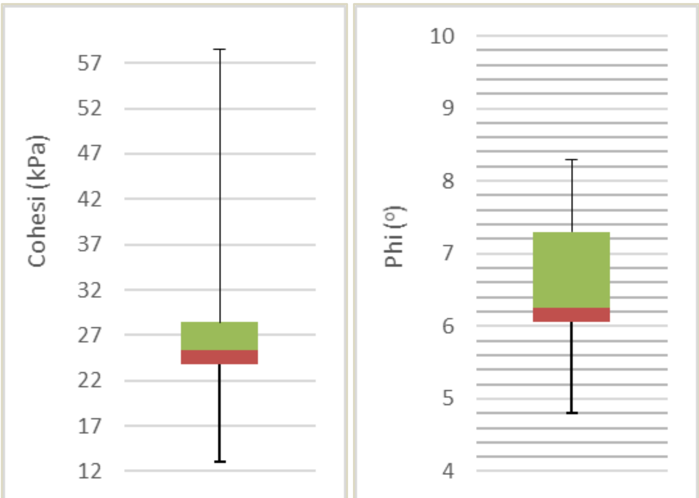
Keterangan: Q2 = Kuartal 2, Q3 = Kuartal 3, Stdev= Standar Deviasi

4.1.3.3. Uji Sifat Mekanik Tanah (*Limonite Mechanical Properties*)

Uji sifat mekanik dilakukan untuk mengetahui sifat mekanik dari tanah. Jenis pengujian yang dilakukan adalah *Triaxial* UU, dan *Triaxial* CU. Uji triaksial dengan cara *unconsolidated undrained*, atau *Triaxial* UU (tak terkonsolidasi-tak terdrainase), digunakan untuk menentukan kuat geser tanah pada kondisi aslinya (di dalam tanah), dimana angka pori benda uji pada permulaan pengujian tidak berubah dari nilai aslinya di dalam tanah. Uji *Triaxial* CU (*consolidated undrained*) digunakan untuk menentukan kuat geser material pada kondisi tak terdrainase (*undrained*), yaitu bila material angka porinya (e) telah berubah dari kondisi asli di lapangan oleh akibat konsolidasi. Rekapitulasi hasil pengujian sifat mekanik tanah/batuan dapat dilihat pada Tabel 4.6.

Tabel 4.6 *Summary* Hasil Pengujian Sifat Mekanik *Limonite*

Litologi	Statistik	Triaxial Test (UU)		Triaxial Test (CU)			
		C (kPa)	phi (degree)	C (kPa)	Phi (degree)	C' kPa)	phi' (degree)
Limonite	Min	13.00	4.80	7.55	24.20	5.02	33.60
	Q2	23.80	6.05				
	Q3	28.43	7.30				
	Max	58.50	8.30				
	Mean	26.95	6.45				
	Stdev	14.10	1.21				



Gambar 4.4 Distribusi Statistik Pengujian *Trixial Test* (UU)

4.1.3.4. Uji Sifat Mekanik Batuan (Rock Mechanical Properties)

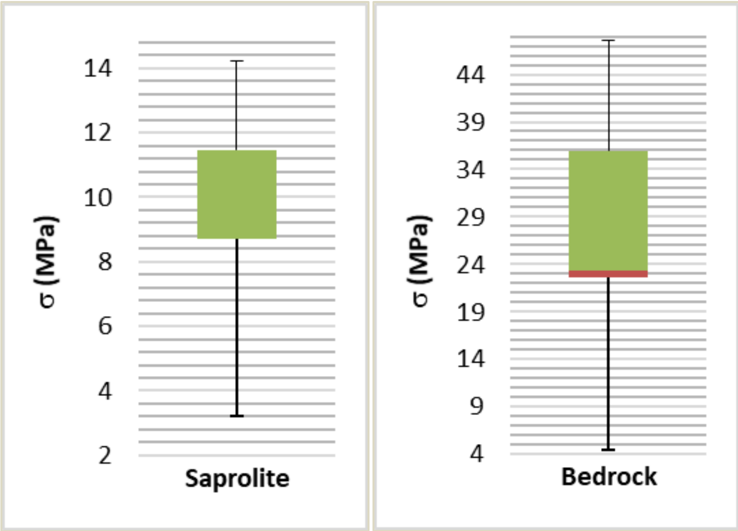
Uji sifat mekanik dilakukan untuk mengetahui sifat mekanik dari tanah. Jenis pengujian yang dilakukan adalah Uji *Uniaxial Compressive Strength* (UCS), *Unconfined Compression Test* (UCT). Uji kuat tekan bebas atau *Unconfined Compression Test* (UCT) merupakan cara yang dilakukan di laboratorium untuk mengukur seberapa besar kuat dukung material menerima kuat tekan yang diberikan sampai material tersebut terpisah dari butiran-butirannya dan juga regangan tanah akibat tekanan tersebut. Rekapitulasi hasil pengujian sifat mekanik tanah/batuan dapat dilihat pada Tabel 4.7 dan Tabel 4.8.

Tabel 4.7 Rekapitulasi Hasil Pengujian Sifat Mekanik *Saprolite*

Litologi	Statistik	UCS			UCT		
		s Max (MPa)	E (MPa)	v	c (kPa)	Sensivity	Ei (kPa)
Saprolite	Min	3.23	444.60	0.21	8.00	1.24	530.00
	Q2	8.73	1746.67	0.29	22.00	1.35	1464.00
	Q3	11.48	2397.70	0.33	42.90	1.54	3382.00
	Max	14.23	3048.74	0.38	81.50	1.55	4284.00
	Mean	8.73	1746.67	0.29	32.70	1.39	2081.00
	Stdev	7.77	1841.40	0.12	30.69	0.15	1667.11

Tabel 4.8 Rekapitulasi Hasil Pengujian Sifat Mekanik *Bedrock*

Litologi	Statistik	UCS		
		σ Max (MPa)	E (MPa)	v
Bedrock	Min	4.51	623.26	0.25
	Q2	22.66	2637.74	0.42
	Q3	36.00	4509.23	0.44
	Max	47.56	6030.54	0.46
	Mean	24.06	3170.16	0.38
	Stdev	16.71	1987.57	0.08



Gambar 4.5 Distribusi Statistik Pengujian *Uniaxial Compressive Strength* (UCS)

4.2. Karakteristik Geoteknik

Karakteristik geoteknik ditentukan berdasarkan dari hasil dari pengeboran geoteknik yang telah dilakukan. Domain geoteknik didefisinikan sebagai unit yang mempunyai karakter dan perilaku yang sama secara geoteknik. Pembagian domain geoteknik pada PT HM dibagi berdasarkan jenis litologi dari batuan yang ada di lokasi tambang, meliputi: *limonite*, *saprolite*, dan *bedrock.*

4.2.1. *Limonite*

Limonite merupakan lapisan batuan yang mengandung mineral oksida besi dan terletak dibawah lapisan *top soil*, memiliki karakteristik seperti tanah dengan warna cokelat kemerahan hingga cokelat kekuningan, dengan ukuran butir lempung sampai dengan medium *silt*, dan kekuatan bervariasi dari S1 (*very soft clay*) hingga S5 (*very stiff clay*).

Gambar 4.6 Contoh Material *Limonite*

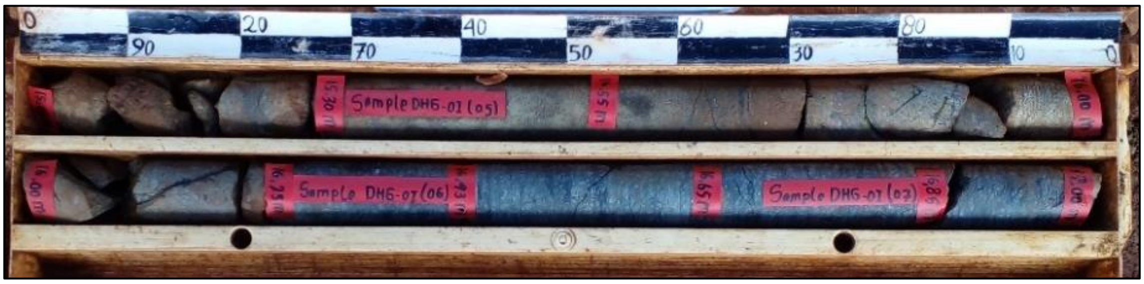
4.2.2. *Saprolite*

Saprolite merupakan lapisan zona pengkayaan unsur Ni, dicirikan oleh warna cokelat kehijauan hingga abu-abu kehijauan, memiliki ukuran butir pasir kasar hingga *boulder*, dan kekuatan bervariasi dari R1 (*very weak rock*) hingga R4 (*strong rock*).

Gambar 4.7 Contoh Material *Saprolite*

4.2.3. *Bedrock*

Bedrock terdiri dari batuan beku *dunite* yang merupakan salah satu jenis batuan beku ultra basa dengan komposisi olivin hampir 100%. Lapisan batuan ini terletak paling dasar, dicirikan dengan tampilannya yang terlihat *fresh* berwarna abu-abu kehijauan hingga abu-abu gelap, dan memiliki kekuatan bervariasi dari R3 (*medium strong rock*) hingga R5 (*very strong rock*).



Gambar 4.8 Contoh Material *Bedrock (Dunite)*

4.3. Evaluasi Properties Massa Batuan

Pada penentuan *properties* material domain yang akan digunakan dalam membangun model untuk estimasi kestabilan lereng, hal yang harus diperhatikan adalah mempertimbangkan *properties* atau sifat-sifat batuan *rock mass* dari setiap domain yang digunakan dan bukan *properties* batuan *intact*. Properties batuan *intact* diperoleh dari hasil pengujian di laboratorium dan nilai ini perlu disesuaikan dengan kondisi massa batuan dilapangan melalui pengumpulan data geoteknik. Dari pengujian di laboratorium dan pengumpulan data di lapangan tersebut, maka dapat diperoleh *properties* massa batuan di area pit PT HM.

Salah satu pendekatan umum yang dilakukan adalah dengan menggunakan kriteria *Hoek & Brown* atau kriteria *Mohr Coulomb*. Berdasarkan pertimbangan teknik dimana kondisi batuan relatif lemah dan merupakan jenis material *laterite*, analisis pada kajian ini menggunakan kriteria *Mohr Coulomb*. Tabel 4.9 menampilkan *properties* material yang akan digunakan untuk analisis kestabilan lereng pada PT Hengjaya Mineralindo.

Tabel 4.9 *Properties* Massa Batuan PT. Hengjaya Mineralindo (PT HM)

Litologi	*Unit Weight* (kN/m^3)	Mohr Coloumb	
		C (kPa)	Phi (Degree)
Limonite	18.77	11	27
Saprolite	20.21	61	18
Bedrock	26.71	217	35

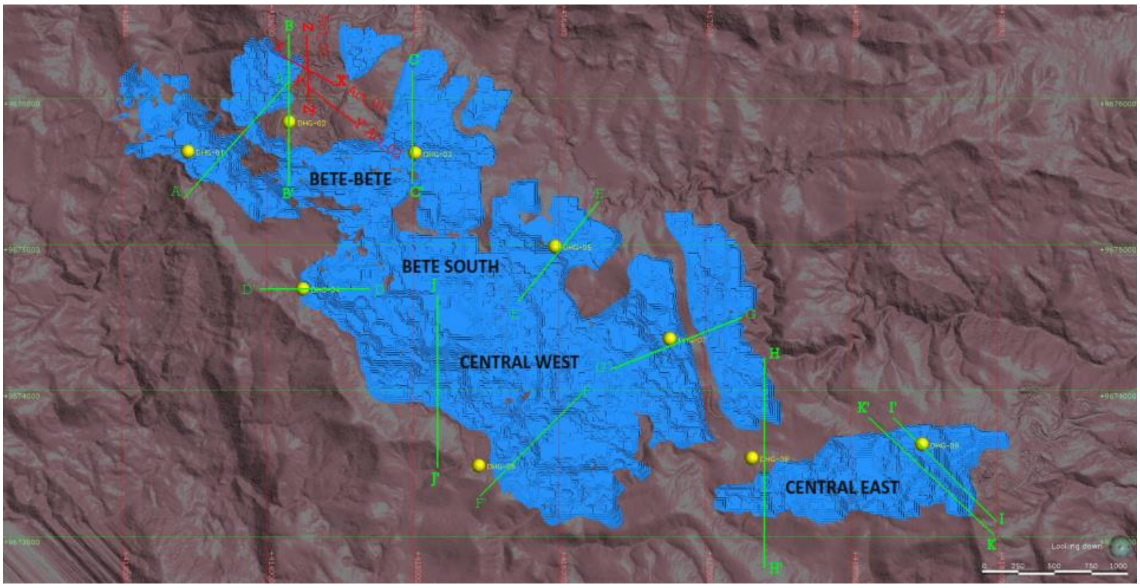
4.4. Model Litologi

Interpretasi model litologi yang digunakan untuk membantu analisis geoteknik, dilakukan dengan menggunakan data sembilan lubang bor geoteknik (DHG01 – DHG09) dan data pengeboran geologi serta akuisisi data GPR yang telah dilakukan sebelumnya. Data-data yang digunakan adalah sebagai berikut:

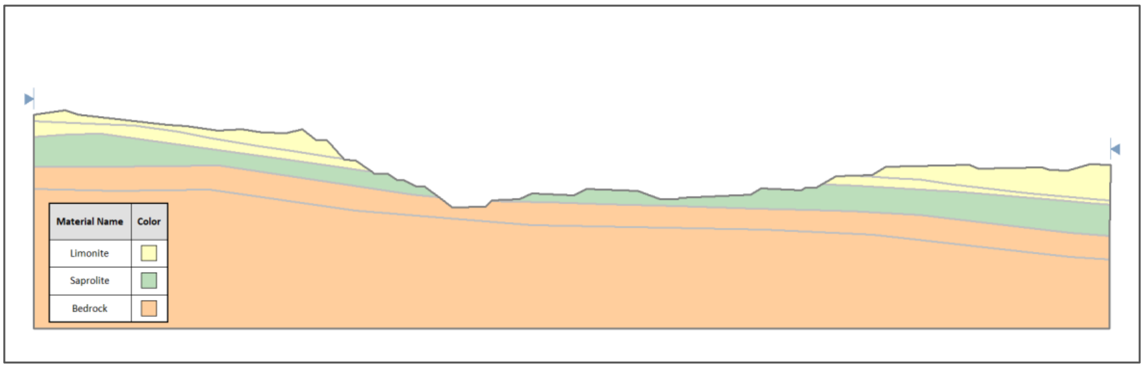
Tabel 4.10 Data untuk Interpretasi dan validasi Model Litologi

Data	Nama File	Type
Floor Bedrock	grd20m_all_floor_bedrock	dtm
Top Bedrock Contact	grd20m_all_top_bedrock	dtm
Top Saprolite Contact	grd20m_all_top_rockysap	dtm
Topo Situasi	topo_situapr20_cont2m_ldr_fltr	dtm
Log Bor Geoteknik	DHG01 – DHG09	pdf

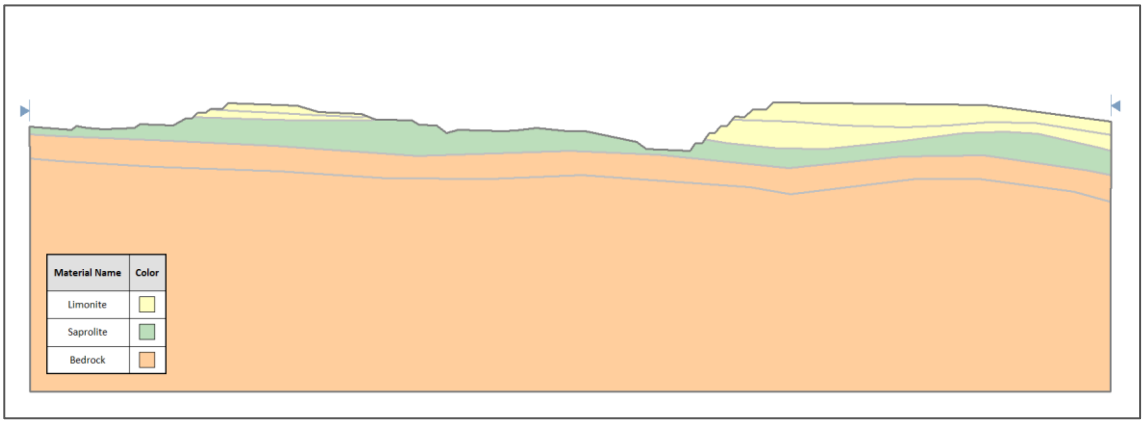
Dari hasil interpretasi tersebut ditentukan 14 *section* (Gambar 4.9) representatif yang terdiri dari 3 *section* dari kondisi aktual dan 11 *section* dari *design* pit untuk keperluan analisis kestabilan lereng. Penentuan *section* tersebut berdasarkan final *pit* terdalam dan jarak terdekat dari lokasi pengeboran geoteknik. Masing-masing *section* yang digunakan dalam analisis kestabilan lereng ditampilkan pada Gambar 4.10 – Gambar 4.23.



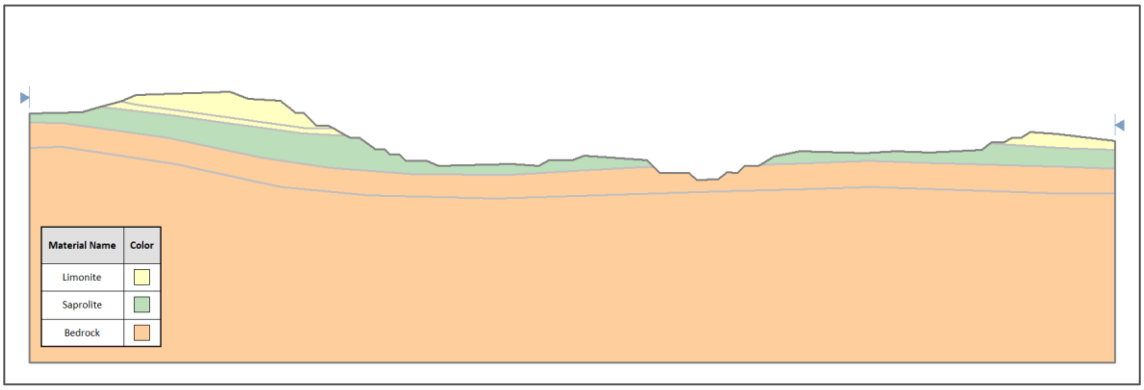
Gambar 4.9 *Section Line* untuk Analisis Kestabilan Lereng



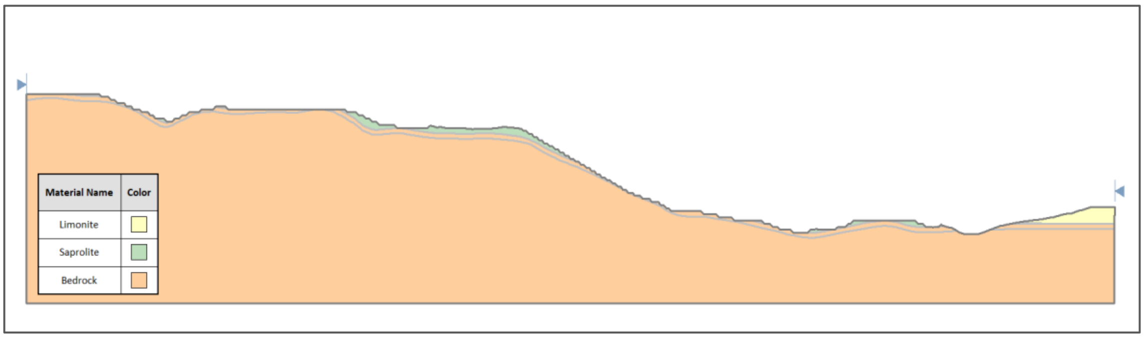
Gambar 4.10 *Section Actual* 01



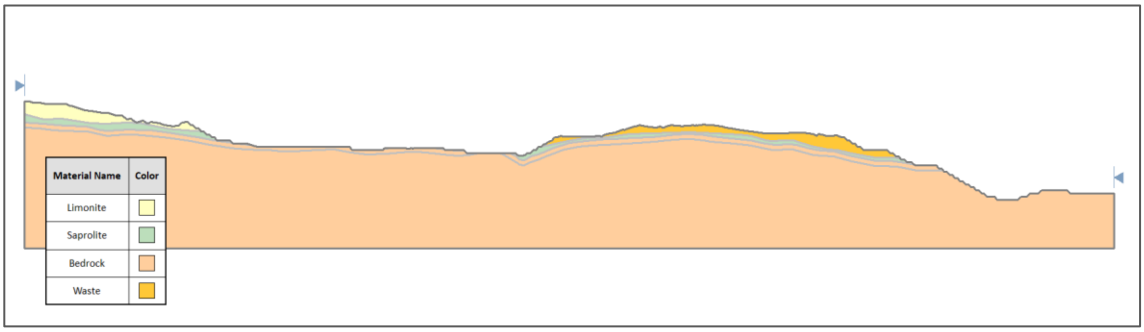
Gambar 4.11 *Section Actual* 02



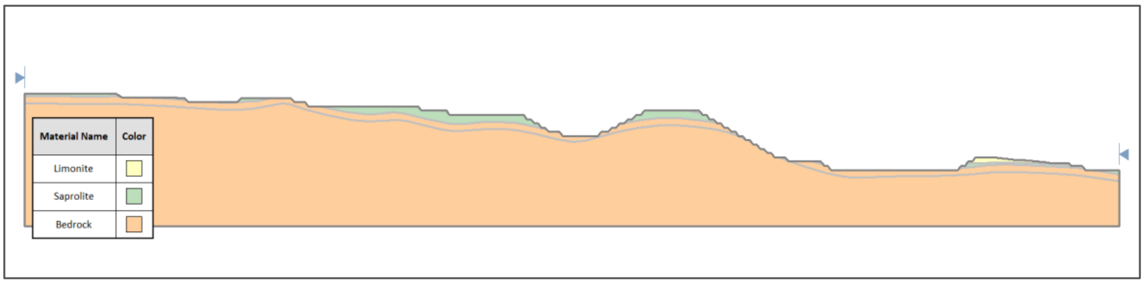
Gambar 4.12 *Section Actual* 03



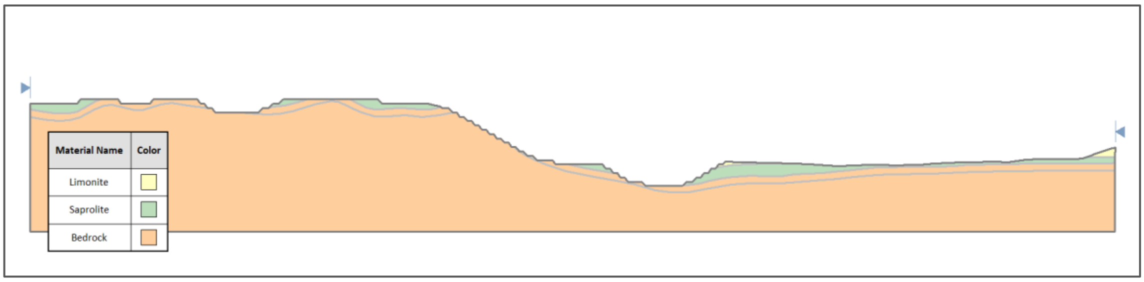
Gambar 4.13 *Section* AA’



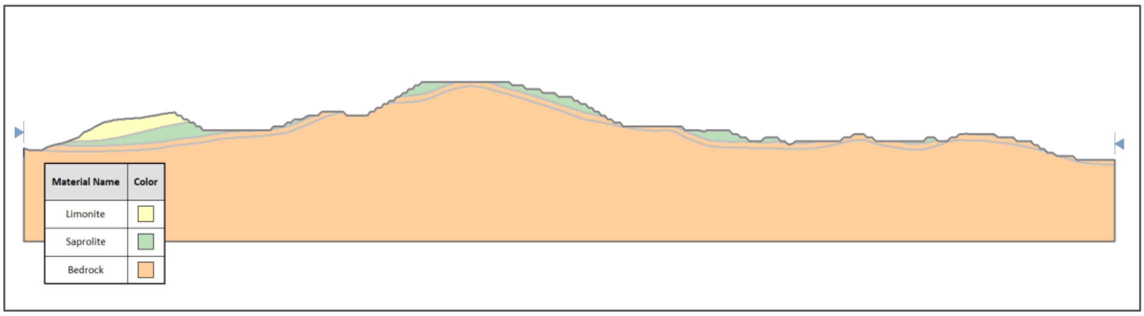
Gambar 4.14 *Section* BB’



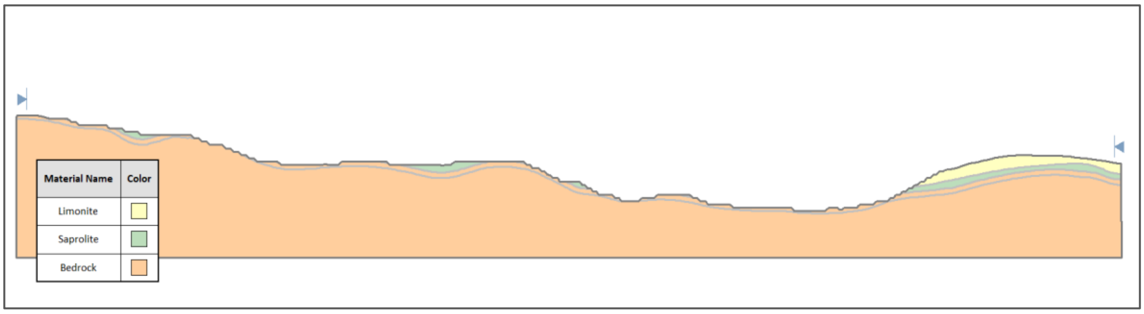
Gambar 4.15 *Section* CC’



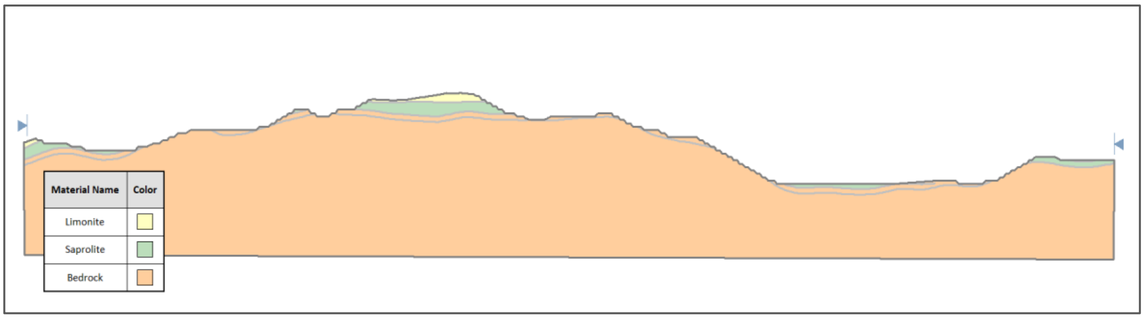
Gambar 4.16 *Section* DD'



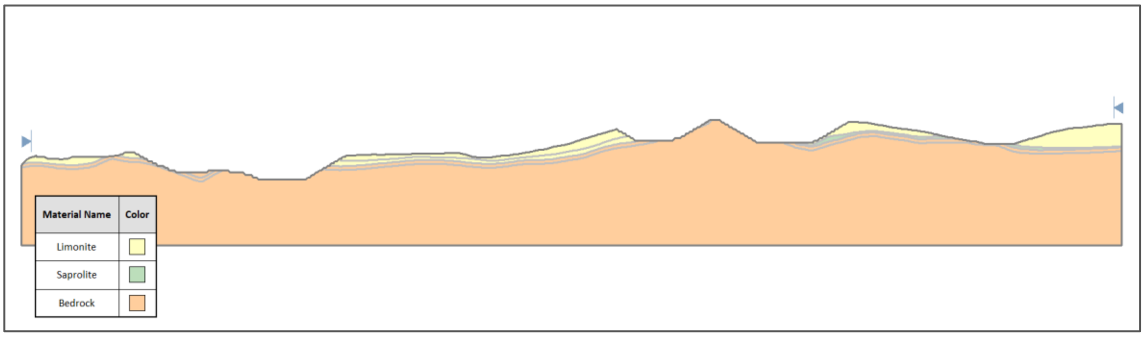
Gambar 4.17 *Section* EE'



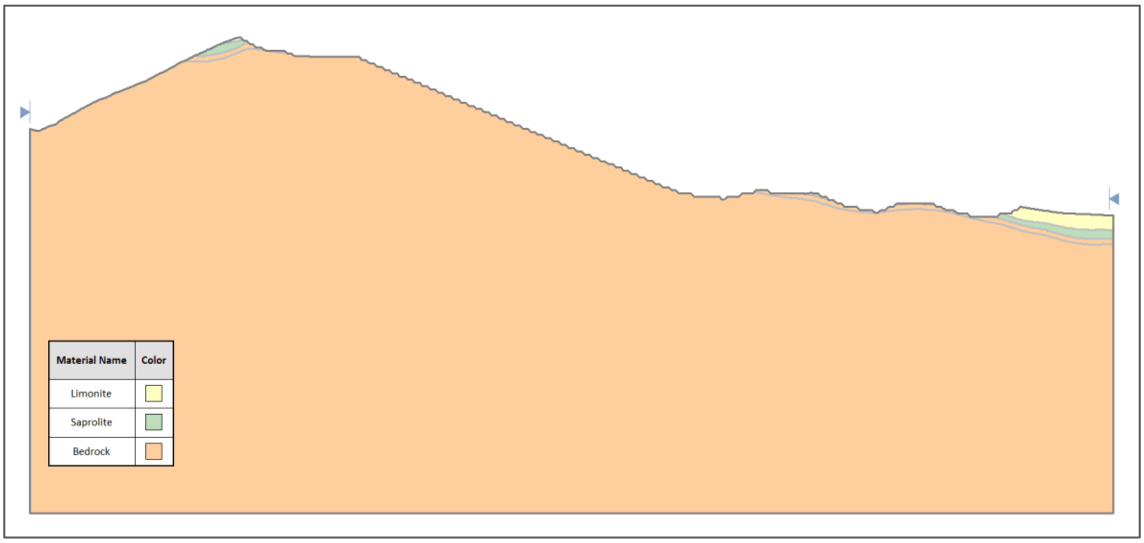
Gambar 4.18 *Section* FF'



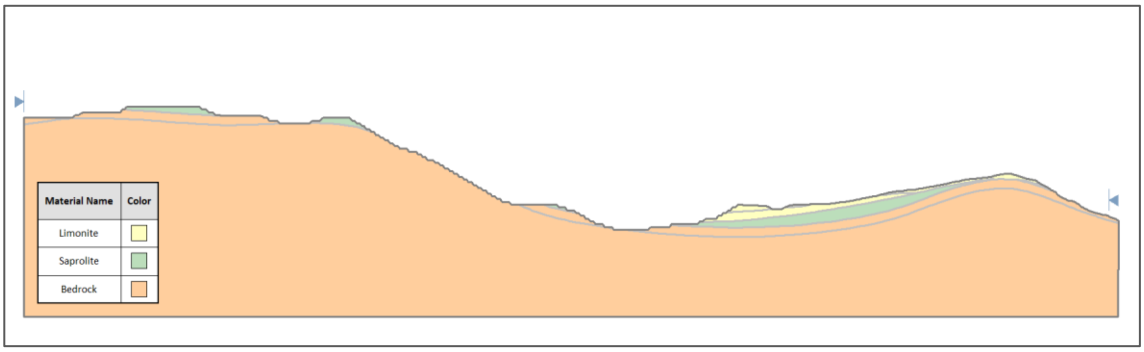
Gambar 4.19 *Section* GG'



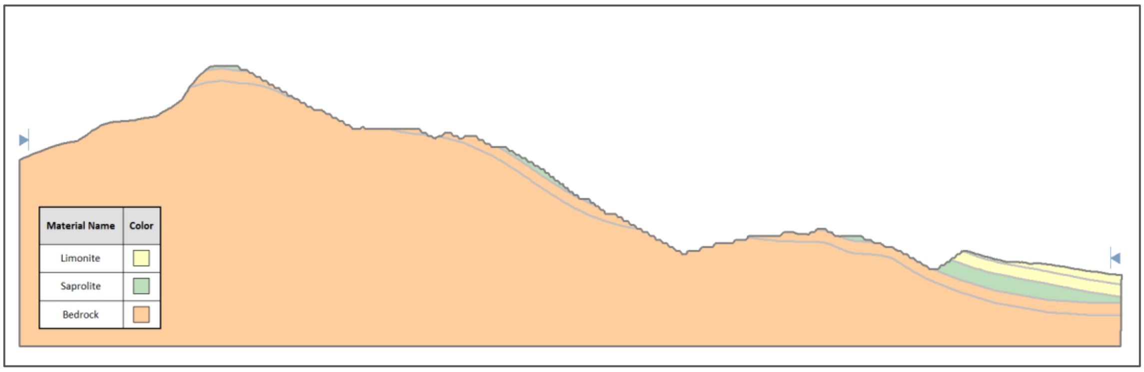
Gambar 4.20 *Section* HH'



Gambar 4.21 *Section* II'



Gambar 4.22 *Section* JJ'



Gambar 4.23 *Section* KK'

4.5. Metode Analisis Kestabilan Lereng

Analisis geoteknik dilakukan pada *section-section* dari model litologi yang dianggap representatif dan mempunyai kepastian data yang cukup baik untuk digunakan dalam analisis kestabilan lereng. Analisis kestabilan lereng dilakukan dengan menggunakan metode kesetimbangan batas (*limit equilibrium*) melalui perangkat lunak *Slide* dari *Rocscience*. Adapun beberapa parameter kondisi tambahan yang diperlukan dalam analisis menggunakan metode kesetimbangan batas dan kriteria kestabilan dijelaskan pada sub bab berikut ini:

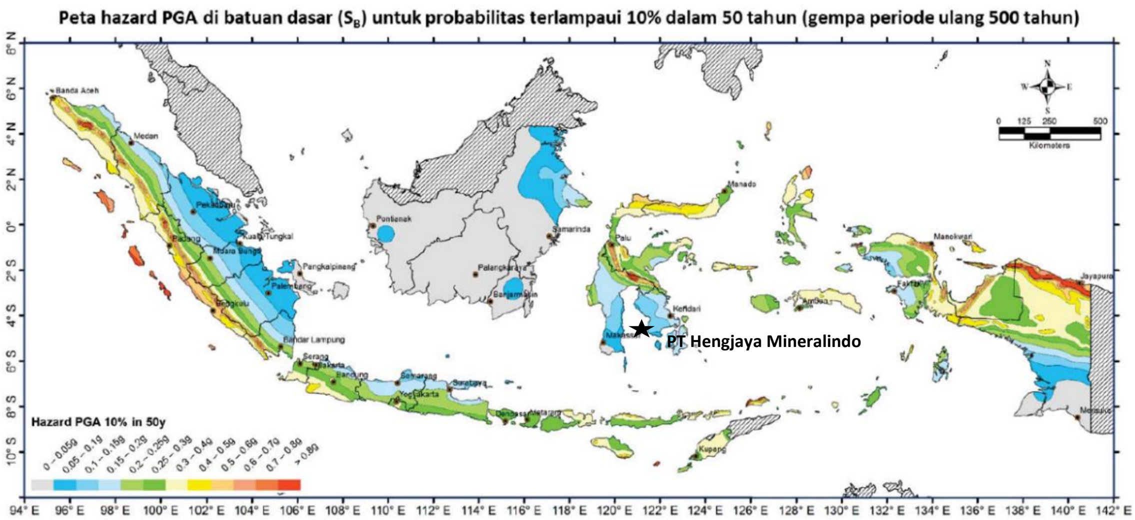
4.5.1. Kondisi Muka Air Tanah dalam Pemodelan

Kondisi muka air tanah merupakan salah satu faktor penting yang harus dipertimbangkan dalam analisis kestabilan lereng. Penentuan kondisi muka air tanah yang digunakan dalam analisis ini diperoleh dari hasil pemodelan muka air tanah berdasarkan dari uji *slug test* yang telah dijelaskan dalam Bab 3 Kajian Hidrologi dan Hidrogeologi.

4.5.2. Kondisi Beban Seismik

Beban seismik yang disebabkan oleh gempa dapat menyebabkan ketidakstabilan pada lereng tambang terbuka terutama pada area zona aktif gempa. Analisa pseudo static menggunakan limit equilibrium dengan horizontal seismic coefficient adalah pendekatan yang umum digunakan untuk mengkaji potensi impak dari beban seismic terhadap kestabilan lereng.

Penentuan pengaruh seismik pada kajian ini mengacu pada Peta Sumber dan Bahaya Gempa Indonesia Tahun 2017 dengan PGA (Peak Ground Acceleration) keterlampauan kejadian sebesar 10% dalam kurun waktu 50 tahun. Pada area IUP PT HM koefisien seismik kegempaan 0.1g berkorelasi dengan nilai PGA di area tersebut (Gambar 4.24).



Gambar 4.24 Peta Sumber dan Bahaya Gempa Indonesia (Pusat Kajian Gempa Nasional, 2017)

4.5.3. Metode Kesetimbangan Batas (*Limit Equilibrium Method*)

Metode kesetimbangan batas untuk kestabilan lereng memagi massa bidang gelincir menjadi irisan-irisan kecil. Gaya-gaya geser yang bekerja pada "n" irisan diasumsikan mewakili seluruh bagian yang sama dari kuat geser batuan/tanah dimana gaya-gaya geser ini bekerja. Dalam analisis Limit Equilibrium, terdapat beberapa metode yang dapat digunakan yaitu Bishop, Fellenius, Janbu, Spencer, Sarma, dll. Dalam kajian geoteknik ini, metode yang digunakan adalah metode Spencer. Metode ini dipilih karena metode Spencer mempertimbangkan kesetimbangan yang lengkap (Tabel 4.11) dan memperhitungkan faktor gaya antar setiap irisan.

Tabel 4.11 Perbandingan kondisi kesetimbangan dan asumsi metode *Limit Equilibrium* (Krahn, 2003)

Method	*Moment Equilibrium*	*Horizontal Force Equilibrium*	*Interslice Normal Force*	*Interslice Shear Force*	*Inclination od Interslice Force*
Fellenius	*Yes*	*No*	*No*	*No*	*No Force*
Bishop Simplified	*Yes*	*No*	*Yes*	*No*	*Horizontal*
Janbu Simplified	*No*	*Yes*	*Yes*	*Yes*	*Horizontal*
Spencer	*Yes*	*Yes*	*Yes*	*Yes*	*Constant*
Morgenstern Price	*Yes*	*Yes*	*Yes*	*Yes*	*Variable*

Method	*Moment Equilibrium*	*Horizontal Force Equilibrium*	*Interslice Normal Force*	*Interslice Shear Force*	*Inclination od Interslice Force*
Corps of Engin. 1	*No*	*Yes*	*Yes*	*Yes*	*= Crest to Toe Average Dip*
Corps of Engin. 2	*No*	*Yes*	*Yes*	*Yes*	*= Slide Ground Surface Dip*
Lowe-Karafiath	*No*	*Yes*	*Yes*	*Yes*	*= Average of Surface and Base Dip*

4.5.4. Kriteria Standar Faktor Keamanan (FK)

Untuk mengevaluasi kestabilan lereng, salah satu pendekatan yang paling sering dilakukan adalah menghitung nilai Faktor Keamanan (FK). Faktor Keamanan didefinisikan sebagai perbandingan gaya penahan terhadap gaya penggerak. Dalam analisis kesetimbangan batas (Limit Equilibrium), Faktor Keamanan dikalkulasikan sebagai perbandingan regangan geser terhadap tegangan geser sepanjang permukaan kritis (Diederichs, 2007).

Tabel 4.12 menunjukkan pedoman yang disarankan untuk kriteria Faktor Keamanan minimum dalam kajian geoteknik PT HM, yang mengacu pada Kepmen ESDM No. 1827 Tahun 2018 tentang pedoman pelaksanaan kaidah teknik pertambangan yang baik.

Tabel 4.12 Kriteria Faktor Keamanan Minimum (Kepmen ESDM No. 1827 Tahun 2018)

Jenis Lereng	**Keparahan Longsor**	**Kriteria dapat diterima**		
		Faktor Keamanan (FK) Statis	**Faktor Keamanan (FK) Dinamis**	**Probabilitas Longsor (PoF) FK ≤ 1**
Lereng tunggal	Rendah-Tinggi	1.1	N/A	25-50%
Inter-ramp	Rendah	1.15-1.2	1	25%
	Menengah	1.2-1.3	1	20%
	Tinggi	1.2-1.3	1.1	10%
Lereng keseluruhan	Rendah	1.2-1.3	1	15-20%
	Menengah	1.3	1.05	10%
	Tinggi	1.3-1.5	1.1	5%

Berdasarkan beberapa pertimbangan di atas, maka kriteria FK minimum yang digunakan pada kajian geoteknik ini adalah 1.3 untuk lereng keseluruhan *pit* pada kondisi statik dan 1.05 pada kondisi pseudostatik atau seismik, dengan acuan *Probability of Failure* (PoF) adalah < 10% untuk keparahan longsor menengah.

Pada lereng keseluruhan *waste dump* digunakan keparahan longsor rendah dengan nilai FK minimum 1.2-1.3 untuk kondisi statik dan nilai FK 1 untuk kondisi pseudostatik, dengan *Probability of Failure* (PoF) adalah 15% - 20%. Sedangkan untuk lereng tunggal, kriteria nilai FK minimum adalah 1.1.

4.5.5. Validasi Properties Material

Pada sub bab 4.3 telah didiskusikan mengenai properties awal material yang akan digunakan untuk menganalisis kestabilan lereng pit pada PT HM. Sebelum properties (Tabel 4.13) tersebut digunakan untuk analisis, validasi properties tersebut terhadap kondisi aktual pada pit perlu dilakukan.

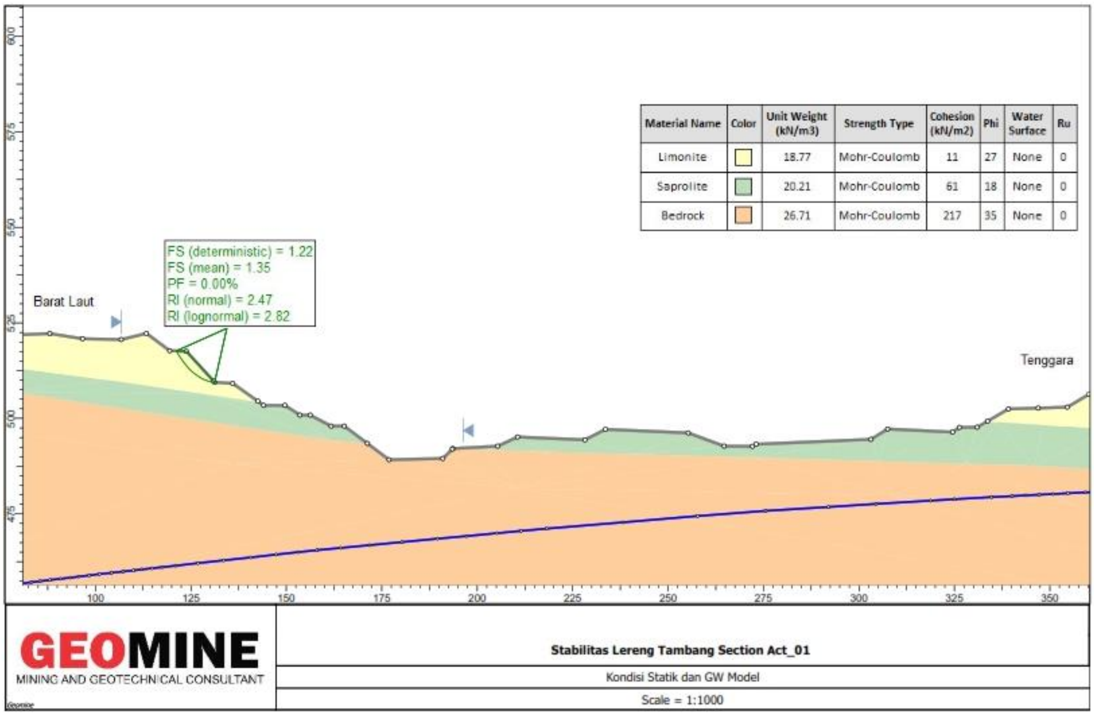
Tabel 4.13 *Properties* Awal Massa Batuan PT. Hengjaya Mineralindo (PT HM)

Litologi	*Unit Weight* (kN/m³)	Mohr Coloumb	
		C (kPa)	Phi (Degree)
Limonite	18.77	11	27
Saprolite	20.21	61	18
Bedrock	26.71	217	35

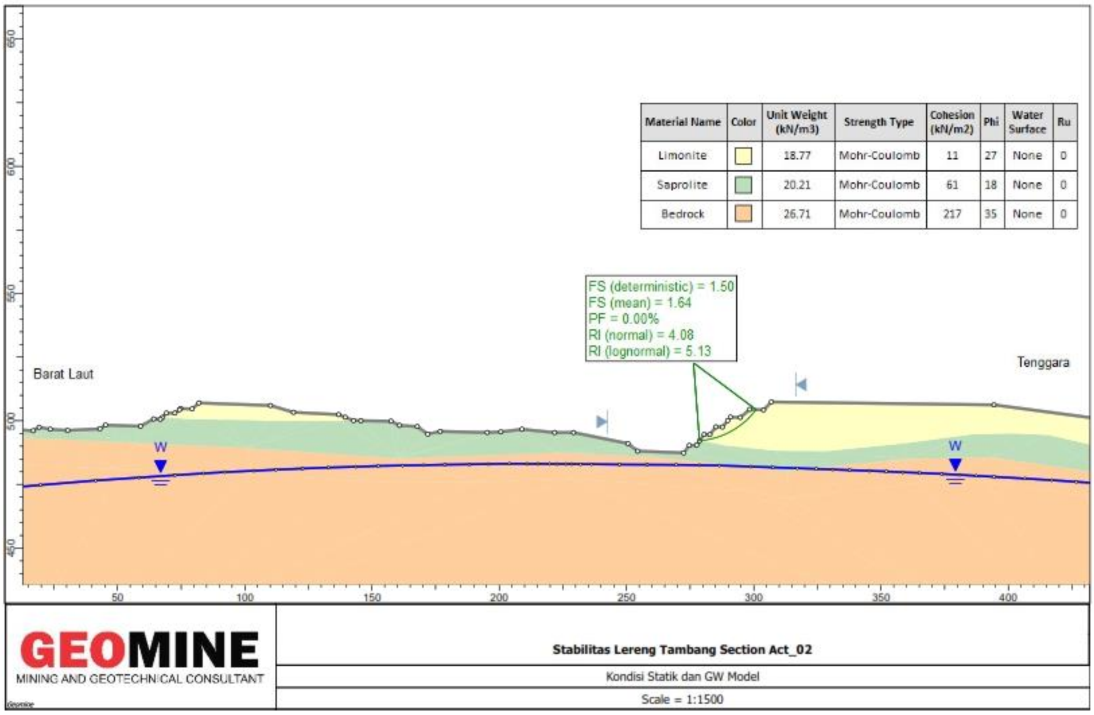
Dari hasil analisis yang dilakukan pada 3 section dari kondisi aktual, diperoleh bahwa kondisi aktual lereng pada 3 penampang tersebut berada pada keadaan *stable* sehingga berdasarkan hasil validasi properties material, properties awal ini akan digunakan pada analisis lebih lanjut (Tabel 4.14 dan Gambar 4.25 sampai 4.27).

Tabel 4.14 Rekapitulasi Analisis Validasi Properties Material

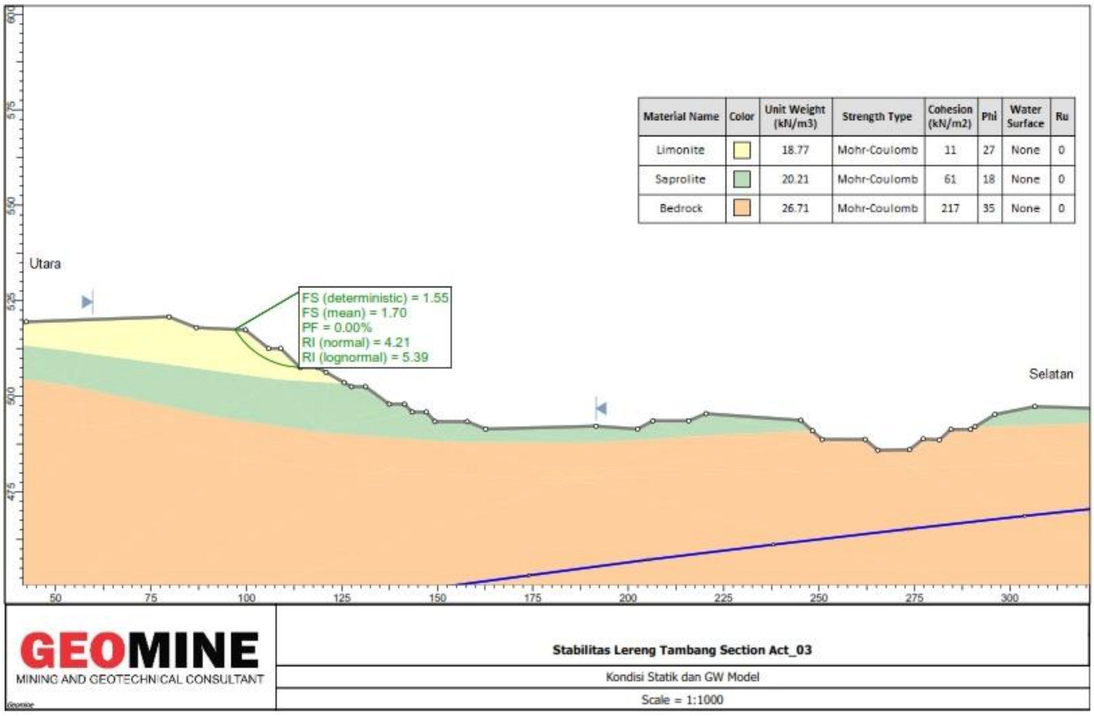
No	Lokasi	Actual Section	FK Statik	POF Statik	FK Dinamik	POF Dinamik	Kondisi Aktual
1	Bete-Bete	Section_Actual_01	1.22	0.0%	1.07	7.7%	*Stable*
2	Bete-Bete	Section_Actual_02	1.50	0.0%	1.29	0.0%	*Stable*
3	Bete-Bete	Section_Actual_03	1.55	0.0%	1.28	0.0%	*Stable*



Gambar 4.25 Hasil Validasi Properties pada *Section Actual* 01



Gambar 4.26 Hasil Validasi Properties pada *Section Actual* 02



Gambar 4.27 Hasil Validasi Properties pada *Section Actual* 03

4.5.6. Analisis Balik *Waste Dump*

Berdasarkan informasi yang diperoleh dari personal site PT Hengjaya Mineral, *waste dump* aktual di area DHG-02 terpantau mengalami ketidakstabilan. Penentuan properties material yang sesuai untuk *waste dump* merupakan tantangan yang lain. Material penyusun *waste dump* umumnya berasal dari campuran material-material *waste* yang tertambang sehingga karakteristiknya juga merupakan campuran daripada material-material penyusunnya. Selain itu kondisi material *waste* tidak lagi dalam kondisi insitu sehingga karakteristiknya akan berbeda dengan kondisi insitu. Dengan pertimbangan di atas, perlu dilakukan analisis balik untuk mendapatkan properties material *waste* yang sedekat mungkin merepresentasikan kondisi aktual yang diamati dan dapat digunakan dalam analisis selanjutnya.

Dalam analisis balik ini digunakan properties awal material *waste* seperti Tabel 4.15 dan kondisi muka air tanah sebagaimana hasil pengukuran muka air tanah (MAT) pada lubang bor DHG-02 yaitu 3.71 m.

Tabel 4.15 *Properties* Awal *Waste* Material

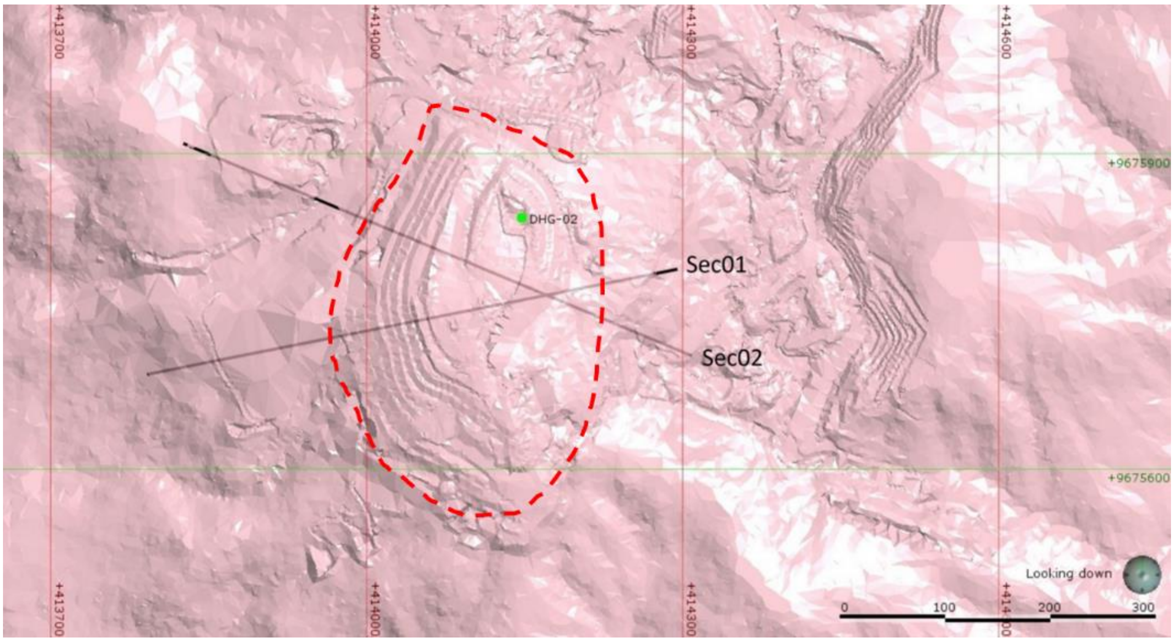
Litologi	*Unit Weight* (kN/m^3)	Mohr Coloumb	
		C (KPa)	Phi (Degree)
Waste	21.9	10	37

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Groundwater Level Measurement Form

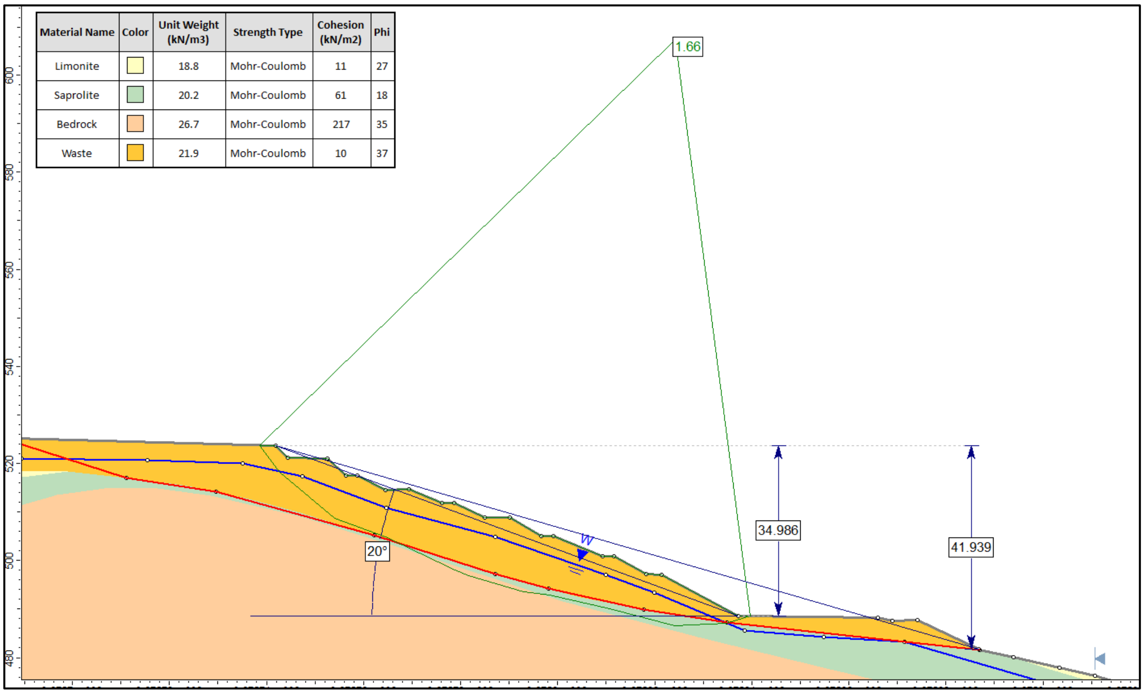
Date Tanggal	Time Jam	GW-Level Depth (mbgs) Kedalaman muka airtanah (mbgs)	Personel Personel	Remarks Keterangan
28/09/2021	08.00	3,71	YAR	DHG-02
	08.10	3,71	YAR	DHG-02
	08.20	3,72	YAR	DHG-02
04/10/2021	14.00	8,58	YAR	DHG-02
	14.05	8,58	YAR	DHG-02
	14.10	8.58	YAR	DHG-02

Gambar 4.28 Hasil Pengukuran Muka Air Tanah DHG-02

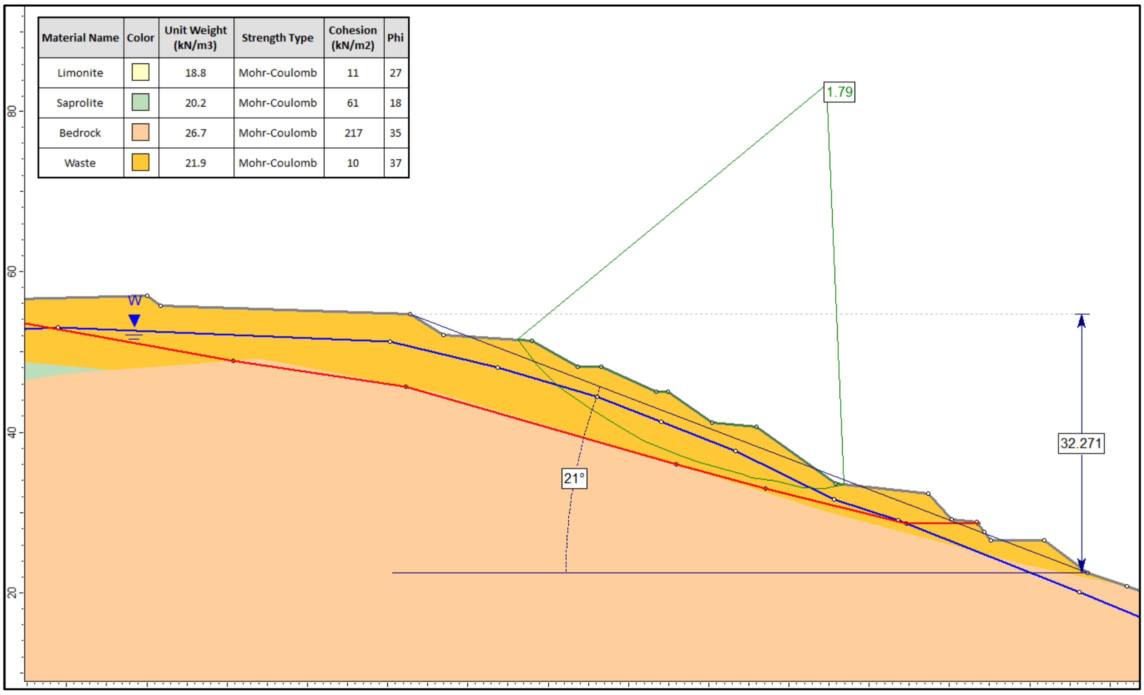


Gambar 4.29 *Section Line Waste Dump* Aktual

Dari dua lokasi *section* pada *waste dump* aktual didapatkan sudut lereng keseluruhan adalah 20° pada *section* 1 dan 21° pada *section* 2, sedangkan tinggi lereng masing-masing adalah 35 m dan 32 m. Adapun hasil analisis berdasarkan properties awal material didapatkan masing-masing faktor keamanan 1.66 dan 1.79 (Gambar 4.30 dan Gambar 4.31).



Gambar 4.30 Hasil analisis properties material awal pada *section* 1

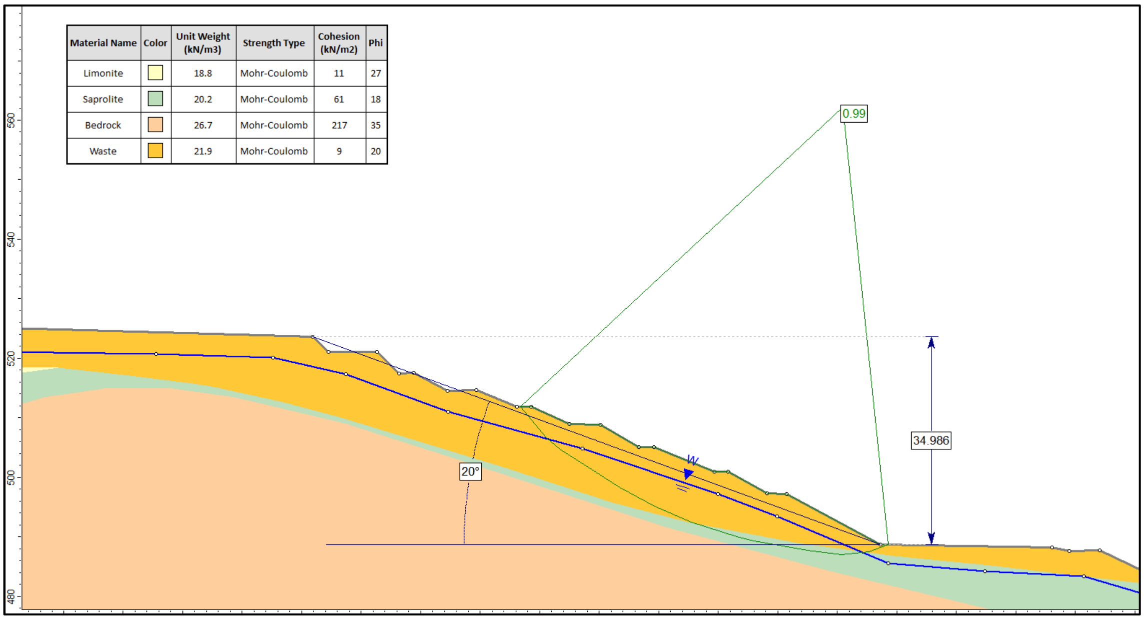


Gambar 4.31 Hasil analisis properties material awal pada *section* 2

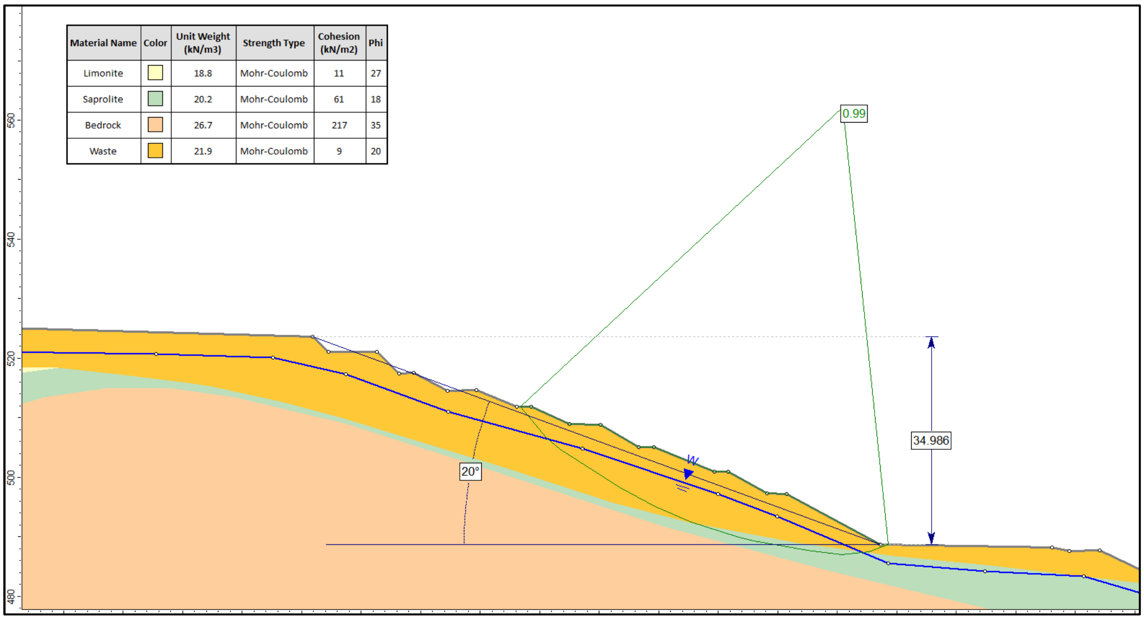
Hasil analisis menggunakan properties *waste* awal tersebut tidak mencerminkan kondisi ketidakstabilan sehingga perlu dilakukan penyesuaian properties material agar permodelan sesuai dengan kondisi aktual. Untuk itu Faktor Keamanan acuan dalam analisis balik ini adalah di sekitar 1.00 dengan pertimbangan material *waste dump* pada zona kritis. Hasil analisis balik terhadap properties *waste* menghasilkan properties *waste* pada Tabel 4.16.

Tabel 4.16 Properties Material Analisis Balik

Litologi	*Unit Weight* (kN/m^3)	Mohr Coloumb	
		C (KPa)	Phi (Degree)
Limonite	18.77	11	27
Saprolite	20.21	61	18
Bedrock	26.71	217	35
Waste	21.9	9	20



Gambar 4.32 Analisis Balik *Section* 1



Gambar 4.33 Analisis Balik *Section* 2

4.6. Analisis Kestabilan Lereng

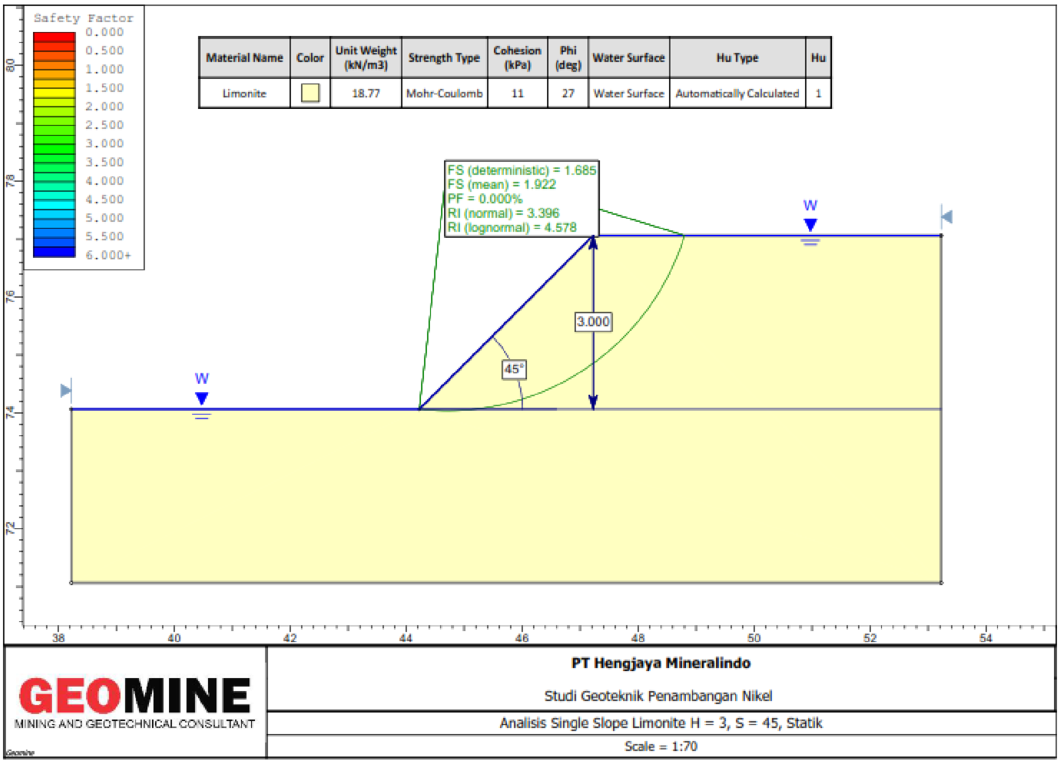
4.6.1. Analisa Kestabilan Lereng Tunggal (Bench Face Angle)

Analisis kestabilan lereng tunggal dilakukan untuk setiap domain, dengan menggunakan kondisi statik (tanpa beban seismik) dan pseudostatik (dengan beban seismik). Pada analisis awal diasumsikan lereng pada keadaan jenuh yang memberikan kondisi terburuk dari sisi pengaruh muka air tanah. Tinggi jenjang yang dianalisis adalah 3 m dan 5 m, dengan sudut *single slope* bervariasi dari 45° hingga sudut maksimum 60°. Hasil analisis kestabilan lereng tunggal ditampilkan pada Tabel 4.17. Dari hasil analisis ini mayoritas geometri lereng tunggal memenuhi kriteria terutama untuk domain *saprolite* dan *bedrock*. Untuk domain *limonite* tinggi jenjang 3 meter dengan kondisi *saturated* memenuhi kriteria namun untuk tinggi jenjang 5 meter perlu berada pada kondisi *dry* untuk dapat memenuhi kriteria.

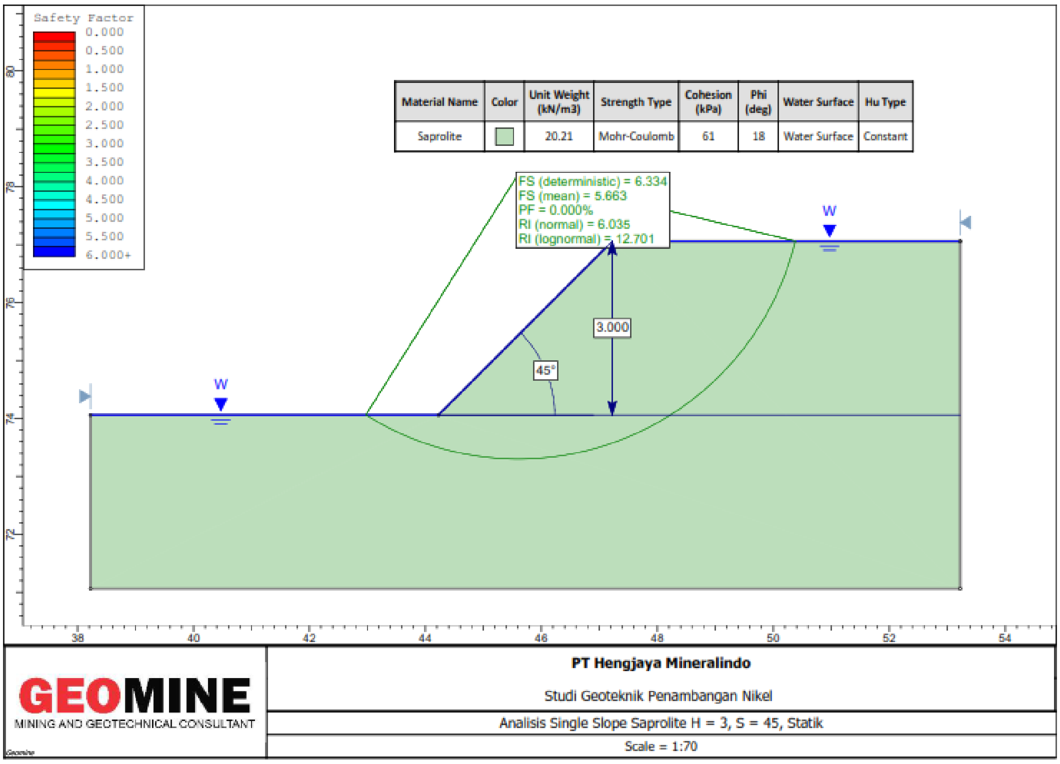
Contoh dari hasil analisis model untuk kestabilan lereng *single slope* ditampilkan Gambar 4.34 sampai 4.36, sementara hasil analisis secara keseluruhan dapat dilihat pada Lampiran D.

Tabel 4.17 Hasil Analisis Kestabilan Lereng Tunggal

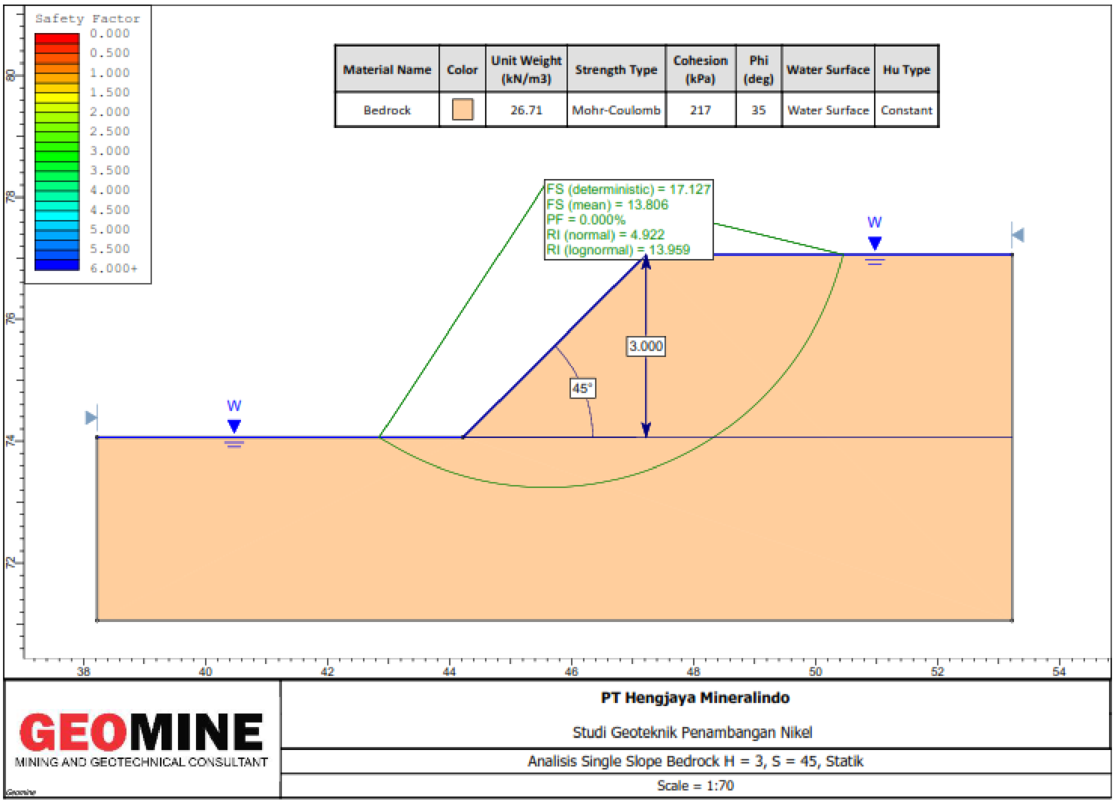
Analisis Lereng Tunggal						
Domain	**Tinggi (m)**	**Sudut (°)**	***Full Saturated***			
			FK Statik	**POF Statik**	**FK Dinamik**	**POF Dinamik**
Limonite	3	45	1.68	0.0%	1.44	0.0%
		50	1.58	0.0%	1.36	0.0%
		55	1.46	0.0%	1.28	0.0%
		60	1.35	0.0%	1.19	0.0%
	5	45	1.20	0.0%	1.03	0.0%
		50	1.11	0.0%	0.96	0.0%
		55	1.02	0.0%	0.89	0.0%
		60	0.92	0.0%	0.82	0.0%
Saprolite	3	45	6.33	0.0%	4.96	0.0%
		50	6.25	0.0%	4.97	0.0%
		55	6.19	0.0%	4.98	0.0%
		60	6.15	0.0%	4.80	0.0%
	5	45	3.91	0.0%	3.23	0.0%
		50	3.82	0.0%	3.11	0.0%
		55	3.80	0.0%	3.04	0.0%
		60	3.77	0.0%	2.92	0.0%
Bedrock	3	45	17.13	0.0%	13.39	0.0%
		50	16.91	0.0%	13.41	0.0%
		55	16.76	0.0%	13.45	0.0%
		60	16.65	0.0%	12.97	0.0%
	5	45	10.63	0.0%	8.71	0.0%
		50	10.48	0.0%	8.59	0.0%
		55	10.38	0.0%	8.29	0.0%
		60	10.37	0.0%	8.00	0.0%
Domain	**Tinggi (m)**	**Sudut (°)**	***Dry***			
			FK Statik	**POF Statik**	**FK Dinamik**	**POF Dinamik**
Limonite	5	45	1.62	0.0%	1.40	0.0%
		50	1.49	0.0%	1.31	0.0%
		55	1.39	0.0%	1.22	0.0%
		60	1.30	0.0%	1.14	0.0%



Gambar 4.34 Hasil Analisis Kestabilan Lereng Tunggal pada Domain *Limonite*



Gambar 4.35 Hasil Analisis Kestabilan Lereng Tunggal pada Domain *Saprolite*



Gambar 4.36 Hasil Analisis Kestabilan Lereng Tunggal pada Domain *Bedrock*

4.6.2. Analisa Kestabilan Lereng Keseluruhan (Overall Slope Angle)

Analisis kestabilan lereng keseluruhan dilakukan pada beberapa lokasi di dalam IUP HM yang merepresentasikan desain *final pit*. Analisis dilakukan pada kondisi statik (tanpa menggunakan beban seismik) dan pada kondisi pseudostatik (menggunakan beban seismik), serta dianalisis dalam kondisi muka air tanah yang didapat dari hasil pemodelan *groundwater table*.

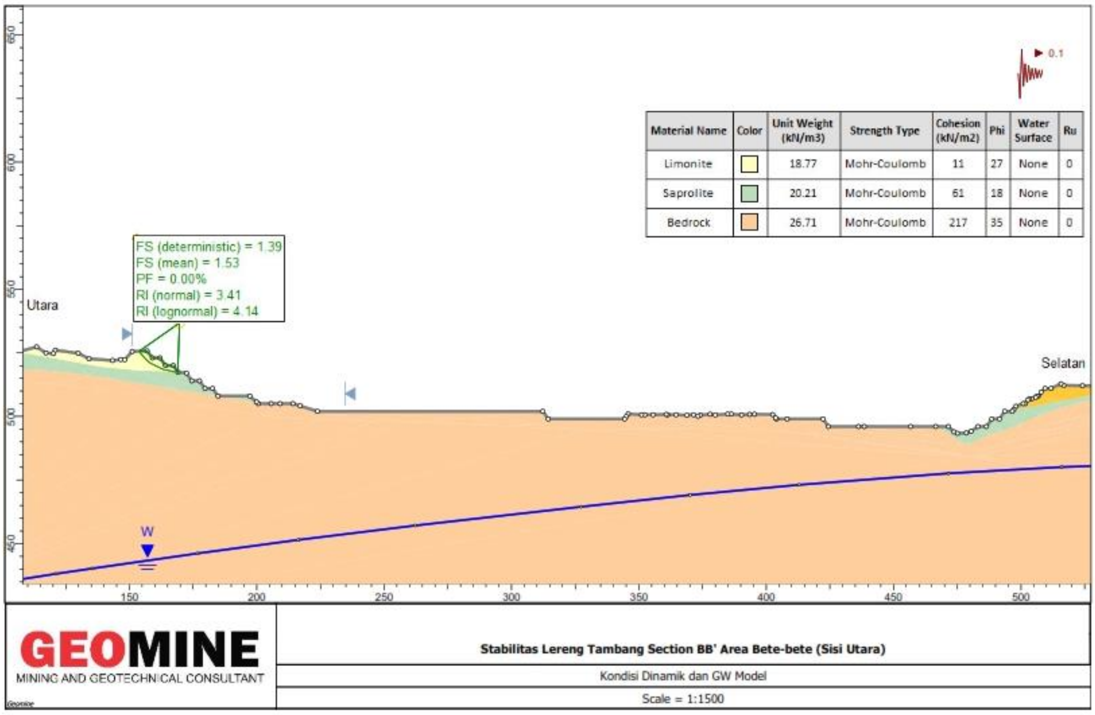
Hasil analisis kestabilan lereng keseluruhan ditampilkan pada Tabel 4.18. Pada setiap *section* yang dibuat terdapat dua lereng di masing-masing sisi (kiri dan kanan). Analisis dilakukan pada kedua lereng tersebut namun data Faktor Keamanan (FK) yang ditampilkan pada Tabel 4.18 merupakan nilai FK minimum dari keduanya.

Contoh dari hasil analisis model untuk kestabilan lereng ditampilkan Gambar 4.37 sampai 4.39, sementara hasil analisis secara keseluruhan dapat dilihat pada Lampiran D.

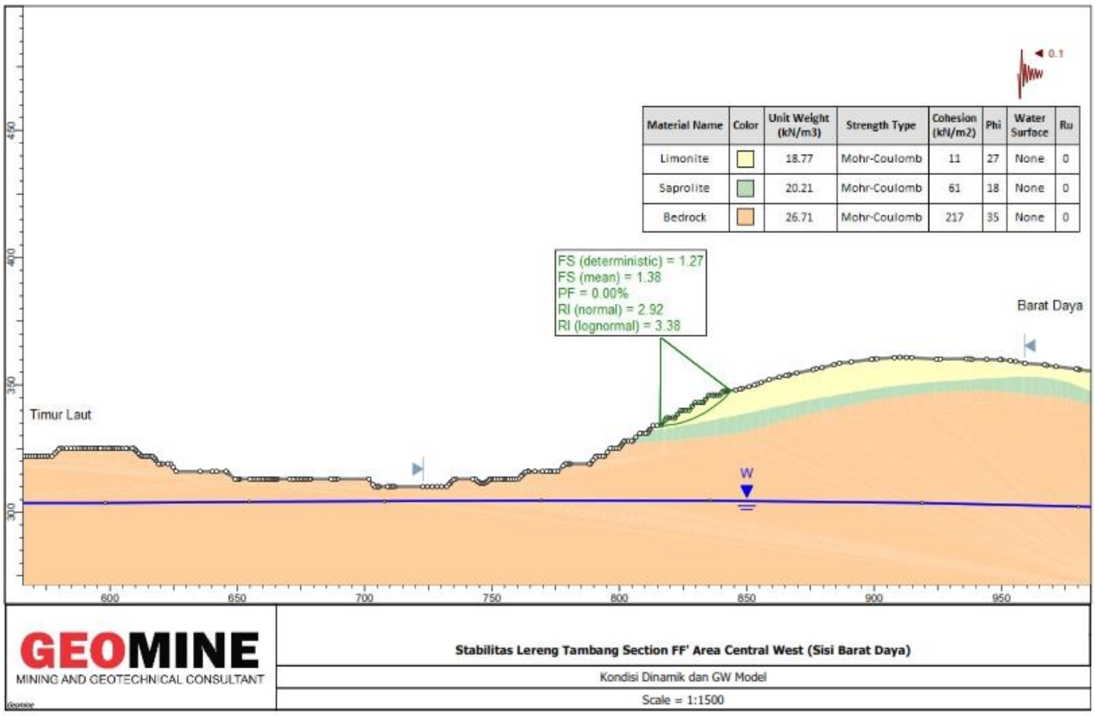
Tabel 4.18 Hasil Analisis Kestabilan Lereng Keseluruhan

No	Lokasi	*Section*	Lereng Keseluruhan		FK Statik	POF Statik	FK Dinamik	POF Dinamik	Kondisi
			Tinggi (m)	Sudut (°)					
1	Bete-Bete	Sec_AA'	80.09	29	2.24	0.0%	1.80	0.0%	*Stable*
2	Bete-Bete	Sec_BB'	17.76	33	1.68	0.0%	1.39	0.0%	*Stable*
3	Bete-Bete	Sec_CC'	9.00	36	1.87	0.0%	1.61	0.0%	*Stable*
4	Bete South	Sec_DD'	17.10	30	2.33	0.0%	1.94	0.0%	*Stable*
5	Bete South	Sec_EE'	14.63	33	1.75	0.0%	1.44	0.0%	*Stable*
6	Central West	Sec_FF'	28.54	29	1.56	0.0%	1.27	0.0%	*Stable*
7	Central West	Sec_GG'	22.62	25	1.96	0.0%	1.60	0.0%	*Stable*
8	Central East	Sec_HH'	31.25	31	1.45	0.0%	1.20	0.0%	*Stable*
9	Central East	Sec_II'	9.00	23	1.87	0.0%	1.56	0.0%	*Stable*
10	Central West	Sec_JJ'	15.00	34	1.38	0.0%	1.14	0.6%	*Stable*
11	Central East	Sec_KK'	14.73	37	1.11	2.4%	0.92	42.7%	*Marginally Stable*

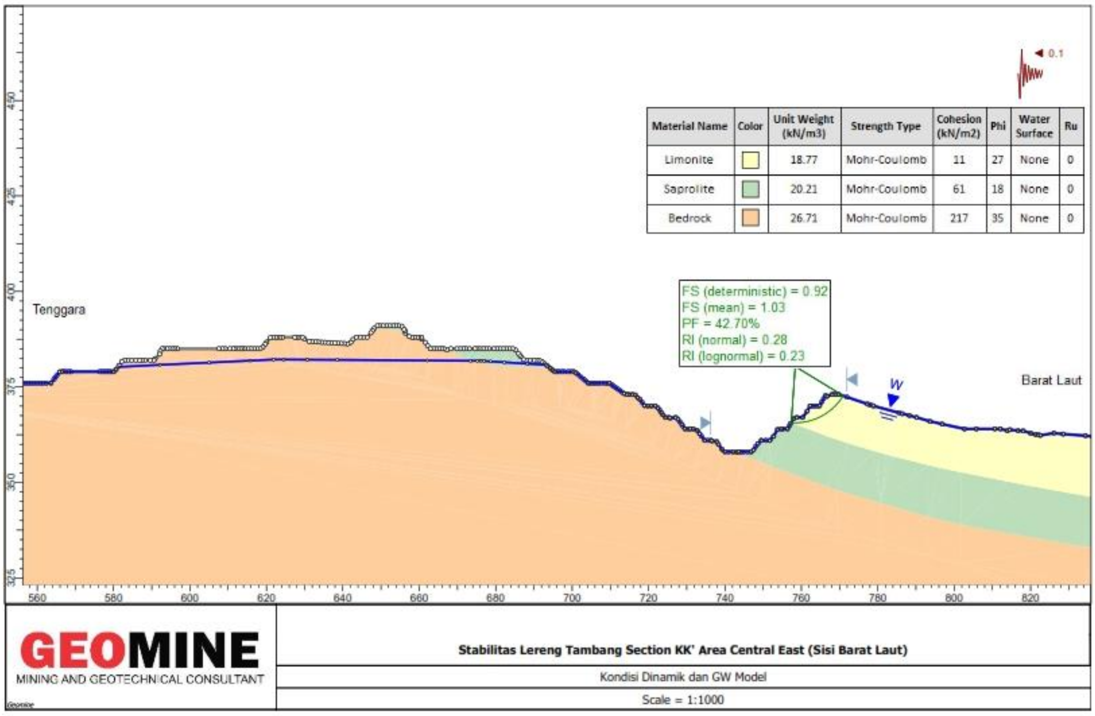
Secara keseluruhan, hasil analisis kestabilan design akhir *pit* PT Hengjaya Mineralindo telah memenuhi kriteria dan menunjukkan kondisi yang stabil dengan nilai Faktor Keamanan (FK) di atas 1.3 untuk kondisi statik dan di atas 1.05, kecuali pada Sec_KK' yang berlokasi di Central East. Hasil analisis pada Sec_KK' menunjukkan nilai FK dan PoF berada di bawah batas kriteria minimum dan menunjukkan kondisi *marginally stable*. Untuk dapat memenuhi kriteria maka ada beberapa rekomendasi yang dapat dilakukan dan dibahas pada Bab 5.



Gambar 4.37 Hasil Analisis Kestabilan Lereng *Section* BB’ Area Bete-Bete (Sisi Utara)



Gambar 4.38 Hasil Analisis Kestabilan Lereng *Section* FF’ Area Central West (Sisi Barat Daya)



Gambar 4.39 Hasil Analisis Kestabilan Lereng *Section* KK’ Area Central East (Sisi Barat Daya)

4.7. Analisis Kemampugalian dan Kemampugaruan

Berbagai metode umum digunakan dalam penentuan kemampugalian dan kemampugaruan. Dalam analisa terkait material di area tambang Hengjaya Mineralindo, metode yang dipilih adalah metode yang diperkenalkan oleh Pettifer-Fookes (1994). Parameter utama yang dibutuhkan adalah kekuatan tekan batuan (*Uniaxial Compressive Strength* - UCS) dan spasi kekar batuan (*Discontinuity Spacing* - m). Data-data tersebut diperoleh dari pengeboran geoteknik yang telah dilakukan di beberapa lokasi seperti yang terlihat pada Gambar 4.1 di atas. Dari kegiatan pengeboran tersebut juga diambil sejumlah sampel uji laboratorium untuk mendapatkan properties material seperti yang ditampilkan pada Tabel 4.3 – Tabel 4.8.

4.7.1. Kekuatan Tekan Batuan (*Uniaxial Compressive Strength*)

Nilai UCS untuk batuan *Saprolite* dan *Bedrock* menggunakan data hasil uji laboratorium, sedangkan untuk *Limonite* dan *Soil* digunakan data *Intact Rock Strength* hasil logging geoteknik (contoh pada Gambar 4.40) yang dikonversi menggunakan metode ISRM 1981 (Tabel 4.19) menjadi estimated UCS.

CORE RUN METERAGE								
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)
0,00	1,00	1,00	1,00			S2	CW	Limonite
1,00	2,50	1,50	0,96			S2	CW	Limonite
2,50	3,50	1,00	0,80			S2	CW	Limonite
3,50	4,50	1,00	1,00			S3	CW	Limonite
4,50	5,00	0,50	1,00			S3	CW	Limonite
5,00	6,50	1,50	1,00			S3	CW	Limonite
6,50	8,00	1,50	1,00			S3	CW	Limonite
8,00	9,50	1,50	1,00			S3	CW	Limonite
9,50	11,00	1,50	1,00			S3	CW	Limonite
11,00	12,50	1,50	1,00			S3	CW	Limonite
12,50	14,00	1,50	1,00			S3	CW	Limonite
14,00	14,80	0,80	1,00			S3	CW	Saprolite

Gambar 4.40 Contoh Data Logging Limonite

Tabel 4.19 Estimasi Kekuatan *Soil* berdasarkan ISRM 1981

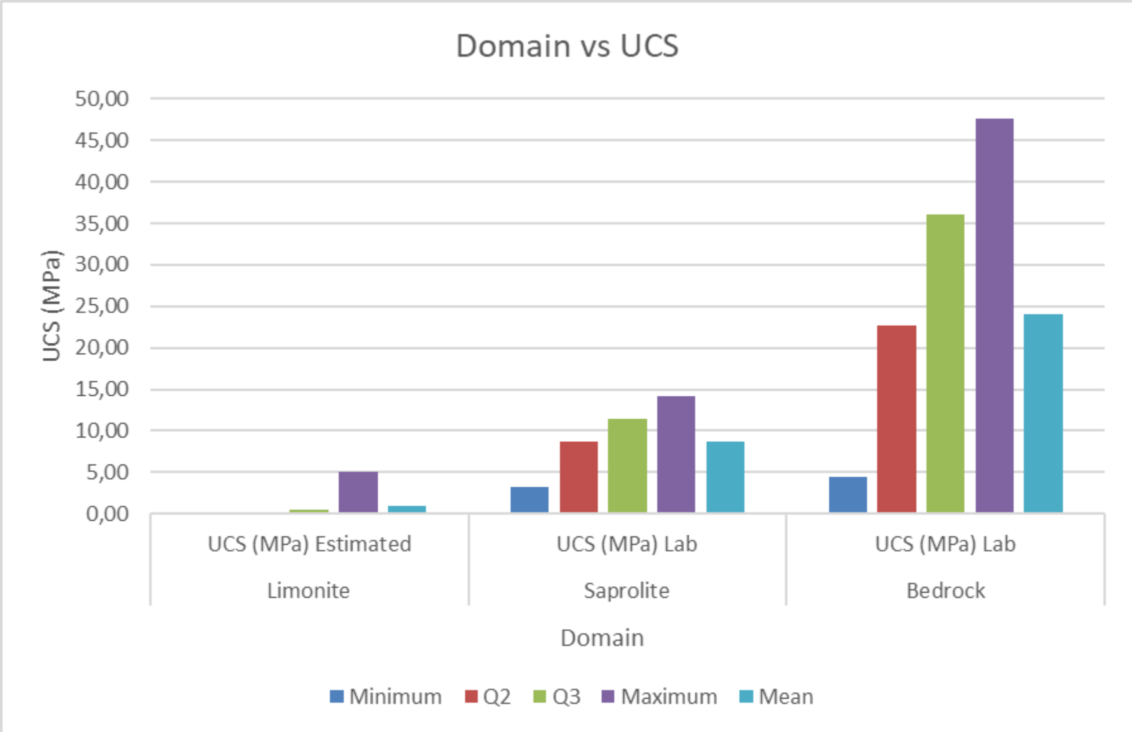
Code **(ISRM, 1981)**	***Description*** **(ISRM, 1981)**	***UCS Estimation*** **(Mpa)**	***Strength Estimation in the Field***
G	*Granular Soil*	0	*Cohesionless, friable*, tanah granular, pasir *Cohesionless, friable, granular soil, sand*
S1	*Very Sft Clay*	< 0.025	Mudah menembus beberapa sentimeter dengan kepalan tangan *Easy penetrated several centimetres by fist*
S2	*Soft Clay*	0.025 - 0.05	Mudah menembus beberapa sentimeter dengan ibu jari *Easy penetrated several centimetres by thumb*
S3	*Firm Clay*	0.05 - 0.1 (< 1.0 on pocket penetrometer)	Dapat menembus beberapa sentimeter dengan ibu jari dengan usaha sedang. Hancur dengan sedikit tekanan dari kuku *Can be penetrated several centimetres with thumb with moderate effort. Crumbles under light preassure from a nail*
S4	*Stiff Clay*	0.10 - 0.25 (1.0 - 2.5 on pocket penetrometer)	Mudah diidentifikasi dengan ibu jari tetapi hanya menembus dengan usaha keras. Hancur di bawah tekanan sedang dari kuku. *Readily intended by thumb but penetrated only with great effort. Crumbles under moderate pressure from a nail.*

Code* (ISRM, 1981*)	***Description* (ISRM, 1981)**	***UCS Estimation* (Mpa)**	***Strength Estimation in the Field***
S5	Very Stiff Clay	0.25 - 0.50	Mudah diidentifikasi oleh kuku ibu jari *Readily intented by thumbnail*
S6	Hard Clay	> 0.50	Indentasi dengan kesulitan dengan kuku ibu jari *Indented with difficulty by thumbnail*

Tabel 4.20 dan Gambar 4.41 memperlihatkan distribusi nilai UCS untuk masing-masing domain HM.

Tabel 4.20 Kuat Tekan Batuan masing-masing Domain

Domain	**Properties**	**Min**	**Q2**	**Q3**	**Max**	**Mean**
		(MPa)	**(MPa)**	**(MPa)**	**(MPa)**	**(MPa)**
Limonite	UCS Estimated	0.1	0.2	0.4	5.0	1.0
Saprolite	UCS Lab	3.2	8.7	11.5	14.2	8.7
Bedrock	UCS Lab	4.5	22.7	36.0	47.6	24.1



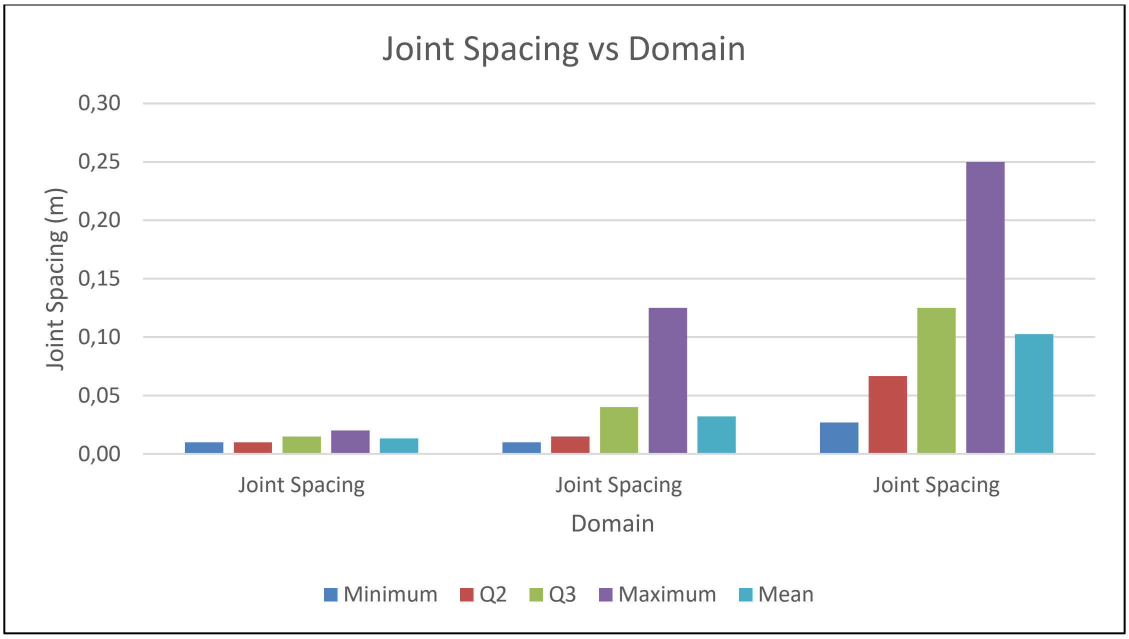
Gambar 4.41 Hubungan Domain dengan Nilai UCS

4.7.2. Spasi Kekar (Discontinuity Spacing)

Nilai spasi kekar diestimasikan dari data logging jumlah kekar dalam satu run dan divalidasi dengan observasi langsung dari fisikal *core*. Sedangkan untuk *Limonite* sama seperti penentuan UCS diestimasi memiliki nilai sebesar 100 rekahan/m karenakan dalam limonite berada pada kondisi sangat lapuk (*completely weathered*) atau seperti tanah, sehingga spasi joint ≤ 0.02m.

