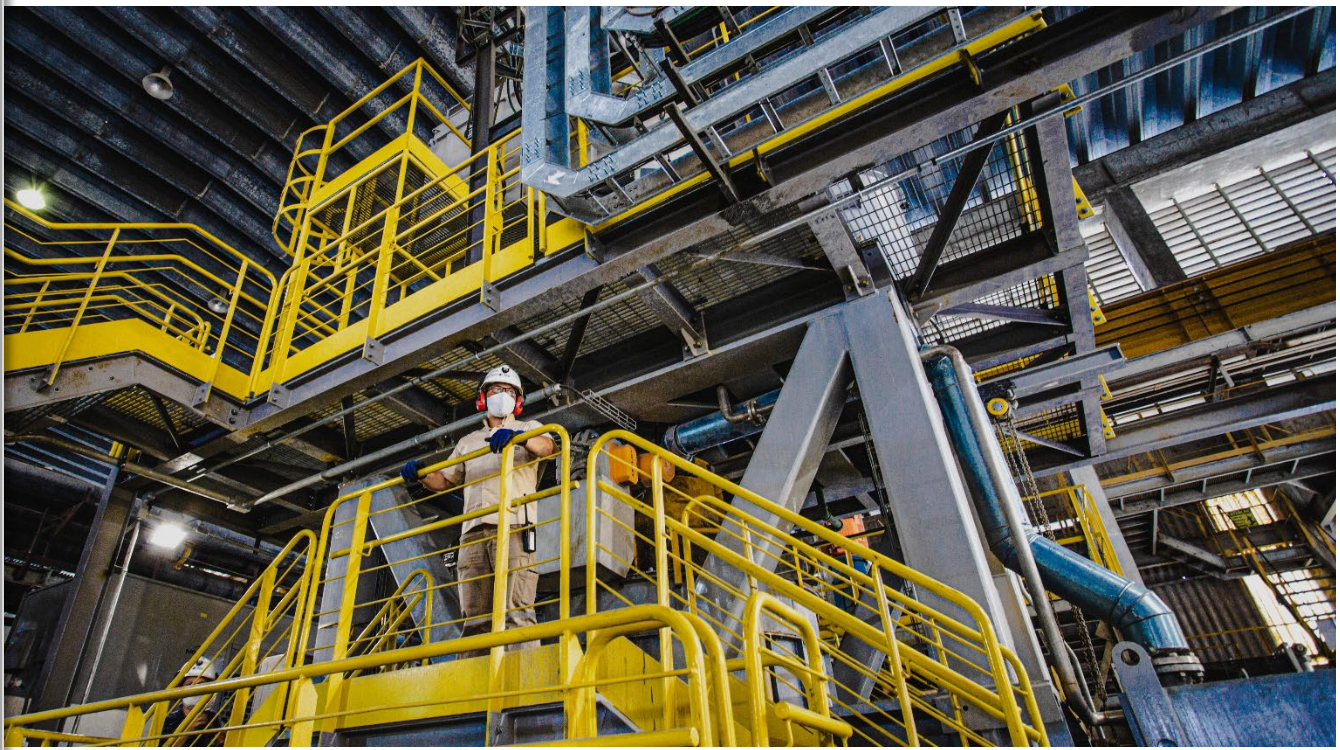
January 14, 2021
Rev. F

2020 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley

Bahia, Brazil



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Signature Date: January 14, 2021

GE21 Consultoria Mineral

The effective date of this report is October 1, 2020. The issue date of this report is January 14, 2021. See Appendix A to this Report for certificates of Qualified Persons, as such term is defined under National Instrument 43-101, Standards of Disclosure for Mineral Projects.

UPDATED MINERAL RESOURCES AND MINERAL RESERVES STATEMENTS
FORM 43-101F1 TECHNICAL REPORT

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1 EXECUTIVE SUMMARY

Ero Copper Corp. ("Ero Copper", "Ero" or the "Company") is a Vancouver-based publicly listed copper mining company that trades on the Toronto Stock Exchange under the ticker "ERO" and exists under the British Columbia *Business Corporations Act*. Ero Copper's principal asset is a 99.6% interest in Mineração Caraíba S.A. ("Mineração Caraíba" or "MCSA"), a Brazilian mining company operating in the Curaçá Valley, northeastern Bahia State, Brazil. The regional MCSA operations include fully integrated processing operations and, currently, two active producing mining locations within the Curaçá Valley. The active operations include the Caraíba Complex (comprised of the underground Pilar Mine ("Pilar UG Mine"), integrated Caraíba Mill and the inactive solvent extraction electrowinning plant ("SX/EW Plant")), and the underground Vermelhos Mine ("Vermelhos UG Mine"). The past producing operations include the open pit mines of R22 ("R22 Mine"), Surubim ("Surubim OP Mine") as well as the historic mines of Angicos ("Angicos Mine") and Suçuarana ("Suçuarana Mine"). Collectively the active and past-producing mines comprise the "MCSA Mining Complex". Additionally, future operations are forecast to occur later in the production plan within the northern part of the Curaçá Valley including: the adjacent Vermelhos West (N8) and Vermelhos East (N9) open pits (collectively the "N8/N9 OP Mine"), the Siriema open pit mine ("Siriema OP Mine"), collectively with the active Vermelhos UG Mine comprise the mineral reserves within the "Vermelhos District". In the central part of the Curaçá Valley, future operations include: the adjacent Surubim and C-12 underground mines (the "Surubim UG Mine" and "C-12 UG Mine") and the C-12 open pit ("C-12 OP Mine"), collectively with the Surubim OP Mine, which is expected to re-start operations during 2021, comprise the stated mineral reserves of the "Surubim District". In the southern part of the Curaçá Valley, the past producing Suçuarana open pit ("Suçuarana OP Mine") and the R22W open pit ("R22W OP Mine"), collectively with the active Pilar UG Mine comprise the stated mineral reserves of the "Pilar District". The Pilar District is located approximately 385 kilometers ("km") north-northwest of Salvador and 90 km southeast of Petrolina, in the State of Bahia, Brazil. The center of the Surubim District is located approximately 33km north of the Caraíba Mine at the Surubim OP Mine, while the center of the Vermelhos District and the Vermelhos UG Mine is located another 31km north-northwest of the Surubim OP Mine. In aggregate, mining and development activities occur over approximately 100km in strike length across the Curaçá Valley.

Within the MCSA Mining Complex life-of-mine ("LOM") production plan, the Company has included production, capital and operating cost projections based upon the mineral reserves derived from the Measured and Indicated mineral resources from within the Deepening Extension Zone of the Pilar Mine (the "Deepening Extension Project").

In addition, the Company has included an independent preliminary economic assessment based upon the Inferred mineral resources within the Deepening Extension Zone of the Pilar Mine (the "Deepening Inferred Project"), that shows the expected synergies associated with utilizing the infrastructure that will be built in support of the Deepening Extension Project, to illustrate the potential of the Deepening Extension Zone. Additional information on the Deepening Inferred Project can be found in Chapter 24 of this Report. The Deepening Inferred Project is preliminary in nature and based on the Inferred mineral resources of the Deepening Extension Zone which are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that the Deepening Inferred Project will be realized. Mineral resources that are not mineral reserves do not have a demonstrated economic viability. The Company has commenced a program to continue infill drilling of the Inferred resource to further upgrade this material; however, until this work is completed and the Inferred resources have been upgraded to reserves, there is no certainty this material will be converted into mineral reserves.

The MCSA Mining Complex has an extensive operating history in the region. Open pit and processing operations started in 1979, while underground mining operations commenced in 1986. MCSA owns a 100% interest in the MCSA Mining Complex including the abovementioned mines, integrated processing facilities and all supporting infrastructure. The Pilar UG Mine currently produces a nominal 4,000 tonnes per day ("t/d"), or approximately 1.4 million tonnes per annum from underground operations that, combined with the nominal 3,000 to 5,000 t/d, or approximately 1.0 million tonnes per annum currently mined from satellite mining operations within the MCSA Mining Complex, including the Vermelhos UG Mine, serves as feed for the Caraíba Mill. The Caraíba Mill is currently producing high quality, low impurity copper concentrate grading approximately 35% copper. The concentrate typically contains minor amounts of precious metals. Historical average grades of precious metals in concentrate are approximately 2 grams per tonne ("g/t" or "gpt") gold and 43 g/t silver in concentrate.

The purpose of this report ("Report" or "Technical Report") is to set out and to provide background and supporting information on the mineral resources and mineral reserves for the MCSA Mining Complex. The Report was prepared by GE21 Consultoria Mineral Ltda. ("GE21") and BNA Mining Solutions ("BNA") on behalf of Ero Copper. This Report and estimates herein have been prepared following the guidelines of the Canadian Securities Administrators' National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* ("NI 43-101") and Form 43-101F1 – Technical Report ("Form 43-101F1").

The effective date of this Report is October 1, 2020 (the "Effective Date"). The issue date of this Report is January 14, 2021.

1.1 PROPERTY DESCRIPTION AND OWNERSHIP

The MCSA Mining Complex is located in northeastern Bahia State, Brazil, about 385 km north-northwest of the capital city of Salvador. The center of the MCSA Mining Complex is located at 9º 52' South, 39º 52' West. As of the Effective Date, MCSA holds, has applications in process, or has negotiated agreements with third-parties for a north-trending set of 110 mineral exploration rights, six mining concessions and one additional mining concession is currently under application. The property, including mining and permits under application covers a total area of 164,377.69 hectares ("ha"). The exploration rights held or with applications in process cover an area of 160,118.81 ha and consist of areas up for renewal as well as negotiated with third-parties under normal course of business. MCSA holds 100% legal and beneficial ownership of exploration rights for a period varying up to three years with three-year extensions provided annual reporting requirements are performed on the property. Within the exploration rights, MCSA's interests include the right to access the property, to engage in exploration, development, processing, and construction activities in support of mineral exploration and development. Where applicable, compensation is provided to the holder of surface rights for occupation or loss caused by the work.

Mining and development activities are contained within six mining concessions covering 3,299.61 ha. In addition, MCSA has one application for mining covering 966.27 ha. Within the mining concessions, MCSA holds 100% legal and beneficial ownership. There are no time constraints provisioned with the mining concessions; however, operating permits and licenses are extended and renewed in normal course of business according to the nature of each permit and requirements therein.

Infrastructure maps of the MCSA Mining Complex and the broader Curaçá Valley are shown in Appendix D to the Report.

1.2 GEOLOGY AND MINERALIZATION

The Curaçá Valley's mafic-ultramafic complex is located within the Curaçá high-grade metamorphic gneissic terrain - part of the Salvador-Curaçá orogen, a northern extension of the Atlantic Coast Granulite Belt in the São Francisco Craton. The mining and development projects located within the MCSA Mining Complex lie within a Trans-Amazonian age belt bordered on the west by volcano-sedimentary rocks of the Jacobina Group and on the east by the Itiúba intrusive syenite rocks.

Known copper deposits are hosted within the Rio Curaçá and Tanque Novo sequences, differentiated by metamorphic facies. The two sequences are located across the base of the MCSA Mining Complex and include the mafic-ultramafic rocks as well as granite, granodiorite and syenite. Pyroxenite has been described within the mafic-ultramafic lenses at the Caraíba Mine, R22W Mine, Angicos Mine, Suçuarana Mine, Surubim OP Mine and the Vermelhos UG Mine.