Tabel 4.21 Spasi Kekar masing-masing Domain

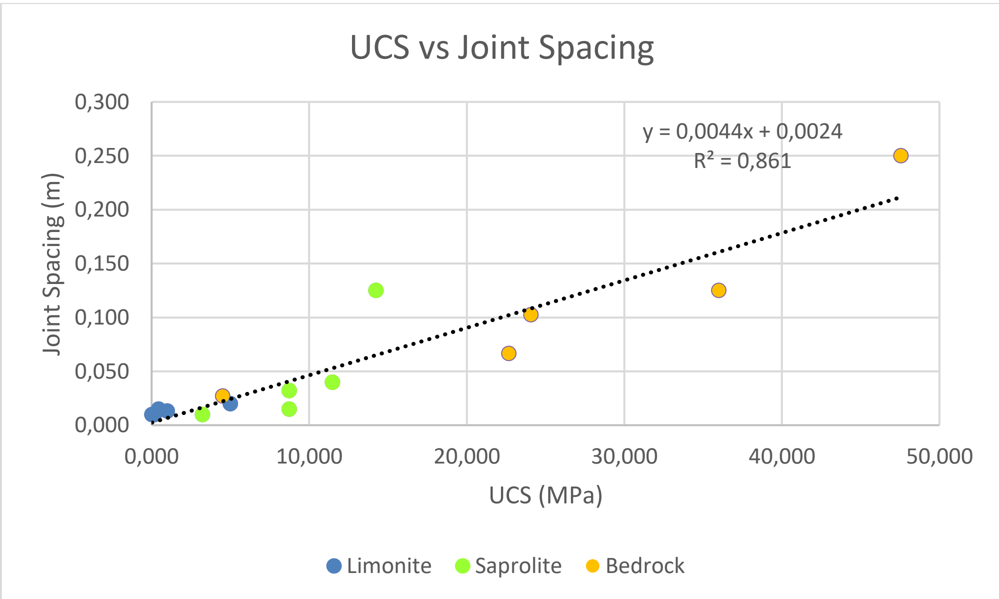
Domain	Properties	Min	Q2	Q3	Max	Mean
		(m)	(m)	(m)	(m)	(m)
Limonite	Joint Spacing	0.010	0.010	0.015	0.020	0.013
Saprolite	Joint Spacing	0.010	0.015	0.040	0.125	0.032
Bedrock	Joint Spacing	0.027	0.067	0.125	0.250	0.103



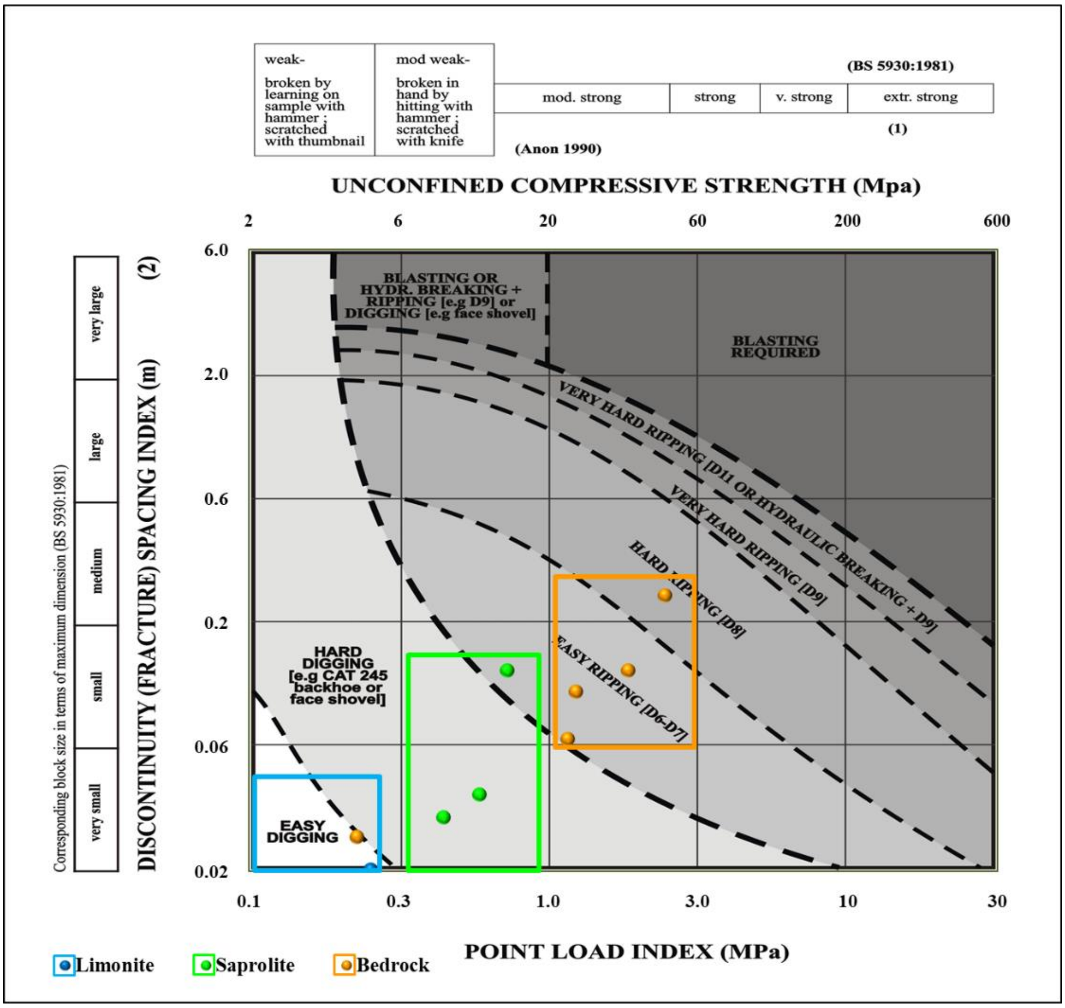
Gambar 4.42 Hubungan Domain dengan Spasi Kekar

4.7.3. Hasil Analisis Kemampugalian dan Kemampugaruan

Data-data UCS dan Spasi Kekar kemudian diplot dalam grafik (Gambar 4.43) untuk melihat korelasi antara kedua parameter tersebut. Selanjutnya data-data tersebut diplot di dalam grafik Pettifer-Fookes untuk mengetahui kemampugalian dan kemampugaruan untuk setiap domain.



Gambar 4.43 Hubungan Nilai Kuat Tekan Batuan dengan Spasi Kekar



Gambar 4.44 Kemampugalian dan Kemampugaruan Berdasarkan Pettifer-Fookes

Dari grafik-grafik di atas terlihat bahwa karakteristik setiap domain terdistribusi dalam kategori yang relatif homogen sehingga perlakuan penggalian atau penggaruan juga relatif sama untuk masing-masing domain tersebut seperti tabel di bawah:

Tabel 4.22 Kemampugalian dan Kemampugaruan per Litologi

Litologi	Metode
Limonite	*Easy Digging*
Saprolite	*Hard Digging*
Bedrock	*Easy-Hard Ripping*

5. KESIMPULAN DAN REKOMENDASI

5.1. Kesimpulan

5.1.1. Kesimpulan Kajian Hidrologi dan Hidrogeologi

Berdasarkan hasil kajian hidrologi dan hidrogeologi yang telah dilakukan, kesimpulan yang dapat diperoleh adalah sebagai berikut:

1. Kebutuhan data untuk keperluan muka airtanah dan konduktivitas hidraulik dianggap telah memenuhi kebutuhan data minimal untuk analisis, data tersebut didapatkan dari pengukuran lapangan pada sembilan lubang bor geoteknik.
2. Hasil estimasi debit puncak air permukaan dengan periode ulang 100 tahun dan metode rasional pada rencana pond berkisar antara 3.8 m^3/detik sampai 20.7 m^3/detik.
3. Lapisan yang membentuk zona akuifer utama pada sistem airtanah adalah laterit bawah dan batuan ultramafik terkekarkan, memiliki ketebalan berkisar antara 10-30 m. Tanah laterit berukuran lempung (*limonite*) berfungsi sebagai lapisan akuiklud. Batuan ultramafik yang tidak terkekarkan bertindak sebagai lapisan akuifug, diasumsikan kontinu hingga ketebalan lebih dari 100 meter.
4. Estimasi *groundwater inflow* pada tahun pertama sebesar 22.2 L/detik dan berangsur turun menuju garis konstan (*steady*) pada tahun-tahun berikutnya di sekitar 19 L/detik. Debit *groundwater inflow* secara umum cenderung kecil karena posisi muka airtanah yang relatif telah turun, sehingga sedikit yang berpotongan dengan bukaan tambang.

5.1.2. Kesimpulan Kajian Geoteknik

Berdasarkan hasil studi geoteknik yang dilakukan, kesimpulan yang dapat diperoleh adalah sebagai berikut:

1. Pengumpulan data properties material HM dilakukan melalui logging geoteknik terhadap core-core dari sembilan lubang pengeboran geoteknik dan hasil pengujian sifat fisik dan mekanik. Validasi terhadap properties menggunakan geometri aktual dan analisis balik menggunakan indikasi ketidakstabilan dilakukan untuk menentukan properties yang merepresentasikan karakteristik domain geoteknik di area HM.

2. Analisis kestabilan lereng tunggal dilakukan untuk setiap domain dan hasilnya ditampilkan pada Tabel 5.1. Dari hasil analisis menunjukkan mayoritas geometri lereng tunggal memenuhi kriteria terutama untuk domain *saprolite* dan *bedrock*. Untuk domain limonite tinggi jenjang 3 meter dengan kondisi *saturated* memenuhi kriteria namun untuk tinggi jenjang 5 meter perlu berada pada kondisi *dry* untuk dapat memenuhi kriteria.

Tabel 5.1 Hasil Analisis Kestabilan Lereng Tunggal

Analisis Lereng Tunggal						
Domain	**Tinggi (m)**	**Sudut (°)**	***Full Saturated***			
			FK Statik	**POF Statik**	**FK Dinamik**	**POF Dinamik**
Limonite	3	55	1.46	0.0%	1.28	0.0%
		60	1.35	0.0%	1.19	0.0%
	5	55	1.02	0.0%	0.89	0.0%
		60	0.92	0.0%	0.82	0.0%
Saprolite	3	55	6.19	0.0%	4.98	0.0%
		60	6.15	0.0%	4.80	0.0%
	5	55	3.80	0.0%	3.04	0.0%
		60	3.77	0.0%	2.92	0.0%
Bedrock	3	55	16.76	0.0%	13.45	0.0%
		60	16.65	0.0%	12.97	0.0%
	5	55	10.38	0.0%	8.29	0.0%
		60	10.37	0.0%	8.00	0.0%

3. Analisis kestabilan lereng keseluruhan dilakukan pada beberapa lokasi di dalam IUP HM yang merepresentasikan desain *final pit* dan hasilnya ditampilkan pada Tabel 5.2. Secara keseluruhan, hasil analisis kestabilan design akhir *pit* PT Hengjaya Mineralindo telah memenuhi kriteria dan menunjukkan kondisi yang stabil dengan nilai Faktor Keamanan (FK) di atas 1.3 untuk kondisi statik dan di atas 1.05, kecuali pada Sec_KK' yang berlokasi di Central East. Hasil analisis pada Sec_KK' menunjukkan nilai FK dan PoF berada di bawah batas kriteria minimum dan menunjukkan kondisi *marginally stable.*

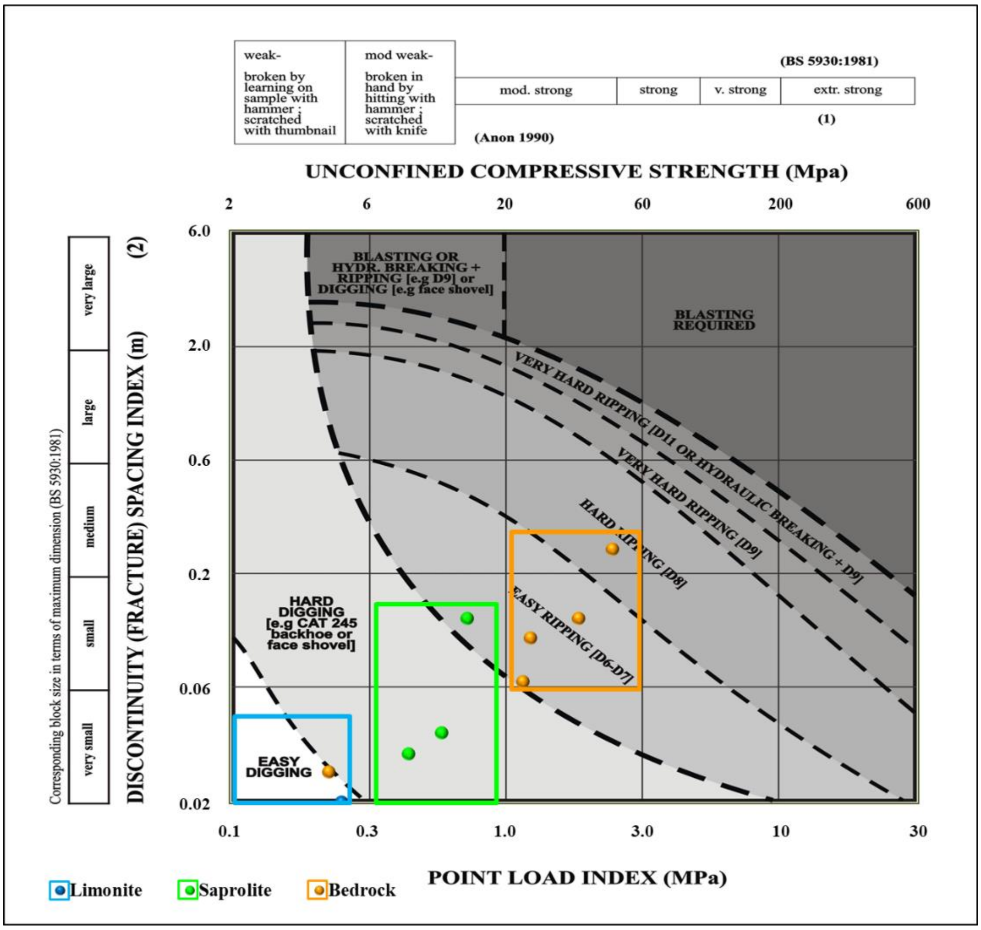
Tabel 5.2 Hasil Analisis Kestabilan Lereng Keseluruhan

Lokasi	*Section*	Lereng Keseluruhan		FK Statik	POF Statik	FK Dinamik	POF Dinamik	Kondisi
		Tinggi (m)	Sudut (°)					
Bete-Bete	Sec_AA'	80	29	2.24	0.0%	1.80	0.0%	*Stable*
Bete-Bete	Sec_BB'	18	33	1.68	0.0%	1.39	0.0%	*Stable*
Bete-Bete	Sec_CC'	9	36	1.87	0.0%	1.61	0.0%	*Stable*
Bete South	Sec_DD'	17	30	2.33	0.0%	1.94	0.0%	*Stable*
Bete South	Sec_EE'	15	33	1.75	0.0%	1.44	0.0%	*Stable*
Central West	Sec_FF'	29	29	1.56	0.0%	1.27	0.0%	*Stable*
Central West	Sec_GG'	23	25	1.96	0.0%	1.60	0.0%	*Stable*
Central East	Sec_HH'	31	31	1.45	0.0%	1.20	0.0%	*Stable*
Central East	Sec_II'	9	23	1.87	0.0%	1.56	0.0%	*Stable*
Central West	Sec_JJ'	15	34	1.38	0.0%	1.14	0.6%	*Stable*
Central East	Sec_KK'	15	37	1.11	2.4%	0.92	42.7%	*Marginally Stable*

4. Analisis kemampugalian dan kemampugaruan dilakukan pada masing-masing litologi berdasarkan data parameter nilai kuat tekan batuan dan spasi rekahan yang di-plot ke dalam grafik Pettifer-Fookes (Gambar 5.1). Dari grafik dapat disimpulkan bahwa karakteristik setiap litologi terdistribusi dalam kategori yang relatif homogen sehingga perlakuan penggalian atau penggaruan juga relatif sama untuk masing-masing litologi tersebut seperti pada Tabel 5.3.

Tabel 5.3 Kemampugalian dan Kemampugaruan per Litologi

Litologi	Metode
Limonite	*Easy Digging*
Saprolite	*Hard Digging*
Bedrock	*Easy-Hard Ripping*



Gambar 5.1 Kemampugalian dan Kemampugaruan Berdasarkan Pettifer-Fookes

5.2. Rekomendasi

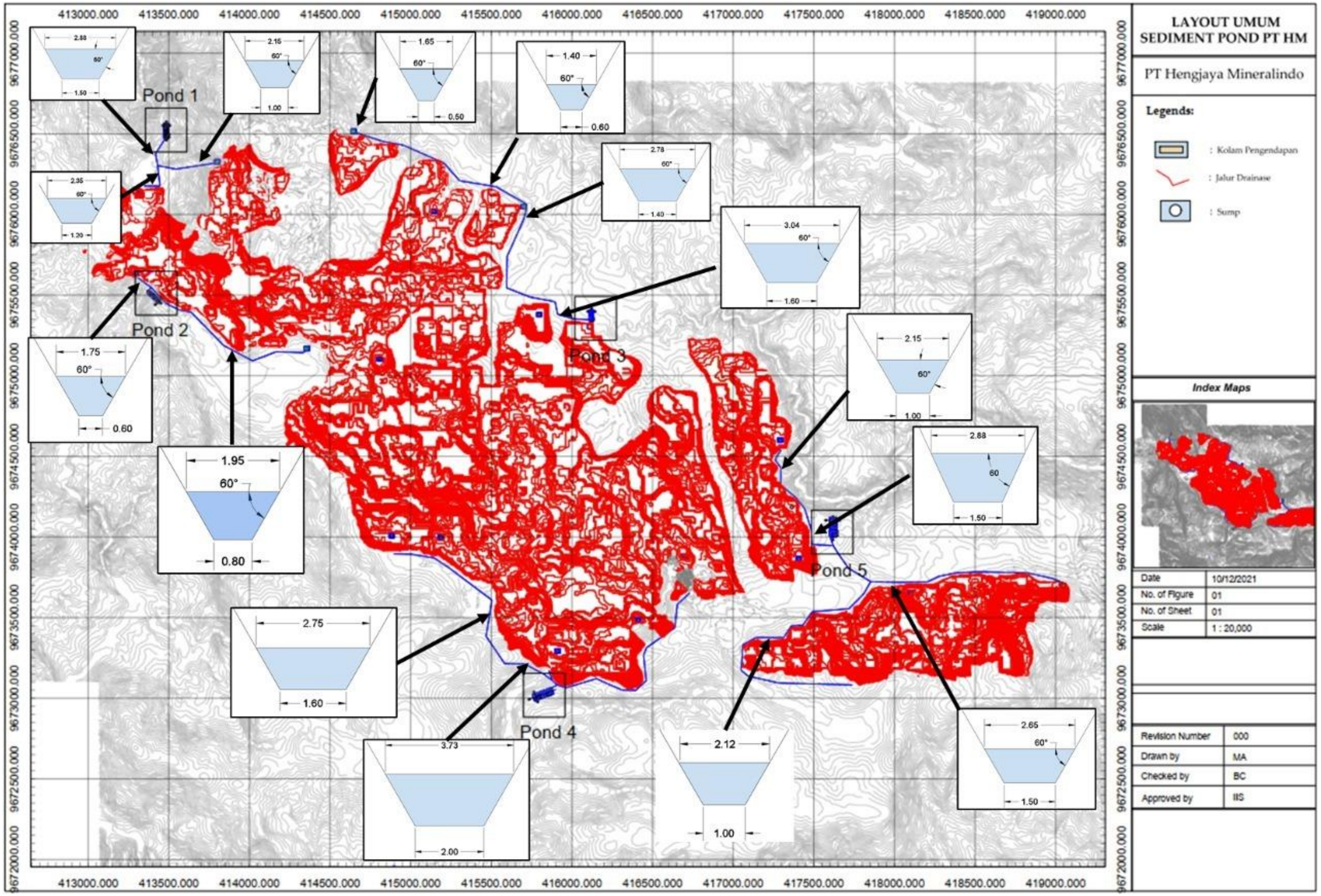
5.2.1. Rekomendasi Hidrologi dan Hidrogeologi

Dari hasil analisis didapatkan beberapa hal yang menjadi rekomendasi teknis terkait dimensi infrastruktur dan peralatan untuk penanganan penyaliran tambang meliputi:

1. **Saluran Drainase**

   Saluran perimeter dibutuhkan khususnya pada bagian Selatan dari area pit *central east* (Gambar 5.2). Saluran ini dibuat untuk mencegah masuknya air permukaan yang cukup besar dari luar ke dalam pit.

   Rekomendasi dimensi perimeter drainase ditentukan berdasarkan hasil analisis yang dilakukan pada debit rencana yang telah dihitung sebelumnya. Pembuatan perimeter drainase direkomendasikan dengan bentuk saluran berupa trapesium. *Layout* rekomendasi perimeter drainase, serta tipikal dimensi saluran dapat dilihat pada Gambar 5.2.



Gambar 5.2 Rekomendasi sistem penyaliran rencana tambang PT HM

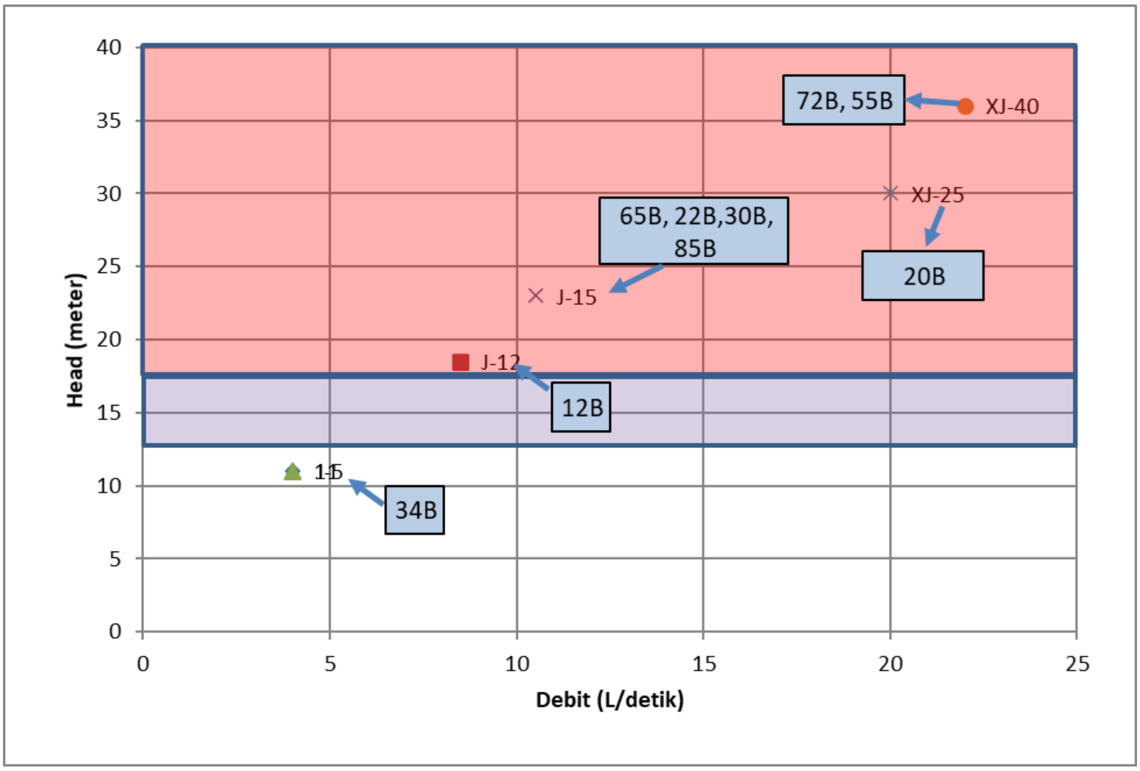
2. *Sump* dan Pemompaan

Penggunaan pompa di tambang terbuka adalah untuk menjaga agar kapasitas *sump* dapat selalu menahan total limpasan air (airtanah dan air permukaan) yang masuk ke dalam pit. Keseimbangan jumlah air masuk-keluar dilakukan dengan memilih pompa dengan kapasitas yang tepat. Secara teknis, pemilihan pompa dibuat berdasarkan dua faktor utama, yaitu kemampuan dorong pompa (*head*) dan jumlah air yang bisa dipompa (volume/waktu). Kapasitas *inflow* dan *head* maksimum dari masing-masing lokasi rencana pit PT HM dapat dilihat pada Tabel 5.4.

Tabel 5.4 Kapasitas *inflow* maksimum dan *head* dari masing-masing rencana pit

Sub-Catchment	Peak Flow Rate (m3/s)	Head (m)	Head Max (85% Efisiensi) (m)
34B	2.21	6	6.90
65B	6.36	12	13.80
20B	4.07	20	23.00
72B	2.93	30	34.50
22B	4.43	6	6.90
55B	3.32	28	32.20
48B	3.29	8	9.20
30B	6.38	10	11.50
12B	4.72	8	9.20
85B	3.28	4	4.60

Penentuan pompa yang digunakan pada masing-masing pit dihitung berdasarkan potensi maksimum debit *inflow* dan kapasitas *head* maksimum masing-masing rencana pit setelah dikurangi efisiensi sebesar 85%. Gambar 5.3 memperlihatkan spesifikasi pompa yang umum digunakan pada tambang terbuka (contoh dalam produk Sultzer) dengan detail pada Tabel 5.5. Blok biru pada Gambar 5.3 memperlihatkan jenis pompa yang dapat digunakan pada lokasi tambang PT HM.



Gambar 5.3 Spesifikasi pompa berdasarkan kemampuan *head* dan *discharge* (contoh dari produk Sultzer)

Tabel 5.5 Rekomendasi spesifikasi jenis pompa (sejenis) untuk mengantisipasi aliran puncak pada tambang PT HM

Catchment	Jenis Pompa	Discharge (m^3/s)	Head Pompa (m)	Inflow (m^3/s)	Head Max (m)	Ratio
34B	J-5	4	11	2.21	6.90	0.55
65B	J-15	10.5	23	6.36	13.80	0.61
20B	XJ-25	20	30	4.07	23.00	0.39
72B	XJ-40	22	36	2.93	34.50	0.13
22B	J-15	10.5	23	4.43	6.90	0.42
55B	XJ-40	22	36	3.32	32.20	0.17
48B	J-12	8.5	18.5	4.72	9.20	0.56
30B	J-15	10.5	23	6.38	11.50	0.61
12B	J-12	8.5	18.5	4.72	9.20	0.56
85B	J-15	10.5	23	3.28	4.60	0.31

Infrastruktur lain yang dibutuhkan untuk penyaliran di dalam tambang adalah *sump*.. Ukuran *sump* utama harus mampu mengakomodasi jumlah air tanah dan air permukaan yang mengalir ke lubang tambang dan idealnya terletak di titik terendah level penambangan. Ukurannya disesuaikan dengan kemampuan total pemompaan yang tersedia. *Sump* pada pit PT HM berjumlah sesuai dengan *sub-catchment* pada area pertambangan. Dari *sump*, air akan dipompa terlebih dahulu ke perimeter drainase, namun tidak semua *sump* membutuhkan pompa karena tidak memiliki *head* ke lokasi perimeter drainase terdekat. Beberapa *sump* yang membutuhkan pemompaan disajikan pada Tabel 5.6.

Tabel 5.6 Karakteristik *sub-catchment* beserta besar *head* untuk dialirkan ke perimeter

Sub-Catchment	Peak Flow Rate (m^3/s)	Head (m)	Head Max (m)
34B	2.21	6	6.90
65B	6.36	12	13.80
20B	4.07	20	23.00
72B	2.93	30	34.50
22B	4.43	6	6.90
55B	3.32	28	32.20
48B	3.29	8	9.20
30B	6.38	10	11.50
12B	4.72	8	9.20
85B	3.28	4	4.60

3. *Sediment Pond*

Sediment Pond adalah suatu penyaliran berbentuk kolam yang berfungsi sebagai kolam pengendapan semua air dari areal tambang, baik air tanah maupun air hujan dan bertujuan untuk menjernihkan air yang keluar ke perairan umum. Data ukuran butir yang digunakan pada perhitungan menggunakan hasil analisis laboratorium, yaitu ukuran butir dominan pada bagian permukaan di lokasi studi adalah partikel dengan ukuran medium *silt*. Resume perhitungan *Fall Velocity* dan luas permukaan *sediment pond* dapat dilihat pada Tabel 5.7. Perhitungan ini telah memasukkan faktor keselamatan (*factor of safety*) dengan mengalikan debit puncak sebesar 1.25 kali sesuai rekomendasi pada Kepmen 1827 tahun 2018.

Tabel 5.7 Perhitungan *fall velocity* dan luas permukaan *sediment pond*

Parameter		Unit	Pond				
			P01	P02	P03	P04	P05
Watershed area	A	ha	120.11	117.75	62.61	431.9	229.84
Peak flow (1,25 x Qp)	Qp	m^3/s	9.175	10.3375	4.7375	25.9	19.2125
Discharge Rate (5% x Qp)	Q	m^3/s	0.37	0.41	0.19	1.04	0.77
Particle size (medium silt)	d	m	2.00E-05	2.00E-05	2.00E-05	2.00E-05	2.00E-05
Soil particle density	pp	kg/m^3	2617	2617	2617	2617	2617
Water density	pe	kg/m^3	1000	1000	1000	1000	1000
Adjusment factor related to turbulence	Ɵ		1	1	1	1	1
Fall velocity	**Vp**	**m/s**	**2.20E-04**	**2.20E-04**	**2.20E-04**	**2.20E-04**	**2.20E-04**
Minimum area of sediment pond	**As**	**m^2**	**1665.79**	**1876.85**	**860.13**	**4702.33**	**3488.17**

Dengan diketahuinya luas permukaan *sediment pond* yang dibutuhkan, maka dapat diperkirakan dimensi secara keseluruhan. Untuk menjaga kestabilan dinding *sediment pond*, maka kemiringannya dijaga pada angka 1:1.5. Perkiraan dimensi untuk *Pond* 1 hingga 5 dapat dilihat pada Tabel 5.8. Dari perhitungan yang dilakukan, *sediment pond* untuk masing-masing *catchment* (*Pond* 1 hingga *Pond* 5) dibagi menjadi 3 kompartemen, dengan estimasi volume tiap kompartemen berkisar antara 598.5 m^3 hingga 8448 m^3.

Tabel 5.8 Perhitungan jumlah dan dimensi *settling pond*

Parameter		Unit	Pond				
			P01	P02	P03	P04	P05
Sediment Pond Dimension							
Slope of sides			1:1.5	1:1.5	1:1.5	1:1.5	1:1.5
Number of sediment pond			3	3	3	3	3
Width at floor of sediment pond	L	m	7	7	5	12	10
Water depth during operation	P	m	5	5	3	8	7
Width of water surface	**W**	**m**	**22**	**22**	**14**	**36**	**31**
Length of sediment pond	**l**	**m**	**26**	**29**	**21**	**44**	**38**
Sediment pond volume (per compartment)		m^3	1885	2102.5	598.5	8448	5453
Total sediment pond volume		m^3	9425	10512.5	1795.5	67584	38171

5.2.2. Rekomendasi Geoteknik

Dari hasil analisis didapatkan beberapa hal yang menjadi rekomendasi meliputi:

1. Sesuai dengan dimensi bench yang direncanakan oleh HM setinggi 3 meter, maka sudut lereng tunggal (*bench face angle*) yang direkomendasikan adalah 55°.

Tabel 5.9 Rekomendasi Analisis Kestabilan Lereng Tunggal

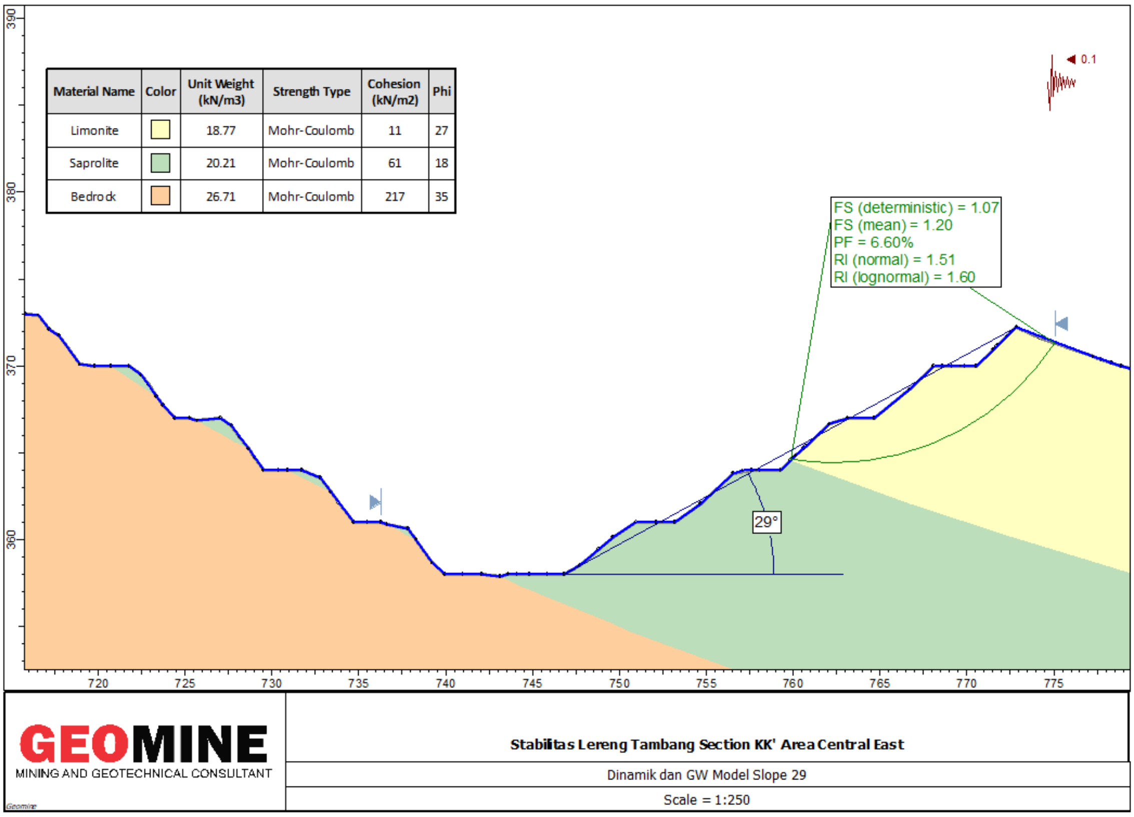
Domain	Tinggi (m)	Sudut (°)	*Full Saturated*			
			FK Statik	POF Statik	FK Dinamik	POF Dinamik
Limonite	3	55	1.46	0.0%	1.28	0.0%
Saprolite	3	55	6.19	0.0%	4.98	0.0%
Bedrock	3	55	16.76	0.0%	13.45	0.0%

2. Mitigasi risiko ketidakstabilan lereng Section KK'

   Analisis kestabilan lereng keseluruhan yang dilakukan terhadap Sec_KK' menunjukkan nilai FK dan PoF berada di bawah batas kriteria minimum dan menunjukkan kondisi *marginally stable.* Terdapat beberapa opsi yang direkomendasikan untuk memitigasi risiko tersebut.

a. <u>Melandaikan sudut *overall slope*</u>

Sudut *overall slope pit* harus diturunkan menjadi sekitar 29º untuk memperoleh nilai FK yang sesuai dengan ketentuan. Gambar 5.4 menunjukkan kondisi lereng setelah dilakukan pelandaian.

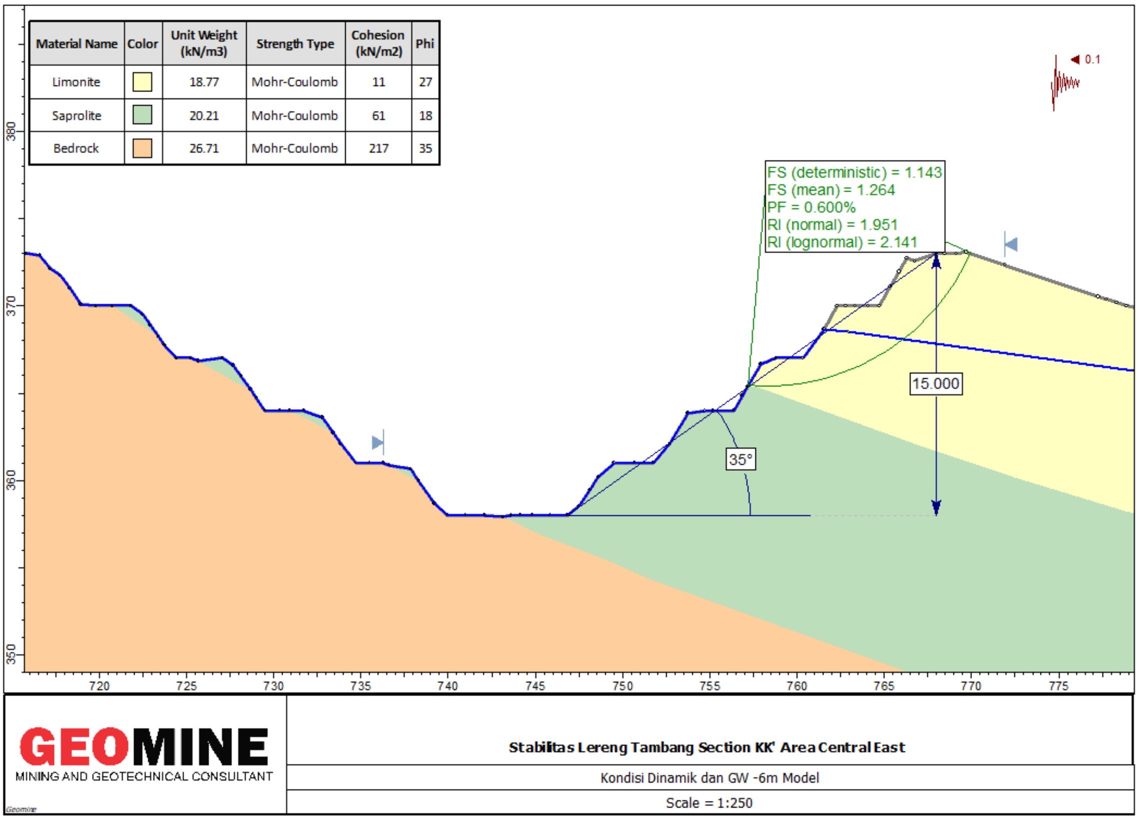


Gambar 5.4 Hasil Analisis Kestabilan Lereng Section KK' Lereng B (*Overall Slope* 29^{o})

b. Menurunkan tinggi muka air tanah

Opsi mitigasi lainntya adalah menurunkan tinggi muka air tanah dengan salah satu nya dengan pemasangan *drain hole*. Gambar 5.5 menunjukkan kondisi lereng setelah dilakukan penurunan muka air tanah sedalam 6 m. Opsi lainnya adalah gabungan antara melandaikan sudut lereng dan menurunkan muka air tanah.

Opsi-opsi mitigasi ini perlu dilakukan bersamaan dengan pemantauan (monitoring) di lapangan dan disesuaikan dengan kemudahan implementasi di lapangan.



Gambar 5.5 Hasil Analisis Kestabilan Lereng Section KK’ Lereng B (GW -6m Model)

3. Sudut overall slope area waste dump harus diturunkan sekitar 2° dari kondisi aktual untuk memperoleh nilai FK yang sesuai dengan ketentuan. Sudut overall slope yang menunjukkan nilai FK aman adalah sebesar 18° atau ratio (1V : 3H). Hasil analisis menggunakan dimensi rekomendasi dapat dilihat pada Tabel 5.10.

Tabel 5.10 Hasil Analisis Rekomendasi Kestabilan Lereng *Waste Dump*

Case	***Slope Geometry***	***Static***		***Dynamic* (0.1g)**	
	***Overall Slope* (°)**	**FoS**	**PoF**	**FoS**	**PoF**
Desain awal	20	1.21	0	0.89	94.1
Rekomendasi	18	1.41	0	1.01	16.9

4. Dari hasil analisis kemampugalian dan kemampugaruan direkomendasikan pada material limonite dengan kekuatan batuan yang rendah dapat dilakukan free digging secara langsung, sedangkan pada material saprolite atau rocky saprolite perlu dilakukan ripping terlebih dahulu sebelum material di-digging dengan excavator.

Lampiran A

Field Drilling Report PT HM

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT-HM
Project: GEOTECH HM
Location: BETE - BETE

Coordinates: 413455
Surface RL: 9675637
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Datum: 380 m

Report of Borehole: DHG-01
Start Date: 28-09-2021
End Date: 29-09-2021
Logged by: Yoga A. Pirmawan
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
0,00	1,00	1,00	1,00			S2	CW	Top Soil	Soil, MP, Fine Sand, Dark brown	
1,00	2,00	1,00	1,00			S2	CW	Limonite	Limonite MP, Medium Sand, Dark brown	
2,00	3,50	1,50	0,93			S2/R1	HW	Saprolite	Sap/Lim, Med. Sand/Boulder, Brownish green	
3,50	5,00	1,50	0,87			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
5.00	6,00	1,00	0,95			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
6,00	7,00	1,00	0.95			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
7.00	8,00	1,00	1.00			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
8.00	9,00	1,00	1.00			R1	HW	Saprolite	Saprolite, Boulder Brownish green.	
9.00	10,00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
10,00	11,00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
11,00	12,00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder Brownish green	
12,00	13.00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder, Brownish green	
13.00	14,00	1,00	1.00			R1	HW	Saprolite	Saprolite, Boulder, Brownish green	
14.00	15,00	1,00	1,00			R1	HW	Saprolite	Saprolite, Boulder, Brownish green	
15.00	16.00	1,00	1,00	0,56	56	R4	FR	Bedrock	Dunite, Boulder, Greenish grey	
16.00	17.00	1,00	1,00	0,80	80	R4	FR	Bedrock	Dunite, Boulder, Dark grey	
	EOH									

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FORM SAMPLING

Client: PT.HM
Project: Geotech HM
Location: BETE-BETE

Coordinates: 413955 9675637
Surface RL:
Datum: 380 m
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Report of Borehole:
Start Date: 28-09-2021
End Date: 29-09-2021
Sampling by: Yoga A. Prmawan
Checked:

FIELD SAMPLING AND TESTING

Date	Project	Sample Type (Core/Bulk)	Hole Diameter	Depth		Interval	Sample Number	Sample Description
				From	To			Field Assessment of Recovered Sample (e.g. Soil or Rock Type, Colour, Weathering)
28/09/21	Geotech	Core	2,5"	1,25	1,65	40	DHG 01 (01)	Limonite, Dark brown, CW
				5,50	5,70	20	DHG-01 (02)	Saprolite, Brownish green, HW
				7,00	7,20	20	DHG-01 (03)	Saprolite, Brownish green, HW
				10,80	11,00	20	DHG-01 (04)	Saprolite, Brownish green, HW
				15.30	15.55	25	DHG-01 (05)	Dunite, Greenish grey, FR
				16,23	16,43	20	DHG 01 (06)	Dunite, Dark grey, FR
				16,65	16.86	21	DHG 01 (07)	Dunite, Dark grey, FR

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Groundwater Level Measurement Form

Date Tanggal	Time Jam	GW-Level Depth (mbgs) Kedalaman muka airtanah (mbgs)	Personel Personel	Remarks Keterangan
28/09/21	14.00	12.40	YAR	DHG-01
	14.05	12.40	YAR	DHG-01
	14.10	12.40	YAR	DHG-01
04/10/21	08.00	13.00	YAR	DHG-01
	08.05	13.00	YAR	DHG-01
	08.10	13.00	YAR	DHG-01

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT.HM
Project: GEOTECH HM
Location: BETE-BETE

Coordinates: 414197 9675839
Surface RL:
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Datum: 480 m

Report of Borehole: DH6-02 (Waste Dump)
Start Date: 27-09-2021
End Date: 27-09-2021
Logged by: Yoga A. Rimawan
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
0,00	1,00	1,00	1,00			S1	CW	Top Soil	Soil, gravel, MP, Medium Silt, Brown	Disposal Material
1,00	2,00	1,00	1,00			S1	CW	Top Soil	Soil, gravel, MP, Medium Silt, Brown	Disposal Material
2,00	3,00	1,00	1,00			S1	CW	Top Soil	Soil, gravel, MP, Medium Silt, Brown	Disposal Material
3,00	4,00	1,00	0,70			S1	CW	Limonite	Limonite, MP, Medium Silt, Brown	
4,00	5,00	1,00	0,80			S1	CW	Limonite	Limonite, MP, Medium Silt, Brown	
5,00	6,00	1,00	1,00			S1	CW	Limonite	Limonite, MP, Medium Silt, Brown	
6,00	7,00	1,00	0,80			S1	CW	Limonite	Limonite, MP, Medium Silt, Brown	
7,00	8,00	1,00	0,80			S1 / R2	CW/HW	Limonite / Saprolite	Limonite / saprolite, Boulder, Brownish green	
8,00	9,00	1,00	1,00			R2	HW	Saprolite	Saprolite, Boulder, Brownish green	
9,00	10,00	1,00	1,00			R2	HW	Saprolite	Saprolite, Boulder, Brownish green	
10,00	11,00	1,00	1,00			R3	MW	Saprolite	Saprolite, Boulder, Greenish grey	
11,00	12,00	1,00	1,00	0,79	79	R3	FR	Bedrock	Dunite, Boulder, Greenish grey	
12,00	13,00	1,00	1,00	0,74	74	R3	FR	Bedrock	Dunite, Boulder, Greenish grey	
13,00	14,00	1,00	1,00	0,68	68	R3	FR	Bedrock	Dunite, Boulder, Greenish grey	
	EOH									

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FORM SAMPLING

Client: PT. HM
Project: GEOTECH HM
Location: BETE - BETE

Coordinates: 414147 / 9675839
Surface RL:
Datum: 480 m
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Report of Borehole: DH6 -02 (Waste Dump)
Start Date: 27-09-2021
End Date: 27-09-2021
Sampling by: Yoga A. Rmawan
Checked:

FIELD SAMPLING AND TESTING

Date	Project	Sample Type (Core/Bulk)	Hole Diameter	Depth		Interval	Sample Number	Sample Description
				From	To			Field Assessment of Recovered Sample (e.g. Soil or Rock Type, Colour, Weathering)
27/09/21	Geotech	Core	2,5"	3,40	3,80	40	DH6-02(01)	Limonite, Brown, CW
				4,30	4,70	40	DH6-02(02)	Limonite, Brown, CW
				9,10	9,20	10	DH6-02(03)	Saprolite, Brownish green, HW
				9,78	9,88	10	DH6-02(04)	Saprolite, Brownish green, HW
				10,27	10,37	10	DH6-02(05)	Saprolite, Greenish grey, MW
				11,70	12,00	30	DH6-02(06)	Dunite, Greenish grey, FR
				12,00	12,20	20	DH6-02(07)	Dunite, Greenish grey, FR
				13,00	13,30	30	DH6-02(08)	Dunite, Greenish grey, FR

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Groundwater Level Measurement Form

Date Tanggal	Time Jam	GW-Level Depth (mbgs) Kedalaman muka airtanah (mbgs)	Personel Personel	Remarks Keterangan
28/09/2021	08.00	3,71	YAR	DHG-02
	08.10	3,71	YAR	DHG-02
	08.20	3,72	YAR	DHG-02
04/10/2021	14.00	8,58	YAR	DHG-02
	14.05	8,58	YAR	DHG-02
	14.10	8.58	YAR	DHG-02

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT. HM
Project: GEOTECH HM
Location: BETE-BETE

Coordinates: 415011 / 9675627
Surface RL:
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Datum: 445 m

Report of Borehole: DHG-03
Start Date: 22-09-2021
End Date: 22-09-2021
Logged by: Yoga A. Rimawan
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
0,00	1,00	1,00	1,00			S1	CW	Top Soil	Soil, HP, Clay, Reddish brown	
1,00	2,00	1,00	1,00			S1	CW	Top Soil	Soil, HP, Clay, Reddish brown	
2,00	3,00	1,00	1,00			S1	CW	Limonite	Limonite, HP, Clay, Reddish brown	
3,00	4,00	1,00	1,00			S1	CW	Limonite	Limonite, HP, Clay, Reddish brown	
4,00	5,00	1,00	0,60			S1	CW	Limonite	Limonite, HP, Clay, Reddish brown	
5,00	6,50	1,50	0,67			S1	CW	Limonite	Limonite, HP, Clay, Reddish brown	
6.50	8,00	1.50	1,00			S1	CW	Limonite	Limonite, HP Clay, Reddis brown	
8,00	9,50	1,50	0,93			S1	CW	Limonite/Saprolite	Limonite/Saprolite, Clay/Boulder, Brown	
9.50	11,00	1,50	1,00			S1/S2	CW	Saprolite	Saprolite, Boulder, Greenish brown	
11,00	12,00	1,00	1,00			R2	HW	Saprolite	Saprolite, Boulder, Greenish brown	
12,00	13,00	1,00	1,00			R2/S2	HW/CW	Saprolite	Saprolite, MP, Medium Silt, Brown	
13,00	14,00	1,00	1,00			S2	CW	Saprolite	Saprolite, MP Medium silt / Boulder, Brown	
14,00	15,50	1,50	1,00			S2/R2	CW/HW	Saprolite	Saprolite, Medium silt / Boulder, Brown	
15,50	17,00	1,50	0,60			R2/S2	HW/CW	Saprolite	Saprolite, MP Medium Silt / Boulder, Brown	
17,00	18,00	1,00	1,00			R2	HW	Saprolite	Saprolite, Boulder, Greenish Brown	
18,00	19,00	1,00	1,00			R2	HW	Saprolite	Saprolite, Boulder, Greenish grey	
19.00	20,00	1,00	0,60			R2	HW	Saprolite	Saprolite, Boulder, Greenish grey	
20,00	21,00	1,00	0,55			R1	HW	Saprolite	Saprolite, Boulder, Greenish brown	
21,00	22,00	1,00	0,85			R1	HW	Saprolite	Saprolite, Boulder, Greenish brown	
22,00	23,00	1,00	0,50	0,20	40	R3	HW	Saprolite	Saprolite, Boulder, Greenish grey	
23,00	24,00	1,00	0,50			R3	HW	Saprolite	Saprolite, Boulder, Greenish grey	
24,00	24.50	0,50	1,00			R3	MW	Saprolite	Saprolite, Boulder Greenish grey	
24,50	25,00	0,50	1,00			R3	MW	Saprolite	Saprolite, Boulder, Greenish grey	
25,00	26,00	1,00	1,00			R4	MW	Saprolite	Saprock, Boulder, Greenish grey	
26,00	26,50	0,50	1,00			R4	SW	Saprolite	Saprock, Boulder, Greenish grey	
26,50	27,50	1,00	1,00			R4	SW	Saprolite	Saprock, Boulder, Greenish grey	
27.50	28,00	0,50	1,00			R4	SW	Saprolite	Saprock Boulder, Greenish grey	
28,00	29,00	1,00	~~0,50~~	0,50	50	R4	FR	Bedrock	Dunite, Boulder, Dark grey	
29,00	29,50	0,50	1,00	0,26	52	R4	FR	Bedrock	Dunite, Boulder, Dark grey	
29,50	30,00	0,50	1,00	0.35	70	R4	FR	Bedrock	Dunite Boulder Dark grey	
30,00	31,00	1,00	0,50	0,12	12	R4	FR	Bedrock.	Dunite, Boulder, Dark grey	
EOH : 31,00 m										

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FORM SAMPLING

Client: PT. HM
Project: GEOTECH HM
Location: BETE - BETE

Coordinates: 411501
9675627
Surface RL:
Datum: 445 m
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Report of Borehole: DHG-03
Start Date: 22-09-2021
End Date: 22-09-2021
Sampling by: Yoga A. Rimawan
Checked:

FIELD SAMPLING AND TESTING

Date	Project	Sample Type (Core/Bulk)	Hole Diameter	Depth		Interval	Sample Number	Sample Description
				From	To			Field Assessment of Recovered Sample (e.g. Soil or Rock Type, Colour, Weathering)
22/09/21	Geotech	Core	2.5"	2,60	3,00	40	DHG-03 (01)	Limonite, Reddish brown, CW
				6,60	7,00	40	DHG-03 (02)	Limonite, Reddish brown, CW
				12,20	12,45	25	DHG-03 (03)	Saprolite, Brown, HW
				13,10	13,35	25	DHG-03 (04)	Saprolite, Brown, HW
				14,60	14,80	20	DHG-03 (05)	Saprolite, Brown, HW
				28,30	28,45	15	DHG-03 (06)	Dunite, Dark grey, FR
				28,75	28,90	15	DHG-03 (07)	Dunite, Dark grey, FR
				29,25	29,41	16	DHG-03 (08)	Dunite, Dark grey, FR
				29,50	29,85	35	DHG-03 (09)	Dunite, Dark grey, FR

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Groundwater Level Measurement Form

Date	Time	GW-Level Depth (mbgs)	Personel	Remarks
Tanggal	Jam	Kedalaman muka airtanah (mbgs)	Personel	Keterangan
22/09/2021	08.30	4,82	YAR	DHG-03
	08.35	4,81	YAR	DHG-03
	08.40	4,82	YAR	DHG-03
30/09/2021	08.00	5,07	YAR	DHG-03
	08.05	5,07	YAR	DHG-03
	08.10	5,07	YAR	DHG-03

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT. HM
Project: GEOTECH HM
Location: BETE - BETE SOUTH

Coordinates: 414243 9674697
Surface RL:
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Datum: 423 m

Report of Borehole: DH6-09
Start Date: 25-09-2021
End Date:
Logged by:
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
0,00	1,00	1,00	1,00			S1	CW	Top Soil	Soil, MP, Medium Silt, Dark brown	
1,00	2,00	1,00	1,00			S1	CW	Top Soil	Soil, MP, Medium Silt, Dark brown	
2,00	3,50	1,50	0,93			S1	CW	Limonite	Limonite, MP, Medium Silt, Dark brown	
3,50	5,00	1,50	1,00			S1	CW	Limonite	Limonite, MP, Medium Silt, Dark brown	
5,00	6,50	1,50	0,83			S1	CW	Limonite	Limonite, MP, Medium Silt, Dark brown	
6,50	8,00	1,50	1,00			S2	CW	Limonite	Limonite, MP, Medium Silt, Dark brown	
8,00	9.50	1,50	1,00			S3	CW	Limonite	Limonite, MP, Fine Sand, Dark brown	
9.50	11,00	1,50	1,00			S3	CW	Limonite	Limonite, MP, Fine Sand, Dark brown	
11,00	12,50	1,50	1,00			S3	CW	Limonite	Limonite, MP, Fine Sand, Brown	
12,50	14,00	1,50	1,00			S3	CW	Limonite	Limonite, MP, Fine Sand, Brown	
14,00	15,50	1,50	1,00			S3	CW	Limonite	Limonite MP, Medium Sand, Brown	
15,50	17,00	1,50	1,00			S3	CW	Limonite	Limonite, MP, Medium Sand, Brown	
17.00	18,50	1,50	1,00			S3	CW	Limonite/Saprolite	Saprolite MP, Medium Sand, Brown	
18,50	20.00	1,50	1,00			R3	HW	Saprolite	Saprolite Rock, Boulder, Greenish dark grey	
20.00	20.50	0,50	0,80			R3	HW	Saprolite	Saprolite Rock, Gravel-Boulder, Dark grey	
20,50	21.00	0,50	0,80			R3	HW	Saprolite	Saprolite Rock, Gravel-Boulder, Dark grey	
21,00	22.00	1,00	0,80			R3	MW	Saprolite	Saprolite Rock, Gravel- Boulder, Dark grey	
22,00	23,00	1,00	0,60			R3	MW	Saprolite	Saprolite Rock, Gravel - Boulder, Dark grey	
23,00	24,00	1,00	0,80			R3	MW	Saprolite	Saprolite Rock, Gravel - Boulder, Dark grey	
24,00	25,00	1,00	1,00			R3	MW	Saprolite	Saprolite Rock, Gravel-Boulder, Dark grey	
25,00	26.50	1,50	1,00			R3	MW	Saprolite	Saprolite Rock, Gravel-Boulder, Dark grey	
26,50	27.50	1,00	1,00			R3	MW	Saprolite	Saprolite Rock, Gravel-Boulder, Dark grey	
27,50	28.00	0,50	1,00			R3	MW	Saprolite	Saprolite Rock, Gravel - Boulder, Dark grey	
28,00	29.00	1,00	1,00			R4	MW/SW	Saprolite	Saprolite Rock, Gravel - Boulder, Dark grey	
29.00	30,00	1,00	0,80			R4	MW/SW	Saprolite	Saprolite Rock, Boulder Dark grey	
30,00	31,00	1,00	1,00			R4	MW/SW	Saprolite/Bedrock	Saprolite Rock, Boulder, Dark grey	
31.00	32,00	1,00	1,00			R4	FR	Bedrock	Dunite, Boulder, Dark grey	
32,00	33,00	1,00	1,00			R4	FR	Bedrock	Dunite, Boulder, Dark grey	
33.00	34,00	1,00	0,50			R4	FR	Bedrock	Dunite, Boulder, Dark grey	
34.00	35,00	1,00	0,50			R4	FR	Bedrock	Dunite Boulder Dark grey	
	EOH									

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FORM SAMPLING

Client: PT.HM
Project: GEOTECH HM
Location: BETE-BETE SOUTH

Coordinates: 414243
Surface RL: 9674697
Datum:
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Report of Borehole:
Start Date: 25-09-2021
End Date:
Sampling by: Yoga A. Rimawan
Checked:

FIELD SAMPLING AND TESTING

Date	Project	Sample Type (Core/Bulk)	Hole Diameter	Depth From	Depth To	Interval	Sample Number	Sample Description: Field Assessment of Recovered Sample (e.g. Soil or Rock Type, Colour, Weathering)
25/09/21	Geotech	Core	2,5"	5,00	5,40	40	DHG-09 (01)	Limonite, Dark brown, CW
				8,25	8,65	40	DHG-09(02)	Limonite, Dark brown, CW
				17,00	17,25	25	DHG-09 (03)	Saprolite, Brown, CW
				18,60	18,20	20	DHG-09 (04)	Saprolite, Greenish dark grey, HW
				24,00	24,25	25	DHG-09 (05)	Saprolite, Dark grey, MW
26/09/21	Geotech	Core	2,5"	31,00	31,10	10	DHG-09 (06)	Dunite, Dark grey, FR
				32,25	32,35	10	DHG-09(07)	Dunite, Dark grey, FR
				33,00	33,10	10	DHG-09(08)	Dunite, Dark grey, FR
				34,20	34,32	12	DHG-09 (09)	Dunite, Dark grey, FR

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Groundwater Level Measurement Form

Date Tanggal	Time Jam	GW-Level Depth (mbgs) Kedalaman muka airtanah (mbgs)	Personel Personel	Remarks Keterangan
26/09/2021	09.00	6,23	YAR	DHG-04
	09.10	6.24	YAR	DHG-04
	09.20	6.24	YAR	DHG-04
03/10/2021	08.00	27.00	YAR	DHG-04
	08.05	27.00	YAR	DHG-04
	08.10	27.00	YAR	DHG-04

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT. HM
Project: GEOTECH HM
Location: BETE-BETE SOUTH

Coordinates: 415969 / 9674988
Surface RL:
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Datum: 452 m

Report of Borehole: DHG-65
Start Date: 19-09-2021
End Date: 21-09-2021
Logged by: Yoga A. Rimawan
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
0,00	1.00	1.00	1,00			S1	CW	Disposal	Disposal, HP, Clay, Brown	
1,00	2,00	1.00	1,00			S1	CW	Disposal	Disposal HP Clay Brown	
2,00	3.50	1.50	0,69			S1	CW	top Soil	Top Soil, HP, Clay, Brown	Root materials
3,50	5,00	1.50	0,80			S1	CW	Limonite	Limonite, HP, Clay, Brown	
5.00	6.50	1.50	0,33			S1	CW	Limonite	Limonite, HP, Clay, Brown	
6.50	7.50	1,00	1.00			S1	CW	Limonite	Limonite. HP. Clay, Brown	
7.50	9.00	1.50	1.00			S1	CW	Limonite	Limonite, HP, Clay, Reddish Brown	
9.00	10.50	1.50	1,00			S1	CW	Limonite	Limonite, HP, Clay, Reddish Brown	
10,50	11,00	0,50	1,00			S1	CW	Limonite	Limonite, HP, Clay, Reddish Brown	
11,00	12,50	1.50	1,00			S1	CW	Limonite	Limonite, HP, Clay Reddish Brown	
12.50	14.00	1,50	0,80			S1	CW	Limonite	Limonite HP, Clay, Brown	
14.00	15.50	1,50	0,80			S2	CW/HW	Saprolite	Saprolite, Clay, Brown	
15,50	17.00	1,50	1,00			R2	HW	Saprolite	Saprolite, Boulder, Greenish grey	
17.00	18.00	1.00	1.00	0,20	20	R2	HW	Saprolite	Saprolite, Boulder, Greenish dark grey	
18.00	19.00	1,00	0,64	0.18	18	R2	HW	Saprolite	Saprolite, Boulder, Greenish dark grey	
19.00	20,00	1,00	0,70			R2	HW	Saprolite	Saprolite, Boulder, Greenish dark grey	
20,00	20.50	0.50	1,00			R4	FR	Bedrock	Bedrock, Boulder, Dark grey	
20.50	21.50	1,00	1,00	0.48	48	R5	FR	Bedrock	Bedrock, Boulder, Dark grey / black	
21,50	22.00	0,50	1,00			R5	FR	Bedrock	Bedrock, Boulder, Dark grey / black	
22.00	22.50	0.50	0,60			R5	FR	Bedrock	Dunite, Boulder, Dark grey / black	
22.50	23,00	0.50	1,00			R5	FR	Bedrock	Dunite, Boulder, Dark grey / black	

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FORM SAMPLING

Client: PT. HM
Project: Geotech HM
Location: BETE-BETE SOUTH

Coordinates: 415969 9674988
Surface RL:
Datum: 452 m
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Report of Borehole: DHG-05
Start Date: 19-09-2021
End Date: 21-09-2021
Sampling by: Yoga A. Rmawan
Checked:

FIELD SAMPLING AND TESTING

Date	Project	Sample Type (Core/Bulk)	Hole Diameter	Depth		Interval	Sample Number	Sample Description
				From	To			Field Assessment of Recovered Sample (e.g. Soil or Rock Type, Colour, Weathering)
19/09/21	Geotech	Core	2,5"	8,45	8,85	40	DHG-05 (01)	Limonite, Reddish brown, CW
				11,60	12,00	40	DHG-05 (02)	Limonite, Reddish brown, CW
				14,75	14,95	20	DHG-05 (03)	Saprolite, Brown, CW
				15,80	16,00	20	DHG-05 (04)	Saprolite, Greenish brown, HW
				17,50	17,70	20	DHG-05 (05)	Saprolite, Greenish brown, HW
21/09/21	Geotech	Core	2,5"	20,10	20,27	17	DHG-05(06)	Dunite, Dark grey / black, FR
				20,70	20,87	17	DHG-05(07)	Dunite, Dark grey / black, FR
				21,20	21,35	15	DHG-05(08)	Dunite, Dark grey / black, FR
				21,50	21,64	14	DHG-05(09)	Dunite, Dark grey / black, FR

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Groundwater Level Measurement Form

Date Tanggal	Time Jam	GW-Level Depth (mbgs) Kedalaman muka airtanah (mbgs)	Personel Personel	Remarks Keterangan
21/09/2021	14.35	7,15	YAR	DH6-05
	14.40	7,15	YAR	DH6-05
	14.50	7,15	YAR	DH6-05
02/10/2021	14.00	18,70	YAR	DH6-05
	14.05	18,70	YAR	DH6-05
	14.10	18,70	YAR	DH6-05

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT. HM
Project: GEOTECH HM
Location: CENTRAL WEST

Coordinates: 415447 / 9673487
Surface RL:
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Datum: 332 m

Report of Borehole: DH6-06
Start Date: 15-09-2021
End Date: 16-09-2021
Logged by: Yoga A. Rimawan
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
0,00	1,00	1,00	1,00			S1	CW	Top Soil	Soil, HP Clay Brown	
1,00	2,00	1,00	1,00			S2	CW	Limonite	Limonite, HP, Clay, Brown.	
2,00	3,50	1,50	0.67			S2	CW	Limonite	Limonite, HP, Clay, Brown	
3,50	5,00	1,50	0,63			S2	CW	Limonite	Limonite, HP, Clay, Brown	
5,00	6,00	1,00	1,00			S2	CW	Limonite	Limonite, HP, Clay, Brown	
6.00	7,00	1,00	0,90			S2	CW	Limonite	Limonite, HP, Clay Brown	
7,00	8,00	1,00	1,00			S2	CW	Limonite	Limonite, HP, Clay, Brown	
8.00	9.00	1.00	1,00			S2	CW	Limonite	Limonite, HP, Clay, Brown	
9.00	10.00	1.00	1,00			S2	CW	Limonite	Limonite, HP, Clay, Brown	
10.00	11,00	1,00	1,00			S2	CW	Limonite	Limonite, MP Medium Silt Brown	
11,00	12.50	1,50	1,00			S3	CW	Limonite	Limonite, MP Medium Silt Brown	
12.50	14.00	1,50	1,00			S3	CW	Limonite	Limonite, MP, Medium Silt, Brown	
14.00	15.50	1,50	1,00			S3	CW	Limonite	Limonite, MP, Medium, Silt, Brown	
15.00	17.00	1,50	1,00			S3	CW	Limonite	Limonite, MP Medium Silt Brown	
17,00	18.50	1,50	1,00			S3	CW	Limonite	Limonite, MP Medium Silt, Brown	
18.50	20.00	1,50	1,00			S3	CW	Limonite	Limonite, MP Medium Silt, Brown	
20.00	21.50	1,50	1,00			S3	CW	Limonite	Limonite, MP, Medium Silt, Brown	
21,50	23.00	1,50	1,00			S3	CW	Limonite / Saprolite	Saprolite, MP, Medium Silt, Brown	
23.00	24,00	1,00	0,80			S3/R2	CW/HW	Saprolite	Rocky Saprolite, Boulder, Brown	
24.00	25.00	1.00	0.50			R2	HW	Saprolite	Rocky Saprolite, Boulder, Brown	
25.00	26.00	1,00	0,80			R3	HW	Saprolite	Saprolite Rock, Boulder, Greenish Brown	
26.00	26.40	0,40	1,00			S3/R3	CW/HW	Saprolite	Saprolite Rock, Boulder, Greenish Brown	
26.40	27.50	1,10	1,00			S3/R3	CW/HW	Saprolite	Saprolite Rock, Boulder, Greenish Brown	
27.50	29.00.	1,50	0,73			R3	MW	Saprolite	Saprolite Rock, Boulder, Greenish Brown	
29,00	30,00	1,00	1,00	0,22	22	R3	SW	Saprolite	Saprolite Rock, Boulder Greenish Brown	
30.00	31,00	1,00	1,00	0,26	26	R4	SW	Saprolite	Saprolite Rock, Boulder Greenish Brown	
31,00	32.00	1.00	1,00	0,28	28	R4	SW	Saprolite	Saprolite Rock, Boulder Greenish Brown	
32.00	33.00	1.00	1,00			R4	SW	Saprolite	Saprolite Rock, Boulder, Greenish Brown	
33.00	34.00	1,00	1,00	0,13	13	R4	SW	Saprolite	Saprolite Rock, Boulder, Greenish Brown	
34.00	35.00	1,00	1,00	0,14	14	R4	SW/FR		Saprolite Rock/ Boulder, Greenish Grey	

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT HM
Project: GEOTECH HM
Location: CENTRAL WEST

Coordinates: 415447 9673487
Surface RL:
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Datum:

Report of Borehole: DHG -06
Start Date: 15-09-2021
End Date: 16-09-2021
Logged by: Yoga A. Rmawan
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
35.00	36.50	1.50	1.00	0.60	40	R4	FR	Bedrock	Dunite, Boulder Greenish grey	
36.50	38.00	1.50	1.00	0.33	22	R4	FR	Bedrock	Dunite, Boulder, Greenish grey	
38.00	39.00	1.00	1.00	0.21	21	R4	FR	Bedrock	Dunite, Boulder, Greenish grey	

FORM SAMPLING

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Client: PT. HM
Project: GEOTECH HM
Location: CENTRAL WEST

Coordinates: 415447 / 9673487
Surface RL:
Datum:
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Report of Borehole: DHG-06
Start Date: 15-09-2021
End Date: 16-09-2021
Sampling by: Yoga A. Pirmawan
Checked:

FIELD SAMPLING AND TESTING

Date	Project	Sample Type (Core/Bulk)	Hole Diameter	Depth		Interval	Sample Number	Sample Description
				From	To			Field Assessment of Recovered Sample (e.g. Soil or Rock Type, Colour, Weathering)
15/09/21	Geotech	Core	2,5"	5,20	5,60	40	DHG-06 (01)	Limonite, Brown, CW
15/09/21		Core	2,5"	7,00	7,40	40	DHG-06(02)	Limonite, Brown CW
15/09/21		Core	2,5"	25,60	25,80	20	DHG-06 (03)	Saprolite, Brown, MW
15/09/21		Core	2,5"	29,70	29,94	24	DHG-06(04)	Saprolite, Greenish Brown, SW
15/09/21		Core	2,5"	31,56	31,74	18	DHG-06(05)	Saprolite Greenish Brown, SW
16/09/21	"	Core	2,5"	35,50	35,70	20	DHG-06 (06)	Dunite, Greenish grey, SW / FR
16/09/21	"	Core	2,5"	36,75	36,90	15	DHG-06(07)	Dunite, Greenish grey, FR
16/09/21	"	Core	2,5"	37,50	37,68	18	DHG-06(08)	Dunite, Greenish grey, FR
16/09/21	"	Core	2,5"	38,79	39,00	21	DHG-06(09)	Dunite, Greenish grey, FR.

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Groundwater Level Measurement Form

Date Tanggal	Time Jam	GW-Level Depth (mbgs) Kedalaman muka airtanah (mbgs)	Personel Personel	Remarks Keterangan
17/09/2021	10.00	20,02 m	YAR	DH6-06
	10.05	20,02 m	YAR	DH6-06
	10.10	20.02	YAR	DH6-06
02/10/2021	10.00	22.80	YAR	DH6-06
	10.05	22,80	YAR	DH6-06
	10.10	22,00	YAR	DH6-06

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT.HM GEOTECH
Project: GEOTECH HM
Location: CENTRAL EAST

Coordinates: 416755
Surface RL: 9674354
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Datum: 417 m

Report of Borehole: DHG-07
Start Date: 11-09-2021
End Date: 12-09-2021
Logged by: Yoga A. Rimawan
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
0.00	1,00	1,00	1,00			S1	CW	Limonite	Limonite, HP, Clay, Brown	
1,00	2,50	1.50	0,93			S1	CW	Limonite	Limonite, HP clay, Brown	
2.50	4.00	1.50	0,87			S2	CW	Limonite	Limonite, HP, Clay, Brown	
4.00	5.50	1.50	0,47			S2	CW	Limonite	Limonite, HP, Clay, Brown	
5,50	6.50	1.00	0,84			S2	CW	Saprolite	Saprolite, MP, Coarse Sand, Brown	
6.50	7.50	1,00	0,30			S2	HW	Saprolite	Rocky Saprolite, Coarse Sand, LP, Brown	
7.50	8.50	1,00	0,70			R2	MW	Saprolite	Saprock, Greenish grey, Boulder	
8.50	10.00	1.50	0,67			R2	MW	Saprolite	Saprock, Boulder, Greenish grey	
10.00	11,00	1,00	1,00			R2	MW	Saprolite	Saprock, Boulder, Greenish grey	
11,00	12.50	1,50	1,00	1.00	67	R4	FR	Bedrock	Bedrock Dunite, Boulder, Grey	
12.50	13.70	1,20	1,00	0,45	45	R4	FR	Bedrock	Dunite, Boulder, Grey	
13,70	14.65	1,00	0,95	0,21	21	R4	FR	Bedrock	Dunite, Boulder, Grey	
14.65	15.00	0,35	1,00			R4	FR	Bedrock	Dunite, Boulder, Grey	
EOH	= 15.00 m									

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FORM SAMPLING

Client: PT HM
Project: Geotech HM
Location: CENTRAL EAST

Coordinates: 416755 / 9674354
Surface RL:
Datum: 419 m
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Report of Borehole: DHG - 07
Start Date: 11-09-2021
End Date: 12-09-2021
Sampling by: Yoga A. Rimawan
Checked:

FIELD SAMPLING AND TESTING

Date	Project	Sample Type (Core/Bulk)	Hole Diameter	Depth From	Depth To	Interval	Sample Number	Sample Description: Field Assessment of Recovered Sample (e.g. Soil or Rock Type, Colour, Weathering)
11/09/21	Geotech	core	2,5"	2,60	3,00	40	DHG-07 (01)	Limonite, Brown, CW
	Geotech	Core	2,5"	3,60	4,00	40	DHG-07 (02)	Limonite, Brown, CW
	Geotech	Core	2,5"	6,50	6,70	20	DHG-07 (03)	Saprolite, Brown, CW
	Geotech	Core	2,5"	9,50	9,85	35	DHG07 (04)	Saprolite, Greenish grey, MW
12/09/21	Geotech	Core	2,5"	11,00	11,20	20	DHG07 (05)	Dunite, Grey, FR
	Geotech	core	2,5"	12,30	12,50	20	DHG-07 (06)	Dunite, Grey, FR
	Geotech	core	2,5"	13,50	13,70	20	DHG-07 (07)	Dunite, Grey, FR

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Groundwater Level Measurement Form

Date Tanggal	Time Jam	GW-Level Depth (mbgs) Kedalaman muka airtanah (mbgs)	Personel Personel	Remarks Keterangan
13/09/2021	10.00	10,19	YAR	DH6 - 07
	10.10	10,19	YAR	DH6-07
	10.20	10,20	YAR	DH6 -07
04/10/2021	08.00	14,20	YAR	DH6-07
	08.05	14.20	YAR	DH6-07
	08.10	14,20	YAR	DH6-07

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT. HM
Project: GEOTECH HM
Location: CENTRAL EAST

Coordinates: 417317 9673539
Surface RL:
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Datum: 361 m

Report of Borehole: DHG-08
Start Date: 08-09-2021
End Date: 11-09-2021
Logged by: Yoga A. Rimawan
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
0,00	1,00	1,00	1,00			S1	CW	LM	Limonite, HP, Clay, Reddish brown	
1,00	2,00	1,00	1,00			S1	CW	LM	Limonite, HP, Clay, Reddish brown	
2,00	3,50	1,50	1,00			S1	CW	LM	Limonite, HP, Clay, Reddish brown	
3,50	5,00	1,50	0,87			S1	CW	LM	Limonite, MP, Med. Silt, Reddish brown	
5,00	6,50	1,50	0,33			S1	CW	LM	Limonite, MP, Med. Silt, Brown	
6,50	8,00	1,50	1,00			S1	CW	LM	Limonite, MP, Med. Silt, Brown	
8,00	9,00	1,00	1,00			S1	CW	LM	Limonite, MP, Med. Silt, Brown	
9,00	9,80	0,80	0,46			R4	SW	SP/BR	Saprock, Boulder, greenish grey	
9,80	10,10	0,30	0,77			R4	SW	SP/BR	Saprock, Boulder, Greenish grey	
10,10	10,40	0,30	0,90	0,12	40	R4	SW	SP/BR	Saprock, Boulder, Greenish grey	
10.40	11,00	0,60	0,88	0,10	17	R4	SW	SP/BR	Saprock, Boulder, Greenish grey	
11,00	11,50	0,50	1,00			R4	SW	SP/BR	Saprock, Boulder, Greenish grey	
11,50	12,00	0,50	1,00			R4	SW	SP/BR	Saprock, Boulder Greenish grey	
12,00	13,00	1,00	0,50			S3	HW	SP	Rocky Saprolite, Coarse sand, Light brown	
13,00	14,00	1,00	0,60	0,11	11	R2	HW	SP	Saprock, Boulder, Greenish brown	
14,00	14,10	0,10	1,00			R2	HW	SP	Saprock, Boulder, Greenish brown	
14,10	15,00	0,90	0,67			R4	SW	SP/BR	Saprock, Boulder, Greenish grey	
15,00	16,00	1,00	0,80	0,22	22	R2	MW	SP/BR	Saprock, Boulder, Greenish brown	
16,00	17,00	1,00	0,70	0,25	25	R4	FR	BR	Dunite, Boulder, Dark grey	
17,00	17,50	0,50	1,00	0,30	60	R4	FR	BR	Dunite, Boulder, Dark grey	
17,50	18,00	0,50	1,00			R4	FR	BR	Dunite, Boulder, Dark grey	
18,00	19,00	1,00	0,95	0,17	17	R4	FR	BR	Dunite, Boulder, Dark grey	
19,00	20,00	1,00	0,87	0,87	87	R4	FR	BR	Dunite, Boulder, Dark grey	
EOH										

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FORM SAMPLING

Client: PT HM
Project: GEOTECH HM
Location: CENTRAL EAST

Coordinates: 417317
Surface RL: 9673539
Datum: 361 m
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Report of Borehole: DHG-08
Start Date: 08-09-2021
End Date: 11-09-2021
Sampling by: Yoga A. Rmawan
Checked:

FIELD SAMPLING AND TESTING

Date	Project	Sample Type (Core/Bulk)	Hole Diameter	Depth		Interval	Sample Number	Sample Description
				From	To			Field Assessment of Recovered Sample (e.g. Soil or Rock Type, Colour, Weathering)
08/09/21	Geotech	Core	2,5"	2,60	3,00	0,40	DHG-08 (01)	Limonite Reddish brown, CW
08/09/21	Geotech	Core	2,5"	4,00	4,40	0,40	DHG-08 (02)	Limonite Reddish brown, CW
10/09/21	Geotech	Core	2,5"	17.30	17.50	0,20	DHG-08 (03)	Dunite, Greenish grey ~~FR~~
11/09/21	Geotech	Core	2,5"	19.15	19.52	0,37	DHG-08 (04)	Dunite, Greenish grey, FR
11/09/21	Geotech	Core	2,5"	19,65	19.87	0,32	DHG-08 (05)	Dunite, Greenish grey, FR

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Groundwater Level Measurement Form

Date Tanggal	Time Jam	GW-Level Depth (mbgs) Kedalaman muka airtanah (mbgs)	Personel Personel	Remarks Keterangan
09/09/2021	10.00	18.10	YAR	DHG-08
	10.10	18.11	YAR	DHG-08
	10.15	18.11	YAR	DHG-08
04/10/2021	11.00	19.20	YAR	DHG-08
	11.05	19.20	YAR	DHG-08
	11.10	19.20	YAR	DHG-08

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

FIELD DRILLING REPORT

Client: PT. HM
Project: GEOTECH HM
Location: CENTRAL EAST

Coordinates: 418482,838
9673633,23
Surface RL:
Datum: 416 m
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Report of Borehole: DH6-09
Start Date: 06-09-2021
End Date: 08-09-2021
Logged by: YOGA A. RIMAWAN
Checked:

CORE RUN METERAGE						FIELD MATERIAL DESCRIPTION				
DEPTH FROM (m)	DEPTH TO (m)	RUN LENTH (M)	CORE RECOVERY (m)	SUMSTICK > 0.1m	RQD (%)	INTACT ROCK STRENGTH	WEATHERING	TYPE OF MATERIAL (Top Soil/ Limonite/ Saprolite/Bedrock)	SOIL/ROCK MATERIAL DESCRIPTION (e.g. Soil or Rock Name, Plasticity, Grain Size, Colour)	STRUCTURE AND ADDITIONAL OBSERVATIONS
0,00	1,00	1,00	1,00			S2	CW	Limonite	Limonite, HP, Clay, Dark brown	
1,00	2,50	1,50	0,96			S2	CW	Limonite	Limonite, MP, Med. Silt, brown	
2,50	3,50	1,00	0,80			S2	CW	Limonite	Limonite, MP, Med. Silt, brown	
3,50	4,50	1,00	1,00			S3	CW	Limonite	Limonite, MP, Med. Silt, brown	
4,50	5,00	0,50	1,00			S3	CW	Limonite	Limonite, MP, Med. Silt, brown	
5,00	6,50	1,50	1,00			S3	CW	Limonite	Limonite, MP, Med. Silt, brown	
6,50	8,00	1,50	1,00			S3	CW	Limonite	Limonite, MP, Med. Silt, brown	
8,00	9,50	1,50	1,00			S3	CW	Limonite	Limonite, MP, Med. Silt, brown	
9,50	11,00	1,50	1,00			S3	CW	Limonite	Limonite, MP, Med. Silt brown	
11,00	12,50	1,50	1,00			S3	CW	Limonite	Limonite, MP, Med. Silt, brown	
12,50	14,00	1,50	1,00			S3	CW	Limonite	Limonite, MP, Med. Silt, brown	
14,00	14,80	0,80	1,00			S3	CW	Saprolite	Saprolite, LP, Fine Sand, Reddish brown	
14,80	16,13	1,33	0,23			R0	HW	Rocky Saprolite	Saprolite, reddish brown, boulder	
16,13	17,00	0,87	1,00			S3	CW	Saprolite	Saprolite LP brown, coarse sand	
17,00	18,50	1,50	0,92			S5	CW	Rocky Saprolite	Saprolite LP, Light brown, coarse sand	
18,50	20,00	1,50	0,87			S5	CW	Rocky Saprolite	Saprolite, LP, Light brown, Coarse sand	
20,00	21,50	1,50	0,67			R0	HW	Rocky Saprolite	Saprolite, Boulder, brown	
21,50	22,00	0,50	0,60	0,10	20	R4	SW	Rocky Saprolite	Saprolite, Boulder, greenish grey	
22,00	23,00	1,00	0,70	0,16	16	S3/R3	HW/SW	Rocky Saprolite	Saprolite, LP, light brown, boulder	
23,00	24,00	1,00	1,00			R1	SW	Rocky Saprolite	Saprolite, greenish dark grey, boulder	
24,00	25,00	1,00	0,90	0,49	49	R1	SW	Rocky Saprolite	Saprolite, boulder greenish dark grey	
25,00	26,00	1,00	0,80	0,28	28	R1	SW	Rocky Saprolite	Saprolite, boulder greenish dark grey	
26,00	26,50	0,50	1,00			R1	SW	Rocky Saprolite	Saprolite, boulder greenish dark grey	
26,50	27,00	0,50	1,00			R1	SW	Saprock	Saprolite, boulder, greenish dark grey	
27,00	28,00	1,00	1,00	0,44	44	R3	SW/FR	Saprock	Saprolite, boulder, greenish dark grey	
28,00	28,50	0,50	1,00	0,20	48	R3	SW/FR	Saprock / Bed rock	Saprolite, boulder, greenish dark grey	
28,50	29,00	0,50	1,00	0,50	100	R3	FR	Saprock / Bed rock	Dunite, boulder, brown	
29,00	29,50	0,50	1,00	0,50	100	R3	FR	Bed rock	Dunite, boulder, brown	
29,50	30,00	0,50	1,00	0,36	72	R3	FR	Bed rock	Dunite, boulder, brown	

EOH

FORM SAMPLING

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Client: PT. HM
Project: GEOTECH HM
Location: CENTRAL EAST

Coordinates: 418 482,338 / ~~964~~ 3633,23
Surface RL:
Datum: 416 m
Drilling Method: TRIPLE TUBE FULL CORING
Inclination: 90°

Report of Borehole: DHG-09
Start Date: 06-09-2021
End Date: 08-09-2021
Sampling by: YOGA A. RIMAWAN
Checked:

FIELD SAMPLING AND TESTING

Date	Project	Sample Type (Core/Bulk)	Hole Diameter	Depth From	Depth To	Interval	Sample Number	Sample Description: Field Assessment of Recovered Sample (e.g. Soil or Rock Type, Colour, Weathering)
06/09/21	Geotech	CORE	2,5"	2,70	3,10	40	DHG-09 (01)	Limonite brown
〃	Geotech	CORE	2,5"	7,00	7,40	40	DHG-09 (02)	Limonite brown
〃	Geotech	CORE	2,5"	14,10	14,31	21	DHG-09 (03)	Saprolite, light brown
〃	Geotech	CORE	2,5"	16,27	16,48	21	DHG-09 (04)	Saprolite, light brown
〃	Geotech	CORE	2,5"	18,30	18,50	20	DHG-09 (05)	Saprolite, light brown
〃	Geotech	CORE	2,5"	28,55	28,76	21	DHG-09 (06)	Dunite, brown
08/09/21	Geotech	CORE	2,5"	29,30	29,52	22	DHG-09 (07)	Dunite, brown
〃	Geotech	CORE	2,5"	29,77	30,00	23	DHG-09 (08)	Dunite, brown

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Groundwater Level Measurement Form

Date Tanggal	Time Jam	GW-Level Depth (mbgs) Kedalaman muka airtanah (mbgs)	Personel Personel	Remarks Keterangan
09/09/2021	10.00	19,20 m	YAR	DH6-09
	10,05	19,21 m	YAR	DH6-09
	10,10	19,20 m	YAR	DH6-09
9/10/2021	14.00	23.20	YAR	DH6-09
	14.05	23.20	YAR	DH6-09
	14.10	23.20	YAR	DH6-09

Lampiran B

Foto Core

Foto Core DHG-01


HOLE ID :
DHG-01
BOX :
5
DEPTH FROM :
15,00 m
DEPTH TO :
17,00 m
DATE of START & FINISH DRILLING :
28-29/09/2021
EOH :
17,00 m
RIG/GEOLOGIST
04/YAR
Sample DHG-01 (05)
Sample DHG-01 (06)
Sample DHG-01 (07)

Foto Core DHG-02

Foto Core DHG-03


HOLE ID :
DHG-03
BOX :
5-7
DEPTH FROM :
17,00 m
DEPTH TO :
31,00 m
DATE of START & FINISH DRILLING
22/09/2021
EOH :
31,00 m
RIG/GEOLOGIST
04/YAR

Foto Core DHG-04


HOLE ID :
DHG-04
BOX :
4 – 6
DEPTH FROM :
12,00 m
DEPTH TO :
25,00 m
DATE of START & FINISH DRILLING :
25-26/09/2021
EOH :
35,00m
RIG/GEOLOGIST
04/YAR
Sample DHG-04 (03)
Sample DHG-04 (04)
Sample DHG-04 (05)


PROJECT :
PT. HENGJAYA MINERALINDO
HOLE ID :
DHG-04
BOX :
7 - 8
DEPTH FROM :
25,00 m
DEPTH TO :
31,00 m
DATE of START & FINISH DRILLING :
25-26/09/2021
EOH :
35,00m
RIG/GEOLOGIST
04/YAR


PROJECT :
PT. HENGJAYA MINERALINDO
HOLE ID :
DHG-04
BOX :
9
DEPTH FROM :
31,00 m
DEPTH TO :
35,00 m
DATE of START & FINISH DRILLING :
25-26/09/2021
EOH :
35,00m
RIG/GEOLOGIST
04/YAR

Foto Core DHG-05


HOLE ID :
DHG-05
BOX :
4-5
DEPTH FROM :
12,70 m
DEPTH TO :
20,00 m
DATE of START & FINISH DRILLING :
19-21/09/2021
EOH :
23,00 m
RIG/GEOLOGIST
04/YAR


HOLE ID :
DHG-05
BOX :
6
DEPTH FROM :
20,00 m
DEPTH TO :
23,00 m
DATE of START & FINISH DRILLING :
19-21/09/2021
EOH :
23,00 m
RIG/GEOLOGIST
04/YAR

Foto Core DHG-06


HOLE ID :
DHG-06
BOX :
5-6
DEPTH FROM :
16.00 m
DEPTH TO :
24.20 m
DATE of START & FINISH DRILLING :
15-16/09/2021
EOH :
39.00 m
RIG/GEOLOGIST
04/YAR
Sample DHG-06 (02)


HOLE ID :
DHG-06
BOX :
7
DEPTH FROM :
24.20m
DEPTH TO :
29.30 m
DATE of START & FINISH DRILLING :
15-16/09/2021
EOH :
39.00 m
RIG/GEOLOGIST
04/YAR
Sample DHG-06 (03)


HOLE ID :
DHG-06
BOX :
8 - 9
DEPTH FROM :
29.30 m
DEPTH TO :
35.00 m
DATE of START & FINISH DRILLING :
15-16/09/2021
EOH :
39.00 m
RIG/GEOLOGIST
04/YAR
Sample DHG-06 (04)
Sample DHG-06 (05)


HOLE ID :
DHG-06
BOX :
10
DEPTH FROM :
35.00 m
DEPTH TO :
39.00 m
DATE of START & FINISH DRILLING :
15-16/09/2021
EOH :
39.00 m
RIG/GEOLOGIST
04/YAR

Foto Core DHG-07


PROJECT :
PT. HENGJAYA MINERALINDO
HOLE ID :
DHG -07
BOX :
4
DEPTH FROM :
11,00 m
DEPTH TO :
15,00 m
DATE of START & FINISH DRILLING :
11-12 / 09-2021
EOH :
15.00 m
RIG/GEOLOGIST
09 / YAR
SamPLe DHG-07(05)
SamPLe DHG-07(06)
SamPLe DHG-07(07)

Foto Core DHG-08


PROJECT :
PT. HENGJAYA MINERALINDO
HOLE ID :
DHG-08
BOX :
4
DEPTH FROM :
13.00 m
DEPTH TO :
18,00 m
DATE of START & FINISH DRILLING :
08-11/09-2021
EOH :
20,00 m
RIG/GEOLOGIST
04/YAR


PROJECT :
PT. HENGJAYA MINERALINDO
HOLE ID :
DHG-08
BOX :
5
DEPTH FROM :
18.00 m
DEPTH TO :
20,00 m
DATE of START & FINISH DRILLING :
08-11/09-2021
EOH :
20.00 m
RIG/GEOLOGIST
04/YAR
Sample DHG-08 (04)
Sample DHG-08 (5)

Foto Core DHG-09


HOLE ID :
DHG-09
BOX :
5
DEPTH FROM :
17,00 m
DEPTH TO :
20,00 m
DATE of START & FINISH DRILLING :
06-08/09-2021
EOH :
30.00 m
RIG/GEOLOGIST
09/YAR
Sample DHG-09 (05)
18.50 m
20.00 m


HOLE ID :
DHG-09
BOX :
6-7
DEPTH FROM :
20,00 m
DEPTH TO :
27,00 m
DATE of START & FINISH DRILLING :
06-08/09-2021
EOH :
30.00 m
RIG/GEOLOGIST
04/YAR
21.50 m
22.00 m
23.00 m
24.00 m
25.00
26.00
27.00


HOLE ID :
DHG-09
BOX :
8
DEPTH FROM :
27,00 m
DEPTH TO :
30.00 m
DATE of START & FINISH DRILLING :
06-08/09-2021
EOH :
30.00 m
RIG/GEOLOGIST
04/YAR
28.00
28.50 m
Sample DHG-09(6)
29.00
Sample DHG-09 (07)
29.50
Sample DHG-09(08)
30.00 m

Lampiran C

Slugtest Result PT HM

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Slugtest ID: **Test No:**

Date	01-16-2021	Well ID	OHG-01
GW-Level Start (mbgs)	0,00 m	Well Diameter (mm)	750
Depth Top Aquifer (mbgs)	3.50 m	Casing Diameter (mm)	600
Depth Bottom Aquifer (mbgs)	16.00 m	Slug Type	
Screen Length (m)	12,00 m	Volume (litre)	480, 420
Across Screen		GW-Level Finish (mbgs)	13.00
Above Screen		Personel	YAR

Entry	Time (Hour : Min. : Sec.)	Water Level (mbgs)	Entry	Time (Hour : Min. : Sec.)	Water Level (mbgs)
1	00:00:02	0.80	35	00:19:40	7,80
2	00:00:04	0,88	36	00:22:40	8,38
3	00:00:06	1,00	37	00:25:40	9.00
4	00:00:08	1,08	38	00:28:40	9.50
5	00:00:10	1,13	39	00:31:40	9,98
6	00:00:15	1,30	40	00:36:40	10,62
7	00:00:20	1,42	41	00:41:40	10.98
8	00:00:25	1,51	42	00:46:40	11,13
9	00:00:30	1,60	43	00:51:40	11,60
10	00:00:35	1,70	44	01:01:40	11,82
11	00:00:40	1,75	45	01:11:40	12,06
12	00:00:45	1,80	46	01:21:40	12,21
13	00:00:50	1,88	47	01:31:40	12,37
14	00:00:55	1,92	48	01:46:40	12,40
15	00:01:00	1,97	49	02:01:40	12,49
16	00:01:10	1,97	50	02:16:40	12,54
17	00:01:20	2,00	51	02:31:40	12,60
18	00:01:30	2,03	52	02:46:40	12,67
19	00:01:40	2,14	53	03:16:40	12,80
20	00:02:10	2,38	54	03:46:40	
21	00:02:40	2,54	55	04:16:40	
22	00:03:10	2,68	56	04:46:40	
23	00:03:40	2,78	57	05:16:40	
24	00:04:10	2,90	58	05:46:40	
25	00:05:10	3,07	59	06:46:40	
26	00:06:10	3,28	60	07:46:40	
27	00:07:10	3,52	61	08:46:40	
28	00:08:10	3,75	62	09:46:40	
29	00:09:10	3,88	63	10:46:40	
30	00:10:40	3,98	64	12:46:40	
31	00:12:10	4,30	65	14:46:40	
32	00:13:40	6,10	66	16:46:40	
33	00:15:10	6,54	67	18:46:40	
34	00:16:40	7,18	68	20:46:40	

Remarks:

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Slugtest ID: **Test No:**

Date	04-10-2021	Well ID	DH6-02
GW-Level Start (mbgs)	0,00	Well Diameter (mm)	750
Depth Top Aquifer (mbgs)	8,00	Casing Diameter (mm)	600
Depth Bottom Aquifer (mbgs)	12,00	Slug Type	
Screen Length (m)	12.00	Volume (litre)	395,640
Across Screen		GW-Level Finish (mbgs)	8.58
Above Screen		Personel	YAR

Entry	Time Hour : Min. : Sec.	Water Level (mbgs)	Entry	Time Hour : Min. : Sec.	Water Level (mbgs)
1	00:00:02	0,17	35	00:19:40	5,90
2	00:00:04	0,27	36	00:22:40	6,15
3	00:00:06	0,37	37	00:25:40	6,30
4	00:00:08	0,43	38	00:28:40	6,47
5	00:00:10	0,47	39	00:31:40	6,55
6	00:00:15	0,60	40	00:36:40	6,71
7	00:00:20	0,64	41	00:41:40	6,87
8	00:00:25	0,80	42	00:46:40	6,98
9	00:00:30	0,86	43	00:51:40	7,07
10	00:00:35	0,92	44	01:01:40	7,18
11	00:00:40	0,95	45	01:11:40	7,25
12	00:00:45	0,97	46	01:21:40	7,37
13	00:00:50	0,99	47	01:31:40	7,49
14	00:00:55	1,02	48	01:46:40	7,54
15	00:01:00	1,14	49	02:01:40	7,63
16	00:01:10	1,20	50	02:16:40	7,70
17	00:01:20	1,33	51	02:31:40	7,78
18	00:01:30	1,46	52	02:46:40	7,84
19	00:01:40	1,56	53	03:16:40	7,95
20	00:02:10	1,89	54	03:46:40	
21	00:02:40	2,12	55	04:16:40	
22	00:03:10	2,40	56	04:46:40	
23	00:03:40	2,64	57	05:16:40	
24	00:04:10	2,84	58	05:46:40	
25	00:05:10	3,50	59	06:46:40	
26	00:06:10	3,64	60	07:46:40	
27	00:07:10	3,85	61	08:46:40	
28	00:08:10	4,28	62	09:46:40	
29	00:09:10	4,54	63	10:46:40	
30	00:10:40	4,78	64	12:46:40	
31	00:12:10	5,12	65	14:46:40	
32	00:13:40	5,30	66	16:46:40	
33	00:15:10	5,50	67	18:46:40	
34	00:16:40	5,60	68	20:46:40	

Remarks:

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Slugtest ID: **Test No:**

Date	30-09-2021	Well ID	DHC-03
GW-Level Start (mbgs)	0,00	Well Diameter (mm)	750
Depth Top Aquifer (mbgs)	11.00	Casing Diameter (mm)	600
Depth Bottom Aquifer (mbgs)	28.00	Slug Type	
Screen Length (m)	20.00	Volume (litre)	876.060
Across Screen		GW-Level Finish (mbgs)	5,07
Above Screen		Personel	

Entry	Time Hour : Min. : Sec.	Water Level (mbgs)	Entry	Time Hour : Min. : Sec.	Water Level (mbgs)
1	00:00:02	0,60	35	00:19:40	5,62
2	00:00:04	0,78	36	00:22:40	5,90
3	00:00:06	0,80	37	00:25:40	5,98
4	00:00:08	0,97	38	00:28:40	6,08
5	00:00:10	1,00	39	00:31:40	6,14
6	00:00:15	1,07	40	00:36:40	6,15
7	00:00:20	1,15	41	00:41:40	6,15
8	00:00:25	1,23	42	00:46:40	6,15
9	00:00:30	1,32	43	00:51:40	
10	00:00:35	1,42	44	01:01:40	
11	00:00:40	1,51	45	01:11:40	
12	00:00:45	1,59	46	01:21:40	
13	00:00:50	1,67	47	01:31:40	
14	00:00:55	1,74	48	01:46:40	
15	00:01:00	1,82	49	02:01:40	
16	00:01:10	1,94	50	02:16:40	
17	00:01:20	2,05	51	02:31:40	
18	00:01:30	2,15	52	02:46:40	
19	00:01:40	2,27	53	03:16:40	
20	00:02:10	2,48	54	03:46:40	
21	00:02:40	2,70	55	04:16:40	
22	00:03:10	2,98	56	04:46:40	
23	00:03:40	3,24	57	05:16:40	
24	00:04:10	3,42	58	05:46:40	
25	00:05:10	3,65	59	06:46:40	
26	00:06:10	3,90	60	07:46:40	
27	00:07:10	4,10	61	08:46:40	
28	00:08:10	4,25	62	09:46:40	
29	00:09:10	4,48	63	10:46:40	
30	00:10:40	4,83	64	12:46:40	
31	00:12:10	5,08	65	14:46:40	
32	00:13:40	5,19	66	16:46:40	
33	00:15:10	5,30	67	18:46:40	
34	00:16:40	5,47	68	20:46:40	

Remarks:

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Slugtest ID: Test No:

Date	03-10-2021	Well ID	DHG-04
GW-Level Start (mbgs)	0,00	Well Diameter (mm)	750
Depth Top Aquifer (mbgs)	20.00	Casing Diameter (mm)	600
Depth Bottom Aquifer (mbgs)	32.00	Slug Type	
Screen Length (m)	20.00	Volume (litre)	989.100
Across Screen		GW-Level Finish (mbgs)	27.00
Above Screen		Personel	YAR

Entry	Time Hour : Min. : Sec.	Water Level (mbgs)	Entry	Time Hour : Min. : Sec.	Water Level (mbgs)
1	00:00:02	0,20	35	00:19:40	6.40
2	00:00:04	0,40	36	00:22:40	6.64
3	00:00:06	0,50	37	00:25:40	6.97
4	00:00:08	0,64	38	00:28:40	7.26
5	00:00:10	0,80	39	00:31:40	7,42
6	00:00:15	1,00	40	00:36:40	8.20
7	00:00:20	1,11	41	00:41:40	8,88
8	00:00:25	1,22	42	00:46:40	9.50
9	00:00:30	1,28	43	00:51:40	10.05
10	00:00:35	1,32	44	01:01:40	11,11
11	00:00:40	1,38	45	01:11:40	12,09
12	00:00:45	1,42	46	01:21:40	13.00
13	00:00:50	1,50	47	01:31:40	14,22
14	00:00:55	1,52	48	01:46:40	16.40
15	00:01:00	1,58	49	02:01:40	17,88
16	00:01:10	1,71	50	02:16:40	18,64
17	00:01:20	1,80	51	02:31:40	20.08
18	00:01:30	1,92	52	02:46:40	21,16
19	00:01:40	2,00	53	03:16:40	23.09
20	00:02:10	2,30	54	03:46:40	
21	00:02:40	2,53	55	04:16:40	
22	00:03:10	2,80	56	04:46:40	
23	00:03:40	3,00	57	05:16:40	
24	00:04:10	3,23	58	05:46:40	
25	00:05:10	3,64	59	06:46:40	
26	00:06:10	4,04	60	07:46:40	
27	00:07:10	4,39	61	08:46:40	
28	00:08:10	4,71	62	09:46:40	
29	00:09:10	5,03	63	10:46:40	
30	00:10:40	5,36	64	12:46:40	
31	00:12:10	5,59	65	14:46:40	
32	00:13:40	5,81	66	16:46:40	
33	00:15:10	6,00	67	18:46:40	
34	00:16:40	6,14	68	20:46:40	

Remarks:

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Slugtest ID: **Test No:**

Date	02-10-2021	Well ID	DH6-05
GW-Level Start (mbgs)	4.34	Well Diameter (mm)	750
Depth Top Aquifer (mbgs)	17.00	Casing Diameter (mm)	600
Depth Bottom Aquifer (mbgs)	20.00	Slug Type	
Screen Length (m)	12.00	Volume (litre)	649.980
Across Screen		GW-Level Finish (mbgs)	18.70
Above Screen		Personel	YAR

Entry	Time (Hour : Min. : Sec.)	Water Level (mbgs)	Entry	Time (Hour : Min. : Sec.)	Water Level (mbgs)
1	00:00:02	4.40	35	00:19:40	7.82
2	00:00:04	4.43	36	00:22:40	7.85
3	00:00:06	4,52	37	00:25:40	7.88
4	00:00:08	4,55	38	00:28:40	7.93
5	00:00:10	4.56	39	00:31:40	7.98
6	00:00:15	4,59	40	00:36:40	8.04
7	00:00:20	4,57	41	00:41:40	8.06
8	00:00:25	4,59	42	00:46:40	8,10
9	00:00:30	4.59	43	00:51:40	8,12
10	00:00:35	4,61	44	01:01:40	8,16
11	00:00:40	4,61	45	01:11:40	8,17
12	00:00:45	4,60	46	01:21:40	8,21
13	00:00:50	4,58	47	01:31:40	8.24
14	00:00:55	4.66	48	01:46:40	8.36
15	00:01:00	4,75	49	02:01:40	8,40
16	00:01:10	4,85	50	02:16:40	8,44
17	00:01:20	4,89	51	02:31:40	8,52
18	00:01:30	5,00	52	02:46:40	
19	00:01:40	5,13	53	03:16:40	
20	00:02:10	5,43	54	03:46:40	
21	00:02:40	5,76	55	04:16:40	
22	00:03:10	6,47	56	04:46:40	
23	00:03:40	6,66	57	05:16:40	
24	00:04:10	6,89	58	05:46:40	
25	00:05:10	7,00	59	06:46:40	
26	00:06:10	7,23	60	07:46:40	
27	00:07:10	7.36	61	08:46:40	
28	00:08:10	7,40	62	09:46:40	
29	00:09:10	7,43	63	10:46:40	
30	00:10:40	7,53	64	12:46:40	
31	00:12:10	7,51	65	14:46:40	
32	00:13:40	7,56	66	16:46:40	
33	00:15:10	7,60	67	18:46:40	
34	00:16:40	7.70	68	20:46:40	

Remarks:

Stuck at 450 to 4.60 m

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Slugtest ID: **Test No:**

Date	02-10-2021	Well ID	DHG-06
GW-Level Start (mbgs)	1,00	Well Diameter (mm)	750
Depth Top Aquifer (mbgs)	24.00	Casing Diameter (mm)	600
Depth Bottom Aquifer (mbgs)	35.00	Slug Type	
Screen Length (m)	20.00	Volume (litre)	1.102.140
Across Screen		GW-Level Finish (mbgs)	22.80
Above Screen		Personel	

Entry	Time Hour : Min. : Sec.	Water Level (mbgs)	Entry	Time Hour : Min. : Sec.	Water Level (mbgs)
1	00:00:02	6,09	35	00:19:40	
2	00:00:04	6.21	36	00:22:40	
3	00:00:06	6,23	37	00:25:40	
4	00:00:08	6.47	38	00:28:40	
5	00:00:10	6.56	39	00:31:40	
6	00:00:15	6,90	40	00:36:40	
7	00:00:20	7,08	41	00:41:40	
8	00:00:25	7.57	42	00:46:40	
9	00:00:30	8,05	43	00:51:40	
10	00:00:35	8.59	44	01:01:40	
11	00:00:40	8.97	45	01:11:40	
12	00:00:45	9.50	46	01:21:40	
13	00:00:50	10,04	47	01:31:40	
14	00:00:55	10,10	48	01:46:40	
15	00:01:00	11,10	49	02:01:40	
16	00:01:10	12,05	50	02:16:40	
17	00:01:20	12,87	51	02:31:40	
18	00:01:30	13,68	52	02:46:40	
19	00:01:40	14,45	53	03:16:40	
20	00:02:10	16,46	54	03:46:40	
21	00:02:40	18,40	55	04:16:40	
22	00:03:10	19,54	56	04:46:40	
23	00:03:40	20,35	57	05:16:40	
24	00:04:10	20,07	58	05:46:40	
25	00:05:10	23,78	59	06:46:40	
26	00:06:10		60	07:46:40	
27	00:07:10		61	08:46:40	
28	00:08:10		62	09:46:40	
29	00:09:10		63	10:46:40	
30	00:10:40		64	12:46:40	
31	00:12:10		65	14:46:40	
32	00:13:40		66	16:46:40	
33	00:15:10		67	18:46:40	
34	00:16:40		68	20:46:40	

Remarks:

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Slugtest ID: Test No:

Date	04-10-2021	Well ID	DHG-07
GW-Level Start (mbgs)	5,00	Well Diameter (mm)	750
Depth Top Aquifer (mbgs)	7.50	Casing Diameter (mm)	600
Depth Bottom Aquifer (mbgs)	11.00	Slug Type	
Screen Length (m)	12.00	Volume (litre)	423.900
Across Screen		GW-Level Finish (mbgs)	14.20
Above Screen		Personel	

Entry	Time Hour : Min. : Sec.	Water Level (mbgs)	Entry	Time Hour : Min. : Sec.	Water Level (mbgs)
1	00:00:02	5,23	35	00:19:40	10,54
2	00:00:04	5,31	36	00:22:40	10,62
3	00:00:06	5,33	37	00:25:40	10,72
4	00:00:08	5,38	38	00:28:40	10,76
5	00:00:10	5,44	39	00:31:40	10,79
6	00:00:15	5,58	40	00:36:40	10,80
7	00:00:20	5,70	41	00:41:40	10,84
8	00:00:25	5,77	42	00:46:40	10,89
9	00:00:30	5,88	43	00:51:40	10,97
10	00:00:35	5,95	44	01:01:40	11,03
11	00:00:40	6,05	45	01:11:40	11,08
12	00:00:45	6,10	46	01:21:40	11,20
13	00:00:50	6,23	47	01:31:40	11,32
14	00:00:55	6,37	48	01:46:40	11.40
15	00:01:00	6,45	49	02:01:40	11,47
16	00:01:10	6,64	50	02:16:40	11,53
17	00:01:20	6,73	51	02:31:40	11,60
18	00:01:30	6,76	52	02:46:40	11,69
19	00:01:40	7,33	53	03:16:40	11,72
20	00:02:10	7,97	54	03:46:40	
21	00:02:40	8,43	55	04:16:40	
22	00:03:10	8,69	56	04:46:40	
23	00:03:40	8,97	57	05:16:40	
24	00:04:10	9.22	58	05:46:40	
25	00:05:10	9,43	59	06:46:40	
26	00:06:10	9,59	60	07:46:40	
27	00:07:10	9,81	61	08:46:40	
28	00:08:10	9,92	62	09:46:40	
29	00:09:10	10,02	63	10:46:40	
30	00:10:40	10,10	64	12:46:40	
31	00:12:10	10,22	65	14:46:40	
32	00:13:40	10,32	66	16:46:40	
33	00:15:10	10,39	67	18:46:40	
34	00:16:40	10,47	68	20:46:40	

Remarks:

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Slugtest ID: Test No:

Date	04-10-2021	Well ID	DHG-08
GW-Level Start (mbgs)	4,40	Well Diameter (mm)	750
Depth Top Aquifer (mbgs)	9.00	Casing Diameter (mm)	600
Depth Bottom Aquifer (mbgs)	17.00	Slug Type	
Screen Length (m)	12.00	Volume (litre)	565.200
Across Screen		GW-Level Finish (mbgs)	19.20
Above Screen		Personel	YAR

Entry	Time Hour : Min. : Sec.	Water Level (mbgs)	Entry	Time Hour : Min. : Sec.	Water Level (mbgs)
1	00:00:02	4.50	35	00:19:40	14.20
2	00:00:04	4.58	36	00:22:40	14.34
3	00:00:06	4.64	37	00:25:40	14.49
4	00:00:08	4.68	38	00:28:40	14,67
5	00:00:10	4,70	39	00:31:40	14.95
6	00:00:15	4.74	40	00:36:40	15,40
7	00:00:20	4.78	41	00:41:40	15.87
8	00:00:25	4,89	42	00:46:40	16,02
9	00:00:30	4.90	43	00:51:40	16.30
10	00:00:35	4.99	44	01:01:40	16,90
11	00:00:40	5,07	45	01:11:40	17.40
12	00:00:45	5,17	46	01:21:40	17.75
13	00:00:50	5,24	47	01:31:40	17.93
14	00:00:55	5.33	48	01:46:40	18.03
15	00:01:00	5,43	49	02:01:40	18,06
16	00:01:10	5.56	50	02:16:40	18.10
17	00:01:20	5,69	51	02:31:40	18.15
18	00:01:30	5,83	52	02:46:40	18.21
19	00:01:40	5.98	53	03:16:40	18.24
20	00:02:10	6,42	54	03:46:40	
21	00:02:40	6.82	55	04:16:40	
22	00:03:10	7.24	56	04:46:40	
23	00:03:40	7.65	57	05:16:40	
24	00:04:10	7.92	58	05:46:40	
25	00:05:10	8.32	59	06:46:40	
26	00:06:10	8.80	60	07:46:40	
27	00:07:10	9.53	61	08:46:40	
28	00:08:10	10,28	62	09:46:40	
29	00:09:10	10,93	63	10:46:40	
30	00:10:40	11,91	64	12:46:40	
31	00:12:10	12,91	65	14:46:40	
32	00:13:40	13.38	66	16:46:40	
33	00:15:10	13,75	67	18:46:40	
34	00:16:40	13.97	68	20:46:40	

Remarks:

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Slugtest ID: **Test No:**

Date	01-10-2021	Well ID	DHG-09
GW-Level Start (mbgs)	1,00	Well Diameter (mm)	750
Depth Top Aquifer (mbgs)	20.00	Casing Diameter (mm)	600
Depth Bottom Aquifer (mbgs)	28.00	Slug Type	
Screen Length (m)	12.00	Volume (litre)	847,800
Across Screen		GW-Level Finish (mbgs)	23.20
Above Screen		Personel	YAR

Entry	Time	Water Level (mbgs)	Entry	Time	Water Level (mbgs)
	Hour : Min. : Sec.			Hour : Min. : Sec.	
1	00:00:02	1,90	35	00:19:40	9.39
2	00:00:04	1,93	36	00:22:40	10,03
3	00:00:06	1,96	37	00:25:40	10,63
4	00:00:08	2,02	38	00:28:40	11,33
5	00:00:10	2,08	39	00:31:40	11,93
6	00:00:15	2,19	40	00:36:40	12,89
7	00:00:20	2,22	41	00:41:40	13,78
8	00:00:25	2,28	42	00:46:40	14,56
9	00:00:30	2,36	43	00:51:40	15,37
10	00:00:35	2,46	44	01:01:40	16.80
11	00:00:40	2,53	45	01:11:40	17,88
12	00:00:45	2,65	46	01:21:40	19,01
13	00:00:50	2,72	47	01:31:40	19,86
14	00:00:55	2,82	48	01:46:40	20,93
15	00:01:00	2,92	49	02:01:40	21,55
16	00:01:10	3,08	50	02:16:40	22,09
17	00:01:20	3,20	51	02:31:40	22,48
18	00:01:30	3,38	52	02:46:40	22,95
19	00:01:40	3,45	53	03:16:40	23.00
20	00:02:10	3,81	54	03:46:40	
21	00:02:40	4,14	55	04:16:40	
22	00:03:10	4.36	56	04:46:40	
23	00:03:40	4,57	57	05:16:40	
24	00:04:10	4,68	58	05:46:40	
25	00:05:10	5,10	59	06:46:40	
26	00:06:10	5,44	60	07:46:40	
27	00:07:10	5,68	61	08:46:40	
28	00:08:10	5,95	62	09:46:40	
29	00:09:10	6.30	63	10:46:40	
30	00:10:40	6,77	64	12:46:40	
31	00:12:10	7.78	65	14:46:40	
32	00:13:40	7,74	66	16:46:40	
33	00:15:10	8,18	67	18:46:40	
34	00:16:40	8,82	68	20:46:40	

Remarks:

Lampiran D

Hasil Uji Lab PT HM

No.	Borehole	Classification: MC (%)	Normal Density (kN/m3)	Dry Density (kN/m3)	Void Ratio	Porosity	Saturation	Gs	LL	PL	PI	Gravel	Sand	Silt	Clay	Fines
1	X-DHG 01 (01.25-01.85m)	51.12	19.18	12.3	1.922	0.658	100	3.605	50.3	32.4	18.3	0	20.87	79.13		79.13
2	X-DHG 01 (05.50-05.70m)															
3	X-DHG 01 (07.00-07.20m)															
4	X-DHG 01 (15.30-15.55m)															
5	X-DHG 01 (18.23-18.43m)															
6	X-DHG 02 (03.40-03.80m)	48.03	19.94	13.3	1.543	0.607	100	3.513	58.1	30	28.1	9.13	12.88	78		78
7	X-DHG 02 (04.30-04.70m)															
8	X-DHG 02 (09.73-09.88m)															
9	X-DHG 02 (11.70-12.00m)															
10	X-DHG 02 (12.00-12.20m)															
11	X-DHG 03 (02.60-03.00m)															
12	X-DHG 03 (06.60-07.00m)	80.88	22.34	11.3	1.807	0.644	100	3.300	65	41	24	0	20.84	79.38		79.38
13	X-DHG 03 (12.20-12.45m)															
14	X-DHG 03 (13.10-13.35m)															
15	X-DHG 03 (23.30-23.45m)															
16	X-DHG 04 (05.00-05.40m)															
17	X-DHG 04 (03.25-03.65m)	58.55	18.62	12.4	1.604	0.62	100	3.288	66.2	25.9	40.3	0	12.18	87.84		87.84
18	X-DHG 04 (17.00-17.25m)															
19	X-DHG 04 (32.25-32.35m)															
20	X-DHG 05 (03.45-03.85m)															
21	X-DHG 05 (11.60-12.00m)	-	-	-	-	-	-	3.131	110.7	48.9	61.8	0	10.59	66.21	23.2	89.41
22	X-DHG 05 (14.75-14.90m)															
23	X-DHG 05 (15.80-16.00m)															
24	X-DHG 05 (20.10-20.27m)															
25	X-DHG 06 (05.20-05.60m)															
26	X-DHG 06 (07.00-07.40m)	55.93	18.77	12.4	1.501	0.605	100	3.143	59.8	33.8	26	0	21.42	78.58		78.58
27	X-DHG 06 (25.60-25.80m)															
28	X-DHG 06 (35.50-35.70m)															
29	X-DHG 07 (02.60-03.00m)															
30	X-DHG 07 (03.60-04.00m)	-	-	-	-	-	-	2.888	54	18.8	37.1	0	16.73	83.27		83.27
31	X-DHG 07 (08.50-08.70m)															
32	X-DHG 07 (09.50-09.85m)															
33	X-DHG 07 (11.00-11.20m)															
34	X-DHG 08 (02.60-03.00m)															
35	X-DHG 08 (04.00-04.40m)	84.25	18.28	11.2	2.200	0.688	100	3.592	78.8	34.1	44.7	0	12.88	87.12		87.12
36	X-DHG 08 (17.30-17.50m)															
37	X-DHG 08 (19.15-19.52m)															
38	X-DHG 09 (02.70-03.10m)															
39	X-DHG 09 (07.00-07.40m)	91.92	17.4	9.5	2.731	0.732	100	3.505	96.9	51.5	45.4	0	4.07	41.44	54.49	95.93
40	X-DHG 09 (14.10-14.31m)															
41	X-DHG 09 (18.27-18.48m)															
42	X-DHG 09 (18.30-18.50m)															
43	X-DHG 09 (23.55-23.78m)															
44	X-DHG 09 (29.30-29.55m)															

No.	Borehole	Triaxial UU: c_uu (kPa)	phi_uu (degree)	UCT: c (kPa)	Sensitivity	Eu (kPa)	Triaxial CU: c_cu (kPa)	phi_cu (degree)	c' (kPa)	phi' (degree)	Falling Head: k (cm/s)	direction
1	X-DHG 01 (01.25-01.85m)	32.1	5.3									
2	X-DHG 01 (05.50-05.70m)			8	1.55	530						
3	X-DHG 01 (07.00-07.20m)											
4	X-DHG 01 (15.30-15.55m)											
5	X-DHG 01 (18.23-18.43m)											
6	X-DHG 02 (03.40-03.80m)	28.4	7.1									
7	X-DHG 02 (04.30-04.70m)						7.55	24.2	5.02	33.8		
8	X-DHG 02 (09.73-09.88m)											
9	X-DHG 02 (11.70-12.00m)											
10	X-DHG 02 (12.00-12.20m)											
11	X-DHG 03 (02.60-03.00m)	19.8	5.3									
12	X-DHG 03 (06.60-07.00m)										1.50505E-08	Vertical
13	X-DHG 03 (12.20-12.45m)			22	1.54	1484						
14	X-DHG 03 (13.10-13.35m)											
15	X-DHG 03 (23.30-23.45m)											
16	X-DHG 04 (05.00-05.40m)	17.8	8.3									
17	X-DHG 04 (03.25-03.65m)										2.98435E-08	Vertical
18	X-DHG 04 (17.00-17.25m)			42.9	1.25	3382						
19	X-DHG 04 (32.25-32.35m)											
20	X-DHG 05 (03.45-03.85m)	53.5	7.9									
21	X-DHG 05 (11.60-12.00m)											
22	X-DHG 05 (14.75-14.90m)			31.5	1.35	4234						
23	X-DHG 05 (15.80-16.00m)											
24	X-DHG 05 (20.10-20.27m)											
25	X-DHG 06 (05.20-05.60m)	27.2	5.8									
26	X-DHG 06 (07.00-07.40m)											
27	X-DHG 06 (25.60-25.80m)											
28	X-DHG 06 (35.50-35.70m)											
29	X-DHG 07 (02.60-03.00m)	9.2	4.3									
30	X-DHG 07 (03.60-04.00m)										4.84986E-07	Vertical
31	X-DHG 07 (08.50-08.70m)											
32	X-DHG 07 (09.50-09.85m)											
33	X-DHG 07 (11.00-11.20m)											
34	X-DHG 08 (02.60-03.00m)	21.2	8.3									
35	X-DHG 08 (04.00-04.40m)										4.84986E-07	Vertical
36	X-DHG 08 (17.30-17.50m)											
37	X-DHG 08 (19.15-19.52m)											
38	X-DHG 09 (02.70-03.10m)	13	4.3									
39	X-DHG 09 (07.00-07.40m)											
40	X-DHG 09 (14.10-14.31m)			9.1	1.24	745						
41	X-DHG 09 (18.27-18.48m)										1.33636E-05	Vertical
42	X-DHG 09 (18.30-18.50m)											
43	X-DHG 09 (23.55-23.78m)											
44	X-DHG 09 (29.30-29.55m)											

No.	Borehole	Properties of Rock: Natural Density (kN/m3)	Rock Dry Density (kN/m3)	Saturated Density (kN/m3)	Specific Gravity	Natural Moisture Content (%)	Absorption (%)	Saturation (%)	Porosity Rock	Void Ratio Rock	UCS Poisson: Sigma_Max (MPa)	E (MPa)	v (-)
1	X-DHG 01 (01.25-01.85m)												
2	X-DHG 01 (05.50-05.70m)												
3	X-DHG 01 (07.00-07.20m)	10.447	4.785	12.341	1.588	54.392	150.594	75.007	0.758	3.125			
4	X-DHG 01 (15.30-15.55m)										3.334	407.205	0.273
5	X-DHG 01 (18.23-18.43m)	28.732	28.802	29.125	3.018	0.456	1.329	24.918	0.052	0.055			
6	X-DHG 02 (03.40-03.80m)												
7	X-DHG 02 (04.30-04.70m)												
8	X-DHG 02 (09.73-09.88m)	22.357	20.350	22.858	2.859	9.881	11.535	85.490	0.235	0.307			
9	X-DHG 02 (11.70-12.00m)										4.758	5320.79	0.250
10	X-DHG 02 (12.00-12.20m)	23.980	22.893	24.285	2.850	4.858	5.592	77.731	0.137	0.159			
11	X-DHG 03 (02.60-03.00m)												
12	X-DHG 03 (06.60-07.00m)												
13	X-DHG 03 (12.20-12.45m)												
14	X-DHG 03 (13.10-13.35m)	10.228	4.504	12.089	1.339	55.887	188.199	75.552	0.750	3.057			
15	X-DHG 03 (23.30-23.45m)										1.343	2339.17	0.431
16	X-DHG 04 (05.00-05.40m)												
17	X-DHG 04 (03.25-03.65m)												
18	X-DHG 04 (17.00-17.25m)												
19	X-DHG 04 (32.25-32.35m)	27.345	28.978	27.718	2.913	1.380	2.733	49.758	0.074	0.080			
20	X-DHG 05 (03.45-03.85m)												
21	X-DHG 05 (11.60-12.00m)												
22	X-DHG 05 (14.75-14.90m)												
23	X-DHG 05 (15.80-16.00m)	10.868	5.158	12.393	1.388	51.855	140.358	78.125	0.724	2.619			
24	X-DHG 05 (20.10-20.27m)										5.32	2230.87	0.333
25	X-DHG 06 (05.20-05.60m)												
26	X-DHG 06 (07.00-07.40m)												
27	X-DHG 06 (25.60-25.80m)										3.23	444.80	0.375
28	X-DHG 06 (35.50-35.70m)										4.51	823.28	0.412
29	X-DHG 07 (02.60-03.00m)												
30	X-DHG 07 (03.60-04.00m)												
31	X-DHG 07 (08.50-08.70m)										14.23	3043.74	0.208
32	X-DHG 07 (09.50-09.85m)	20.214	18.995	20.507	2.620	13.943	20.889	91.845	0.251	0.341			
33	X-DHG 07 (11.00-11.20m)										14.97	1255.49	0.447
34	X-DHG 08 (02.60-03.00m)												
35	X-DHG 08 (04.00-04.40m)												
36	X-DHG 08 (17.30-17.50m)										42.48	2388.31	0.432
37	X-DHG 08 (19.15-19.52m)	30.893	30.750	31.274	3.245	0.430	1.705	28.308	0.052	0.055			
38	X-DHG 09 (02.70-03.10m)												
39	X-DHG 09 (07.00-07.40m)												
40	X-DHG 09 (14.10-14.31m)												
41	X-DHG 09 (18.27-18.48m)												
42	X-DHG 09 (18.30-18.50m)	13.250	7.972	14.870	2.414	68.208	34.012	78.308	0.870	2.023			
43	X-DHG 09 (23.55-23.78m)										30.35	8030.54	0.485
44	X-DHG 09 (29.30-29.55m)	22.804	21.193	22.935	2.535	8.650	8.500	78.301	0.130	0.220			

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 01.25 - 01.65 m

Date Tested : 26/10/2021

GEOMINE

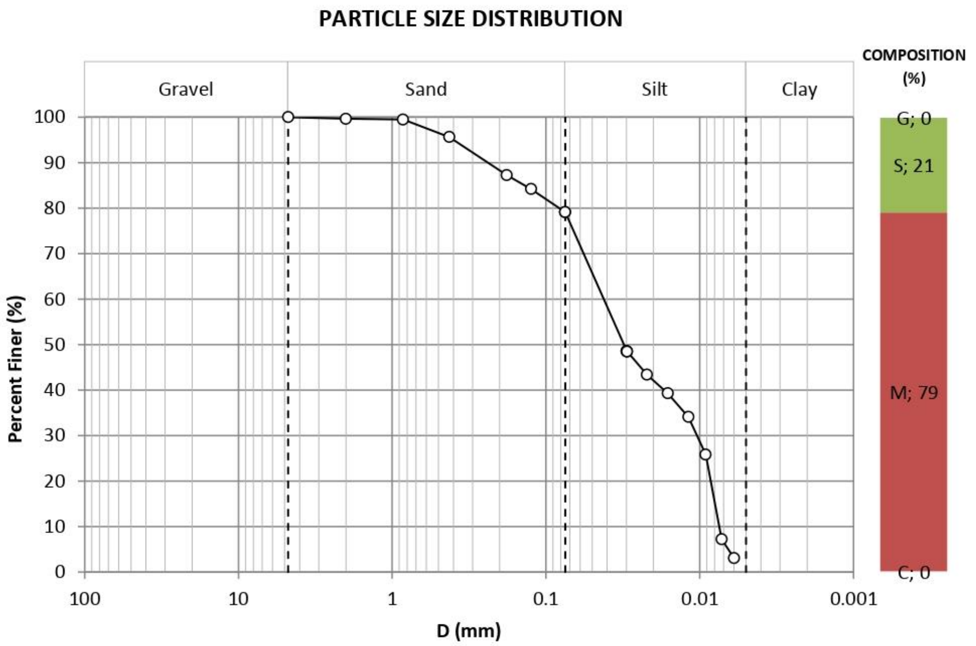
Test		Results
Unit Weight	kN/m^3	19.2
SL	%	-
Gs	-	3.60
MC	%	51
PL	%	32
LL	%	51
PI	%	18
Fines (#200)	%	79
D_{10}	mm	0.0075
D_{30}	mm	0.0104
D_{60}	mm	0.0421
C_u	-	6
C_c	-	0.35

* Casagrande's Method

** Based on Consistency Index (Ic)

Properties		Results
I_F	%	-0.15
I_T	%	-119.80
I_L	%	1.02
I_C	%	-0.02
S_r	%	100.00
e	-	1.92
n	-	0.66
A	-	12.29

Consistency**	**Very Soft**
Activity	**Active**
Plasticity Symbol	**MH or OH**



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(01.25-01.65 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 01.25 - 01.65 m

Date Tested : 26/10/2021

GEOMINE

Moisture Content

No. Test	1	2	3
No. Container	1111	1234	1035
Weight of Container	4.55	4.57	5.36
Weight of wet soil and container	145.07	155.48	171.56
Weight of dry soil and container	96.30	102.51	119.10
Moisture Content	53.16	54.08	46.12
Average MC	51.12		

Unit weight

No. Ring	1
No. Container	1056
Weight of Ring	27.82
Volume of Ring	15.669
Weight of Container	5.99
Weight of wet soil and ring and containe	63.83
Weight of dry soil and ring and containe	53.14
Water Content	55.303
Density	19.158
Dry Density	12.336
Saturation	100
Void ratio	1.9222
Porosity	0.6578

Specific Gravity

No. Test	1	2
No. Pycknometer	201	201
Weight of Pycknometer + soil	77.9	77.9
Weight of Pycknometer + water + soil	171.56	171.56
T° C	26	26
Weight of Pycknometer	52.92	52.92
Weight of Pycknometer + water	153.51	153.51
Specific Gravity	3.605	3.605
Average Specific Gravity	3.605	

Shrinkage Limit

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and container	-
Weight of dry soil and container	-
Weight of plate	-
Weight of plate and Mercury	-
Volume dry soil	-
Shrinkage Limit	-

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(01.25-01.65 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

GEOMINE

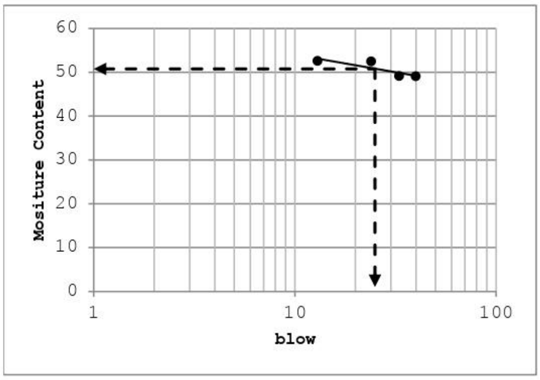
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 01.25 - 01.65 m
Date Tested : 26/10/2021

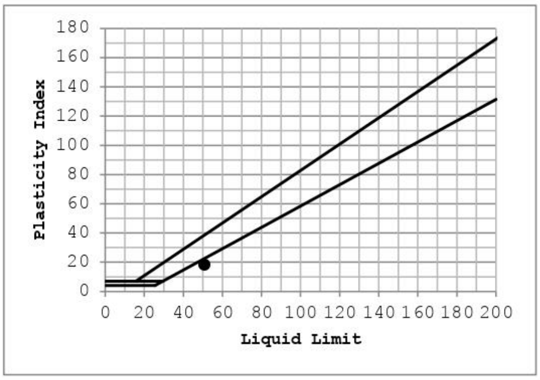
Plastic Limit

No. Test	1	2	3
No. Container	1013	1183	1030
Weight of Container	5.41	4.42	5.86
Weight of wet soil and container	14.43	14.33	14.55
Weight of dry soil and container	12.38	11.83	12.34
Plastic Limit	29.41	33.74	34.10
Average	32.42		

Liquid Limit

No. Test	1	2	3	4	5
No. Container	1149	1146	1125	1105	-
Weight of Container	4.39	4.66	5.54	4.65	-
Weight of wet soil and container	14.45	14.68	14.7	14.75	-
Weight of dry soil and container	11.14	11.38	11.55	11.27	-
Water Content	49.04	49.11	52.41	52.57	-
Number of blows	40	33	24	13	-
Liquid Limit	50.76				





Sieve Analysis

Bowl	0
Soil + Bowl	80.18
Weight of dry soil	80.18

Sieve No.	Sieve Diameter	Weight of Soil Retained	Percent Retained	Cumulative Percent Retained	Percent Finer
4	4.75	0.001	0.00	0.00	100.00
10	2	0.28	0.35	0.35	99.65
20	0.85	0.14	0.17	0.53	99.47
40	0.425	3.06	3.82	4.34	95.66
80	0.18	6.72	8.38	12.72	87.28
120	0.125	2.45	3.06	15.78	84.22
200	0.075	4.08	5.09	20.87	79.13
Pan	0	3.06	79.13	100	0.00

F GWL OL 001; R 12-(17/10/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(01.25-01.65 m)-Classification.xlsm

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 01.25 - 01.65 m
Date Tested : 26/10/2021

GEOMINE

Hydrometer

Dry Sample

Weight of sample	60.389		
Zerro correction	-1	Gs	3.6048
Meniscus correction	1	a	0.8617

Time	t (minute)	T (Co)	Ra	Diameter	Percent Finer
12:20	0				
12:21	1	27	44	0.0299	48.61
12:22	2	27	39	0.0220	43.44
12:24	4	27	35	0.0161	39.30
12:28	8	27	30	0.0118	34.13
12:35	15	27	22	0.0091	25.86
12:50	30	27	4	0.0072	7.24
13:05	45	27	0	0.0060	3.10
13:50	90	0	0	0.0000	1.03
15:20	180	0	0	0.0000	0.00
9:20	1260	0	0	0.0000	0.00
12:20	1440	0	0	0.0000	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(01.25-01.65 m)-Classification.xlsm

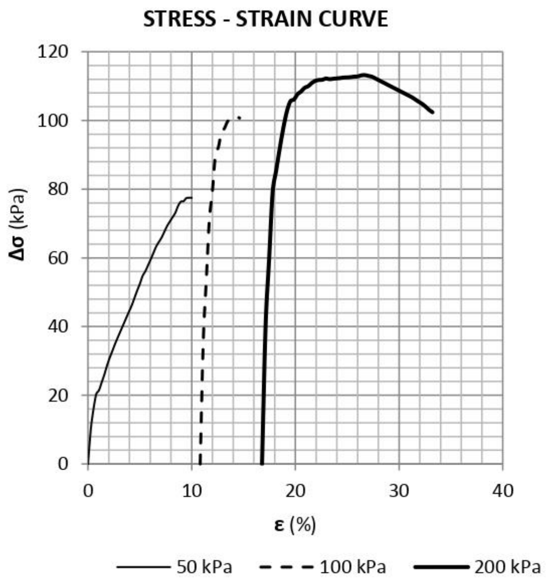
F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

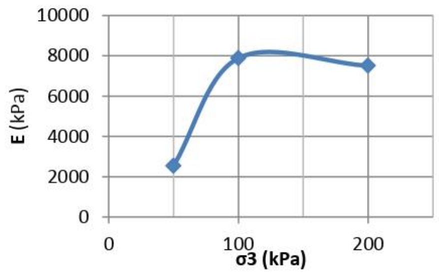
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 01.25 -01.65 m
Date Tested : 28/10/2021

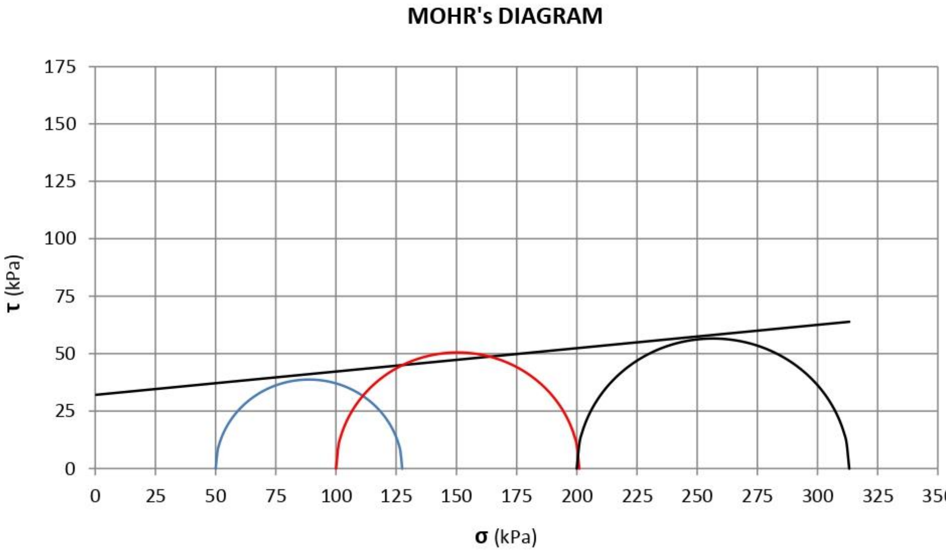
GEOMINE



No.	σ3 (kPa)	Δσ (kPa)	ε_f (%)
1.	50	77.50	9.74
2.	100	101.05	14.33
3.	200	113.20	26.71

Results		
c	kPa	32.1
ø	°	5.8





D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(01.25-01.65 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 01.25 -01.65 m
Date Tested : 28/10/2021

GEOMINE

Height of Sample: 76 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
0	0	0
20	10	0.26
40	15.96	0.53
60	20.3	0.79
80	21.44	1.05
100	23.75	1.32
120	26.06	1.58
140	28.75	1.84
160	31.03	2.11
180	33.06	2.37
200	35.16	2.63
220	37.01	2.89
240	38.85	3.16
260	40.68	3.42
280	42.51	3.68
300	44.32	3.95
320	46.12	4.21
340	48.29	4.47
360	50.45	4.74
380	52.44	5
400	54.73	5.26
420	56.1	5.53
440	57.83	5.79
460	59.63	6.05
480	61.49	6.32
500	63.34	6.58
520	64.66	6.84
540	65.97	7.11
560	67.64	7.37
580	69.3	7.63
600	70.58	7.89
620	71.85	8.16
640	73.11	8.42
660	75.1	8.68
680	76.35	8.95
700	76.49	9.21
720	77.36	9.47
740	77.5	9.74
760	77.49	10

Deviator Stress Maximum: 77.50 kPa E_0: 1156.31 kPa
Strain at Failure: 10.00 % E_{50}: 1048.88 kPa
Deviator Stress at (50%): 52.44 kPa
D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(01.25-01.65 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 01.25 -01.65 m
Date Tested : 28/10/2021

GEOMINE

Strain at (50%): 5.00 %

+ + + + + + + + + STAGE - 1 + + + + + + + + +

Height of Sample: 68.4 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
740	0	10.82
760	35.31	11.11
780	53.32	11.4
800	70.85	11.7
820	79.09	11.99
840	89.74	12.28
860	92.25	12.57
880	96.48	12.87
900	97.69	13.16
920	99.66	13.45
940	100.36	13.74
960	100.84	14.04
980	101.05	14.33
1000	100.71	14.62

Deviator Stress Maximum: 101.05 kPa E_0: 6625.80 kPa
Strain at Failure: 14.62 % E_{50}: 733.69 kPa
Deviator Stress at (50%): 92.25 kPa
Strain at (50%): 12.57 %

+ + + + + + + + + STAGE - 2 + + + + + + + + +

Height of Sample: 58.4 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
980	0	16.78
1000	39.9	17.12
1020	59.6	17.47
1040	79.14	17.81
1060	85.51	18.15
1080	91.89	18.49
1100	97.75	18.84
1120	102.59	19.18
1140	105.58	19.52
1160	106.1	19.86
1180	107.63	20.21

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 01.25 -01.65 m
Date Tested : 28/10/2021

GEOMINE

1200	108.44	20.55
1220	109.5	20.89
1240	109.97	21.23
1260	110.88	21.58
1280	111.52	21.92
1300	111.78	22.26
1320	111.85	22.6
1340	112.22	22.95
1360	112.03	23.29
1380	112.14	23.63
1400	112.25	23.97
1420	112.35	24.32
1440	112.5	24.66
1460	112.53	25
1480	112.62	25.34
1500	112.76	25.68
1520	112.83	26.03
1540	113.14	26.37
1560	113.2	26.71
1580	112.96	27.05
1600	112.72	27.4
1620	112.19	27.74
1640	111.66	28.08
1660	111.13	28.42
1680	110.6	28.77
1700	110.07	29.11
1720	109.53	29.45
1740	109	29.79
1760	108.47	30.14
1780	107.94	30.48
1800	107.41	30.82
1820	106.88	31.16
1840	106.23	31.51
1860	105.54	31.85
1880	104.9	32.19
1900	104.1	32.53
1920	103.14	32.88
1940	102.4	33.22

Deviator Stress Maximum: 113.20 kPa E_{o}: 1914.38 kPa
Strain at Failure: 33.22 % E_{50}: 450.14 kPa
Deviator Stress at (50%): 112.53 kPa
Strain at (50%): 25.00 %

+ + + + + + + + + STAGE - 3 + + + + + + + + +

No. Container : 1156
Wet Soil + Container : 170.68 gram
Dry Soil + Container : 121.93 gram
Weight of Container : 4.38 gram
Density : 19.29 kN/m3
Moisture Content : 41.47 %

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(01.25-01.65 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

GEOMINE

Client ID	: Geomine
Project ID	: Hengjaya Mineralindo
GWL ID	: 21 031
Area	: -
Point ID	: DHG 01
Depth	: 01.25 -01.65 m

Date Tested : 28/10/2021

Dry Density : 13.64 kN/m3

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(01.25-01.65 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

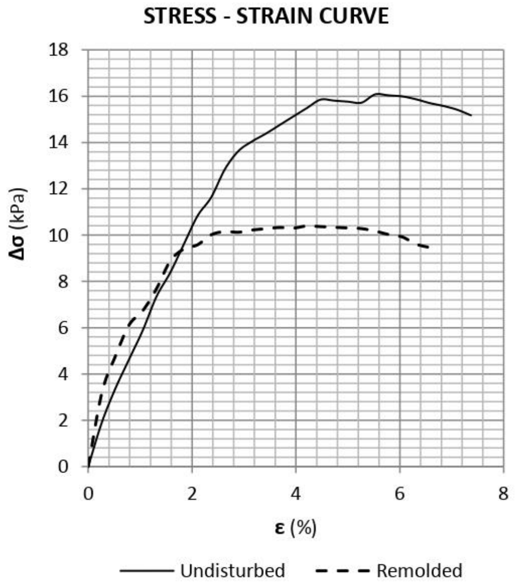
PARTNER FOR DESIGN

Unconfined Compression Test

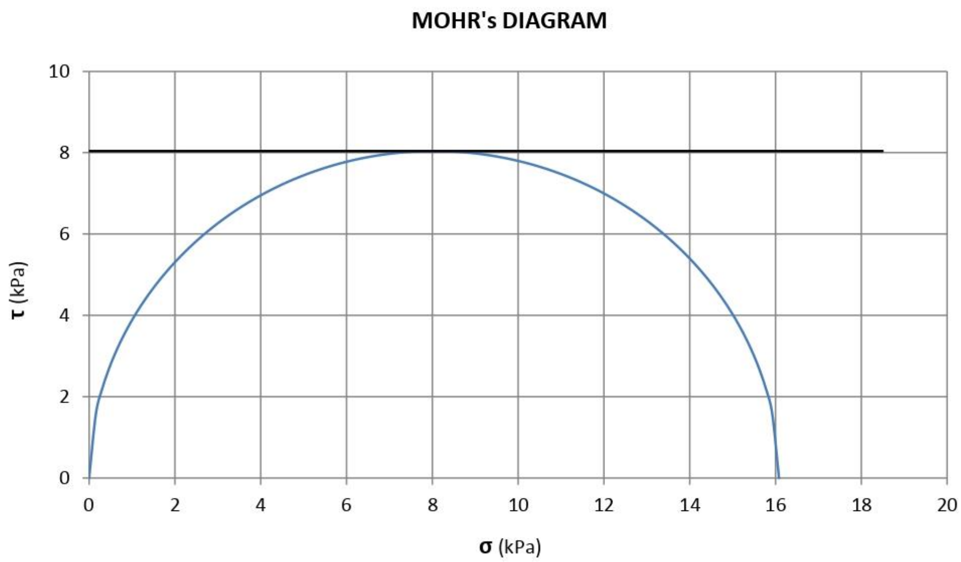
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 05.50 - 05.70 m

Date Tested : 29/10/2021

GEOMINE



Results		Undisturbed	Remolded
σ_{max}	kPa	16.1	10.4
ε_f	%	5.53	4.21
S_t	-	1.55	
c	kPa	8.0	5.2
E_{50}	kPa	530	584
E_{sec}	kPa	291	247



F GWL OL 002; R 05-(6/09/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(05.50-05.70 m)-UCT.xlsm

PARTNER FOR DESIGN

Unconfined Compression Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 05.50 - 05.70 m

Date Tested : 29/10/2021

GEOMINE

Undisturbed

Height of Sample : 76 mm
Diameter of Sample : 38 mm
Calibration Dial Gauge : 0.04826 kg/div
Calibration Strain Load : 0.01 mm/div

Water Content : 121.52 %
Unit Weight : 11.45 kN/m3
Dry Density : 5.17 kN/m3

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
0	0.00	0.0000
20	1.91	0.2632
40	3.39	0.5263
60	4.64	0.7895
80	5.89	1.0526
100	7.35	1.3158
120	8.38	1.5789
140	9.61	1.8421
160	10.83	2.1053
180	11.63	2.3684
200	12.84	2.6316
220	13.64	2.8947
240	14.05	3.1579
260	14.38	3.4211
280	14.75	3.6842
300	15.12	3.9474
320	15.49	4.2105
340	15.85	4.4737
360	15.81	4.7368
380	15.77	5.0000
400	15.72	5.2632
420	16.08	5.5263
440	16.04	5.7895
460	15.99	6.0526
480	15.87	6.3158
500	15.70	6.5789
520	15.58	6.8421
540	15.42	7.1053
560	15.18	7.3684

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
-	-	-

F GWL OL 002; R 05-(6/09/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(05.50-05.70 m)-UCT.xlsm

PARTNER FOR DESIGN

Unconfined Compression Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 05.50 - 05.70 m

Date Tested : 29/10/2021

GEOMINE

Remolded

Height of Sample : 76 mm
Diameter of Sample : 38 mm
Calibration Dial Gauge : 0.04826 kg/div
Calibration Strain Load : 0.01 mm/div

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)	Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
0	0	0.0000	-	-	-
20	3.18	0.2632			
40	4.78	0.5263			
60	6.12	0.7895			
80	6.74	1.0526			
100	7.68	1.3158			
120	8.88	1.5789			
140	9.40	1.8421			
160	9.58	2.1053			
180	10.01	2.3684			
200	10.15	2.6316			
220	10.12	2.8947			
240	10.22	3.1579			
260	10.27	3.4211			
280	10.33	3.6842			
300	10.30	3.9474			
320	10.39	4.2105			
340	10.37	4.4737			
360	10.34	4.7368			
380	10.31	5.0000			
400	10.28	5.2632			
420	10.17	5.5263			
440	10.02	5.7895			
460	9.91	6.0526			
480	9.61	6.3158			
500	9.46	6.5789			

F GWL OL 002; R 05-(6/09/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(05.50-05.70 m)-UCT.xlsm

PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 01
Depth : 07.00 - 07.20 m
Date Tested : 25/10/2021

GEOMINE

Result		
Natural Density	kN/m^3	10.45
Dry Density	kN/m^3	4.76
Saturated Density	kN/m^3	12.34
Spesific Gravity	-	1.97
Natural Water Content	%	54
Absorption	%	159
Saturation	%	0.76
Porosity	-	0.76
Void Ratio	-	3.13

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(07.00-07.20 m)-Properties (Rock).xlsm

F GWL OL 026; R 04-(10/7/21)

PARTNER FOR DESIGN

Uniaxial Compressive Strength Test (v)

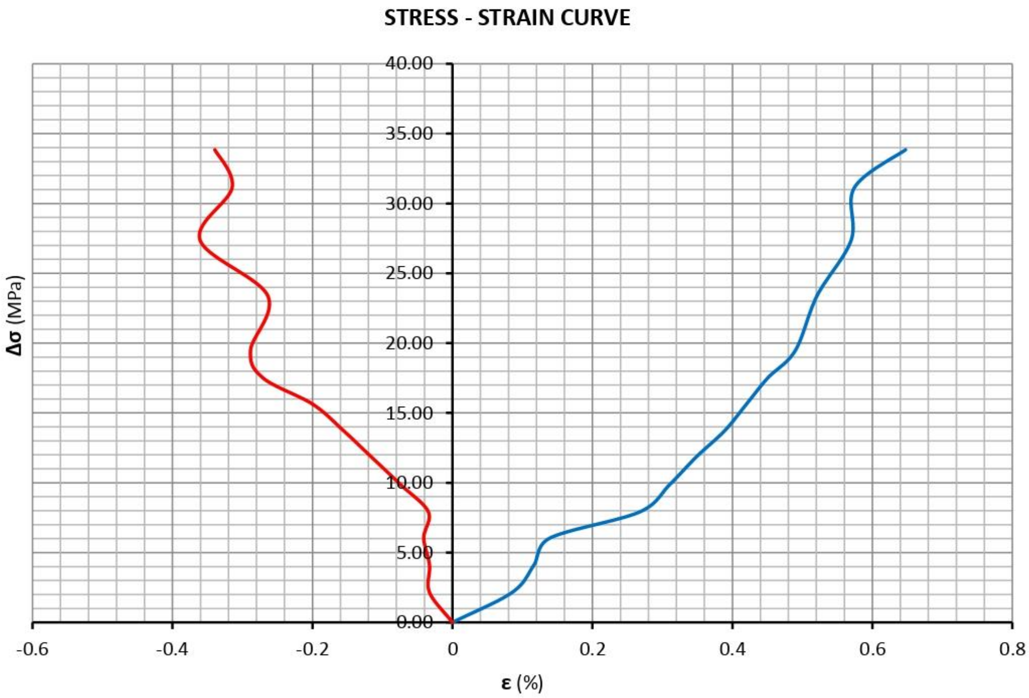
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 01
Depth : 15.30 - 15.55 m

Date Tested : 3/11/2021

GEOMINE

Results		
σ_{max*}	MPa	33.84
v	-	0.27
E	MPa	4072

* Coreccted by Hoek and Brown (1980a)



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(15.30-15.55 m)-UCS (Poisson).xlsm

F GWL OL 033; R 01-(22/09/14)

PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 01
Depth : 16.23 - 16.43 m
Date Tested : 27/10/2021

GEOMINE

Result		
Natural Density	kN/m^3	28.73
Dry Density	kN/m^3	28.60
Saturated Density	kN/m^3	29.13
Spesific Gravity	-	3.02
Natural Water Content	%	0
Absorption	%	2
Saturation	%	0.05
Porosity	-	0.05
Void Ratio	-	0.06

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 01-(16.23-16.43 m)-Properties (Rock).xlsm

F GWL OL 026; R 04-(10/7/21)

PARTNER FOR DESIGN

Classification Test

GEOMINE

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 03.40 - 03.80 m

Date Tested : 26/10/2021

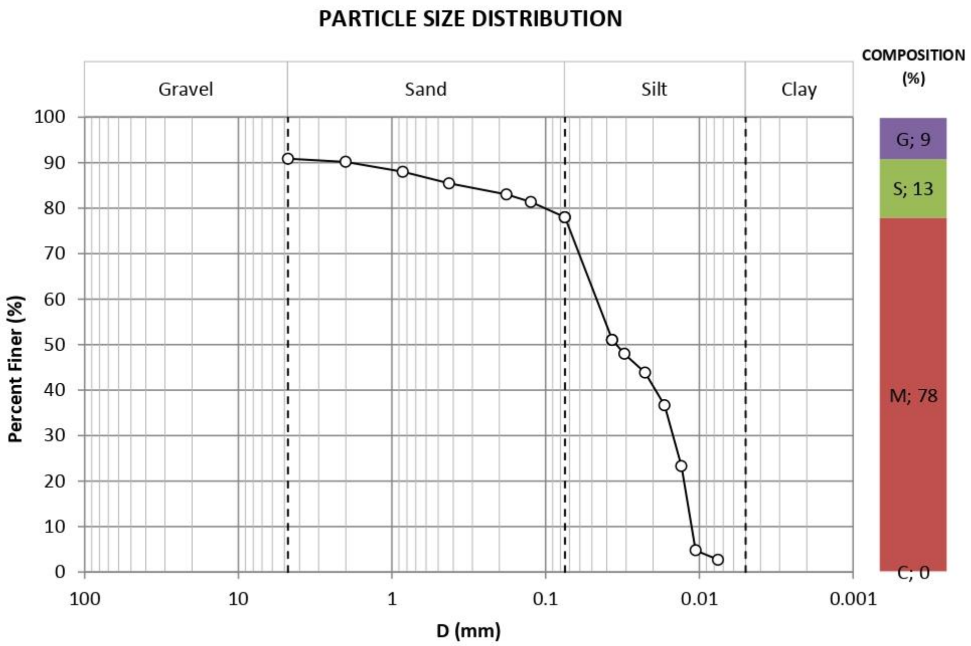
Test		Results
Unit Weight	kN/m^3	19.9
SL	%	-
Gs	-	3.51
MC	%	46
PL	%	30
LL	%	56
PI	%	26
Fines (#200)	%	78
D_{10}	mm	0.0112
D_{30}	mm	0.0149
D_{60}	mm	0.0467
C_u	-	4
C_c	-	0.42

Properties		Results
I_F	%	-0.11
I_T	%	-238.86
I_L	%	0.62
I_C	%	0.38
S_r	%	100.00
e	-	1.54
n	-	0.61
A	-	19.59

Consistency**	**Soft**
Activity	**Active**
Plasticity Symbol	**MH or OH**

* Casagrande's Method

** Based on Consistency Index (Ic)



PARTNER FOR DESIGN

Classification Test

GEOMINE

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 03.40 - 03.80 m
Date Tested : 26/10/2021

Moisture Content

No. Test	1	2	3
No. Container	1125	1105	1146
Weight of Container	5.54	4.65	4.66
Weight of wet soil and container	144.48	152.82	141.02
Weight of dry soil and container	100.28	106.13	98.33
Moisture Content	46.65	46.01	45.57
Average MC	46.08		

Unit weight

No. Ring	16
No. Container	1149
Weight of Ring	26.86
Volume of Ring	15.216
Weight of Container	4.39
Weight of wet soil and ring and containe	61.59
Weight of dry soil and ring and containe	52.27
Water Content	44.339
Density	19.939
Dry Density	13.814
Saturation	100
Void ratio	1.5429
Porosity	0.6068

Specific Gravity

No. Test	1	2
No. Pycknometer	201	201
Weight of Pycknometer + soil	84.11	84.11
Weight of Pycknometer + water + soil	175.75	175.75
T° C	28	28
Weight of Pycknometer	52.92	52.92
Weight of Pycknometer + water	153.44	153.44
Specific Gravity	3.513	3.513
Average Specific Gravity	3.513	

Shrinkage Limit

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and container	-
Weight of dry soil and container	-
Weight of plate	-
Weight of plate and Mercury	-
Volume dry soil	-
Shrinkage Limit	-

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(03.40-03.80 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

GEOMINE

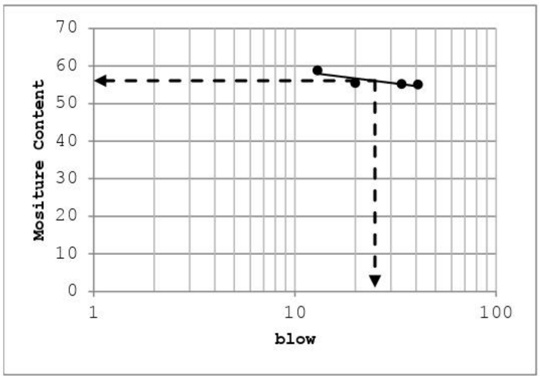
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 03.40 - 03.80 m
Date Tested : 26/10/2021

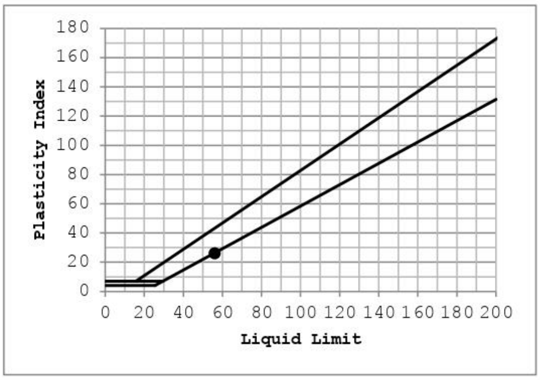
Plastic Limit

No. Test	1	2	3
No. Container	1012	1214	1240
Weight of Container	5.87	4.53	4.43
Weight of wet soil and container	14.55	14.67	13.96
Weight of dry soil and container	12.59	12.28	11.76
Plastic Limit	29.17	30.84	30.01
Average	30.01		

Liquid Limit

No. Test	1	2	3	4	5
No. Container	1120	1060	1001	1050	-
Weight of Container	4.96	5.61	5.89	5.77	-
Weight of wet soil and container	15.89	15.93	15.62	15.31	-
Weight of dry soil and container	12.01	12.26	12.15	11.78	-
Water Content	55.04	55.19	55.43	58.74	-
Number of blows	41	34	20	13	-
Liquid Limit	56.09				





Sieve Analysis

Bowl	0
Soil + Bowl	80.7
Weight of dry soil	80.7

Sieve No.	Sieve Diameter	Weight of Soil Retained	Percent Retained	Cumulative Percent Retained	Percent Finer
4	4.75	7.37	9.13	9.13	90.87
10	2	0.56	0.69	9.83	90.17
20	0.85	1.76	2.18	12.01	87.99
40	0.425	2.04	2.53	14.54	85.46
80	0.18	1.96	2.43	16.96	83.04
120	0.125	1.34	1.66	18.62	81.38
200	0.075	2.72	3.37	22.00	78.00
Pan	0	1.29	78.00	100	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(03.40-03.80 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 03.40 - 03.80 m

Date Tested : 26/10/2021

GEOMINE

Hydrometer

Dry Sample

Weight of sample	61.66		
Zerro correction	-1	Gs	3.5129
Meniscus correction	1	a	0.8704

Time	t (minute)	T (Co)	Ra	Diameter	Percent Finer
12:20	0				
12:21	1	26	44	0.0307	47.97
12:22	2	26	40	0.0226	43.86
12:24	4	26	33	0.0169	36.66
12:28	8	26	20	0.0131	23.29
12:35	15	26	2	0.0106	4.78
12:50	30	26	0	0.0076	2.73
13:05	45	0	0	0.0000	1.03
13:50	90	0	0	0.0000	1.03
15:20	180	0	0	0.0000	0.00
9:20	1260	0	0	0.0000	0.00
12:20	1440	0	0	0.0000	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(03.40-03.80 m)-Classification.xlsm

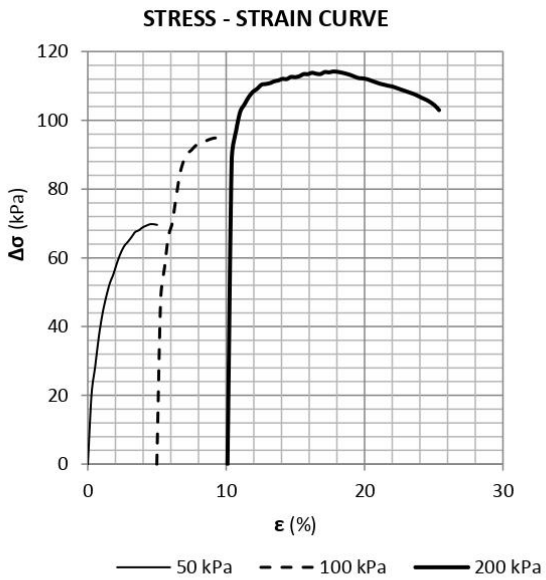
F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

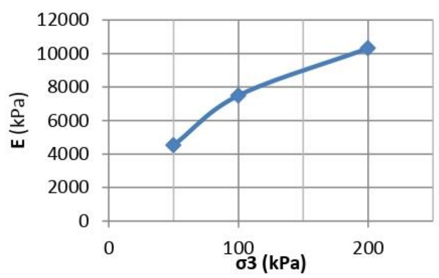
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 03.40 -03.80 m
Date Tested : 28/10/2021

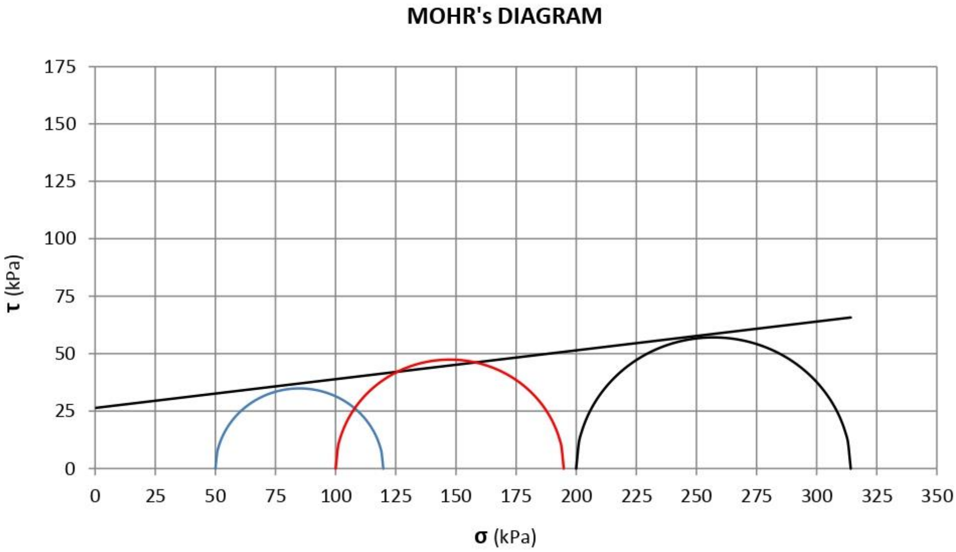
GEOMINE



No.	σ3 (kPa)	Δσ (kPa)	ε_f (%)
1.	50	69.79	4.74
2.	100	94.85	9.42
3.	200	114.19	17.74

Results		
c	kPa	26.4
ø	°	7.1





D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(03.40-03.80 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 03.40 -03.80 m
Date Tested : 28/10/2021

GEOMINE

Height of Sample: 76 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
0	0	0
20	20.25	0.26
40	28.33	0.53
60	37.02	0.79
80	43.67	1.05
100	48.54	1.32
120	52.52	1.58
140	55.21	1.84
160	58.52	2.11
180	61.34	2.37
200	63.44	2.63
220	64.67	2.89
240	66.05	3.16
260	67.5	3.42
280	68.01	3.68
300	68.82	3.95
320	69.33	4.21
340	69.75	4.47
360	69.79	4.74
380	69.6	5

Deviator Stress Maximum: 69.79 kPa
E_{0}: 3492.06 kPa
Strain at Failure: 5.00 %
E_{50}: 2589.87 kPa
Deviator Stress at (50%): 61.34 kPa
Strain at (50%): 2.37 %

+ + + + + + + + + STAGE - 1 + + + + + + + + +

Height of Sample: 72.2 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
360	0	4.99
380	47.89	5.26
400	57.07	5.54
420	66.12	5.82
440	70.07	6.09
460	77.38	6.37
480	84.27	6.65
500	88.2	6.93

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(03.40-03.80 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 03.40 -03.80 m
Date Tested : 28/10/2021

GEOMINE

520	90.32	7.2
540	91.31	7.48
560	92.52	7.76
580	93.2	8.03
600	93.43	8.31
620	94.11	8.59
640	94.55	8.86
660	94.85	9.14
680	94.85	9.42

Deviator Stress Maximum: 94.85 kPa $E_{o:}$ 4770.44 kPa
Strain at Failure: 9.42 % E_{50}: 1254.05 kPa
Deviator Stress at (50%): 90.32 kPa
Strain at (50%): 7.20 %

+ + + + + + + + + STAGE - 2 + + + + + + + + +

Height of Sample: 65.4 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
660	0	10.09
680	88.79	10.4
700	96.73	10.7
720	102.47	11.01
740	104.6	11.31
760	106.73	11.62
780	108.26	11.93
800	109.16	12.23
820	110.32	12.54
840	110.56	12.84
860	110.8	13.15
880	111.32	13.46
900	111.61	13.76
920	112.05	14.07
940	111.99	14.37
960	112.62	14.68
980	112.56	14.98
1000	112.83	15.29
1020	113.44	15.6
1040	113.43	15.9
1060	113.83	16.21
1080	113.55	16.51
1100	113.46	16.82
1120	114.04	17.13
1140	113.95	17.43
1160	114.19	17.74
1180	114.1	18.04

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(03.40-03.80 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 03.40 -03.80 m
Date Tested : 28/10/2021

GEOMINE

1200	113.87	18.35
1220	113.57	18.65
1240	113.21	18.96
1260	112.72	19.27
1280	112.29	19.57
1300	112.18	19.88
1320	111.95	20.18
1340	111.52	20.49
1360	111.09	20.8
1380	110.66	21.1
1400	110.36	21.41
1420	110.06	21.71
1440	109.81	22.02
1460	109.38	22.32
1480	108.95	22.63
1500	108.52	22.94
1520	108.09	23.24
1540	107.66	23.55
1560	107.11	23.85
1580	106.49	24.16
1600	105.94	24.46
1620	105.21	24.77
1640	104.3	25.08
1660	102.98	25.38

Deviator Stress Maximum: 114.19 kPa E_{0}: 1393.35 kPa
Strain at Failure: 25.38 % E_{50}: 643.81 kPa
Deviator Stress at (50%): 114.19 kPa
Strain at (50%): 17.74 %

+ + + + + + + + + STAGE - 3 + + + + + + + + +

No. Container : 1120
Wet Soil + Container : 169.35 gram
Dry Soil + Container : 117.39 gram
Weight of Container : 4.96 gram
Density : 19.07 kN/m3
Moisture Content : 46.22 %
Dry Density : 13.04 kN/m3

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(03.40-03.80 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

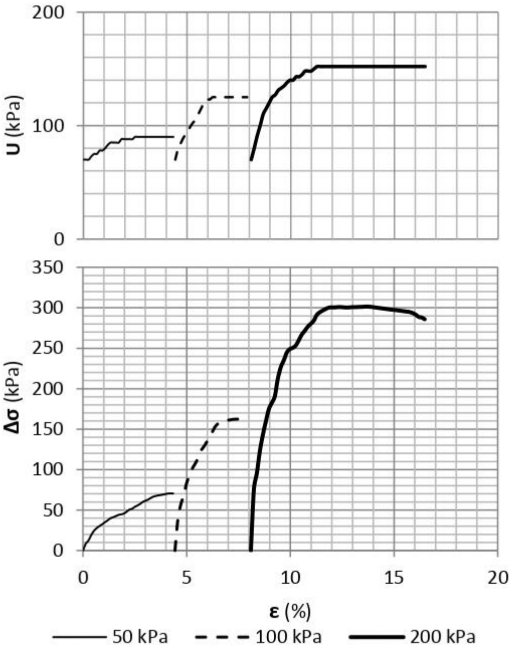
PARTNER FOR DESIGN

Triaxial Consolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 04.30 - 04.70 m
Date Tested : 2/11/2021

GEOMINE

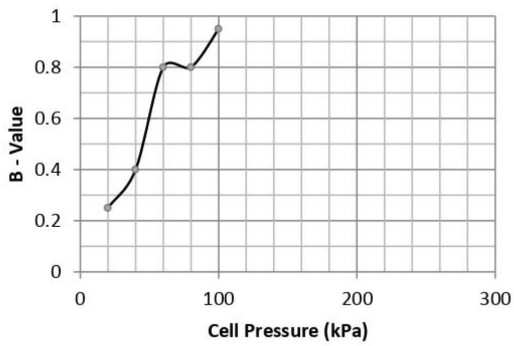
PWP-STRAIN AND STRESS-STRAIN CURVE



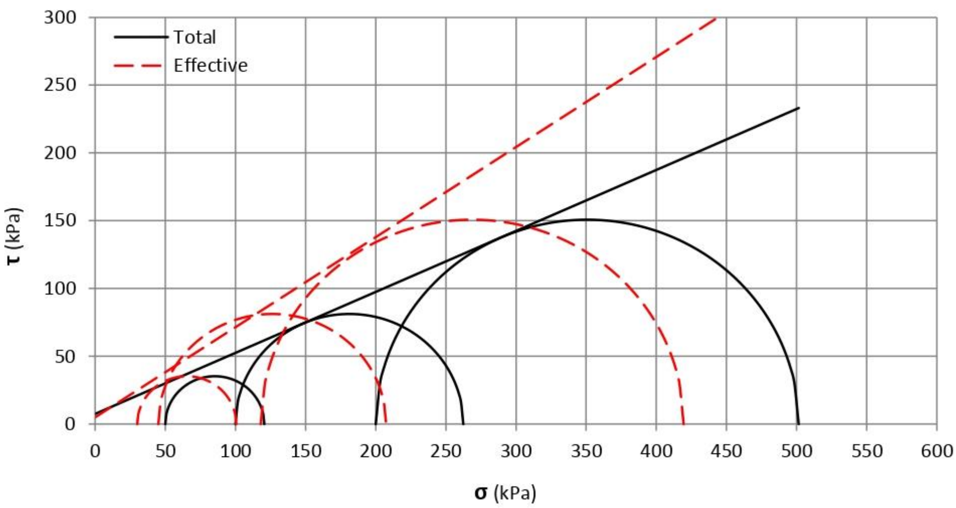
No.	σ3 (kPa)	σ1 (kPa)	σ3' (kPa)	σ1' (kPa)	Δσ (kPa)	U (kPa)
1.	50	121	30	101	71	90
2.	100	262	45	207	162	125
3.	200	501	118	419	301	152

Results		Total	Effective
c	kPa	7.5	5.0
ø	°	24.2	33.6

SATURATION BUILD - UP



MOHR's DIAGRAM



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(04.30-04.70 m)-TX CU.xlsm

F GWL OL 009; R 08-(6/09/18)

PARTNER FOR DESIGN

Triaxial Consolidated Undrained Test

GEOMINE

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 04.30 - 04.70 m
Date Tested : 2/11/2021

Height of Sample: 76.00 mm
Diameter of Sample: 38.00 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

Cell Pressure: 120 kPa
Back Pressure: 70 kPa
Effective Pressure: 50 kPa

--- TRIAXIAL S A T U R A T I O N ---

CP (kPa)	BP (kPa)	PWP (kPa)	B Value -
0	0	0	0
20		5	0.25
	10	10	
40		18	0.4
	30	22	
60		38	0.8
	50	42	
80		58	0.8
	70	62	
100		81	0.95

--- TRIAXIAL C O N S O L I D A T I O N ---

Cell Pressure	120	kPa
Back Pressure	70	kPa
PWP bulit up	0	kPa
Effective Pressure	50	kPa
Different	30	kPa

tf: 48.7 minute
tfmin: 120.0 minute
Strain to Failure: 8.0%
Rate of Strain: 0.0507 mm/minute

mv: 0.46 m2/MN
Cv: 1.11 m2/year
k: 1.596E-10 m/s

t (minute)	√t (-)	PWP (kPa)	dPWP (kPa)	Dissipation (%)	Volume Change of BP (cm3)	dVolume (cm3)
0	0	100	0	0	34.8	0
1	1	95	5	16.7	34.6	0.2
4	2	90	10	33.3	34	0.8
9	3	83	17	56.7	33.7	1.1
16	4	75	25	83.3	33.5	1.3
25	5	72	28	93.3	33.2	1.6
36	6	70	30	100	33	1.8
49	7	70	30	100	33	1.8
64	8	70	30	100	33	1.8

--- TRIAXIAL S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)	U (kPa)	dU (kPa)	s1 (kPa)	s1' (kPa)	s3 (kPa)	s3' (kPa)
0	0	0	70	0	50	50	50	50
10	8.29	0.13	70	0	58.29	58.29	50	50
20	12.42	0.26	70	0	62.42	62.42	50	50
30	19.05	0.39	73	3	69.05	66.05	50	47
40	24.28	0.53	75	5	74.28	69.28	50	45
50	27.65	0.66	75	5	77.65	72.65	50	45
60	30.11	0.79	78	8	80.11	72.11	50	42

F GWL OL 009; R 08-(6/09/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(04.30-04.70 m)-TX CU.xlsm

PARTNER FOR DESIGN

Triaxial Consolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 04.30 - 04.70 m
Date Tested : 2/11/2021

GEOMINE

70	32.41	0.92	78	8	82.41	74.41	50	42
80	34.86	1.05	80	10	84.86	74.86	50	40
90	37.15	1.18	83	13	87.15	74.15	50	37
100	39.75	1.32	85	15	89.75	74.75	50	35
110	41.06	1.45	85	15	91.06	76.06	50	35
120	42.45	1.58	85	15	92.45	77.45	50	35
130	43.99	1.71	85	15	93.99	78.99	50	35
140	44.73	1.84	88	18	94.73	76.73	50	32
150	45.71	1.97	88	18	95.71	77.71	50	32
160	47.95	2.11	88	18	97.95	79.95	50	32
170	50.52	2.24	88	18	100.52	82.52	50	32
180	51.64	2.37	88	18	101.64	83.64	50	32
190	54.03	2.5	90	20	104.03	84.03	50	30
200	55.7	2.63	90	20	105.7	85.7	50	30
210	57.76	2.76	90	20	107.76	87.76	50	30
220	60.21	2.89	90	20	110.21	90.21	50	30
230	61.63	3.03	90	20	111.63	91.63	50	30
240	63.2	3.16	90	20	113.2	93.2	50	30
250	65.32	3.29	90	20	115.32	95.32	50	30
260	66.8	3.42	90	20	116.8	96.8	50	30
270	67.65	3.55	90	20	117.65	97.65	50	30
280	68.26	3.68	90	20	118.26	98.26	50	30
290	68.87	3.82	90	20	118.87	98.87	50	30
300	69.56	3.95	90	20	119.56	99.56	50	30
310	70.33	4.08	90	20	120.33	100.33	50	30
320	70.54	4.21	90	20	120.54	100.54	50	30
330	70.44	4.34	90	20	120.44	100.44	50	30

Deviator Stress Maximum: 70.54 kPa
Strain at Failure: 4.21 %
Deviator Stress at (50%): 47.95 kPa
Strain at (50%): 2.11 %

E_o: 4187 kPa
E_{50}: 2278 kPa

+ + + + + + + + + STAGE - 1 + + + + + + + + +

Height of Sample: 72.17 mm
Diameter of Sample: 38.58 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

Cell Pressure: 170 kPa
Back Pressure: 70 kPa
Effective Pressure: 100 kPa

--- TRIAXIAL S A T U R A T I O N ---

CP	BP	PWP	B Value
(kPa)	(kPa)	(kPa)	-
0	0	0	0

--- TRIAXIAL C O N S O L I D A T I O N ---

Cell Pressure	170	kPa	tf: 98.3 minute	mv: 0.18 m2/MN
Back Pressure	70	kPa	tfmin: 120.0 minute	Cv: 0.55 m2/year
PWP bulit up	0	kPa	Strain to Failure: 8.0%	k: 3.049E-11 m/s
Effective Pressure	100	kPa	Rate of Strain: 0.0481 mm/minute	
Different	75	kPa		

F GWL OL 009; R 08-(6/09/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(04.30-04.70 m)-TX CU.xlsm

PARTNER FOR DESIGN

Triaxial Consolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 04.30 - 04.70 m
Date Tested : 2/11/2021

GEOMINE

t	√t	PWP	dPWP	Dissipation	Volume Change of BP	dVolume
(minute)	(-)	(kPa)	(kPa)	(%)	(cm3)	(cm3)
0	0	145	0	0	33	0
1	1	138	7	9.3	32.8	0.2
4	2	125	20	26.7	32.5	0.5
9	3	115	30	40	32.3	0.7
16	4	100	45	60	32.1	0.9
25	5	90	55	73.3	31.8	1.2
36	6	81	64	85.3	31.5	1.5
49	7	75	70	93.3	31.4	1.6
64	8	70	75	100	31.3	1.7
81	9	70	75	100	31.3	1.7
100	10	70	75	100	31.3	1.7

--- TRIAXIAL S H E A R I N G ---

Strain Gauge	Deviator Stress	Strain	U	dU	s1	s1'	s3	s3'
(div)	(kPa)	(%)	(kPa)	(kPa)	(kPa)	(kPa)	(kPa)	(kPa)
320	0	4.43	70	0	100	100	100	100
330	37.87	4.57	80	10	137.87	127.87	100	90
340	56.39	4.71	85	15	156.39	141.39	100	85
350	67.56	4.85	90	20	167.56	147.56	100	80
360	82.46	4.99	93	23	182.46	159.46	100	77
370	92.47	5.13	98	28	192.47	164.47	100	72
380	101.05	5.27	102	32	201.05	169.05	100	68
390	107.1	5.4	105	35	207.1	172.1	100	65
400	114.02	5.54	110	40	214.02	174.02	100	60
410	123.01	5.68	115	45	223.01	178.01	100	55
420	128.18	5.82	120	50	228.18	178.18	100	50
430	133.78	5.96	123	53	233.78	180.78	100	47
440	140.92	6.1	123	53	240.92	187.92	100	47
450	146.55	6.24	125	55	246.55	191.55	100	45
460	153.13	6.37	125	55	253.13	198.13	100	45
470	156.74	6.51	125	55	256.74	201.74	100	45
480	158.35	6.65	125	55	258.35	203.35	100	45
490	160.54	6.79	125	55	260.54	205.54	100	45
500	161.04	6.93	125	55	261.04	206.04	100	45
510	161.31	7.07	125	55	261.31	206.31	100	45
520	162.02	7.21	125	55	262.02	207.02	100	45
530	162.29	7.34	125	55	262.29	207.29	100	45
540	162.41	7.48	125	55	262.41	207.41	100	45
550	162.39	7.62	125	55	262.39	207.39	100	45
560	162.15	7.76	125	55	262.15	207.15	100	45
570	162.05	7.9	125	55	262.05	207.05	100	45

Deviator Stress Maximum: 162.41 kPa
Strain at Failure: 7.48 %
Deviator Stress at (50%): 133.78 kPa
Strain at (50%): 5.96 %

E_o: 12523 kPa
E_{50}: 2245 kPa

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(04.30-04.70 m)-TX CU.xlsm

F GWL OL 009; R 08-(6/09/18)

PARTNER FOR DESIGN

Triaxial Consolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 04.30 - 04.70 m
Date Tested : 2/11/2021

GEOMINE

+ + + + + + + + + STAGE - 2 + + + + + + + + +

Height of Sample: 69.19 mm
Diameter of Sample: 39.93 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

Cell Pressure: 270 kPa
Back Pressure: 70 kPa
Effective Pressure: 200 kPa

--- TRIAXIAL S A T U R A T I O N ---

CP	BP	PWP	B Value
(kPa)	(kPa)	(kPa)	-
0	0	0	0

--- TRIAXIAL C O N S O L I D A T I O N ---

Cell Pressure	270	kPa
Back Pressure	70	kPa
PWP bulit up	0	kPa
Effective Pressure	200	kPa
Different	140	kPa

tf: 68.7 minute
tfmin: 120.0 minute
Strain to Failure: 8.0%
Rate of Strain: 0.0461 mm/minute

mv: 0.16 m2/MN
Cv: 0.79 m2/year
k: 3.881E-11 m/s

t	√t	PWP	dPWP	Dissipation	Volume Change of BP	dVolume
(minute)	(-)	(kPa)	(kPa)	(%)	(cm3)	(cm3)
0	0	210	0	0	31.3	0
1	1	190	20	14.3	31	0.3
4	2	170	40	28.6	30.5	0.8
9	3	155	55	39.3	30.1	1.2
16	4	140	70	50	29.7	1.6
25	5	122	88	62.9	29.5	1.8
36	6	110	100	71.4	29.3	2
49	7	90	120	85.7	29.1	2.2
64	8	80	130	92.9	28.9	2.4
81	9	75	135	96.4	28.7	2.6
100	10	75	135	96.4	28.7	2.6
121	11	75	135	96.4	28.7	2.6
144	12	75	135	96.4	28.7	2.6
169	13	75	135	96.4	28.7	2.6
196	14	75	135	96.4	28.7	2.6
225	15	75	135	96.4	28.7	2.6
1440	37.947	70	140	100	28.4	2.9

--- TRIAXIAL S H E A R I N G ---

Strain Gauge	Deviator Stress	Strain	U	dU	s1	s1'	s3	s3'
(div)	(kPa)	(%)	(kPa)	(kPa)	(kPa)	(kPa)	(kPa)	(kPa)
560	0	8.09	70	0	200	200	200	200
570	75.23	8.24	80	10	275.23	265.23	200	190
580	95.47	8.38	91	21	295.47	274.47	200	179
590	122.72	8.53	100	30	322.72	292.72	200	170
600	142.75	8.67	110	40	342.75	302.75	200	160
610	159.4	8.82	115	45	359.4	314.4	200	155
620	174.64	8.96	120	50	374.64	324.64	200	150

F GWL OL 009; R 08-(6/09/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(04.30-04.70 m)-TX CU.xlsm

PARTNER FOR DESIGN

Triaxial Consolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 04.30 - 04.70 m
Date Tested : 2/11/2021

GEOMINE

630	182.47	9.11	125	55	382.47	327.47	200	145
640	190.55	9.25	127	57	390.55	333.55	200	143
650	212.26	9.39	131	61	412.26	351.26	200	139
660	226.72	9.54	133	63	426.72	363.72	200	137
670	235.08	9.68	135	65	435.08	370.08	200	135
680	244.69	9.83	138	68	444.69	376.69	200	132
690	248.98	9.97	140	70	448.98	378.98	200	130
700	250.52	10.12	140	70	450.52	380.52	200	130
710	253.45	10.26	143	73	453.45	380.45	200	127
720	259.9	10.41	143	73	459.9	386.9	200	127
730	266.93	10.55	145	75	466.93	391.93	200	125
740	271.61	10.7	148	78	471.61	393.61	200	122
750	276.67	10.84	148	78	476.67	398.67	200	122
760	280.19	10.98	148	78	480.19	402.19	200	122
770	284.1	11.13	150	80	484.1	404.1	200	120
780	291.15	11.27	152	82	491.15	409.15	200	118
790	294.43	11.42	152	82	494.43	412.43	200	118
800	296.64	11.56	152	82	496.64	414.64	200	118
810	298.59	11.71	152	82	498.59	416.59	200	118
820	300.2	11.85	152	82	500.2	418.2	200	118
830	300.55	12	152	82	500.55	418.55	200	118
840	300.45	12.14	152	82	500.45	418.45	200	118
850	300.87	12.29	152	82	500.87	418.87	200	118
860	300.9	12.43	152	82	500.9	418.9	200	118
870	300.53	12.57	152	82	500.53	418.53	200	118
880	300.36	12.72	152	82	500.36	418.36	200	118
890	300.51	12.86	152	82	500.51	418.51	200	118
900	300.85	13.01	152	82	500.85	418.85	200	118
910	300.8	13.15	152	82	500.8	418.8	200	118
920	301.07	13.3	152	82	501.07	419.07	200	118
930	301.15	13.44	152	82	501.15	419.15	200	118
940	301.42	13.59	152	82	501.42	419.42	200	118
950	301.49	13.73	152	82	501.49	419.49	200	118
960	301.18	13.88	152	82	501.18	419.18	200	118
970	300.67	14.02	152	82	500.67	418.67	200	118
980	300.17	14.16	152	82	500.17	418.17	200	118
990	299.66	14.31	152	82	499.66	417.66	200	118
1000	299.16	14.45	152	82	499.16	417.16	200	118
1010	298.65	14.6	152	82	498.65	416.65	200	118
1020	298.15	14.74	152	82	498.15	416.15	200	118
1030	297.64	14.89	152	82	497.64	415.64	200	118
1040	297.32	15.03	152	82	497.32	415.32	200	118
1050	296.82	15.18	152	82	496.82	414.82	200	118
1060	296.31	15.32	152	82	496.31	414.31	200	118
1070	295.81	15.47	152	82	495.81	413.81	200	118
1080	295.3	15.61	152	82	495.3	413.3	200	118
1090	294.79	15.75	152	82	494.79	412.79	200	118
1100	293.48	15.9	152	82	493.48	411.48	200	118
1110	291.54	16.04	152	82	491.54	409.54	200	118
1120	288.73	16.19	152	82	488.73	406.73	200	118

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(04.30-04.70 m)-TX CU.xlsm

F GWL OL 009; R 08-(6/09/18)

PARTNER FOR DESIGN

Triaxial Consolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 04.30 - 04.70 m
Date Tested : 2/11/2021

GEOMINE

1130	287.98	16.33	152	82	487.98	405.98	200	118
1140	285.87	16.48	152	82	485.87	403.87	200	118

Deviator Stress Maximum: 301.49 kPa
Strain at Failure: 13.73 %
Deviator Stress at (50%): 276.67 kPa
Strain at (50%): 10.84 %

E_o: 20298 kPa
E_{50}: 2552 kPa

+ + + + + + + + + STAGE - 3 + + + + + + + + +

Weight of Sample: 160.93 gram

No. Container: 1133
Wet Soil + Container: 157.88 gram
Dry Soil + Container: 113.38 gram
Weight of Container: 4.55 gram

Density initial: 18.67 kN/m3
Moisture Content initial: 39.51 %
Dry Density initial: 13.38 kN/m3

Density after: 17.79 kN/m3
Moisture Content after: 40.89 %
Dry Density after: 12.63 kN/m3

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(04.30-04.70 m)-TX CU.xlsm

F GWL OL 009; R 08-(6/09/18)

PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 02
Depth : 09.78 - 09.88 m
Date Tested : 4/11/2021

GEOMINE

Result		
Natural Density	kN/m^3	22.36
Dry Density	kN/m^3	20.35
Saturated Density	kN/m^3	22.70
Spesific Gravity	-	2.66
Natural Water Content	%	10
Absorption	%	12
Saturation	%	0.23
Porosity	-	0.23
Void Ratio	-	0.31

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(09.78-09.88 m)-Properties (Rock).xlsm

F GWL OL 026; R 04-(10/7/21)

PARTNER FOR DESIGN

Uniaxial Compressive Strength Test (v)

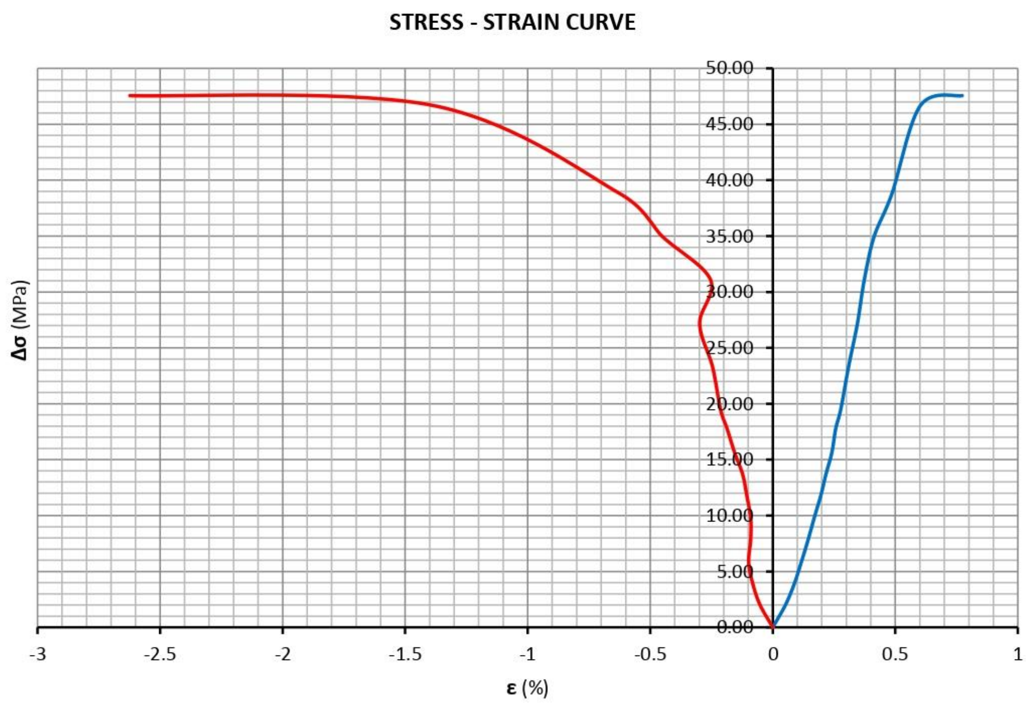
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 02
Depth : 11.70 - 12.00 m

Date Tested : 3/11/2021

GEOMINE

Results		
σ_{max*}	MPa	47.56
v	-	0.25
E	MPa	5821

* Coreccted by Hoek and Brown (1980a)



PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 02
Depth : 12.00 - 12.20 m
Date Tested : 4/11/2021

GEOMINE

Result		
Natural Density	kN/m^3	23.96
Dry Density	kN/m^3	22.89
Saturated Density	kN/m^3	24.27
Spesific Gravity	-	2.65
Natural Water Content	%	5
Absorption	%	6
Saturation	%	0.14
Porosity	-	0.14
Void Ratio	-	0.16

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 02-(12.00-12.20 m)-Properties (Rock).xlsm

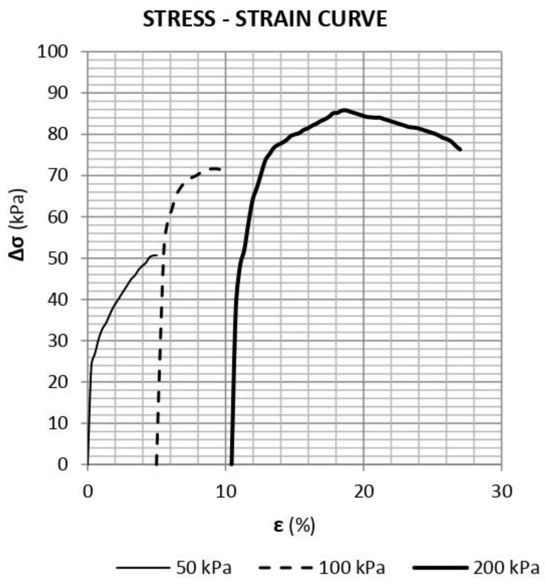
F GWL OL 026; R 04-(10/7/21)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

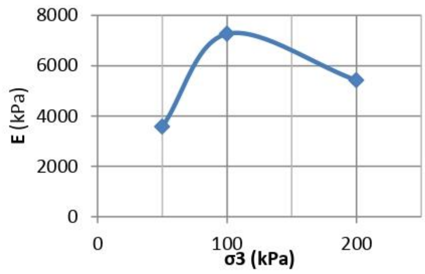
GEOMINE

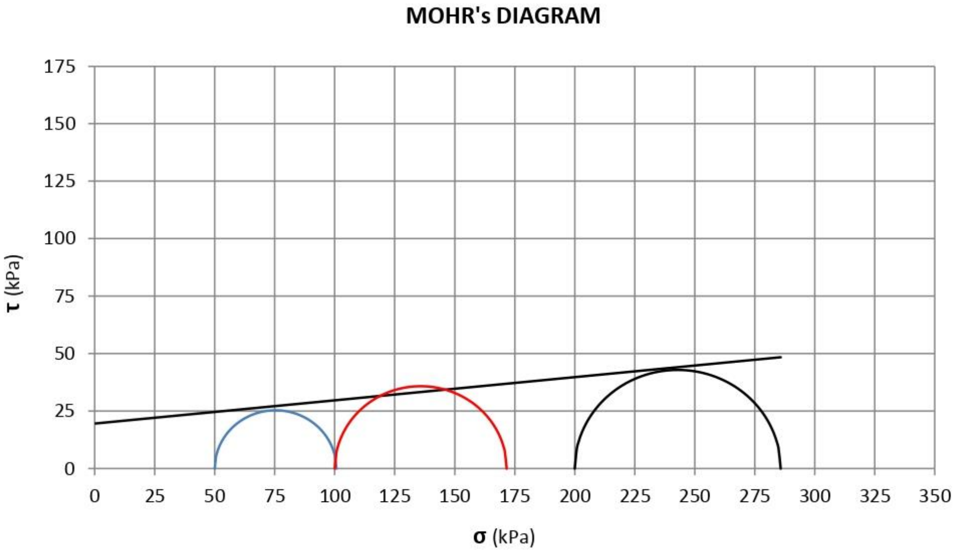
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021



No.	σ3 (kPa)	Δσ (kPa)	ε_f (%)
1.	50	50.67	5.00
2.	100	71.63	9.14
3.	200	85.81	18.71

Results		
c	kPa	19.6
ø	°	5.8





D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021

GEOMINE

Height of Sample: 76 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.11567 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
0	0	0
20	23.9	0.26
40	26.89	0.53
60	30.36	0.79
80	32.8	1.05
100	34.22	1.32
120	36.14	1.58
140	38.04	1.84
160	39.44	2.11
180	40.83	2.37
200	42.21	2.63
220	43.58	2.89
240	44.94	3.16
260	45.8	3.42
280	47.15	3.68
300	48.1	3.95
320	48.85	4.21
340	50.18	4.47
360	50.62	4.74
380	50.67	5

Deviator Stress Maximum: 50.67 kPa E_{0}: 2185.05 kPa
Strain at Failure: 5.00 % E_{50}: 1723.77 kPa
Deviator Stress at (50%): 40.83 kPa
Strain at (50%): 2.37 %

+ + + + + + + + + STAGE - 1 + + + + + + + + +

Height of Sample: 72.2 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.11567 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
360	0	4.99
380	28.99	5.26
400	52.99	5.54
420	59.08	5.82
440	61.78	6.09
460	64.94	6.37
480	66.65	6.65
500	67.87	6.93

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(02.60-03.00 m)-TX UU.xlsm
F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021

GEOMINE

520	68.14	7.2
540	69.36	7.48
560	69.81	7.76
580	70.35	8.03
600	71.07	8.31
620	71.32	8.59
640	71.57	8.86
660	71.63	9.14
680	71.6	9.42
700	71.38	9.7

Deviator Stress Maximum: 71.63 kPa — E_{o}: 4426.18 kPa
Strain at Failure: 9.70 % — E_{50}: 946.17 kPa
Deviator Stress at (50%): 68.14 kPa
Strain at (50%): 7.20 %

\+ + + + + + + + + STAGE - 2 + + + + + + + + +

Height of Sample: 65.2 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.11567 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
680	0	10.43
700	37.78	10.74
720	48.09	11.04
740	51.99	11.35
760	58.57	11.66
780	64.2	11.96
800	67.11	12.27
820	70.53	12.58
840	73.75	12.88
860	75.26	13.19
880	76.76	13.5
900	77.45	13.8
920	77.96	14.11
940	78.65	14.42
960	79.58	14.72
980	79.99	15.03
1000	80.3	15.34
1020	81.05	15.64
1040	81.44	15.95
1060	82.08	16.26
1080	82.54	16.56
1100	83.17	16.87
1120	83.63	17.18
1140	84.24	17.48
1160	85.1	17.79
1180	85.2	18.1

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021

GEOMINE

1200	85.72	18.4
1220	85.81	18.71
1240	85.49	19.02
1260	85.16	19.33
1280	84.84	19.63
1300	84.51	19.94
1320	84.19	20.25
1340	84.11	20.55
1360	84.03	20.86
1380	84.02	21.17
1400	83.7	21.47
1420	83.37	21.78
1440	83.04	22.09
1460	82.71	22.39
1480	82.39	22.7
1500	82.06	23.01
1520	81.73	23.31
1540	81.64	23.62
1560	81.47	23.93
1580	81.14	24.23
1600	80.81	24.54
1620	80.48	24.85
1640	80.15	25.15
1660	79.67	25.46
1680	79.12	25.77
1700	78.79	26.07
1720	78.16	26.38
1740	77.17	26.69
1760	76.32	26.99

Deviator Stress Maximum: 85.81 kPa E_{o}: 1323.57 kPa
Strain at Failure: 26.99 % E_{50}: 458.59 kPa
Deviator Stress at (50%): 85.81 kPa
Strain at (50%): 18.71 %

+ + + + + + + + + STAGE - 3 + + + + + + + + +

No. Container : 1216
Wet Soil + Container : 164.92 gram
Dry Soil + Container : 113.64 gram
Weight of Container : 4.6 gram
Density : 18.60 kN/m3
Moisture Content : 47.03 %
Dry Density : 12.65 kN/m3