The Cu-rich deposits are hosted by irregular-shaped intrusive bodies of pyroxenite (hypersthenite) and minor gabbro-norite that have been intruded into granulite facies gneiss and migmatite at the northern margin of the São Francisco Craton. The intrusions have been interpreted as either deformed sill-like bodies or irregular shaped intrusions into an anastomosing ductile shear zone. Mineralized textures include interstitial, net-textured, stringer and sulphide-rich matrix breccias. There is additional evidence throughout the Curaçá Valley of sulphide zonation, characterized as pyrrhotite +/- pentlandite zoning to pyrrhotite +/- pentlandite plus chalcopyrite and finally to chalcopyrite plus bornite. High-grade mineralization is often closely associated with phlogopite enrichment. Additional work is underway to evaluate recent observed occurrences of nickel and platinum group elements throughout the Curaçá Valley.

1.3 EXPLORATION STATUS

Once open pit operations began in 1979, limited exploration work was performed regionally outside of the main Caraíba Mine area. Where it did occur, such exploration work focused primarily on exploration permit renewal requirements. The Caraíba Mine was privatized in 1994 and further exploration work was limited until the formation of the Codelco Joint Venture in 2004 (the "Codelco JV") which existed until 2008. Under the Codelco JV, work was conducted on several prospects outside of the Caraíba Mine area including an airborne Versatile Time Domain Electromagnetic ("VTEM") survey over the Vermelhos District. Ground Moving-loop Electromagnetic and Bore-hole Electromagnetic test surveys were also conducted.

Near-surface copper mineralization in the Curaçá Valley has historically been well-defined by geochemical sampling methods. Mineralized mafic-ultramafic intrusions show anomalous copper, nickel, cobalt, gold and silver. Several soil geochemical surveys have been conducted regionally throughout the Curaçá Valley. Leveling efforts undertaken by Ero Copper in 2018 to normalize multiple surveys into a central database have been successful and the dataset, supplemented with ongoing soil geochemistry campaigns, continues to be used to define areas of exploration potential.

Historic regional exploration activities also included geophysical surveys performed locally on specific targets. These include ground magnetic, gravity and induced polarization ("IP") surveys. Regional airborne geophysical surveys consist of a historic magnetic and radiometric survey flown by the Brazil National Department of Mineral Production ("DNPM" which was replaced in 2018 by the new federal mining agency of Brazil, the Agência Nacional de Mineração ("ANM")). Based on known deposits, mineralized mafic-ultramafic intrusions respond well to gravity, IP and electromagnetic ("EM") surveys including the use of bore-hole EM ("BHEM").

Since the acquisition of MCSA in late 2016, Ero Copper has worked with MCSA to compile, organize, validate, analyze and interpret the various historical data sets. A list of prioritized exploration targets using district-wide dataset compilation and validation has been created for the first time for the MCSA exploration permits throughout the Curaçá Valley. Priority targets occur in three main areas or "Districts": the Pilar District, the Vermelhos District and the Surubim District.

In 2018, Ero Copper advanced its exploration efforts and completed approximately 158,000 meters ("m") of drilling with the objective of upgrading and increasing mineral resources and reserves as well as commenced testing new regional targets in the Curaçá Valley. Simultaneously, Ero Copper continued development and production from the Pilar UG Mine, Surubim OP Mine (expected to re-start operations in 2021) and commenced production from the Vermelhos UG Mine. In support of its regional exploration efforts, Ero Copper commissioned and completed a ~24,000 line-km airborne electromagnetic and gravity geophysical survey focused on high-grade discoveries throughout the Curaçá Valley. In 2019, Ero Copper significantly increased drilling activities and completed approximately 235,000m of drilling, continuing to focus on upgrading and increasing mineral resources and reserves as well as testing of new regional targets in the Curaçá Valley.

Ero Copper significantly increased drilling activities through 2020, where as at the date of this Report, a total of 27 drill rigs are on the property. Over 220,000m of drilling is planned for 2020 throughout the Curaçá Valley. Drilling continues to focus on in-mine extensions, near-mine discoveries, including further exploration of the Deepening Extension Zone, new near-mine discoveries and new regional discoveries within the three main mineralized Districts of the Curaçá Valley.

1.4 DEVELOPMENT AND OPERATIONS

Mining operations within the Curaçá Valley are currently comprised of two core operations: the Pilar UG Mine and the Vermelhos UG Mine. Production from these two mines currently serves as feed for the Caraíba Mill. Ongoing development and exploration activities include: the continued advancement of the primary ramp and associated infrastructure of the Pilar and Vermelhos underground mines in support of mine life extensions, including the delivery of the Deepening Extension Project, as well as associated plant and site refurbishments undertaken in support of the LOM plan and during the normal course of business.

In support of the current mineral resource and mineral reserve estimate, a total of 857,589 m of diamond core drilling was incorporated into the geological model.

1.5 DATA VERIFICATION AND QA/QC

GE21 has visited MCSA's operations on a regular basis since 2017 to assess MCSA's exploration data, including overall procedures for drilling, logging, sample handling, control, storage, quality-assurance quality-control ("QA/QC"), database preparation and density measures.

Sample Preparation, Analyses and SecurityMCSA's sampling procedures are well-defined, in line with the industry best practices. Physical preparation and chemical analysis of core samples are performed by MCSA's on-site laboratory, following well-defined procedures. GE21 evaluated the sample collection, analysis and security methods, as well as the procedures used by MCSA's internal laboratory.

Quality Assurance and Quality Control

Standard QA/QC procedures implemented by MCSA were found to be complete and aligned with industry best practices. A selection of historic information (collected before the current QA/QC procedures were implemented in 2007) was verified by the authors of this Report via a post-mortem validation process. Data from historic drill holes that could not be validated were omitted from the mineral resource estimate.

The QA/QC process implemented includes the analysis of blanks, standards, pulverized duplicates, coarse tailings duplicates, field duplicates and a second third-party laboratory check-assay. Check-assay analysis of copper grades by a second third-party laboratory was implemented as part of MCSA's QA/QC program in 2020. As part of the validation process, GE21 verified 377 holes totaling 96,417m of drilling. Density information has been obtained for over 40 years, and measurement processes are aligned with standard industry practice. Based upon the validation process, GE21 concluded that MCSA's exploration data is adequate for the current mineral resource and mineral reserve estimate.

1.6 MINERAL RESOURCE AND MINERAL RESERVE ESTIMATES

Mineral resource and mineral reserve estimates for the MCSA Mining Complex were classified and prepared in accordance with the Canadian Institute of Mining, Metallurgy and Petroleum ("CIM") Definition Standards for Mineral Resources and Mineral Reserves, adopted by the CIM Council on May 10, 2014, as amended (the "CIM Standards"), and the CIM Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines, adopted by CIM Council on November 29, 2019, as amended (the "CIM Guidelines") by Sr. Porfirio Cabaleiro Rodriguez, MAIG, with contributions from others at GE21. All are independent Qualified Persons as such term is defined under NI 43-101.

The authors of this Report validated the current mineral resource estimate that was prepared by MCSA under the supervision of GE21, by preparing a separate 3D model using Leapfrog Geo software, to define and interpolate geological domains. The variograms prepared by MCSA under the supervision of GE21 were reproduced and applied through an independent grade estimate, using Leapfrog Edge software. Resource classification was determined based upon the number of "passes" and results were used to compare the tonnage, grade and contained copper content within each geological domain. Differences of less than 5% of the contained copper content was considered acceptable within each domain. The validation performed did not indicate any material differences between the two estimates.

Mineral reserves were classified according to the CIM Standards and the CIM Guidelines by Dr. Beck (Alizeibek) Nader, FAIG, of BNA, an independent Qualified Person as such term is defined under NI 43-101.

1.6.1 Mineral Resources

Cut-off grades of 0.51% copper as well as a marginal cut-off grade of 0.32% copper, were used for underground mineral resources and 0.21% copper for open pit mineral resources. Mineral resources were estimated using ordinary kriging within 5m by 5m by 5m block sizes. Mineral resources are shown inclusive of mineral reserves. Underground mineral resource effective date varies by deposit, with an effective date of August 8, 2020 except for P1P2 (July 24, 2020), R75 (July 9, 2019) and Suçuarana (July 3, 2020) within the Pilar District; Vermelhos Mine (July 29 2020), Siriema and N8 (July 4, 2020), N9 (July 9, 2019) within the Vermelhos District; and Surubim District effective date of July 9, 2019 except for Terra do Sal (July 3, 2020). Open pit mineral resource effective date varies by deposit, with an effective date of August 8, 2020, except for Suçuarana (July 3, 2020), R22W and R75 (July 9, 2019) within the Pilar District; Siriema and N8 (July 4, 2020), N9 and Vermelhos North (July 9, 2019) within the Vermelhos District; and an effective date of July 9, 2019 for the Surubim District except Terra do Sal (July 3, 2020).

Table 1-1: Underground Mineral Resources

Underground Mine / Deposit	Classification	Tonnage (000 tonnes)	Grade (Cu %)	Cu Contained (000 tonnes)
Deepening Extension Zone, Pilar Mine *(Pilar Mine below Level -965)*	Measured	-	-	-
	Indicated	7,527	1.86	140.0
	Measured & Indicated	**7,527**	**1.86**	**140.0**
	Inferred	4,476	2.12	94.8
Pilar Mine Ex-Deepening Extension Zone *(Pilar Mine above Level -965)*	Measured	26,829	1.50	401.3
	Indicated	13,991	1.11	154.8
	Measured & Indicated	**40,820**	**1.36**	**556.0**
	Inferred	12,790	0.87	111.6
Pilar District, Other Underground *(R75, Sucuarana)*	Measured	816	0.72	5.9
	Indicated	1,045	0.89	9.3
	Measured & Indicated	**1,861**	**0.82**	**15.2**
	Inferred	742	0.60	4.5
Pilar District Underground Total	Measured	27,645	1.47	407.2
	Indicated	22,563	1.35	304.2
	Measured & Indicated	**50,208**	**1.42**	**711.3**
	Inferred	18,008	1.17	210.9
Vermelhos Mine	Measured	3,389	2.80	94.9
	Indicated	4,514	1.19	53.7
	Measured & Indicated	**7,903**	**1.88**	**148.6**
	Inferred	4,128	0.86	35.5
Vermelhos District, Other Underground *(Siriema, N8/N9)*	Measured	1,465	0.79	11.6
	Indicated	4,153	0.80	33.4
	Measured & Indicated	**6,676**	**0.91**	**61.1**
	Inferred	7,689	0.88	67.9
Vermelhos District Underground Total	Measured	4,402	2.33	102.4
	Indicated	8,667	1.00	87.1
	Measured & Indicated	**13,069**	**1.45**	**189.5**
	Inferred	13,781	0.93	127.6
Surubim District, Other Underground *(Surubim, C12, Cercado Velho, Lagoa da Mina, Terra do Sal)*	Measured	1,841	0.96	17.7
	Indicated	3,062	0.96	29.3
	Measured & Indicated	**4,904**	**0.96**	**47.0**
	Inferred	4,482	0.92	41.3
Surubim District Underground Total	Measured	1,841	0.96	17.7
	Indicated	3,062	0.96	29.3
	Measured & Indicated	**4,904**	**0.96**	**47.0**
	Inferred	4,482	0.92	41.3
Total, Underground	Measured	33,888	1.56	527.3
	Indicated	34,292	1.23	420.6
	Measured & Indicated	**68,180**	**1.39**	**947.9**
	Inferred	36,271	1.05	379.8

Underground Mineral Resource Notes:

1. Mineral resource effective date varies by deposit, with an effective date of August 8, 2020 except for P1P2 (July 24, 2020), R75 (July 9, 2019) and Suçuarana (July 3, 2020) within the Pilar District; Vermelhos Mine (July 29 2020), Siriema and N8 (July 4, 2020), N9 (July 9, 2019) within the Vermelhos District; and Surubim District effective date of July 9, 2019 except for Terra do Sal (July 3, 2020).
2. Presented mineral resources inclusive of mineral reserves. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
3. Mineral resources have been constrained within newly developed 3D lithology models applying a 0.45% and 0.20% copper grade envelope for high and marginal grade, respectively. Within these envelopes, mineral resources for underground deposits were constrained using varying stope dimensions of up to 20m by 10m by 35m applying a 0.51% copper cut-off grade, as well as a 0.32% copper marginal cut-off grade. Mineral resources have been estimated using ordinary kriging inside 5m by 5m by 5m block sizes. The mineral resource estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate to the deposit.

Mineral resources which are not mineral reserves do not have demonstrated economic viability.

Table 1-2: Open Pit Mineral Resources

Open Pit Mine / Deposit	Classification	Tonnage (000 tonnes)	Grade (Cu %)	Cu Contained (000 tonnes)
Pilar District, Open Pit *(R22W, Suçuarana, R75)*	Measured	3,172	0.49	15.4
	Indicated	365	0.45	1.6
	Measured & Indicated	**3,537**	**0.48**	**17.0**
	Inferred	351	0.47	1.6
Pilar District Open Pit Total	Measured	3,172	0.49	15.4
	Indicated	365	0.45	1.6
	Measured & Indicated	**3,537**	**0.48**	**17.0**
	Inferred	351	0.47	1.6
Siriema Deposit	Measured	-	-	-
	Indicated	2,956	0.92	27.1
	Measured & Indicated	**2,956**	**0.92**	**27.1**
	Inferred	187	0.99	1.9
N8/N9 Deposits	Measured	7,420	0.55	41.1
	Indicated	13,562	0.48	64.9
	Measured & Indicated	**20,982**	**0.51**	**106.0**
	Inferred	858	0.40	3.4
Vermelhos North	Measured	-	-	-
	Indicated	-	-	-
	Measured & Indicated	**-**	**-**	**-**
	Inferred	121	0.88	1.1
Vermelhos District Open Pit Total	Measured	7,420	0.55	41.1
	Indicated	16,518	0.56	92.0
	Measured & Indicated	**23,938**	**0.56**	**133.1**
	Inferred	1,166	0.55	6.4
Surubim Mine	Measured	2,340	0.93	21.7
	Indicated	73	0.84	0.6
	Measured & Indicated	**2,413**	**0.92**	**22.3**
	Inferred	3	0.80	0.0
C12 Deposit	Measured	1,272	0.94	11.9
	Indicated	942	0.70	6.6
	Measured & Indicated	**2,214**	**0.84**	**18.6**
	Inferred	154	0.56	0.9
Surubim District, Other Open Pit *(Cercado Velho, Lagoa da Mina, Terra do Sal)*	Measured	1,067	0.61	6.5
	Indicated	1,436	0.67	9.6
	Measured & Indicated	**2,503**	**0.64**	**16.1**
	Inferred	1,255	0.15	1.9
Surubim District Open Pit Total	Measured	4,678	0.86	40.1
	Indicated	2,452	0.69	16.8
	Measured & Indicated	**7,130**	**0.80**	**56.9**
	Inferred	1,413	0.20	2.8
Total, Open Pit	Measured	15,270	0.63	96.6
	Indicated	19,335	0.57	110.5
	Measured & Indicated	**34,605**	**0.60**	**207.0**
	Inferred	2,930	0.37	10.8

Open Pit Mineral Resource Notes:

1. Mineral resource effective date varies by deposit, with an effective date of August 8, 2020, except for Suçuarana (July 3, 2020), R22W and R75 (July 9, 2019) within the Pilar District; Siriema and N8 (July 4, 2020), N9 and Vermelhos North (July 9, 2019) within the Vermelhos District; and an effective date of July 9, 2019 for the Surubim District except Terra do Sal (July 3, 2020).
2. Presented mineral resources inclusive of mineral reserves. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
3. Mineral resources have been constrained within newly developed 3D lithology models using a 0.21% copper cut-off grade for open pit deposits. Mineral resources have been estimated using ordinary kriging inside 5m by 5m by 5m block sizes. The mineral resource estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate to the deposit.

Mineral resources which are not mineral reserves do not have demonstrated economic viability.

1.6.2 Mineral Reserves

The Mineral Reserves for the Pilar UG Mine, Vermelhos UG Mine, N8/N9 OP Mine, Siriema OP Mine, C12 UG Mine, C12 OP Mine and the Surubim OP Mine are derived from the Measured and Indicated mineral resources as defined within the resource block models following the application of economic and other modifying factors further described below. Inferred mineral resources, where unavoidably included within a defined mining shape, have been assigned zero grade.

Table 1-3: Mineral Reserves

	Classification	Tonnage (000 tonnes)	Grade (Cu %)	Cu Contained (000 tonnes)
Reserves, Underground				
Deepening Extension Zone, Pilar UG Mine	Proven	-	-	-
(Pilar Mine below Level -965)	Probable	7,432	1.68	125
Pilar UG Mine Ex-Deepening Extension Zone	Proven	5,835	1.41	82
(Pilar Mine above Level -965)	Probable	7,725	1.09	84
Vermelhos UG Mine	Proven	3,359	2.09	70
	Probable	1,844	1.23	23
Surubim District, Underground	Proven	513	1.09	6
(C12 Underground)	Probable	515	0.83	4
Total Proven, Underground		**9,707**	**1.63**	**158**
Total Probable, Underground		**17,516**	**1.34**	**236**
Total Proven & Probable, Underground		**27,224**	**1.45**	**394**
Reserves, Open Pit				
N8/N9 OP Mine	Proven	7,355	0.55	40
(Vermelhos District)	Probable	8,012	0.54	44
Siriema OP Mine	Proven	-	-	-
(Vermelhos District)	Probable	3,011	0.88	26
Surubim District, Open Pit	Proven	2,778	0.82	23
(Surubim & C12)	Probable	123	0.55	1
Suçuarana South OP Mine	Proven	1,623	0.42	7
(Pilar District)	Probable	328	0.46	2
Total Proven, Open Pit		**11,757**	**0.60**	**70**
Total Probable, Open Pit		**11,474**	**0.63**	**72**
Total Proven & Probable, Open Pit		**23,230**	**0.61**	**142**

Mineral Reserve Notes:

1. Mineral reserve effective date of October 1, 2020.
2. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
3. Mineral reserve estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate for the deposit. Mineral reserves are based on a long-term copper price of US$2.75 per pound ("lb"), and a USD:BRL foreign exchange rate of 4.27, except for the C12 (Surubim District) and Suçuarana (Pilar District) open pit mines, whose design was not changed since 2019, and continued to assume a 3.70 USD:BRL foreign exchange rate. Mineral reserves are the economic portion of the Measured and Indicated mineral resources. Mining dilution and recovery factors vary for specific mineral reserve sources and are influenced by factors such as deposit type, deposit shape, stope orientation and selected mining method. Inferred resource blocks, where unavoidably mined, were assigned zero grade. Dilution occurring from Measured & Indicated resource blocks was assigned grade based upon the mineral resource grade of the blocks included in the dilution envelope. Please see "Technical and Scientific Information" for additional information on the stated mineral reserves.

A summary of the Mineral Reserve estimate parameters is provided below:

Table 1-4: Mineral Reserve Estimate Parameters

Mining Costs (US$/tonne ore mined)	
Pilar UG Mine	$23.52
Vermelhos UG Mine	$21.95
C12 UG Mine	$18.66
Surubim OP Mine	$2.65
Suçuarana & C12 OP Mine	$3.06
N8/N9 & Siriema OP Mines	$2.17
Transportation Costs (US$/tonne to mill)	
Pilar Mine	(none)
Vermelhos Mine	$10.96
Surubim OP Mine	$5.48
C12 OP/UG Mine	$5.98
Suçuarana mine	$3.54
Processing Costs (US$/tonne milled)	
Pilar & Vermelhos Mines	$7.41
Suçuarana & C12 OP/UG Mine	$7.90
Surubim, Siriema & N8/N9 OP Mines	$4.12
Metallurgical Recovery (average)	
Pilar UG Mine	90.39%
Vermelhos UG Mine	91.49%
N8/N9, Siriema, Suçuarana & C12 OP/UG Mines	89.0%
Surubim OP Mine	85.0%

LME Copper Price (US$/lb)	**$2.75**
Net Smelter Return	**94.53%**
Transport & Sales Costs (US$/tonne copper)	**$82.15**
CFEM Royalty (after tax)	**1.58%**
Foreign Exchange Rate (USD:BRL)	*4.27*

Reserve Parameters Note

All road-maintenance costs associated with the Curaçá Valley haul road have been allocated to Vermelhos. Calculated differences between open pit mining and processing costs are a result of additional incurred costs related to contract mining vs. employee operated and allocation of mining and processing administrative / fixed costs between mines. Metallurgical recoveries vary by area as outlined. G&A costs of US$4.16 per tonne were applied to the current operating underground mining operations of Pilar and Vermelhos. USD:BRL foreign exchange rate of 4.27 applied to all mines, except Suçuarana and C12 OP/UG mines, as the mine designs did not change from 2019, thus remain based on a USD:BRL foreign exchange rate of 3.70.

Other modifying factors considered in the determination of the Mineral Reserve estimate include:

- 10% dilution has been applied to all mines, with the exception of the Pilar UG Mine which varies with stope height. For planned stopes within the Pilar UG Mine with a height above 35 meters, dilution of 15% has been applied, while for planned stopes with a height of 26 meters, dilution of 7% has been applied.

- Maximum bench height of 15 meters for open pit mines. Maximum underground stope dimensions based on geotechnical assessments from previous studies and past operating experience within each mining area, combined with evaluation of induced stresses and the Rock Mass Rating ("RMR").

- The Vertical Retreat Mining ("VRM") method with cemented paste fill was selected for the Pilar UG Mine, where the method is currently in use. For the Vermelhos UG Mine, Sublevel with cemented rockfill ("CRF") is the mining method currently in use on consideration of the dip, plunge and thickness of the ore-bodies, the rock quality designation ("RQD") and overall competence of the host rock.

- Mining recovery of 100% has been applied for open pit mines. The Pilar UG Mine and Vermelhos UG Mine assume 96% and 95% mine recovery, respectively.

- Within designed stopes, all contained material was assumed to be mined with no selectivity. Inferred mineral resources, where unavoidably included within a defined mining shape, have been included in the mineral reserves estimate at zero grade. Mining dilution resulting from Measured and Indicated blocks was assigned the grade of those blocks captured in the dilution envelope using the estimated grade within the blocks of the dilution and development model.

Additionally, GE21 and BNA Mining Solutions presents the following accompanying comments to the mineral resource and mineral reserve estimate:

- MCSA holds the surface rights required to support the mine operations considered in the Mineral Reserve estimate. Future development beyond the stated mineral reserves of these areas may require additional acquisition of surface rights.