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 06.60 - 07.00 m

Date Tested : 26/10/2021

GEOMINE

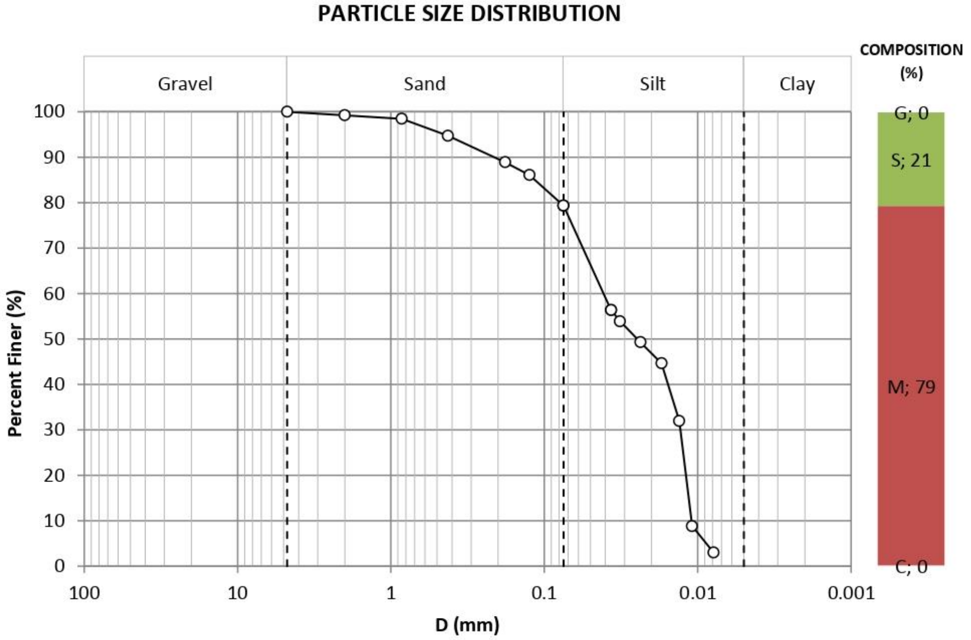
Test		Results
Unit Weight	kN/m^3	22.3
SL	%	-
Gs	-	3.30
MC	%	61
PL	%	41
LL	%	65
PI	%	24
Fines (#200)	%	79
D_{10}	mm	0.0110
D_{30}	mm	0.0130
D_{60}	mm	0.0410
C_u	-	4
C_c	-	0.37

* Casagrande's Method

** Based on Consistency Index (Ic)

Properties		Results
I_F	%	-0.22
I_T	%	-109.14
I_L	%	0.82
I_C	%	0.18
S_r	%	100.00
e	-	1.81
n	-	0.64
A	-	16.24

Consistency**	**Very Soft**
Activity	**Active**
Plasticity Symbol	**MH or OH**



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(06.60-07.00 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 06.60 - 07.00 m

Date Tested : 26/10/2021

GEOMINE

Moisture Content

No. Test	1	2	3
No. Container	1149	1240	1129
Weight of Container	4.39	4.43	4.56
Weight of wet soil and container	119.39	109.80	111.29
Weight of dry soil and container	75.46	70.18	71.31
Moisture Content	61.81	60.26	59.90
Average MC	60.66		

Unit weight

No. Ring	5
No. Container	1214
Weight of Ring	27.63
Volume of Ring	15.669
Weight of Container	4.53
Weight of wet soil and ring and containe	67.17
Weight of dry soil and ring and containe	50.6
Water Content	89.859
Density	22.343
Dry Density	11.768
Saturation	100
Void ratio	1.8069
Porosity	0.6437

Specific Gravity

No. Test	1	2
No. Pycknometer	203	203
Weight of Pycknometer + soil	76.13	76.13
Weight of Pycknometer + water + soil	167.52	167.52
T° C	26	26
Weight of Pycknometer	54.5	54.5
Weight of Pycknometer + water	152.44	152.44
Specific Gravity	3.303	3.303
Average Specific Gravity	3.303	

Shrinkage Limit

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and container	-
Weight of dry soil and container	-
Weight of plate	-
Weight of plate and Mercury	-
Volume dry soil	-
Shrinkage Limit	-

F GWL OL 001; R 12-(17/10/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(06.60-07.00 m)-Classification.xlsm

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 06.60 - 07.00 m
Date Tested : 26/10/2021

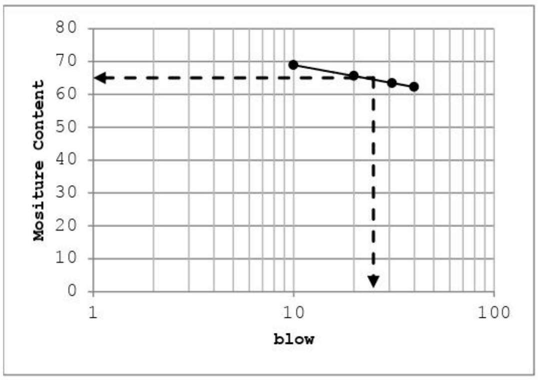
GEOMINE

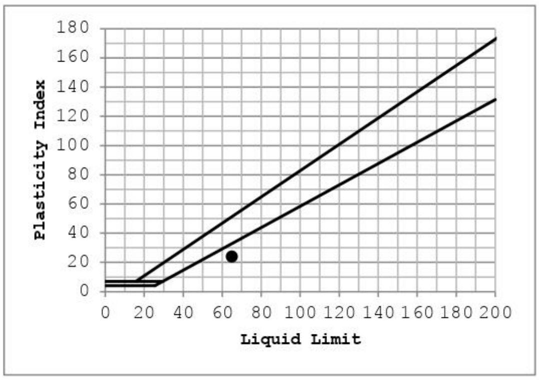
Plastic Limit

No. Test	1	2	3
No. Container	1047	1056	1213
Weight of Container	5.46	5.99	4.54
Weight of wet soil and container	13.26	13.85	13.77
Weight of dry soil and container	11.08	11.5	11.06
Plastic Limit	38.79	42.65	41.56
Average	41.00		

Liquid Limit

No. Test	1	2	3	4	5
No. Container	1115	1144	1064	1203	-
Weight of Container	4.76	4.45	4.83	4.46	-
Weight of wet soil and container	16.8	16.74	16.54	16.2	-
Weight of dry soil and container	12.18	11.97	11.9	11.41	-
Water Content	62.26	63.43	65.63	68.92	-
Number of blows	40	31	20	10	-
Liquid Limit	65.04				





Sieve Analysis

Bowl	0
Soil + Bowl	80.57
Weight of dry soil	80.57

Sieve No.	Sieve Diameter	Weight of Soil Retained	Percent Retained	Cumulative Percent Retained	Percent Finer
4	4.75	0.001	0.00	0.00	100.00
10	2	0.62	0.77	0.77	99.23
20	0.85	0.62	0.77	1.54	98.46
40	0.425	3	3.72	5.26	94.74
80	0.18	4.69	5.82	11.08	88.92
120	0.125	2.28	2.83	13.91	86.09
200	0.075	5.42	6.73	20.64	79.36
Pan	0	1.62	79.36	100	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(06.60-07.00 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 06.60 - 07.00 m

Date Tested : 26/10/2021

GEOMINE

Hydrometer

Dry Sample

Weight of sample	62.319		
Zerro correction	-1	Gs	3.3032
Meniscus correction	1	a	0.893

Time	t (minute)	T (Co)	Ra	Diameter	Percent Finer
12:20	0				
12:21	1	26	44	0.0321	53.92
12:22	2	26	40	0.0236	49.30
12:24	4	26	36	0.0172	44.68
12:28	8	26	25	0.0132	31.96
12:35	15	26	5	0.0109	8.84
12:50	30	26	0	0.0079	3.06
13:05	45	0	0	0.0000	1.16
13:50	90	0	0	0.0000	1.16
15:20	180	0	0	0.0000	0.00
9:20	1260	0	0	0.0000	0.00
12:20	1440	0	0	0.0000	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(06.60-07.00 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Falling Head

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 06.60 -07.00 m
Date Tested : 27/10/2021

GEOMINE

Time (minute)	Volume (cm3)	delta time (minute)	delta volume (cm3)
0	7.7	0	0
30	8	30	0.3
80	8.4	50	0.4
140	8.9	60	0.5
210	9.5	70	0.6
288	10	78	0.5
348	10.4	60	0.4
400	10.7	52	0.3

t-sample (cm): 6.60
Area-sample (cm2): 11.34
Head (cm): 50

k (cm/s): 1.505E-06

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(06.60-07.00 m)-Falling Head.xlsm

F GWL OL 040; R 01-(6/12/18)

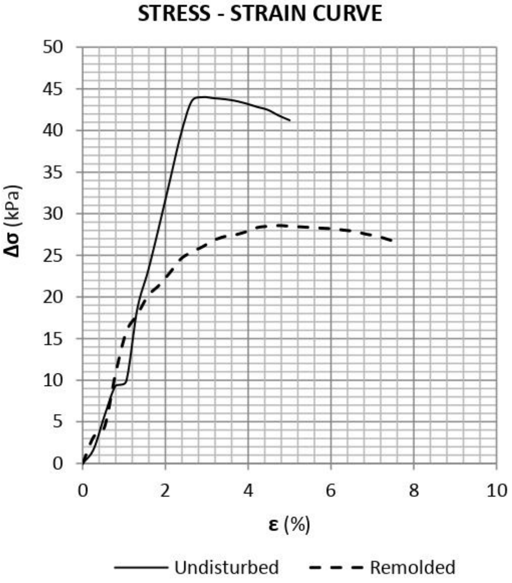
PARTNER FOR DESIGN

Unconfined Compression Test

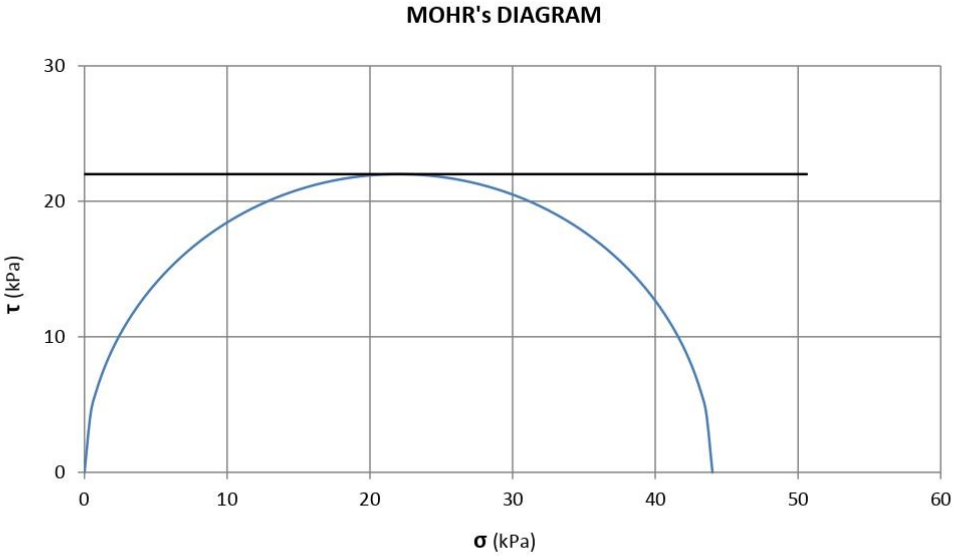
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 12.20 - 12.45 m

Date Tested : 29/10/2021

GEOMINE



Results		Undisturbed	Remolded
σ_{max}	kPa	44.0	28.6
ε_f	%	2.89	4.74
S_t	-	1.54	
c	kPa	22.0	14.3
E_{50}	kPa	1464	1356
E_{sec}	kPa	1520	603



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(12.20-12.45 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Unconfined Compression Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 12.20 - 12.45 m

Date Tested : 29/10/2021

GEOMINE

Undisturbed

Height of Sample : 76 mm
Diameter of Sample : 38 mm
Calibration Dial Gauge : 0.04826 kg/div
Calibration Strain Load : 0.01 mm/div

Water Content : 103.66 %
Unit Weight : 11.48 kN/m3
Dry Density : 5.64 kN/m3

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)	Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
0	0.00	0.0000	-	-	-
20	1.70	0.2632			
40	5.71	0.5263			
60	9.29	0.7895			
80	9.89	1.0526			
100	18.48	1.3158			
120	23.12	1.5789			
140	28.40	1.8421			
160	33.95	2.1053			
180	39.47	2.3684			
200	43.50	2.6316			
220	44.01	2.8947			
240	43.89	3.1579			
260	43.77	3.4211			
280	43.57	3.6842			
300	43.24	3.9474			
320	42.84	4.2105			
340	42.48	4.4737			
360	41.79	4.7368			
380	41.23	5.0000			

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(12.20-12.45 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Unconfined Compression Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 12.20 - 12.45 m

Date Tested : 29/10/2021

GEOMINE

Remolded

Height of Sample : 76 mm
Diameter of Sample : 38 mm
Calibration Dial Gauge : 0.04826 kg/div
Calibration Strain Load : 0.01 mm/div

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)	Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
0	0	0.0000	-	-	-
20	3.18	0.2632			
40	4.36	0.5263			
60	10.68	0.7895			
80	15.79	1.0526			
100	17.85	1.3158			
120	20.14	1.5789			
140	21.39	1.8421			
160	22.91	2.1053			
180	24.55	2.3684			
200	25.40	2.6316			
220	26.03	2.8947			
240	26.79	3.1579			
260	27.25	3.4211			
280	27.46	3.6842			
300	27.83	3.9474			
320	28.33	4.2105			
340	28.50	4.4737			
360	28.58	4.7368			
380	28.50	5.0000			
400	28.42	5.2632			
420	28.34	5.5263			
440	28.26	5.7895			
460	28.18	6.0526			
480	28.03	6.3158			
500	27.87	6.5789			
520	27.55	6.8421			
540	27.31	7.1053			
560	26.92	7.3684			
580	26.53	7.6316			

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(12.20-12.45 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 03
Depth : 13.10 - 13.35 m
Date Tested : 25/10/2021

GEOMINE

Result		
Natural Density	kN/m^3	10.23
Dry Density	kN/m^3	4.53
Saturated Density	kN/m^3	12.07
Spesific Gravity	-	1.84
Natural Water Content	%	56
Absorption	%	166
Saturation	%	0.75
Porosity	-	0.75
Void Ratio	-	3.06

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(13.10-13.35 m)-Properties (Rock).xlsm

F GWL OL 026; R 04-(10/7/21)

PARTNER FOR DESIGN

Uniaxial Compressive Strength Test (v)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 03
Depth : 28.30 - 28.45 m

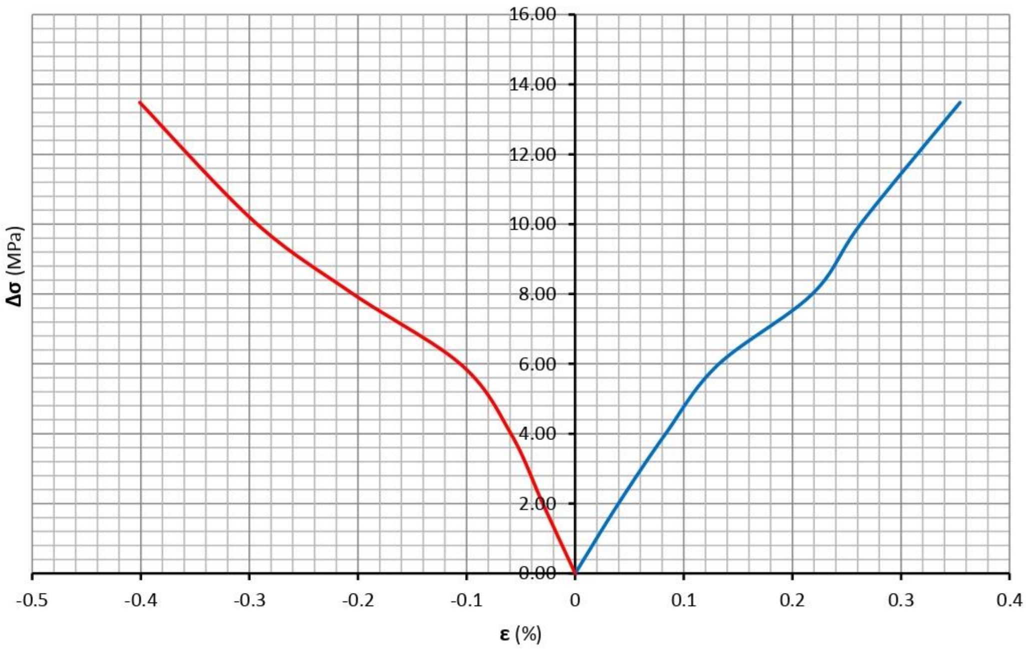
Date Tested : 3/11/2021

GEOMINE

Results		
σ_{max*}	MPa	13.48
v	-	0.43
E	MPa	2889

* Coreccted by Hoek and Brown (1980a)

STRESS - STRAIN CURVE



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 03-(28.30-28.45 m)-UCS (Poisson).xlsm

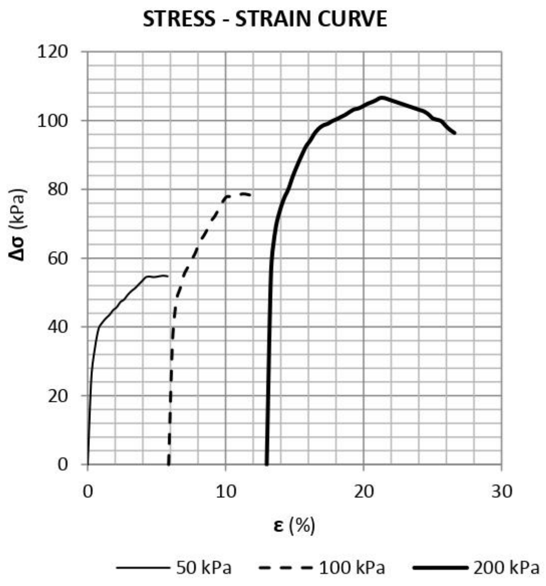
F GWL OL 033; R 01-(22/09/14)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

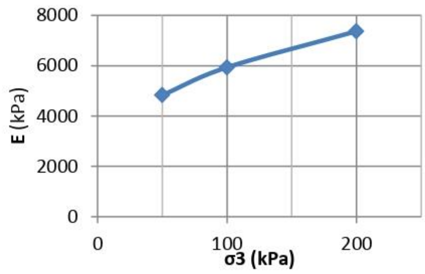
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 05.00 -05.40 m
Date Tested : 28/10/2021

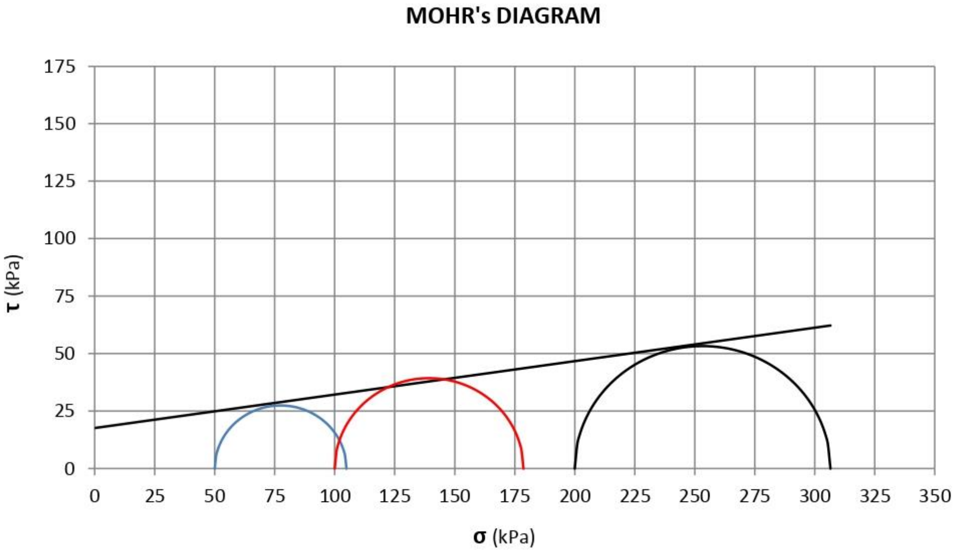
GEOMINE



No.	σ3 (kPa)	Δσ (kPa)	ε_f (%)
1.	50	54.87	5.53
2.	100	78.62	11.17
3.	200	106.56	21.20

Results		
c	kPa	17.6
ø	°	8.3





D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(05.00-05.40 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 05.00 -05.40 m
Date Tested : 28/10/2021

GEOMINE

Height of Sample: 76 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1432 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
0	0	0
20	25.19	0.26
40	33.91	0.53
60	39.46	0.79
80	41.23	1.05
100	42.49	1.32
120	43.5	1.58
140	44.87	1.84
160	45.73	2.11
180	47.21	2.37
200	47.95	2.63
220	49.29	2.89
240	50.38	3.16
260	51.22	3.42
280	52.29	3.68
300	53.36	3.95
320	54.43	4.21
340	54.64	4.47
360	54.49	4.74
380	54.58	5
400	54.79	5.26
420	54.87	5.53
440	54.72	5.79

Deviator Stress Maximum: 54.87 kPa E_0: 2339.84 kPa
Strain at Failure: 5.79 % E_{50}: 1702.73 kPa
Deviator Stress at (50%): 49.29 kPa
Strain at (50%): 2.89 %

+ + + + + + + + + STAGE - 1 + + + + + + + + +

Height of Sample: 71.6 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1432 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
420	0	5.87
440	35.55	6.15
460	47.62	6.42
480	51.24	6.7
500	55.2	6.98

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(05.00-05.40 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 05.00 -05.40 m
Date Tested : 28/10/2021

GEOMINE

520	57.38	7.26
540	59.54	7.54
560	61.69	7.82
580	64.75	8.1
600	66.29	8.38
620	68.28	8.66
640	70.71	8.94
660	72.21	9.22
680	74.28	9.5
700	76.33	9.78
720	77.79	10.06
740	77.89	10.34
760	77.88	10.61
780	78.19	10.89
800	78.62	11.17
820	78.6	11.45
840	78.35	11.73

Deviator Stress Maximum: 78.62 kPa E_o: 2938.82 kPa
Strain at Failure: 11.73 % E_{50}: 788.49 kPa
Deviator Stress at (50%): 68.28 kPa
Strain at (50%): 8.66 %

+ + + + + + + + + STAGE - 2 + + + + + + + + +

Height of Sample: 63.2 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1432 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
820	0	12.97
840	56.06	13.29
860	68.18	13.61
880	73.69	13.92
900	77.42	14.24
920	80.16	14.56
940	83.84	14.87
960	86.95	15.19
980	89.83	15.51
1000	92.47	15.82
1020	94.24	16.14
1040	96.31	16.46
1060	97.73	16.77
1080	98.62	17.09
1100	99.07	17.41
1120	99.84	17.72
1140	100.39	18.04
1160	101.03	18.35
1180	101.66	18.67

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(05.00-05.40 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 05.00 -05.40 m
Date Tested : 28/10/2021

GEOMINE

1200	102.5	18.99
1220	103.22	19.3
1240	103.52	19.62
1260	104.13	19.94
1280	104.82	20.25
1300	105.31	20.57
1320	105.89	20.89
1340	106.56	21.2
1360	106.53	21.52
1380	106.1	21.84
1400	105.67	22.15
1420	105.24	22.47
1440	104.81	22.78
1460	104.38	23.1
1480	103.95	23.42
1500	103.52	23.73
1520	103.09	24.05
1540	102.66	24.37
1560	101.85	24.68
1580	100.67	25
1600	100.24	25.32
1620	99.82	25.63
1640	98.46	25.95
1660	97.29	26.27
1680	96.41	26.58

Deviator Stress Maximum: 106.56 kPa E_{0}: 1862.96 kPa
Strain at Failure: 26.58 % E_{50}: 527.63 kPa
Deviator Stress at (50%): 103.52 kPa
Strain at (50%): 19.62 %

+ + + + + + + + + STAGE - 3 + + + + + + + + +

No. Container : 1004
Wet Soil + Container : 177.86 gram
Dry Soil + Container : 127.96 gram
Weight of Container : 5.84 gram
Density : 19.96 kN/m3
Moisture Content : 40.86 %
Dry Density : 14.17 kN/m3

F GWL OL 008; R 05-(14/09/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(05.00-05.40 m)-TX UU.xlsm

PARTNER FOR DESIGN

Classification Test

GEOMINE

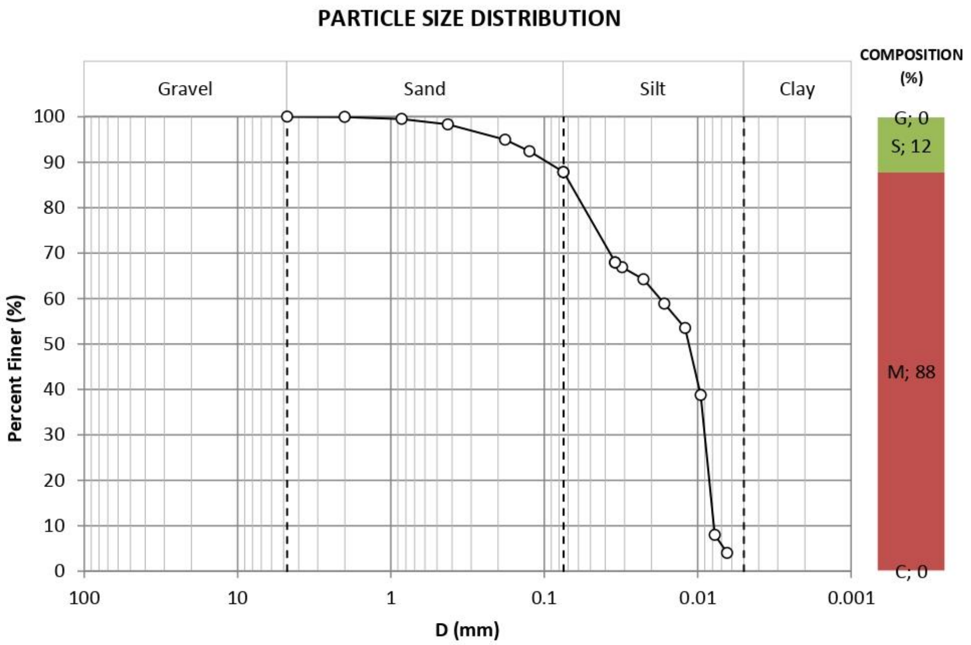
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 08.25 - 08.65 m
Date Tested : 26/10/2021

Test		Results
Unit Weight	kN/m^3	18.6
SL	%	-
Gs	-	3.27
MC	%	57
PL	%	26
LL	%	66
PI	%	40
Fines (#200)	%	88
D_{10}	mm	0.0078
D_{30}	mm	0.0090
D_{60}	mm	0.0176
C_u	-	2
C_c	-	0.59

* Casagrande's Method
** Based on Consistency Index (Ic)

Properties		Results
I_F	%	-0.46
I_T	%	-87.22
I_L	%	0.76
I_C	%	0.24
S_r	%	100.00
e	-	1.63
n	-	0.62
A	-	21.39

Consistency**	**Very Soft**
Activity	**Active**
Plasticity Symbol	**CH or OH**



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(08.25-08.65 m)-Classification.xlsm
F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 08.25 - 08.65 m
Date Tested : 26/10/2021

GEOMINE

Moisture Content

No. Test	1	2	3
No. Container	1002	1140	1142
Weight of Container	5.65	4.37	5.03
Weight of wet soil and container	77.79	91.60	93.96
Weight of dry soil and container	51.82	59.72	62.11
Moisture Content	56.25	57.60	55.80
Average MC	56.55		

Unit weight

No. Ring	19
No. Container	1041
Weight of Ring	26.8
Volume of Ring	15.216
Weight of Container	5.34
Weight of wet soil and ring and containe	60.47
Weight of dry soil and ring and containe	51.01
Water Content	50.132
Density	18.618
Dry Density	12.401
Saturation	100
Void ratio	1.6336
Porosity	0.6203

Specific Gravity

No. Test	1	2
No. Pycknometer	201	201
Weight of Pycknometer + soil	76.17	76.17
Weight of Pycknometer + water + soil	169.57	169.57
T° C	28	28
Weight of Pycknometer	52.92	52.92
Weight of Pycknometer + water	153.44	153.44
Specific Gravity	3.266	3.266
Average Specific Gravity	3.266	

Shrinkage Limit

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and container	-
Weight of dry soil and container	-
Weight of plate	-
Weight of plate and Mercury	-
Volume dry soil	-
Shrinkage Limit	-

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(08.25-08.65 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

GEOMINE

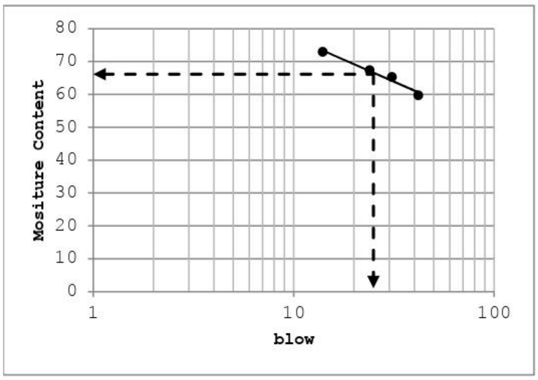
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 08.25 - 08.65 m
Date Tested : 26/10/2021

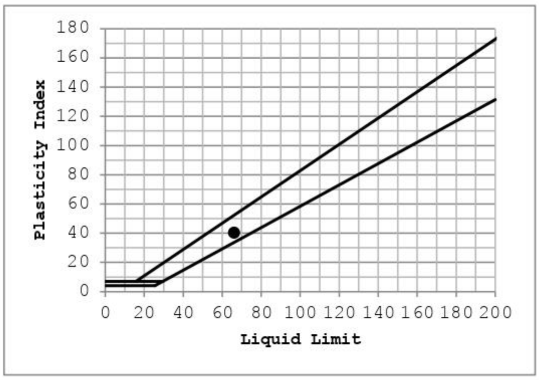
Plastic Limit

No. Test	1	2	3
No. Container	1084	1119	1160
Weight of Container	4.67	4.94	4.48
Weight of wet soil and container	12.18	12.23	11.21
Weight of dry soil and container	10.7	10.68	9.82
Plastic Limit	24.54	27.00	26.03
Average	25.86		

Liquid Limit

No. Test	1	2	3	4	5
No. Container	1016	1011	1025	1145	-
Weight of Container	6.15	5.75	5.16	4.62	-
Weight of wet soil and container	16.45	16.77	16.74	16.62	-
Weight of dry soil and container	12.6	12.42	12.08	11.56	-
Water Content	59.69	65.22	67.34	72.91	-
Number of blows	42	31	24	14	-
Liquid Limit	66.15				





Sieve Analysis

Bowl	0
Soil + Bowl	80.26
Weight of dry soil	80.26

Sieve No.	Sieve Diameter	Weight of Soil Retained	Percent Retained	Cumulative Percent Retained	Percent Finer
4	4.75	0.001	0.00	0.00	100.00
10	2	0.04	0.05	0.05	99.95
20	0.85	0.36	0.45	0.50	99.50
40	0.425	0.95	1.18	1.68	98.32
80	0.18	2.69	3.35	5.03	94.97
120	0.125	2.05	2.55	7.59	92.41
200	0.075	3.67	4.57	12.16	87.84
Pan	0	1.76	87.84	100	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(08.25-08.65 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 08.25 - 08.65 m
Date Tested : 26/10/2021

GEOMINE

Hydrometer

Dry Sample

Weight of sample	68.739		
Zerro correction	-1	Gs	3.266
Meniscus correction	1	a	0.8974

Time	t (minute)	T (Co)	Ra	Diameter	Percent Finer
12:20	0				
12:21	1	27	47	0.0311	66.89
12:22	2	27	45	0.0225	64.21
12:24	4	27	41	0.0165	58.86
12:28	8	27	37	0.0121	53.51
12:35	15	27	26	0.0096	38.80
12:50	30	27	3	0.0077	8.03
13:05	45	27	0	0.0064	4.01
13:50	90	0	0	0.0000	1.34
15:20	180	0	0	0.0000	0.00
9:20	1260	0	0	0.0000	0.00
12:20	1440	0	0	0.0000	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(08.25-08.65 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Falling Head

Client ID :	Geomine
Project ID :	Hengjaya Mineralindo
GWL ID :	21 031
Area :	-
Point ID :	DHG 04
Depth :	08.25 -08.65 m

Date Tested : 27/10/2021

GEOMINE

Time (minute)	Volume (cm3)	delta time (minute)	delta volume (cm3)
0	5.3	0	0
30	5.9	30	0.6
80	6.7	50	0.8
150	7.5	70	0.8
228	8.6	78	1.1
288	9.8	60	1.2
348	10.6	60	0.8
400	11.5	52	0.9

t-sample (cm): 6.60
Area-sample (cm2): 11.34
Head (cm): 50

k (cm/s): 2.954E-06

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(08.25-08.65 m)-Falling Head.xlsm

F GWL OL 040; R 01-(6/12/18)

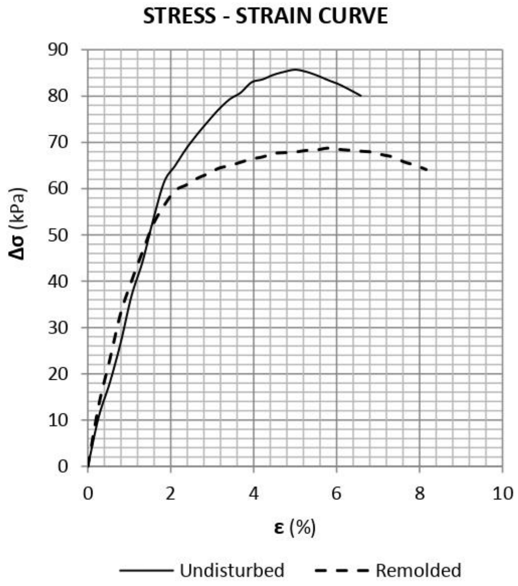
PARTNER FOR DESIGN

Unconfined Compression Test

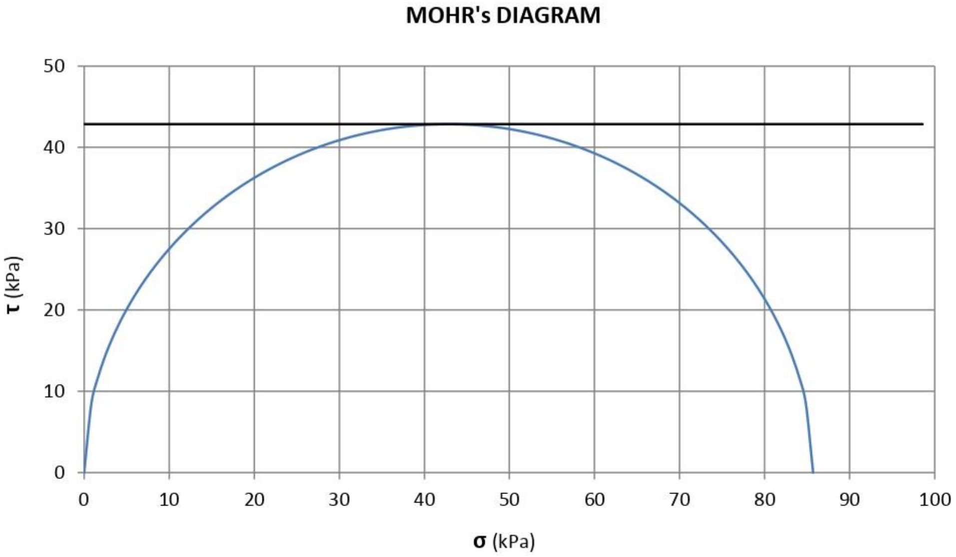
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 17.00 - 17.25 m

Date Tested : 29/10/2021

GEOMINE



Results		Undisturbed	Remolded
σ_{max}	kPa	85.7	68.8
ε_f	%	5.00	5.79
S_t	-	1.25	
c	kPa	42.9	34.4
E_{50}	kPa	3382	3520
E_{sec}	kPa	1714	1188



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(17.00-17.25 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Unconfined Compression Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 17.00 - 17.25 m

Date Tested : 29/10/2021

GEOMINE

Undisturbed

Height of Sample : 76 mm
Diameter of Sample : 38 mm
Calibration Dial Gauge : 0.04826 kg/div
Calibration Strain Load : 0.01 mm/div

Water Content : 91.03 %
Unit Weight : 13.15 kN/m3
Dry Density : 6.88 kN/m3

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)	Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
0	0.00	0.0000	-	-	-
20	10.74	0.2632			
40	17.99	0.5263			
60	26.64	0.7895			
80	36.84	1.0526			
100	44.13	1.3158			
120	53.40	1.5789			
140	61.48	1.8421			
160	64.99	2.1053			
180	68.59	2.3684			
200	71.68	2.6316			
220	74.50	2.8947			
240	77.14	3.1579			
260	79.32	3.4211			
280	80.74	3.6842			
300	82.97	3.9474			
320	83.60	4.2105			
340	84.59	4.4737			
360	85.25	4.7368			
380	85.70	5.0000			
400	85.26	5.2632			
420	84.46	5.5263			
440	83.47	5.7895			
460	82.55	6.0526			
480	81.37	6.3158			
500	80.10	6.5789			

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(17.00-17.25 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Unconfined Compression Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 04
Depth : 17.00 - 17.25 m

Date Tested : 29/10/2021

GEOMINE

Remolded

Height of Sample : 76 mm
Diameter of Sample : 38 mm
Calibration Dial Gauge : 0.04826 kg/div
Calibration Strain Load : 0.01 mm/div

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)	Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
0	0	0.0000	-	-	-
20	13.24	0.2632			
40	22.94	0.5263			
60	33.01	0.7895			
80	40.00	1.0526			
100	46.32	1.3158			
120	52.35	1.5789			
140	56.39	1.8421			
160	59.57	2.1053			
180	60.78	2.3684			
200	62.19	2.6316			
220	63.22	2.8947			
240	64.41	3.1579			
260	64.97	3.4211			
280	65.70	3.6842			
300	66.42	3.9474			
320	66.85	4.2105			
340	67.60	4.4737			
360	67.78	4.7368			
380	67.91	5.0000			
400	68.25	5.2632			
420	68.38	5.5263			
440	68.75	5.7895			
460	68.48	6.0526			
480	68.29	6.3158			
500	68.10	6.5789			
520	67.91	6.8421			
540	67.32	7.1053			
560	66.81	7.3684			
580	65.76	7.6316			
600	65.06	7.8947			
620	64.13	8.1579			

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(17.00-17.25 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 04
Depth : 32.25 - 32.35 m
Date Tested : 27/10/2021

GEOMINE

Result		
Natural Density	kN/m^3	27.35
Dry Density	kN/m^3	26.98
Saturated Density	kN/m^3	27.72
Spesific Gravity	-	2.91
Natural Water Content	%	1
Absorption	%	3
Saturation	%	0.07
Porosity	-	0.07
Void Ratio	-	0.08

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 04-(32.25-32.35 m)-Properties (Rock).xlsm

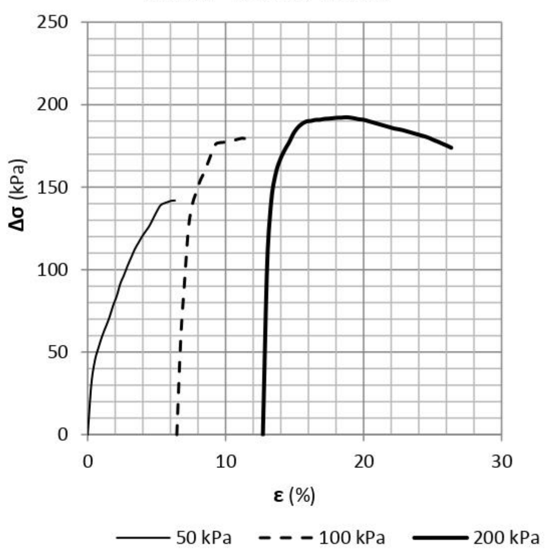
F GWL OL 026; R 04-(10/7/21)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

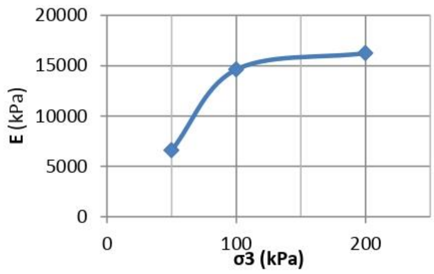
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 08.45 -08.85 m
Date Tested : 28/10/2021

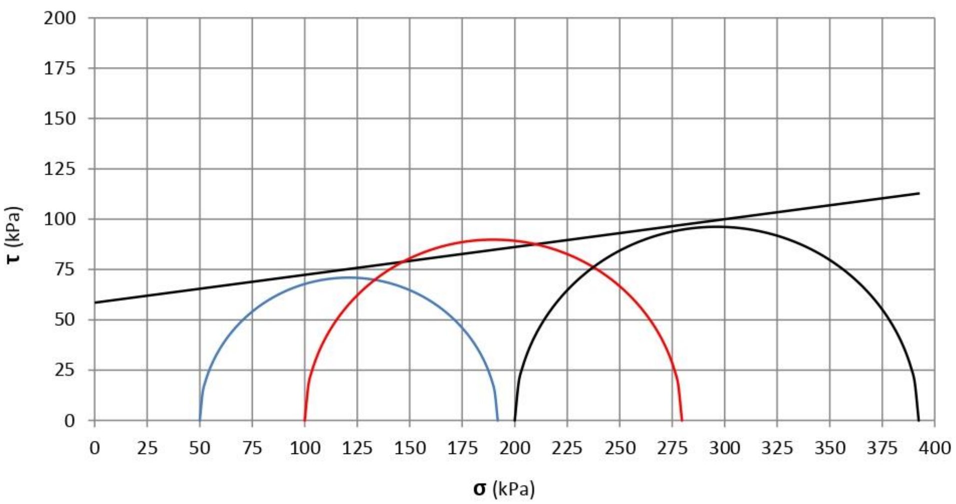
GEOMINE



No.	σ3 (kPa)	Δσ (kPa)	ε_f (%)
1.	50	141.91	6.32
2.	100	179.64	11.24
3.	200	192.38	18.73

Results		
c	kPa	58.5
ø	°	7.9





D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(08.45-08.85 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 08.45 -08.85 m
Date Tested : 28/10/2021

GEOMINE

Height of Sample: 76 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1391 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
0	0	0
20	30.58	0.26
40	45.14	0.53
60	52.93	0.79
80	59.83	1.05
100	65.48	1.32
120	71.22	1.58
140	78.25	1.84
160	84.05	2.11
180	91.61	2.37
200	96.73	2.63
220	102.43	2.89
240	107.49	3.16
260	112.53	3.42
280	116.36	3.68
300	120.17	3.95
320	123.36	4.21
340	126.54	4.47
360	130.86	4.74
380	135.16	5
400	138.85	5.26
420	140.21	5.53
440	140.97	5.79
460	141.73	6.05
480	141.91	6.32

Deviator Stress Maximum: 141.91 kPa — E_0: 3704.52 kPa
Strain at Failure: 6.32 % — E_{50}: 3403.97 kPa
Deviator Stress at (50%): 107.49 kPa
Strain at (50%): 3.16 %

\+ + + + + + + + + STAGE - 1 + + + + + + + + +

Height of Sample: 71.2 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1391 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
460	0	6.46
480	57.53	6.74
500	92.94	7.02

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(08.45-08.85 m)-TX UU.xlsm
F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 08.45 -08.85 m
Date Tested : 28/10/2021

GEOMINE

520	125.06	7.3
540	139.42	7.58
560	146.91	7.87
580	153.78	8.15
600	158.7	8.43
620	164.6	8.71
640	170.79	8.99
660	175.94	9.27
680	176.94	9.55
700	177.17	9.83
720	177.83	10.11
740	178.59	10.39
760	178.58	10.67
780	179.22	10.96
800	179.64	11.24
820	179.07	11.52

Deviator Stress Maximum: 179.64 kPa E_{o}: 10296.55 kPa
Strain at Failure: 11.52 % E_{50}: 1900.01 kPa
Deviator Stress at (50%): 170.79 kPa
Strain at (50%): 8.99 %

+ + + + + + + + + STAGE - 2 + + + + + + + + +

Height of Sample: 63 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1391 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
800	0	12.7
820	104.87	13.02
840	143.71	13.33
860	158.97	13.65
880	167.04	13.97
900	172.62	14.29
920	177.22	14.6
940	182.61	14.92
960	186.19	15.24
980	188.5	15.56
1000	189.86	15.87
1020	190.17	16.19
1040	190.78	16.51
1060	190.87	16.83
1080	191.36	17.14
1100	191.54	17.46
1120	191.81	17.78
1140	192.07	18.1
1160	192.13	18.41
1180	192.38	18.73

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(08.45-08.85 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 08.45 -08.85 m
Date Tested : 28/10/2021

GEOMINE

1200	192.12	19.05
1220	191.67	19.37
1240	191.11	19.68
1260	190.84	20
1280	190.09	20.32
1300	189.33	20.63
1320	188.57	20.95
1340	187.82	21.27
1360	187.06	21.59
1380	186.3	21.9
1400	185.54	22.22
1420	185.07	22.54
1440	184.5	22.86
1460	183.74	23.17
1480	182.98	23.49
1500	182.22	23.81
1520	181.46	24.13
1540	180.71	24.44
1560	179.76	24.76
1580	178.54	25.08
1600	177.51	25.4
1620	176.3	25.71
1640	175.19	26.03
1660	173.89	26.35

Deviator Stress Maximum: 192.38 kPa E_{0}: 3698.11 kPa
Strain at Failure: 26.35 % E_{50}: 989.76 kPa
Deviator Stress at (50%): 191.67 kPa
Strain at (50%): 19.37 %

+ + + + + + + + + STAGE - 3 + + + + + + + + +

No. Container : 1223
Wet Soil + Container : 159.71 gram
Dry Soil + Container : 108.05 gram
Weight of Container : 4.58 gram
Density : 18.00 kN/m3
Moisture Content : 49.93 %
Dry Density : 12.00 kN/m3

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(08.45-08.85 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 11.60 - 12.00 m
Date Tested : 26/10/2021

GEOMINE

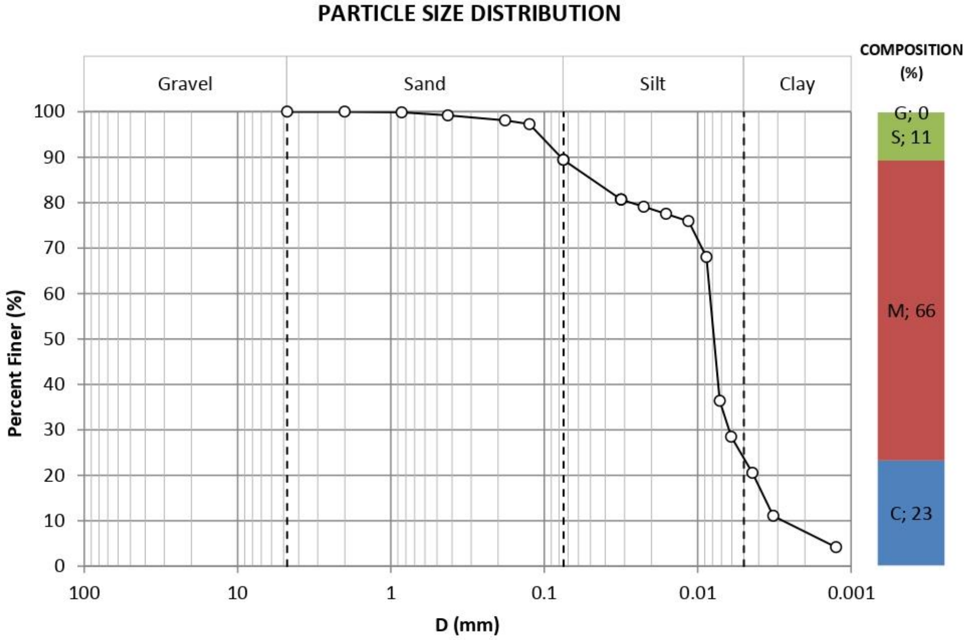
Test		Results
Unit Weight	kN/m^3	-
SL	%	-
Gs	-	3.18
MC	%	-
PL	%	49
LL	%	111
PI	%	62
Fines (#200)	%	89
D_{10}	mm	0.0028
D_{30}	mm	0.0062
D_{60}	mm	0.0083
C_u	-	3
C_c	-	1.69

Properties		Results
I_F	%	-0.58
I_T	%	-107.18
I_L	%	-
I_C	%	-
S_r	%	-
e	-	-
n	-	-
A	-	10.17

Consistency**	-
Activity	**Active**
Plasticity Symbol	**MH or OH**

* Casagrande's Method

** Based on Consistency Index (Ic)



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(11.60-12.00 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

GEOMINE

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 11.60 - 12.00 m

Date Tested : 26/10/2021

Moisture Content

No. Test	1	2	3
No. Container	-	-	-
Weight of Container	-	-	-
Weight of wet soil and container	-	-	-
Weight of dry soil and container	-	-	-
Moisture Content	-	-	-
Average MC	-		

Unit weight

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and ring and containe	-
Weight of dry soil and ring and containe	-
Water Content	-
Density	-
Dry Density	-
Saturation	-
Void ratio	-
Porosity	-

Specific Gravity

No. Test	1	2
No. Pycknometer	203	203
Weight of Pycknometer + soil	73.33	73.33
Weight of Pycknometer + water + soil	165.27	165.27
T° C	28	28
Weight of Pycknometer	54.5	54.5
Weight of Pycknometer + water	152.36	152.36
Specific Gravity	3.181	3.181
Average Specific Gravity	3.181	

Shrinkage Limit

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and container	-
Weight of dry soil and container	-
Weight of plate	-
Weight of plate and Mercury	-
Volume dry soil	-
Shrinkage Limit	-

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(11.60-12.00 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

GEOMINE

Client ID	: Geomine
Project ID	: Hengjaya Mineralindo
GWL ID	: 21 031
Area	: -
Point ID	: DHG 05
Depth	: 11.60 - 12.00 m

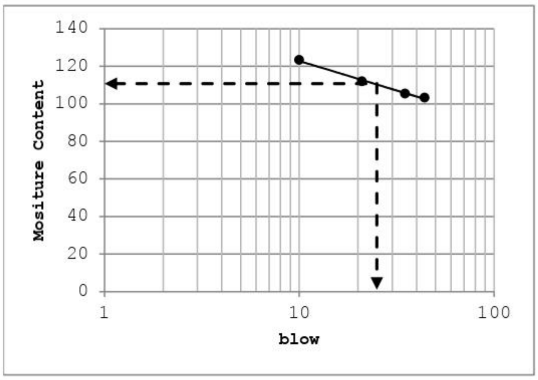
Date Tested : 26/10/2021

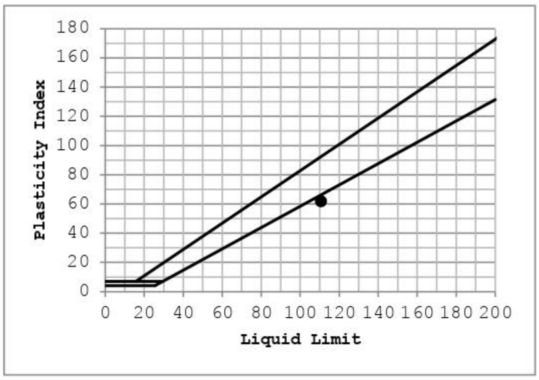
Plastic Limit

No. Test	1	2	3
No. Container	1234	1099	1209
Weight of Container	4.57	4.76	4.52
Weight of wet soil and container	12.67	11.37	11.76
Weight of dry soil and container	10	9.18	9.41
Plastic Limit	49.17	49.55	48.06
Average	48.93		

Liquid Limit

No. Test	1	2	3	4	5
No. Container	1196	1151	1204	1207	-
Weight of Container	4.41	4.51	4.37	4.48	-
Weight of wet soil and container	13.9	13.65	13.44	13.61	-
Weight of dry soil and container	9.08	8.96	8.65	8.57	-
Water Content	103.21	105.39	111.92	123.23	-
Number of blows	44	35	21	10	-
Liquid Limit	110.74				





Sieve Analysis

Bowl	0
Soil + Bowl	80.35
Weight of dry soil	80.35

Sieve No.	Sieve Diameter	Weight of Soil Retained	Percent Retained	Cumulative Percent Retained	Percent Finer
4	4.75	0.001	0.00	0.00	100.00
10	2	0	0.00	0.00	100.00
20	0.85	0.1	0.12	0.13	99.87
40	0.425	0.53	0.66	0.79	99.21
80	0.18	0.89	1.11	1.89	98.11
120	0.125	0.66	0.82	2.71	97.29
200	0.075	6.33	7.88	10.59	89.41
Pan	0	1.31	89.41	100	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(11.60-12.00 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 11.60 - 12.00 m

Date Tested : 26/10/2021

GEOMINE

Hydrometer

Dry Sample

Weight of sample	70.529		
Zerro correction	-1	Gs	3.181
Meniscus correction	1	a	0.9081

Time	t (minute)	T (Co)	Ra	Diameter	Percent Finer
12:20	0				
12:21	1	27	48	0.0315	80.69
12:22	2	27	47	0.0224	79.10
12:24	4	27	46	0.0160	77.52
12:28	8	27	45	0.0115	75.94
12:35	15	27	40	0.0088	68.03
12:50	30	27	20	0.0072	36.39
13:05	45	27	15	0.0060	28.48
13:50	90	27	10	0.0044	20.57
15:20	180	27	4	0.0032	11.07
9:20	1260	26	0	0.0013	4.19
12:20	1440	0	0	0.0000	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(11.60-12.00 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

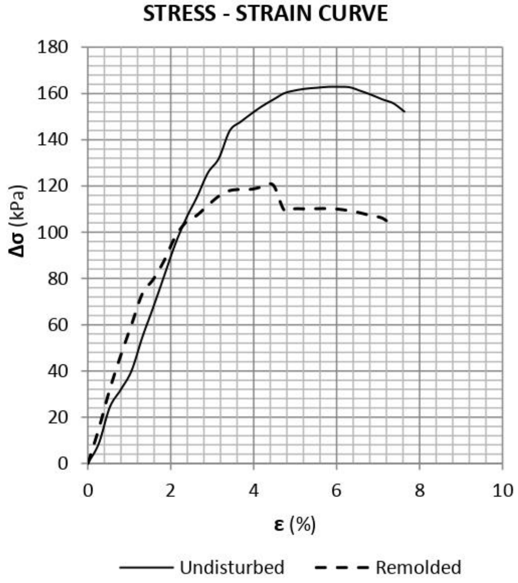
PARTNER FOR DESIGN

Unconfined Compression Test

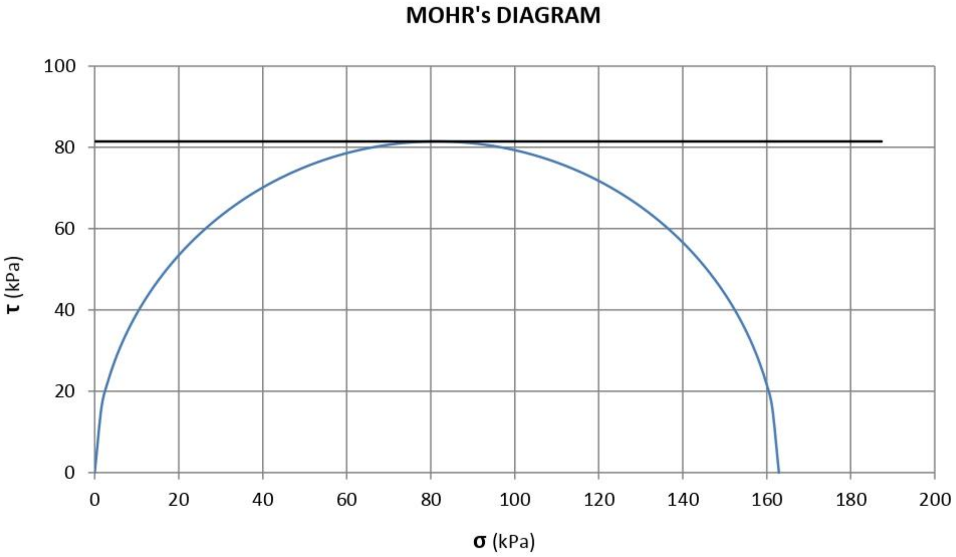
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 14.75 - 14.90 m

Date Tested : 29/10/2021

GEOMINE



Results		Undisturbed	Remolded
σ_{max}	kPa	162.9	120.3
ε_f	%	6.05	4.47
S_t	-	1.35	
c	kPa	81.5	60.2
E_{50}	kPa	4284	5585
E_{sec}	kPa	2692	2690



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(14.75-14.90 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Unconfined Compression Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 14.75 - 14.90 m
Date Tested : 29/10/2021

GEOMINE

Undisturbed

Height of Sample : 76 mm
Diameter of Sample : 38 mm
Calibration Dial Gauge : 0.04826 kg/div
Calibration Strain Load : 0.01 mm/div

Water Content : 69.49 %
Unit Weight : 14.44 kN/m3
Dry Density : 8.52 kN/m3

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)	Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
0	0.00	0.0000	-	-	-
20	8.62	0.2632			
40	24.21	0.5263			
60	31.79	0.7895			
80	40.04	1.0526			
100	54.72	1.3158			
120	67.64	1.5789			
140	81.24	1.8421			
160	94.77	2.1053			
180	105.94	2.3684			
200	115.23	2.6316			
220	125.70	2.8947			
240	131.91	3.1579			
260	143.88	3.4211			
280	147.75	3.6842			
300	151.31	3.9474			
320	154.61	4.2105			
340	157.39	4.4737			
360	160.12	4.7368			
380	161.34	5.0000			
400	162.10	5.2632			
420	162.49	5.5263			
440	162.88	5.7895			
460	162.91	6.0526			
480	162.69	6.3158			
500	161.12	6.5789			
520	159.40	6.8421			
540	157.45	7.1053			
560	155.74	7.3684			
580	152.19	7.6316			

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(14.75-14.90 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Unconfined Compression Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 14.75 - 14.90 m
Date Tested : 29/10/2021

GEOMINE

Remolded

Height of Sample : 76 mm
Diameter of Sample : 38 mm
Calibration Dial Gauge : 0.04826 kg/div
Calibration Strain Load : 0.01 mm/div

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)	Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
0	0	0.0000	-	-	-
20	14.98	0.2632			
40	31.87	0.5263			
60	46.52	0.7895			
80	60.00	1.0526			
100	73.49	1.3158			
120	79.66	1.5789			
140	87.80	1.8421			
160	97.94	2.1053			
180	104.36	2.3684			
200	107.35	2.6316			
220	111.65	2.8947			
240	115.59	3.1579			
260	117.99	3.4211			
280	118.53	3.6842			
300	118.61	3.9474			
320	119.63	4.2105			
340	120.32	4.4737			
360	109.49	4.7368			
380	110.16	5.0000			
400	110.10	5.2632			
420	110.19	5.5263			
440	110.25	5.7895			
460	109.94	6.0526			
480	109.27	6.3158			
500	108.33	6.5789			
520	107.07	6.8421			
540	106.06	7.1053			
560	102.56	7.3684			

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(14.75-14.90 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 05
Depth : 15.80 - 16.00 m
Date Tested : 25/10/2021

GEOMINE

Result		
Natural Density	kN/m^3	10.67
Dry Density	kN/m^3	5.16
Saturated Density	kN/m^3	12.39
Spesific Gravity	-	1.87
Natural Water Content	%	52
Absorption	%	140
Saturation	%	0.72
Porosity	-	0.72
Void Ratio	-	2.62

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(15.80-16.00 m)-Properties (Rock).xlsm

F GWL OL 026; R 04-(10/7/21)

PARTNER FOR DESIGN

Uniaxial Compressive Strength Test (v)

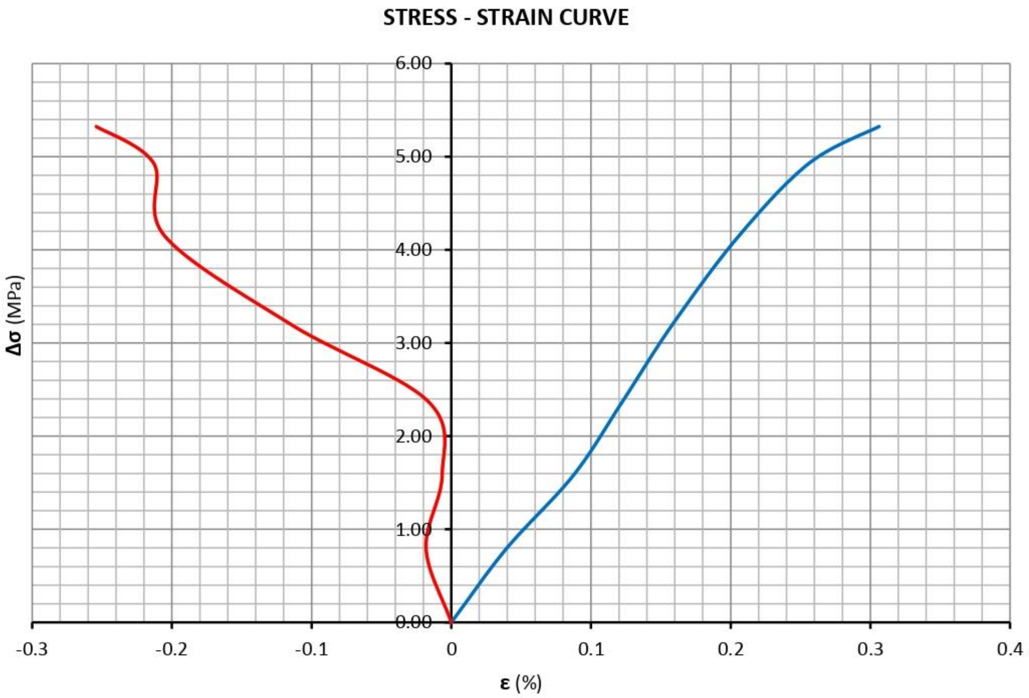
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 05
Depth : 20.10 - 20.27 m

Date Tested : 3/11/2021

GEOMINE

Results		
σ_{max*}	MPa	5.32
v	-	0.33
E	MPa	2284

* Coreccted by Hoek and Brown (1980a)



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 05-(20.10-20.27 m)-UCS (Poisson).xlsm

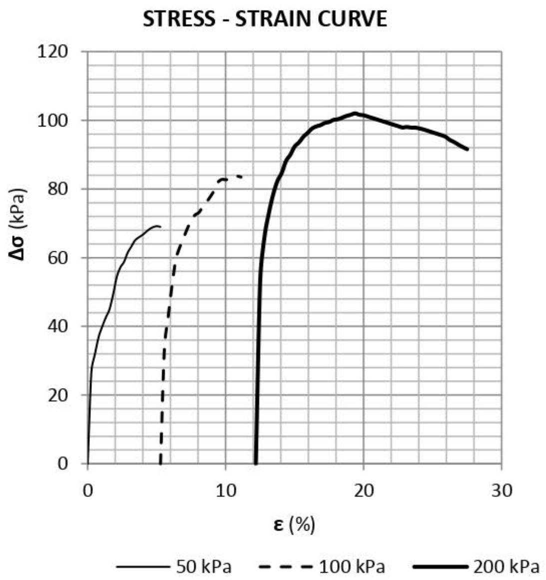
F GWL OL 033; R 01-(22/09/14)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

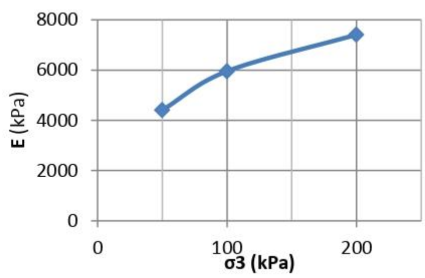
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 06
Depth : 05.20 -05.60 m
Date Tested : 28/10/2021

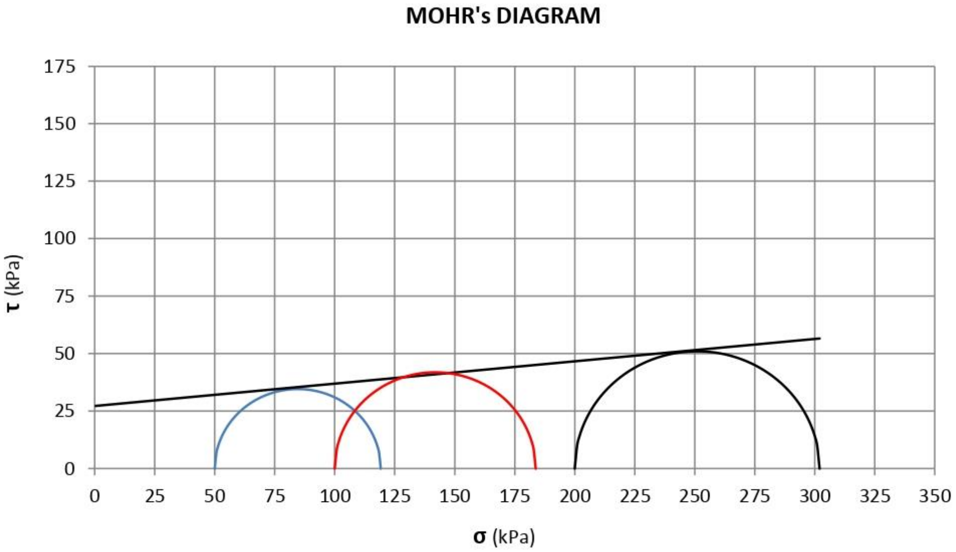
GEOMINE



No.	σ3 (kPa)	Δσ (kPa)	ε_f (%)
1.	50	69.17	5.00
2.	100	83.73	10.83
3.	200	102.03	19.38

Results		
c	kPa	27.2
ø	°	5.6





D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 06-(05.20-05.60 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 06
Depth : 05.20 -05.60 m
Date Tested : 28/10/2021

GEOMINE

Height of Sample: 76 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1139 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
0	0	0
20	26.54	0.26
40	31.97	0.53
60	36.87	0.79
80	39.95	1.05
100	42.62	1.32
120	44.97	1.58
140	49.29	1.84
160	54.37	2.11
180	57.16	2.37
200	58.77	2.63
220	61.44	2.89
240	63.22	3.16
260	64.99	3.42
280	65.87	3.68
300	66.56	3.95
320	67.44	4.21
340	68.31	4.47
360	68.88	4.74
380	69.17	5
400	68.98	5.26

Deviator Stress Maximum: 69.17 kPa E_{o}: 2375.66 kPa
Strain at Failure: 5.26 % E_{50}: 2233.28 kPa
Deviator Stress at (50%): 58.77 kPa
Strain at (50%): 2.63 %

+ + + + + + + + + STAGE - 1 + + + + + + + + +

Height of Sample: 72 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1139 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
380	0	5.28
400	33.2	5.56
420	42.75	5.83
440	51.96	6.11
460	59.42	6.39
480	62.99	6.67
500	65.7	6.94

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 06-(05.20-05.60 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 06
Depth : 05.20 -05.60 m
Date Tested : 28/10/2021

GEOMINE

520	68.49	7.22
540	70.79	7.5
560	72.43	7.78
580	73.13	8.06
600	74.75	8.33
620	76.18	8.61
640	77.78	8.89
660	79.55	9.17
680	81.94	9.44
700	82.78	9.72
720	82.7	10
740	82.9	10.28
760	83.54	10.56
780	83.73	10.83
800	83.47	11.11

Deviator Stress Maximum: 83.73 kPa — E_0: 3514.56 kPa
Strain at Failure: 11.11 % — E_{50}: 907.87 kPa
Deviator Stress at (50%): 73.13 kPa
Strain at (50%): 8.06 %

+ + + + + + + + + STAGE - 2 + + + + + + + + +

Height of Sample: 64 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1139 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
780	0	12.19
800	52.99	12.5
820	65.93	12.81
840	72.85	13.13
860	78.33	13.44
880	82.29	13.75
900	84.67	14.06
920	88.14	14.38
940	89.96	14.69
960	92.37	15
980	93.56	15.31
1000	95.16	15.63
1020	96.33	15.94
1040	97.57	16.25
1060	98.21	16.56
1080	98.59	16.88
1100	99.22	17.19
1120	99.51	17.5
1140	100.12	17.81
1160	100.32	18.13
1180	100.75	18.44

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 06-(05.20-05.60 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 06
Depth : 05.20 -05.60 m
Date Tested : 28/10/2021

GEOMINE

1200	101.27	18.75
1220	101.61	19.06
1240	102.03	19.38
1260	101.63	19.69
1280	101.48	20
1300	101.08	20.31
1320	100.68	20.63
1340	100.29	20.94
1360	99.89	21.25
1380	99.49	21.56
1400	99.1	21.88
1420	98.7	22.19
1440	98.3	22.5
1460	97.91	22.81
1480	98.05	23.13
1500	97.88	23.44
1520	97.87	23.75
1540	97.62	24.06
1560	97.29	24.38
1580	96.89	24.69
1600	96.49	25
1620	96.09	25.31
1640	95.68	25.63
1660	95.21	25.94
1680	94.29	26.25
1700	93.67	26.56
1720	92.9	26.88
1740	92.21	27.19
1760	91.6	27.5

Deviator Stress Maximum: 102.03 kPa E_{o}: 1582.25 kPa
Strain at Failure: 27.50 % E_{50}: 516.21 kPa
Deviator Stress at (50%): 101.63 kPa
Strain at (50%): 19.69 %

+ + + + + + + + + STAGE - 3 + + + + + + + + +

No. Container : 1237
Wet Soil + Container : 167.3 gram
Dry Soil + Container : 117.7 gram
Weight of Container : 4.48 gram
Density : 18.89 kN/m3
Moisture Content : 43.81 %
Dry Density : 13.14 kN/m3

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 06-(05.20-05.60 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Classification Test

GEOMINE

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 06
Depth : 07.00 - 07.40 m
Date Tested : 26/10/2021

Test		Results
Unit Weight	kN/m^3	18.8
SL	%	-
Gs	-	3.15
MC	%	56
PL	%	34
LL	%	60
PI	%	26
Fines (#200)	%	79
D_{10}	mm	0.0093
D_{30}	mm	0.0125
D_{60}	mm	0.0429
C_u	-	5
C_c	-	0.39

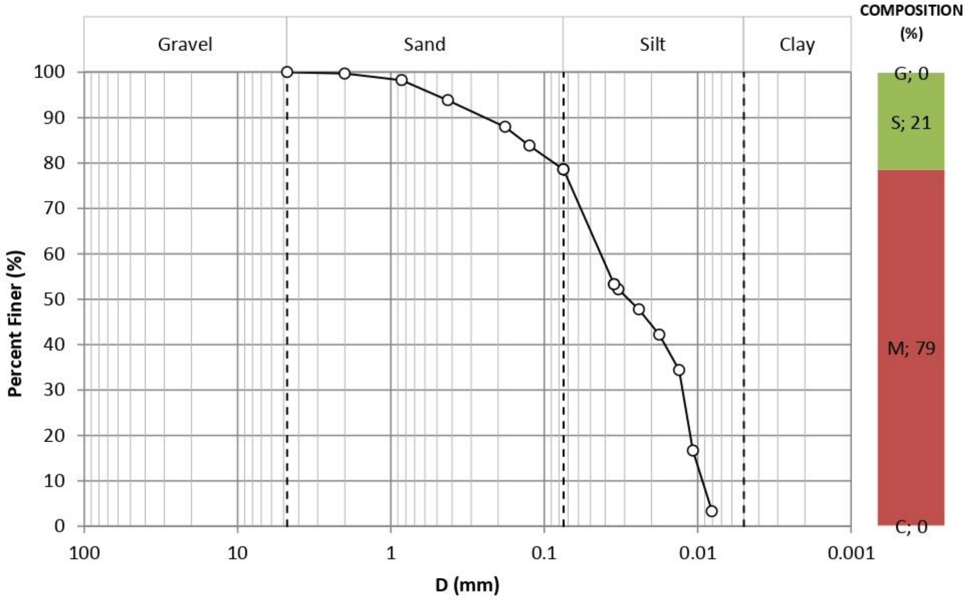
Properties		Results
I_F	%	-0.08
I_T	%	-329.92
I_L	%	0.86
I_C	%	0.14
S_r	%	100.00
e	-	1.53
n	-	0.60
A	-	17.86

Consistency**	**Very Soft**
Activity	**Active**
Plasticity Symbol	**MH or OH**

* Casagrande's Method

** Based on Consistency Index (Ic)

PARTICLE SIZE DISTRIBUTION



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 06-(07.00-07.40 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

GEOMINE

Client ID	: Geomine
Project ID	: Hengjaya Mineralindo
GWL ID	: 21 031
Area	: -
Point ID	: DHG 06
Depth	: 07.00 - 07.40 m

Date Tested : 26/10/2021

Moisture Content

No. Test	1	2	3
No. Container	1224	1030	1176
Weight of Container	4.57	5.86	4.42
Weight of wet soil and container	125.47	112.59	128.43
Weight of dry soil and container	81.03	74.76	84.55
Moisture Content	58.12	54.91	54.76
Average MC	55.93		

Unit weight

No. Ring	9
No. Container	1166
Weight of Ring	27.15
Volume of Ring	15.669
Weight of Container	4.55
Weight of wet soil and ring and containe	61.11
Weight of dry soil and ring and containe	51.19
Water Content	50.898
Density	18.769
Dry Density	12.438
Saturation	100
Void ratio	1.5308
Porosity	0.6049

Specific Gravity

No. Test	1	2
No. Pycknometer	203	203
Weight of Pycknometer + soil	72.41	72.41
Weight of Pycknometer + water + soil	164.58	164.58
T° C	28	28
Weight of Pycknometer	54.5	54.5
Weight of Pycknometer + water	152.36	152.36
Specific Gravity	3.148	3.148
Average Specific Gravity	3.148	

Shrinkage Limit

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and container	-
Weight of dry soil and container	-
Weight of plate	-
Weight of plate and Mercury	-
Volume dry soil	-
Shrinkage Limit	-

F GWL OL 001; R 12-(17/10/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 06-(07.00-07.40 m)-Classification.xlsm

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 06
Depth : 07.00 - 07.40 m
Date Tested : 26/10/2021

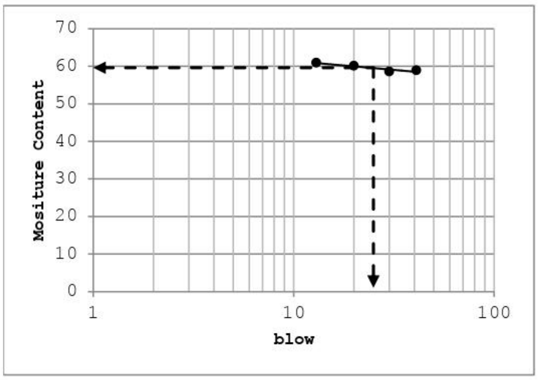
GEOMINE

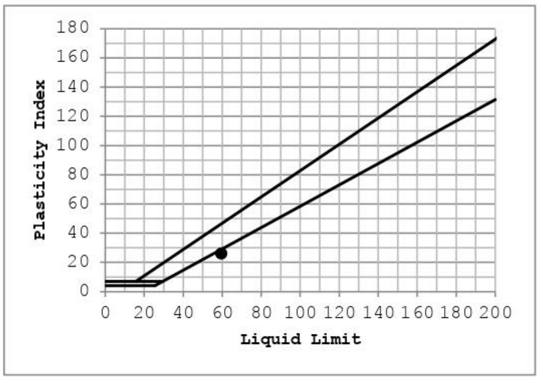
Plastic Limit

No. Test	1	2	3
No. Container	1178	1143	1031
Weight of Container	4.12	4.18	5.77
Weight of wet soil and container	13.14	13.55	13.7
Weight of dry soil and container	10.87	11.16	11.74
Plastic Limit	33.63	34.24	32.83
Average	33.57		

Liquid Limit

No. Test	1	2	3	4	5
No. Container	1184	1034	1199	1139	-
Weight of Container	4.24	5.22	4.59	4.45	-
Weight of wet soil and container	15.33	15.7	15.94	15.49	-
Weight of dry soil and container	11.22	11.83	11.68	11.31	-
Water Content	58.88	58.55	60.08	60.93	-
Number of blows	41	30	20	13	-
Liquid Limit	59.61				





Sieve Analysis

Bowl	0
Soil + Bowl	80.31
Weight of dry soil	80.31

Sieve No.	Sieve Diameter	Weight of Soil Retained	Percent Retained	Cumulative Percent Retained	Percent Finer
4	4.75	0.001	0.00	0.00	100.00
10	2	0.23	0.29	0.29	99.71
20	0.85	1.18	1.47	1.76	98.24
40	0.425	3.54	4.41	6.16	93.84
80	0.18	4.72	5.88	12.04	87.96
120	0.125	3.32	4.13	16.18	83.82
200	0.075	4.21	5.24	21.42	78.58
Pan	0	1.39	78.58	100	0.00

F GWL OL 001; R 12-(17/10/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 06-(07.00-07.40 m)-Classification.xlsm

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 06
Depth : 07.00 - 07.40 m

Date Tested : 26/10/2021

GEOMINE

Hydrometer

Dry Sample

Weight of sample	61.719		
Zerro correction	-1	Gs	3.1478
Meniscus correction	1	a	0.9125

Time	t (minute)	T (Co)	Ra	Diameter	Percent Finer
12:20	0				
12:21	1	27	44	0.0329	52.20
12:22	2	27	40	0.0242	47.76
12:24	4	27	35	0.0178	42.21
12:28	8	27	28	0.0132	34.43
12:35	15	27	12	0.0107	16.66
12:50	30	27	0	0.0081	3.33
13:05	45	0	0	0.0000	1.11
13:50	90	0	0	0.0000	1.11
15:20	180	0	0	0.0000	0.00
9:20	1260	0	0	0.0000	0.00
12:20	1440	0	0	0.0000	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 06-(07.00-07.40 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Uniaxial Compressive Strength Test (v)

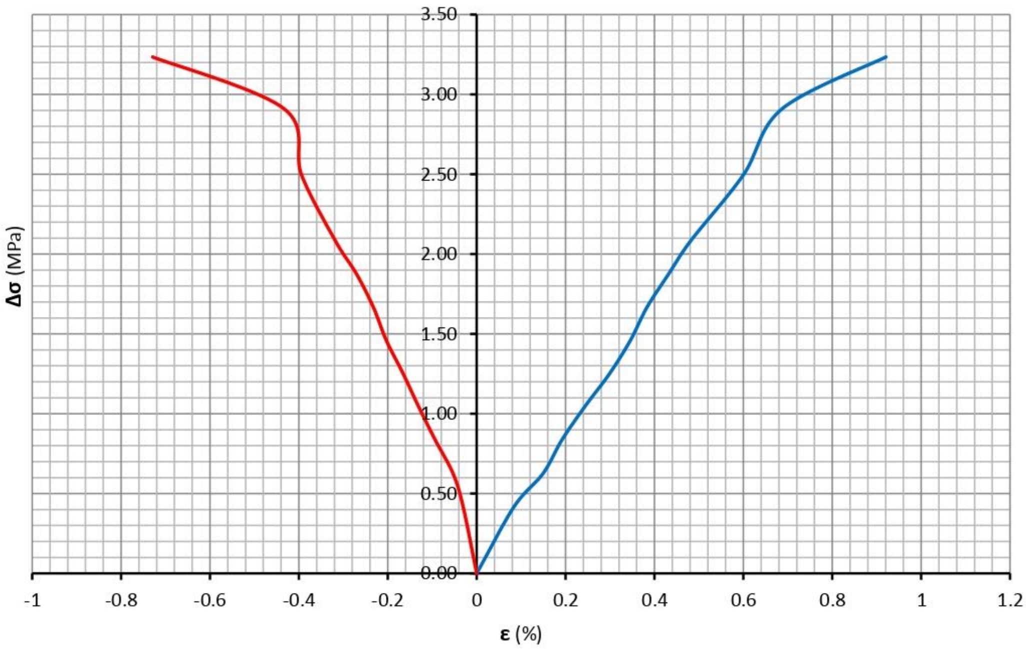
GEOMINE

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 06
Depth : 25.60 - 25.80 m
Date Tested : 3/11/2021

Results		
σ_{max*}	MPa	3.23
v	-	0.38
E	MPa	445

* Coreccted by Hoek and Brown (1980a)

STRESS - STRAIN CURVE



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 06-(25.60-25.80 m)-UCS (Poisson).xlsm

F GWL OL 033; R 01-(22/09/14)

PARTNER FOR DESIGN

Uniaxial Compressive Strength Test (v)

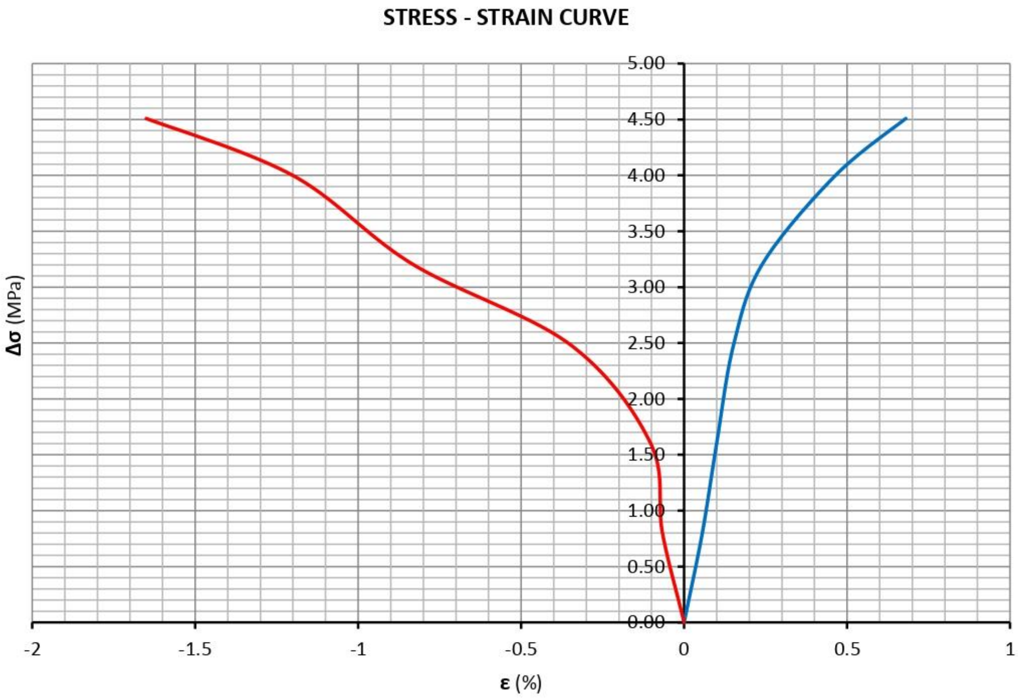
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 06
Depth : 35.50 - 35.70 m

Date Tested : 3/11/2021

GEOMINE

Results		
σ_{max*}	MPa	4.51
v	-	0.41
E	MPa	623

* Coreccted by Hoek and Brown (1980a)



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 06-(35.50-35.70 m)-UCS (Poisson).xlsm

F GWL OL 033; R 01-(22/09/14)

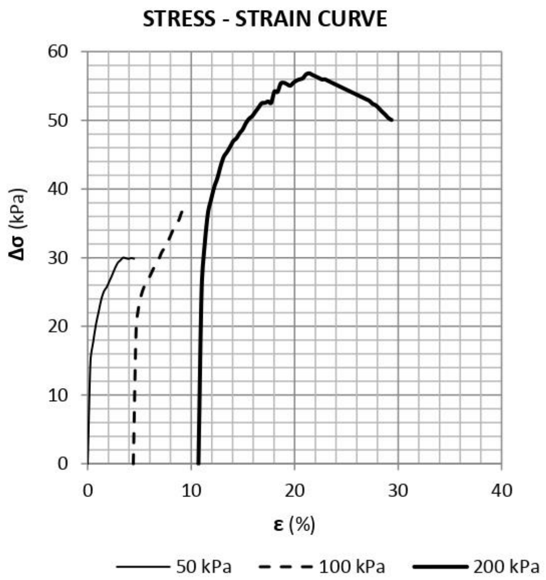
PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 02.60 -03.00 m

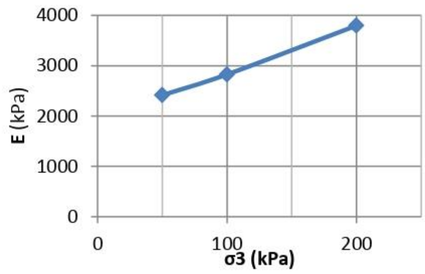
Date Tested : 28/10/2021

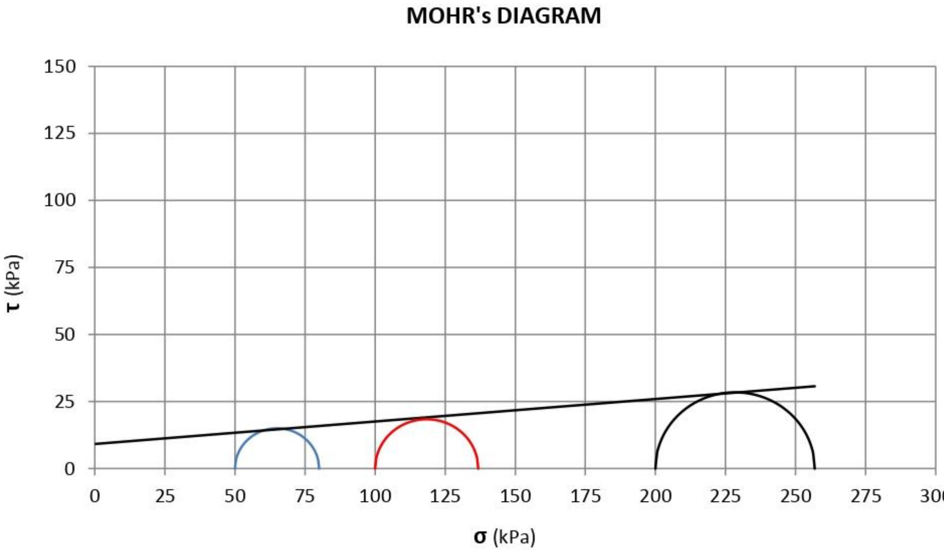
GEOMINE



No.	σ3 (kPa)	Δσ (kPa)	ε_f (%)
1.	50	30.00	3.42
2.	100	36.78	9.37
3.	200	56.84	21.41

Results		
c	kPa	9.2
ø	°	4.8





D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021

GEOMINE

Height of Sample: 76 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1101 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
0	0	0
20	14.81	0.26
40	17.67	0.53
60	20.23	0.79
80	22.09	1.05
100	23.95	1.32
120	25.13	1.58
140	25.73	1.84
160	26.61	2.11
180	27.49	2.37
200	28.45	2.63
220	29.22	2.89
240	29.61	3.16
260	30	3.42
280	29.92	3.68
300	29.84	3.95
320	29.94	4.21
340	29.86	4.47

Deviator Stress Maximum: 30.00 kPa — E_0: 1565.00 kPa
Strain at Failure: 4.47 % — E_{50}: 1263.98 kPa
Deviator Stress at (50%): 26.61 kPa
Strain at (50%): 2.11 %

+ + + + + + + + + STAGE - 1 + + + + + + + + +

Height of Sample: 72.6 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1101 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
320	0	4.41
340	19.71	4.68
360	23.07	4.96
380	24.84	5.23
400	25.96	5.51
420	26.71	5.79
440	27.45	6.06
460	28.37	6.34
480	29.01	6.61
500	29.83	6.89

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021

GEOMINE

520	30.82	7.16
540	31.45	7.44
560	32.25	7.71
580	33.14	7.99
600	34.11	8.26
620	34.89	8.54
640	35.5	8.82
660	36.63	9.09
680	36.78	9.37
700	36.67	9.64
720	36.56	9.92

Deviator Stress Maximum: 36.78 kPa — E_{o}: 1286.57 kPa
Strain at Failure: 9.92 % — E_{50}: 430.34 kPa
Deviator Stress at (50%): 30.82 kPa
Strain at (50%): 7.16 %

+ + + + + + + + + STAGE - 2 + + + + + + + + +

Height of Sample: 65.4 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1101 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
700	0	10.7
720	25.31	11.01
740	32.03	11.31
760	36.46	11.62
780	38.48	11.93
800	40.3	12.23
820	41.6	12.54
840	43.32	12.84
860	44.69	13.15
880	45.37	13.46
900	46.13	13.76
920	46.97	14.07
940	47.38	14.37
960	48.12	14.68
980	48.69	14.98
1000	49.59	15.29
1020	50.23	15.6
1040	50.62	15.9
1060	51.25	16.21
1080	51.87	16.51
1100	52.49	16.82
1120	52.54	17.13
1140	52.74	17.43
1160	52.55	17.74
1180	54.18	18.04

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021

GEOMINE

1200	54.14	18.35
1220	55.36	18.65
1240	55.46	18.96
1260	55.26	19.27
1280	55.05	19.57
1300	55.46	19.88
1320	55.79	20.18
1340	55.96	20.49
1360	56.13	20.8
1380	56.68	21.1
1400	56.84	21.41
1420	56.62	21.71
1440	56.4	22.02
1460	56.18	22.32
1480	55.96	22.63
1500	55.96	22.94
1520	55.74	23.24
1540	55.52	23.55
1560	55.29	23.85
1580	55.07	24.16
1600	54.85	24.46
1620	54.63	24.77
1640	54.41	25.08
1660	54.18	25.38
1680	53.96	25.69
1700	53.74	25.99
1720	53.52	26.3
1740	53.3	26.61
1760	53.07	26.91
1780	52.85	27.22
1800	52.42	27.52
1820	52.2	27.83
1840	51.77	28.13
1860	51.27	28.44
1880	50.84	28.75
1900	50.35	29.05
1920	50.06	29.36

Deviator Stress Maximum: 56.84 kPa

E_0: 638.59 kPa

Strain at Failure: 29.36 %

E_{50}: 279 kPa

Deviator Stress at (50%): 55.46 kPa

Strain at (50%): 19.88 %

+ + + + + + + + + STAGE - 3 + + + + + + + + +

No. Container : 1232

Wet Soil + Container : 164.29 gram

Dry Soil + Container : 114.53 gram

Weight of Container : 4.39 gram

Density : 18.55 kN/m3

Moisture Content : 45.18 %

Dry Density : 12.78 kN/m3

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 03.60 - 04.00 m
Date Tested : 26/10/2021

GEOMINE

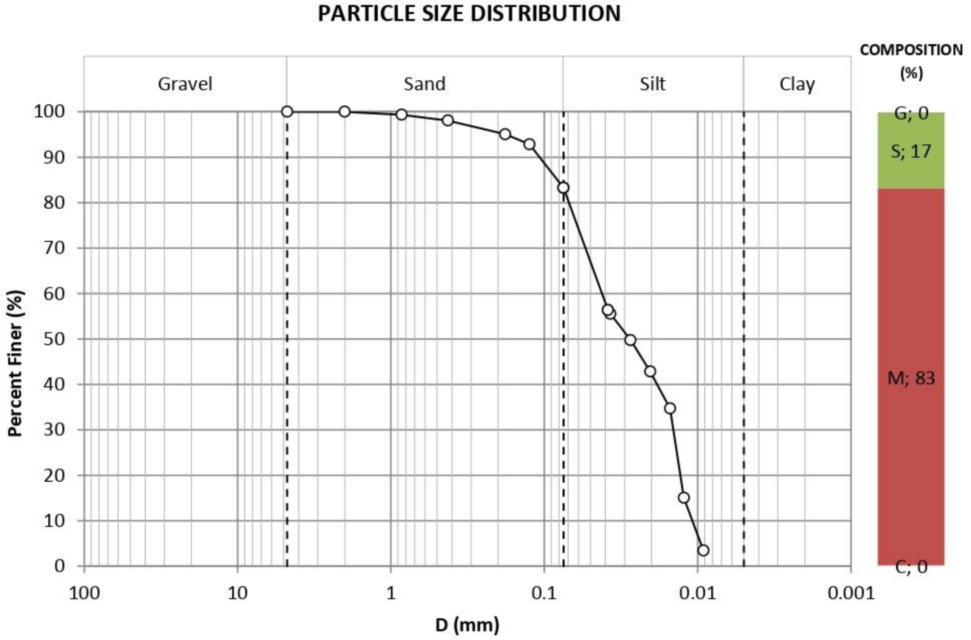
Test		Results
Unit Weight	kN/m^3	-
SL	%	-
Gs	-	2.67
MC	%	-
PL	%	17
LL	%	54
PI	%	37
Fines (#200)	%	83
D_{10}	mm	0.0108
D_{30}	mm	0.0144
D_{60}	mm	0.0421
C_u	-	4
C_c	-	0.46

Properties		Results
I_F	%	-0.19
I_T	%	-198.18
I_L	%	-
I_C	%	-
S_r	%	-
e	-	-
n	-	-
A	-	25.25

Consistency**	-
Activity	**Active**
Plasticity Symbol	**CH or OH**

* Casagrande's Method

** Based on Consistency Index (Ic)



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(03.60-04.00 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 03.60 - 04.00 m
Date Tested : 26/10/2021

GEOMINE

Moisture Content

No. Test	1	2	3
No. Container	-	-	-
Weight of Container	-	-	-
Weight of wet soil and container	-	-	-
Weight of dry soil and container	-	-	-
Moisture Content	-	-	-
Average MC	-		

Unit weight

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and ring and containe	-
Weight of dry soil and ring and containe	-
Water Content	-
Density	-
Dry Density	-
Saturation	-
Void ratio	-
Porosity	-

Specific Gravity

No. Test	1	2
No. Pycknometer	201	201
Weight of Pycknometer + soil	92.86	92.86
Weight of Pycknometer + water + soil	178.4	178.4
T° C	28	28
Weight of Pycknometer	52.92	52.92
Weight of Pycknometer + water	153.44	153.44
Specific Gravity	2.666	2.666
Average Specific Gravity	2.666	

Shrinkage Limit

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and container	-
Weight of dry soil and container	-
Weight of plate	-
Weight of plate and Mercury	-
Volume dry soil	-
Shrinkage Limit	-

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(03.60-04.00 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 03.60 - 04.00 m
Date Tested : 26/10/2021

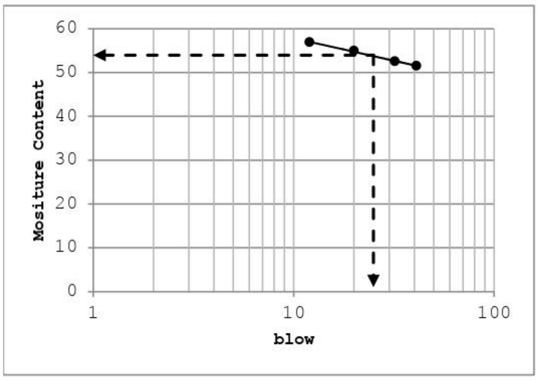
GEOMINE

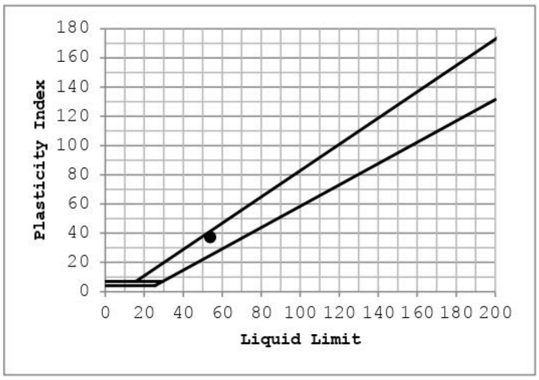
Plastic Limit

No. Test	1	2	3
No. Container	1035	1002	1129
Weight of Container	5.36	5.65	4.56
Weight of wet soil and container	13.95	13.88	13.3
Weight of dry soil and container	12.69	12.75	12.01
Plastic Limit	17.19	15.92	17.32
Average	16.81		

Liquid Limit

No. Test	1	2	3	4	5
No. Container	1194	1092	1027	1225	-
Weight of Container	4.56	4.71	5.06	4.6	-
Weight of wet soil and container	15.68	15.45	15.35	15.88	-
Weight of dry soil and container	11.9	11.75	11.7	11.79	-
Water Content	51.50	52.56	54.97	56.88	-
Number of blows	41	32	20	12	-
Liquid Limit	53.95				





Sieve Analysis

Bowl	0
Soil + Bowl	80.4
Weight of dry soil	80.4

Sieve No.	Sieve Diameter	Weight of Soil Retained	Percent Retained	Cumulative Percent Retained	Percent Finer
4	4.75	0.001	0.00	0.00	100.00
10	2	0	0.00	0.00	100.00
20	0.85	0.52	0.65	0.65	99.35
40	0.425	1.02	1.27	1.92	98.08
80	0.18	2.43	3.02	4.94	95.06
120	0.125	1.78	2.21	7.15	92.85
200	0.075	7.7	9.58	16.73	83.27
Pan	0	1.62	83.27	100	0.00

F GWL OL 001; R 12-(17/10/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(03.60-04.00 m)-Classification.xlsm

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 03.60 - 04.00 m
Date Tested : 26/10/2021

GEOMINE

Hydrometer

Dry Sample

Weight of sample	65.329		
Zerro correction	-1	Gs	2.6664
Meniscus correction	1	a	0.9963

Time	t (minute)	T (Co)	Ra	Diameter	Percent Finer
12:20	0				
12:21	1	27	45	0.0371	55.57
12:22	2	27	40	0.0274	49.78
12:24	4	27	34	0.0204	42.83
12:28	8	27	27	0.0151	34.73
12:35	15	27	10	0.0123	15.05
12:50	30	27	0	0.0092	3.47
13:05	45	0	0	0.0000	1.16
13:50	90	0	0	0.0000	1.16
15:20	180	0	0	0.0000	0.00
9:20	1260	0	0	0.0000	0.00
12:20	1440	0	0	0.0000	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(03.60-04.00 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Falling Head

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 03.60 -04.00 m
Date Tested : 27/10/2021

GEOMINE

Time (minute)	Volume (cm3)	delta time (minute)	delta volume (cm3)
0	6.9	0	0
80	7.1	80	0.2
140	7.3	60	0.2
210	7.5	70	0.2
288	7.6	78	0.1
348	7.7	60	0.1
400	7.9	52	0.2
456	8.1	56	0.2

t-sample (cm): 6.60
Area-sample (cm2): 11.34
Head (cm): 50

k (cm/s): 4.850E-07

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(03.60-04.00 m)-Falling Head.xlsm

F GWL OL 040; R 01-(6/12/18)