- As of the date of this Report, MCSA possesses the requisite permits to allow for current mining and processing operations from its core assets of the Pilar UG Mine and Vermelhos UG Mine and is in the process of obtaining mining permits for future production areas commensurate with the envisioned production timelines of those areas as outlined in the LOM plan. Based upon the long operating history of MCSA, the well-established timelines and procedures to obtain such permits, it is the opinion of the QPs that permitting of future production areas within the envisioned timelines does not pose a material risk for the development of the stated mineral reserves.

- Overall, GE21 considers that the components of the mineral reserve estimate (including but not limited to geology, mining, processing, infrastructure, logistics, market, environmental and social considerations) have been conducted at a feasibility level of study and in accordance with NI 43-101.

It is the opinion of the QPs that there are no known mining, metallurgical, infrastructure, permitting, legal, political, environmental, title, taxation, socio-economic, marketing or other relevant factors that could materially affect the potential development of the stated mineral reserves.

1.7 RECOVERY METHODS

The Caraíba Mill has been producing copper concentrate since commissioning in 1979 and has benefited from improvement projects over the years, including most recently those undertaken by Ero Copper. The mill has been designed to process ore from both the Pilar UG Mine, via a production shaft supported by two primary underground jaw crushers as well as ore from throughout the Curaçá Valley (including within the Vermelhos and Surubim Districts) via a primary cone crusher located on surface. The concentrator is operated 24 hours per day, 7 days per week with monthly scheduled downtime for routine maintenance. In its current configuration, the plant is capable of processing a nominal 3.2 million tonnes of copper ore per annum assuming 91% availability. Pursuant to the current LOM plan, the milling capacity of the Caraíba Mill will be increased to 4.2 million tonnes per annum ("Mtpa") through integration of the Company's high intensity grinding mill ("HIG Mill") that was successfully installed during the third quarter of 2020, and a to-be-installed high pressure grinding roll ("HPGR"). In support of the LOM production plan, the Company will integrate ore sorting technology into the future open pit operations of the Vermelhos District.

Through the end of 2019, the Caraíba Mill has produced over 3.0 million tonnes of concentrate containing over 1.0 million tonnes of copper. The Caraíba Mill operating results from 2011 to 2019, and from January to September 30th of 2020 are provided below in Table 1-5 and Table 1-6, respectively.

Table 1-5: Caraíba Mill Processing Results, 2011 to 2019

	Caraíba Mill Feed		Copper Production	
Year	**Tonnes**	**Grade (% Cu)**	**Tonnes**	**Recovery (%)**
2011	2,749,812	1.09	25,096	83.7
2012	2,717,980	1.07	24,827	85.4
2013	2,940,566	0.91	22,494	84.3
2014	3,014,269	1.01	25,717	84.7
2015	2,836,528	1.11	27,046	86.0
2016	826,759	0.71	4,895	83.5
2017	1,771,209	1.31	20,133	86.8
2018	2,257,917	1.56	30,426	86.3
2019	2,424,592	1.93	42,318	90.5

Table 1-6: January 2020 to September 30, 2020 Processing Results

	Caraíba Mill Feed		Copper Production	
Year	**Tonnes**	**Grade (%Cu)**	**Tonnes**	**Recovery (%)**
2020 (Jan-Sep)	1,788,178	2.03	32,796	90.2

The table below shows the production plan for the Caraíba Mill as outlined for the current mineral reserve estimate and LOM production plan. Production has been adjusted from mined totals, where appropriate, for forecast stockpiles and in-process inventories, as well as the integration of ore-sorting. Metallurgical recoveries, including the impacts of ore sorting on the open pit mines of the Vermelhos District are discussed in greater detail in Chapter 13 – Mineral Processing and Metallurgical Testing and Chapter 17 – Recovery Methods.

Table 1-7: LOM production plan

	Q4 2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Underground Operations														
Pilar UG Mine, Ex-Deepening														
Tonnes Mined (000s)	233	945	1,146	1,232	1,010	644	749	1,100	778	851	875	-	-	-
Grade Mined (% Cu)	1.24%	1.09%	1.12%	1.26%	1.14%	1.06%	1.09%	0.94%	1.05%	0.97%	0.98%	-	-	-
Pilar UG Mine, Deepening (below -965)														
Tonnes Mined (000s)	-	-	6	184	650	979	1,007	939	946	555	244	397	664	757
Grade Mined (% Cu)	-	-	0.61%	0.98%	1.46%	1.29%	1.54%	1.47%	1.75%	2.11%	1.48%	1.85%	1.98%	2.42%
Pilar UG Mine, Deepening (above -965)														
Tonnes Mined (000s)	131	556	540	680	564	693	575	9	194	55	-	-	-	-
Grade Mined (% Cu)	2.17%	2.03%	2.17%	1.27%	1.75%	1.53%	1.07%	0.93%	0.83%	0.74%	-	-	-	-
Vermelhos UG Mine														
Tonnes Mined (000s)	184	839	851	882	813	876	700	-	-	-	-	-	-	-
Grade Mined (% Cu)	2.42%	2.48%	2.17%	1.88%	1.38%	1.35%	1.03%	-	-	-	-	-	-	-
Surubim UG Mine														
Tonnes Mined (000s)	-	-	-	-	-	-	-	8	184	206	630	-	-	-
Grade Mined (% Cu)	-	-	-	-	-	-	-	0.83%	0.98%	0.99%	0.95%	-	-	-
Open Pit Operations														
Vermelhos District, Open Pit (ex-Ore Sorting)														
Tonnes Mined (000s)	-	-	390	-	-	-	-	-	-	-	-	-	-	-
Grade Mined (% Cu)	-	-	0.54%	-	-	-	-	-	-	-	-	-	-	-
Surubim District, Open Pit														
Tonnes Mined (000s)	-	240	353	522	627	428	418	314	-	-	-	-	-	-
Grade Mined (% Cu)	-	0.63%	0.64%	0.65%	0.75%	0.89%	1.19%	0.89%	-	-	-	-	-	-
Ore Sorting Operations														
Vermelhos District, Open Pit														
Tonnes Crushed & Sorted (000s)	-	-	-	635	840	1,140	1,755	2,681	4,046	3,777	1,920	3,175	-	-
Grade Crushed & Sorted (% Cu)	-	-	-	0.62%	0.74%	0.55%	0.66%	0.74%	0.59%	0.52%	0.52%	0.36%	-	-
Sort Product, Vermelhos District														
Sorted Tonnes to Mill (000s)	-	-	-	302	399	542	834	1,273	1,922	1,794	912	914	-	-
Sorted Grade to Mill (% Cu)	-	-	-	1.23%	1.47%	1.09%	1.31%	1.47%	1.17%	1.02%	1.03%	1.03%	-	-
Production Plan														
Tonnes Mined & Processed (000s)	482	2,722	3,196	3,686	4,162	4,129	4,007	3,940	3,959	3,555	2,808	1,311	664	757
Grade Mined & Processed (% Cu)	2.07%	1.70%	1.46%	1.34%	1.29%	1.23%	1.26%	1.22%	1.27%	1.17%	1.04%	1.28%	1.98%	2.42%
Recoveries (%)	92.5%	92.8%	92.0%	91.5%	91.3%	91.1%	91.2%	91.0%	91.2%	90.8%	90.2%	91.3%	93.5%	94.5%
Copper in Concentrate (000 tonnes)	**9.2**	**43.0**	**42.9**	**45.1**	**48.9**	**46.3**	**46.2**	**43.9**	**46.0**	**37.8**	**26.3**	**15.3**	**12.3**	**17.3**

*Q4 2020 outlines the mineral reserve schedule for the three months from the Effective Date to December 31, 2020. All figures have been rounded to reflect the accuracy of the estimates. Summed amounts may not add due to rounding. LOM plan totals are based on mineral reserves and does not include the Deepening Inferred Project, which is addressed separately in Chapter 24. The Deepening Inferred Project is preliminary in nature and based on the Inferred mineral resources of the Deepening Extension Zone which are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that the Deepening Inferred Project will be realized. Mineral resources that are not mineral reserves do not have a demonstrated economic viability.

1.8 INFRASTRUCTURE

The MCSA Mining Complex infrastructure includes fully integrated mining and processing operations located within the Curaçá Valley. All supporting infrastructure required for mining operations are currently in place. The current mining operations include the Pilar UG Mine and Vermelhos UG Mine. Primary components of installed infrastructure comprising the MCSA Mining Complex, outside of the individual mining operations, include:

- Caraíba Mill processing plant with current installed capacity of approximately 9,600 t/d;
- access to water via an MCSA owned, operated and maintained 86km permanent steel pipeline, 80 centimeters ("cm") in diameter, from the São Francisco River;
- water treatment plant;
- metallurgical laboratory;
- main substation and transformers, each configured with 60 MVA / 230 kV / 13.8 kV;
- power lines supplied by Companhia Hidroelétrica do São Francisco ("CHESF"), a Brazilian State-owned power company;
- ancillary surface buildings including maintenance, security and administration; and
- inactive Solvent Extraction and Electrowinning ("SX/EW") operations

1.9 ENVIRONMENT

The current permitting status for the active operations of the MCSA Mining Complex can be summarized in the following table:

Table 1-8: Summary of Primary Operational Permits

Mine/Project	License Scope	Project Phase	License Phase	Permit Period Start	Permit Period Expiry	Status
Caraíba Mine	Mining Operations	Operational	Renewal	April 6, 2017	April 6, 2020	Valid (1)
Caraíba Mine	Chemical Products	Operational	Renewal	October 23, 2020	October 22, 2021	Valid
Caraíba Mine	Fuel Station	Operational	Renewal	May 6, 2020	May 6, 2023	Valid
Surubim OP Mine	Mining Operations	Operational	New	September 6, 2017	September 6, 2019	Valid (1)
Surubim OP Mine	Fuel Station	Operational	Renewal	May 18, 2018	May 18, 2021	Valid
Vermelhos UG Mine	Mining Operations	Operational	New	October 10, 2018	October 10, 2020	Valid (1)
Vermelhos UG Mine	Fuel Station	Operational	New	May 14, 2018	May 14, 2021	Valid

The Operation Licenses for the Pilar, Surubim, and Vermelhos Mines are valid and in compliance with the applicable legislation, specifically the State Decree 15,682/2014 that regulates environmental permitting in the Bahia State.

MCSA maintains an excellent relationship with the communities throughout the Curaçá Valley, having held regular meetings and consultation sessions with local stakeholders routinely for over 40 years. In support of this relationship, MCSA undertakes several key initiatives annually focused on sustainable community development ensuring the social license to operate.

1.10 CAPITAL AND OPERATING COSTS

Capital and operating costs are shown for the period from October 2020 to December 2033. It is expected that a combination of resource conversion and delineation of new mineralization within the Curaçá Valley will continue to augment the production profile, subject to satisfactory exploration results, technical, economic, legal and environmental conditions.

Total capital costs are estimated at R$2,767 million Brazilian Real ("R$", or "BRL") and are summarized in the table below. All costs are shown in BRL, unless otherwise noted.

Table 1-9: MCSA Mining Complex – Total Capital Expenditures

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Capital Costs (R$ 000s)														
Deepening below -965	2,314	108,418	171,209	204,433	206,038	78,018	89,588	49,945	25,767	15,786	53	-	-	-
Pilar District (ex-Deepening below -965)	96,974	229,703	166,004	161,739	104,204	79,010	59,365	44,903	15,003	14,171	16,418	6,647	-	-
Vermelhos Underground	9,185	44,315	50,288	39,876	40,720	14,038	395	595	495	495	495	395	-	-
Vermelhos Open Pit	2,650	29,819	69,234	33,241	57,029	22,945	64,748	66,348	356	-	7,504	-	-	-
Surubim Underground	-	-		-	-	-	-	8,180	13,180	12,120	3,290	-	-	-
Surubim Open Pit	3,306	52,215	54,201	52,322	46,072	4,876	10,916	4,194	331	338	345	353	-	-
Total Capital Costs (R$ 000s)	**114,429**	**464,470**	**510,935**	**491,611**	**454,062**	**198,886**	**225,012**	**174,166**	**55,132**	**42,910**	**28,105**	**7,395**	**-**	**-**

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

An operating cost forecast model was generated utilizing MCSA's extensive historical cost data and consumption coefficients. Mine and plant activities are subdivided and adjusted selectively, reflecting the impact of producing from different areas and changes in the infrastructure going forward. A fixed and variable component was included in all estimations, allowing the costs to reflect the production rate of each year. Operating costs are summarized in the table below.

Table 1-10: MCSA Mining Complex - Operating Costs

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Operating Cost Summary (R$/tonne)														
Pilar UG*	100.12	102.56	105.32	100.68	95.44	91.79	90.34	94.65	93.34	96.99	101.76	175.16	129.96	118.60
Vermelhos Underground*	162.39	151.59	145.58	146.94	152.70	148.69	147.75	-	-	-	-	-	-	-
Vermelhos Open Pit*	-	-	12.32	11.69	12.80	9.87	11.84	12.37	13.72	15.95	13.96	32.84	-	-
Surubim Underground*	-	-	-	-	-	-	-	284.58	113.67	108.40	70.27	-	-	-
Surubim Open Pit*	-	18.26	14.86	14.95	16.01	27.95	35.22	11.17	-	-	-	-	-	-
Plant**	46.85	35.92	33.65	32.02	30.57	31.05	31.09	31.32	30.85	32.39	34.86	47.01	83.52	85.19
Operational Support**	32.11	24.65	19.84	17.45	15.78	15.75	16.15	15.04	13.99	13.73	14.44	24.89	44.51	39.49
G&A**	50.78	34.02	28.98	25.12	22.25	22.43	23.11	23.50	23.39	26.05	32.98	47.09	69.74	65.49

* R$/tonne mined (ore + opex waste)
** R$/tonne processed

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

Table 1-11: MCSA Mining Complex – C1 Cash Costs

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Operating Costs (R$000s)														
Mining Costs (incl. transport and sorting)	67,830	299,064	369,784	413,498	448,932	543,247	493,964	404,625	415,249	330,385	254,303	158,982	86,495	89,983
Processing	22,558	97,774	107,541	117,623	127,424	126,737	124,240	122,857	123,246	114,924	99,558	68,765	55,454	57,370
Operational Support	15,459	67,107	63,409	64,238	65,731	64,728	64,672	59,096	55,699	48,760	40,896	33,565	29,505	28,952
less: Precious Metal Credits	(18,531)	(70,776)	(72,701)	(76,323)	(82,851)	(78,467)	(78,223)	(74,297)	(77,850)	(64,079)	(44,609)	(25,982)	(20,498)	(28,944)
plus: TC/RCs, Net of Tax	(6,223)	(6,834)	(41,893)	(48,268)	(50,641)	(48,164)	(48,992)	(44,973)	(49,791)	(39,351)	(28,557)	(18,049)	(13,511)	(17,723)
C1 Cash Costs Basis (R$ 000s)	**81,093**	**386,336**	**426,141**	**470,767**	**508,594**	**608,082**	**555,662**	**467,308**	**466,553**	**390,639**	**321,592**	**217,282**	**137,444**	**129,638**
C1 Cash Costs (US$/lb)	**$0.80**	**$0.81**	**$0.90**	**$0.95**	**$0.94**	**$1.19**	**$1.09**	**$0.97**	**$0.92**	**$0.94**	**$1.11**	**$1.28**	**$1.02**	**$0.68**

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

1.11 ECONOMIC ANALYSIS

An economic analysis was prepared considering production, capital and operating expenditures for all of the assets comprising the current mineral reserves of the Curaçá Valley, including both core and non-core assets. For additional detail regarding core and non-core assets as well as associated production, capital and operating expenditures by asset, please refer to Chapter 21of this Report. The economic analysis used the following primary assumptions:

- The economic analysis considers commencing on the month of the Effective Date and does not include actual performance achieved through September 31, 2020.
- The economic analysis of MCSA's Vale do Curaçá mineral assets is based solely on mineral reserves and does not include Measured and Indicated mineral resources, which are not part of the mineral reserve estimate.
- Total ore processed of 39.4 million tonnes at an average feed grade of 1.33% copper.
- Total sales of 480,802 tonnes of contained copper in concentrate.
- Metal prices of US$3.00 per lb. copper from 2020 through 2033.
- USD:BRL exchange rate of 5.00 in years 2020 through 2033.

The Vale do Curaçá mineral assets comprising the MCSA Mining Complex produce an undiscounted after-tax cash flow of R$5.2 billion, or US$1.0 billion.

The after-tax Net Present Value ("NPV") at an 8% discount rate is US$663.7 million. Average C1 cash costs over the production forecast period are estimated to be US$0.97 per lb of copper produced. C1 cash costs per lb of copper produced is a non-IFRS measure. Please refer to Chapter 22.6 for additional detail regarding non-IFRS measures.

After-tax sensitivity analyses were prepared considering changes in copper price, foreign exchange, capital costs and operating costs. The analysis shows that the MCSA Mining Complex is most sensitive to copper price and exchange rates.

Table 1-12: After-tax Cash Flow Summary, MCSA Mining Complex

Assumptions		2020 [1]	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Exchange Rate	R$/US$	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Copper Price	US$/tonne	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614
Copper Price	US$/lb	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Production															
Ore Processed	tonnes	481,500	2,722,259	3,195,865	3,685,914	4,162,318	4,128,927	4,007,498	3,940,287	3,959,190	3,554,640	2,807,691	1,310,943	663,931	757,090
Copper Grade Processed	%	2.07	1.70	1.46	1.34	1.29	1.23	1.26	1.22	1.27	1.17	1.04	1.28	1.98	2.42
Metallurgical Recovery	%	92.5	92.8	92.0	91.5	91.3	91.1	91.2	91.0	91.2	90.8	90.2	91.3	93.5	94.5
Copper Contained	**tonnes**	**9,234**	**43,032**	**42,940**	**45,080**	**48,936**	**46,346**	**46,202**	**43,883**	**45,982**	**37,848**	**26,348**	**15,346**	**12,283**	**17,343**
Copper Contained	**lbs**	**20,358,107**	**94,868,533**	**94,667,248**	**99,383,625**	**107,884,558**	**102,175,902**	**101,857,551**	**96,745,835**	**101,372,188**	**83,439,963**	**58,087,148**	**33,832,134**	**27,078,774**	**38,235,472**
Capex															
Total Capex	**000 R$**	**114,429**	**464,470**	**510,935**	**491,611**	**454,062**	**198,886**	**225,012**	**174,166**	**55,132**	**42,910**	**28,105**	**7,395**	**-**	**-**
Operating Costs															
Mining Costs (incl. transport and sorting)	000 R$	67,830	299,064	369,784	413,498	448,932	543,247	493,964	404,625	415,249	330,385	254,303	158,982	86,495	89,983
General & Administrative	000 R$	24,451	92,606	92,606	92,606	92,606	92,606	92,606	92,606	92,606	92,606	92,606	61,737	46,303	46,303
Operational Support	000 R$	15,459	67,107	63,409	64,238	65,731	64,728	64,672	59,096	55,699	48,760	40,896	33,565	29,505	28,952
Processing	000 R$	22,558	97,774	107,541	117,623	127,424	126,737	124,240	122,857	123,246	114,924	99,558	68,765	55,454	57,370
Sub Total	**000 R$**	**130,298**	**556,551**	**633,340**	**687,964**	**734,693**	**827,318**	**775,482**	**679,184**	**686,800**	**586,674**	**487,363**	**323,049**	**217,757**	**222,608**
Depreciation/Exhaustion	**000 R$**	**20,312**	**103,289**	**135,100**	**174,210**	**211,009**	**202,139**	**227,548**	**173,398**	**166,473**	**157,345**	**163,732**	**132,001**	**99,577**	**64,594**
Total Costs	**000 R$**	**150,610**	**659,840**	**768,440**	**862,174**	**945,702**	**1,029,457**	**1,003,030**	**852,582**	**853,273**	**744,020**	**651,095**	**455,050**	**317,334**	**287,203**
Revenue															
Copper Sales	tonnes	9,234	43,032	42,940	45,080	48,936	46,346	46,202	43,883	45,982	37,848	26,348	15,346	12,283	17,343
Gross Metal Revenue	000 R$	305,378	1,423,035	1,420,016	1,490,762	1,618,277	1,532,647	1,527,871	1,451,195	1,520,591	1,251,606	871,312	507,485	406,184	573,535
Total Net Metal Revenue	000 R$	317,825	1,393,131	1,405,441	1,479,757	1,604,549	1,519,813	1,516,204	1,440,293	1,508,256	1,243,658	868,006	506,617	402,016	568,294
Other Revenue [2]	000 R$	981	3,924	3,444	3,444	3,444	3,444	3,444	3,444	3,444	3,444	3,444	3,444	3,444	3,444
Total Net Revenue	**000 R$**	**318,806**	**1,397,055**	**1,408,885**	**1,483,201**	**1,607,993**	**1,523,257**	**1,519,648**	**1,443,737**	**1,511,700**	**1,247,102**	**871,450**	**510,061**	**405,460**	**571,738**
Revenue Invoiced with Taxes Added Back	*000 R$*	*352,974*	*1,520,801*	*1,587,114*	*1,666,185*	*1,808,704*	*1,712,998*	*1,707,661*	*1,621,962*	*1,699,523*	*1,398,886*	*973,842*	*567,202*	*454,123*	*641,225*
Cash Flow															
Revenue Invoiced with Taxes Added Back	000 R$	352,974	1,520,801	1,587,114	1,666,185	1,808,704	1,712,998	1,707,661	1,621,962	1,699,523	1,398,886	973,842	567,202	454,123	641,225
Opex (ex-Depreciation & Exhaustion)	000 R$	(130,298)	(556,551)	(633,340)	(687,964)	(734,693)	(827,318)	(775,482)	(679,184)	(686,800)	(586,674)	(487,363)	(323,049)	(217,757)	(222,608)
Less Capitalized Development [3]	000 R$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Income & Social Contribution Taxes	000 R$	(30,933)	(145,288)	(146,982)	(157,834)	(173,416)	(153,818)	(161,588)	(163,141)	(186,304)	(157,278)	(101,334)	(55,120)	(39,547)	(74,284)
Other Taxes & Credits	000 R$	19,976	47,229	(6,932)	(5,644)	(1,883)	-	-	-	-	-	-	-	-	-
Employee Profit Sharing & Bonuses	000 R$	-	(23,927)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)
Operating Cash Flow	**000 R$**	**211,720**	**842,264**	**764,040**	**778,923**	**862,893**	**696,042**	**734,770**	**743,817**	**790,600**	**619,114**	**349,325**	**153,213**	**160,999**	**308,513**
CAPEX	000 R$	(114,429)	(464,470)	(510,935)	(491,611)	(454,062)	(198,886)	(225,012)	(174,166)	(55,132)	(42,910)	(28,105)	(7,395)	-	-
Free Cash Flow	**000 R$**	**97,291**	**377,795**	**253,105**	**287,312**	**408,830**	**497,156**	**509,758**	**569,651**	**735,468**	**576,204**	**321,220**	**145,818**	**160,999**	**308,513**
Accumulated Free Cash Flow	000 R$	97,291	475,086	728,190	1,015,502	1,424,333	1,921,488	2,431,246	3,000,898	3,736,366	4,312,570	4,633,790	4,779,607	4,940,606	5,249,119
Free Cash Flow	**000 US$**	**19,458**	**75,559**	**50,621**	**57,462**	**81,766**	**99,431**	**101,952**	**113,930**	**147,094**	**115,241**	**64,244**	**29,164**	**32,200**	**61,703**
Accumulated Free Cash Flow	000 US$	19,458	95,017	145,638	203,100	284,867	384,298	486,249	600,180	747,273	862,514	926,758	955,921	988,121	1,049,824
EBITDA	**000 R$**	**188,508**	**840,504**	**775,544**	**795,237**	**873,300**	**695,939**	**744,166**	**764,554**	**824,901**	**660,428**	**384,087**	**187,012**	**187,702**	**349,129**
EBITDA	**000 US$**	**37,702**	**168,101**	**155,109**	**159,047**	**174,660**	**139,188**	**148,833**	**152,911**	**164,980**	**132,086**	**76,817**	**37,402**	**37,540**	**69,826**