PARTNER FOR DESIGN

Uniaxial Compressive Strength Test (v)

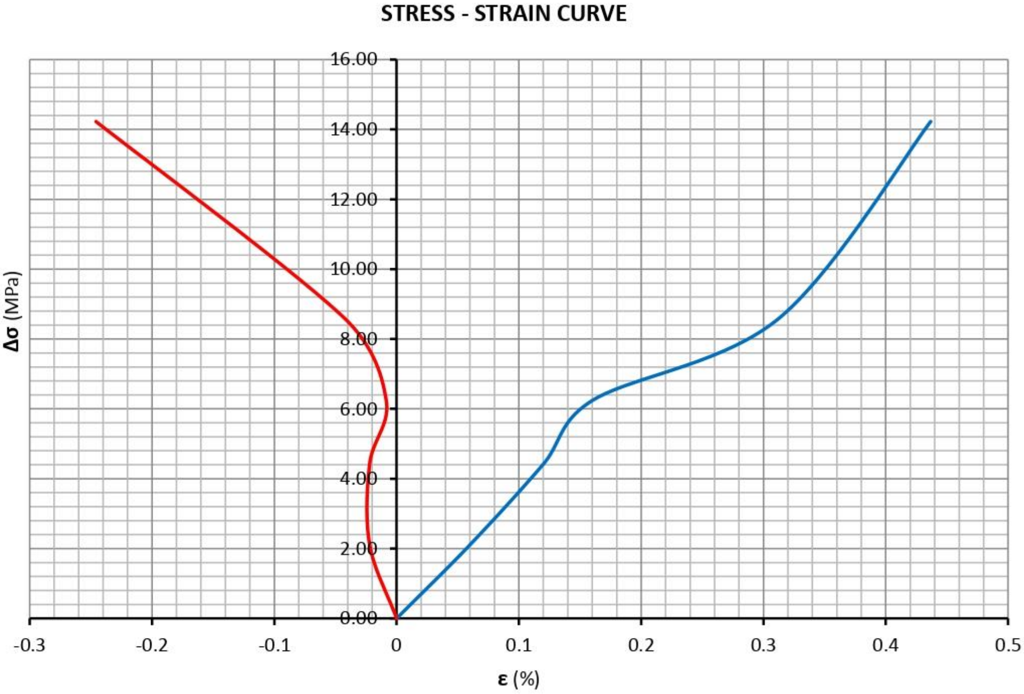
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 06.50 - 06.70 m

Date Tested : 3/11/2021

GEOMINE

Results		
σ_{max*}	MPa	14.23
v	-	0.21
E	MPa	3049

* Coreccted by Hoek and Brown (1980a)



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(06.50-06.70 m)-UCS (Poisson).xlsm

F GWL OL 033; R 01-(22/09/14)

PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 07
Depth : 09.50 - 09.85 m
Date Tested : 27/10/2021

GEOMINE

Result		
Natural Density	kN/m^3	20.21
Dry Density	kN/m^3	16.99
Saturated Density	kN/m^3	20.51
Spesific Gravity	-	2.62
Natural Water Content	%	19
Absorption	%	21
Saturation	%	0.35
Porosity	-	0.35
Void Ratio	-	0.54

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(09.50-09.85 m)-Properties (Rock).xlsm

F GWL OL 026; R 04-(10/7/21)

PARTNER FOR DESIGN

Uniaxial Compressive Strength Test (v)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 07
Depth : 11.00 - 11.20 m

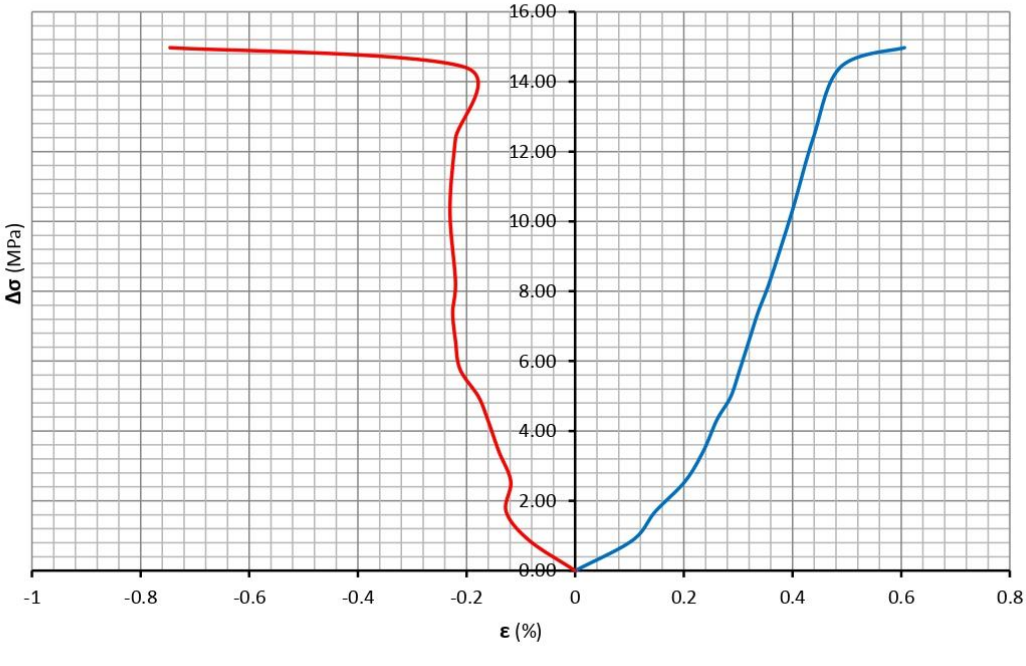
Date Tested : 3/11/2021

GEOMINE

Results		
σ_{max*}	MPa	14.97
v	-	0.45
E	MPa	1255

* Coreccted by Hoek and Brown (1980a)

STRESS - STRAIN CURVE



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 07-(11.00-11.20 m)-UCS (Poisson).xlsm

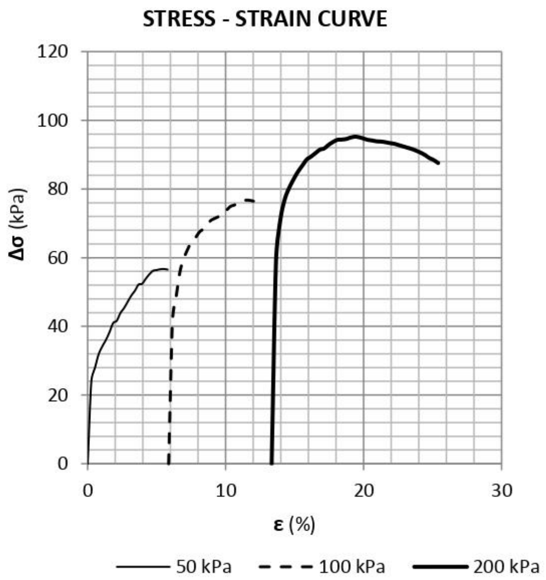
F GWL OL 033; R 01-(22/09/14)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

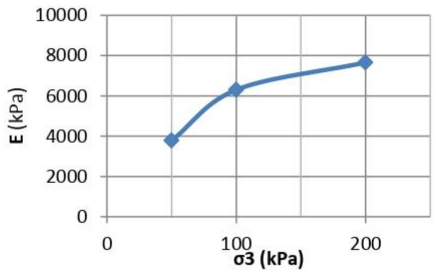
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 08
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021

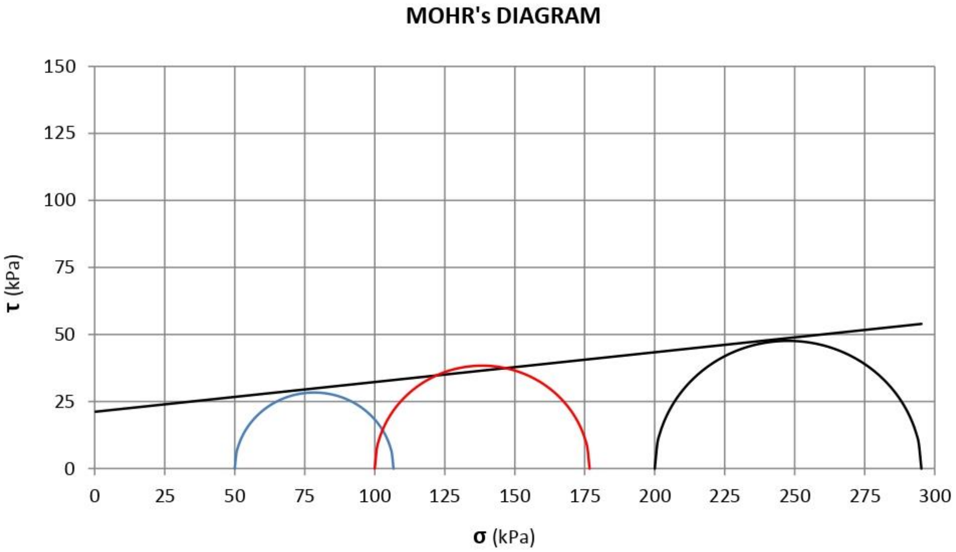
GEOMINE



No.	σ3 (kPa)	Δσ (kPa)	ε_f (%)
1.	50	56.70	5.53
2.	100	76.73	11.45
3.	200	95.24	19.37

Results		
c	kPa	21.2
ø	°	6.3





D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 08
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021

GEOMINE

Height of Sample: 76 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
0	0	0
20	24.01	0.26
40	27.94	0.53
60	31.84	0.79
80	34.14	1.05
100	36.03	1.32
120	38.3	1.58
140	40.96	1.84
160	41.63	2.11
180	43.87	2.37
200	45.31	2.63
220	47.14	2.89
240	48.95	3.16
260	50.37	3.42
280	52.17	3.68
300	52.41	3.95
320	53.88	4.21
340	55.19	4.47
360	56.18	4.74
380	56.41	5
400	56.63	5.26
420	56.7	5.53
440	56.54	5.79

Deviator Stress Maximum: 56.70 kPa　　E_0: 1969.86 kPa
Strain at Failure: 5.79 %　　E_{50}: 1628.45 kPa
Deviator Stress at (50%): 47.14 kPa
Strain at (50%): 2.89 %

+ + + + + + + + + STAGE - 1 + + + + + + + + +

Height of Sample: 71.6 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
420	0	5.87
440	41.65	6.15
460	49.03	6.42
480	56.22	6.7
500	59.93	6.98

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 08
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021

GEOMINE

520	62.58	7.26
540	64.77	7.54
560	65.9	7.82
580	67.47	8.1
600	68.37	8.38
620	69.7	8.66
640	70.87	8.94
660	71.46	9.22
680	72.04	9.5
700	73.26	9.78
720	73.83	10.06
740	74.9	10.34
760	75.31	10.61
780	75.86	10.89
800	76.41	11.17
820	76.73	11.45
840	76.7	11.73
860	76.46	12.01

Deviator Stress Maximum: 76.73 kPa E_{0}: 3158.95 kPa
Strain at Failure: 12.01 % E_{50}: 792.91 kPa
Deviator Stress at (50%): 70.87 kPa
Strain at (50%): 8.94 %

+ + + + + + + + + STAGE - 2 + + + + + + + + +

Height of Sample: 63 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.091 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
840	0	13.33
860	59.1	13.65
880	71.1	13.97
900	77.03	14.29
920	80.31	14.6
940	82.81	14.92
960	85.01	15.24
980	86.8	15.56
1000	88.56	15.87
1020	89.44	16.19
1040	90.44	16.51
1060	91.43	16.83
1080	91.81	17.14
1100	92.85	17.46
1120	93.68	17.78
1140	94.31	18.1
1160	94.4	18.41
1180	94.55	18.73

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

Triaxial Unconsolidated Undrained Test

PARTNER FOR DESIGN

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 08
Depth : 02.60 -03.00 m
Date Tested : 28/10/2021

GEOMINE

1200	94.96	19.05
1220	95.24	19.37
1240	95.06	19.68
1260	94.68	20
1280	94.31	20.32
1300	94.12	20.63
1320	93.87	20.95
1340	93.81	21.27
1360	93.62	21.59
1380	93.37	21.9
1400	93.18	22.22
1420	92.79	22.54
1440	92.41	22.86
1460	92.03	23.17
1480	91.65	23.49
1500	91.15	23.81
1520	90.59	24.13
1540	89.91	24.44
1560	89.05	24.76
1580	88.43	25.08
1600	87.58	25.4

Deviator Stress Maximum: 95.24 kPa $E_{o:}$ 1861.9 kPa
Strain at Failure: 25.40 % E_{50}: 491.81 kPa
Deviator Stress at (50%): 95.24 kPa
Strain at (50%): 19.37 %

+ + + + + + + + + STAGE - 3 + + + + + + + + +

No. Container : 1155
Wet Soil + Container : 167.52 gram
Dry Soil + Container : 117.85 gram
Weight of Container : 4.24 gram
Density : 18.94 kN/m3
Moisture Content : 43.72 %
Dry Density : 13.18 kN/m3

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(02.60-03.00 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Classification Test

GEOMINE

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 08
Depth : 04.00 - 04.40 m
Date Tested : 26/10/2021

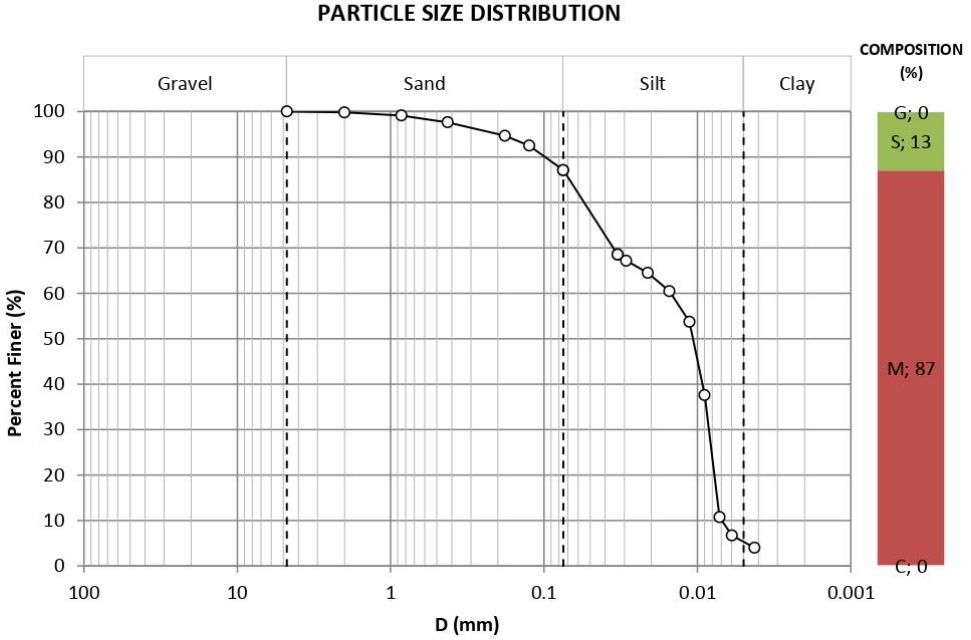
Test		Results
Unit Weight	kN/m^3	18.3
SL	%	-
Gs	-	3.59
MC	%	64
PL	%	34
LL	%	79
PI	%	45
Fines (#200)	%	87
D_{10}	mm	0.0069
D_{30}	mm	0.0084
D_{60}	mm	0.0149
C_u	-	2
C_c	-	0.69

* Casagrande's Method

** Based on Consistency Index (Ic)

Properties		Results
I_F	%	-0.29
I_T	%	-154.53
I_L	%	0.67
I_C	%	0.33
S_r	%	100.00
e	-	2.20
n	-	0.69
A	-	-

Consistency**	**Soft**
Activity	-
Plasticity Symbol	**CH or OH**



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(04.00-04.40 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 08
Depth : 04.00 - 04.40 m
Date Tested : 26/10/2021

GEOMINE

Moisture Content

No. Test	1	2	3
No. Container	1074	1085	1061
Weight of Container	4.90	4.93	4.70
Weight of wet soil and container	113.77	103.68	114.94
Weight of dry soil and container	71.16	65.40	71.46
Moisture Content	64.31	63.30	65.13
Average MC	64.25		

Unit weight

No. Ring	3
No. Container	1081
Weight of Ring	27.16
Volume of Ring	15.669
Weight of Container	4.69
Weight of wet soil and ring and containe	60.46
Weight of dry soil and ring and containe	49.42
Water Content	62.834
Density	18.259
Dry Density	11.213
Saturation	100
Void ratio	2.2032
Porosity	0.6878

Specific Gravity

No. Test	1	2
No. Pycknometer	201	201
Weight of Pycknometer + soil	71.09	71.09
Weight of Pycknometer + water + soil	166.55	166.55
T° C	28	28
Weight of Pycknometer	52.92	52.92
Weight of Pycknometer + water	153.44	153.44
Specific Gravity	3.592	3.592
Average Specific Gravity	3.592	

Shrinkage Limit

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and container	-
Weight of dry soil and container	-
Weight of plate	-
Weight of plate and Mercury	-
Volume dry soil	-
Shrinkage Limit	-

F GWL OL 001; R 12-(17/10/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(04.00-04.40 m)-Classification.xlsm

PARTNER FOR DESIGN

Classification Test

GEOMINE

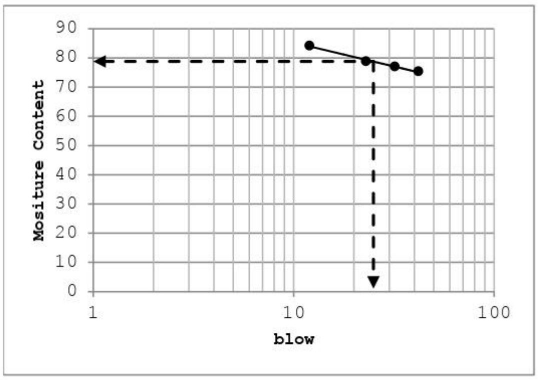
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 08
Depth : 04.00 - 04.40 m
Date Tested : 26/10/2021

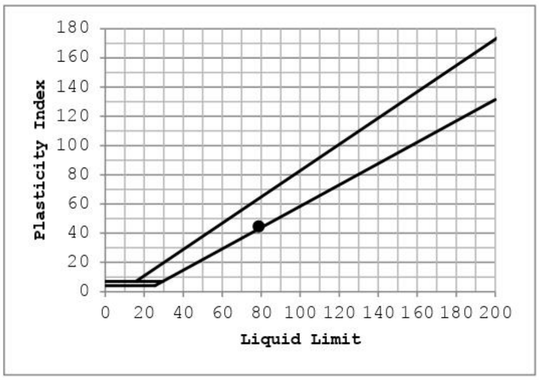
Plastic Limit

No. Test	1	2	3
No. Container	1142	1108	1041
Weight of Container	5.03	4.71	5.34
Weight of wet soil and container	12.68	12.67	12.41
Weight of dry soil and container	10.75	10.66	10.58
Plastic Limit	33.74	33.78	34.92
Average	34.15		

Liquid Limit

No. Test	1	2	3	4	5
No. Container	1141	1179	1110	1140	-
Weight of Container	4.54	4.33	5.03	4.37	-
Weight of wet soil and container	15.57	15.64	15.92	15.68	-
Weight of dry soil and container	10.83	10.72	11.12	10.51	-
Water Content	75.36	77.00	78.82	84.20	-
Number of blows	42	32	23	12	-
Liquid Limit	78.80				





Sieve Analysis

Bowl	0
Soil + Bowl	80.3
Weight of dry soil	80.3

Sieve No.	Sieve Diameter	Weight of Soil Retained	Percent Retained	Cumulative Percent Retained	Percent Finer
4	4.75	0.001	0.00	0.00	100.00
10	2	0.14	0.17	0.18	99.82
20	0.85	0.56	0.70	0.87	99.13
40	0.425	1.19	1.48	2.35	97.65
80	0.18	2.37	2.95	5.31	94.69
120	0.125	1.77	2.20	7.51	92.49
200	0.075	4.31	5.37	12.88	87.12
Pan	0	3.03	87.12	100	0.00

F GWL OL 001; R 12-(17/10/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(04.00-04.40 m)-Classification.xlsm

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 08
Depth : 04.00 - 04.40 m

Date Tested : 26/10/2021

GEOMINE

Hydrometer

Dry Sample

Weight of sample	66.929		
Zerro correction	-1	Gs	3.5918
Meniscus correction	1	a	0.8629

Time	t (minute)	T (Co)	Ra	Diameter	Percent Finer
12:20	0				
12:21	1	27	47	0.0291	67.19
12:22	2	27	45	0.0211	64.50
12:24	4	27	42	0.0152	60.47
12:28	8	27	37	0.0113	53.75
12:35	15	27	25	0.0090	37.63
12:50	30	27	5	0.0072	10.75
13:05	45	27	2	0.0059	6.72
13:50	90	27	0	0.0042	4.03
15:20	180	0	0	0.0000	0.00
9:20	1260	0	0	0.0000	0.00
12:20	1440	0	0	0.0000	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(04.00-04.40 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Falling Head

GEOMINE

Client ID :	Geomine
Project ID :	Hengjaya Mineralindo
GWL ID :	21 031
Area :	-
Point ID :	DHG 08
Depth :	04.00 -04.40 m

Date Tested : 27/10/2021

Time (minute)	Volume (cm3)	delta time (minute)	delta volume (cm3)
0	4.4	0	0
80	4.6	80	0.2
140	4.8	60	0.2
210	5	70	0.2
288	5.2	78	0.2
348	5.3	60	0.1
400	5.4	52	0.1
456	5.5	56	0.1

t-sample (cm): 6.60
Area-sample (cm2): 11.34
Head (cm): 50

k (cm/s): 4.850E-07

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(04.00-04.40 m)-Falling Head.xlsm

F GWL OL 040; R 01-(6/12/18)

PARTNER FOR DESIGN

Uniaxial Compressive Strength Test (v)

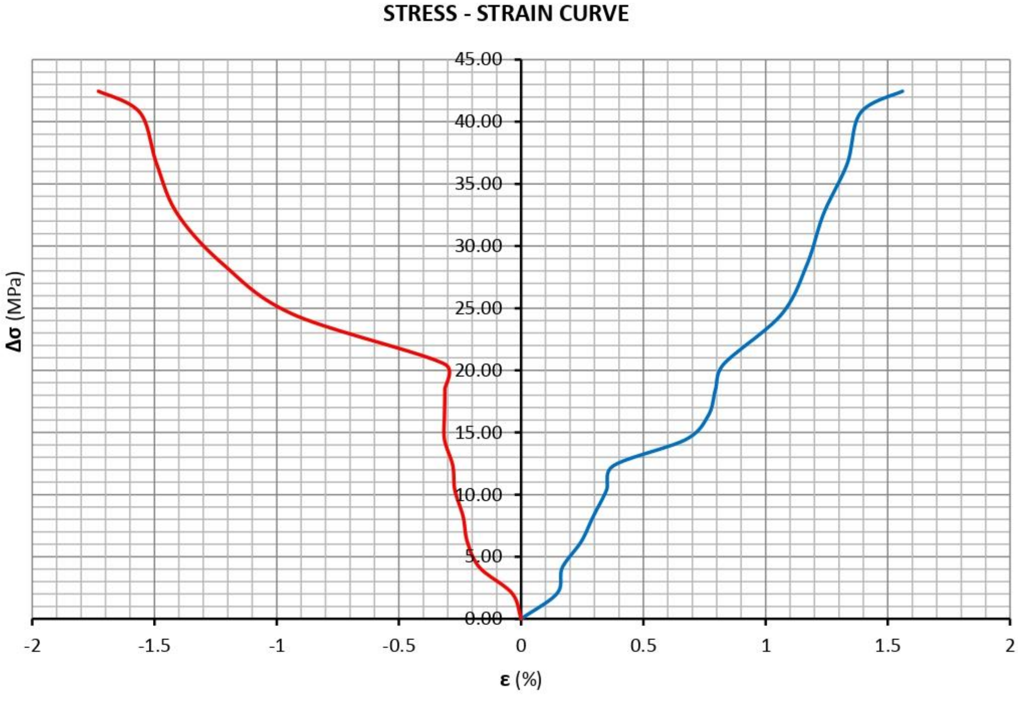
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 08
Depth : 17.30 - 17.50 m

Date Tested : 3/11/2021

GEOMINE

Results		
σ_{max*}	MPa	42.46
v	-	0.43
E	MPa	2386

* Coreccted by Hoek and Brown (1980a)



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(17.30-17.50 m)-UCS (Poisson).xlsm

F GWL OL 033; R 01-(22/09/14)

PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 08
Depth : 19.15 - 19.52 m
Date Tested : 27/10/2021

GEOMINE

Result		
Natural Density	kN/m³	30.90
Dry Density	kN/m³	30.75
Saturated Density	kN/m³	31.27
Spesific Gravity	-	3.25
Natural Water Content	%	0
Absorption	%	2
Saturation	%	0.05
Porosity	-	0.05
Void Ratio	-	0.06

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 08-(19.15-19.52 m)-Properties (Rock).xlsm

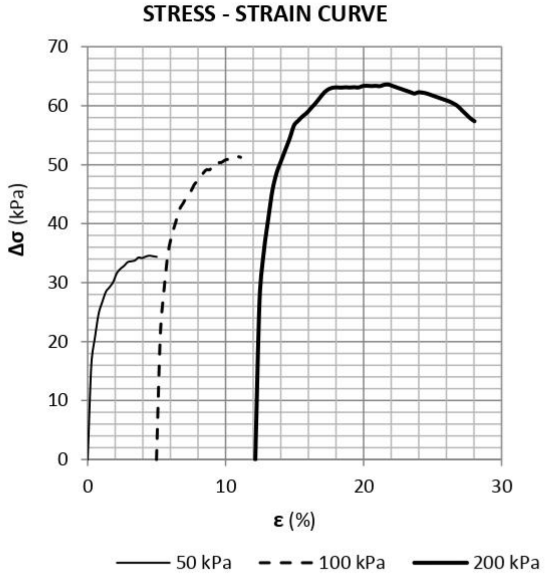
F GWL OL 026; R 04-(10/7/21)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

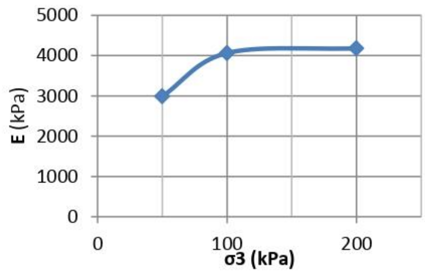
GEOMINE

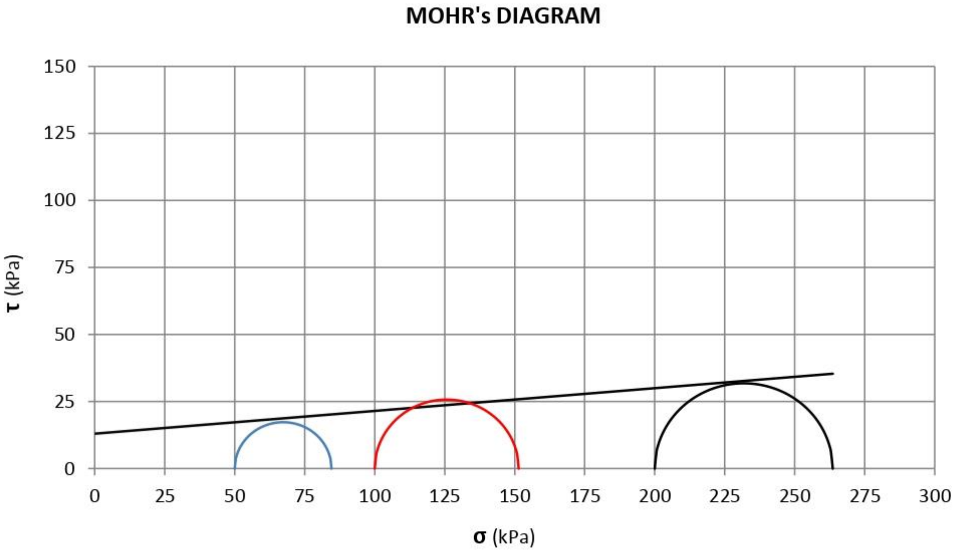
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 02.70 -03.10 m
Date Tested : 28/10/2021



No.	σ3 (kPa)	Δσ (kPa)	ε_f (%)
1.	50	34.56	4.47
2.	100	51.42	10.80
3.	200	63.58	21.81

Results		
c	kPa	13.0
ø	°	4.8





D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(02.70-03.10 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 02.70 -03.10 m
Date Tested : 28/10/2021

GEOMINE

Height of Sample: 76 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1391 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
0	0	0
20	16.15	0.26
40	20.74	0.53
60	24.7	0.79
80	26.7	1.05
100	28.44	1.32
120	29.21	1.58
140	30.1	1.84
160	31.58	2.11
180	32.33	2.37
200	32.84	2.63
220	33.47	2.89
240	33.61	3.16
260	33.76	3.42
280	34.26	3.68
300	34.16	3.95
320	34.42	4.21
340	34.56	4.47
360	34.47	4.74
380	34.37	5

Deviator Stress Maximum: 34.56 kPa — E_0: 1930.77 kPa
Strain at Failure: 5.00 % — E_{50}: 1365.10 kPa
Deviator Stress at (50%): 32.33 kPa
Strain at (50%): 2.37 %

+ + + + + + + + + STAGE - 1 + + + + + + + + +

Height of Sample: 72.2 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1391 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
360	0	4.99
380	21.03	5.26
400	28.96	5.54
420	34.89	5.82
440	38.01	6.09
460	40.19	6.37
480	42.36	6.65
500	43.49	6.93

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(02.70-03.10 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 02.70 -03.10 m
Date Tested : 28/10/2021

GEOMINE

520	44.62	7.2
540	45.5	7.48
560	46.73	7.76
580	47.38	8.03
600	48.36	8.31
620	49.11	8.59
640	49.18	8.86
660	50.15	9.14
680	50.33	9.42
700	50.4	9.7
720	50.79	9.97
740	50.97	10.25
760	51.36	10.53
780	51.42	10.8
800	51.26	11.08

Deviator Stress Maximum: 51.42 kPa — E_{0}: 2249.27 kPa
Strain at Failure: 11.08 % — E_{50}: 589.74 kPa
Deviator Stress at (50%): 47.38 kPa
Strain at (50%): 8.03 %

+ + + + + + + + + STAGE - 2 + + + + + + + + +

Height of Sample: 64.2 mm
Diameter of Sample: 38 mm
Calibration Dial Gauge: 0.1391 kg/div
Calibration Strain Gauge: 0.01 mm/div

--- Triaxial S H E A R I N G ---

Strain Gauge (div)	Deviator Stress (kPa)	Strain (%)
780	0	12.15
800	27.16	12.46
820	35.31	12.77
840	40.72	13.08
860	45.67	13.4
880	48.69	13.71
900	50.62	14.02
920	52.54	14.33
940	54.44	14.64
960	56.64	14.95
980	57.47	15.26
1000	58.19	15.58
1020	58.8	15.89
1040	59.61	16.2
1060	60.42	16.51
1080	61.31	16.82
1100	62.2	17.13
1120	62.78	17.45
1140	63.04	17.76
1160	63.11	18.07
1180	63.07	18.38

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(02.70-03.10 m)-TX UU.xlsm
F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Triaxial Unconsolidated Undrained Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 02.70 -03.10 m
Date Tested : 28/10/2021

GEOMINE

1200	63.13	18.69
1220	63.08	19
1240	63.14	19.31
1260	63.09	19.63
1280	63.34	19.94
1300	63.38	20.25
1320	63.33	20.56
1340	63.37	20.87
1360	63.32	21.18
1380	63.55	21.5
1400	63.58	21.81
1420	63.33	22.12
1440	63.08	22.43
1460	62.82	22.74
1480	62.57	23.05
1500	62.32	23.36
1520	62.06	23.68
1540	62.28	23.99
1560	62.21	24.3
1580	62.04	24.61
1600	61.79	24.92
1620	61.53	25.23
1640	61.28	25.55
1660	61.02	25.86
1680	60.76	26.17
1700	60.42	26.48
1720	59.98	26.79
1740	59.28	27.1
1760	58.58	27.41
1780	57.89	27.73
1800	57.37	28.04

Deviator Stress Maximum: 63.58 kPa E_0: 1072.54 kPa
Strain at Failure: 28.04 % E_{50}: 317.67 kPa
Deviator Stress at (50%): 63.34 kPa
Strain at (50%): 19.94 %

+ + + + + + + + + STAGE - 3 + + + + + + + + +

No. Container : 1132
Wet Soil + Container : 153.19 gram
Dry Soil + Container : 100.19 gram
Weight of Container : 4.46 gram
Density : 17.26 kN/m3
Moisture Content : 55.36 %
Dry Density : 11.11 kN/m3

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(02.70-03.10 m)-TX UU.xlsm

F GWL OL 008; R 05-(14/09/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 07.00 - 07.40 m
Date Tested : 26/10/2021

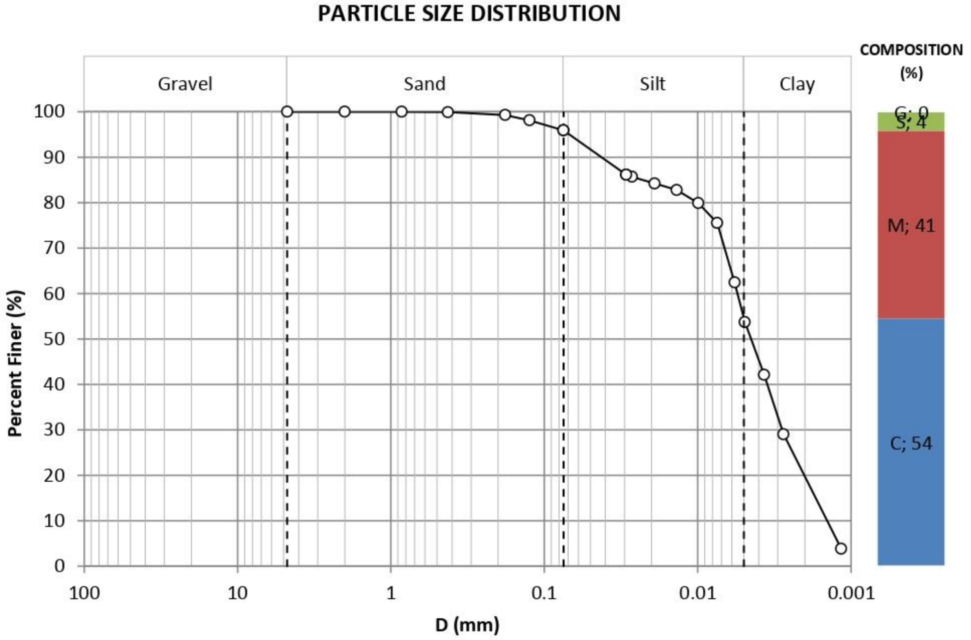
GEOMINE

Test		Results
Unit Weight	kN/m^3	17.4
SL	%	-
Gs	-	3.54
MC	%	92
PL	%	52
LL	%	97
PI	%	45
Fines (#200)	%	96
D_{10}	mm	0.0014
D_{30}	mm	0.0028
D_{60}	mm	0.0055
C_u	-	4
C_c	-	1.01

* Casagrande's Method
** Based on Consistency Index (Ic)

Properties		Results
I_F	%	-0.59
I_T	%	-77.34
I_L	%	0.89
I_C	%	0.11
S_r	%	100.00
e	-	2.73
n	-	0.73
A	-	4.07

Consistency**	Very Soft
Activity	Active
Plasticity Symbol	MH or OH



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(07.00-07.40 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

GEOMINE

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 07.00 - 07.40 m

Date Tested : 26/10/2021

Moisture Content

No. Test	1	2	3
No. Container	1229	1117	1069
Weight of Container	4.62	4.96	4.97
Weight of wet soil and container	107.42	128.54	123.72
Weight of dry soil and container	58.70	69.04	66.56
Moisture Content	90.09	92.85	92.81
Average MC	91.92		

Unit weight

No. Ring	11
No. Container	1070
Weight of Ring	26.93
Volume of Ring	15.216
Weight of Container	4.77
Weight of wet soil and ring and containe	58.17
Weight of dry soil and ring and containe	46.12
Water Content	83.564
Density	17.396
Dry Density	9.4768
Saturation	100
Void ratio	2.7305
Porosity	0.7319

Specific Gravity

No. Test	1	2
No. Pycknometer	203	203
Weight of Pycknometer + soil	77.16	77.16
Weight of Pycknometer + water + soil	168.61	168.61
T° C	28	28
Weight of Pycknometer	54.5	54.5
Weight of Pycknometer + water	152.36	152.36
Specific Gravity	3.535	3.535
Average Specific Gravity	3.535	

Shrinkage Limit

No. Ring	-
No. Container	-
Weight of Ring	-
Volume of Ring	-
Weight of Container	-
Weight of wet soil and container	-
Weight of dry soil and container	-
Weight of plate	-
Weight of plate and Mercury	-
Volume dry soil	-
Shrinkage Limit	-

F GWL OL 001; R 12-(17/10/18)

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(07.00-07.40 m)-Classification.xlsm

PARTNER FOR DESIGN

Classification Test

GEOMINE

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 07.00 - 07.40 m

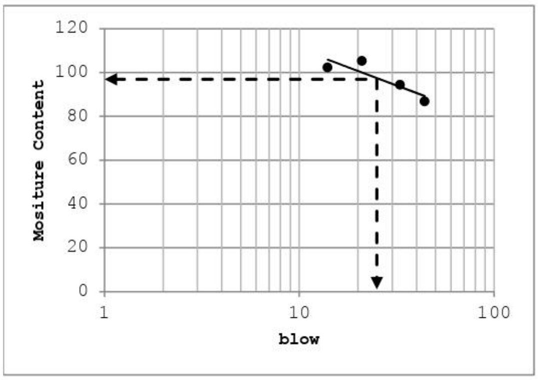
Date Tested : 26/10/2021

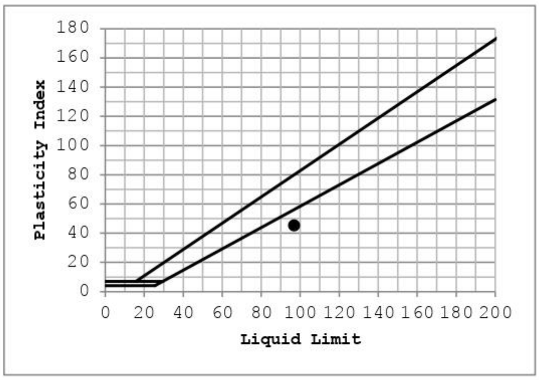
Plastic Limit

No. Test	1	2	3
No. Container	1191	1187	1230
Weight of Container	4.28	4.44	4.56
Weight of wet soil and container	11.8	11.82	11.12
Weight of dry soil and container	9.28	9.25	8.91
Plastic Limit	50.40	53.43	50.80
Average	51.54		

Liquid Limit

No. Test	1	2	3	4	5
No. Container	1232	1066	1224	1120	-
Weight of Container	4.39	4.8	4.57	4.96	-
Weight of wet soil and container	15.54	15.7	15.53	15.7	-
Weight of dry soil and container	10.36	10.41	9.91	10.27	-
Water Content	86.77	94.30	105.24	102.26	-
Number of blows	44	33	21	14	-
Liquid Limit	96.92				





Sieve Analysis

Bowl	0
Soil + Bowl	80.33
Weight of dry soil	80.33

Sieve No.	Sieve Diameter	Weight of Soil Retained	Percent Retained	Cumulative Percent Retained	Percent Finer
4	4.75	0.001	0.00	0.00	100.00
10	2	0	0.00	0.00	100.00
20	0.85	0	0.00	0.00	100.00
40	0.425	0.05	0.06	0.06	99.94
80	0.18	0.52	0.65	0.71	99.29
120	0.125	0.93	1.16	1.87	98.13
200	0.075	1.77	2.20	4.07	95.93
Pan	0	1.39	95.93	100	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(07.00-07.40 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

PARTNER FOR DESIGN

Classification Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 07.00 - 07.40 m

Date Tested : 26/10/2021

GEOMINE

Hydrometer

Dry Sample

Weight of sample	75.669		
Zerro correction	-1	Gs	3.5353
Meniscus correction	1	a	0.8682

Time	t (minute)	T (Co)	Ra	Diameter	Percent Finer
12:20	0				
12:21	1	27	56	0.0269	85.70
12:22	2	27	55	0.0191	84.25
12:24	4	27	54	0.0137	82.80
12:28	8	27	52	0.0099	79.89
12:35	15	27	49	0.0075	75.53
12:50	30	27	40	0.0057	62.46
13:05	45	27	34	0.0049	53.75
13:50	90	27	26	0.0037	42.12
15:20	180	27	17	0.0028	29.05
9:20	1260	26	0	0.0012	3.85
12:20	1440	0	0	0.0000	0.00

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(07.00-07.40 m)-Classification.xlsm

F GWL OL 001; R 12-(17/10/18)

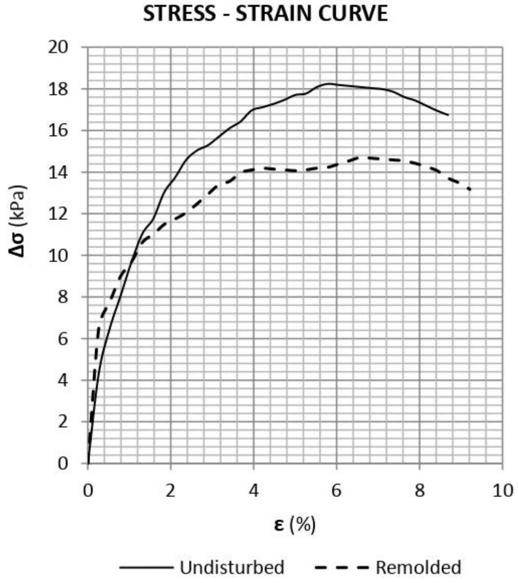
PARTNER FOR DESIGN

Unconfined Compression Test

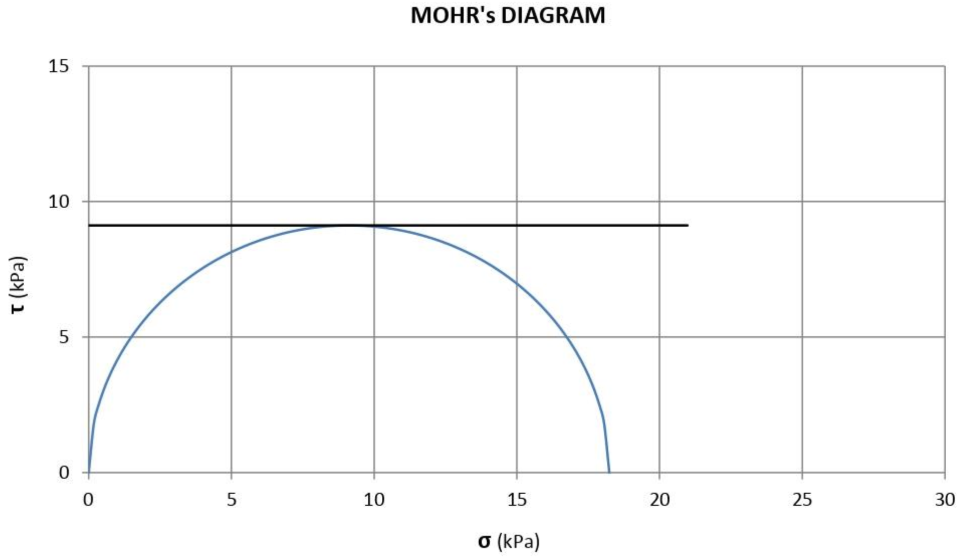
Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 14.10 - 14.31 m

Date Tested : 29/10/2021

GEOMINE



Results		Undisturbed	Remolded
σ_{max}	kPa	18.2	14.7
ε_f	%	5.79	6.58
S_t	-	1.24	
c	kPa	9.1	7.4
E_{50}	kPa	745	807
E_{sec}	kPa	315	224



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(14.10-14.31 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Unconfined Compression Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 14.10 - 14.31 m
Date Tested : 29/10/2021

GEOMINE

Undisturbed

Height of Sample : 76 mm
Diameter of Sample : 38 mm
Calibration Dial Gauge : 0.04826 kg/div
Calibration Strain Load : 0.01 mm/div

Water Content : 62.66 %
Unit Weight : 13.98 kN/m3
Dry Density : 8.59 kN/m3

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)	Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
0	0.00	0.0000	-	-	-
20	4.33	0.2632			
40	6.48	0.5263			
60	8.06	0.7895			
80	9.68	1.0526			
100	11.04	1.3158			
120	11.77	1.5789			
140	13.03	1.8421			
160	13.75	2.1053			
180	14.58	2.3684			
200	15.04	2.6316			
220	15.29	2.8947			
240	15.70	3.1579			
260	16.11	3.4211			
280	16.44	3.6842			
300	16.96	3.9474			
320	17.12	4.2105			
340	17.28	4.4737			
360	17.47	4.7368			
380	17.71	5.0000			
400	17.78	5.2632			
420	18.09	5.5263			
440	18.24	5.7895			
460	18.19	6.0526			
480	18.14	6.3158			
500	18.09	6.5789			
520	18.04	6.8421			
540	17.99	7.1053			
560	17.86	7.3684			
580	17.61	7.6316			
600	17.44	7.8947			
620	17.20	8.1579			
640	16.95	8.4211			
660	16.75	8.6842			

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(14.10-14.31 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Unconfined Compression Test

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 14.10 - 14.31 m
Date Tested : 29/10/2021

GEOMINE

Remolded

Height of Sample : 76 mm
Diameter of Sample : 38 mm
Calibration Dial Gauge : 0.04826 kg/div
Calibration Strain Load : 0.01 mm/div

Strain Gauge (div)	Deviator Stress (kPa)	ε (%)	Strain Gauge (div)	Deviator Stress (kPa)	ε (%)
0	0	0.0000	-	-	-
20	6.49	0.2632			
40	7.75	0.5263			
60	8.99	0.7895			
80	9.68	1.0526			
100	10.62	1.3158			
120	11.01	1.5789			
140	11.49	1.8421			
160	11.75	2.1053			
180	12.05	2.3684			
200	12.47	2.6316			
220	12.93	2.8947			
240	13.39	3.1579			
260	13.56	3.4211			
280	13.98	3.6842			
300	14.10	3.9474			
320	14.18	4.2105			
340	14.15	4.4737			
360	14.11	4.7368			
380	14.07	5.0000			
400	14.11	5.2632			
420	14.19	5.5263			
440	14.23	5.7895			
460	14.39	6.0526			
480	14.55	6.3158			
500	14.71	6.5789			
520	14.67	6.8421			
540	14.63	7.1053			
560	14.58	7.3684			
580	14.54	7.6316			
600	14.42	7.8947			
620	14.26	8.1579			
640	14.07	8.4211			
660	13.72	8.6842			
680	13.48	8.9474			
700	13.17	9.2105			

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(14.10-14.31 m)-UCT.xlsm

F GWL OL 002; R 05-(6/09/18)

PARTNER FOR DESIGN

Falling Head

GEOMINE

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 16.27 -16.48 m
Date Tested : 27/10/2021

Time (minute)	Volume (cm3)	delta time (minute)	delta volume (cm3)
0	5.6	0	0
30	9.3	30	3.7
80	14.6	50	5.3
210	20.5	130	5.9
288	25.2	78	4.7
348	30	60	4.8
400	34.2	52	4.2
456	37.5	56	3.3

t-sample (cm): 6.60
Area-sample (cm2): 11.34
Head (cm): 50

k (cm/s): 1.387E-05

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(16.27-16.48 m)-Falling Head.xlsm

F GWL OL 040; R 01-(6/12/18)

PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 09
Depth : 18.30 - 18.50 m
Date Tested : 25/10/2021

GEOMINE

Result		
Natural Density	kN/m^3	13.25
Dry Density	kN/m^3	7.97
Saturated Density	kN/m^3	14.67
Spesific Gravity	-	2.41
Natural Water Content	%	66
Absorption	%	84
Saturation	%	0.67
Porosity	-	0.67
Void Ratio	-	2.03

D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(18.30-18.50 m)-Properties (Rock).xlsm

F GWL OL 026; R 04-(10/7/21)

PARTNER FOR DESIGN

Uniaxial Compressive Strength Test (v)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : 21 031
Area : -
Point ID : DHG 09
Depth : 28.55 - 28.76 m

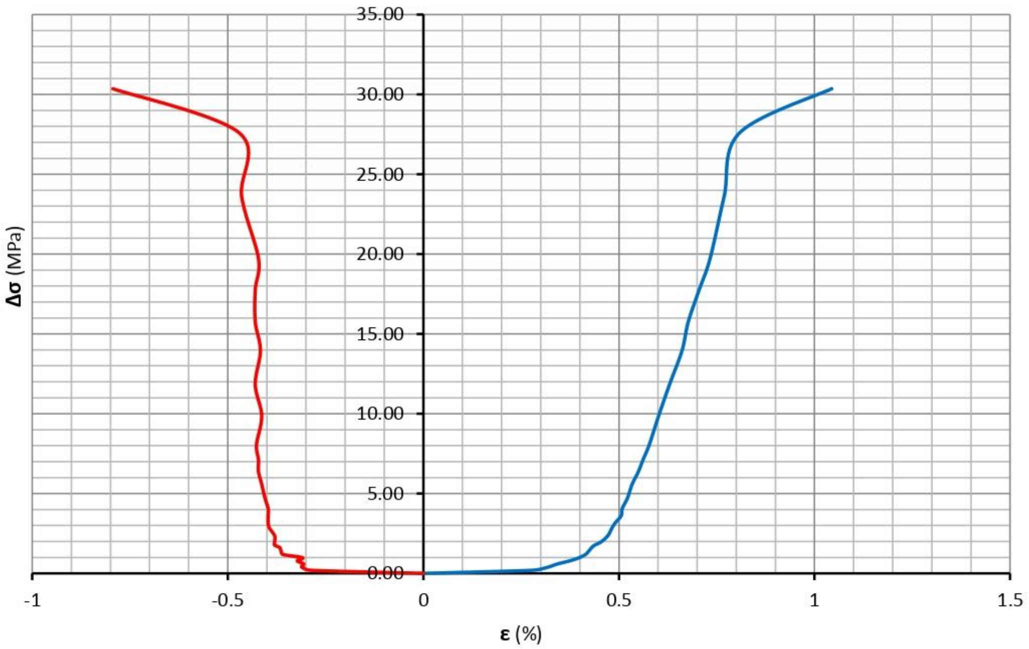
Date Tested : 3/11/2021

GEOMINE

Results		
σ_{max*}	MPa	30.35
v	-	0.46
E	MPa	6031

* Coreccted by Hoek and Brown (1980a)

STRESS - STRAIN CURVE



D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(28.55-28.76 m)-UCS (Poisson).xlsm

F GWL OL 033; R 01-(22/09/14)

PARTNER FOR DESIGN

Properties Test (Rock)

Client ID : Geomine
Project ID : Hengjaya Mineralindo
GWL ID : : 21 031
Area : -
Point ID : DHG 09
Depth : 29.30 - 29.55 m
Date Tested : 27/10/2021

GEOMINE

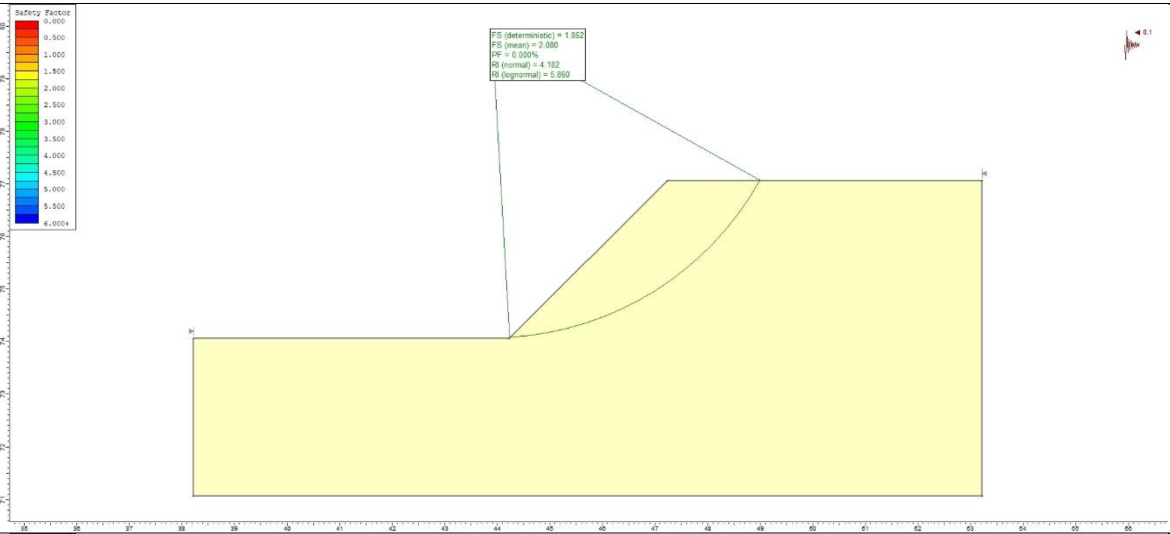
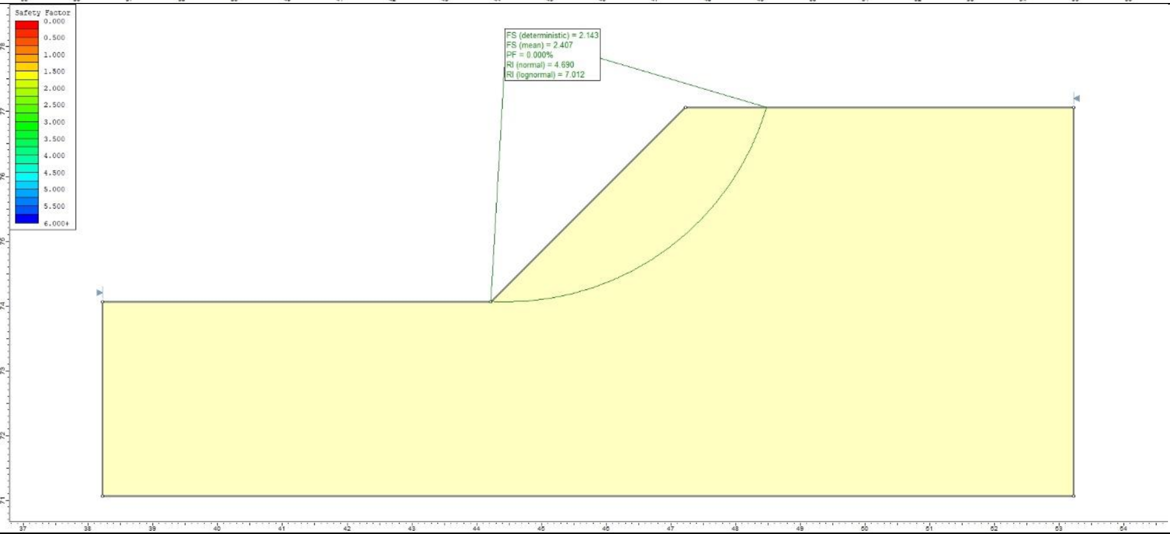
Result		
Natural Density	kN/m^3	22.60
Dry Density	kN/m^3	21.19
Saturated Density	kN/m^3	23.00
Spesific Gravity	-	2.59
Natural Water Content	%	7
Absorption	%	9
Saturation	%	0.18
Porosity	-	0.18
Void Ratio	-	0.22

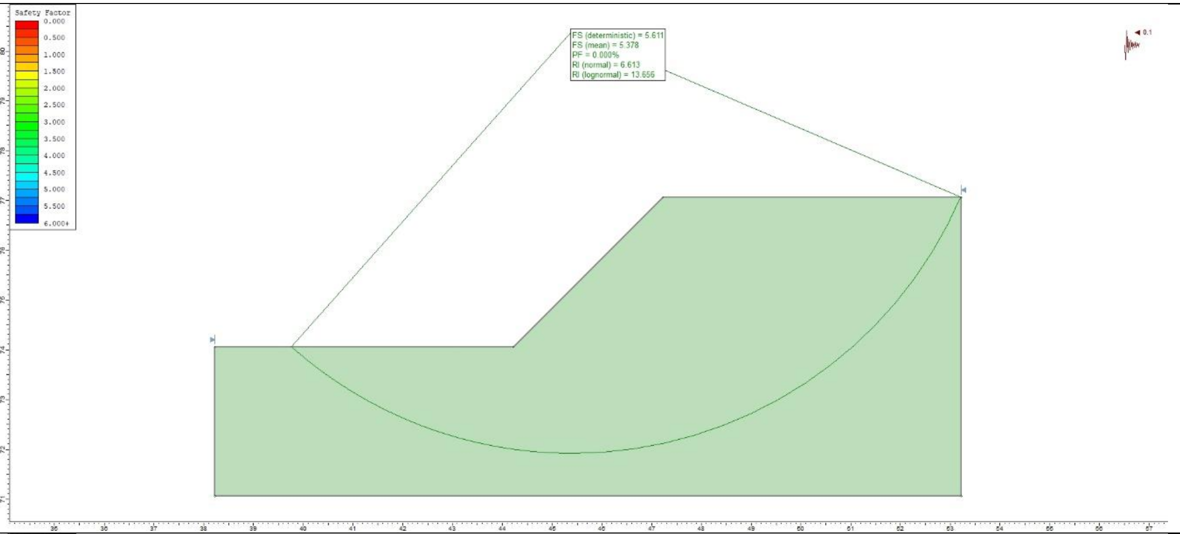
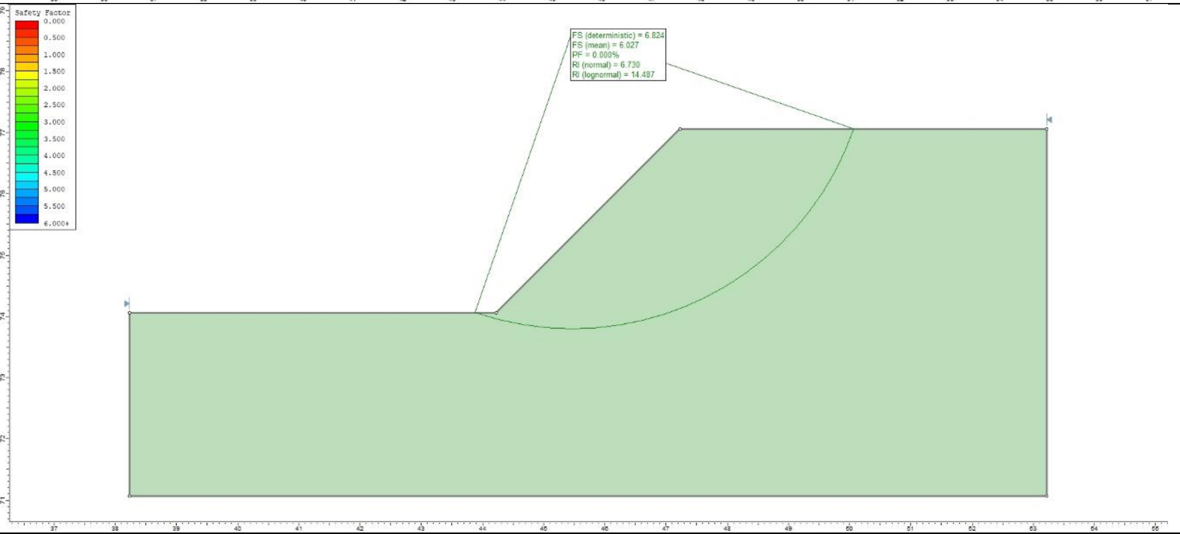
D:\Projects\2021\21 031\Technical\Test Data\F 21 031 GWL-X-DHG 09-(29.30-29.55 m)-Properties (Rock).xlsm

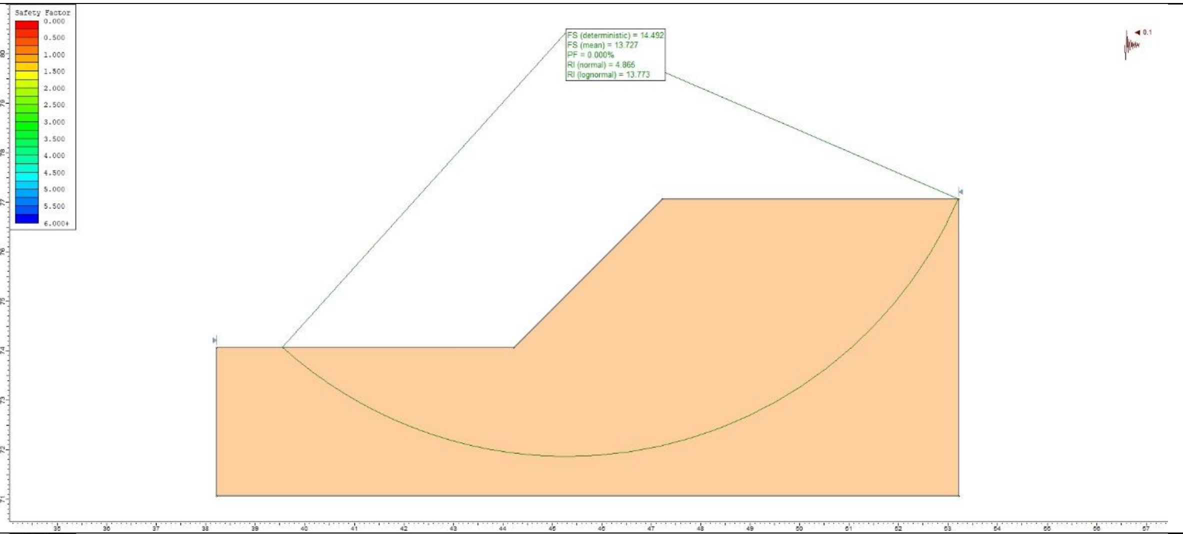
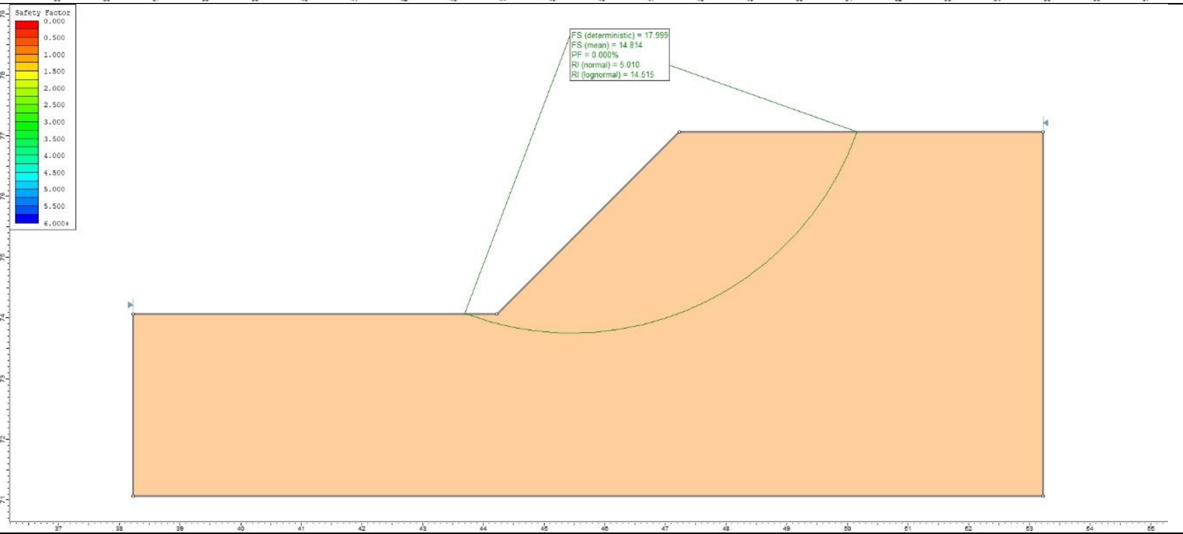
F GWL OL 026; R 04-(10/7/21)

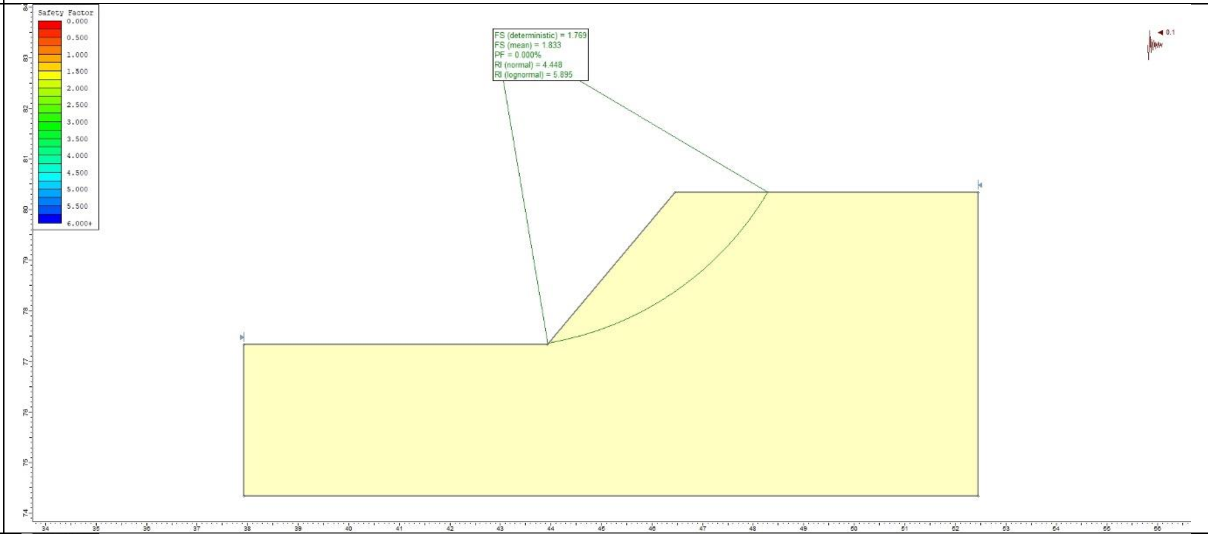
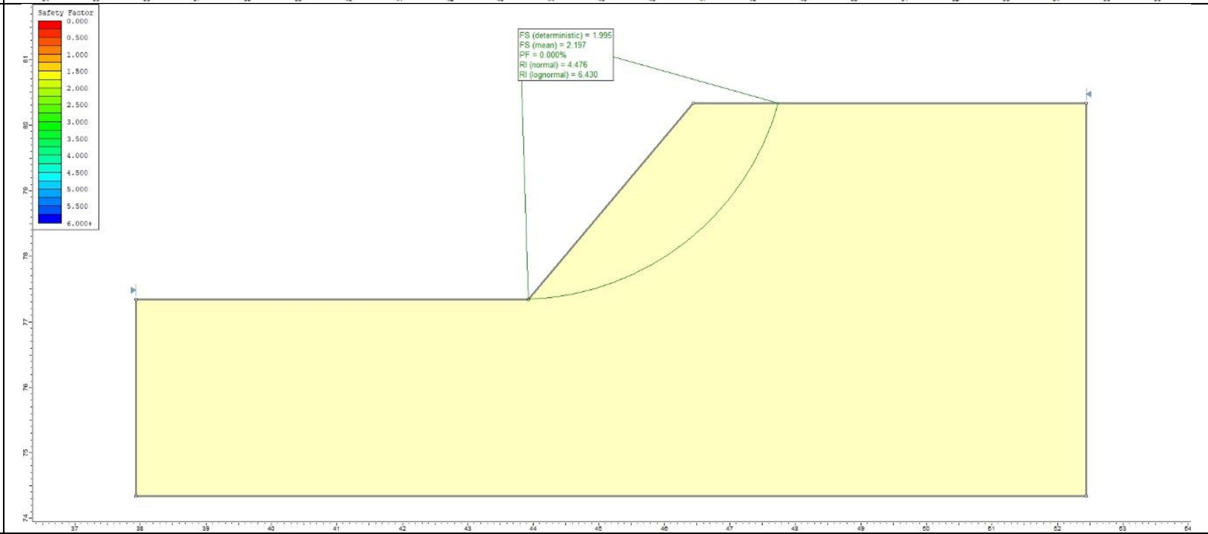
Lampiran E

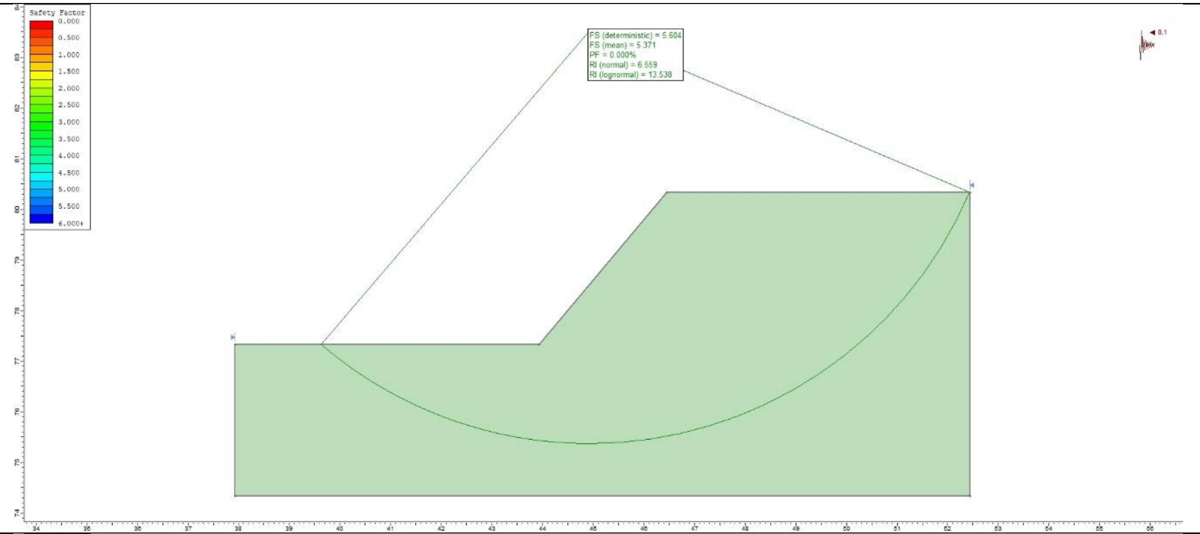
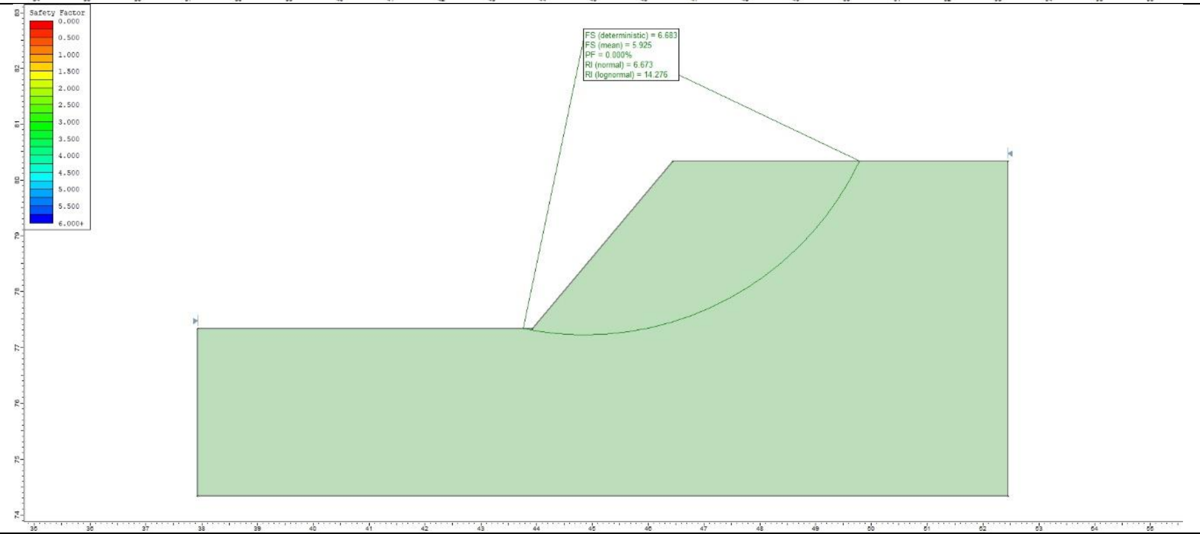
Hasil Analisis Kestabilan Lereng

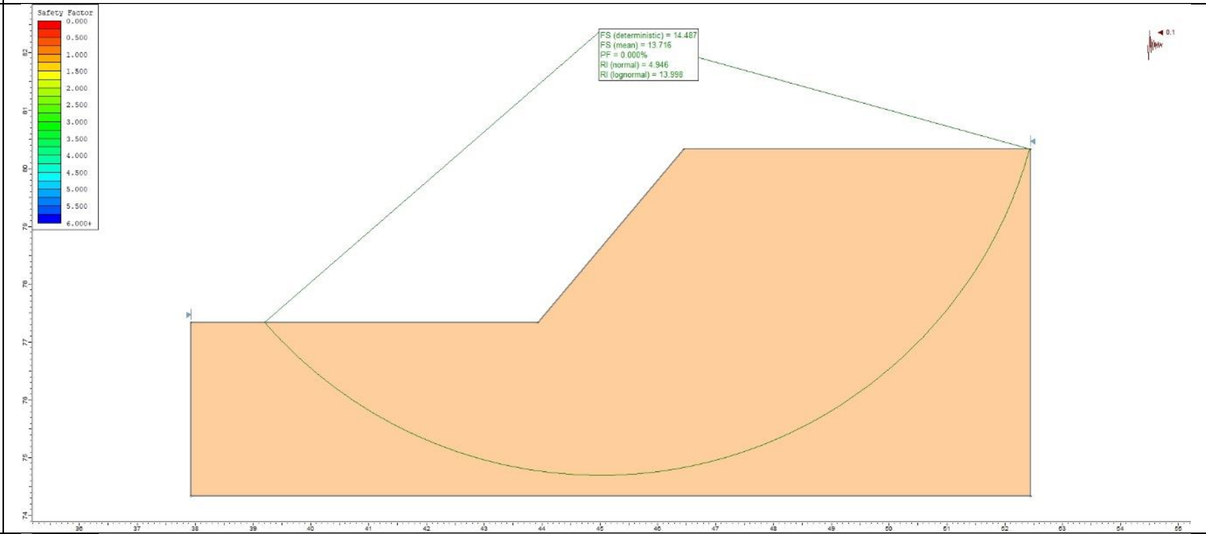
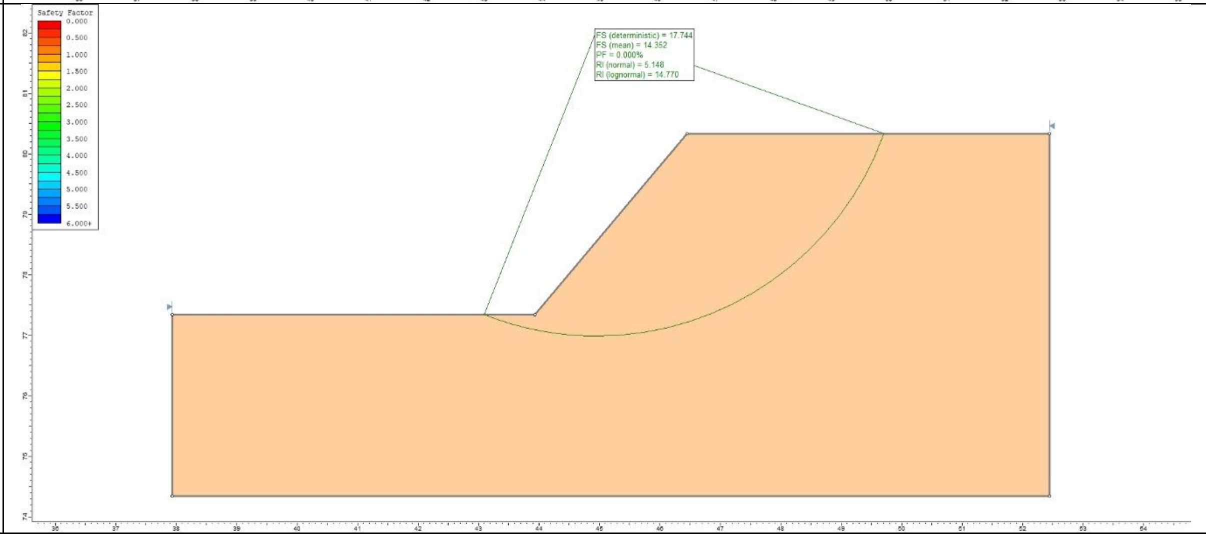
Limonite			
Lereng	Kondisi	Gambar	FK
H=3 S=45	Dinamik		1,86
	Statik		2,14

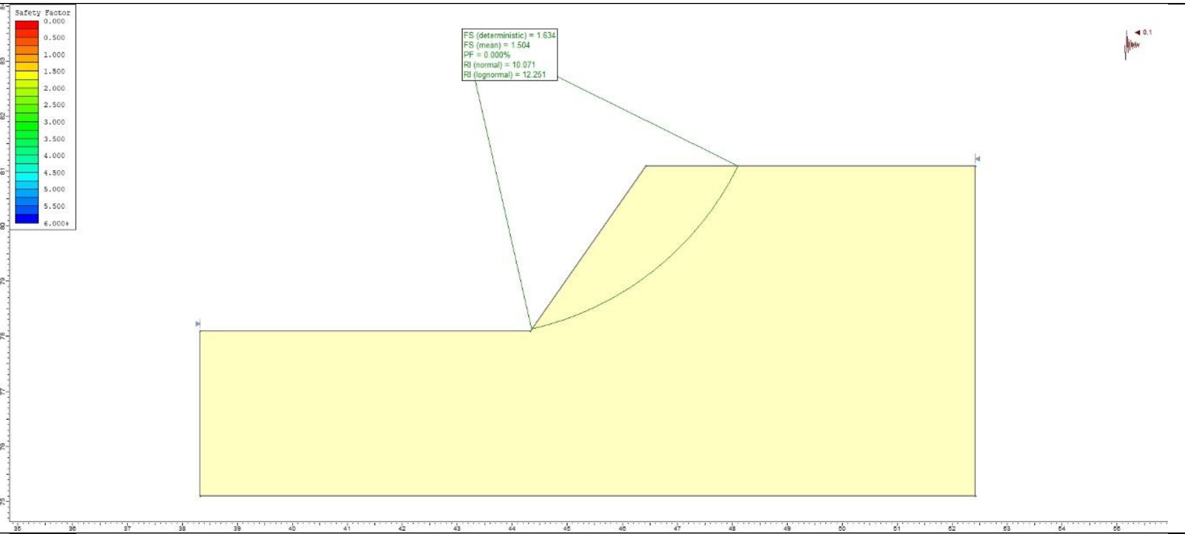
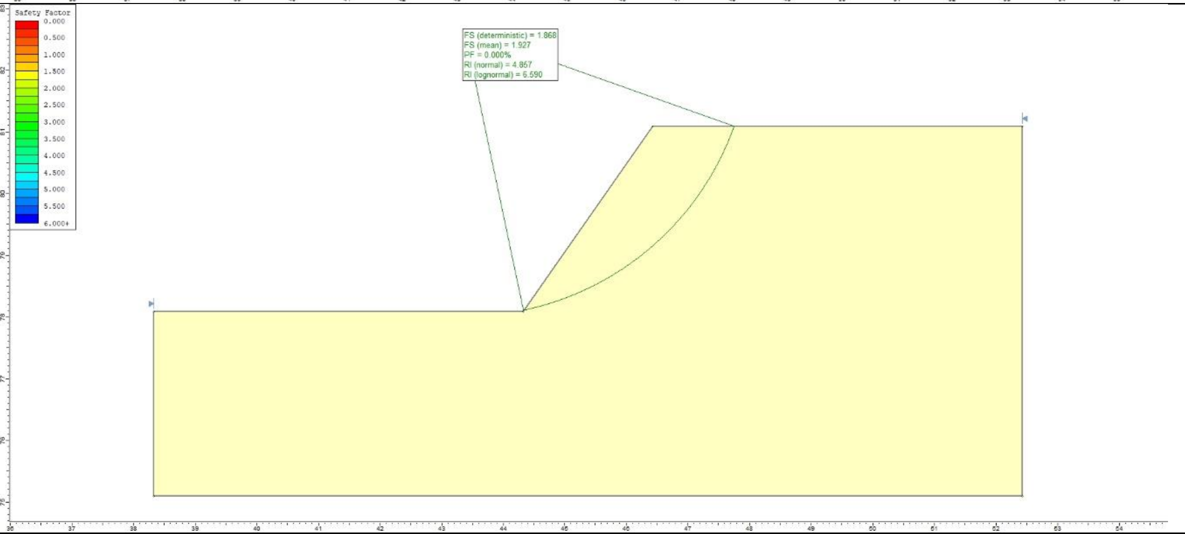
Saprolite			
Lereng	Kondisi	Gambar	FK
H=3 S=45	Dinamik		5,61
	Statik		6,82

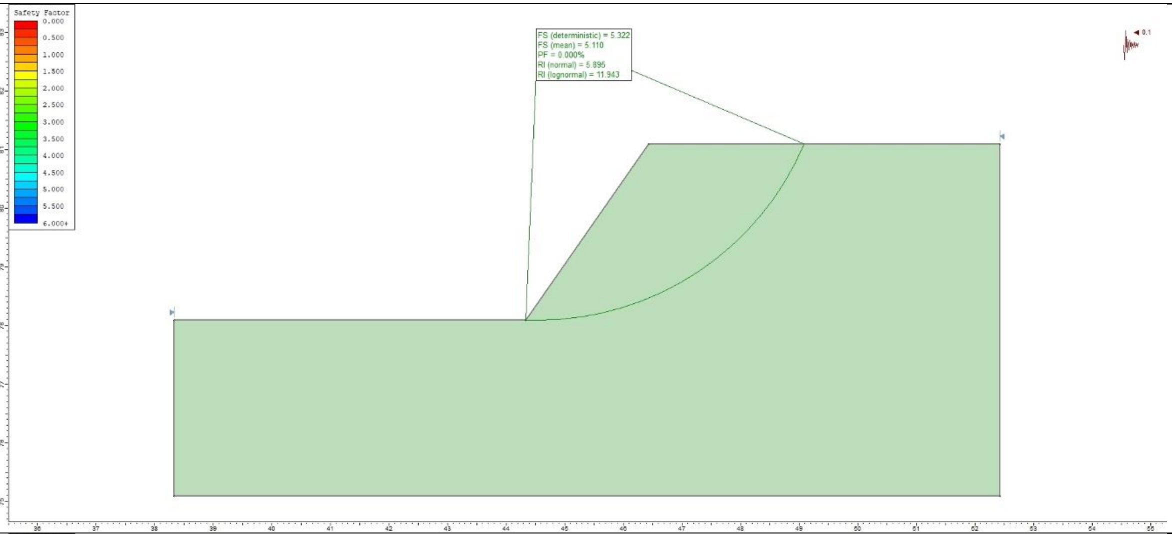
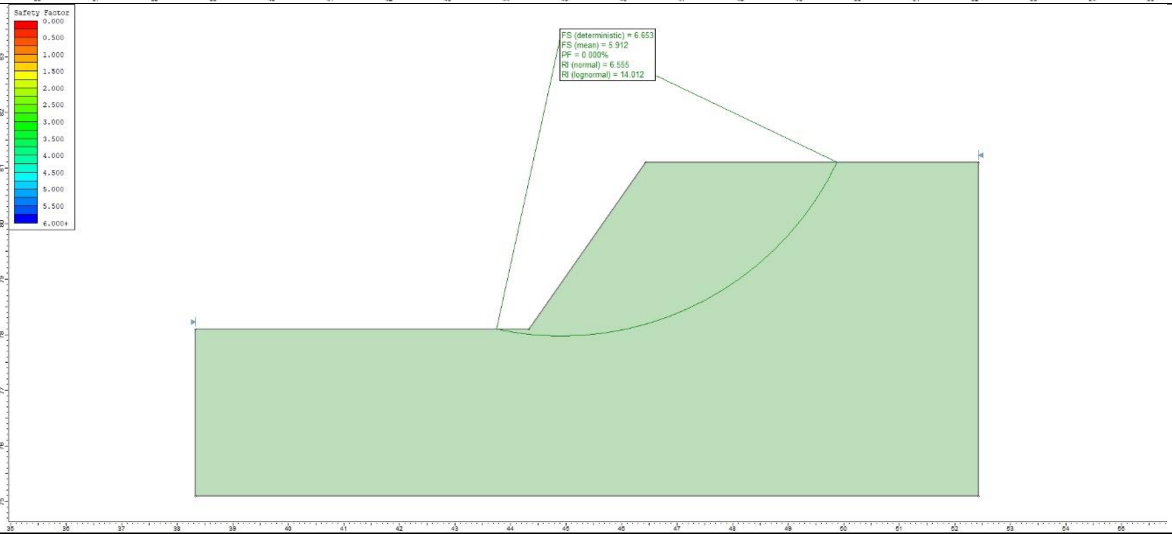
Bedrock			
Lereng	Kondisi	Gambar	FK
H=3 S=45	Dinamik		14,49
	Statik		17,99

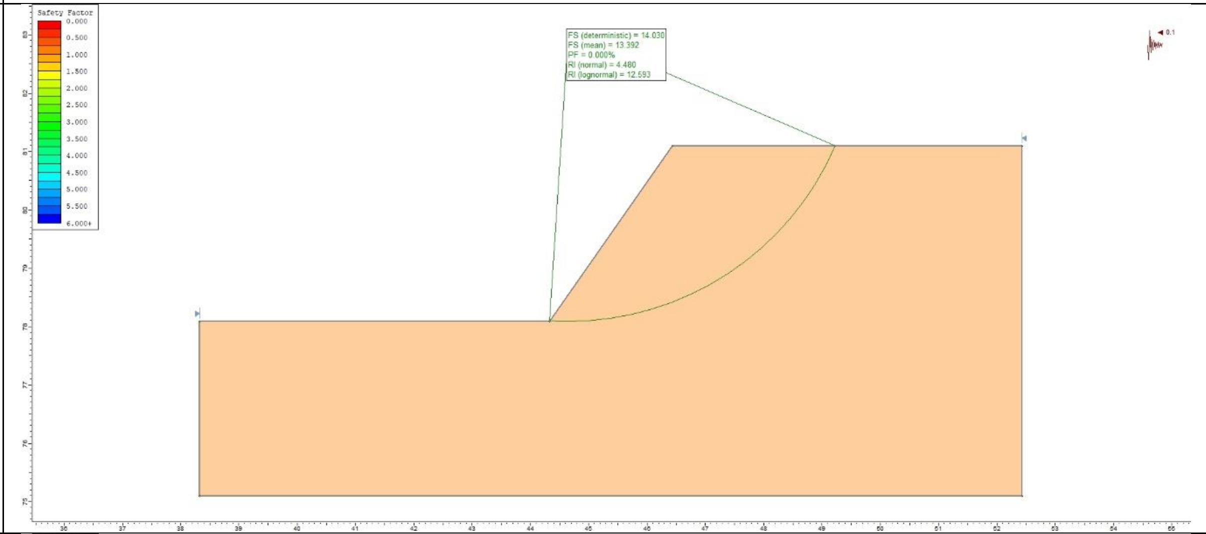
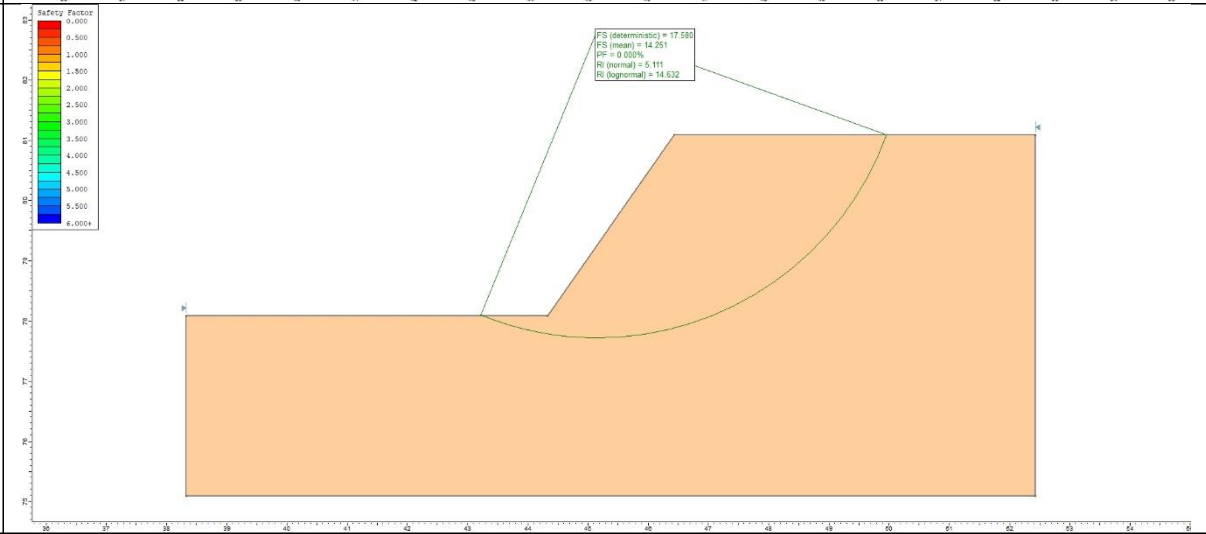
Limonite			
Lereng	Kondisi	Gambar	FK
H=3 S=50	Dinamik		1,77
	Statik		1,99

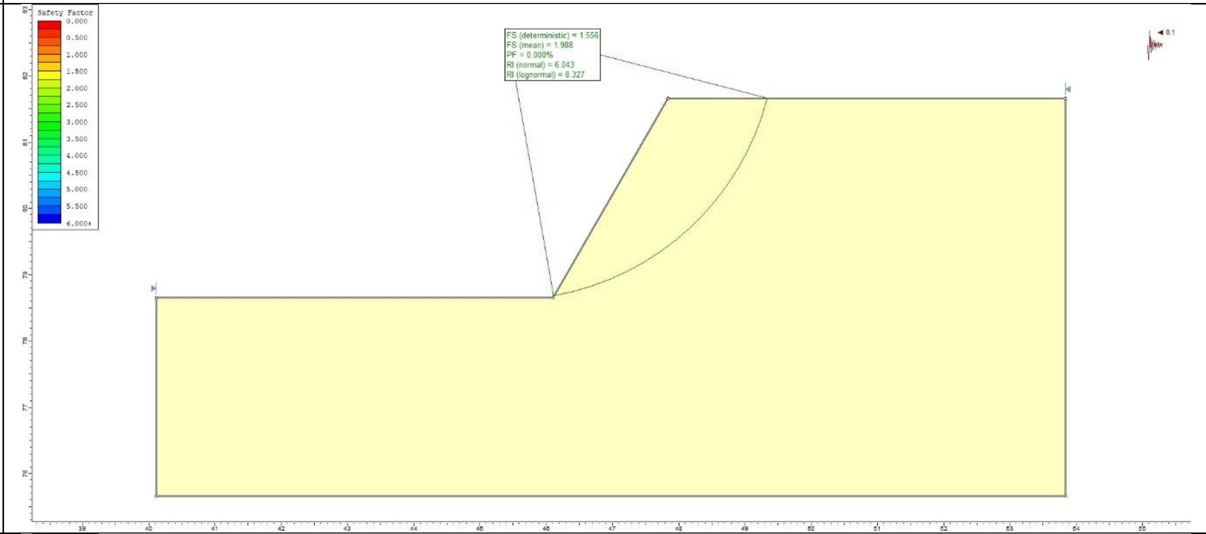
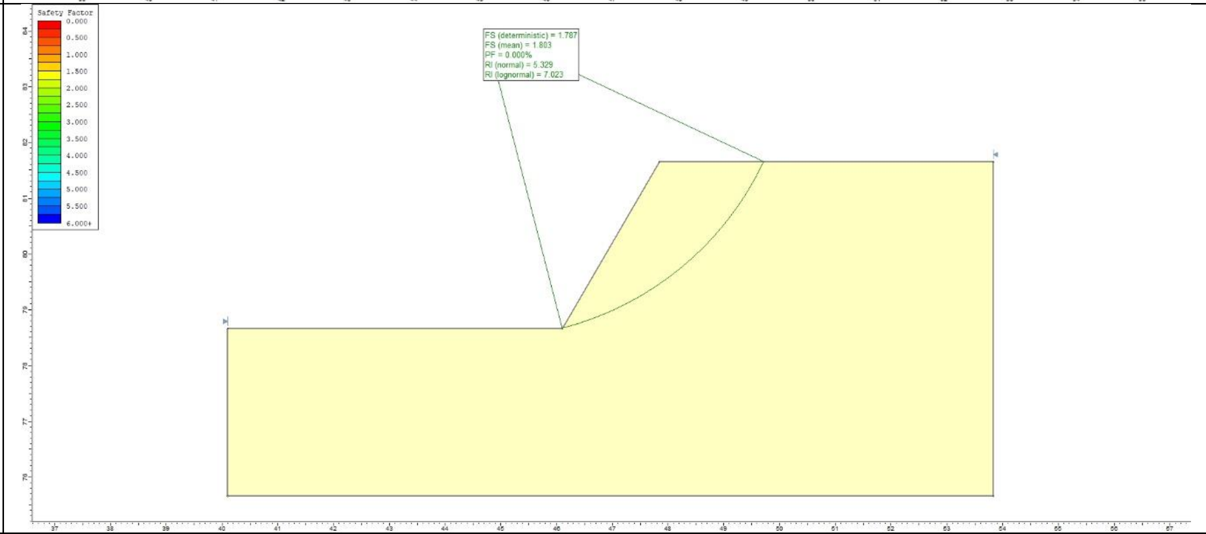
Saprolite			
Lereng	Kondisi	Gambar	FK
H=3 S=50	Dinamik		5,60
	Statik		6,68

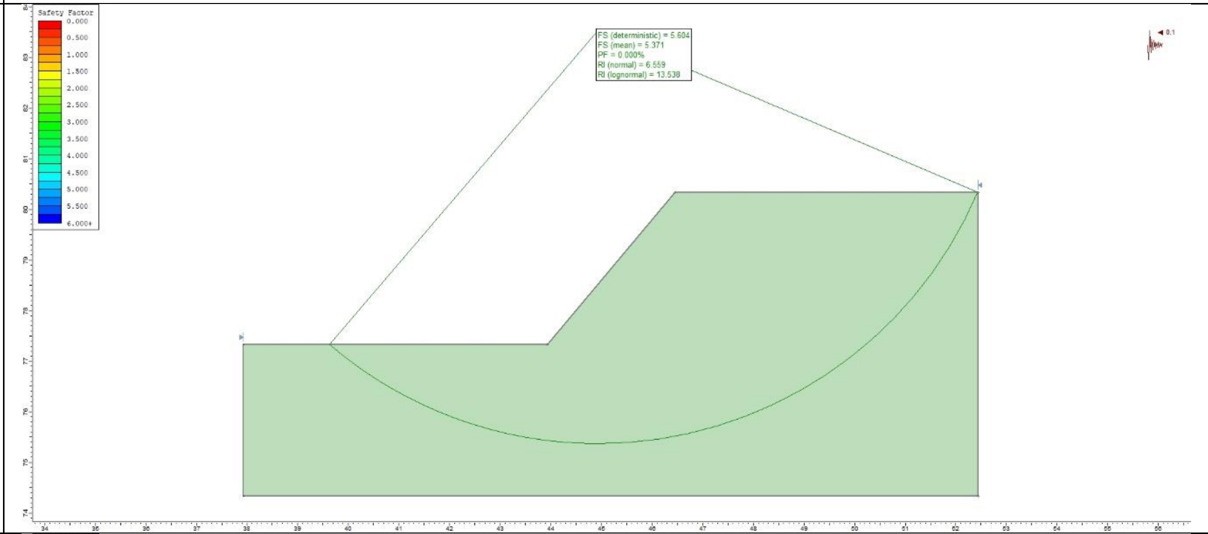
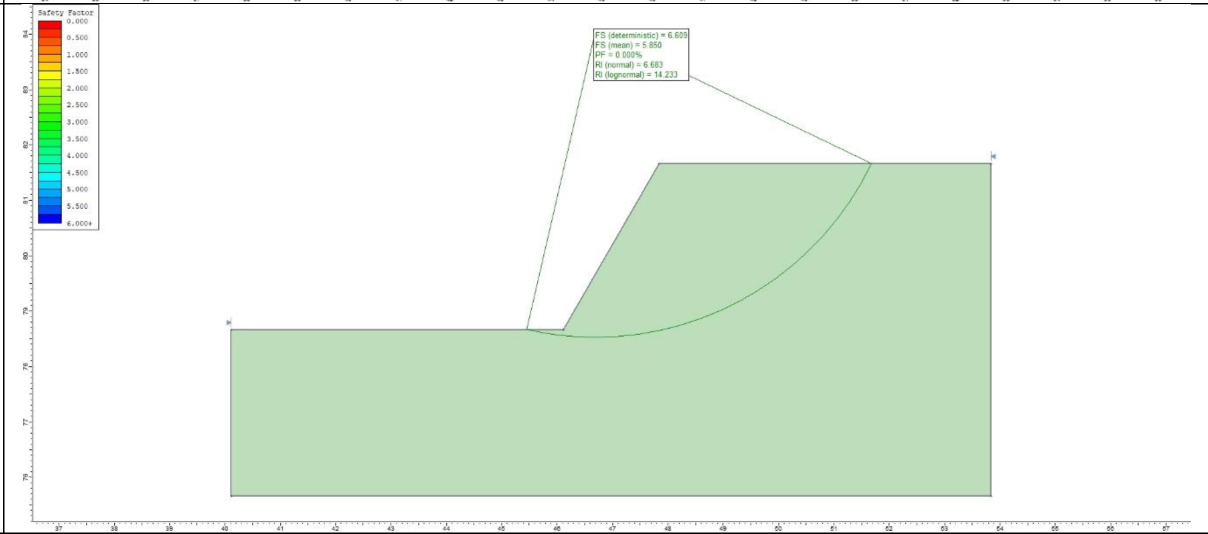
Bedrock			
Lereng	Kondisi	Gambar	FK
H=3 S=50	Dinamik		14,49
	Statik		17,74

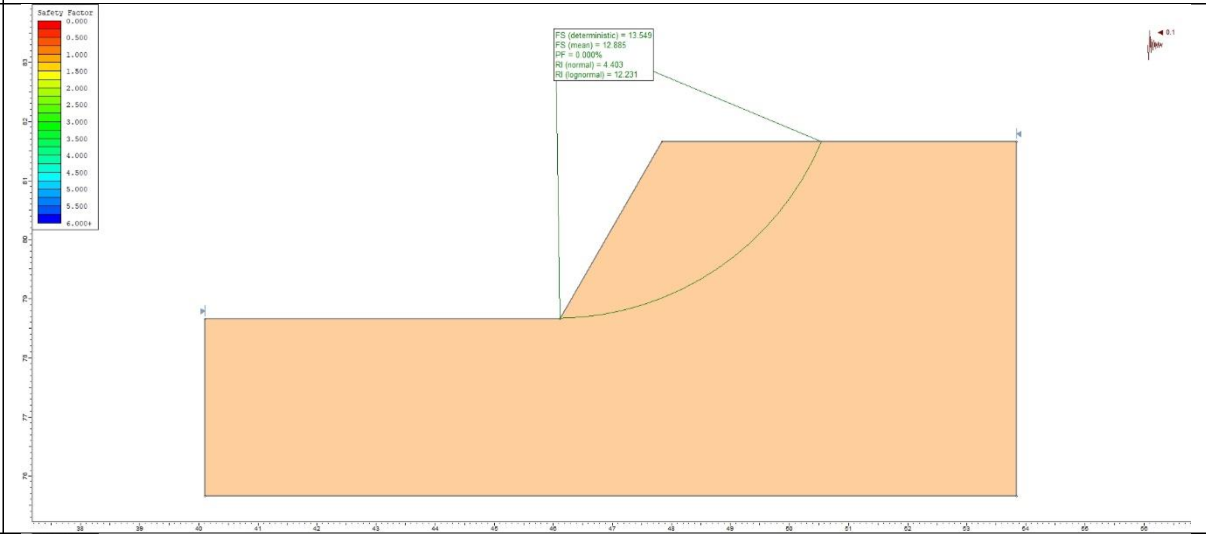
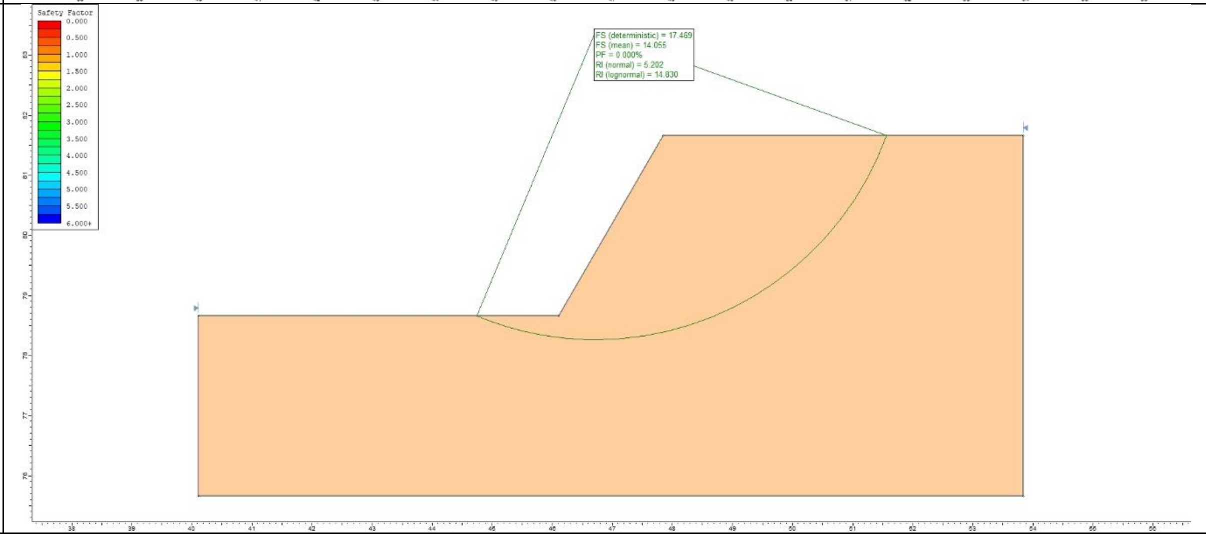
Limonite			
Lereng	Kondisi	Gambar	FK
H=3 S=55	Dinamik		1,63
	Statik		1,87

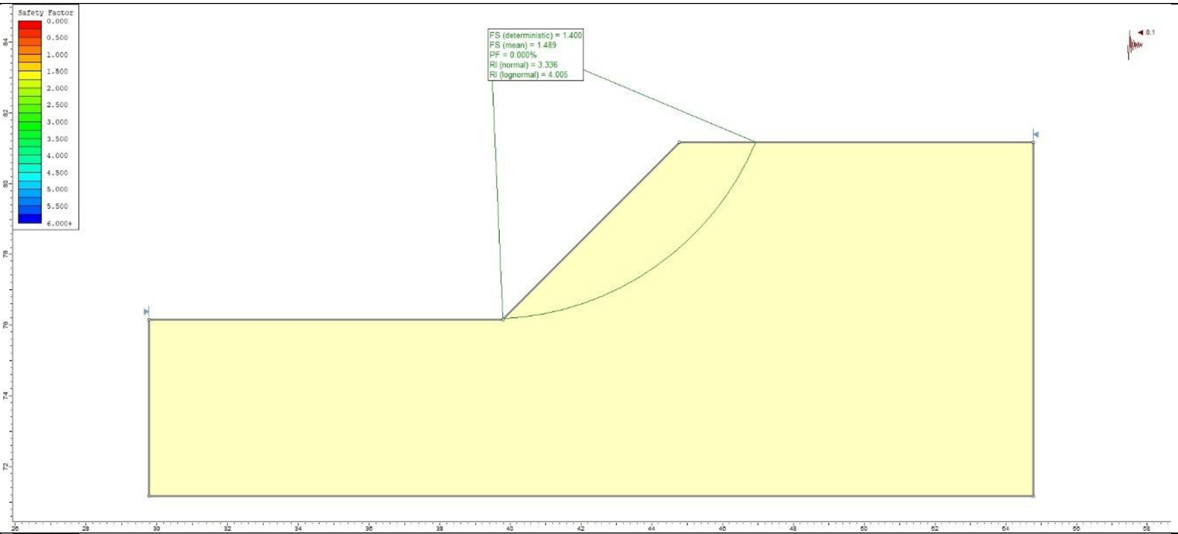
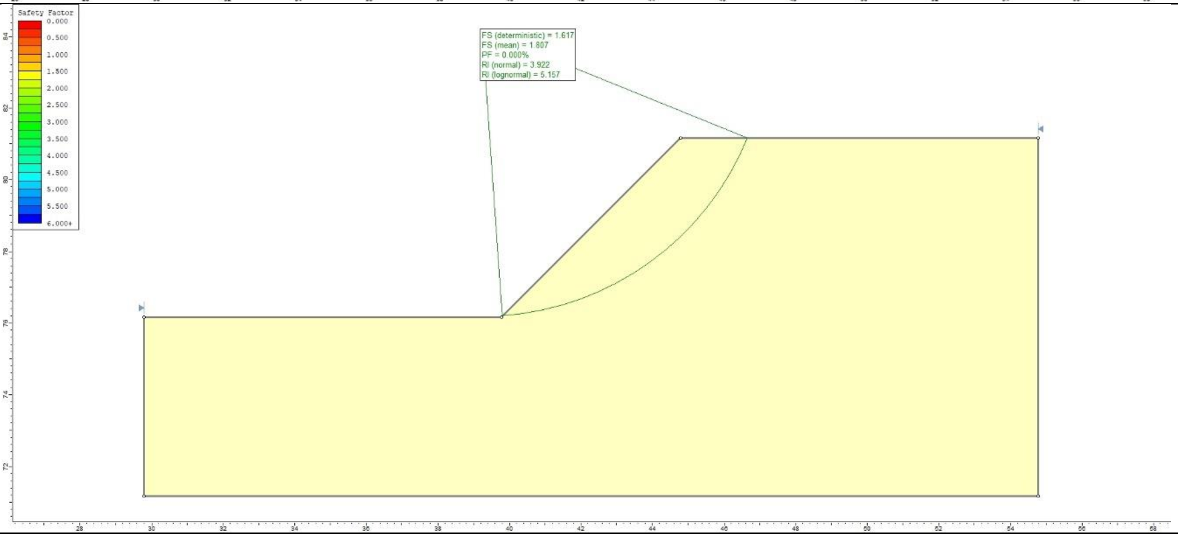
<table>
<tr><th colspan="4">Saprolite</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=3
S=55</td><td>Dinamik</td><td>
</td><td>5,32</td></tr>
<tr><td>Statik</td><td>
</td><td>6,65</td></tr>
</table>

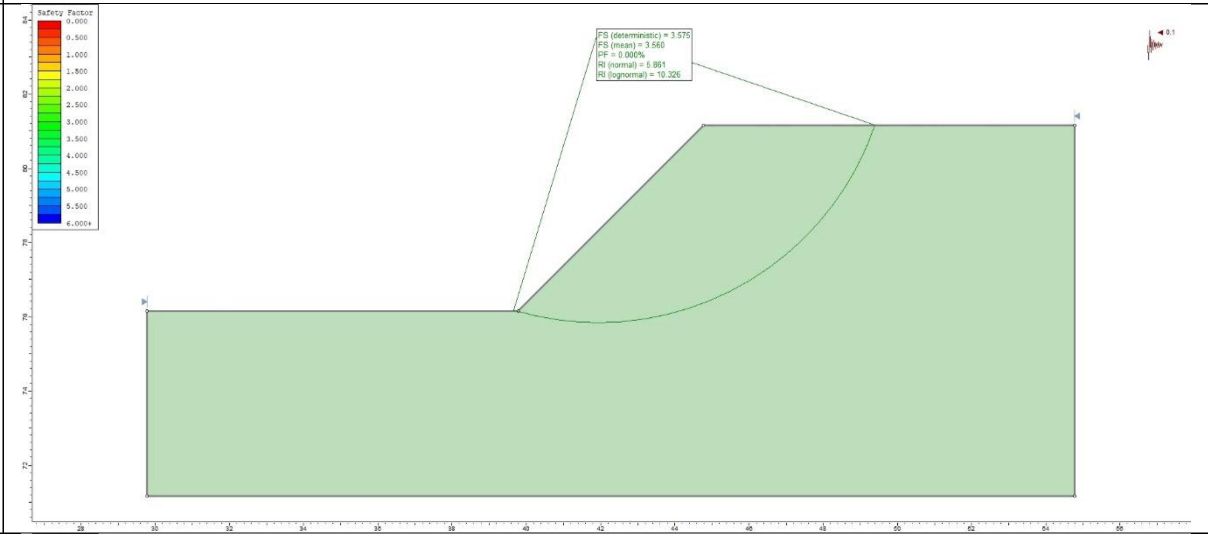
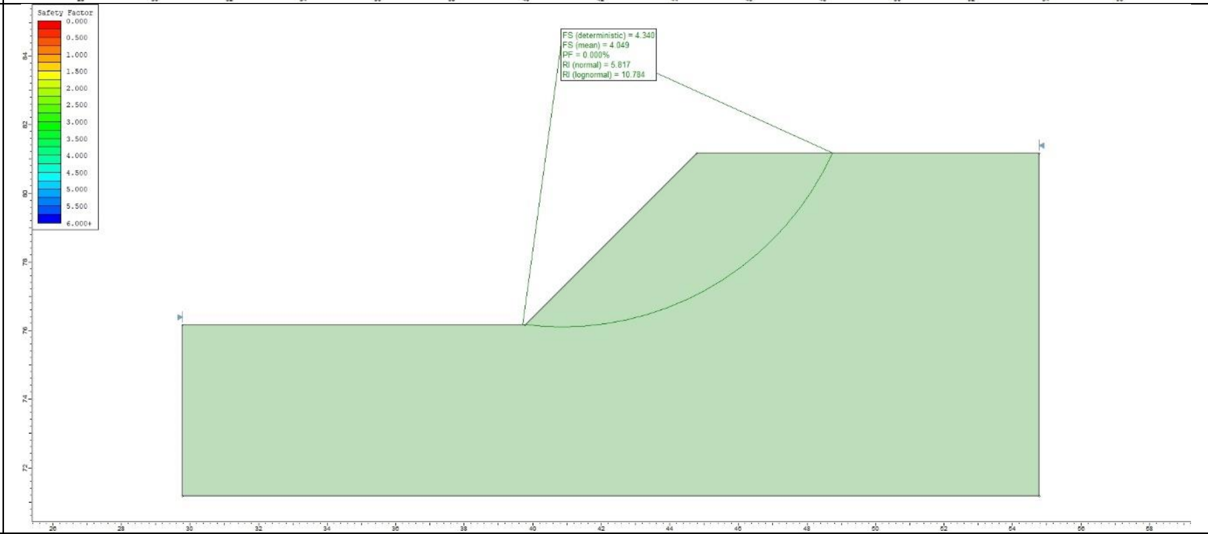
Bedrock			
Lereng	Kondisi	Gambar	FK
H=3 S=55	Dinamik		14,03
	Statik		17,58

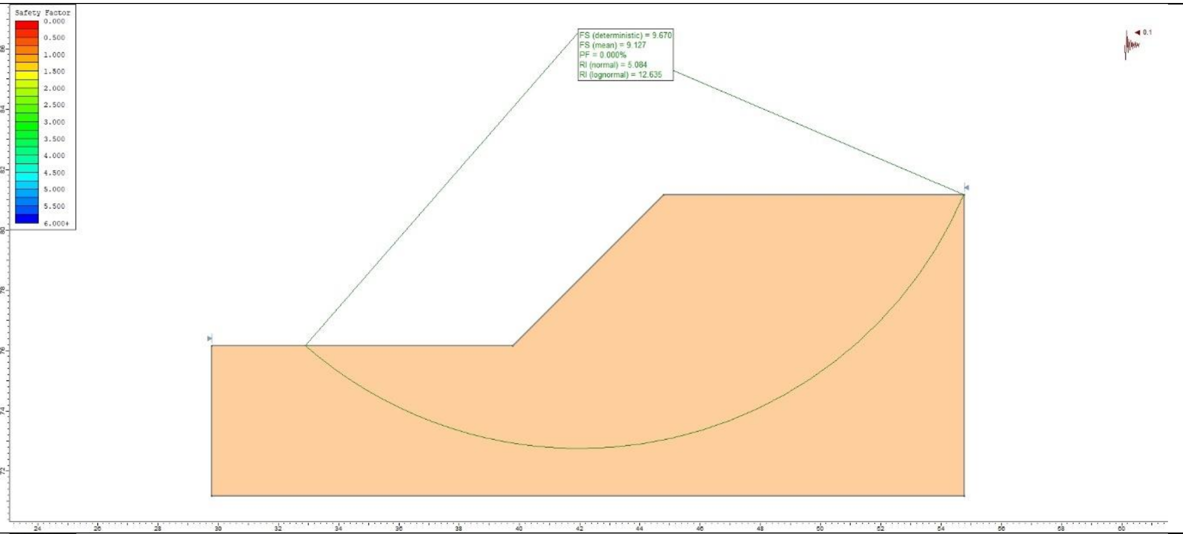
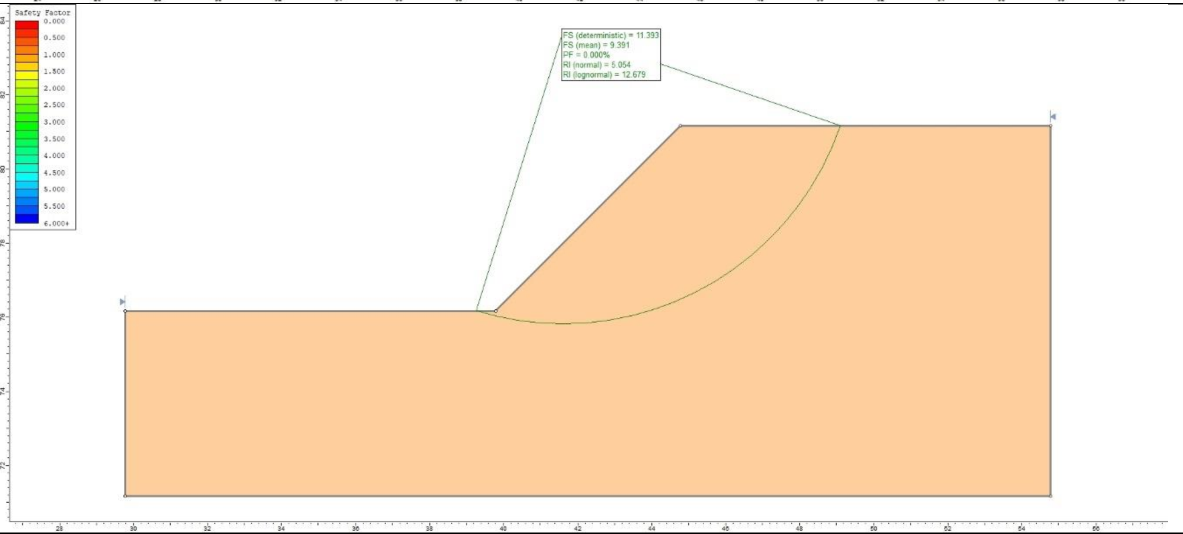
<table>
<tr><th colspan="4">Limonite</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=3
S=60</td><td>Dinamik</td><td>
</td><td>1,56</td></tr>
<tr><td>Statik</td><td>
</td><td>1,79</td></tr>
</table>

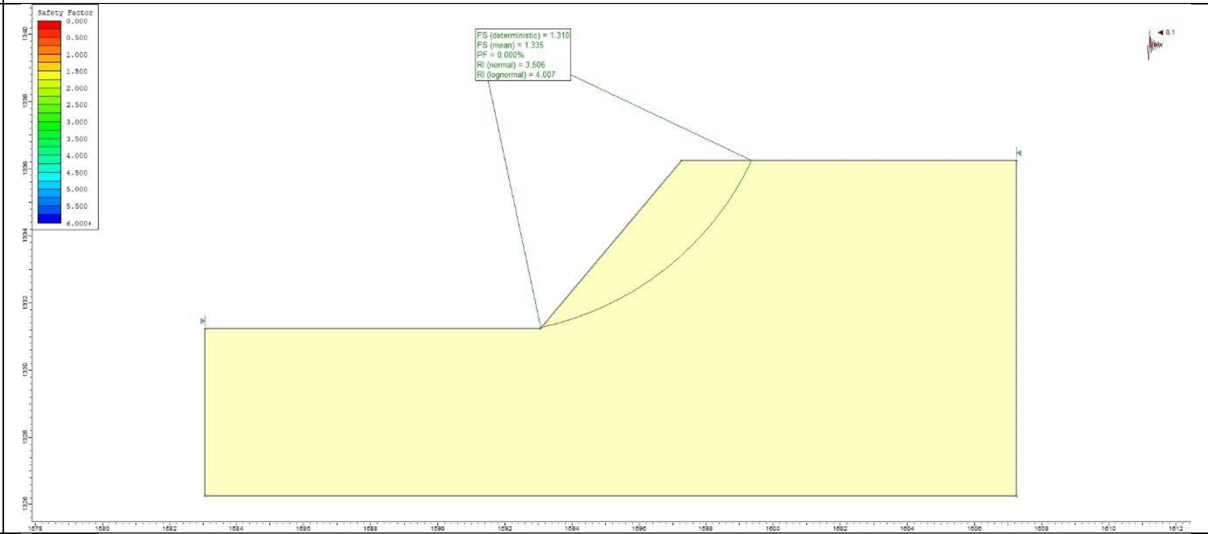
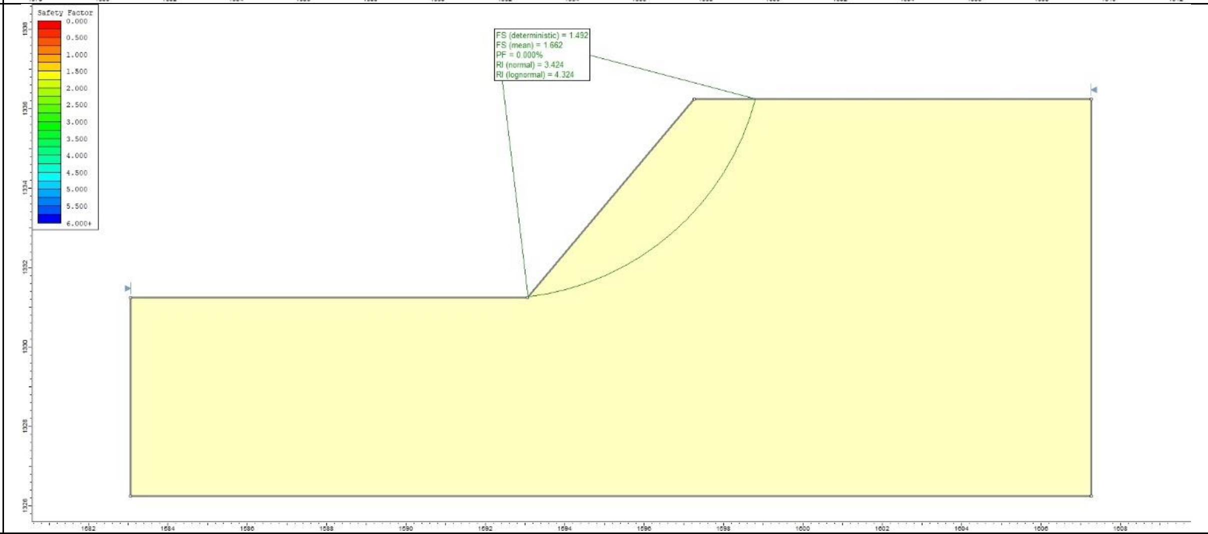
<table>
<tr><th colspan="4">Saprolite</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=3
S=60</td><td>Dinamik</td><td>
</td><td>5,13</td></tr>
<tr><td>Statik</td><td>
</td><td>6,61</td></tr>
</table>

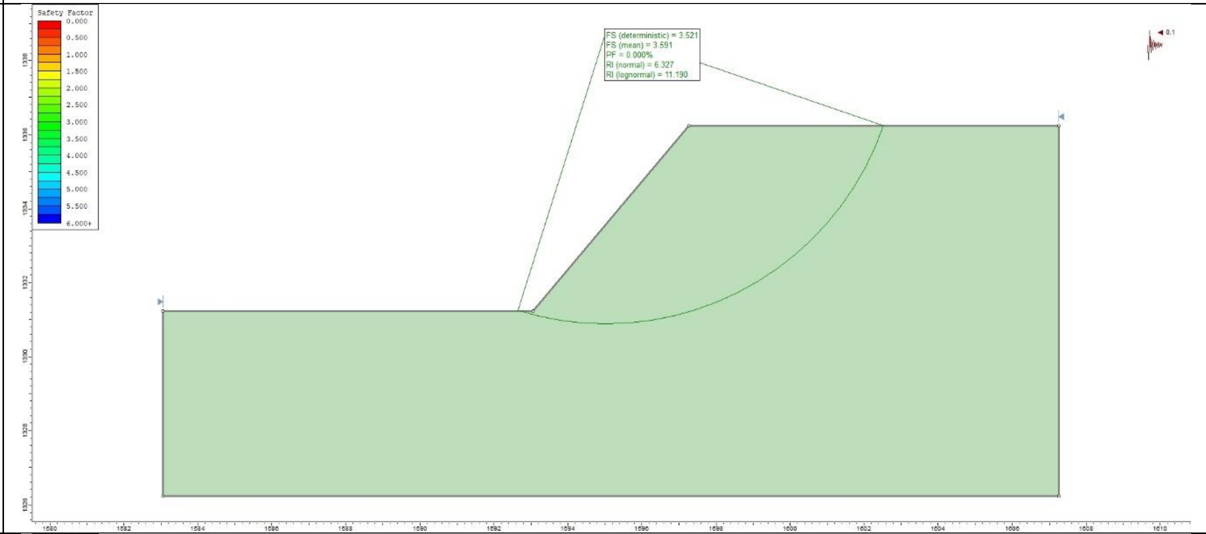
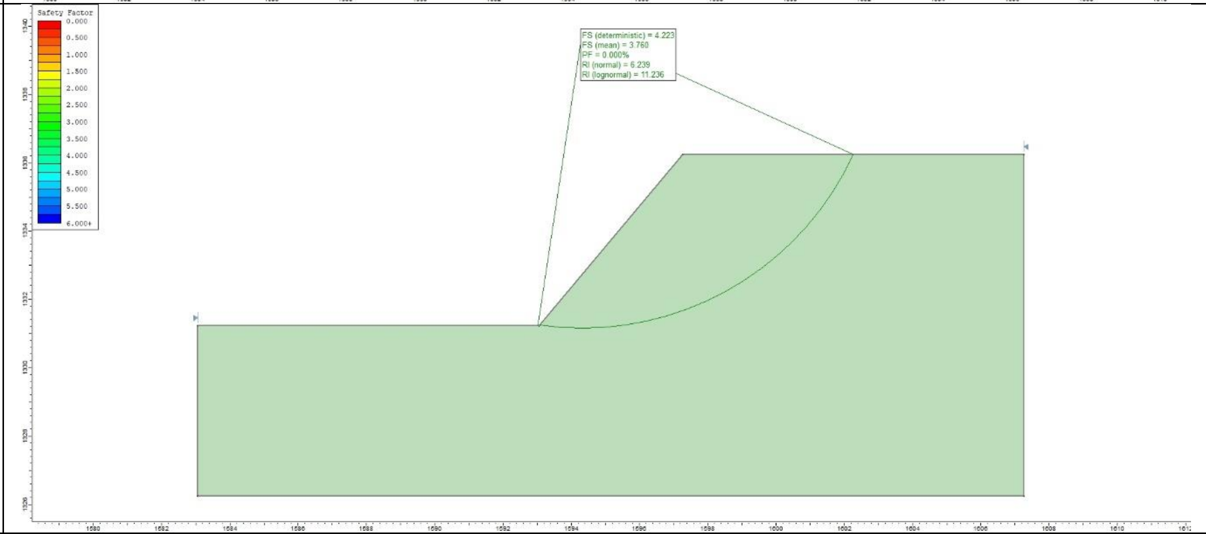
Bedrock			
Lereng	Kondisi	Gambar	FK
H=3 S=60	Dinamik	 	13,55
	Statik	 	17,47

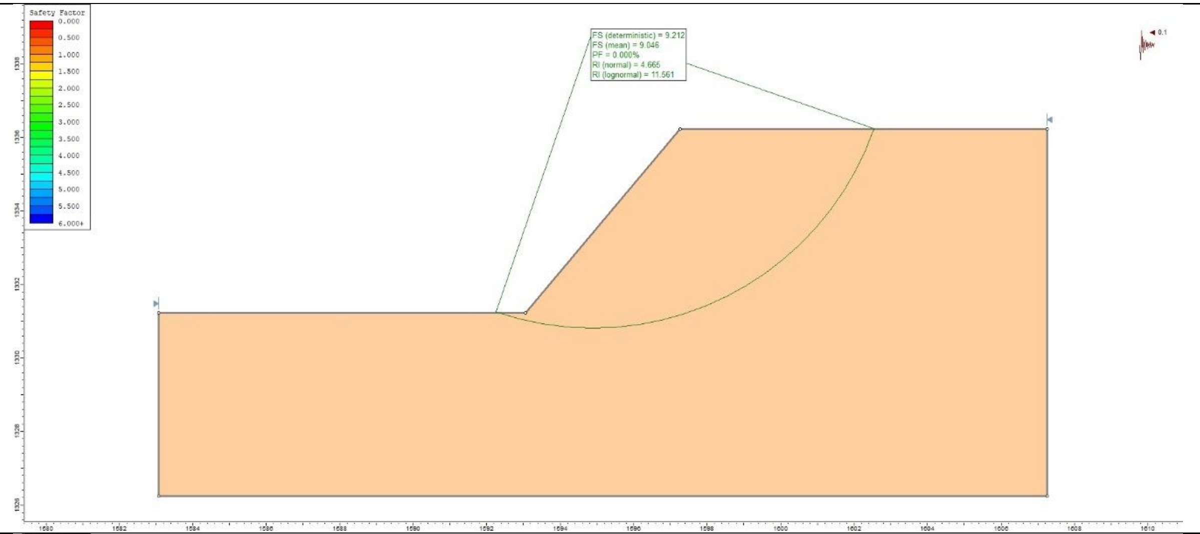
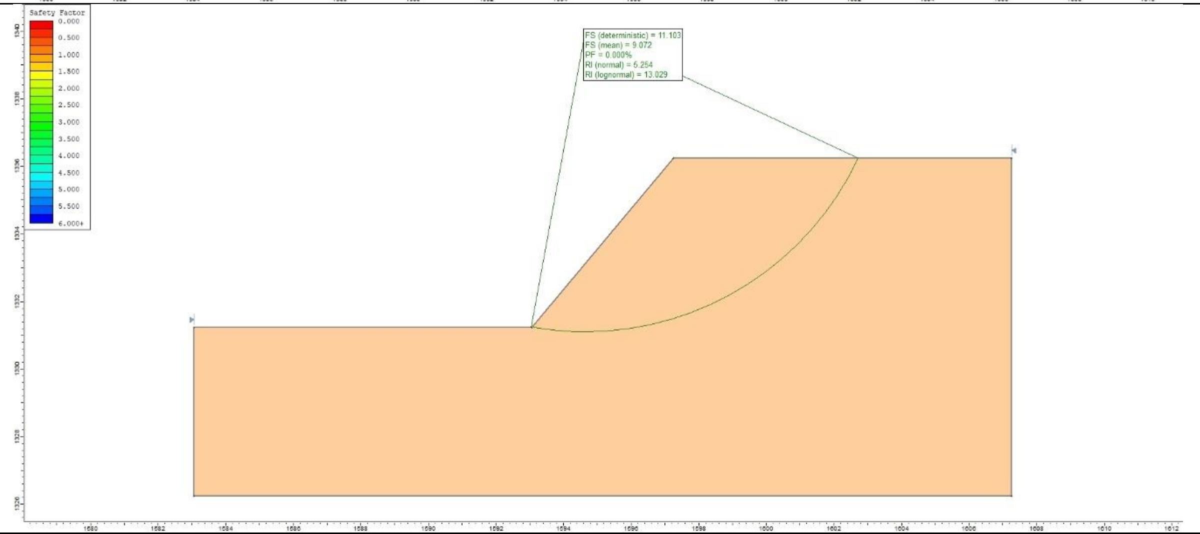
Limonite			
Lereng	Kondisi	Gambar	FK
H=5 S=45	Dinamik		1,40
	Statik		1,62

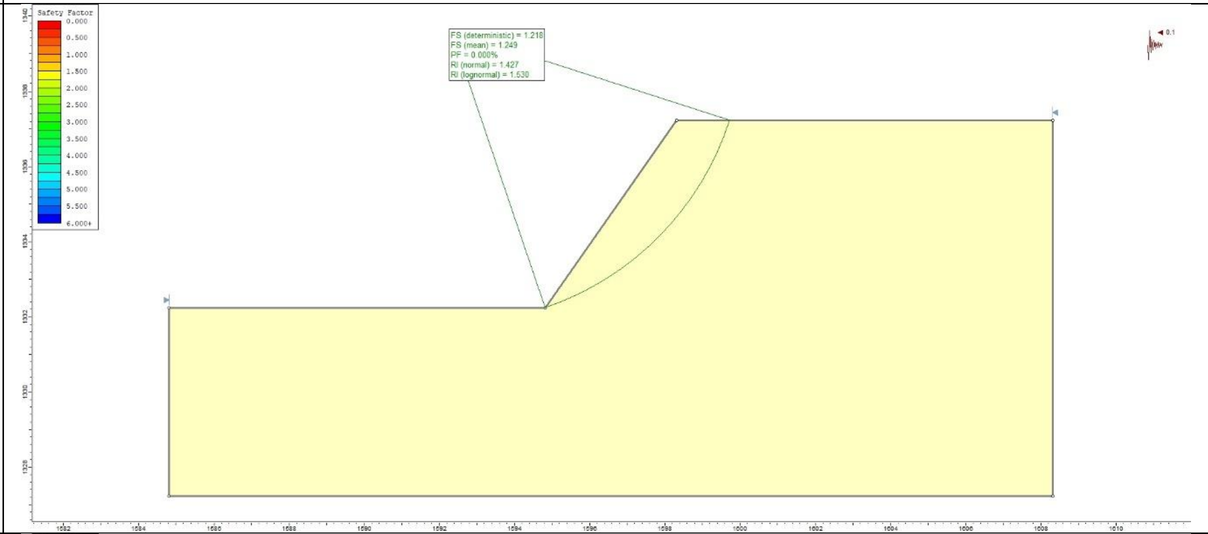
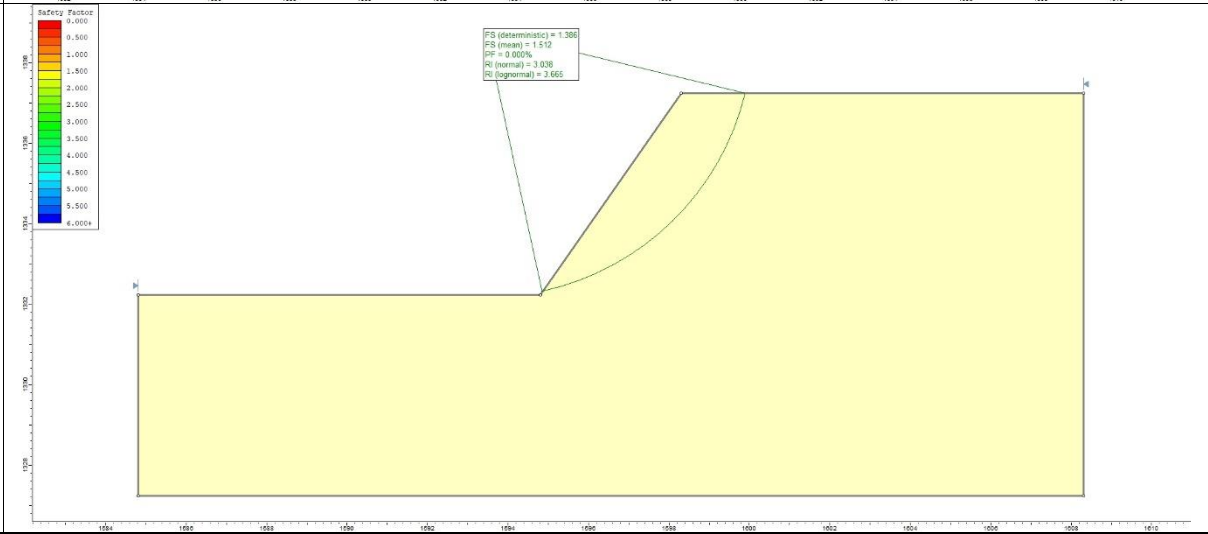
<table>
<tr><th colspan="4">Saprolite</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=45</td><td>Dinamik</td><td>
</td><td>3,57</td></tr>
<tr><td>Statik</td><td>
</td><td>4,34</td></tr>
</table>

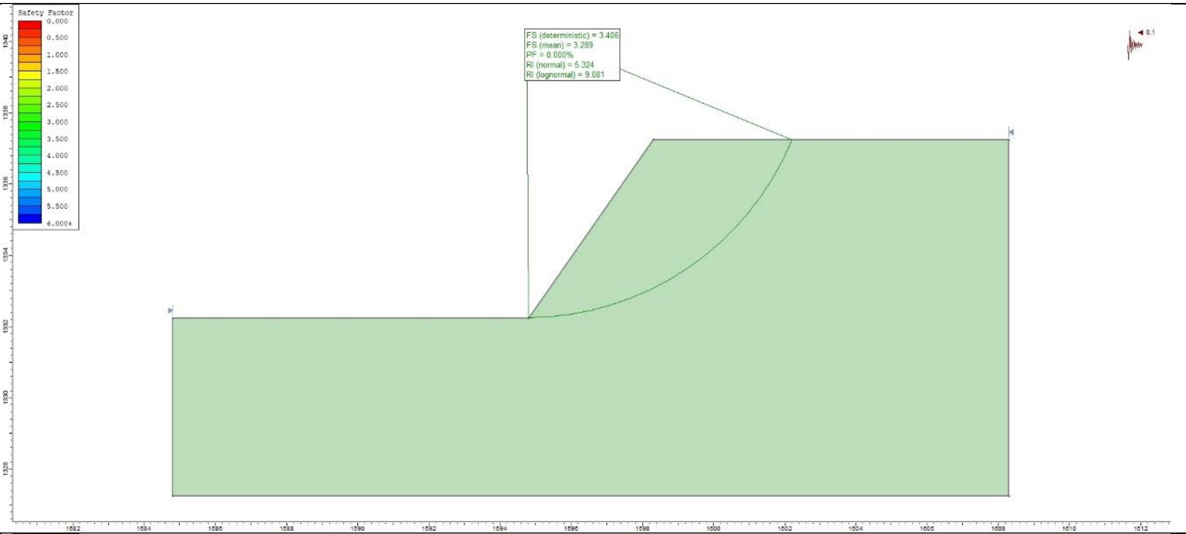
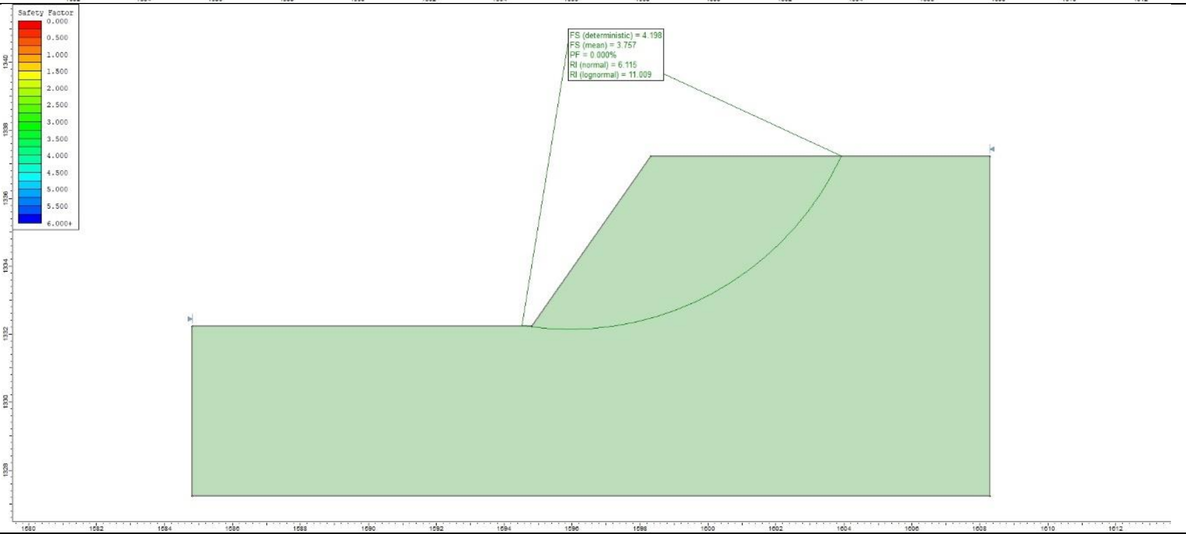
<table>
<tr><th colspan="4">Bedrock</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=45</td><td>Dinamik</td><td>
</td><td>9,67</td></tr>
<tr><td>Statik</td><td>
</td><td>11,39</td></tr>
</table>

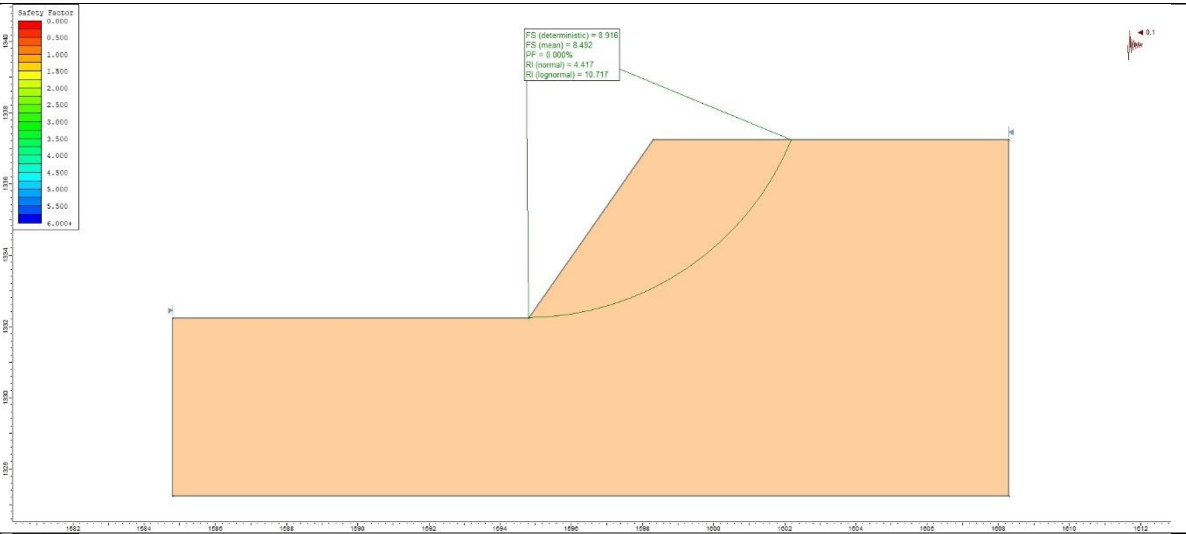
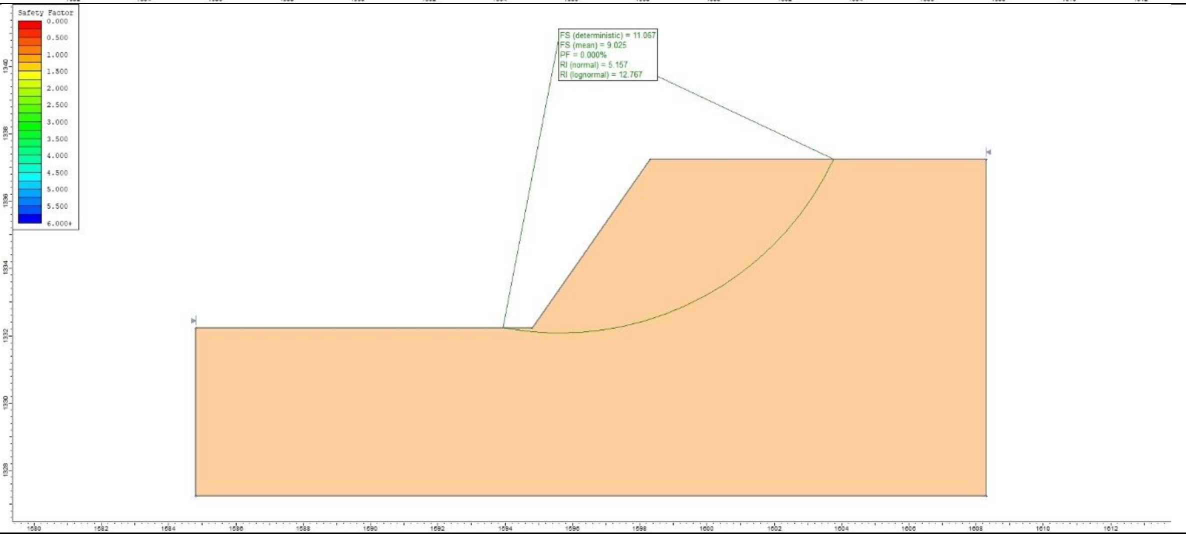
<table>
<tr><th colspan="4">Limonite</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=50</td><td>Dinamik</td><td>
</td><td>1,30</td></tr>
<tr><td>Statik</td><td>
</td><td>1,49</td></tr>
</table>

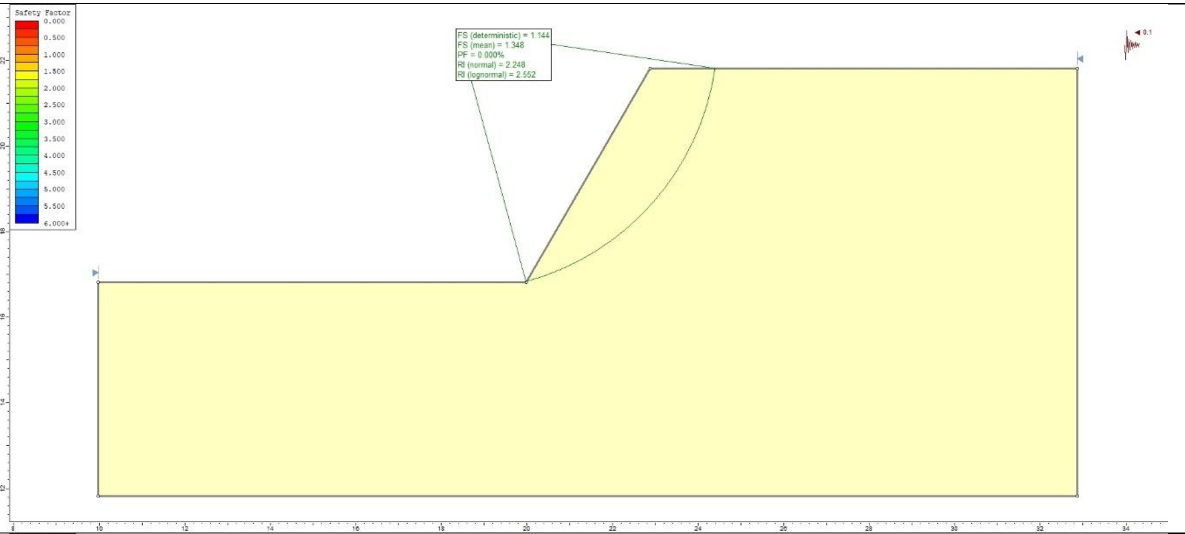
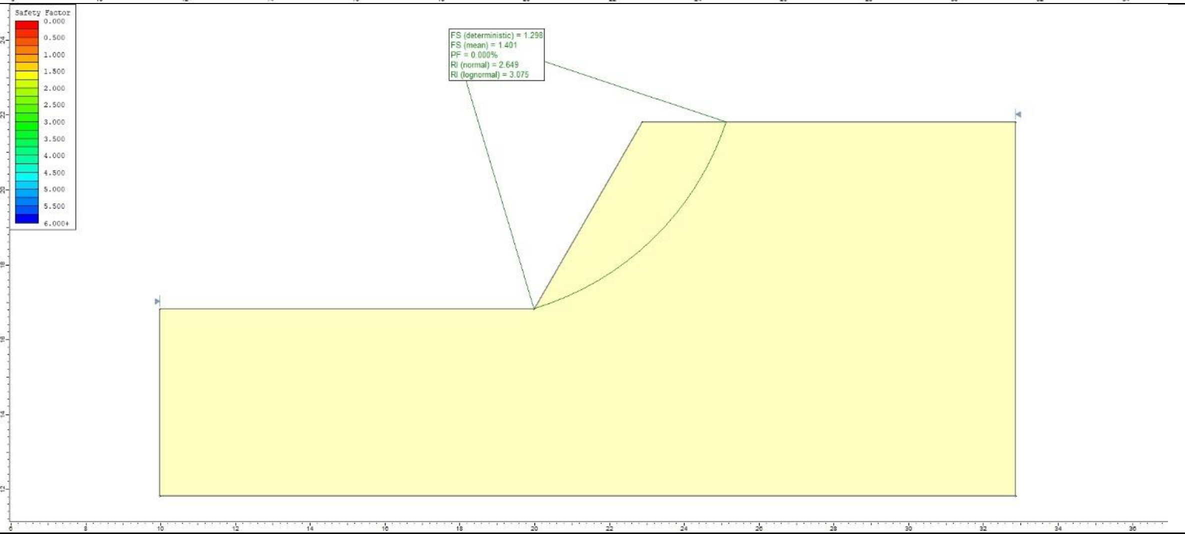
Saprolite			
Lereng	Kondisi	Gambar	FK
H=5 S=50	Dinamik		3,52
	Statik		4,22

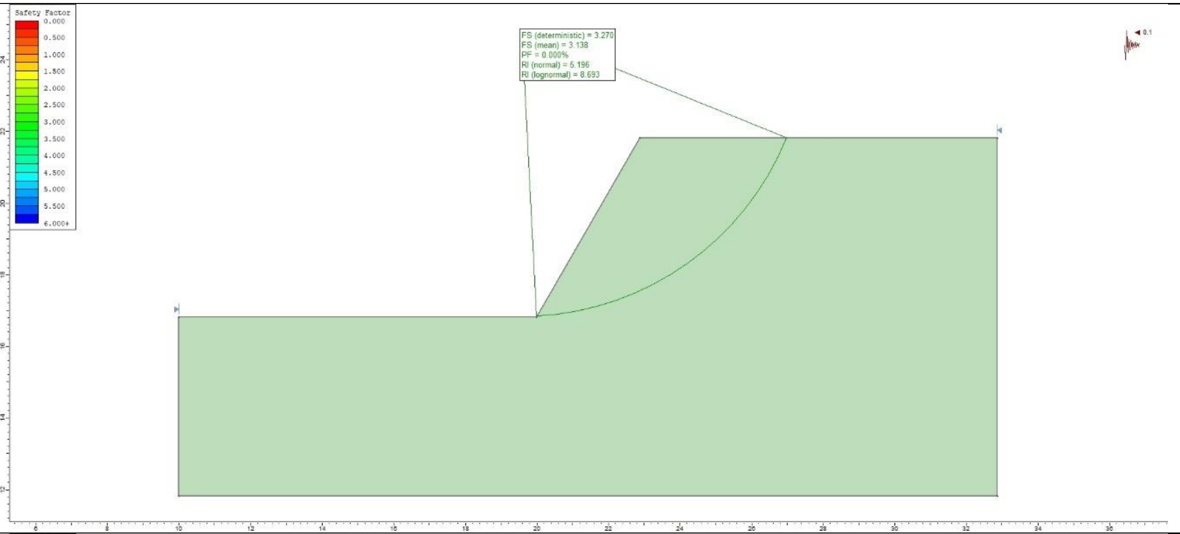
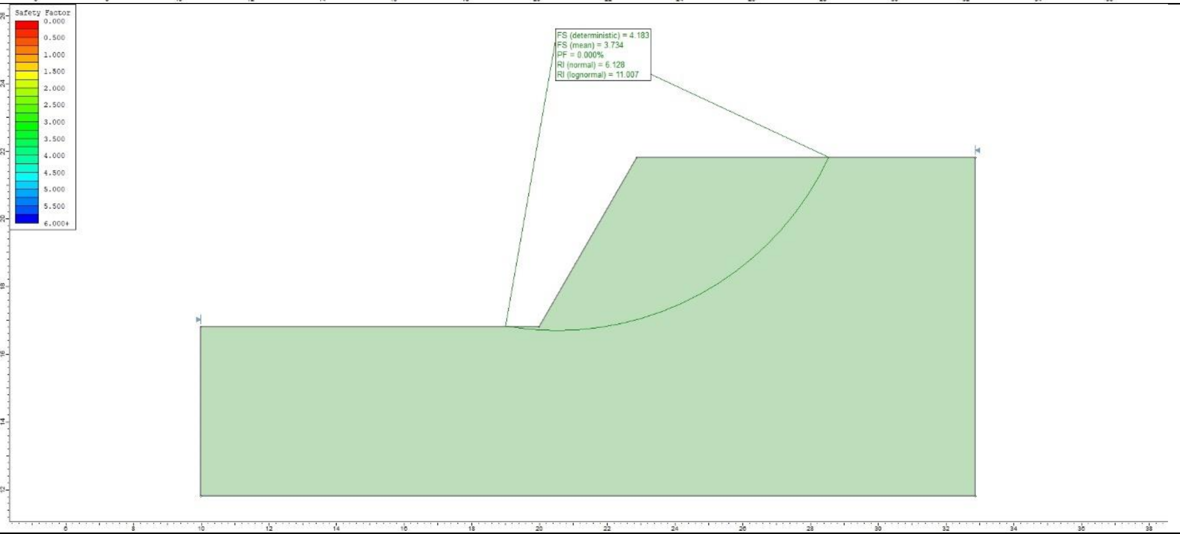
<table>
<tr><th colspan="4">Bedrock</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=50</td><td>Dinamik</td><td>
</td><td>9,21</td></tr>
<tr><td>Statik</td><td>
</td><td>11,10</td></tr>
</table>

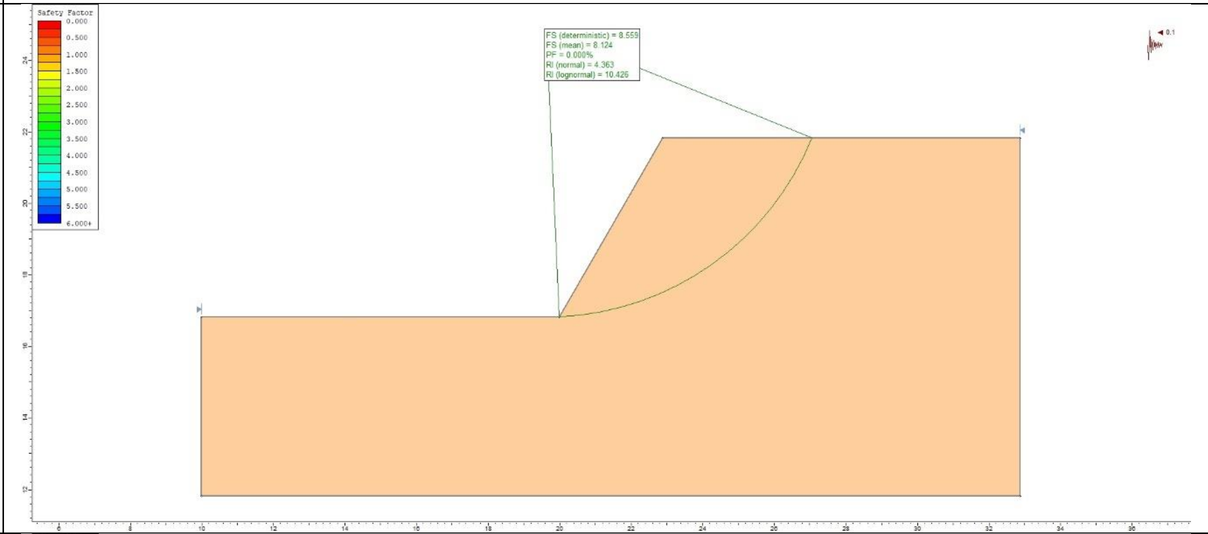
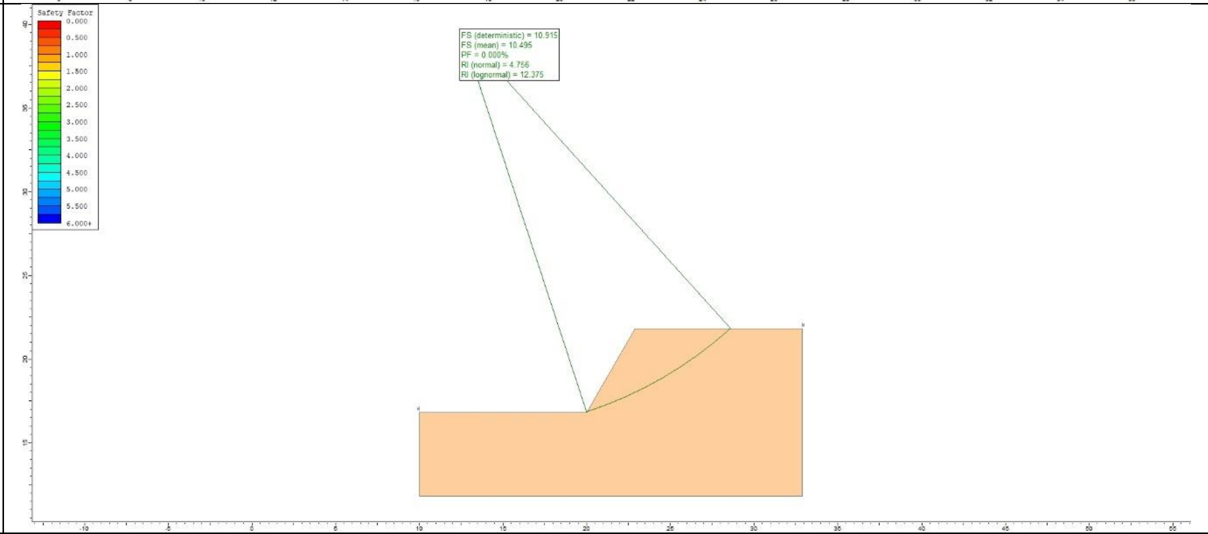
Limonite			
Lereng	Kondisi	Gambar	FK
H=5 S=55	Dinamik		1,22
	Statik		1,39

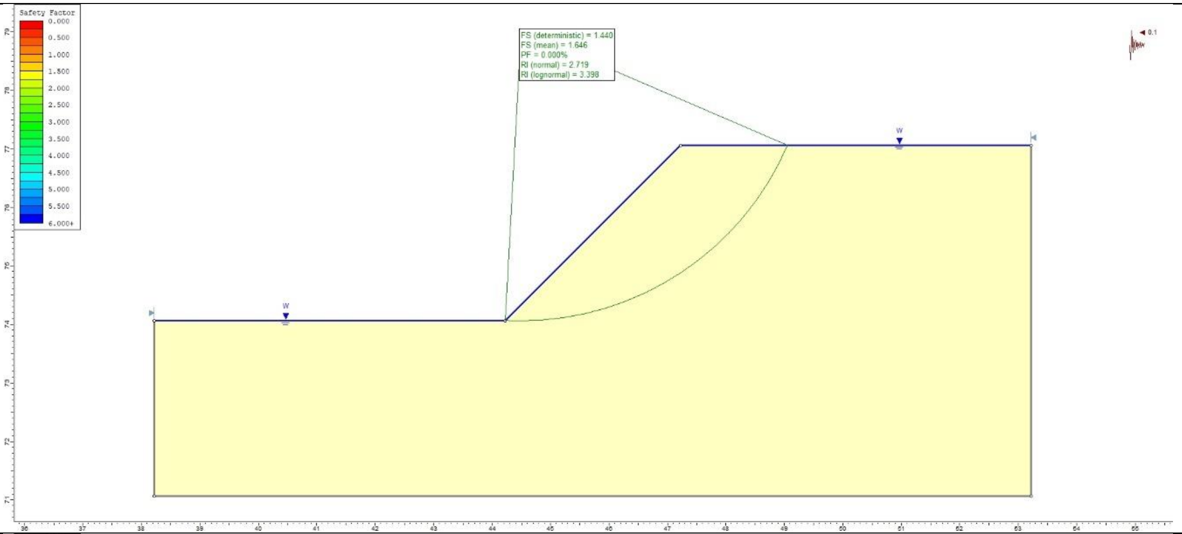
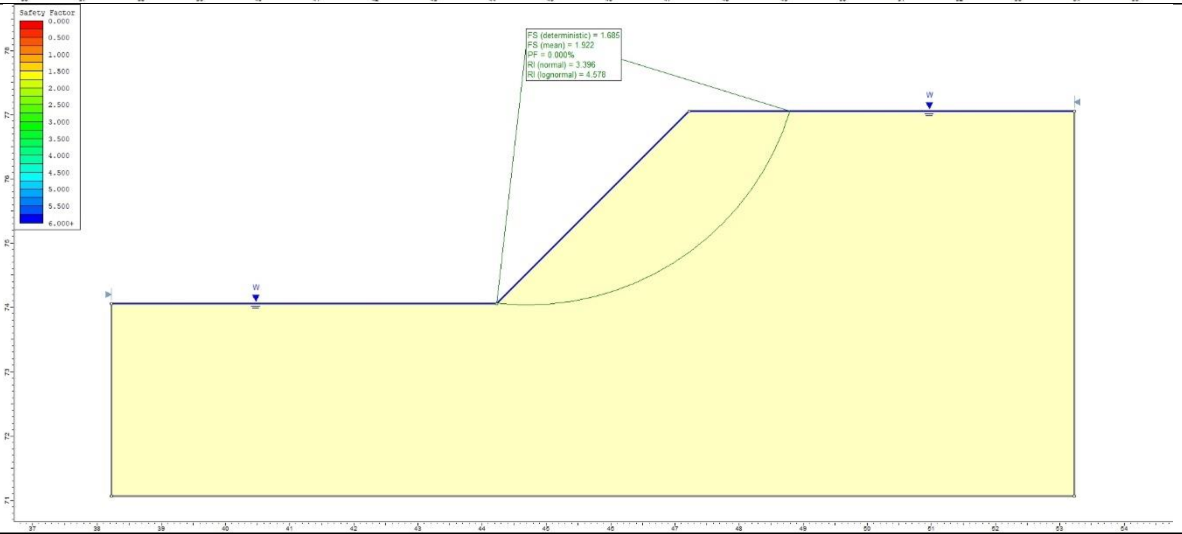
Saprolite			
Lereng	Kondisi	Gambar	FK
H=5 S=55	Dinamik		3,41
	Statik		4,20

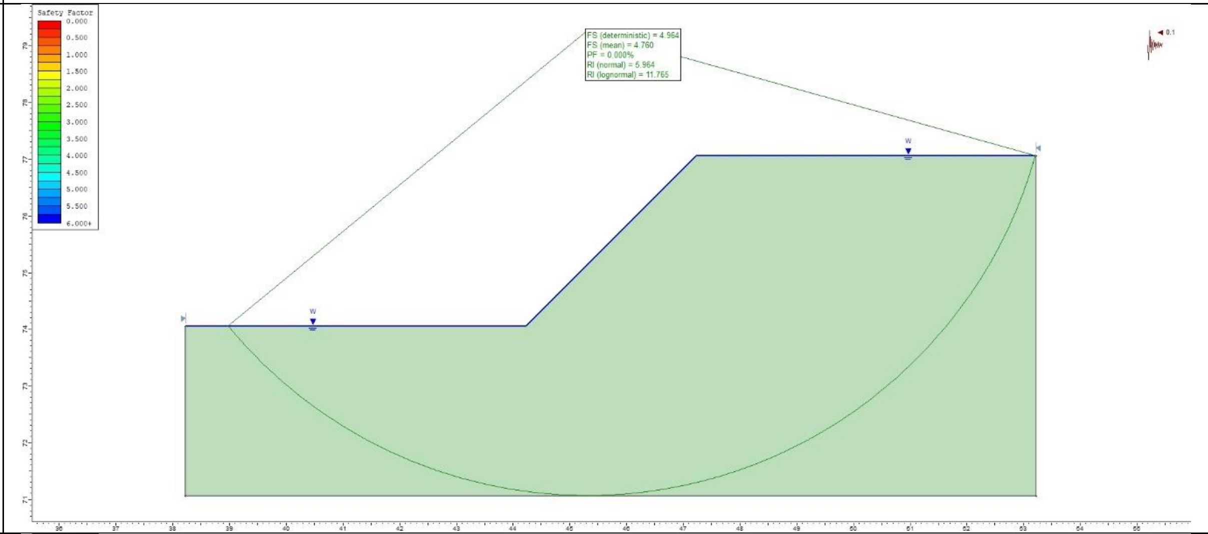
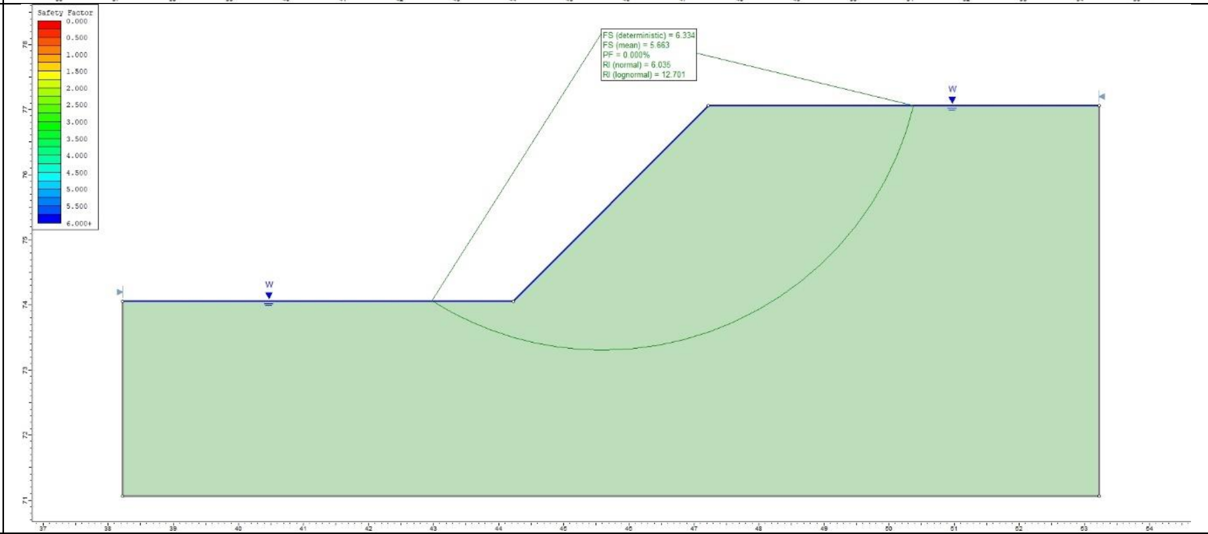
<table>
<tr><th colspan="4">Bedrock</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=55</td><td>Dinamik</td><td>
</td><td>8,92</td></tr>
<tr><td>Statik</td><td>
</td><td>11,07</td></tr>
</table>

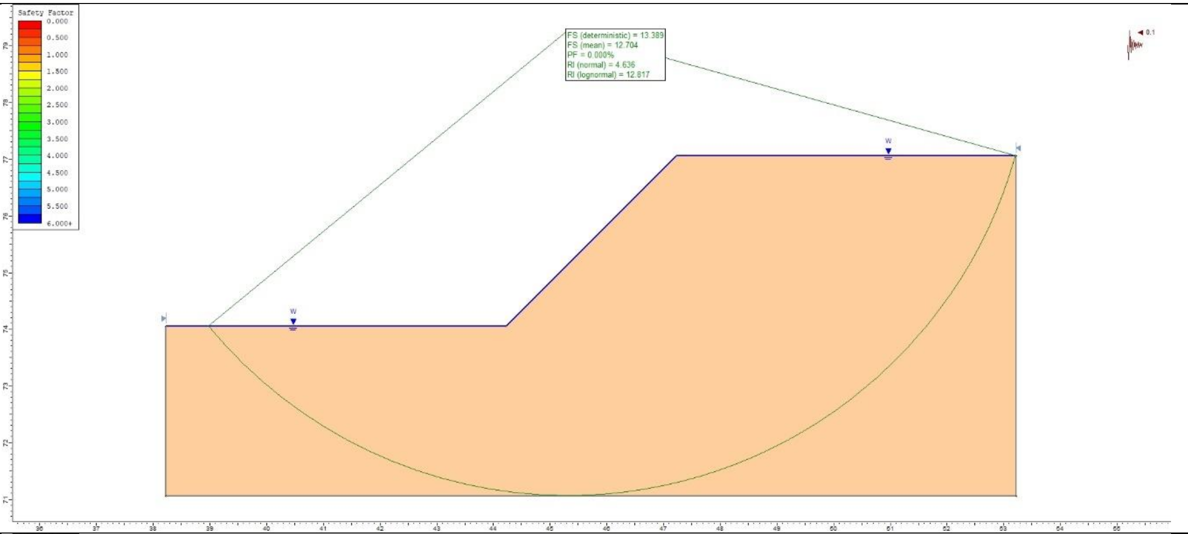
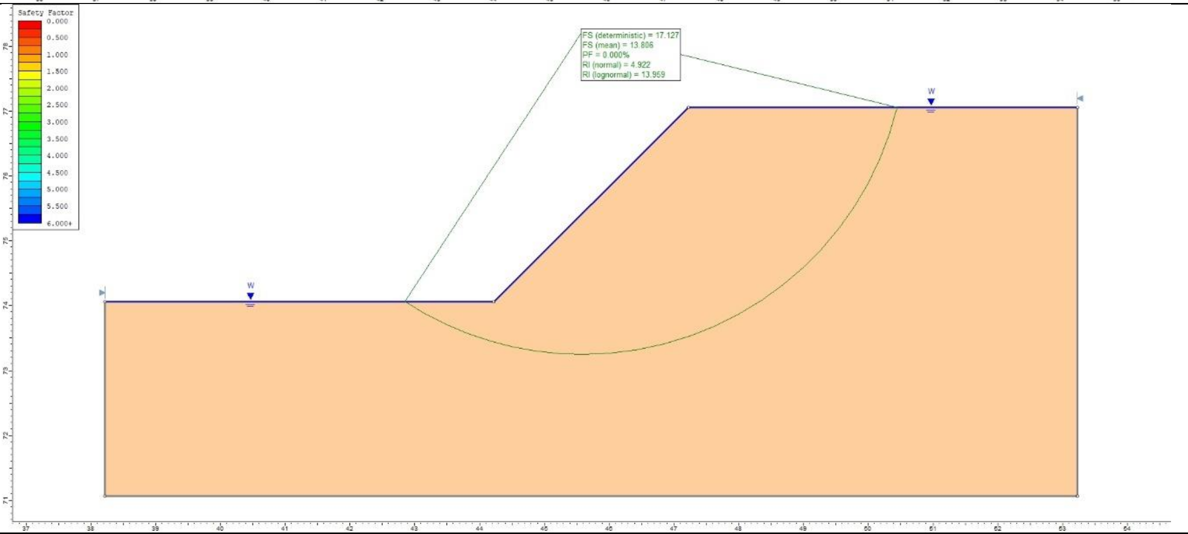
Limonite			
Lereng	Kondisi	Gambar	FK
H=5 S=60	Dinamik		1,14
	Statik		1,30

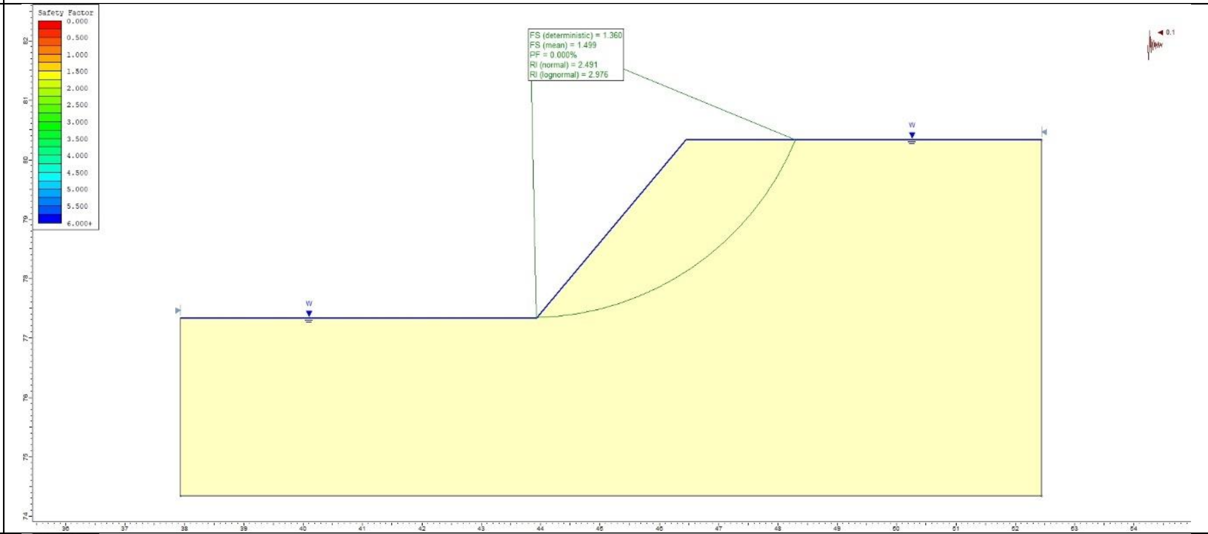
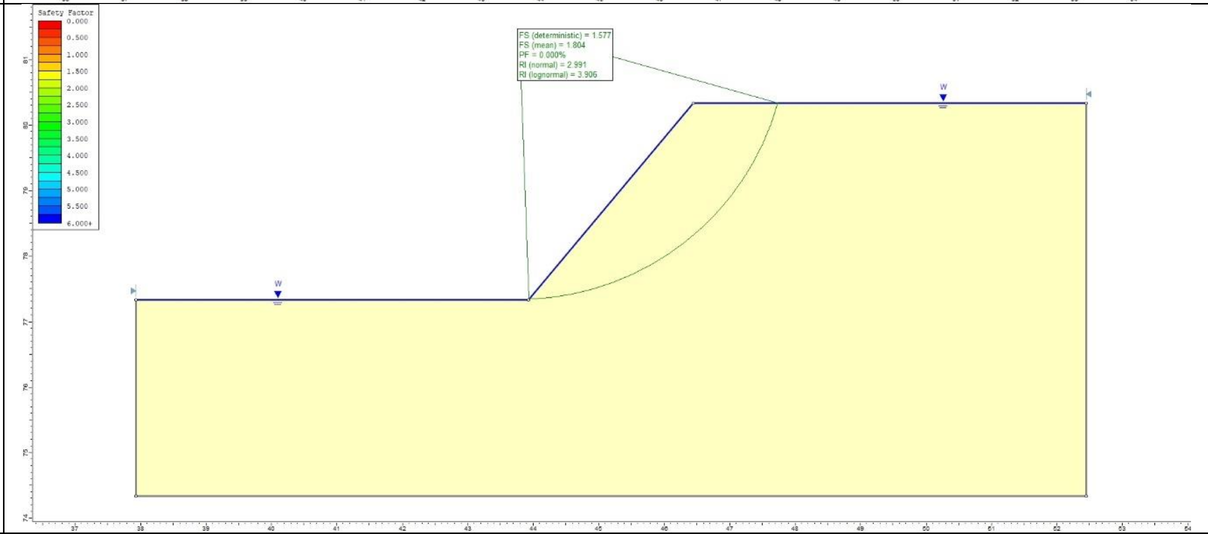
<table>
<tr><th colspan="4">Saprolite</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=60</td><td>Dinamik</td><td></td><td>3,27</td></tr>
<tr><td>Statik</td><td></td><td>4,18</td></tr>
</table>

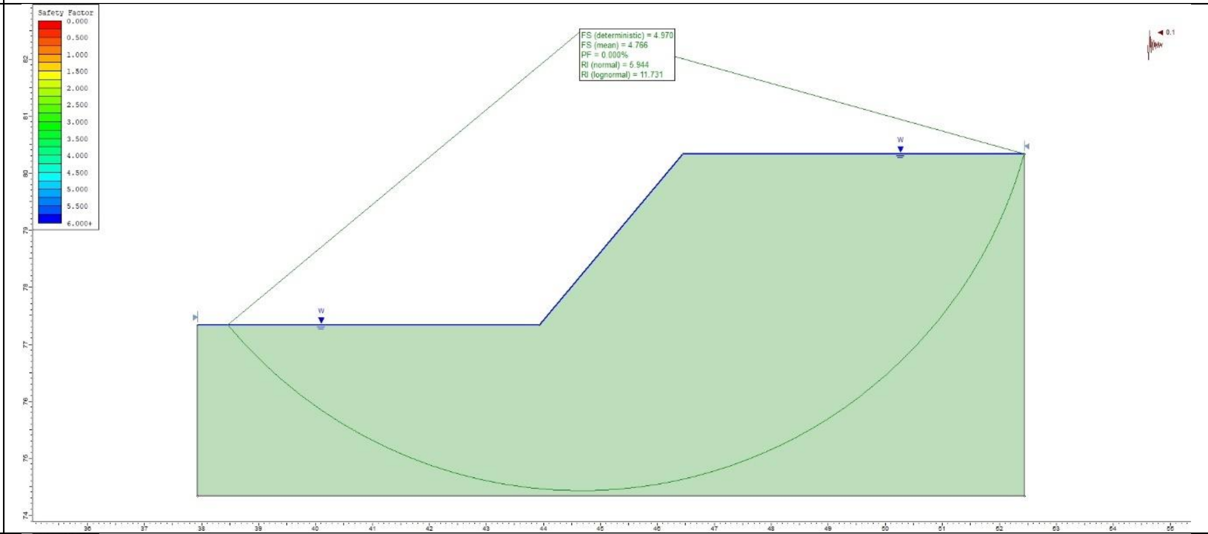
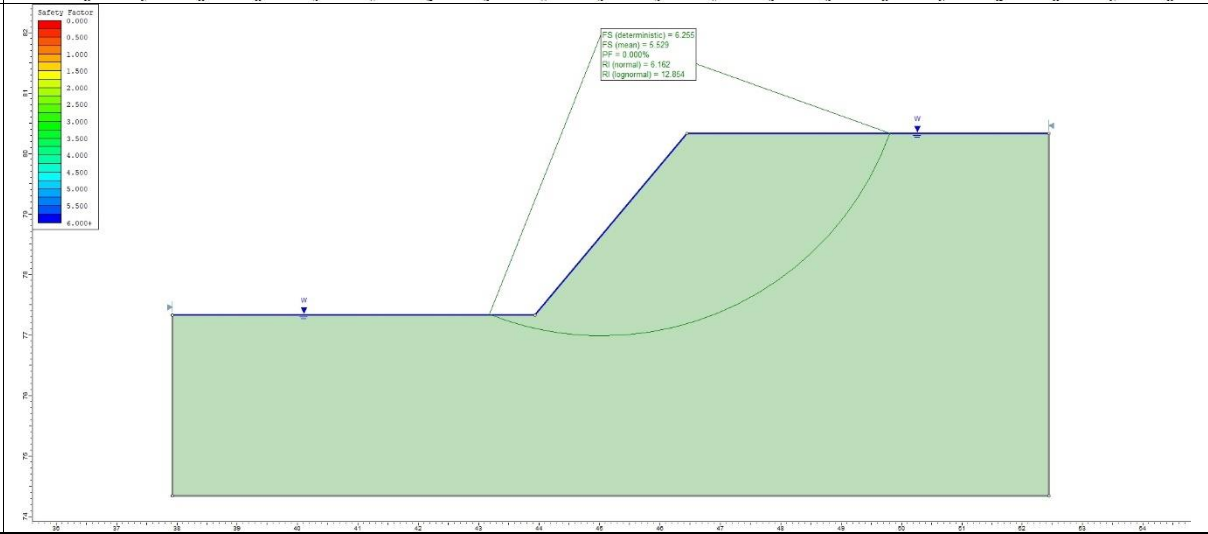
<table>
<tr><th colspan="4">Bedrock</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=60</td><td>Dinamik</td><td>
</td><td>8,56</td></tr>
<tr><td>Statik</td><td>
</td><td>10,91</td></tr>
</table>

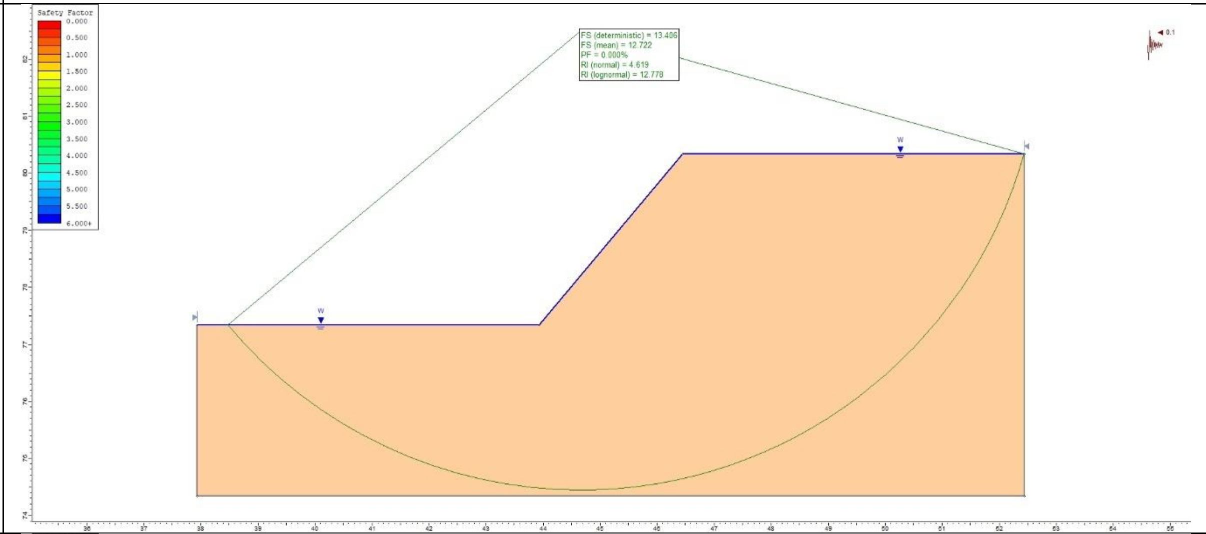
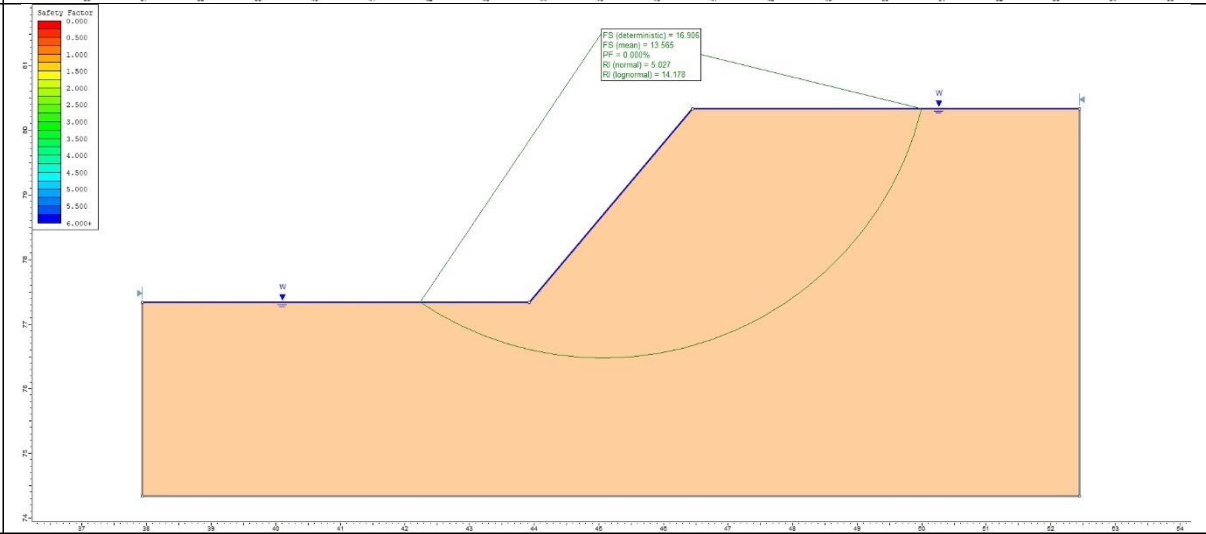
<table>
<tr><th colspan="4">Limonite</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=3
S=45</td><td>Dinamik</td><td>
</td><td>1,44</td></tr>
<tr><td>Statik</td><td>
</td><td>1,68</td></tr>
</table>

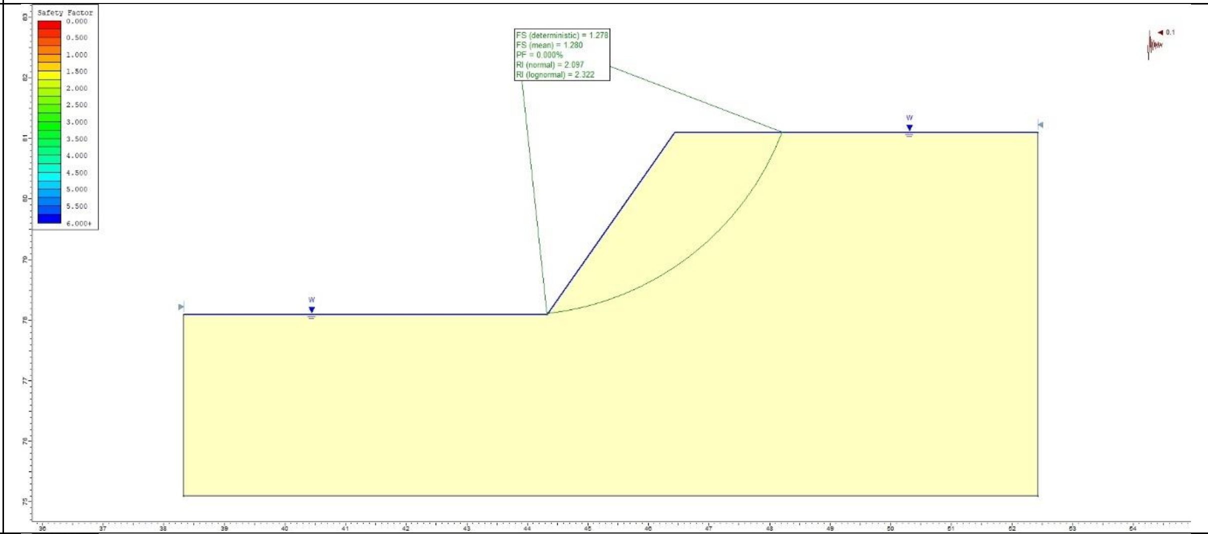
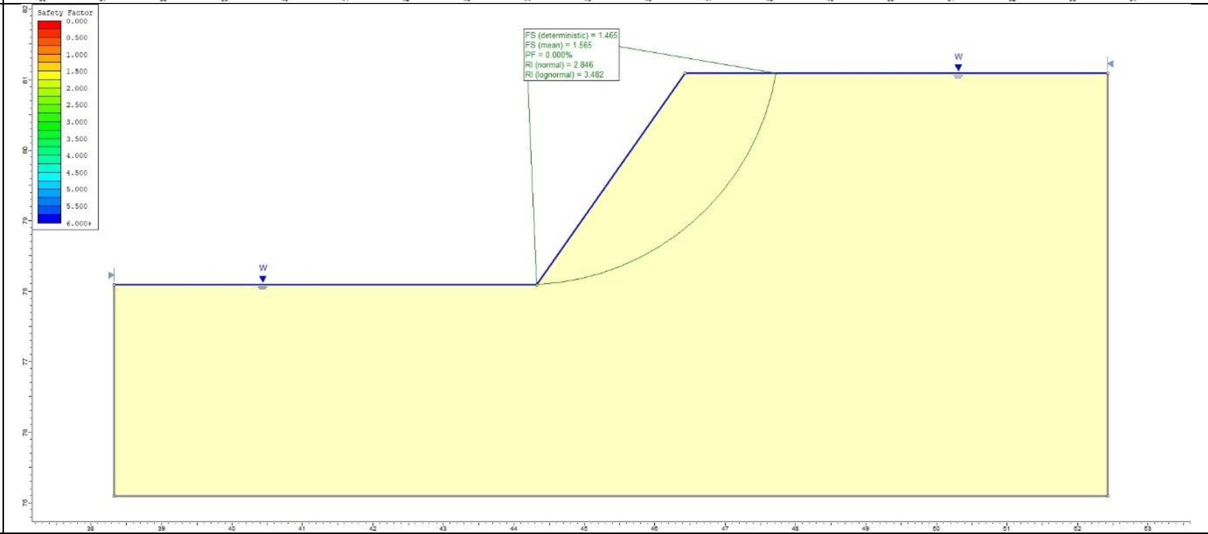
<table>
<tr><th colspan="4">Saprolite</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=3
S=45</td><td>Dinamik</td><td>
</td><td>4,96</td></tr>
<tr><td>Statik</td><td>
</td><td>6,33</td></tr>
</table>

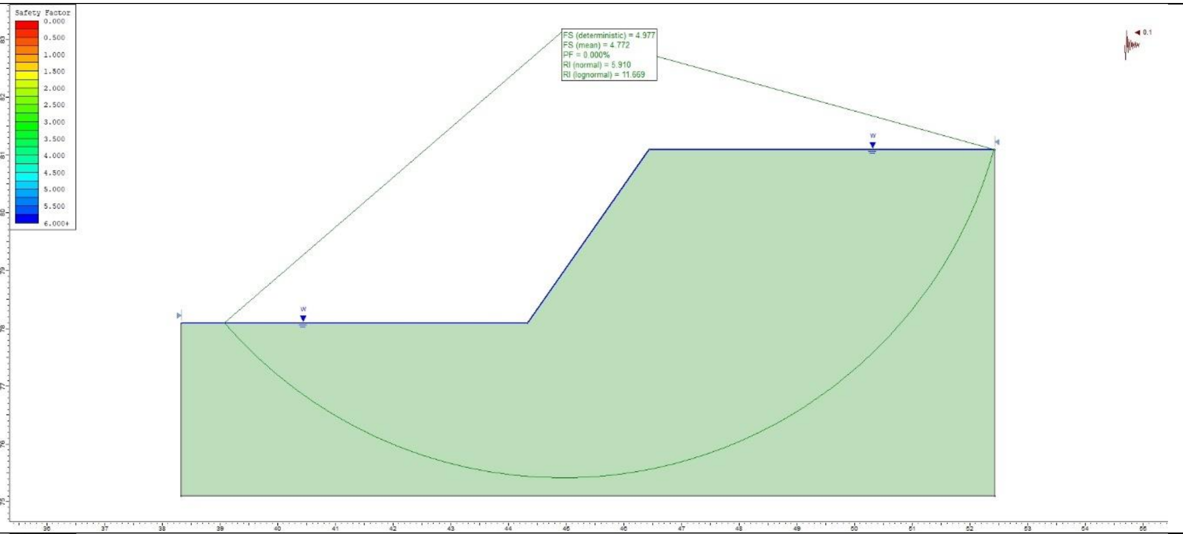
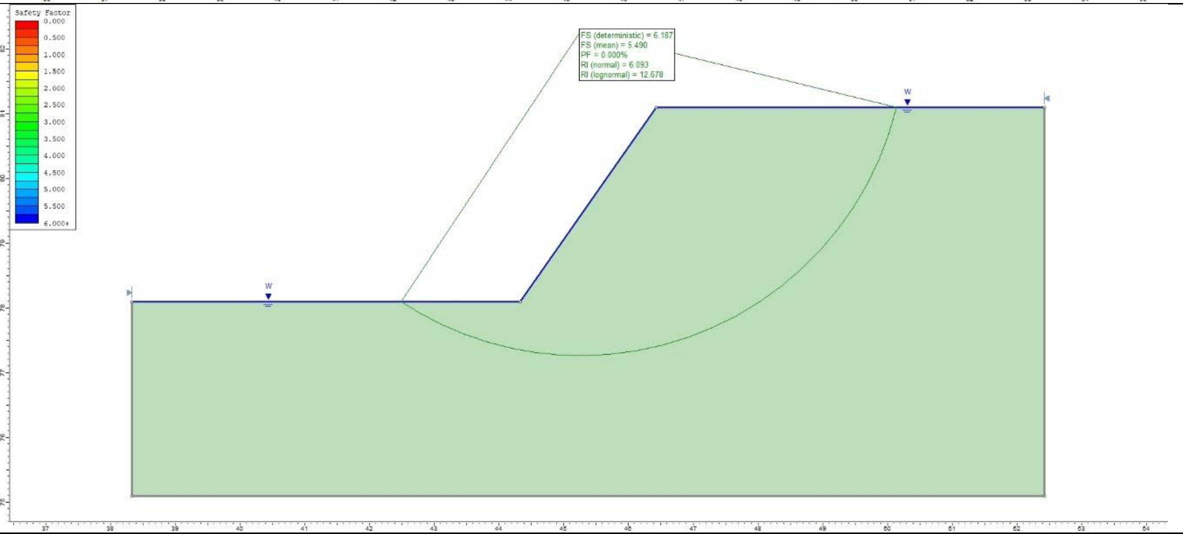
<table>
<tr><th colspan="4">Bedrock</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=3
S=45</td><td>Dinamik</td><td>
</td><td>13,39</td></tr>
<tr><td>Statik</td><td>
</td><td>17,13</td></tr>
</table>

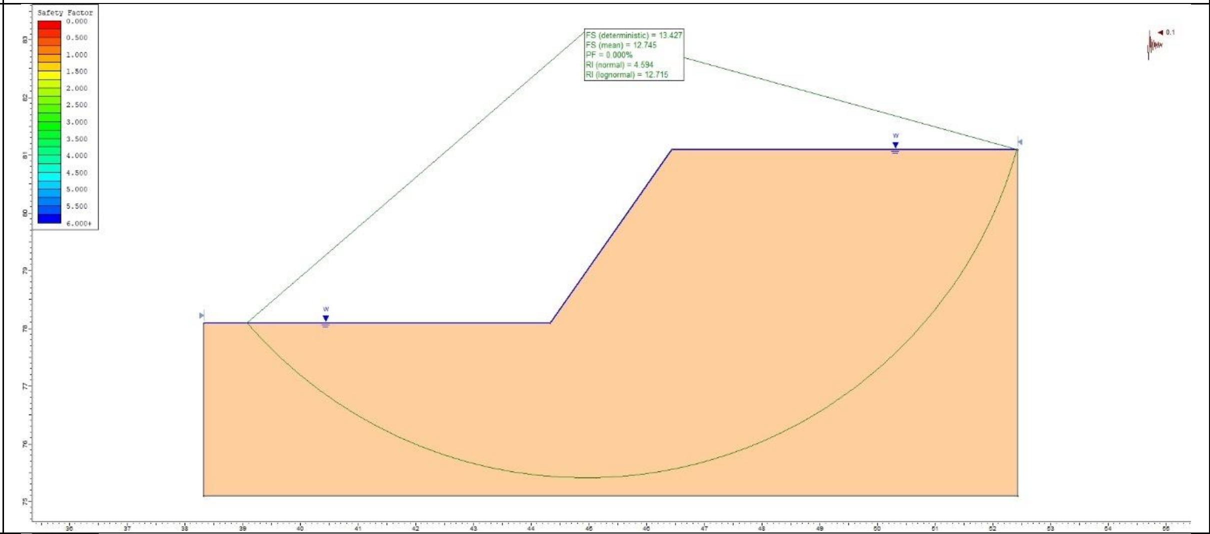
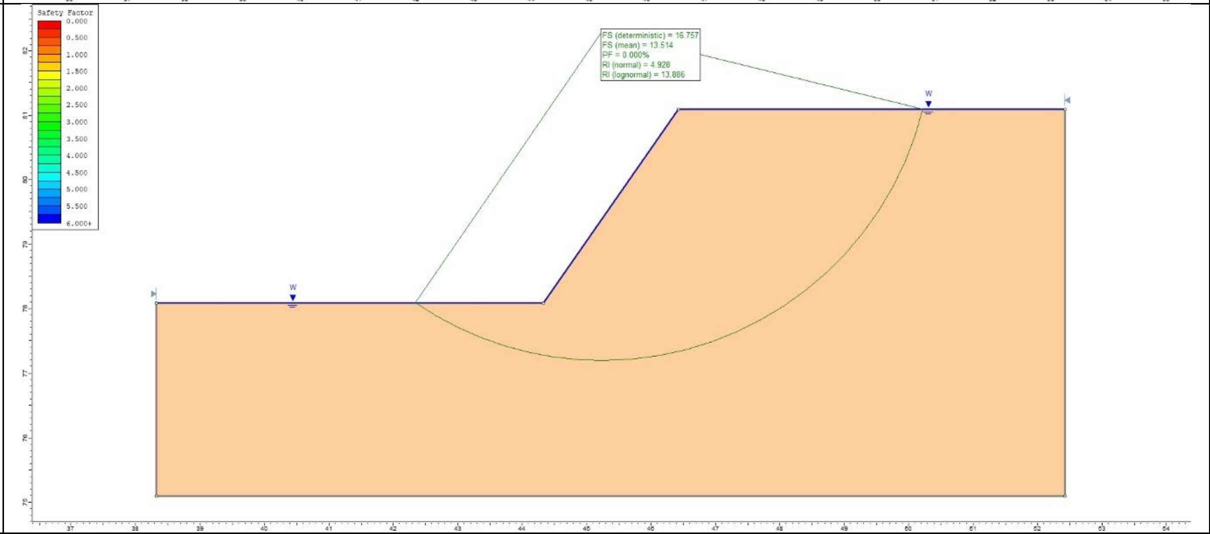
Limonite			
Lereng	Kondisi	Gambar	FK
H=3 S=50	Dinamik		1,36
	Statik		1,58