Discount Rate	**%pa**	**8%**
Results		
After-Tax NPV_8	000 US$	663,663
IRR	%pa	n/a
Simple Payback	years	n/a

(2) 2020 based on the 3 months from the Effective Date to December 31, 2020
(3) Other Revenue includes recovery of water pipeline operating costs and scrap sales

Earnings before interest, taxes, depreciation and amortization ("EBITDA") is a non-IFRS measure. Please see Chapter 22.6 for additional detail regarding non-IFRS measures used by the Company.

1.12 DEEPENING INFERRED PROJECT, PRELIMINARY ECONOMIC ANALYSIS

The Deepening Inferred Project is based upon an ongoing exploration campaign in the Pilar UG Mine below level -965 which, as at the Effective Date, had identified a significant portion of Inferred mineral resources within the Deepening Extension Zone. Given the intrinsic synergies associated with the Deepening Extension Project, MCSA commissioned NCL Ingeniería y Construcción SpA. ("NCL") to undertake engineering and trade-off studies for the development of the Deepening Inferred Project.

The Deepening Inferred Project is preliminary in nature and based on the Inferred mineral resources of the Deepening Extension Zone which are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that the Deepening Inferred Project will be realized. Mineral resources that are not mineral reserves do not have a demonstrated economic viability. The Company has commenced a program to continue infill drilling of the Inferred resource to further upgrade this material; however, until this work is completed and the Inferred resources have been upgraded to reserves, there is no certainty this material will be converted into mineral reserves.

The primary objective of the Deepening Inferred Project is to evaluate the potential to utilize the planned infrastructure to mine and process the Inferred mineral resources within the in the Pilar UG Mine's Deepening Extension Zone, as well as evaluate the potential for the integration of required development in support of the Deepening Inferred Project. Inferred mineral resources of the Pilar UG Mine, Deepening Extension Zone are detailed below. Mineral resources which are not mineral reserves do not have demonstrated economic viability.

The Deepening Inferred Project envisions application of the same mining and recovery methods as the Deepening Extension Project as more fully described in Chapters 13, 15 and 16 of this Report. Accordingly, the same mining, recovery and dilution modifying factors have been applied to the Deepening Inferred Project. Specifically, these modifying factors include: mining recovery of 96% and dilution that varies with stope height. For planned stopes with a height above 35m, dilution of 15% has been applied, while for planned stopes with a height of 26m, dilution of 7% has been applied.

The assumed available material and contained copper based on these parameters, after application of stated mining factors, is shown in Table 1-13. Modified Inferred mineral resources are not mineral reserves. Mineral resources that are not mineral reserves do not have a demonstrated economic viability.

Table 1-13: Modified Inferred Mineral Resources in the Pilar UG Mine Below Level -965

	Deepening Extension Zone, Inferred Resources	Deepening Inferred Project, Captured Inferred Resource
Tonnes (000s)	4,476	4,203
Grade (% Cu)	2.12	2.01
Contained Cu (000 tonnes)	**94.8**	**84.5**

Deepening Inferred Project Notes:

1. Mineral resource effective date of August 8, 2020. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding. Mineral resources which are not mineral reserves do not have demonstrated economic viability.
2. The Inferred mineral resources (undiluted) outlined in this table are further detailed in Chapter 14 – Mineral Resource Estimates, of this Report. Mineral resources of the Pilar Mine are based on copper prices of US$2.90 per pound, net smelter return of 94.53%, average metallurgical recoveries of 90.7%, processing costs of US$5.65 per tonne (run of mine) and mining costs of US$17.30 per tonne.
3. Mineral resources have been constrained within newly developed 3D lithology models applying a 0.45% and 0.20% copper grade envelope for high and marginal grade, respectively. Within these envelopes, mineral resources for underground deposits were constrained using varying stope dimensions of up to 20m by 10m by 35m applying a 0.51% copper cut-off grade, as well as a 0.32% copper marginal cut-off grade. Mineral resources have been estimated using ordinary kriging inside 5m by 5m by 5m block sizes. The mineral resource estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or

classical methods, plus economic and mining parameters appropriate to the deposit. Please refer to Chapter 14 – Mineral Resource Estimates of this Report for additional details.

Mining operations were assumed to be the same as for the Deepening Inferred Project, using a combination of transverse stoping and longitudinal stoping mining method. Dilution was set to 1.0m, comprised of 0.5m for the hanging wall, 0.5m for the footwall and a maximum waste percentage of 75%.

Extraction of mined material from the Deepening Inferred Project required the addition of two new panels below -1381L, as the production panels and supporting infrastructure to be built from level -1069 to -1381 are shared by the Deepening Extension Project. The primary ramp continues at depth beyond the Deepening Extension Project and is designed to follow the mineralization to the north. The bottom of the new external hoisting shaft that will be built in support of the Deepening Extension Project will be completed to the -1075 Level. Two new panels with 4 production levels each are designed below -1381 Level in support of the Deepening Inferred Project.

The mine ventilation system for the deeper panels of the mine in support of the Deepening Inferred Project will utilize the existing mine ramp and internal ventilation raises connecting the production levels. This infrastructure, including cooling requirements, will be shared with the Deepening Extension Project, as more fully described in Chapter 18 of this Report.

The same assumptions for development rates and production schedules were incorporated into the mine design for the Deepening Inferred Project as were used for the mineral reserves incorporated into the Deepening Extension Project.

The Deepening Inferred Project is expected to utilize the same infrastructure that will be built in support of the Deepening Extension Project, including a new external shaft as described in Chapter 18. Over the Deepening Inferred Project life, approximately 4.2 million tonnes grading 2.01% copper are expected to be mined, producing a total of approximately 78,900 tonnes of copper after average metallurgical recoveries of 93.2%. First development from the Deepening Inferred Project is expected in 2023 and first mined ore is expected after the completion of the new external shaft and associated development in support of the Deepening Extension Project of the Pilar UG Mine.

Table 1-14: Deepening Inferred Project Production Schedule

	Q4 2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Production Plan															
Ore Mined & Processed (kt)	-	-	-	19	40	71	193	260	254	645	956	803	536	426	4,203
Grade Mined & Processed (% Cu)	-	-	-	0.62%	0.77%	1.30%	1.20%	1.68%	1.66%	1.90%	2.59%	2.30%	1.61%	1.94%	2.01%
Recoveries (%)	-	-	-	85.6%	87.8%	91.3%	90.9%	92.4%	92.4%	92.9%	93.8%	93.9%	92.3%	93.3%	93.2%
Copper in Concentrate (kt)	**0.0**	**0.0**	**0.0**	**0.1**	**0.3**	**0.8**	**2.1**	**4.0**	**3.9**	**11.4**	**23.2**	**17.4**	**8.0**	**7.7**	**78.9**

The production detailed in the production schedule for the Deepening Inferred Project contains only Inferred mineral resources. Inferred mineral resources are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that value from such Inferred mineral resources will be realized either in whole or in part. Mining of the Inferred mineral resource within the Pilar UG Mine's Deepening Extension Zone, as envisioned, reflects a continuation of mining of the Deepening Extension Project.

1.12.1 Operating and Capital Costs, Deepening Inferred Project

As there is no certainty that the Deepening Inferred Project will be realized due to the nature of the preliminary economic assessment, fixed processing costs and the majority of operational support costs, other than variable operational support costs associated with concentrate transport for the Deepening Inferred Project, have been allocated to the Company's LOM production plan.

Mining costs for the Deepening Inferred Project were estimated using first principles and are based on the assumed costs of the Deepening Extension Project, and are shown below.

Table 1-15: Operating Costs, Deepening Inferred Project

Operating Costs (R$ 000s)														
Mining Costs	-	-	-	650	3,226	6,709	15,602	24,456	27,593	62,295	66,358	52,316	34,314	25,890
Processing	-	-	-	398	830	1,462	3,960	5,342	5,216	13,275	19,665	16,515	11,027	8,767
Operational Support	-	-	-	40	106	327	811	1,562	1,505	4,420	8,994	6,727	3,080	2,980
less: Precious Metal Credits	-	-	-	(174)	(464)	(1,431)	(3,546)	(6,828)	(6,580)	(19,320)	(39,315)	(29,406)	(13,270)	(12,838)
plus: TC/RCs, Net of Tax	-	-	-	(110)	(284)	(878)	(2,221)	(4,133)	(4,208)	(11,864)	(25,168)	(20,427)	(8,747)	(7,861)
C1 Cash Costs Basis (R$ 000s)	**-**	**-**	**-**	**805**	**3,414**	**6,189**	**14,606**	**20,399**	**23,526**	**48,806**	**30,534**	**25,726**	**26,403**	**16,937**
C1 Cash Costs (US$/lb)	**-**	**-**	**-**	**$0.71**	**$1.13**	**$0.66**	**$0.63**	**$0.46**	**$0.55**	**$0.39**	**$0.12**	**$0.13**	**$0.30**	**$0.20**

As a result of shared infrastructure and associated synergies with the Deepening Extension Project as reflected in the Company's LOM production plan, total capital costs for the Deepening Inferred Project, comprised of only equipment and development, are expected to total R$139.1 million over the production schedule, as detailed below.

Table 1-16: Capital Costs, Deepening Inferred Project

	Q4 2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Capital Costs (R$ 000s)															
Deepening below -965															
Equipment	-	-	-	-	-	-	-	18,678	13,392	-	20,146	-	-	-	52,216
Ventilation and Cooling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Development	-	-	-	1,010	5,486	4,571	5,761	14,960	32,820	22,165	105	-	-	-	86,878
Shaft	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Infrastructure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital Costs (R$ 000s)	**-**	**-**	**-**	**1,010**	**5,486**	**4,571**	**5,761**	**33,638**	**46,212**	**22,165**	**20,251**	**-**	**-**	**-**	**139,095**

The economic analysis for the Deepening Inferred Project has been prepared by Ero Copper and MCSA with inputs from NCL and under the supervision of BNA and GE21. MCSA provided the mining and processing cost estimates, and NCL provided capital cost estimates. The estimates were reviewed by the authors of this Report who have found the estimation procedures and outcomes to be in-line with industry best practice and well correlated to the performance of the existing operations.

1.12.2 Financial Analysis, Deepening Inferred Project

Table 1-17: After-tax Cash Flow Summary – Deepening Inferred Project

Assumptions		2020 [1]	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Exchange Rate	R$/US$	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Copper Price	US$/tonne	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614
Copper Price	US$/lb	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Production															
Ore Processed	tonnes	-	-	-	19,363	40,351	71,075	192,504	259,715	253,578	645,362	955,989	802,886	536,069	426,184
Copper Grade Processed	%	-	-	-	0.62	0.77	1.30	1.20	1.68	1.66	1.90	2.59	2.30	1.61	1.94
Metallurgical Recovery	%	-	-	-	85.6	87.8	91.3	90.9	92.4	92.4	92.9	93.8	93.9	92.3	93.3
Copper Contained	**tonnes**	**-**	**-**	**-**	**103**	**274**	**845**	**2,095**	**4,033**	**3,886**	**11,411**	**23,221**	**17,368**	**7,952**	**7,693**
Copper Contained	**lbs**	**-**	**-**	**-**	**226,138**	**604,398**	**1,863,095**	**4,617,751**	**8,891,550**	**8,567,959**	**25,156,847**	**51,194,201**	**38,290,626**	**17,530,410**	**16,959,400**
Capex															
Total Capex	**000 R$**	**-**	**-**	**-**	**1,010**	**5,486**	**4,571**	**5,761**	**33,638**	**46,212**	**22,165**	**20,251**	**-**	**-**	**-**
Operating Costs															
Mining Costs (incl. transport and sorting)	000 R$	-	-	-	650	3,226	6,709	15,602	24,456	27,593	62,295	66,358	52,316	34,314	25,890
Operational Support	000 R$	-	-	-	40	106	327	811	1,562	1,505	4,420	8,994	6,727	3,080	2,980
Processing	000 R$	-	-	-	398	830	1,462	3,960	5,342	5,216	13,275	19,665	16,515	11,027	8,767
Sub Total	**000 R$**	**-**	**-**	**-**	**1,088**	**4,162**	**8,499**	**20,373**	**31,361**	**34,315**	**79,990**	**95,017**	**75,559**	**48,420**	**37,636**
Depreciation/Exhaustion	**000 R$**	**-**	**-**	**-**	**8,757**	**10,607**	**10,161**	**11,438**	**8,716**	**8,368**	**7,909**	**8,230**	**6,635**	**5,005**	**3,247**
Total Costs	**000 R$**	**-**	**-**	**-**	**9,845**	**14,769**	**18,659**	**31,812**	**40,077**	**42,683**	**87,899**	**103,247**	**82,194**	**53,426**	**40,883**
Revenue															
Copper Sales	tonnes	-	-	-	103	274	845	2,095	4,033	3,886	11,411	23,221	17,368	7,952	7,693
Gross Metal Revenue	000 R$	-	-	-	3,392	9,066	27,947	69,268	133,376	128,522	377,360	767,928	574,371	262,961	254,396
Total Net Metal Revenue	000 R$	-	-	-	3,367	8,989	27,713	68,739	132,374	127,479	374,964	765,015	573,389	260,263	252,071
Other Revenue [2]	000 R$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Net Revenue	**000 R$**	**-**	**-**	**-**	**3,367**	**8,989**	**27,713**	**68,739**	**132,374**	**127,479**	**374,964**	**765,015**	**573,389**	**260,263**	**252,071**
Revenue Invoiced with Taxes Added Back	*000 R$*	-	-	-	*3,791*	*10,133*	*31,236*	*77,419*	*149,071*	*143,646*	*421,765*	*858,293*	*641,959*	*293,997*	*284,421*
Cash Flow															
Revenue Invoiced with Taxes Added Back	000 R$	-	-	-	3,791	10,133	31,236	77,419	149,071	143,646	421,765	858,293	641,959	293,997	284,421
Opex (ex-Depreciation & Exhaustion)	000 R$	-	-	-	(1,088)	(4,162)	(8,499)	(20,373)	(31,361)	(34,315)	(79,990)	(95,017)	(75,559)	(48,420)	(37,636)
Less Capitalized Development [3]	000 R$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Effective Tax Rate	%	8.8	9.6	9.3	9.5	9.6	9.0	9.5	10.1	11.0	11.2	10.4	9.7	8.7	11.6
Income & Social Contribution Taxes	000 R$	-	-	-	(359)	(972)	(2,805)	(7,326)	(14,994)	(15,747)	(47,419)	(89,310)	(62,385)	(25,602)	(32,949)
Other Taxes & Credits	000 R$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Employee Profit Sharing & Bonuses	000 R$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Operating Cash Flow	**000 R$**	**-**	**-**	**-**	**2,344**	**4,999**	**19,932**	**49,719**	**102,716**	**93,584**	**294,356**	**673,966**	**504,015**	**219,974**	**213,835**
CAPEX	000 R$	-	-	-	(1,010)	(5,486)	(4,571)	(5,761)	(33,638)	(46,212)	(22,165)	(20,251)	-	-	-
Free Cash Flow	**000 R$**	**-**	**-**	**-**	**1,334**	**(487)**	**15,361**	**43,958**	**69,078**	**47,373**	**272,191**	**653,715**	**504,015**	**219,974**	**213,835**
Accumulated Free Cash Flow	000 R$	-	-	-	1,334	847	16,208	60,166	129,244	176,616	448,808	1,102,522	1,606,537	1,826,511	2,040,346
Free Cash Flow	**000 US$**	**-**	**-**	**-**	**267**	**(97)**	**3,072**	**8,792**	**13,816**	**9,475**	**54,438**	**130,743**	**100,803**	**43,995**	**42,767**
Accumulated Free Cash Flow	000 US$	-	-	-	267	169	3,242	12,033	25,849	35,323	89,762	220,504	321,307	365,302	408,069
EBITDA	**000 R$**	**-**	**-**	**-**	**2,279**	**4,827**	**19,214**	**48,365**	**101,013**	**93,165**	**294,974**	**669,998**	**497,831**	**211,843**	**214,435**
EBITDA	**000 US$**	**-**	**-**	**-**	**456**	**965**	**3,843**	**9,673**	**20,203**	**18,633**	**58,995**	**134,000**	**99,566**	**42,369**	**42,887**

Discount Rate	%pa	8%
Results		
After-Tax NPV_8	000 US$	188,661
IRR	%pa	n/a
Simple Payback	years	n/a

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020
(2) Other Revenue includes recovery of water pipeline operating costs and scrap sales

1.13 CONCLUSIONS

1.13.1 Mineral Exploration and Geology

The geological descriptions, sampling procedures and density tests that were evaluated were found to be of acceptable quality and in accordance with industry best practices. Data was stored in a standardized database, which was found to be secure and auditable. The complexity of the mineralization controls and the quantity and phases of data in the Curaçá Valley merits the use of visualization and data integration tools that are more advanced than those which MCSA had at its disposal at the time of this Technical Report.

While GE21 believes that the current QA/QC program can guarantee the quality of the exploration data used in the resource estimates, GE21 suggests that a chain of custody program be implemented for good measure. GE21 supervised the process through which density was determined and concluded that it aligns with industry best practices.

1.13.2 QA/QC

GE21 performed the evaluation of the data generated after the last validation and concluded that the QA/QC procedures are being followed using the same standards. GE21 considered the standard QA/QC procedures to be in accordance with mining industry best practice and appropriate for use in the current mineral resource estimation.

It was observed throughout the 2020 review period by GE21, that the MCSA laboratory continues to display a tendency to underestimate the copper assay values when using certified reference material ("CRM") ITAK 825; however, the results of the laboratory when using CRM ITAK 851, which features a similar copper grade range, demonstrate better reproducibility.

1.13.3 Geological Model

The procedure that was adopted to produce the 3D geological model (wireframes), consisting of generating triangulations between interpreted geological cross sections, was executed properly and in accordance with the opinions of GE21. Due to the plunge of the mineralized zone at the Pilar UG Mine towards the north and the east-west geological cross sections, a pattern of sub-vertical discontinuous lenses was created locally within the regions of lower drill hole density.

GE21 noted that, with respect to the integration and interpretation of geological data, limited lithostructural mapping (mine, surface and subsurface) had been undertaken. GE21 also notes that the field interpretation and 3D interpretation were historically focused on interpreting only copper grade, therefore, few vertical and horizontal lithostructural geological sections have been developed which may provide greater understanding and control of aspects relating to the geology and other potential metals of significance in the Curaçá Valley. In 2020, MCSA started to adopt 3D implicit modelling techniques based upon grouped lithologies and copper grade shells using Leapfrog software. This methodology was used by GE21 to create 3D validation models and GE21 encourages the expansion of this program at MCSA.

1.13.4 Grade Estimation

The variograms that were used in the estimation method are satisfactory and consistent with respect to the grade estimation that was calculated via ordinary kriging, making use of search anisotropy determined in the variographic analysis.

GE21 considers the resource classification model and the analysis of criteria for the classification of those mineral resources, to be satisfactory although some processes could be improved. Such recommended improvements did not impose limitations on the classification of Measured and Indicated mineral resources.

1.13.5 Mineral Resource Estimate

The authors of this Report are not aware of any environmental, permitting, legal, title, taxation, socio-economic, marketing, political or other relevant factors which could materially affect the current mineral resource estimate. It is the opinion of GE21 that the current drilling information is sufficiently reliable to interpret with confidence the boundaries of higher-grade mineralized domains and that the assay data is sufficiently reliable to support estimation of mineral resources. The authors of this Report that validated the mineral resource estimate did not identify overall or local grade biases, as demonstrated by Swath Plot analysis. The authors found that the quality of the data is appropriate for the classification of the mineral resource, in accordance with the CIM Standards and CIM Guidelines.

1.13.6 Mineral Reserve Estimate

GE21 and BNA carried out a detailed review of the current mineral reserves for Curaçá Valley, aimed at demonstrating its technical and profitable extraction for the production and sale of copper concentrate. The results for this review, demonstrated a good adherence using detailed verification procedures performed by the authors of this Report. In general, resulting in differences of less than 1% in the total copper metal contained, which BNA considered acceptable.

Several observations related with the current mineral reserve are worth noting:

- The metallurgical recovery value is expected to rise after commissioning of the HIG Mill. This potential gain was not applied for this current estimation of reserves, which was a correct measure, according to BNA assessment given the limited operating history of the HIG Mill prior to the Effective Date;

- Within the Vermelhos District ore sorting will be integrated within the open pit operations to reduce transport and processing costs. However, these potential savings have not been considered in current reserve estimation as the Ero Copper and MCSA teams continue to conduct additional project assessments as at the Effective Date of this Report;

- The operating mines of the Company (Pilar UG Mine and Vermelhos UG Mine) currently employ a joint reconciliation process in which it is difficult to accurately differentiate mine-to-mill reconciliation from one mine to another; and,

- As at the date of this Report, the ventilation and cooling infrastructure for the Pilar UG Mine, is being upgraded according to the plans developed by the Ero Copper and MCSA teams.

The mineral reserve estimation has been performed according to industry best practice and conform to the CIM Standards and CIM Guidelines.