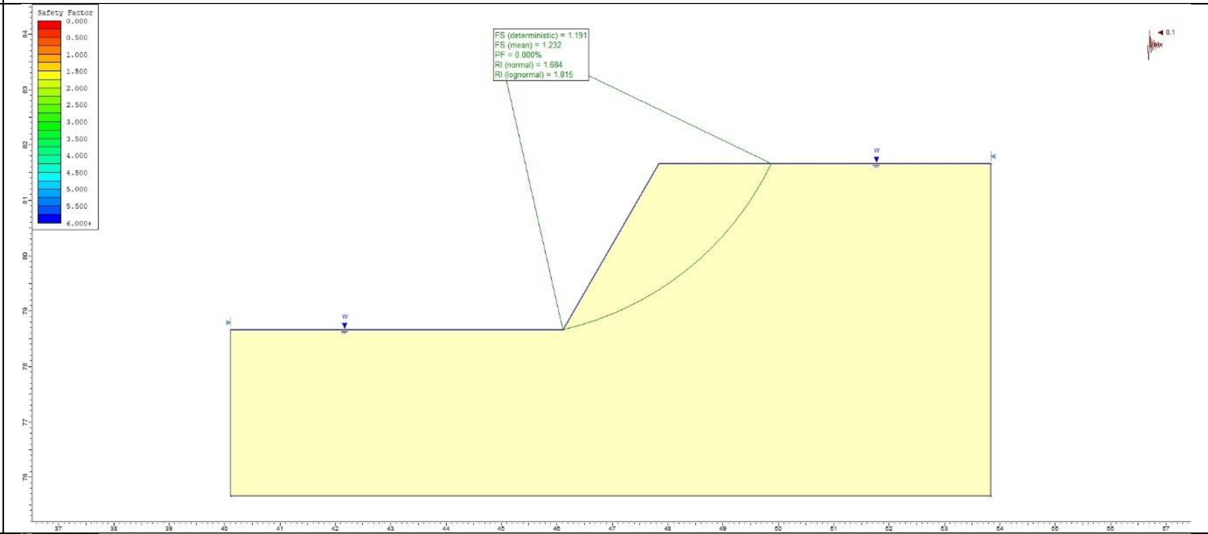
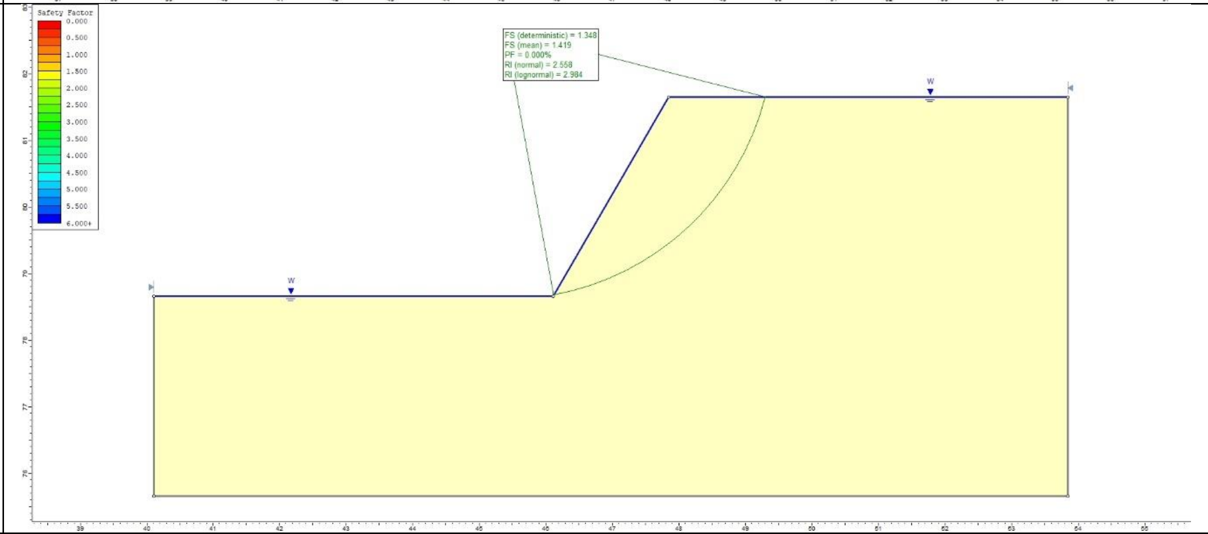
Saprolite			
Lereng	Kondisi	Gambar	FK
H=3 S=50	Dinamik		4,97
	Statik		6,25

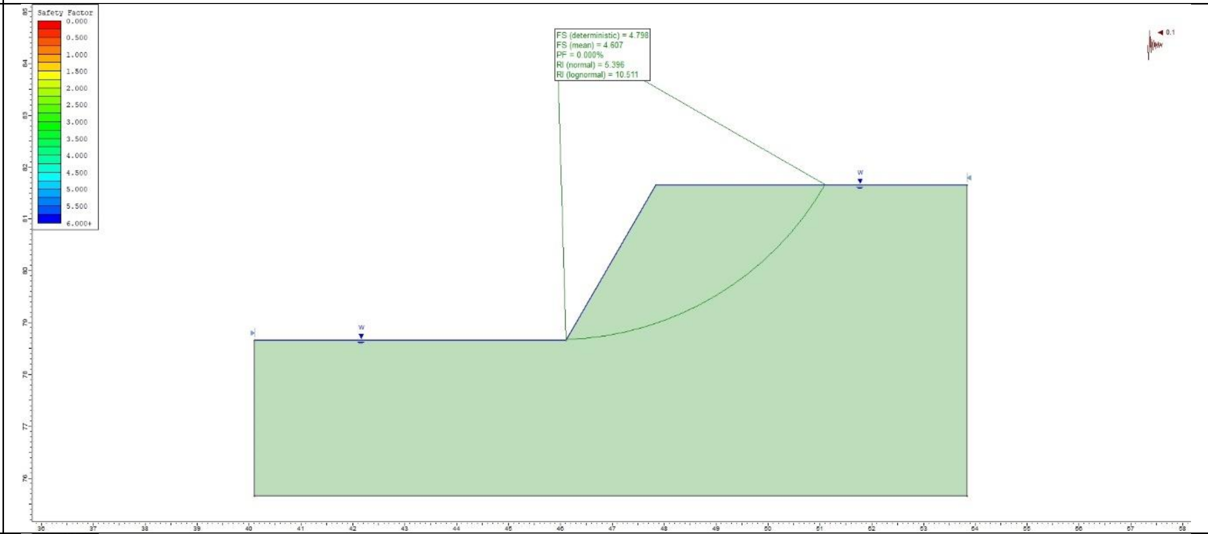
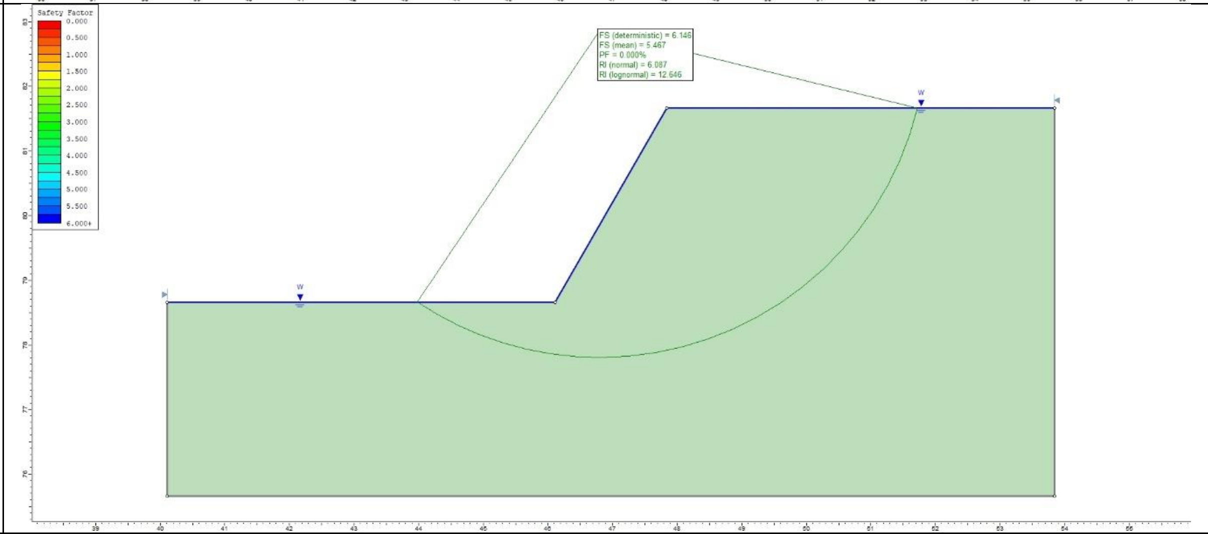
Bedrock			
Lereng	Kondisi	Gambar	FK
H=3 S=50	Dinamik		13,41
	Statik		16,61

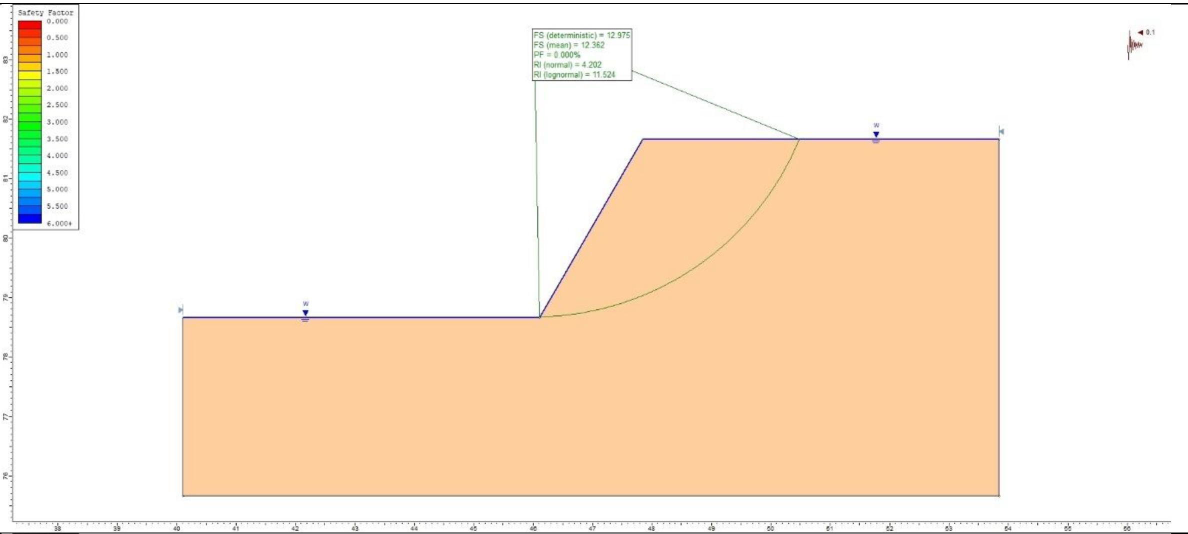
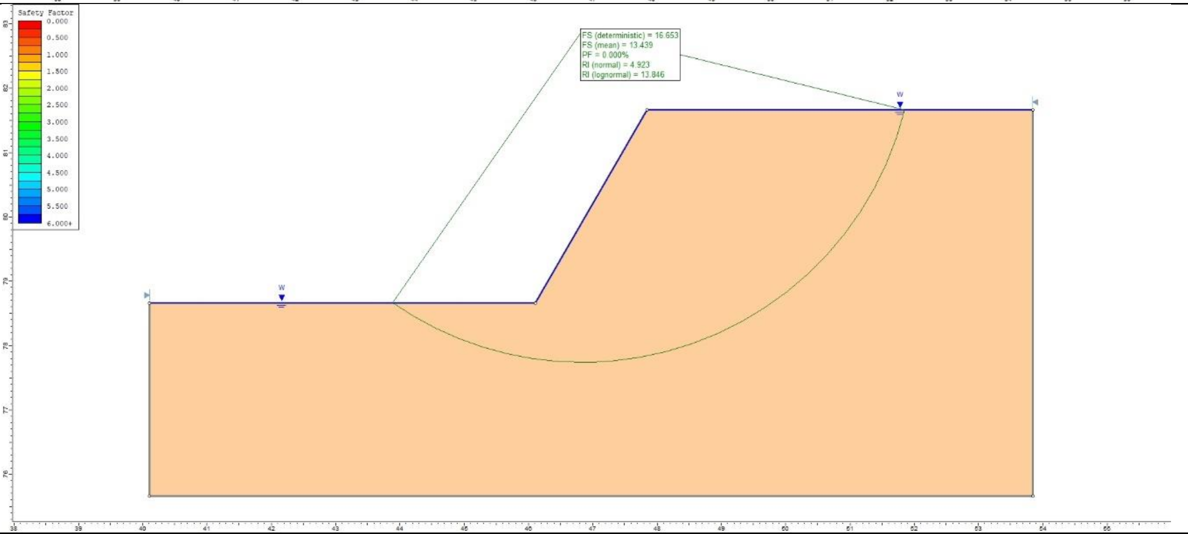
Limonite			
Lereng	Kondisi	Gambar	FK
H=3 S=55	Dinamik		1,29
	Statik		1,46

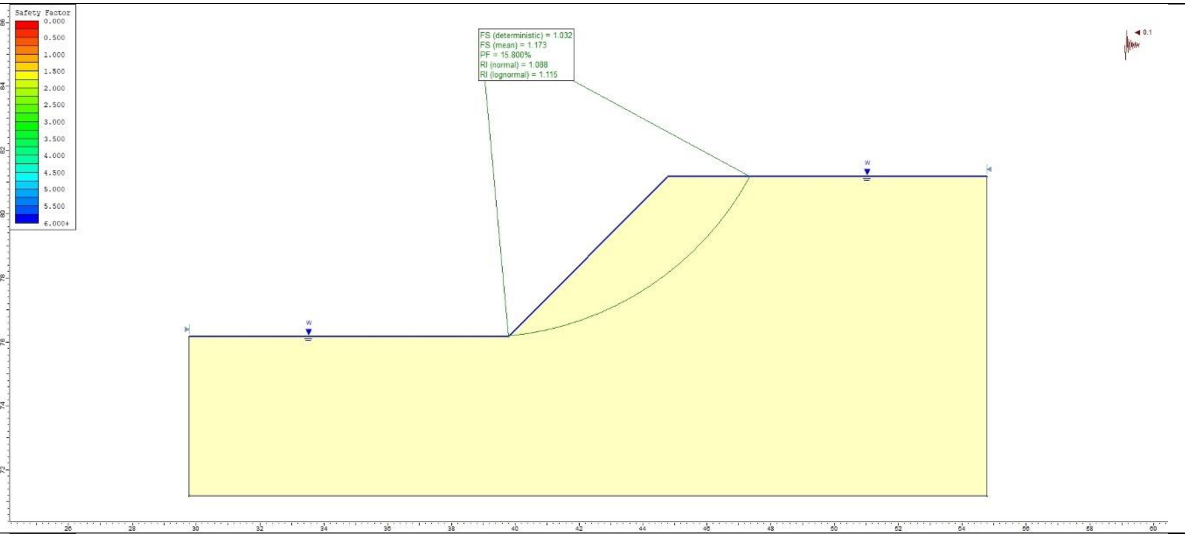
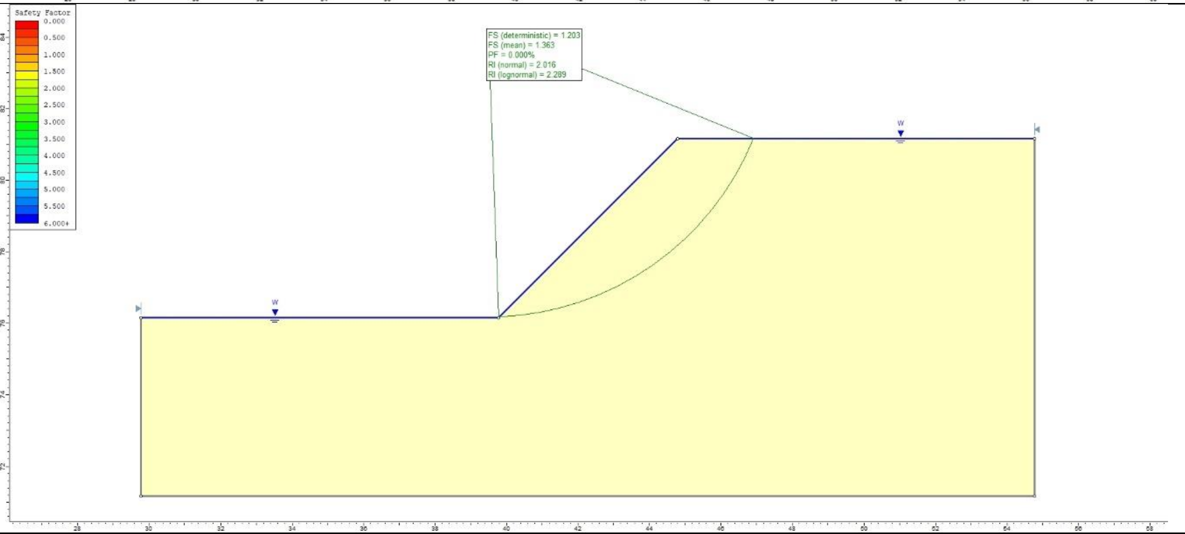
Saprolite			
Lereng	Kondisi	Gambar	FK
H=3 S=55	Dinamik		4,97
	Statik		6,19

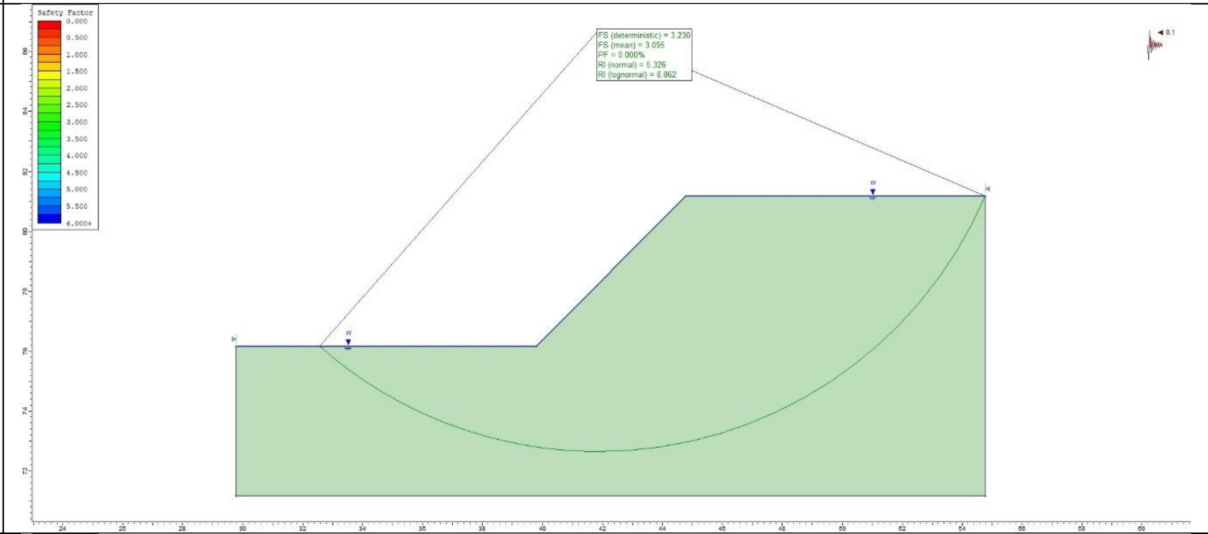
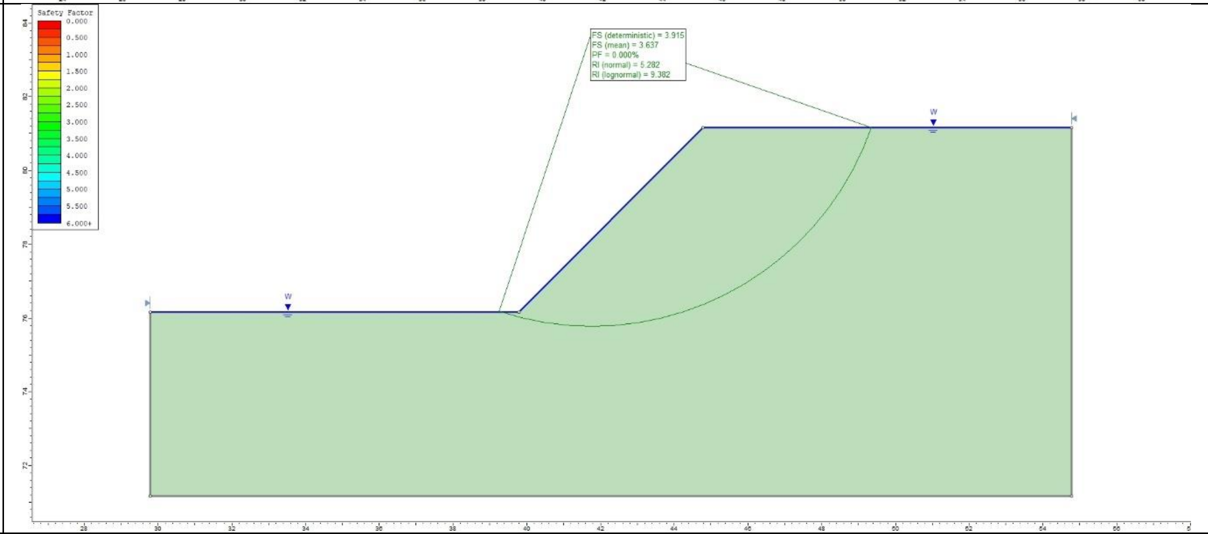
<table>
<tr><th colspan="4">Bedrock</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=3
S=55</td><td>Dinamik</td><td>
</td><td>13,43</td></tr>
<tr><td>Statik</td><td>
</td><td>16,76</td></tr>
</table>

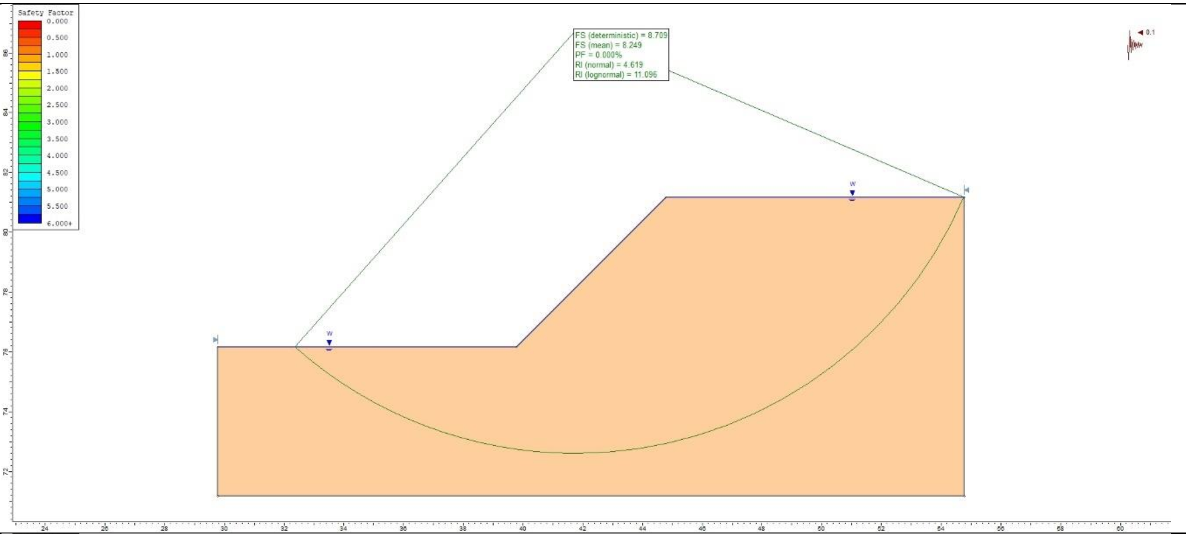
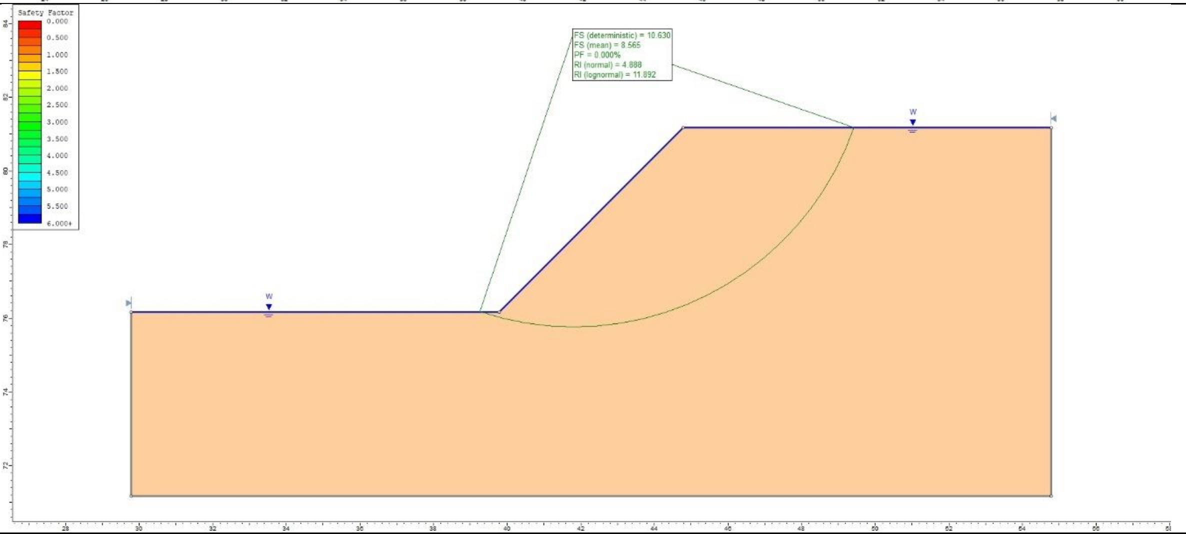
Limonite			
Lereng	Kondisi	Gambar	FK
H=3 S=60	Dinamik		1,19
	Statik		1,35

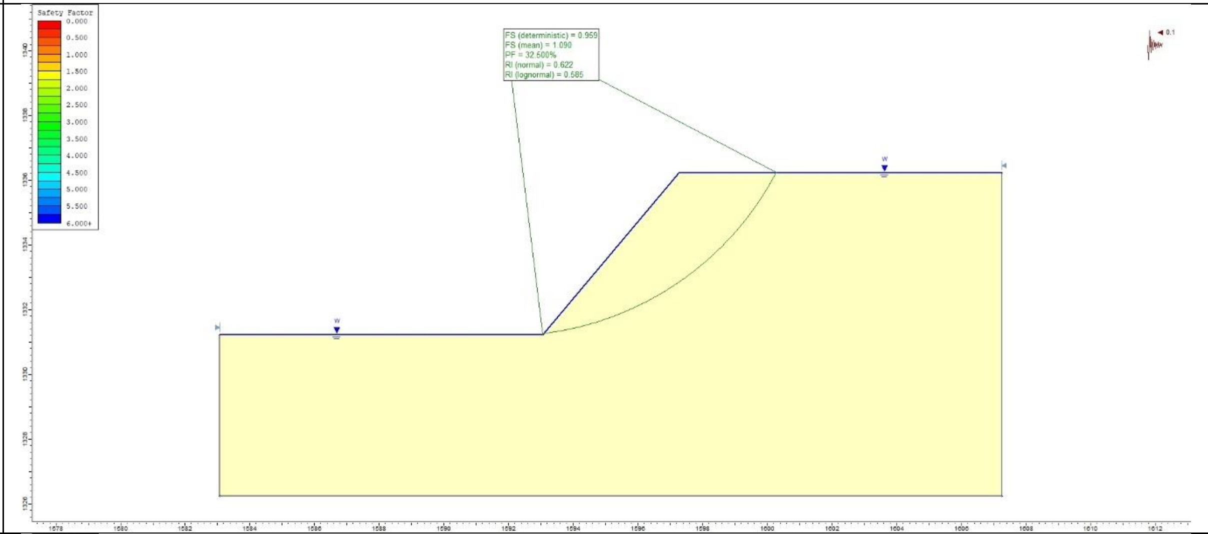
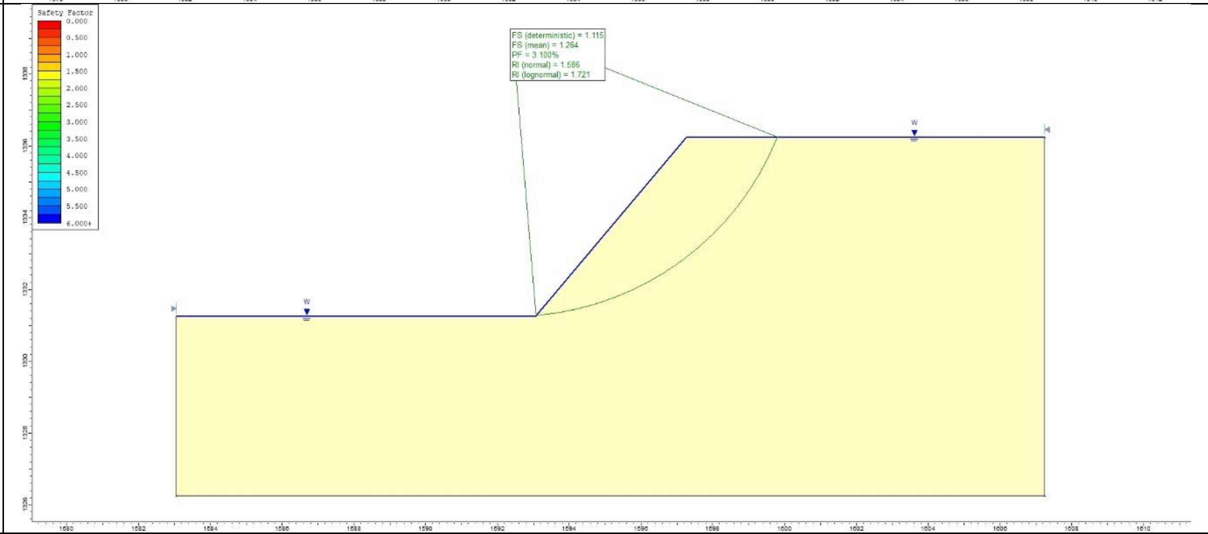
Saprolite			
Lereng	Kondisi	Gambar	FK
H=3 S=60	Dinamik		4,80
	Statik		6,15

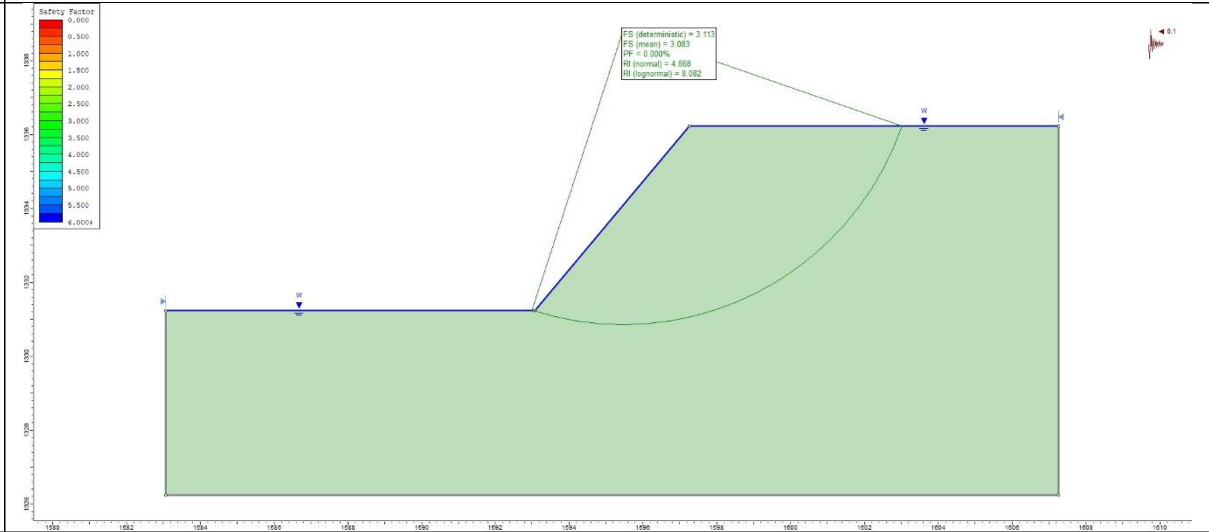
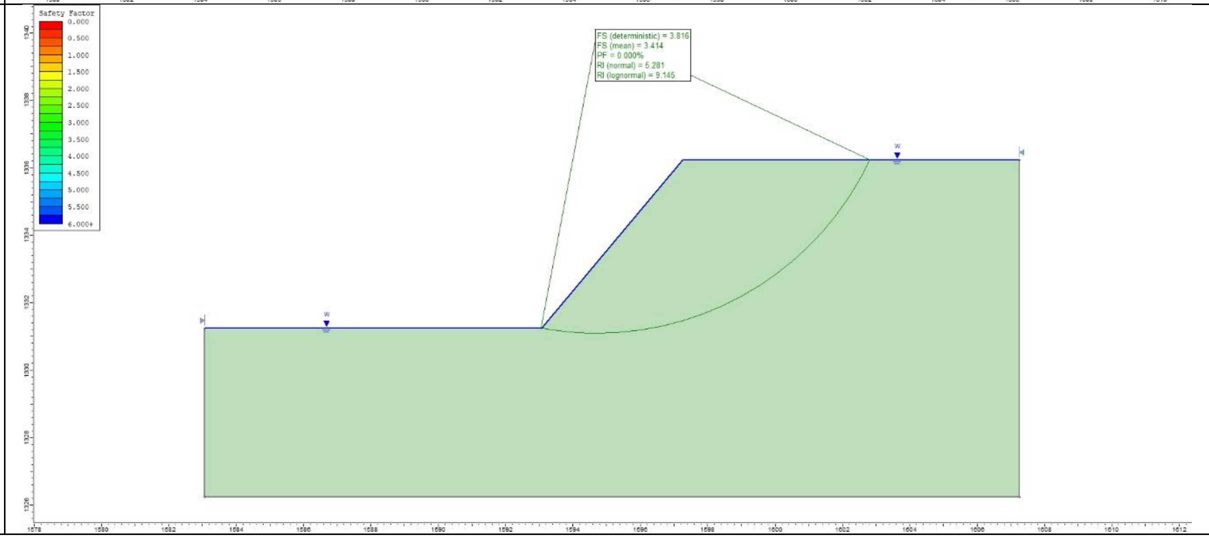
Bedrock			
Lereng	Kondisi	Gambar	FK
H=3 S=60	Dinamik		12,97
	Statik		16,65

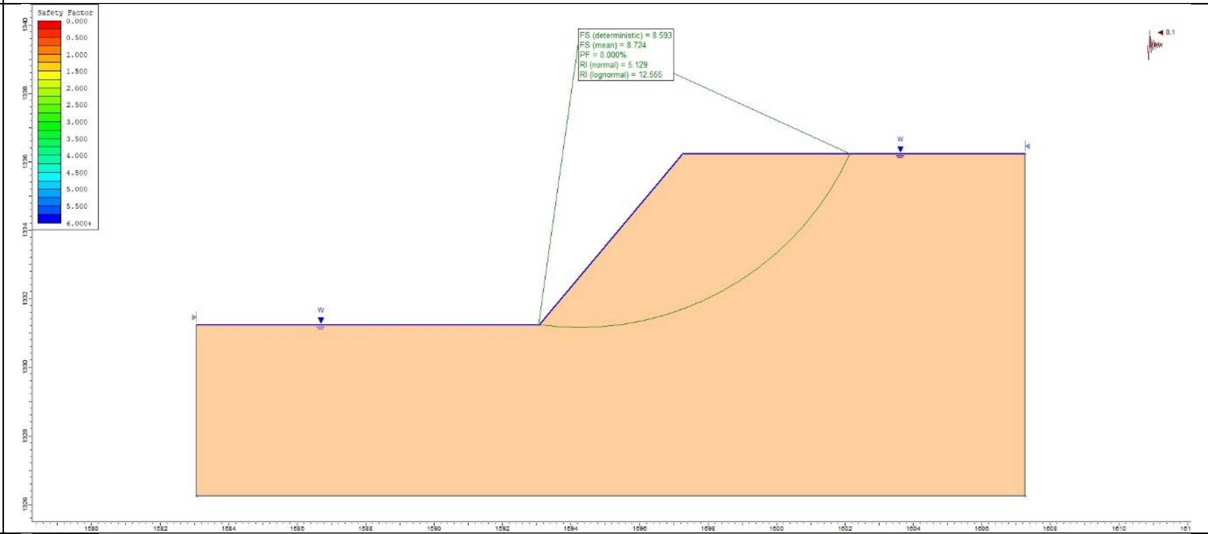
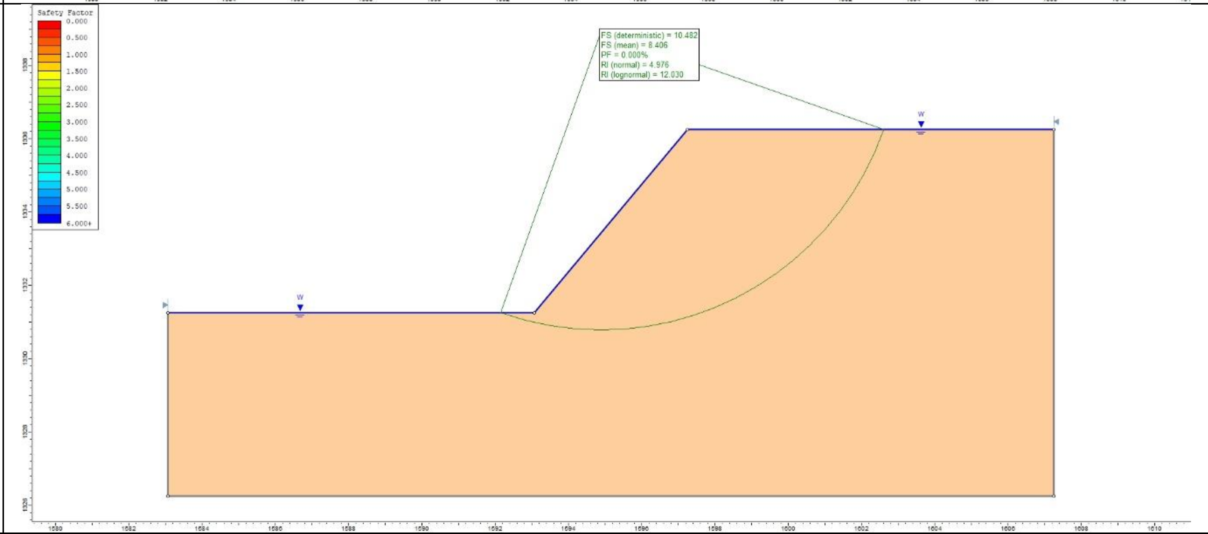
Limonite			
Lereng	Kondisi	Gambar	FK
H=5 S=45	Dinamik		1,03
	Statik		1,20

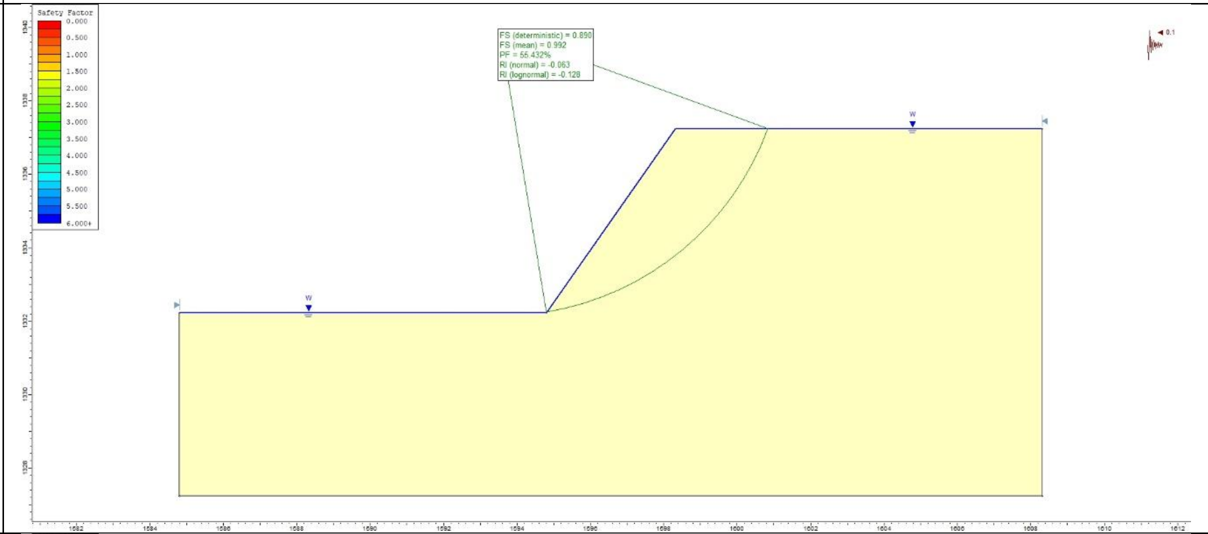
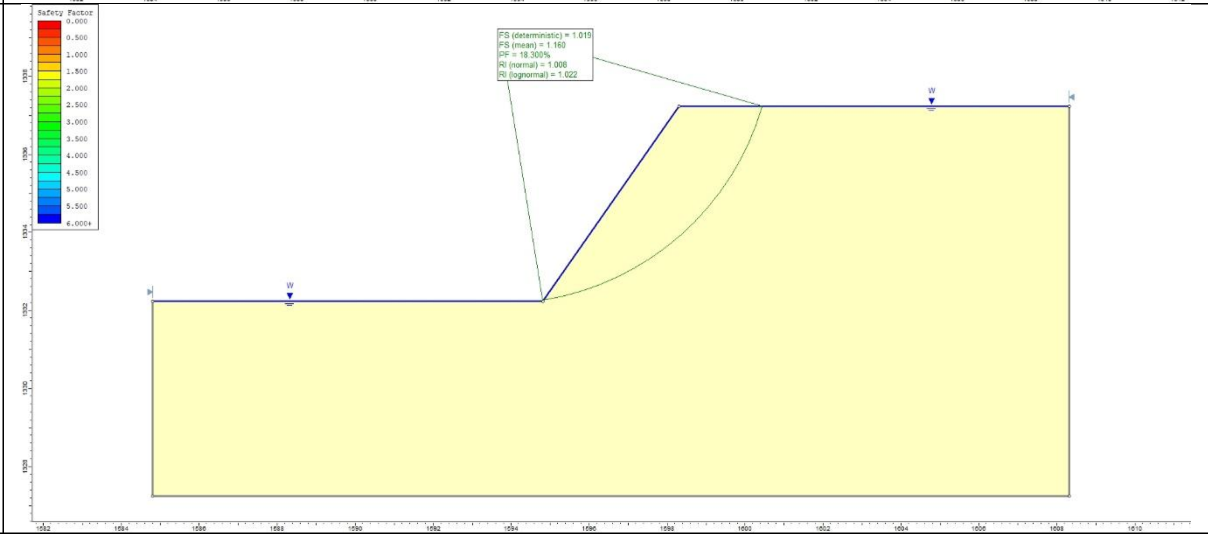
<table>
<tr><th colspan="4">Saprolite</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=45</td><td>Dinamik</td><td>
</td><td>3,23</td></tr>
<tr><td>Statik</td><td>
</td><td>3,91</td></tr>
</table>

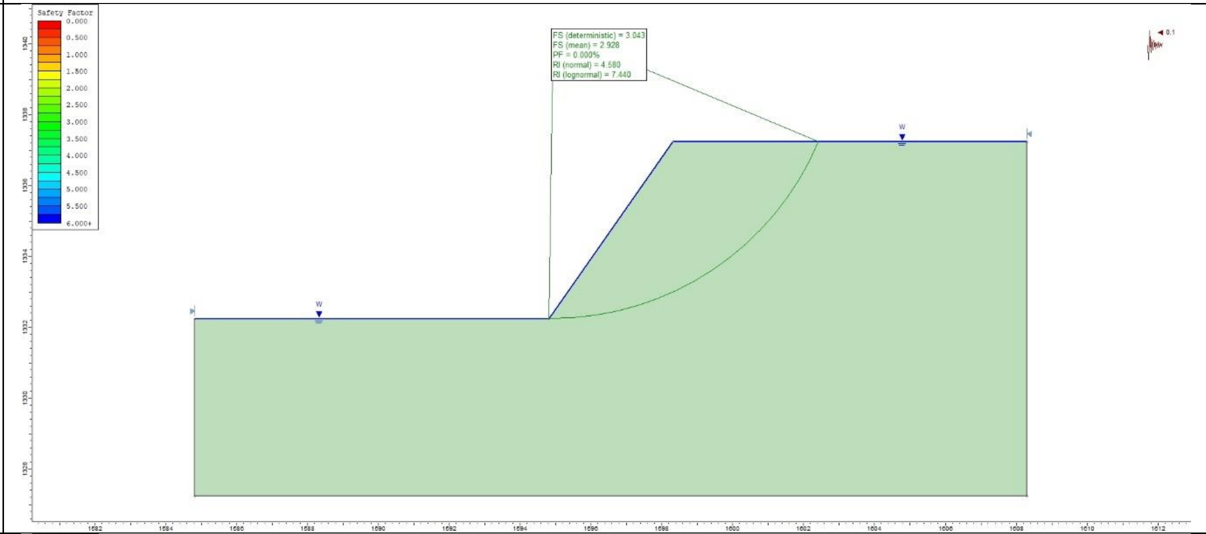
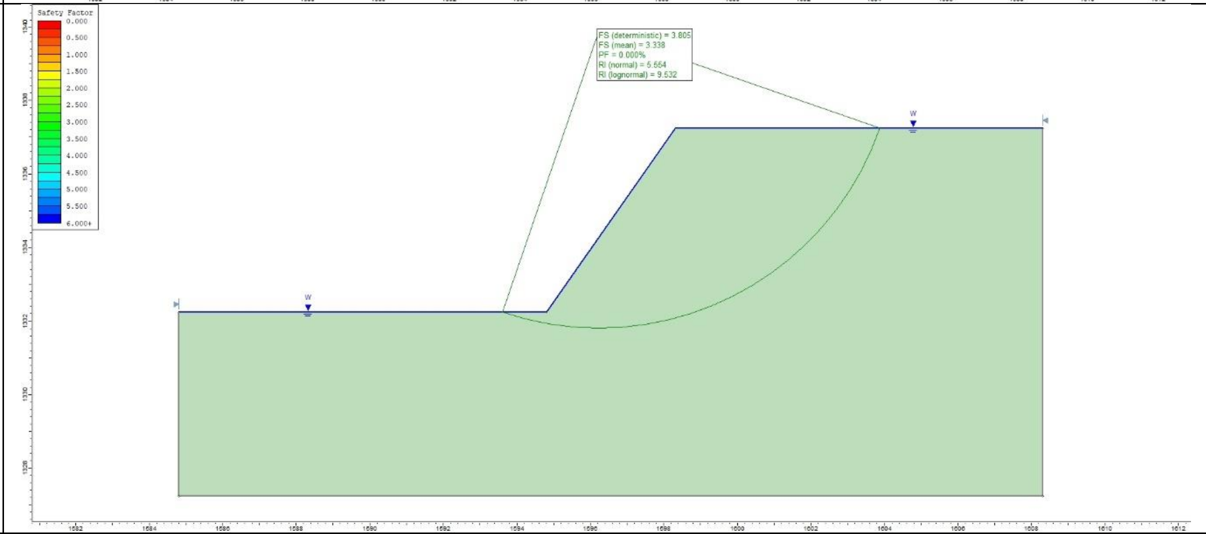
<table>
<tr><th colspan="4">Bedrock</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=45</td><td>Dinamik</td><td>
</td><td>8,71</td></tr>
<tr><td>Statik</td><td>
</td><td>10,63</td></tr>
</table>

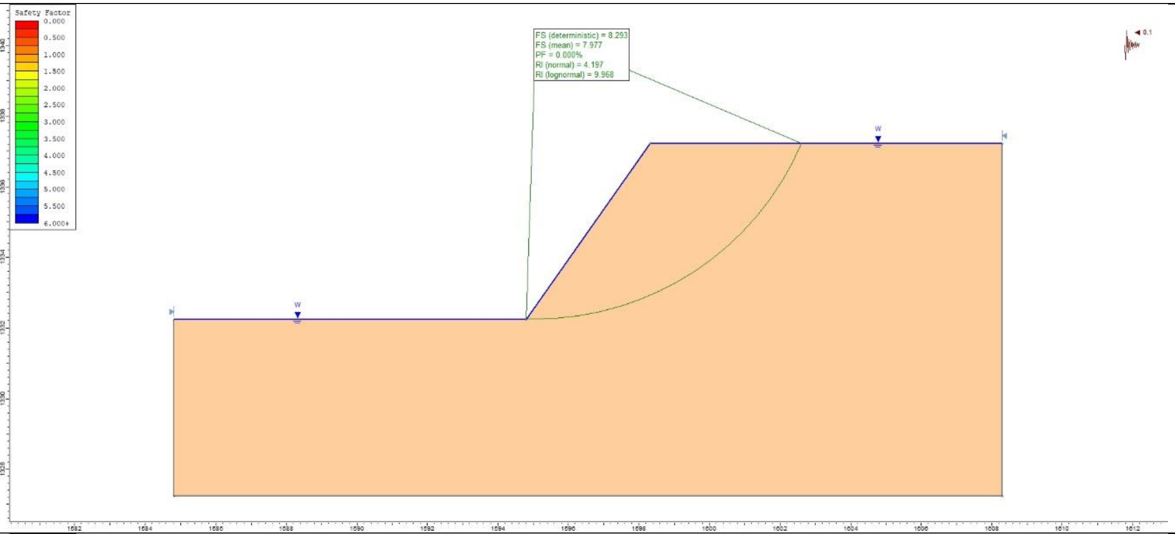
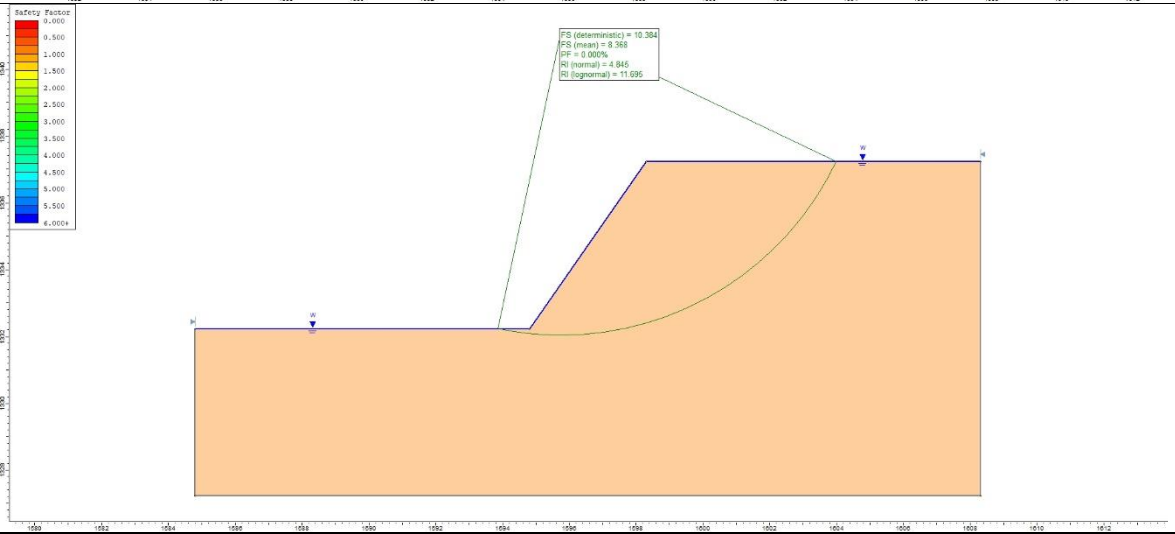
<table>
<tr><th colspan="4">Limonite</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=50</td><td>Dinamik</td><td>
</td><td>0,96</td></tr>
<tr><td>Statik</td><td>
</td><td>1,11</td></tr>
</table>

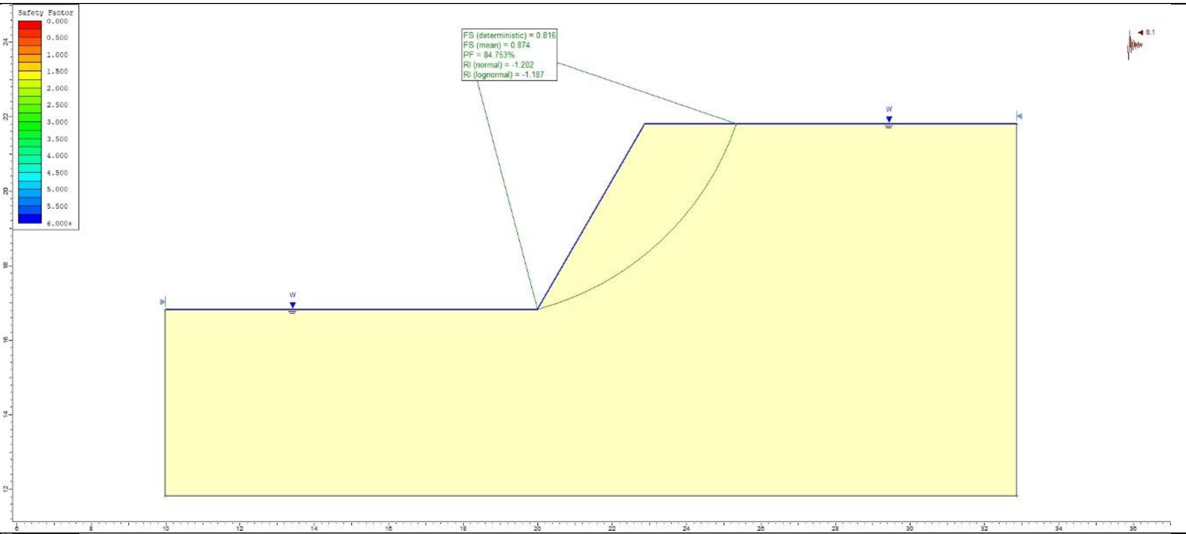
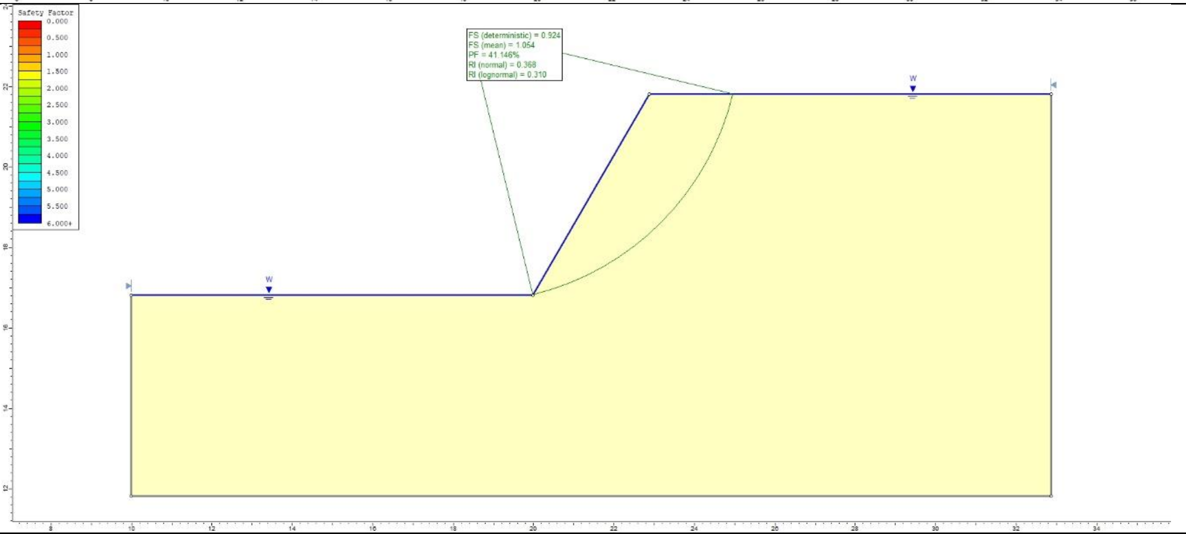
Saprolite			
Lereng	Kondisi	Gambar	FK
H=5 S=50	Dinamik		3,11
	Statik		3,82

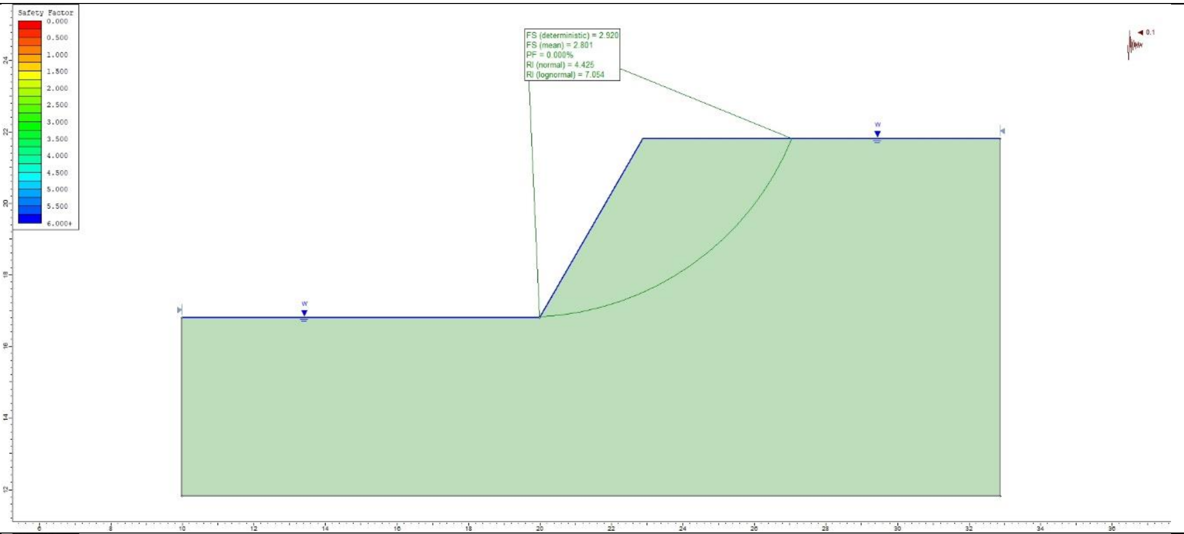
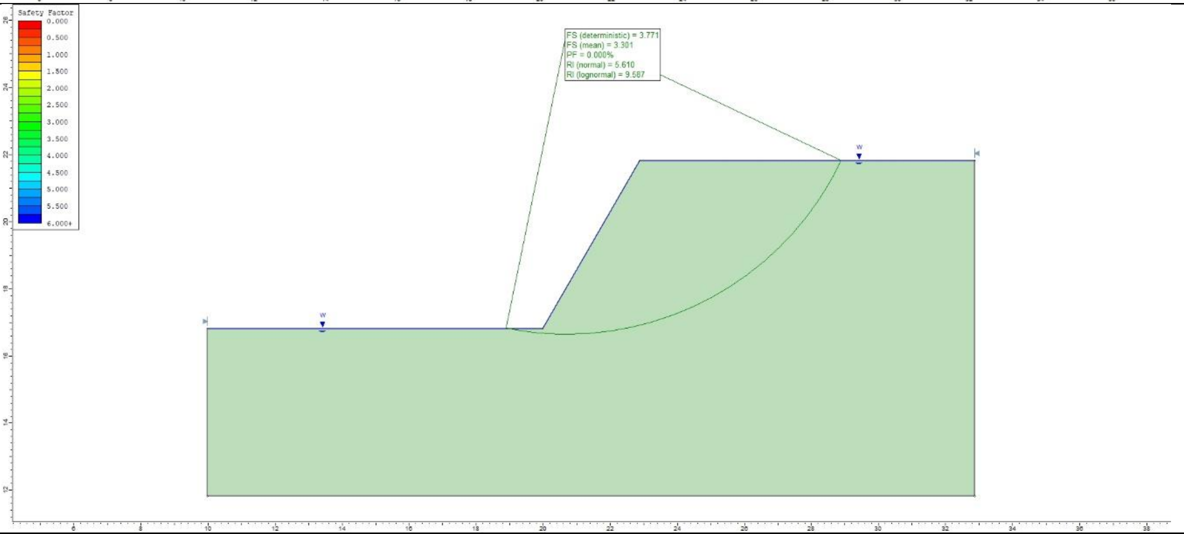
<table>
<tr><th colspan="4">Bedrock</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=50</td><td>Dinamik</td><td>
</td><td>8,59</td></tr>
<tr><td>Statik</td><td>
</td><td>10,48</td></tr>
</table>

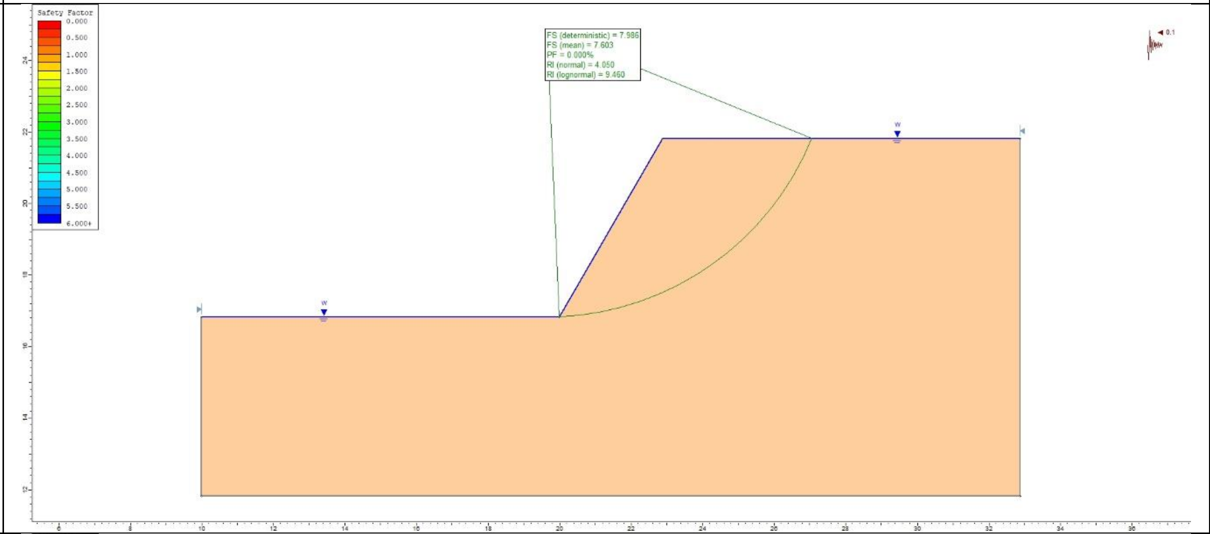
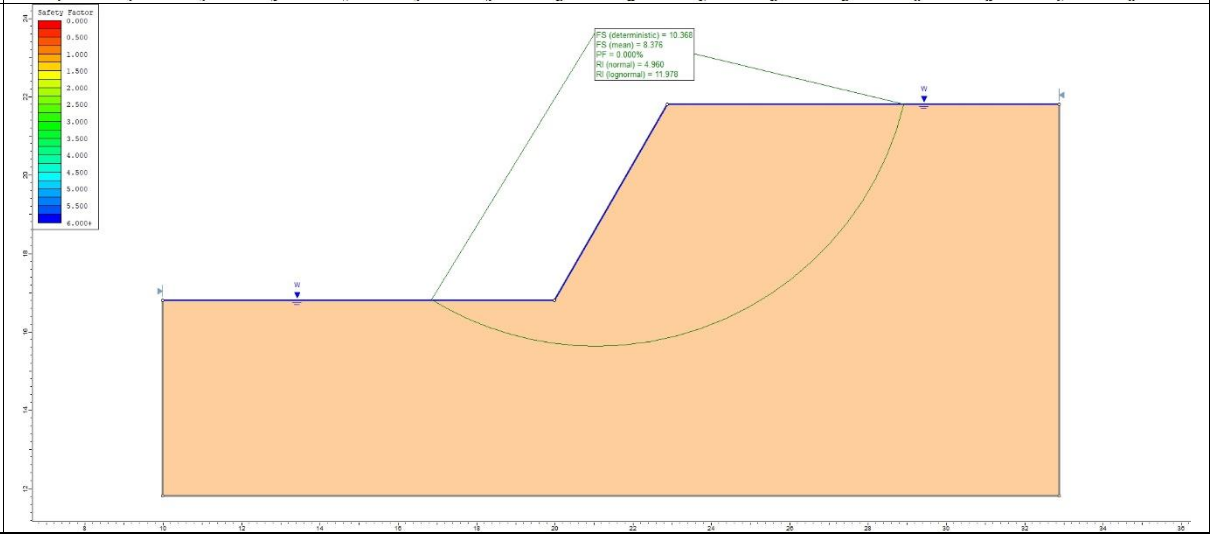
Limonite			
Lereng	Kondisi	Gambar	FK
H=5 S=55	Dinamik		0,89
	Statik		1,02

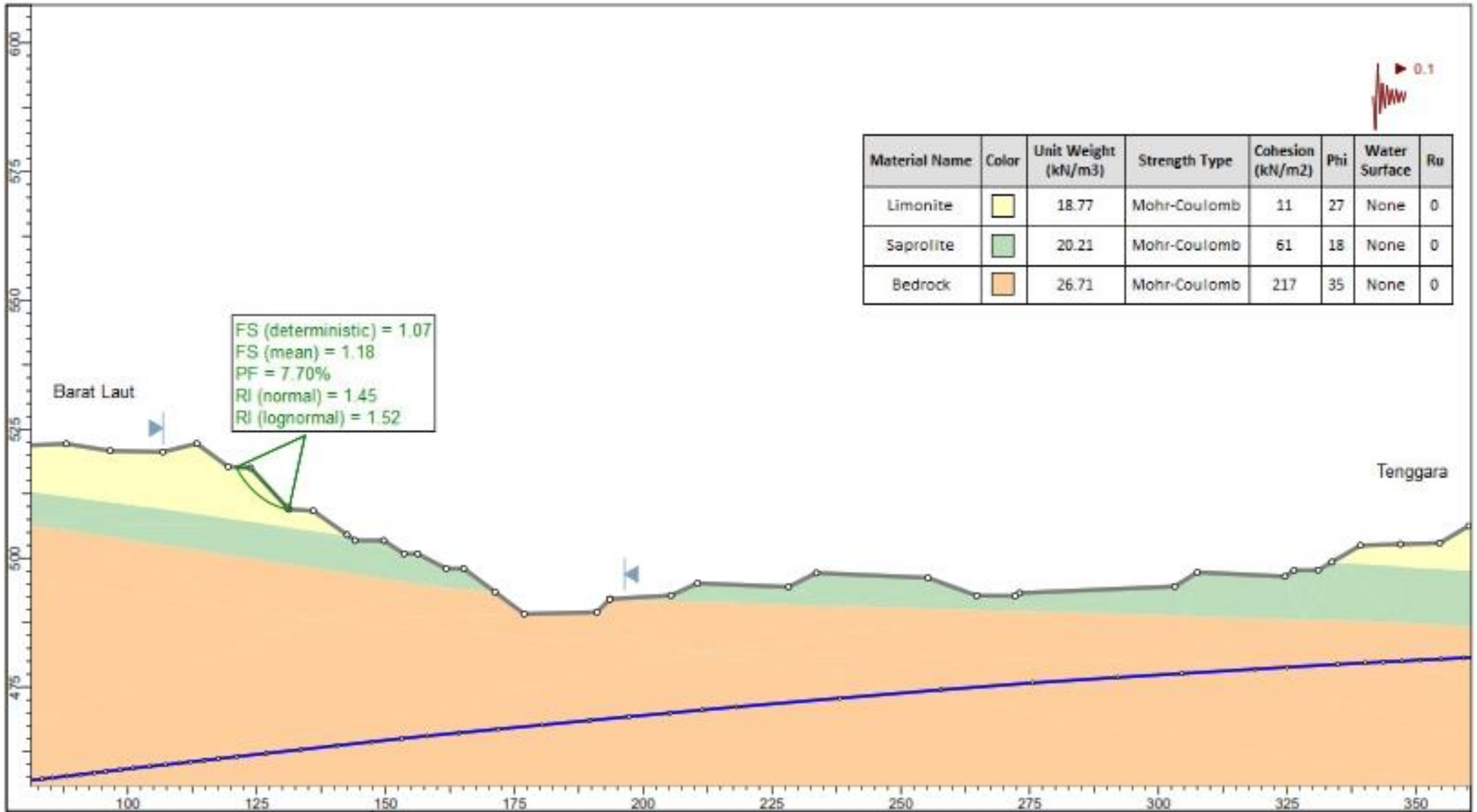
Saprolite			
Lereng	Kondisi	Gambar	FK
H=5 S=55	Dinamik		3,04
	Statik		3,80

<table>
<tr><th colspan="4">Bedrock</th></tr>
<tr><th>Lereng</th><th>Kondisi</th><th>Gambar</th><th>FK</th></tr>
<tr><td rowspan="2">H=5
S=55</td><td>Dinamik</td><td>
</td><td>8,29</td></tr>
<tr><td>Statik</td><td>
</td><td>10,38</td></tr>
</table>

Limonite			
Lereng	Kondisi	Gambar	FK
H=5 S=60	Dinamik		0,82
	Statik		0,92

Saprolite			
Lereng	Kondisi	Gambar	FK
H=5 S=60	Dinamik		2,92
	Statik		3,77

Bedrock			
Lereng	Kondisi	Gambar	FK
H=5 S=60	Dinamik		7,99
	Statik		10,37



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

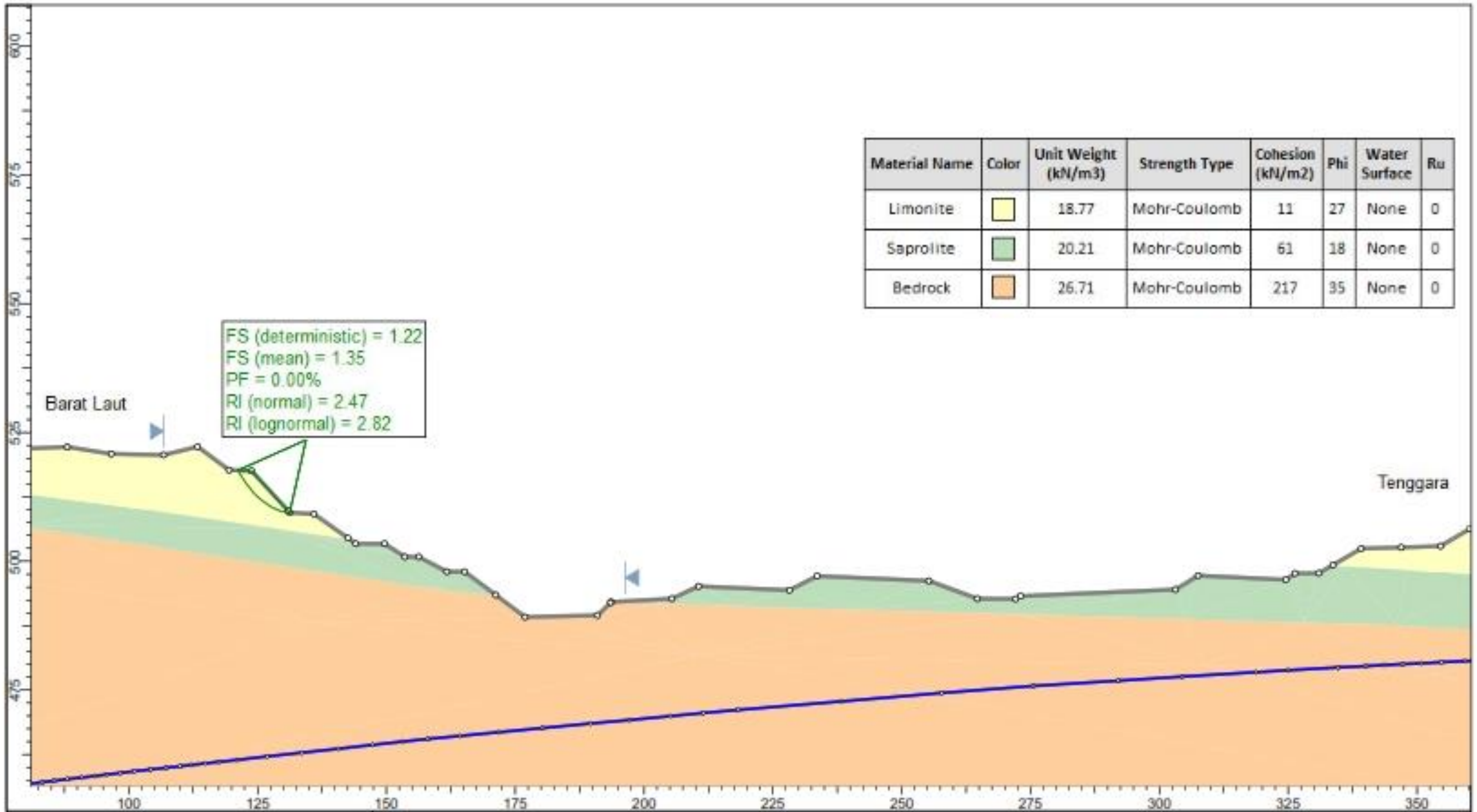
GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section Act_01

Kondisi Dinamik dan GW Model

Scale = 1:1000

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

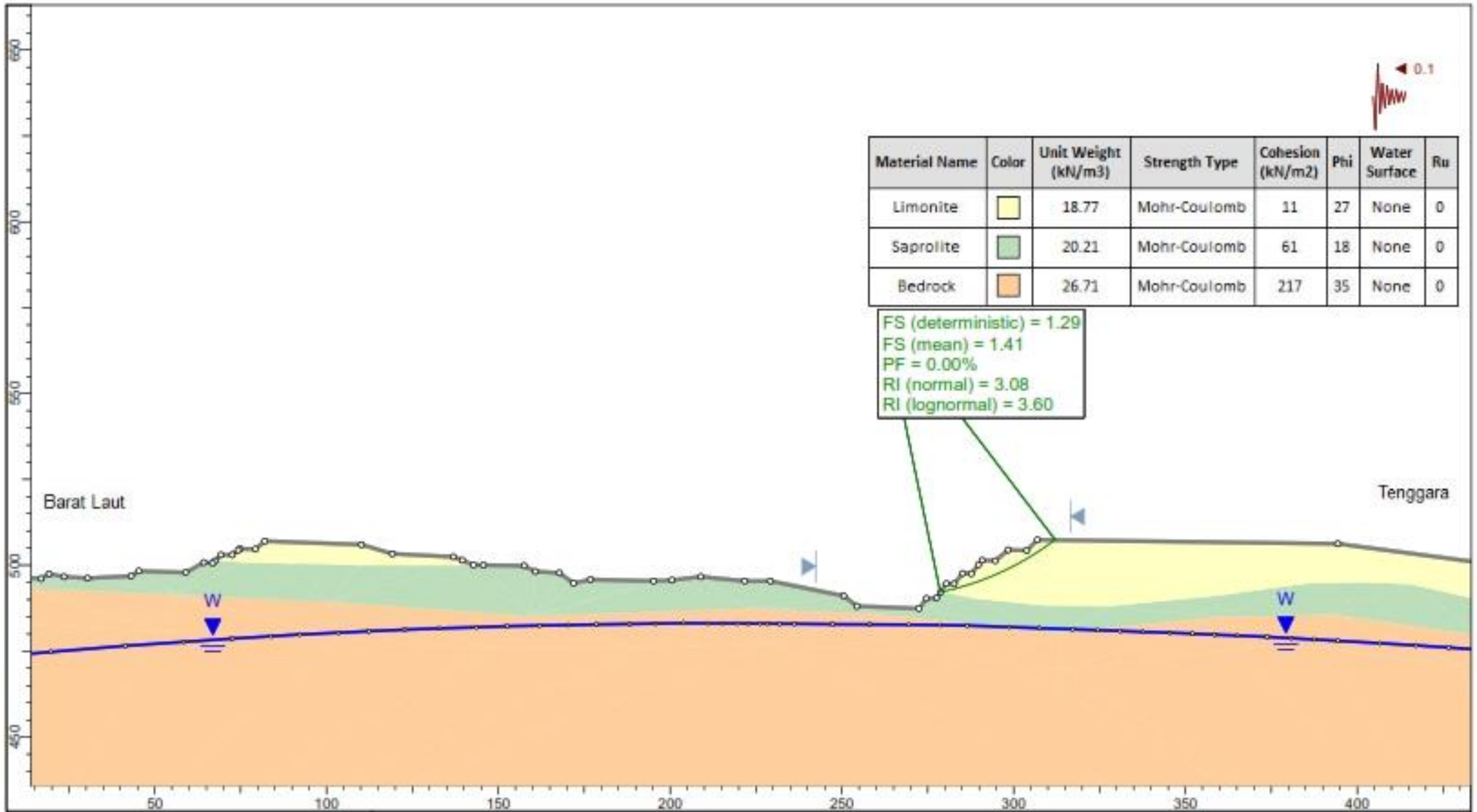


GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section Act_01

Kondisi Statik dan GW Model

Scale = 1:1000



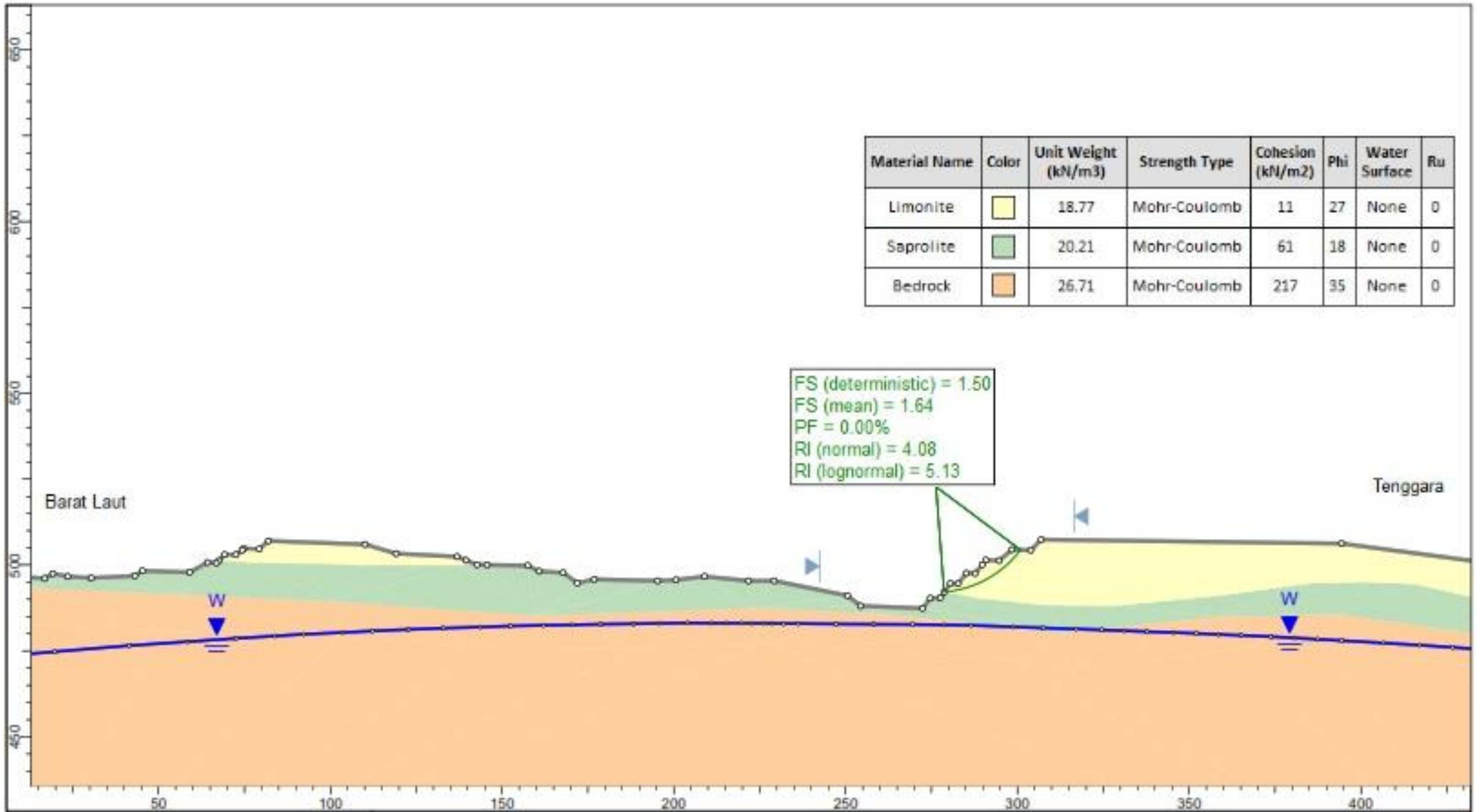
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section Act_02

Kondisi Dinamik dan GW Model

Scale = 1:1500



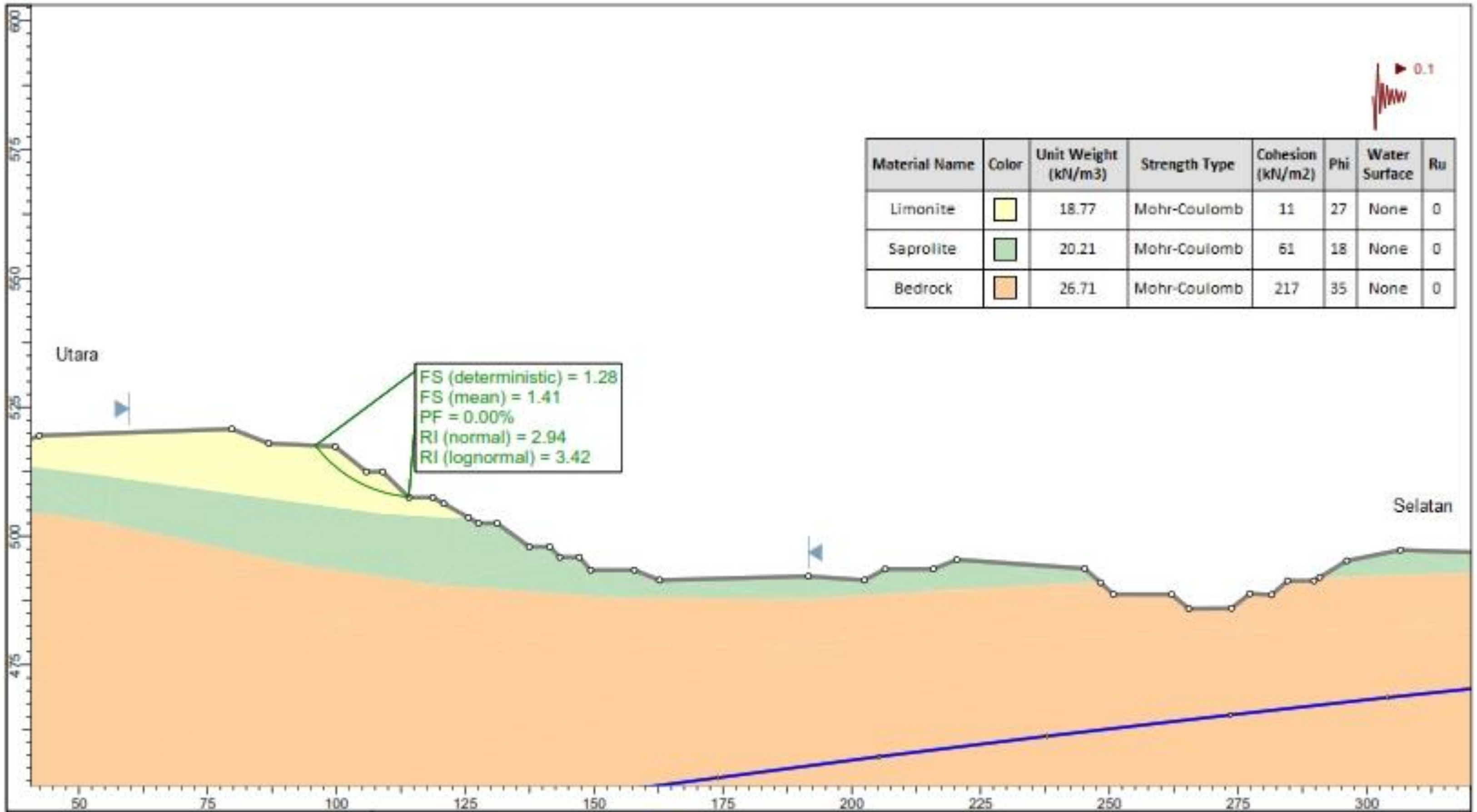
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section Act_02

Kondisi Statik dan GW Model

Scale = 1:1500



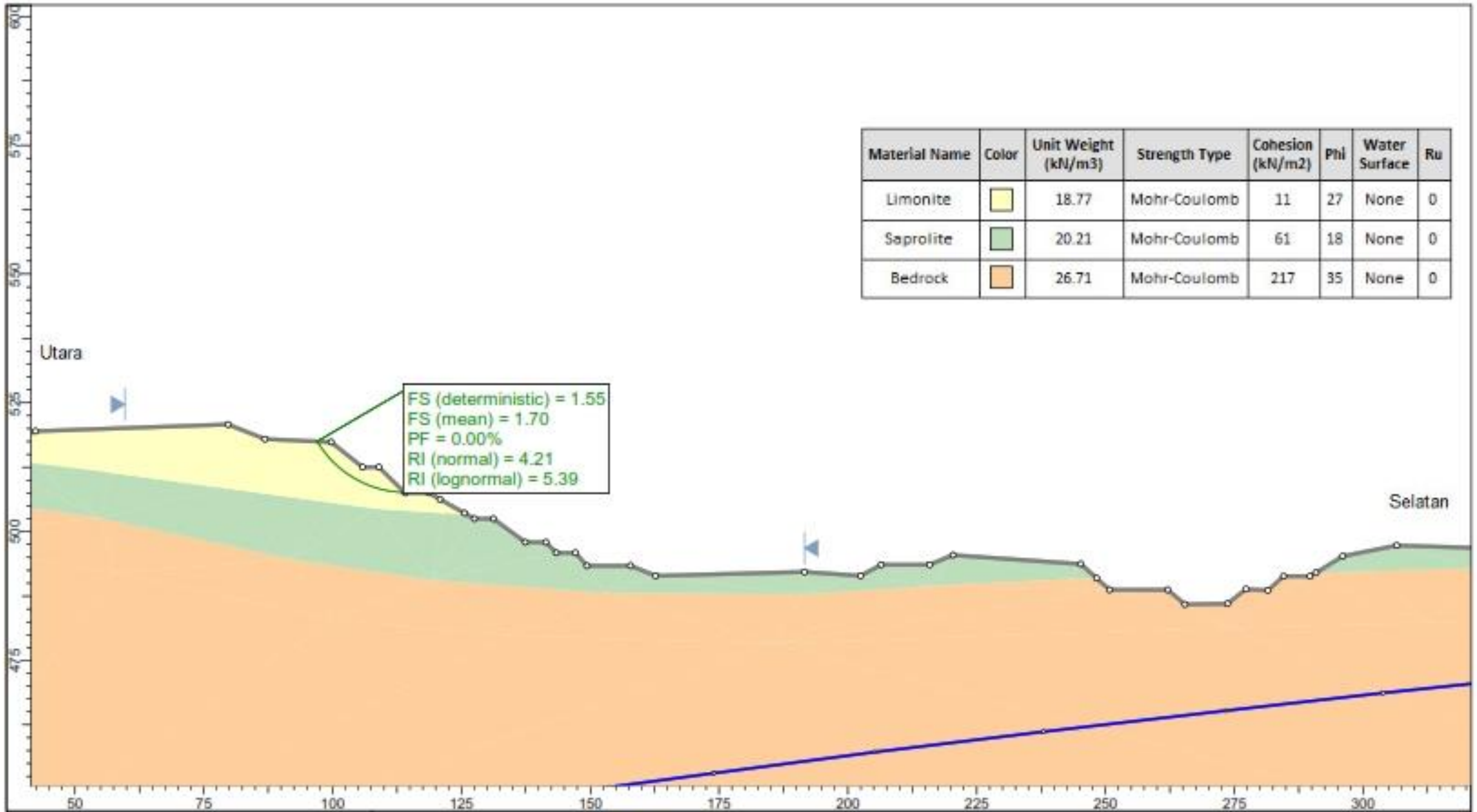
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section Act_03

Kondisi Dinamik dan GW Model

Scale = 1:1000



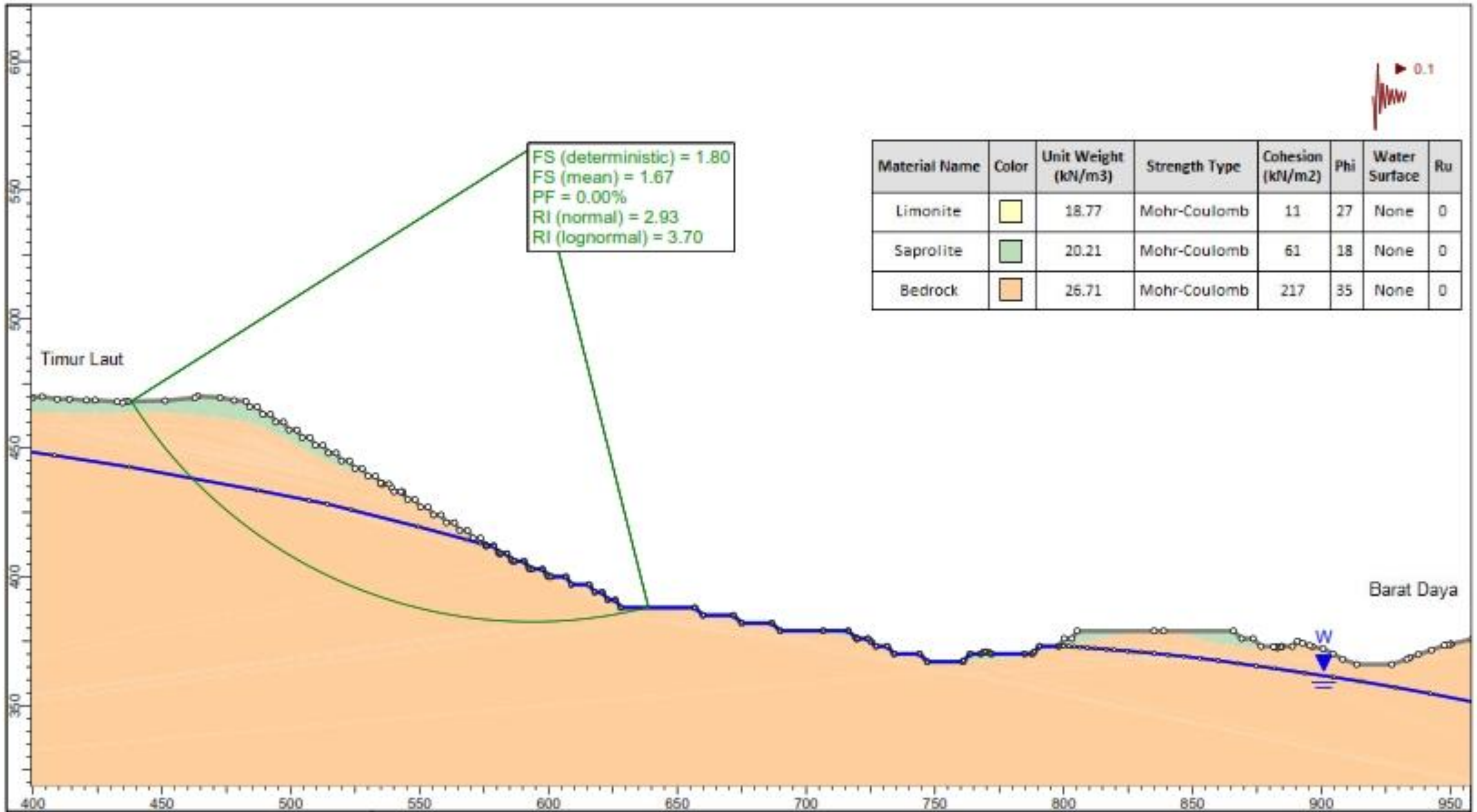
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section Act_03

Kondisi Statik dan GW Model

Scale = 1:1000



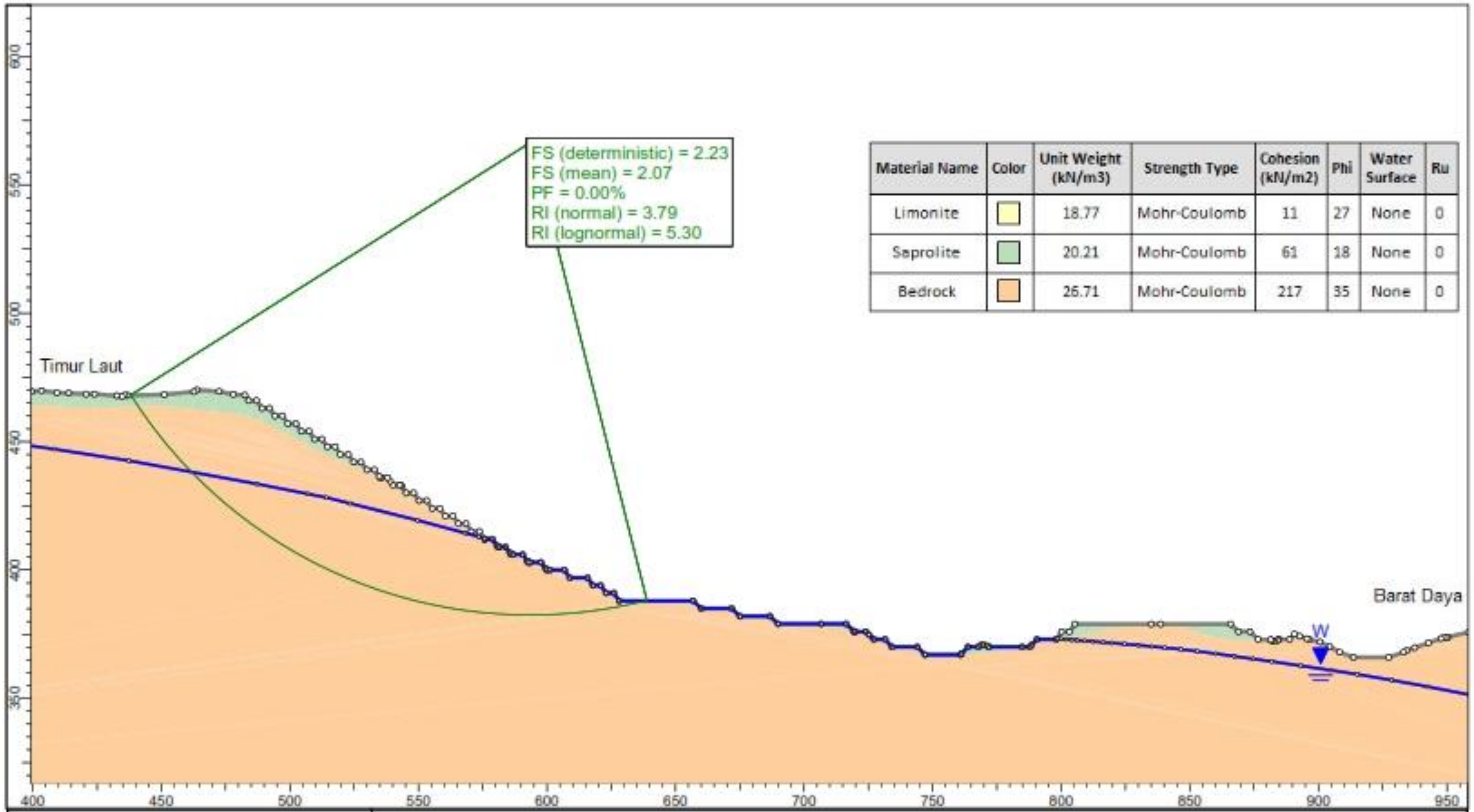
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section AA' Area Bete-bete (Sisi Timur Laut)

Kondisi Dinamik dan GW Model

Scale = 1:2000

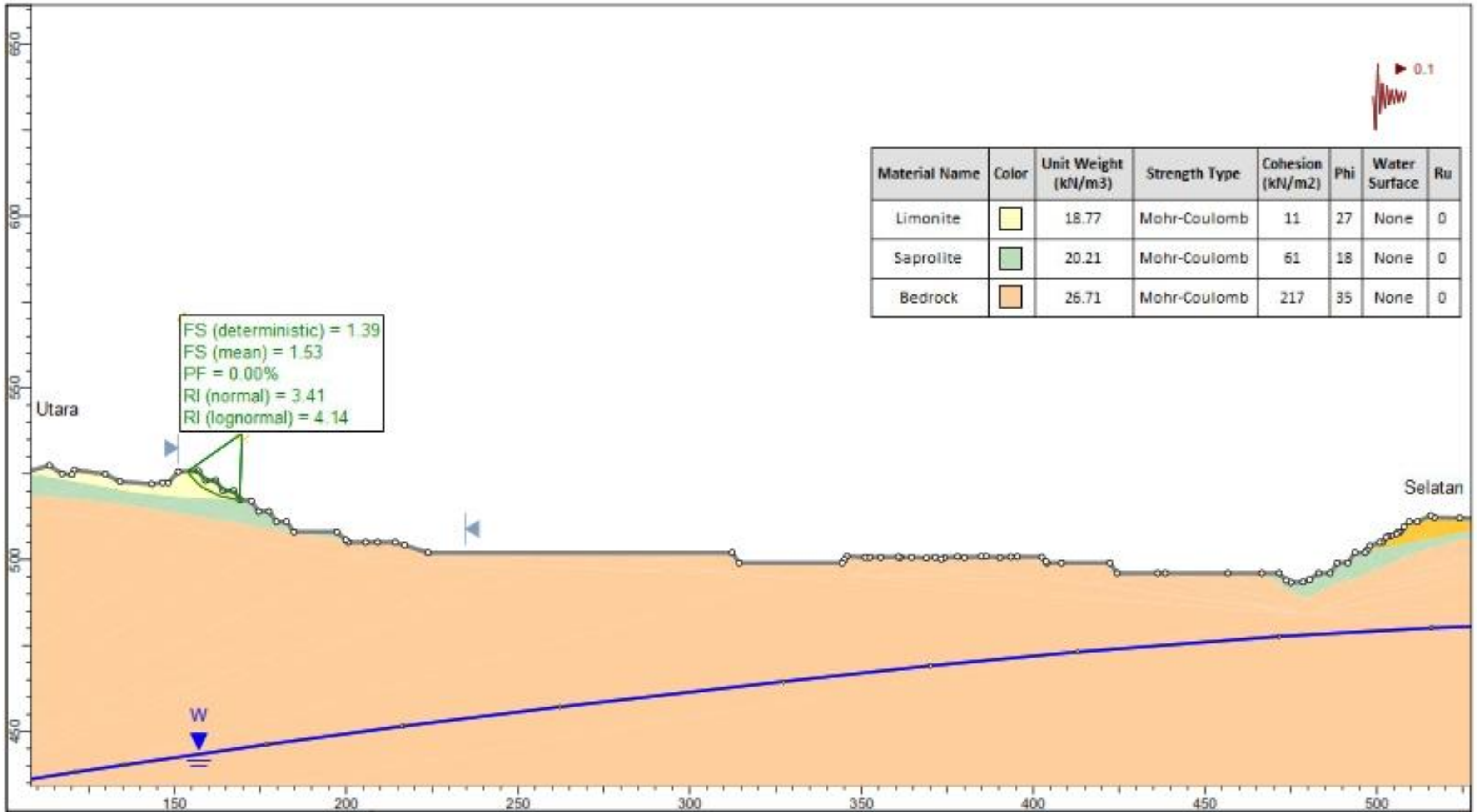


GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section AA' Area Bete-bete (Sisi Timur Laut)

Kondisi Statik dan GW Model

Scale = 1:2000



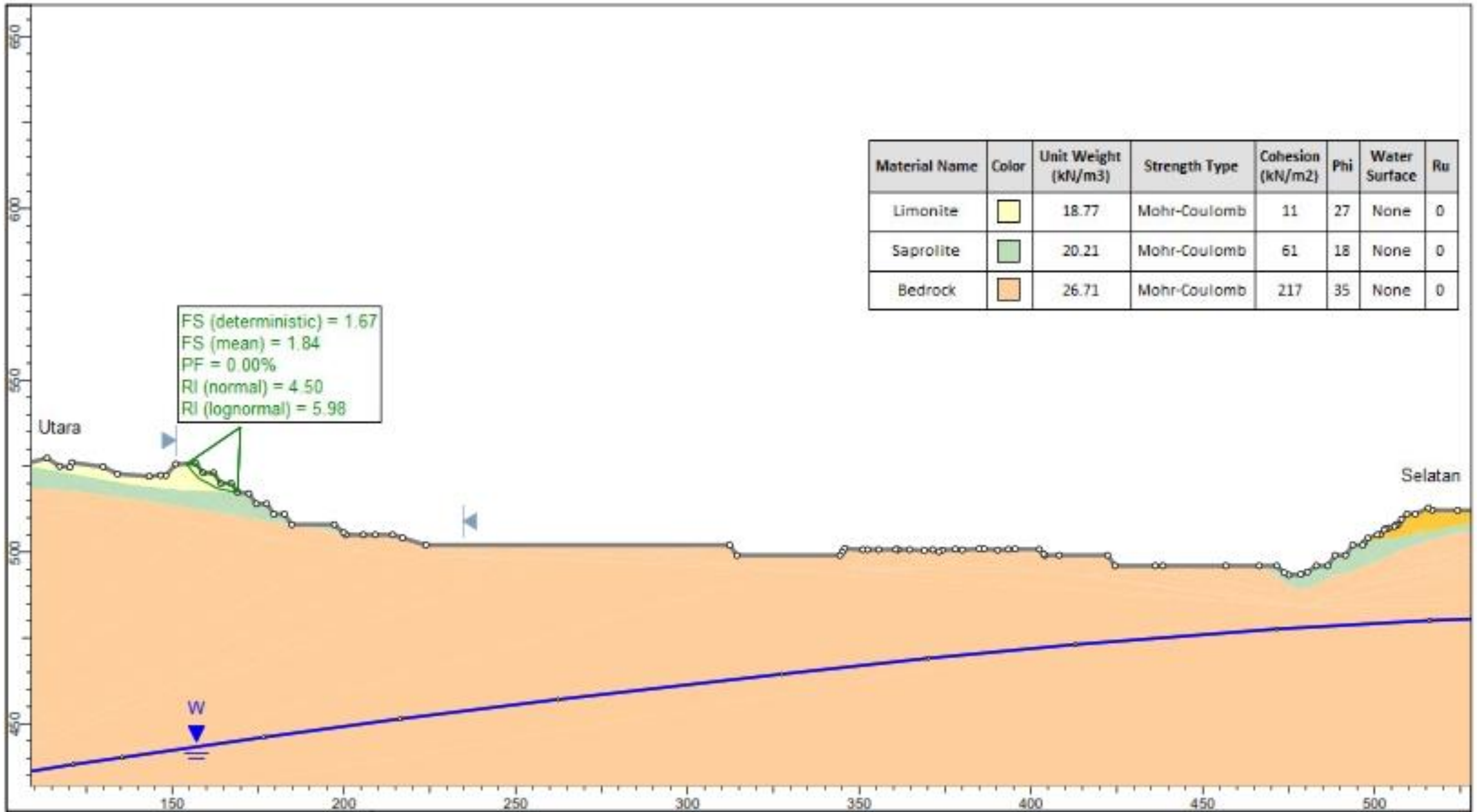
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section BB' Area Bete-bete (Sisi Utara)

Kondisi Dinamik dan GW Model

Scale = 1:1500



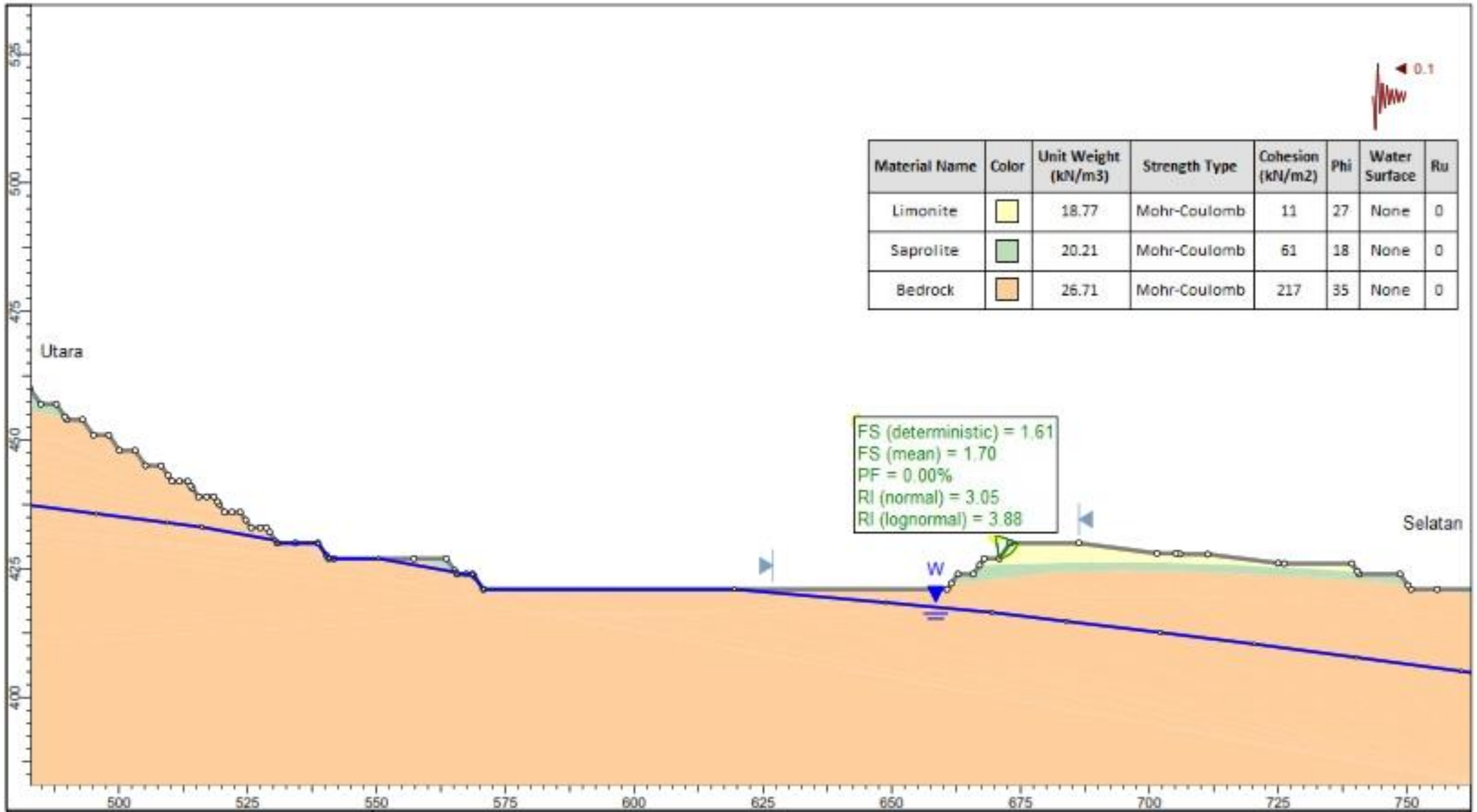
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section BB' Area Bete-bete (Sisi Utara)

Kondisi Statik dan GW Model

Scale = 1:1500



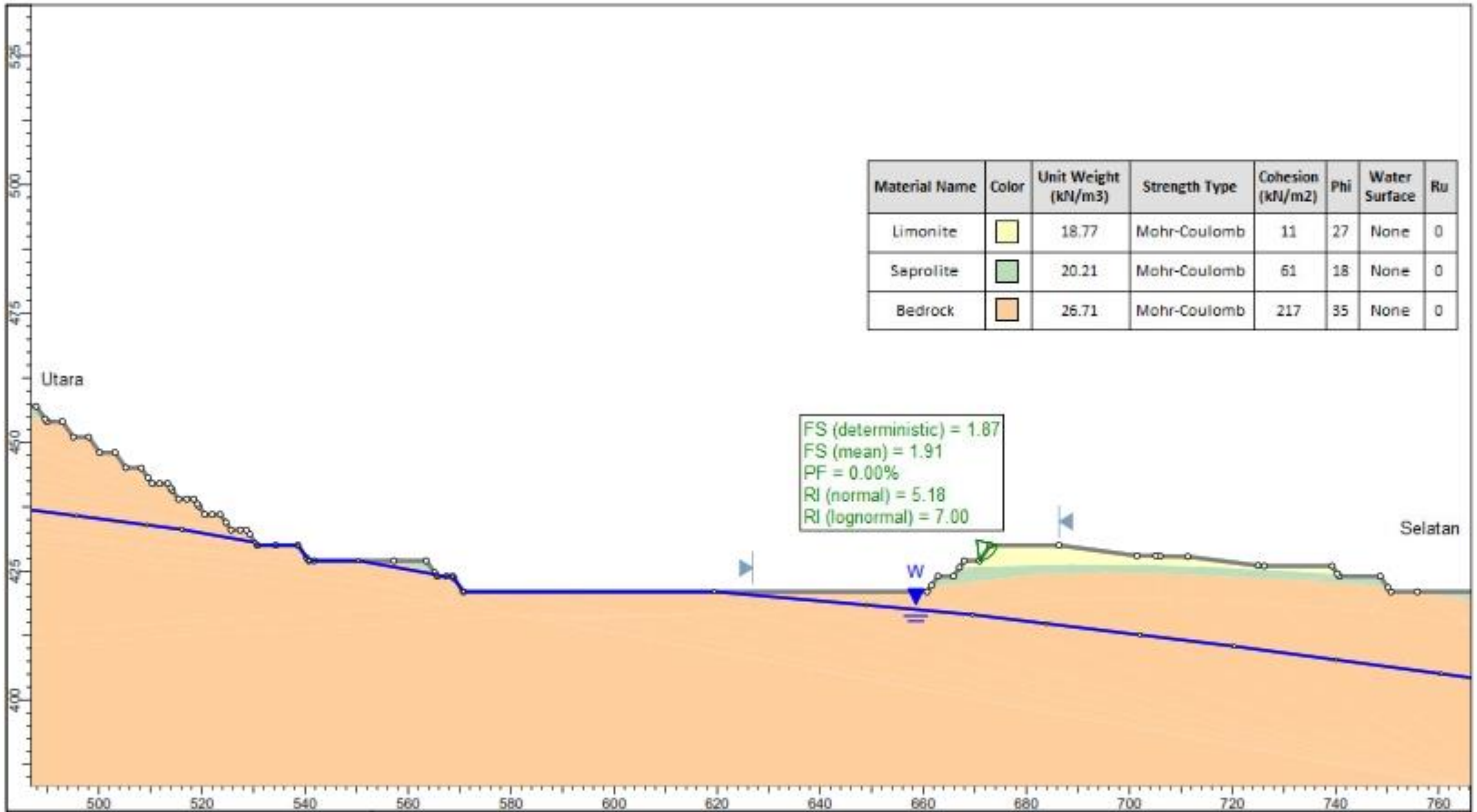
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section CC' Area Bete-bete (Sisi Selatan)

Kondisi Dinamik dan GW Model

Scale = 1:1000



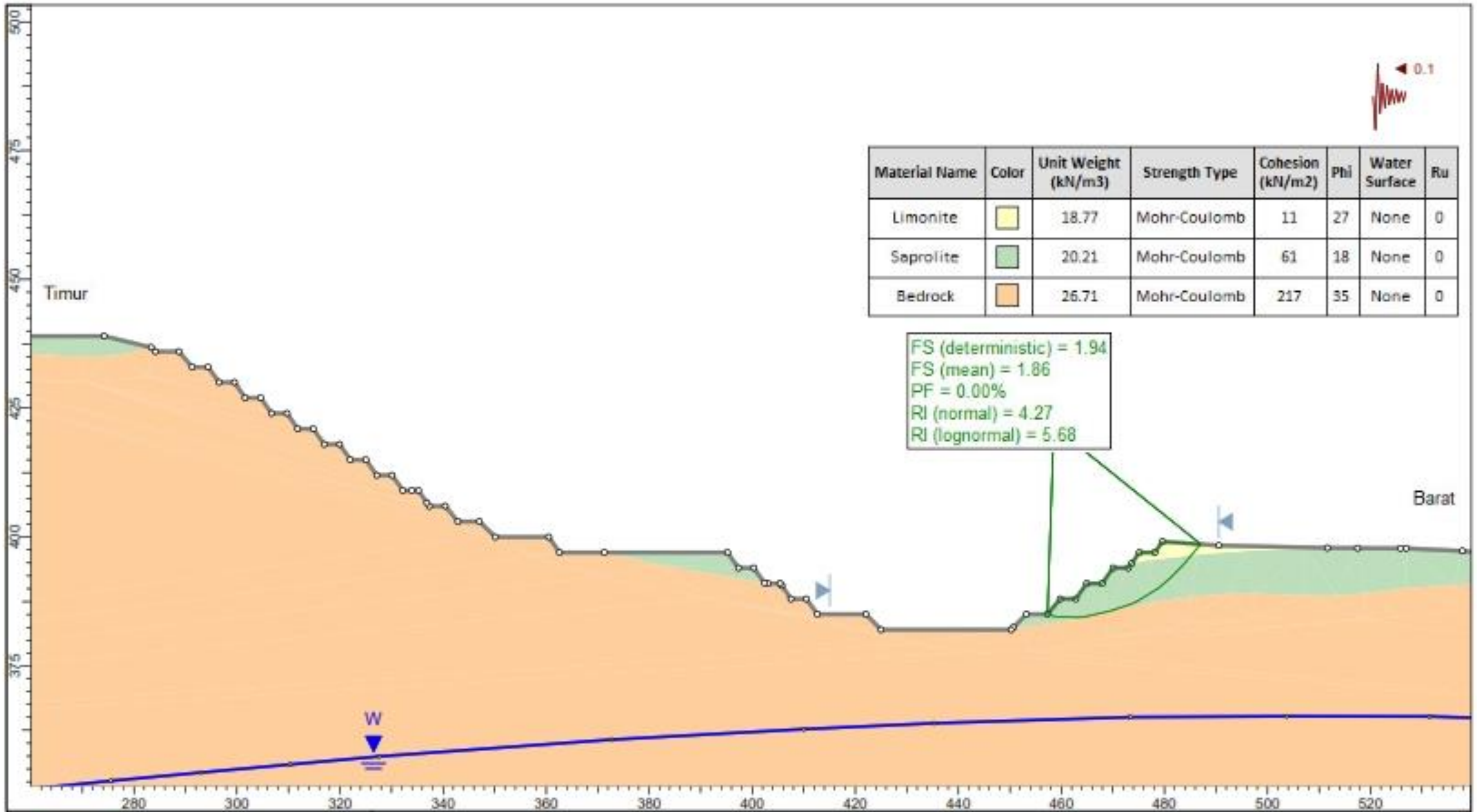
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section CC' Area Bete-bete (Sisi Selatan)

Kondisi Statik dan GW Model

Scale = 1:1000



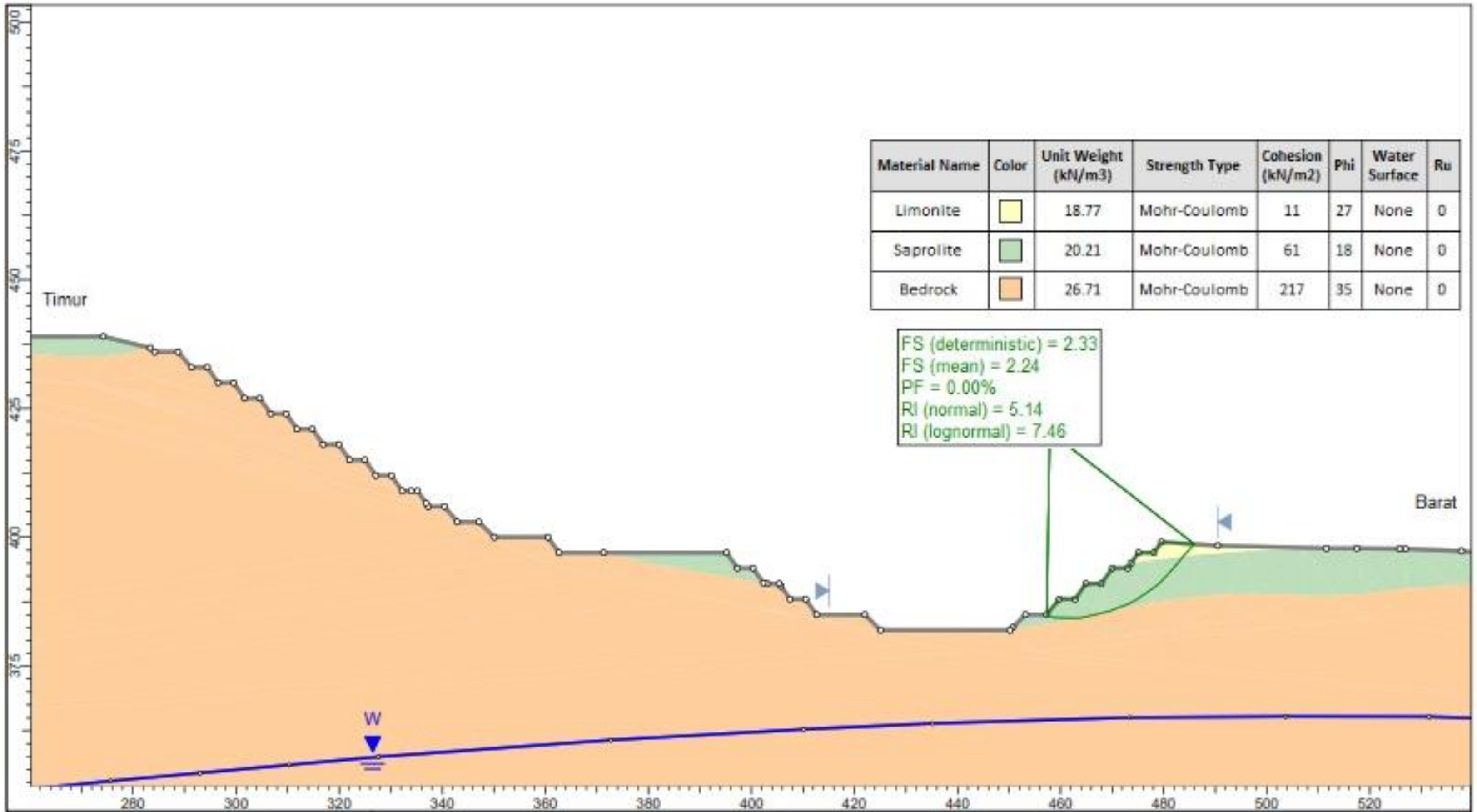
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section DD' Area Bete South (Sisi Barat)

Kondisi Dinamik dan GW Model

Scale = 1:1000



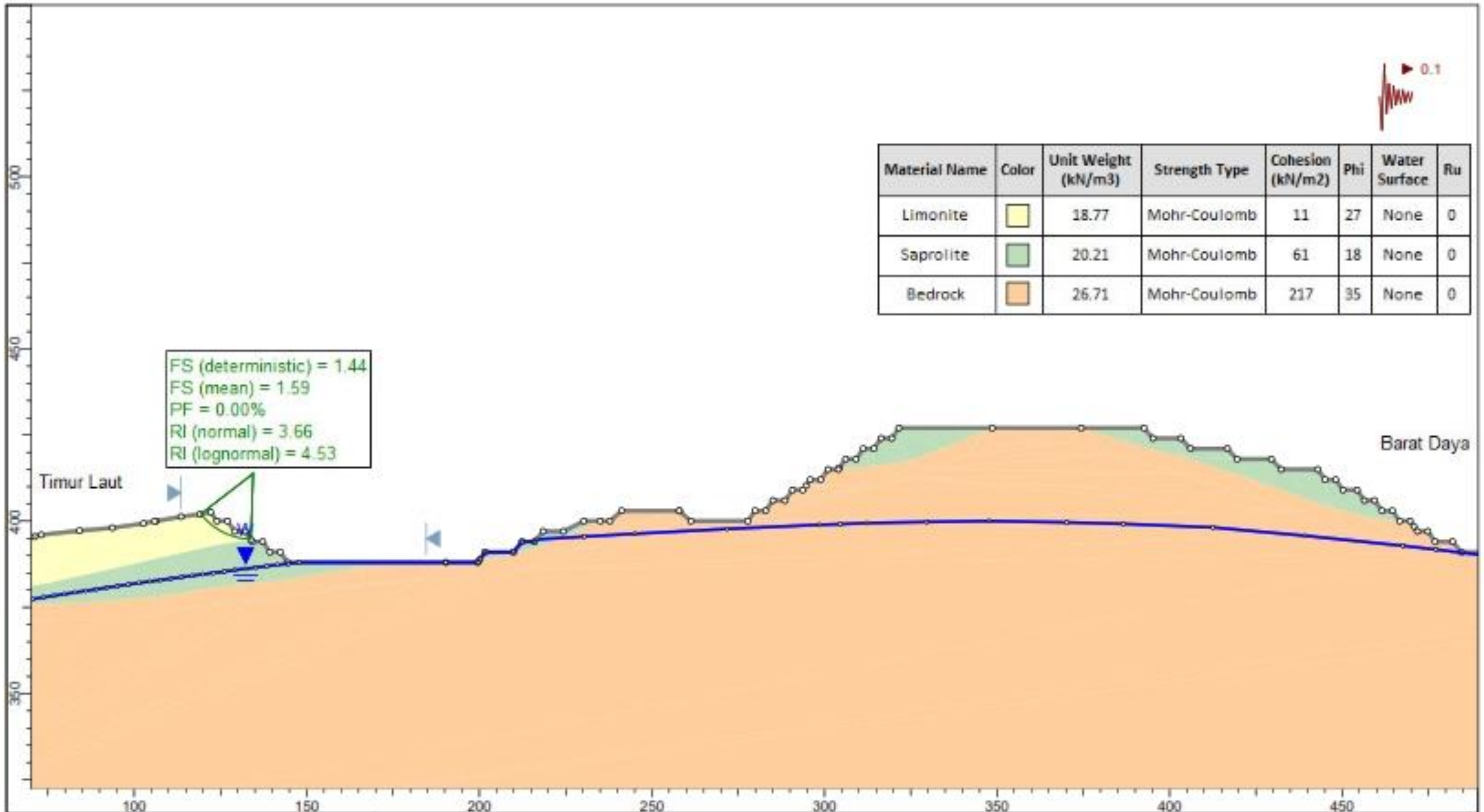
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section DD' Area Bete South (Sisi Barat)

Kondisi Statik dan GW Model

Scale = 1:1000



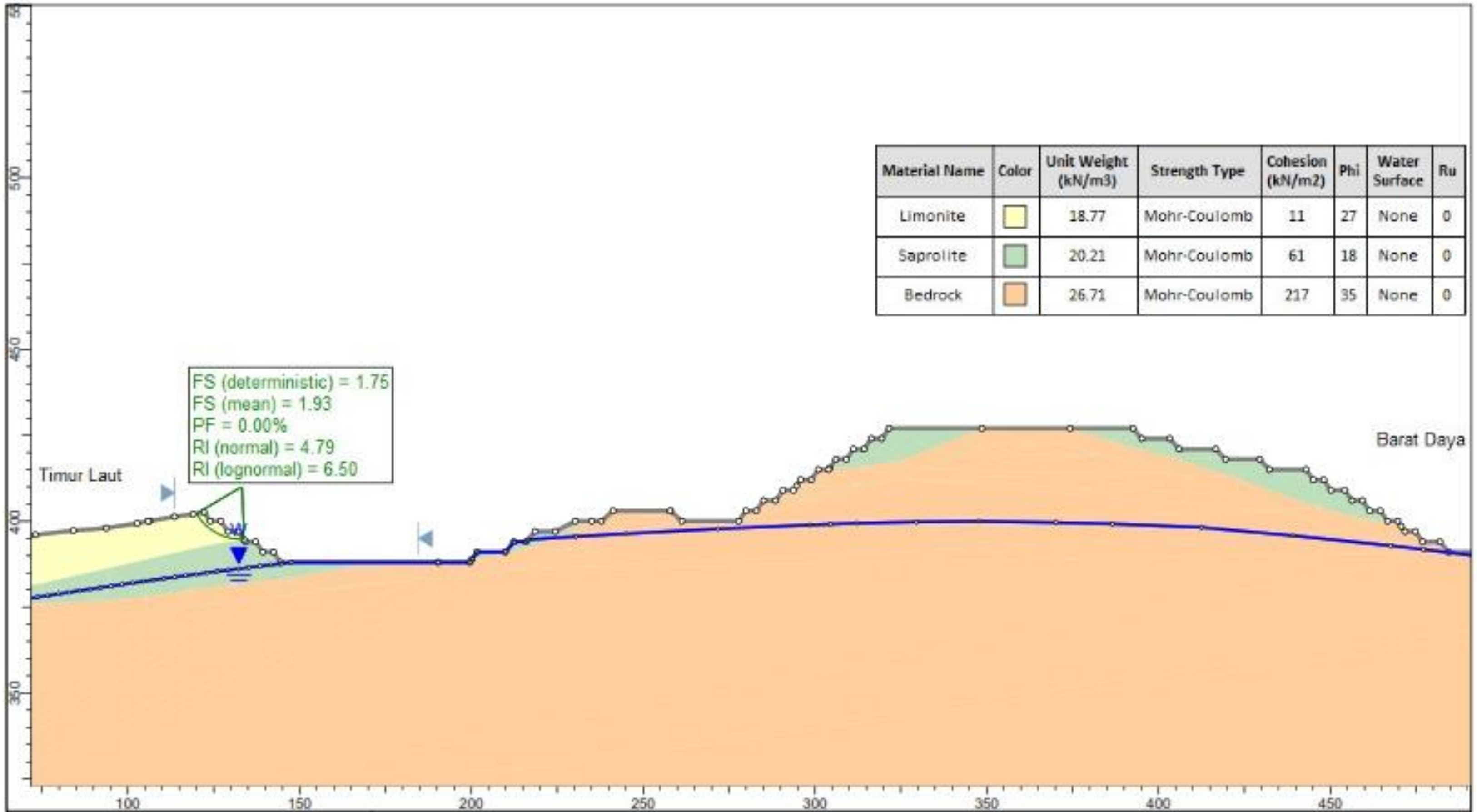
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section EE' Area Bete South (Sisi Timur Laut)

Kondisi Dinamik dan GW Model

Scale = 1:1500



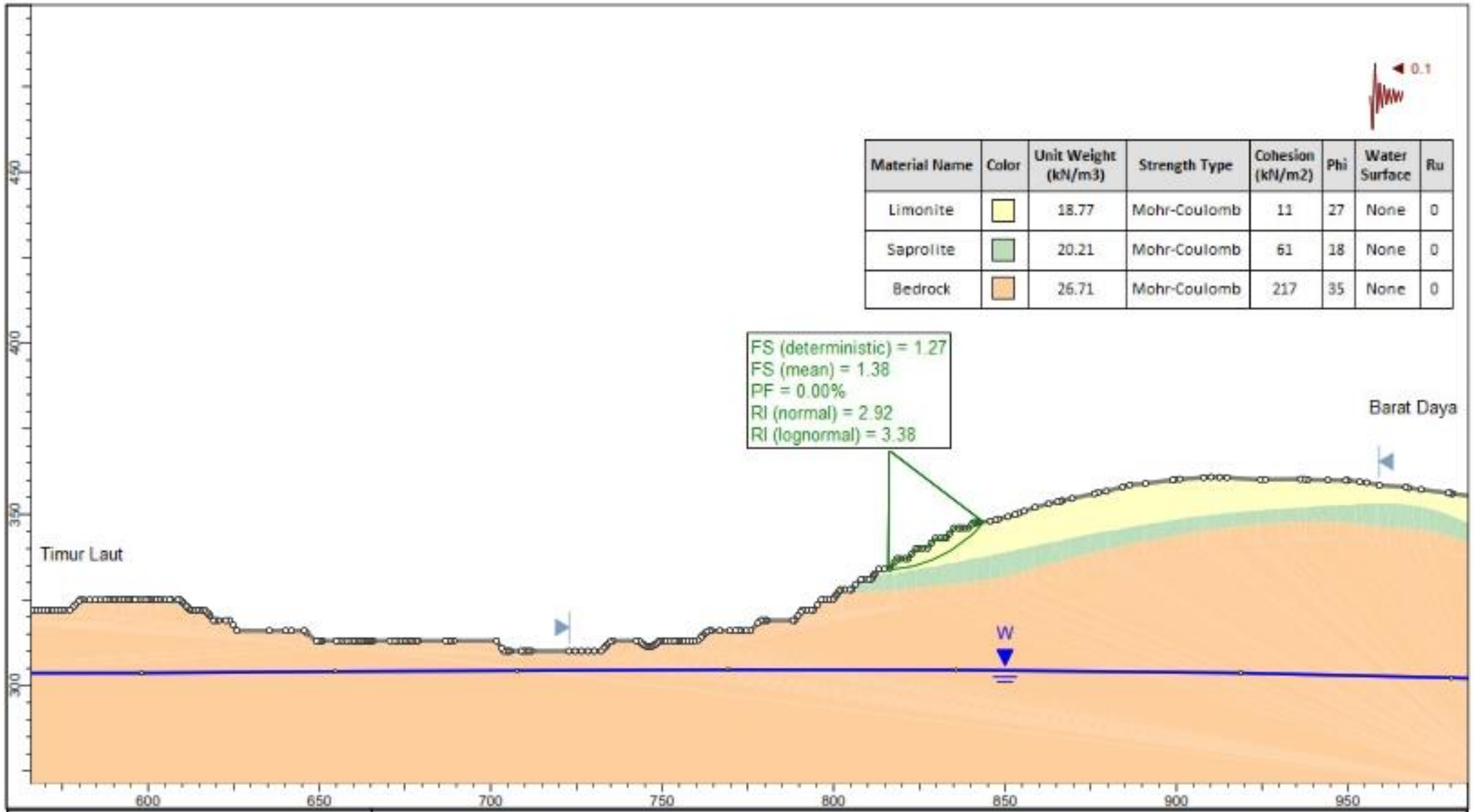
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section EE' Area Bete South (Sisi Timur Laut)

Kondisi Statik dan GW Model

Scale = 1:1500



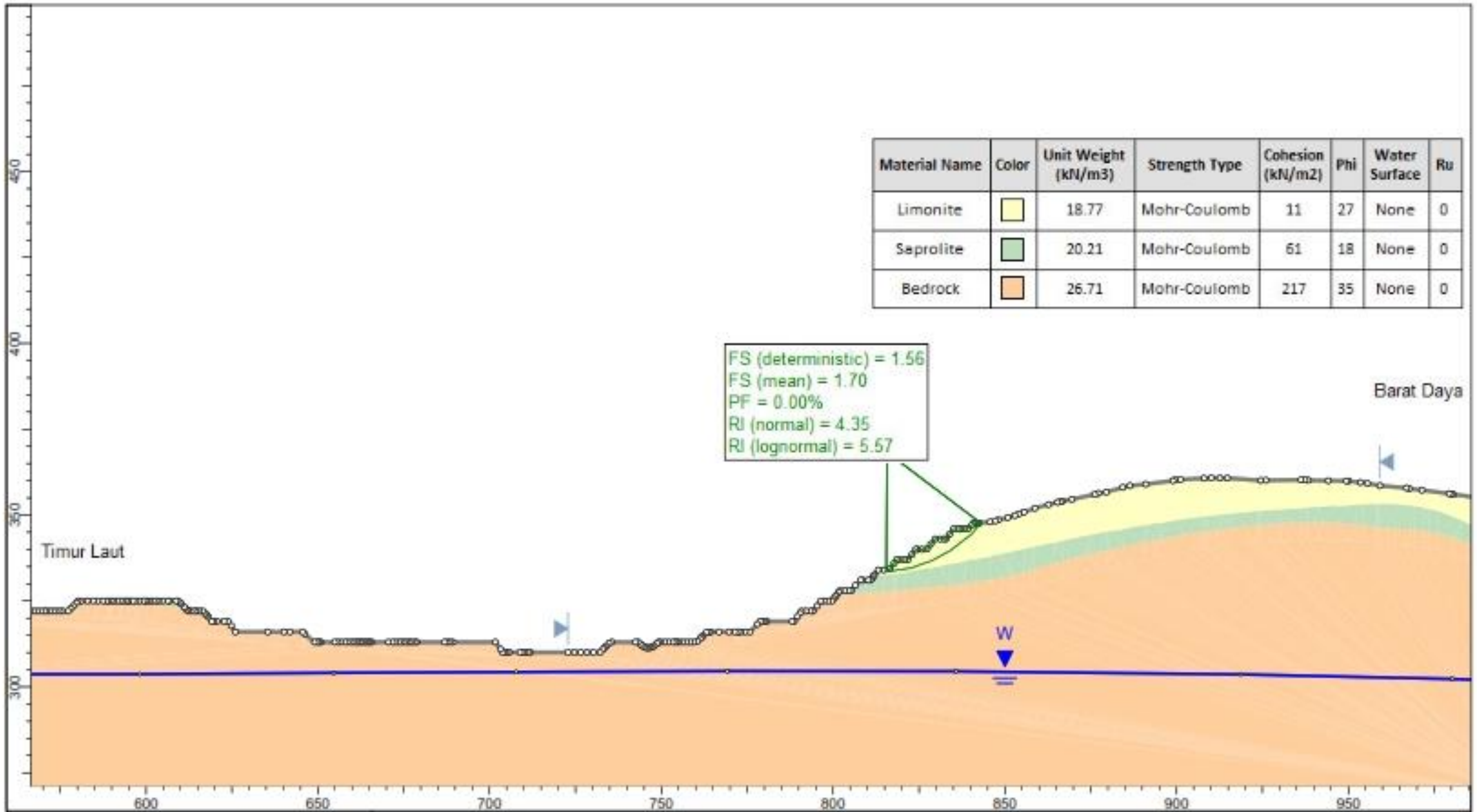
GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section FF' Area Central West (Sisi Barat Daya)

Kondisi Dinamik dan GW Model

Scale = 1:1500

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

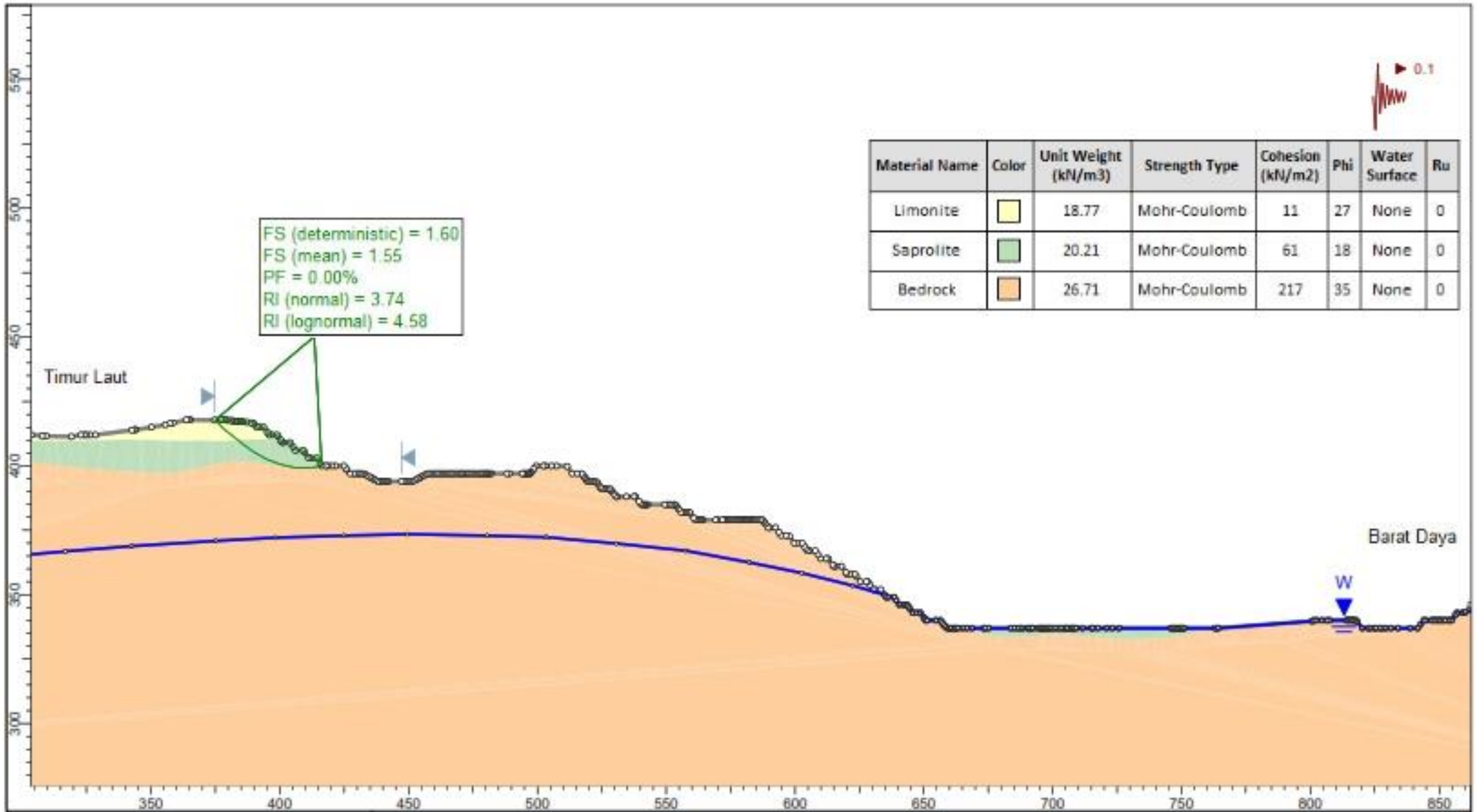


GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section FF' Area Central West (Sisi Barat Daya)

Kondisi Statik dan GW Model

Scale = 1:1500

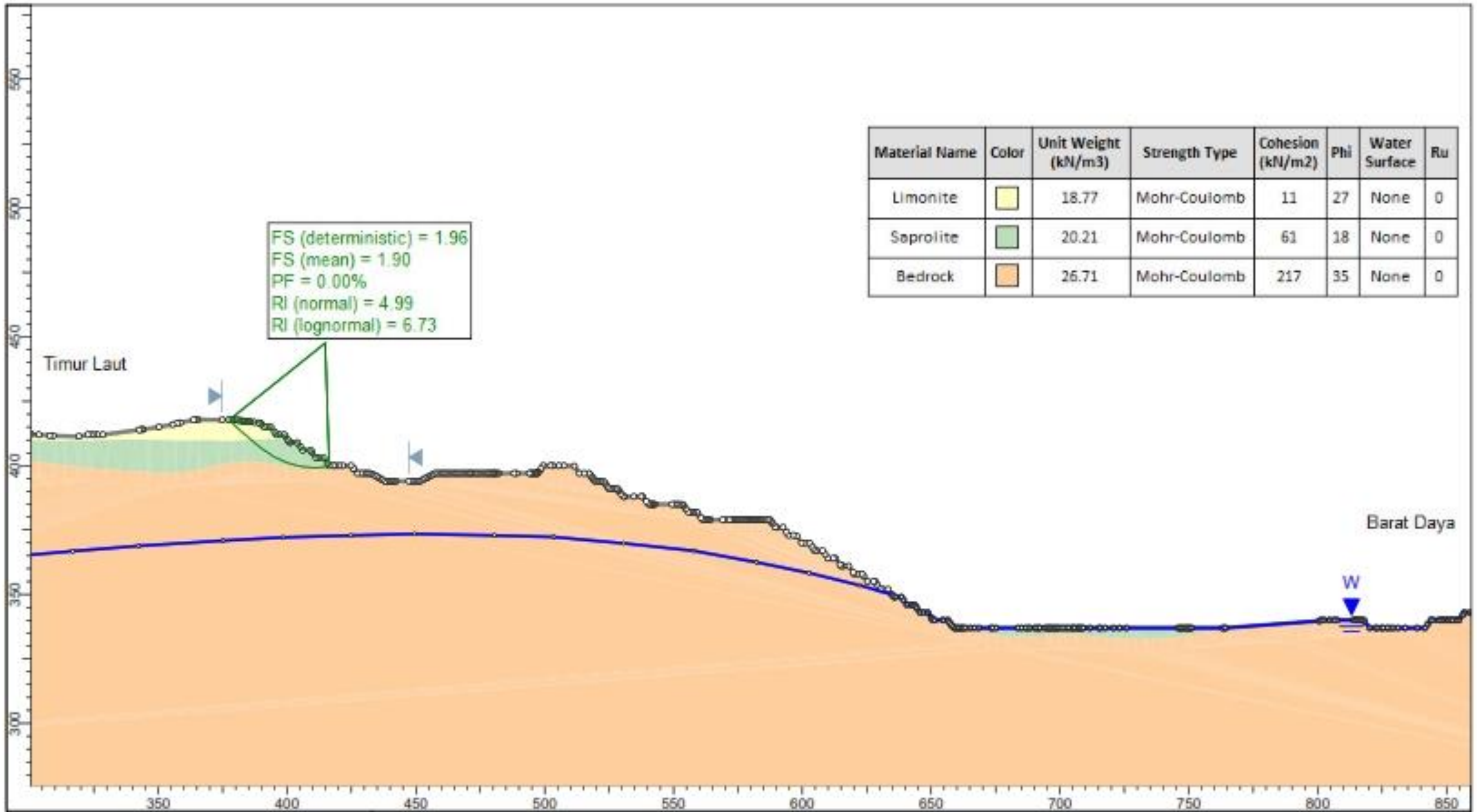


GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section GG' Area Central West (Sisi Timur Laut)

Kondisi Dinamik dan GW Model

Scale = 1:2000



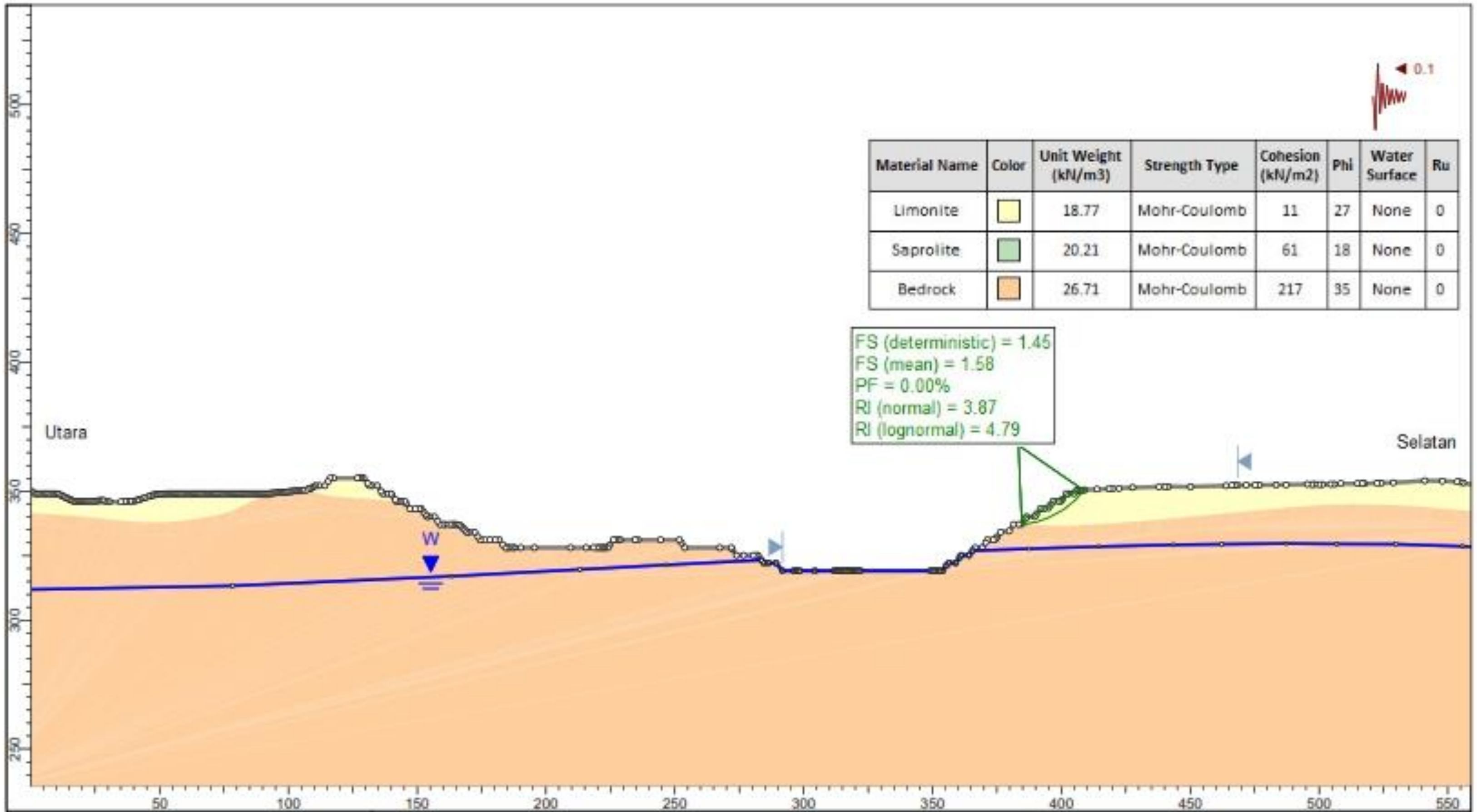
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section GG' Area Central West (Sisi Timur Laut)

Kondisi Statik dan GW Model

Scale = 1:2000



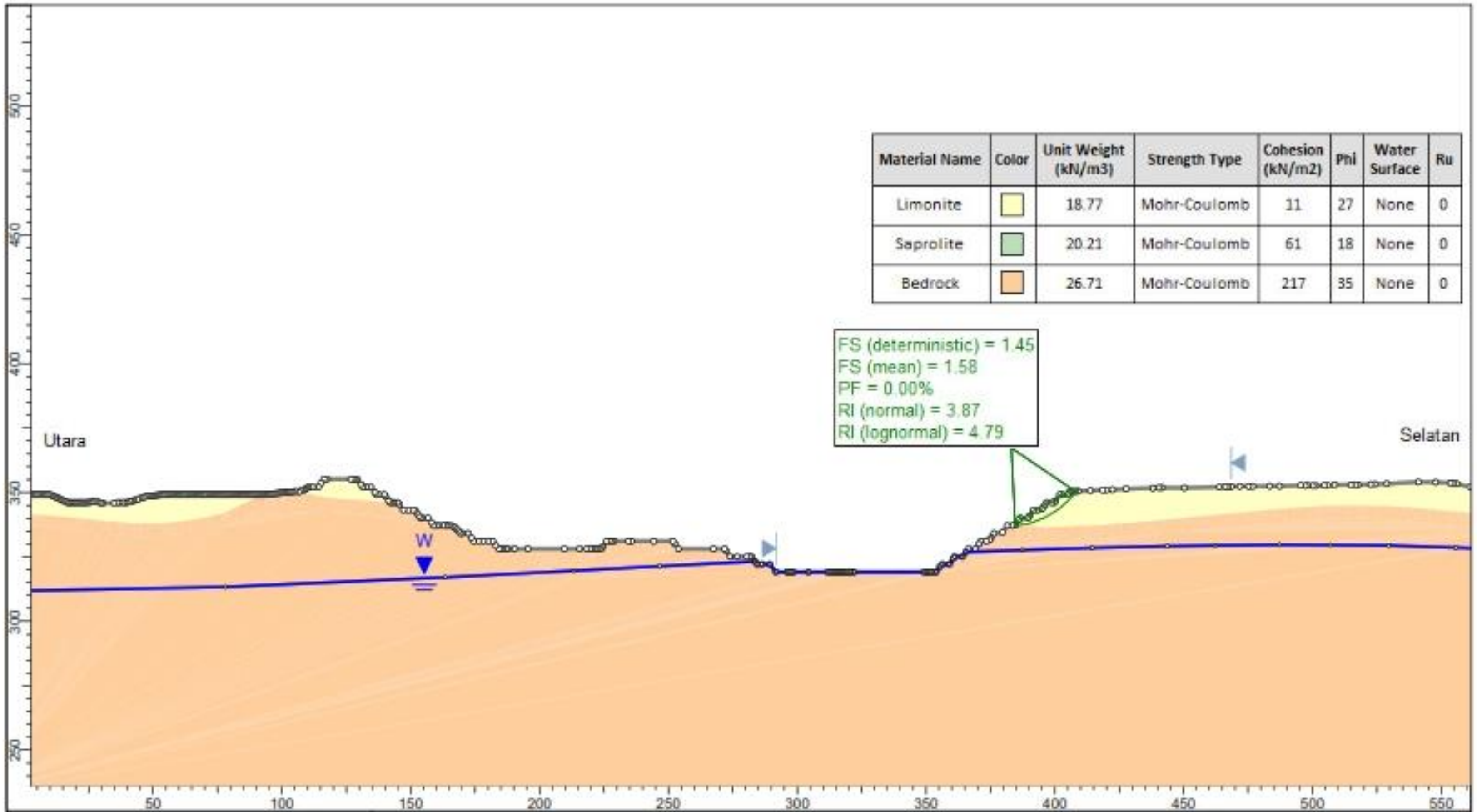
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section HH' Area Central East (Sisi Selatan)

Kondisi Dinamik dan GW

Model Scale = 1:2000



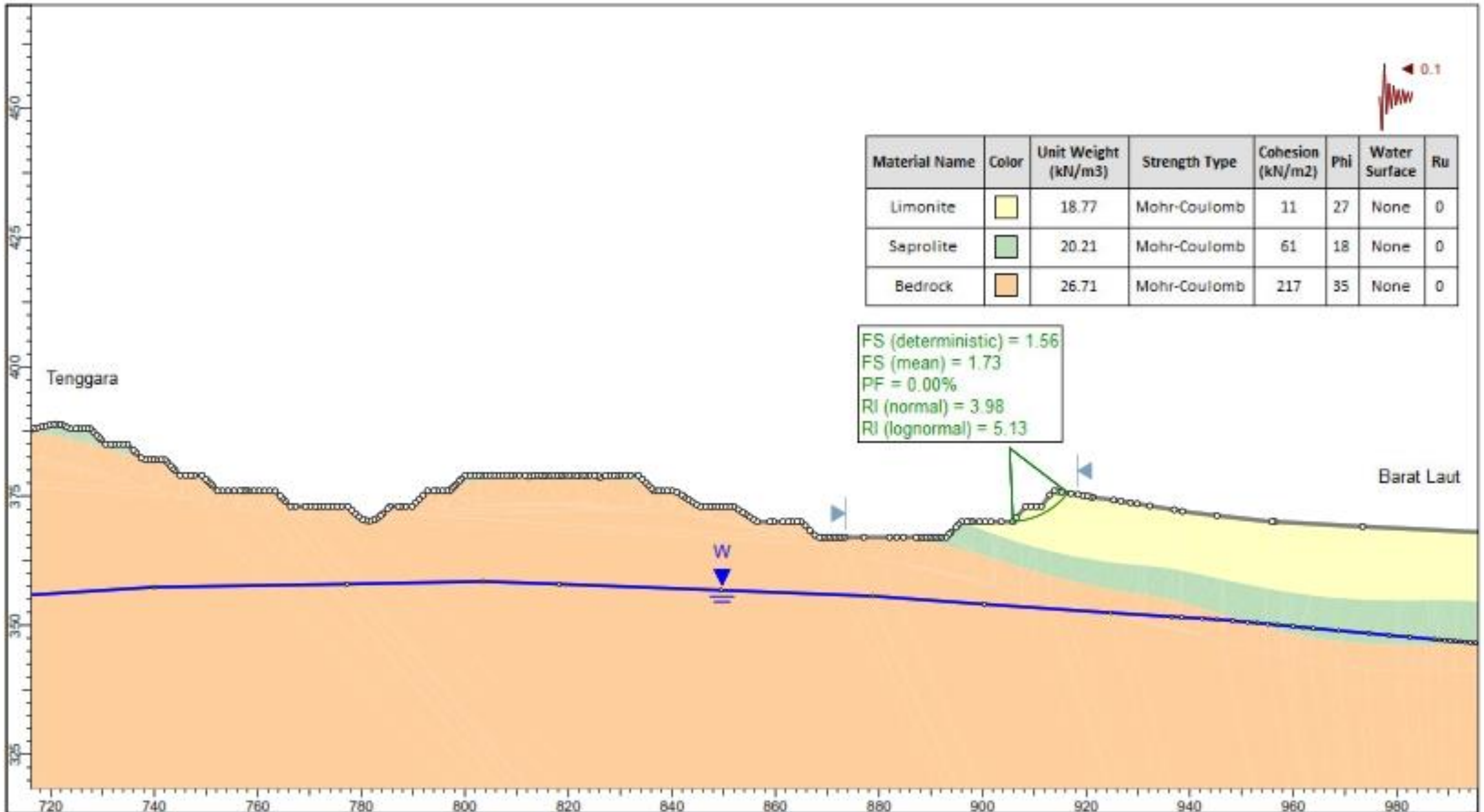
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section HH' Area Central East (Sisi Selatan)

Kondisi Statik dan GW Model

Scale = 1:2000



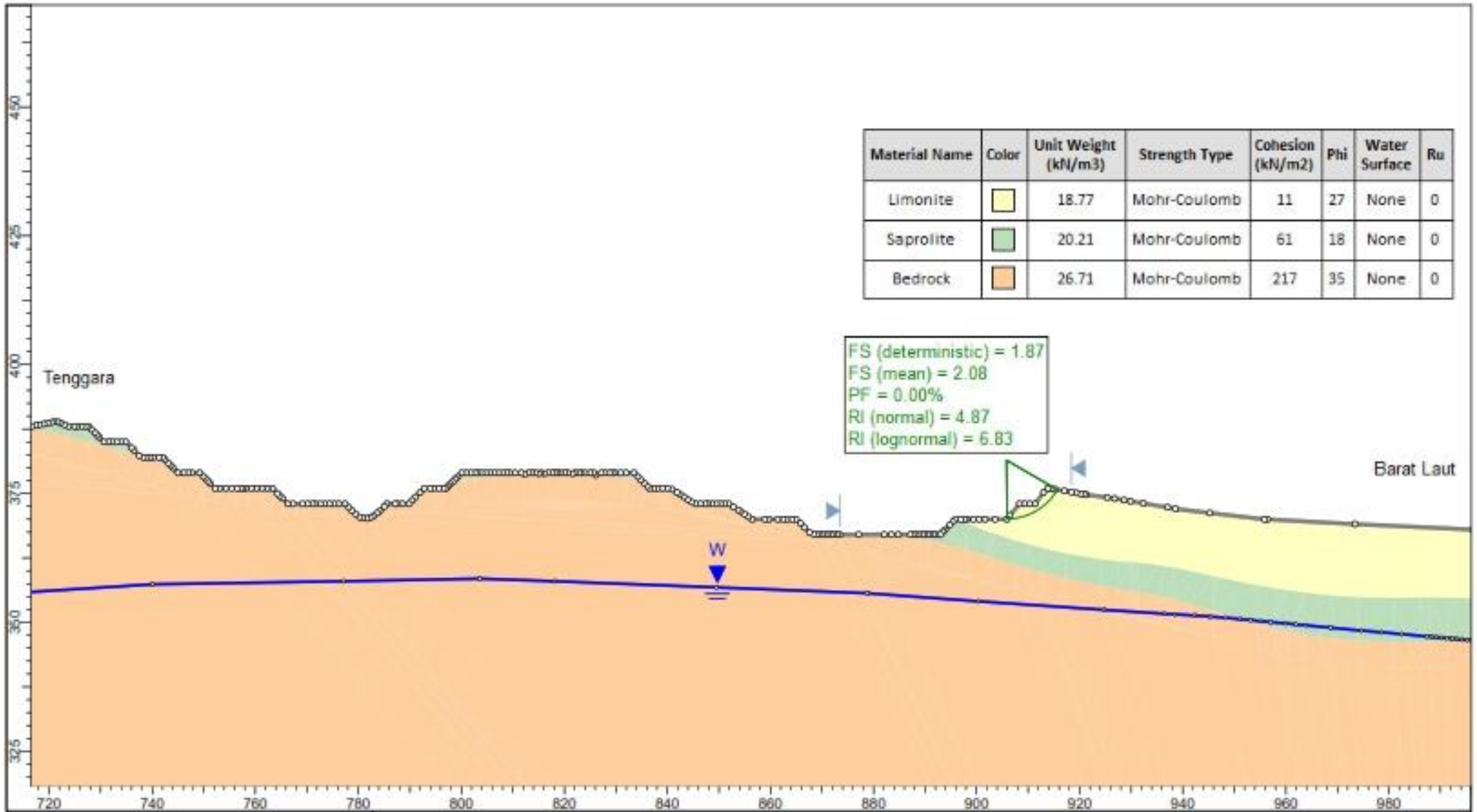
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section II' Area Central East (Sisi Barat Laut)

Kondisi Dinamik dan GW Model

Scale = 1:1000



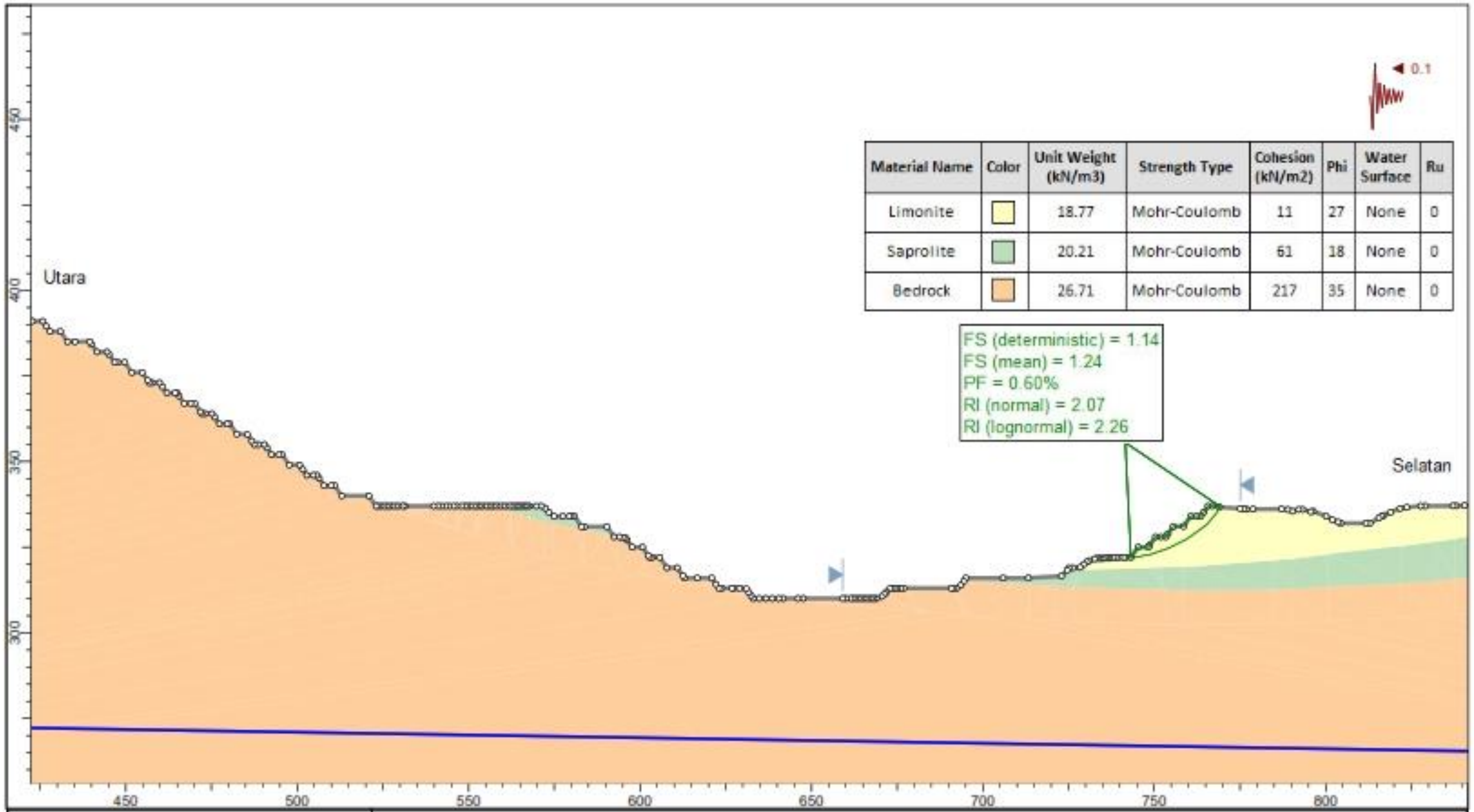
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section II' Area Central East (Sisi Barat Laut)

Kondisi Statik dan GW Model

Scale = 1:1000

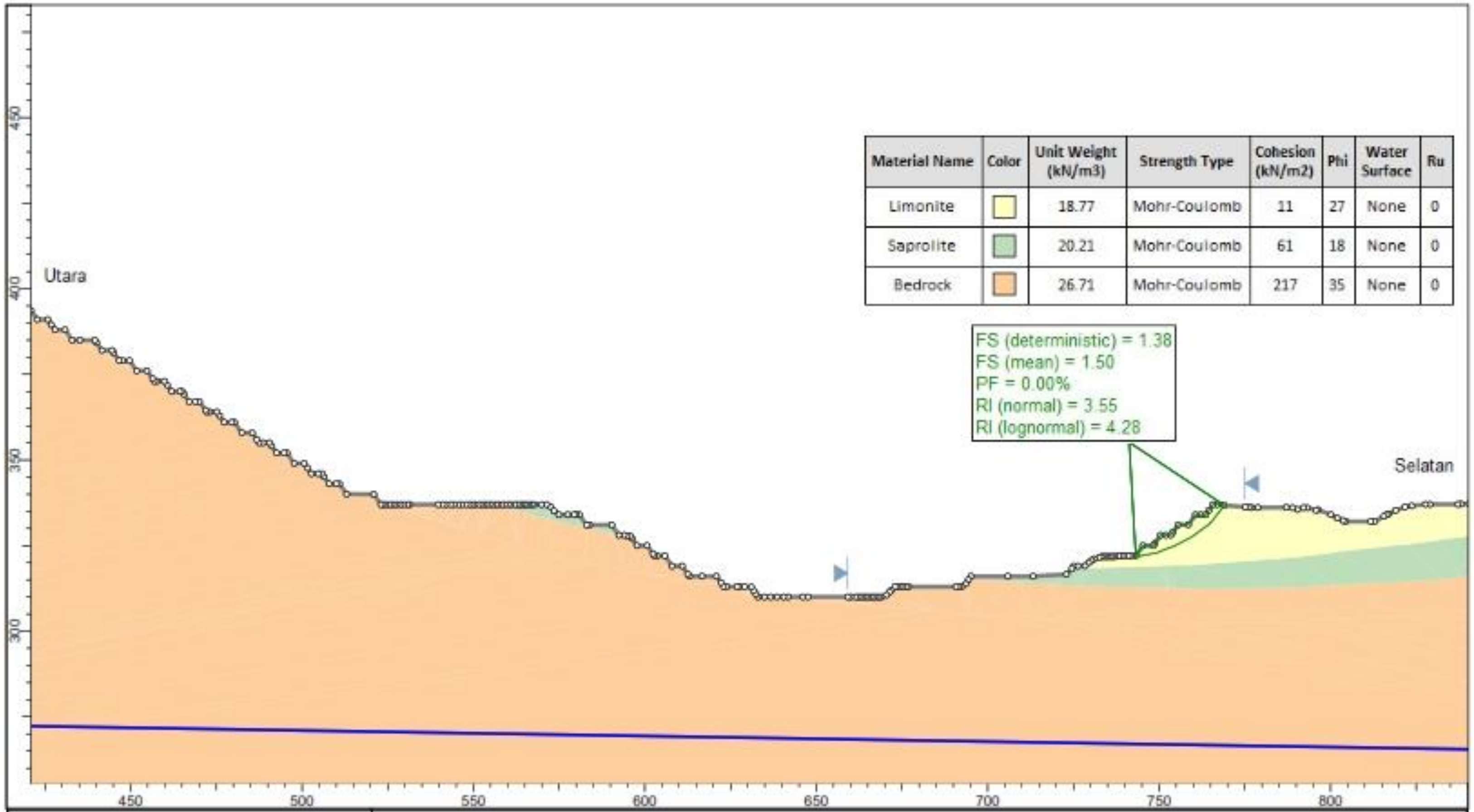


GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section JJ' Area Central West (Sisi Selatan)

Kondisi Dinamik dan GW Model

Scale = 1:1500

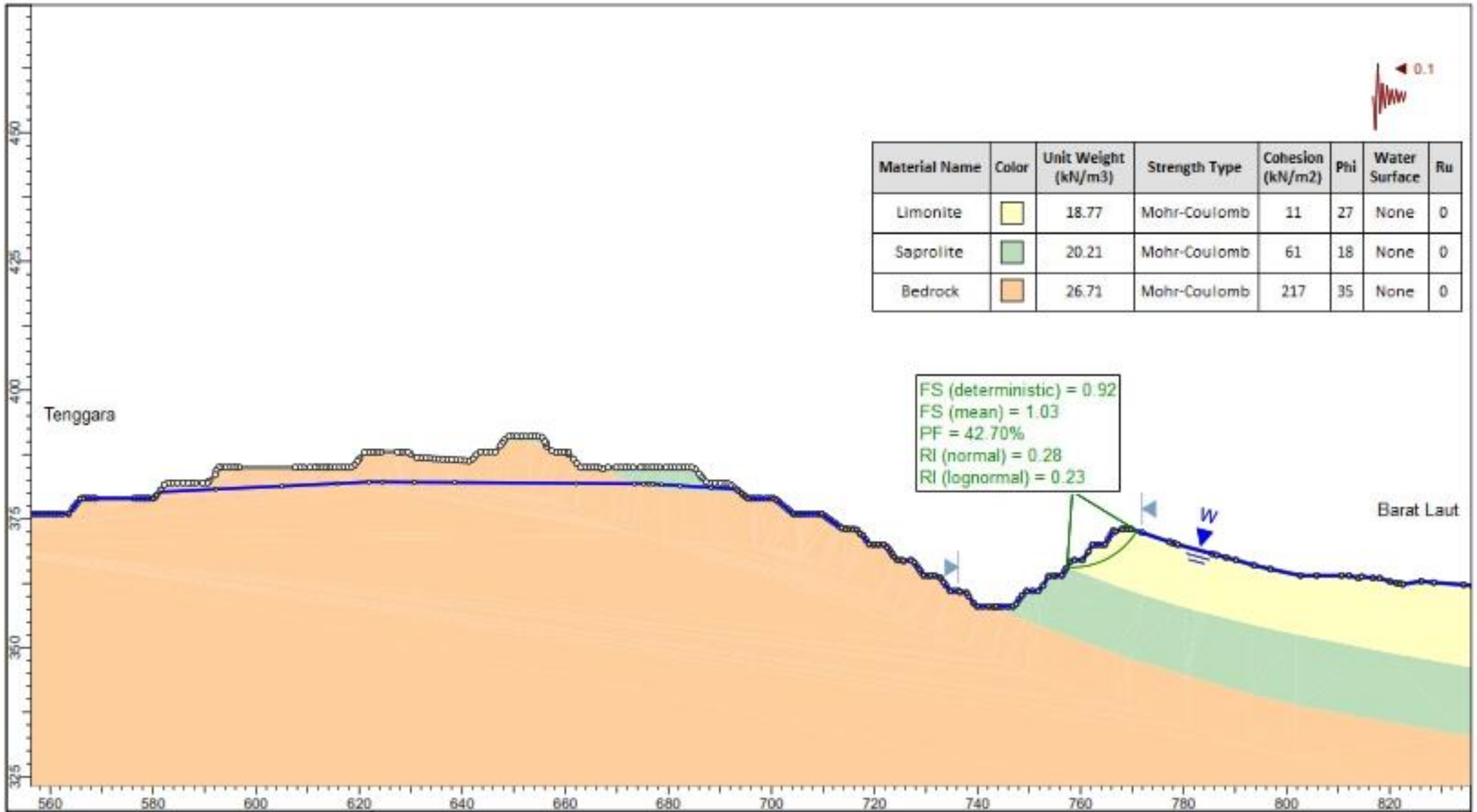


GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section JJ' Area Central West (Sisi Selatan)

Kondisi Statik dan GW Model

Scale = 1:1500



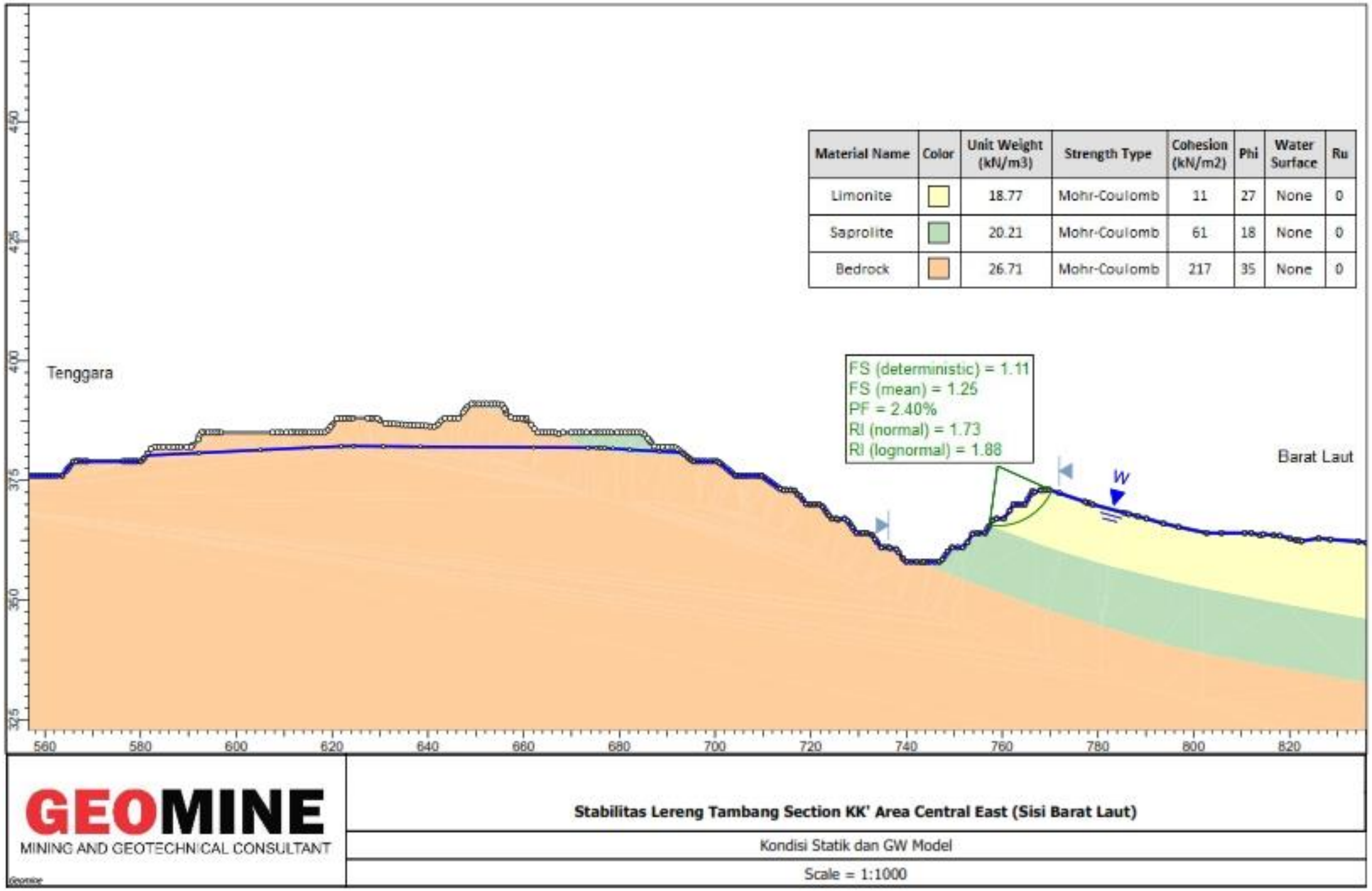
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Limonite		18.77	Mohr-Coulomb	11	27	None	0
Saprolite		20.21	Mohr-Coulomb	61	18	None	0
Bedrock		26.71	Mohr-Coulomb	217	35	None	0

GEOMINE
MINING AND GEOTECHNICAL CONSULTANT

Stabilitas Lereng Tambang Section KK' Area Central East (Sisi Barat Laut)

Kondisi Dinamik dan GW Model

Scale = 1:1000


Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kN/m2) | Phi | Water Surface | Ru
Limonite | 18.77 | Mohr-Coulomb | 11 | 27 | None | 0
Saprolite | 20.21 | Mohr-Coulomb | 61 | 18 | None | 0
Bedrock | 26.71 | Mohr-Coulomb | 217 | 35 | None | 0
FS (deterministic) = 1.11
FS (mean) = 1.25
PF = 2.40%
RI (normal) = 1.73
RI (lognormal) = 1.88
Tenggara
Barat Laut
W
GEOMINE
MINING AND GEOTECHNICAL CONSULTANT
Stabilitas Lereng Tambang Section KK' Area Central East (Sisi Barat Laut)
Kondisi Statik dan GW Model
Scale = 1:1000

Appendix 7
Curriculum Vitae Authors

DANIEL MADRE , MSc (GEOLOGY)

EXPLORATION SPECIALIST

Summary

Daniel Madre has been an Australian coal and mineral geologist since 1980, with full time work experience in Indonesia since 1988. He is specialist in exploration and for this reason is familiar with most coal and mineral projects in the country since their earliest stage of development. He has a diverse network of professionals throughout the industry. Daniel has a Master of Science degree in Geology. Daniel Madre is a member of the Australasian Institute of Mining and Metallurgy (no: 100878), the Australian Institute of Geoscientists (no: 5632), Ikatan Ahli Geologi Indonesia (no: 5000) and Masyarakat Geologi, Ekonomi Indonesia (no: B-0718). Daniel is a Competent Person in Indonesia for KCMI Code for Coal Resources.

Daniel runs a successful exploration consultancy and has in-house capabilities that range from geology, geophysics, drilling, geological modelling, mine design and planning. The company has discovered coal in East Kalimantan and Sumatra which has resulted in numerous coal mine developments. The company is formally registered by the Indonesian Department of Minerals and Energy to carry out exploration surveys and report coal and mineral resources.

Since 2005, the company diversified into nickel and mineral sands exploration and resource development. This work resulted in the development of the first nickel mine in Kalimantan. Other nickel projects investigated by the company are located in Sulawesi, Halmahera and Papua. Mineral sands projects have been investigated in Sumatra and Papua.

Commodities

Coal, oil shale, nickel laterites, phosphate, gold, manganese and mineral sands

Countries

Indonesia, Australia, USA, PNG, Kenya

Experience

Nov, 2000 - present PT Danmar Explorindo Jakarta, Indonesia
Managing Director

1996–Nov 2000 Independent Consultant Jakarta, Indonesia
Consultant Geologist

1988–1996 PT Petrosea Jakarta, Indonesia
Manager of Geology

1982–1988 Greenvale/Esperance group Sydney, Australia
Exploration Manager

1981–1982 Oil Refining & Exploration PL Sydney, Australia
Field geologist

1980 – 1981 NSW Coastal Engineers Sydney, Australia
Lab attendant

Education

1986- 1989 University of Wollongong Australia
Master of Science (geology)

1978- 1980 University of Sydney Australia
Bachelor of Science (geology and marine science)

Some Articles & Publications

- 1987, The Geology of the Alpha Oil Shale Deposit, Fuel, Vol.66, Butterworths UK
- 1990, Torbanite Deposits of the World, Thesis: University of Wollongong
- 2000, Coal Geology of the Bengkulu Block, Journal Asian Earth Science, Elsevier Advances in Sedimentology Series, Elsevier Special editions
- 2005, Coal Geology of the Bengkulu Block. Proc. SE Asian Coal Geology Conference, Bandung
- 2012, Coal Deposits of Sumatra, Coal Trans Conference Bali
- 2012, Low Rank Coal Deposits of Indonesia, Coal Trans Conference Bali
- 2013, Tectonic Framework of Sumatra & the Distribution of Coal Deposits, Ozmine Conference, Jakarta
- 2014, Coal Potential of Sumatra, Coal Markets Workshop, Singapore
- 2014 Adding Value Through Optimizing Exploration Techniques, 2nd Asian Nickel Conference
- 2014 Coal Potential of Sumatra, World Coal Magazine volume 23
- 2016 The Exploration Potential of Sumatra, Sumatra Miner Conference, Palembang Sumatra
- 2016 Why Things are Improving in the Indonesian Coal Industry, RTC Kalimantan, Conference Balipapan, Indonesia
- 2019 The Coal and Mineral Potential of Sumatra, Sumatra Miner Conference, Palembang Sumatra

Resume

Name: Tobias Geoffrey Maya
Date of Birth: 26 March 1981
Marital Status: Married
Nationality: Australian

Address: Jl. H. Saidi II No. 16 RT.011 RW.07,
Cipete Utara, Kebayoran Baru,
Jakarta Selatan 12150,

Mobile: (+62) 0812 3869379 ;
Email : tobiasmaya@yahoo.com.au
tobias.maya@danmar.asia

Since 2004, Tobias has been working full time in the Indonesian coal and minerals exploration industry specializing in exploration geology, regional mineral studies, due diligence work, database validation and resource development. Tobias has a Bachelor of Science degree from the Charles Sturt University in NSW, Australia. He has also held a membership with the AusIMM since 2009.

Tobias has more than 15 years exploration experience throughout the country. This work includes the exploration and development of numerous nickel laterite projects. providing a key role in the optimization of exploration techniques that can be used to minimize costs & maximize project value, increasing confidence in estimation of Nickel laterite volumes to determine what are the controlling factors for project development within Indonesian deposits.

EDUCATION AND TRAINING

2006-2013	Completed BSc with major in Spatial Science with 2 minors in information technology and management Charles Sturt University, Wagga Wagga, NSW
2013	Certificate for successful completion of Valuation and Technical-Economic Assessment of Mining Projects, SRK Consultancy
2009	Certificate for successful completion of Mining and Minerals optimization course, Whittle Consultacy
1999-2001	Completed Geographic Information Systems (GIS)Diploma Wollongong TAFE
1998	Higher School Certificate; Bulli High School
1996	School Certificate; Bulli High School
1994	St Johns Ambulance First Aid Certificate

MEMBERSHIP OF PROFESSIONAL ORGANIZATIONS

Since 2009 Member of the AusIMM (No.304661)

EMPLOYMENT & WORK EXPERIENCE

2013 – Present **PT. Geo Search (full-time) part of the Danmar Group**

- President Director.
- Geophysical surveys
- Principle consultant to PT Danmar Explorindo

2004 – 2013 **PT. Danmar Explorindo (full-time)**

- Head GIS/Resource Geologist (SURPAC).
- Management Coal and Mineral Exploration, (Drilling, Survey, Resource Estimates).
- Business development / client relationship manager
- Coal Reconciliations of Operational Mines(monthly)
- Database validation (JORC)
- Training Personnel in GIS (SURPAC, Mapinfo, ESRI,).
- Drafting JORC reports under Principle Mr Daniel Madre, MSc (AusIMM member - 100878)

Provided above Consultancy services for following projects:

2018-present **PT.Hengjaya Mineralindo (HM) -** Morowali, Sulawesi.
-Laterite Nickel Exploration and database validation
-Resource Geology assessments
-Mine planning and production reconciliations
-UltraGPR survey 203km

2018-Present **PT.Kumamba Mining (KM**) **-** Sarmi, Papua, Indonesia
-Exploration management and database validation
- Geology assessments
- Trial UltraGPR survey 30km
- Trial Ground Magnetometer survey 30km

2018-present **PT.Halmahera Sukses Minerals (HSM)** - Halmahera, Maluku.
-Laterite Nickel Exploration and database validation
-Resource Geology assessments
-UltraGPR survey 75km

2017-2019 **PT.Sarana Mineralindo Perkasa (SMP) -** Morowali, Sulawesi..
- Laterite Nickel Exploration and database validation
-Resource Geology assessments
-Mine planning and pit optimization
-UltraGPR survey 85km

2017-2018 **PT.Ceria Nugraha Indotama (CNI)** - Kolaka, Sulawesi..
-Laterite Nickel Exploration and database validation
-UltraGPR survey 175km

2017-2018 **PT.Tiga Samudra Perkasa (TPS)** - Malili, Sulawesi
-Laterite Nickel Exploration and database validation
-Resource Geology assessments
-UltraGPR survey 75km

2018-2019 **PT.Sulawesi Cahaya Mineral (SCM)** – North Konawe, Sulawesi
-Laterite Nickel Exploration and Project support
-UltraGPR survey 600km

2005-2019 **PT.Ratu Samban Mining (RSM) -** Bengkulu, Sumatra.
-Thermal Coal Exploration management and database validation
-Resource Geology assessments
-Mine planning and production reconciliations
-Nedo regional study 2011
-Jogmec regional study 2013
-Bathymetric survey

2009-2018 **PT.Gunung Bara utama (GBU) -** Kutai Barat, East Kalimantan.
-Thermal Coal Exploration management and database validation
-Resource Geology assessments
-Pre-JORC study 2010
-JORC (2004) compliant reports 2011 & 2012

2005-2011 **PT.Itamatra Nusantara (ITM) -** Morowali, Central Sulawesi.
-Laterite Nickel Exploration management and database validation
-Resource Geology assessments
-Bathymetric survey

2004-2010 **PT.Telen Indoclay (TIC) Long Ikis Nickel -** Pasir, East Kalimantan
-Laterite Nickel Exploration management
-database validation
-Resource Geology assessments
-Mine Construction and Production
-Mine planning and production reconciliations
-Grade control
-Bathymetric survey

2010-2016 **PT.Trisula Kencana Sakti (TKS) -** Barito Utara, Central Kalimantan
for **Golden Energy Mines (GEMS)**
-Thermal Coal Exploration management and database validation
-Resource Geology assessments
-JORC (2004) compliant reports 2010 & 2012
-JORC (2012) compliant reports 2013

2010-2018 **PT.Moa Maju Kurina Utama (MMKU) -** Bulungan, North Kalimantan
-Lignite Exploration management and database validation
-Resource Geology assessments
-Mine planning
-JORC (2004) compliant reports 2010 & 2011
-JORC (2012) compliant reports 2013

2011-2015 **PT.Delta Samudra (DS) -** Kutai Barat, East Kalimantan
-Lignite Exploration management and database validation
-Resource Geology assessments
-JORC (2004) compliant reports 2013

2012-2018 **PT.Berau Usaha Mandiri (BUM) -** Berau, East Kalimantan
-Lignite database validation
-Resource Geology assessments
-Mine planning

2010-2015 **PT.Inti Putera Kanaan (IPK) -** Musi banyuisn, South Sumatra
-Lignite Exploration management and database validation
-Resource Geology assessments
-Mine planning
-JORC (2004) compliant report 2012

2006-2014 **PT.Mulawarman Putra Abadi Sakti (MPAS) -** East Kalimantan
-PCI Coal Exploration management and database validation
-Resource Geology assessments
-JORC (2012) compliant reports 2014

2011-2013 **PT.Satria Lestari (SL) -** Tenggarong, East Kalimantan
-Thermal Coal exploration management and database validation
- Resource Geology assessment

2013 **Jingella Resources Pty Ltd -** Dingo, Queensland, Australia
-PCI Coal database validation
-Resource Geology assessments

2013 **Greenvale Mining Pty Ltd - (Alpha Oil shale)**
Alpha, Queensland, Australia
-Torbanite / Cannel Coal database validation
-Resource Geology assessments

2013 **PT.Bumi Merapi Energi (BME) -** Lahat, South Sumatra
-Thermal Coal database validation
-Resource Geology assessments
-Mine planning
-JORC (2004) compliant report 2012

2010-2012 **PT.Komunitas Bangun Bersama (KBB) -** Samarinda, East Kalimantan
-Lignite Resource Geology assessment
-JORC (2004) compliant reports 2010 & 2012

2012 **PT.Delma Mining Corporation (DMC) -** Bulungan, North Kalimantan
-Lignite database validation
-Resource Geology assessments
-JORC (2004) compliant report 2012

2012 | **PT.Indonesia Pacific Energy (IPE) & PT.Mega Multi Cemerlang (MMC) -** Meulaboh, Aceh Barat & Nagan Raya, Aceh
-Lignite database validation
-Resource Geology assessments
-JORC (2004) compliant report 2012

2012 | **Draig Resources Pty. Ltd -** Teeg & Nariin Teeg mining license, ovorhangay Province, Central Mongolia
-PCI COAL database validation
-Resource Geology assessments
-JORC (2004) compliant report 2012

2004-2010 | **PT.Tunas Inti Abdai (TIA) -** Tanah Bumbu, South Kalimantan for **ABM investama (ABM)**
-Thermal Coal Exploration management and database validation
-Resource Geology assessments
-JORC (2004) compliant reports 2010 & 2011

2010 | **PT.Bukit Utama Sehjatera (BUS) -** Sorong, West Papua
-Lignite Exploration management and database validation
-Resource Geology assessments

2010 | **PT.Sri Bangun Jaya Persada (SBJP) -** East Kalimantan
-PCI COAL Exploration management and database validation
-Resource Geology assessments

2006-2010 | **PT.Mifa Bersaudara (MIFA) & PT.Bara Energy Leastari (BEL)**
- Meulaboh, Aceh Barat & Nagan Raya, Aceh
-Lignite Exploration management and database validation
-Resource Geology assessments
-Mine planning
-JORC (2004) compliant report 2010

2009 | **PT.Bakti Pertiwi Nusantara (BPN)** –
Weda Utara, Central Halmahera, maluku
-Laterite Nickel database validation
-Resource Geology assessments
-JORC (2004) compliant report 2009

2009 | **Bildan.Pty.Ltd -** Pulau Talud, North sulawesi
-Manganese Exploration management

2008 | **PT.Berau Bara Energy (BBE) -** Berau, East Kalimantan
-Thermal Coal database validation
-Resource Geology assessments
-JORC (2004) compliant report 2008

2008 | **PT.Tripabara (TPB) -** Tapan, West Sumatra Province
-Thermal Coal Exploration management and database validation

2008 **PT.Lion Power Energy (LPE) -** Prabumuliah, South Sumatra
-Lignite Exploration management and database validation
-Resource Geology assessments

2007-2008 **PT.Ratu Samban Mining (RSM) -** Krui, Lampung. Sumatra.
-Iron Sand Exploration management

2006-2008 **PT.Tekno Marina Cipta (TMC) -** Kota Bangun, East Kalimantan
-Thermal Coal Exploration management and database validation
-Resource Geology assessments

2004-2007 **CV. Gudang Hitam Prima (GHP/BBM) -** Sanga Sanga Coal Mine, Samarinda, East Kalimantan
-Thermal Coal Exploration management and database validation
-Resource Geology assessments
-Mine planning and production reconciliations

2006 **PT.Borneo Indobara (BIB) -** Tanah Bumbu, south kalimantan for SINAR MAS MINING
- Project Due diligence study Grimulya Block

2004-2006 **PT. Multi Prima Energy (MPE) -** Loa Raya Coal Mine, Tenggarong, East Kalimantan.
-Thermal Coal Exploration management and database validation
-Resource Geology assessments
-Mine planning and production reconciliations

Previous Employment

1999- 2004 Natural Beauty Floor Sanding (full-time)

- Surface preparation; punch & fill, sanding & edging
- Applying coating product

September 2000 Hydrographic Sciences Australia (2 weeks work experience)

- Re-editing Hydrographic charts
- Hydrographic chart compilation
- Sounding selection

CONFERENCE PAPER PRESENTATIONS

November 2018	**"Indoneisa, Hi-CV coal supply?"** - 7th annual Coaltrans Emerging Asia Marketes, Hanoi, Vietnam
May 2018	**" Developing efficiency in the Indonesian coal supply chain"** - 24th annual Coaltrans Asia, Bali,
September 2017	" **Exploration potential for new Nickel supplies in Indonesia"** - Metal Bulletin: 5th Asian Nickel Conference, Jakarta,
July 2016	**" Which Indonesian coal energy projects will attract Korean investors through 2020?"** - Korea Coaltrans Asia, Seoul,
March 2015	**"The Coal Potential of Sumatra"** - Sumatra Miner 2015 conference
September 2014	**"Adding value through optimizing exploration techniques"** - 2nd Asian Nickel Conference
December 2012	**"Low Rank Coal Deposits of Indonesia"** - IHS Mcloskey Asia Pacific Coal Outlook Conference 2012, Bali
June 2012	**"The Coal Deposits of Sumatra"** - 18th annual Coaltrans Asia, Bali

SOFTWARE EXPERIENCE

- SURPAC Mining software – Good Knowledge of Geodatabase, Surface modelling, Block Modelling, Pit optimisation, Pit design modules.
- WHITTLE Pit optimisation Software – good knowledge of Pit optimisation procedure and analysis
- ArcGIS 9.3 and ArcView 3.2 GIS Software – Good knowledge of Spatial interpolation techniquies and map design
- MapINFO and Surfer GIS software
- Microsoft 7-10, VISTA, XP and NT operation systems
- Microsoft office 2003, 2007 & 2010 Word, Excel, Access, Powerpoint
- Adobe acrobat 8 Professional
- AutoCAD 2009

REFERENCES

Daniel Madre (Director)
PT.Danmar Explorindo
SANUR, BALI
Ph. +62 81 23851151
daniel.madre@danmar.asia

CV – Charles Edward Watson

Date of Birth : 9th October 1951
Nationality : British
Address : 11 Cassidy Avenue, Lincoln
7608, Canterbury, New Zealand

Education : B.Sc (Hons) Geology, University of London (1971-1974)
Australasian Institution of Mining & Metallurgy, Fellow (2012)

Professional Experience :

July 2022 – present: Technical Adviser, PT Hengjaya Mineralindo, Sulawesi, Indonesia

Assisted QAQC HOD to update, report and submit final QAQC section for JORC 2012 compliant technical report. Assess existing sample prep lab/assay lab procedures and implement improvements to increase output while maintaining accuracy and precision.Plan, design and implement changes to accommodate Limonite production phase.

July 2019 – Mar 2020: Technical Adviser, PT Hengjaya Mineralindo, Sulawesi, Indonesia

Undertook a Technical Audit of the Sample Processing and Assay Laboratories at the PTHM mine site at Tangofa, Sulawesi, Indonesia. Prime objective the optimization of production and Quality Control during the ramp up in lateritic nickel ore production from 70,000 wmt to 200,000 wmt per month. Addressed sampling flow and assay capacity & capability; current restrictions eg sample turnaround time, shift hours and manpower; staff skillsets required for current and expanded operations; equipment selection and utilisation; liaison with Drilling Contractor Danmar on JORC compliance, assay results and storage; amendment of SOP's where required; implemented improved monthly reporting of data for management. Included as a Qualified Person for the compilation of QA/QC section of independent JORC Compliant Nickel Resource Estimate, 30th June 2020, for submission to the ASX.

Jan 2013 – Dec 2017: Managing Director, Mineral Services Ltd. Lincoln, New Zealand

Established, commissioned and managed Mineral Processing Laboratory at Kiunga, in the Western Province, Papua New Guinea, processing drill samples collected from a high quality magnetite source. Trained local staff in skills required and monitored programme to meet the throughput from the drill programme. Working in a very challenging environment, programme was completed on time and selected sample cons sent off for assay.

Established and operated Mineral Processing Facility at Greymouth providing heavy mineral separation, recovery and identification services to the West Coast alluvial gold mining sector and overseas clients. Undertook mineralogical examination and reporting on heavy mineral samples containing diamonds, gold and tin from various projects in West Africa.

Commissioned and operated Gold Room at Greymouth for smelting of alluvial gold and the production of gold dore bars for Southern Gold Buyers; undertook fire assay of samples from gold dore bars to determine gold fineness prior to despatch of bars to Perth Mint for refining.

Apr 2010 – Dec 2012 : Geologist, Gold & Green Resources, Hokitika, New Zealand

Compiled Gold Exploration and Mining Permit applications for clients; compiled and submitted Resource Consent and Access Agreement applications for clients; mineralogical investigation of concentrates from West Coast gold mining operations; researched West Coast and Central Otago alluvial gold mining operations.

Jan 2009 – Mar 2010 : Technical Services Manager, Woodlark Mining Limited, PNG

Established, commissioned and managed Prep Lab at Woodlark Mining gold project; recovered gold grains from island wide pan con survey and classified based on morphology and surface textures of alluvial gold grains. Responsible for maintaining company relations with Provincial Government & the Mineral Resources Authority in Port Moresby.

Mar 2005 – Dec 2009 : Alotau Manager, Woodlark Mining Limited, Papua New Guinea

Established base for exploration operations on Woodlark Island supporting two drill gold sampling programme; Managed Logistics for field operations, including initial construction of Bomagai Camp, while establishing and managing gold Preparation Laboratory in Alotau.

Dec 2001 – Oct 2004 : Operations Manager, PT Galuh Cempaka, Indonesia

Managed operations at Galuh Cempaka Diamond Project following purchase from Ashton Mining / MMC JV; Designed drill sampling programme to increase diamond reserves; produced updated Feasibility Study prior to commencing Dry Mining operations.

2000 – May 2011 : Director, Tristate Resources, Mildura, Victoria, Australia

Established and commissioned Heavy Mineral Laboratory at Mildura to process samples produced from major Mineral Sand companies' drilling and bulk sampling activities in the Murray Basin.

Jan 1993 – Dec 1999 : Technical Advisor, PT Indo Mineratama, Indonesia

Provided technical and logistical support to IndoMin Resources and Ocean Resources projects; Compilation of technical data for IndoMin Resources IPO on Vancouver Stock Exchange; Undertook Technical Audit of Aokam Thai No. 3 Dredge prior to mobilisation to Ocean Resources Offshore Diamond Project; Commissioned Navstar DGPS system and instructed local staff in its use at the Offshore Diamond Project; Monitored drill programme

Undertook detailed Scoping Study on Tin Tailings Project on Indonesian Tin Islands.

Oct 1989 – Dec 1992 : Operations Manager, Shell-Billiton Heavy Mineral Project, Indonesia

Managed field programmes from first reconnaissance through to follow-up drilling at Kumamba and other Mineral Sand projects; prepared semi-annual work programmes and budgets and submitted Monthly and Quarterly Reports to Government and Joint Venture partners; Established and managed fully equipped Heavy Mineral Laboratory at Pangkal Pinang for processing of samples from Heavy Mineral Sands project, gold, diamond and tin projects with particular reference to gold grain morphologies and surface textures as part of provenance studies.

Mar 1989 – Sep 1989 : Geologist, BP Minerals, Indonesia

Managed exploration programme and upgraded sample processing lab at gold / zircon project in Central Kalimantan, Indonesia.

Sep 1987 – Mar 1989 : Project Manager, Acorn Diamonds Indonesia

Managed advanced exploration programme at alluvial diamond project in South Kalimantan; included bulk sampling with open pits and sheet pile caissons, plant operation, diamond and gold recovery and recording; supervised drilling programme utilising five drills; prepared budgets and work programmes for Government and management; active in preparation of Feasibility Study by Alluvial Dredges; undertook investor presentations in Australia & Europe.

Jan 1983 – Mar 1987 : Senior Geologist, De Beers, Kimberley, South Africa

Managed De Beers Kimberley Heavy Mineral Laboratory and co-ordinated operations at four other regional laboratories; Liaised with Exploration Managers over new techniques for improving operational efficiency and with Research Geologists to ensure new developments in mineral chemistry and surface texture analysis circulated into all laboratories.

Jan 1982 – Dec 1982 : Senior Geologist, De Beers, Lobatse, Botswana

Supervised loam sampling, geophysical surveys and RC Drill programme in Prospecting Licences for diamonds in South Western Botswana.

Aug 1977 – Dec 1981 : Staff Geologist, Zaire Exploration, Tshikapa / Lubumbashi, Congo

Supervised loam sampling, ground magnetometry and drilling programmes for diamonds in Kasai and Shaba (Katanga) provinces; follow up test work on kimberlites on Kundelungu Plateau; Responsible for staff of 800; introduced to diamond sorting, grading and purchasing.

Dec 1974 – Jul 1977 : Geologist, De Beers, Kimberley, South Africa

Introduction to all aspects of hard rock diamond exploration, eg loam and stream sampling, ground magnetometry, churn and reverse circulation drilling, laboratory techniques, target selection and mining operations.

C.E.Watson
11th July 2022