BNA has not identified any mining, metallurgical, infrastructure, permitting, legal, political, environmental, technical, or other relevant factors that could materially affect the potential development of the current mineral reserves.

1.13.7 Deepening Inferred Project

NCL has carried out a mine schedule, production plan and capital cost estimates at a preliminary economic analysis level for the Deepening Inferred Project under the supervision of GE21 and BNA. Mining and processing operating costs were prepared by MCSA under the supervision of GE21 and BNA. GE21 reviewed these plans and estimates and agrees with the potential economic value of the inferred mineral resource contained within the Deepening Extension Zone. GE21 is satisfied that the technical work adheres to industry best practices and that the favorable results of the potential economic assessment have been demonstrated, thereby warranting further work.

As at the date of this Report, the Company has commenced an approximate US$7 million drill program to continue infill drilling of the Inferred mineral resource to further upgrade this material; however, until this work is completed and the Inferred mineral resources have been upgraded to mineral reserves, there is no certainty this material will be converted into mineral reserves.

1.14 RECOMMENDATIONS

Regarding the mineral resources and mineral reserves estimation, the authors recommend a work program to include the following, most of which can be completed at little or no cost. Estimated costs of the work program are shown in the table below.

i. Formalize the use of implicit modelling internally throughout the Company, emphasizing structural geology and variation in lithology for domain definition and exploration target integration.

ii. Implement additional empirical criteria for resource classification, based on the '15% Rule', as commonly attributed to Dr. Harry Parker and since expanded upon in multiple sources of geostatistical literature.

iii. Expand ongoing geometallurgical studies to encompass all deposits and blends therein to study mill feed interaction. Suggest including standardized laboratory tests as normal operating procedure. Additionally, it is recommended that the Company advance geometallurgical studies for inclusion in mineral reserve definition, to classify metallurgical recovery according to the different characteristics associated with each lithological domain rather than by deposit.

iv. Confirm the expected improvement in metallurgical recoveries following the addition of the HIG Mill to validate a recovery improvement in the definition of mineral reserves in the future.

v. Validate of the certified grade for CRM ITAK 825 due to the observed inconsistencies in assay values, in contrast with the consistent results obtained when utilizing CRM ITAK 851, which has a similar Cu grade range.

vi. Recommend standardizing QA/QC mass controls during assay sample crushing and grinding to evaluate the quality of the comminution procedures and ensure no sample loss during sample preparation.

vii. Install a sample tower to improve the mine to mill reconciliation process for the current operating mines. Such an installation will allow differentiation of ore source reconciliation within the processing plant.

viii. Improve systems for mineral reserve attribute database management to standardize fleet sizing, economic and consumable parameters, swell factors, dilution and mine call factors as well as store historic block model and design attributes including mathematical pit designs and supporting assumptions within a centralized validated database to improve the application of mineral reserve modifying factors in future studies.

ix. Advance geotechnical monitoring campaigns and 3D geotechnical lithological models to improve structural understanding of the current and future operations of the Curaçá Valley.

x. Execute the installation of ventilation and cooling within the operations of the Pilar UG Mine, both in the short term and in the long term as currently envisioned to ensure safe delivery of the Deepening Extension Project.

xi. A drill program for the Deepening Inferred Project be executed so as to promote the resource classification from Inferred to Measured or Indicated mineral resources. Additional engineering work should continue alongside the exploration program to promote the confidence of the mine design and costing parameters of the Deepening Inferred Project. The authors note as at the date of this Report, such programs were underway.

Table 1-18: Proposed Budget for Recommended Work

Program	Budget (US$)
Advance geometallurgical studies	$200,000
Continued multi-element assays for the Vermelhos District (incl. check assays)	$50,000
Installation of sampling tower to enhance Mine-to-Mill reconciliation for multiple mining operations	$500,000
Improvement of reconciliation systems	$60,000
Advance geotechnical monitoring campaings and geotechnical-lithology model development	$100,000
Deepening Inferred Project drill program	$7,000,000
Total	**$7,910,000**

2 INTRODUCTION AND TERMS OF REFERENCE

Ero Copper is a Vancouver-based publicly listed copper mining company that trades on the Toronto Stock Exchange under the ticker "ERO" and exists under the British Columbia *Business Corporations Act*. Ero Copper's principal asset is a 99.6% interest in MCSA, a Brazilian mining company operating in the Curaçá Valley, northeastern Bahia State, Brazil. The regional MCSA operations include fully integrated processing operations and, currently, two active producing mining locations within the Curaçá Valley. The active operations include the Caraíba Complex, including the Pilar UG Mine, and the Vermelhos UG Mine. The past producing operations include the open pit mines of the "R22 Mine, Surubim OP Mine as well as the historic Angicos Mine and Suçuarana Mine. Collectively the active and past-producing mines comprise the "MCSA Mining Complex". Additionally, future operations are forecast to occur later in the production plan within the northern part of the Curaçá Valley including: the N8/N9 OP Mine, the Siriema OP Mine, collectively with the active Vermelhos UG Mine comprise the mineral reserves within the "Vermelhos District". In the central part of the Curaçá Valley, future operations include the Surubim UG Mine, the adjacent C-12 UG Mine and the C-12 OP Mine, collectively with the Surubim OP Mine, expected to restart operations in 2021, comprise the stated mineral reserves of the "Surubim District". In the southern part of the Curaçá Valley, the past producing Suçuarana OP Mine and the R22W OP Mine, collectively with the active Pilar UG Mine comprise the stated mineral reserves of the "Pilar District". The Pilar District is located approximately 385 km north-northwest of Salvador and 90 km southeast of Petrolina, in the State of Bahia, Brazil. The center of the Surubim District is located approximately 33km north of the Caraíba Mine at the Surubim OP Mine, while the center of the Vermelhos District and the Vermelhos UG Mine is located another 31km north-northwest of the Surubim OP Mine. In aggregate, mining and development activities occur over approximately 100km in strike length across the Curaçá Valley.

Within the MCSA Mining Complex LOM production plan, the Company has included production, capital and operating cost projections based upon the mineral reserves derived from the Measured and Indicated mineral resources from within the Deepening Extension Zone of the Pilar Mine (herein referred to as the "Deepening Extension Project").

In addition, the Company has included an independent preliminary economic assessment based upon the Inferred mineral resources within the Deepening Extension Zone of the Pilar Mine (herein refereed to as the "Deepening Inferred Project"), that shows the expected synergies associated with utilizing the infrastructure that will be built in support of the Deepening Extension Project, to illustrate the potential of the Deepening Extension Zone. Additional information on the Deepening Inferred Project can be found in Chapter 24 of this Report. The Deepening Inferred Project is preliminary in nature and based on the Inferred mineral resources of the Deepening Extension Zone which are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that the Deepening Inferred Project will be realized. Mineral resources that are not mineral reserves do not have a demonstrated economic viability. The Company has commenced a program to continue infill drilling of the Inferred resource to further upgrade this material; however, until this work is completed and the Inferred resources have been upgraded to reserves, there is no certainty this material will be converted into mineral reserves.

The MCSA Mining Complex has an extensive operating history in the region. Open pit and processing operations started in 1979, while underground mining operations commenced in 1986. MCSA owns a 100% interest in the MCSA Mining Complex including the abovementioned mines, integrated processing facilities and supporting infrastructure. The Pilar UG Mine currently produces a nominal 4,000 tonnes per day ("t/d"), or approximately 1.4 million tonnes per annum from underground operations that, combined with the nominal 3,000 to 5,000 t/d, or approximately 1.0 million tonnes per annum currently mined from satellite mining operations within the MCSA Mining Complex, including the Vermelhos UG Mine, serves as feed for the Caraíba Mill. The Caraíba Mill is currently producing high quality, low impurity copper concentrate grading approximately 35% copper. The concentrate typically contains minor amounts of precious metals. Historical average grades of precious metals in concentrate are approximately 2 grams per tonne ("g/t") gold and 43 g/t silver in concentrate.

The purpose of this Report is to set out and to provide background and supporting information on the current mineral resources and mineral reserves for the MCSA Mining Complex. This Report was prepared by GE21 and BNA on behalf of Ero Copper. This Report and estimates herein have been prepared following NI 43-101 and Form 43-101F1.

2.1 SCOPE OF WORK

The scope of work undertaken by GE21 included:

- Project management as lead QP of the Technical Report;
- review and validate the Company's QA/QC program and data collected during the 2018-2020 drill programs;
- perform validation of the geological models prepared by MCSA;
- update mineral resource block models using an industry standard geostatistical approach;
- classify the Company's mineral resource into Measured, Indicated and Inferred categories, following CIM Standards and CIM Guidelines for the known copper sulphide mineralization of the MCSA Mining Complex; and,
- where relevant, GE21, reviewed work prepared by independent third-party consultants that constitute an integral component of current and planned operations as contemplated in this Report.

The scope of work undertaken by BNA included:

- Review of updated mineral resource block models prepared by MCSA, verified and classified with the support of GE21;
- review of mine design and planning on Measured and Indicated mineral resource for the deposits in support of the mineral reserve estimate;
- Where relevant, due to the operating nature of the MCSA Mining Complex and the Deepening Extension Project, review work prepared by independent third-party consultants that constitute an integral component of current and planned operations as contemplated in this Report;
- review and validate the economic analysis performed to verify economic feasibility in support of the mineral reserves; and,
- compilation of the Technical Report detailing the mineral resource and mineral reserve for the MCSA Mining Complex incorporating the work performed by GE21 and the work of the MCSA technical team.

2.2 QUALIFICATION, EXPERIENCE AND INDEPENDENCE

GE21 is an independent mineral consulting firm based in Brazil developed by a team of professionals accredited by the Australian Institute of Geoscientists ("AIG"), The Society for Mining, Metallurgy and Exploration, Inc. or Australasian Institute of Mining and Metallurgy as Qualified Persons for estimate of mineral resources and mineral reserves in accordance with NI 43-101.

BNA is an independent Mining and Engineering consulting firm based in Brazil.

Each of the authors of this report has the appropriate qualifications, experience, competence and independence, to be considered as qualified person ("QP" or "Qualified Person"), as such term is defined in NI 43-101. Neither GE21 nor BNA nor the authors of this Report have or have had any material interest in Ero Copper, MCSA or related entities. The relationship between these companies and Ero Copper and MCSA is solely of professional association between client and independent consultant. This Report was prepared in exchange for fees based on rates set by a commercial agreement. Payment of these fees is in no way dependent on the results of this Report.

In accordance with NI 43-101 guidelines, at least one of the Qualified Persons, including the lead QP, has visited the MCSA Mining Complex on multiple prior occasions, and most recently during February 2020, as shown in the table below and as outlined in the QP certificates found in Appendix A to the Report.

Table 2-1: Qualified Persons and Dates of Recent Site Visit

Company	Qualified Person	Recent Site Visit	Responsibility*
GE21	Porfírio Cabaleiro Rodriguez, MAIG (#3708)	3 days' duration, February 2020	Lead QP and supervised the preparation of the Technical Report. Overall responsibility on behalf GE21, responsible for Chapters 2, 3, 14, 19, 22, 23, and 27 and jointly responsible for Chapters 21 and 24.
GE21	Bernardo Horta de Cerqueira Viana, MAIG (#3709)	3 days' duration, February 2020	Jointly responsible for Chapters 4, 5, 6, 7, 8, 9, 10, 11, 12 and 24.
GE21	Paulo Roberto Bergmann, FAusIMM (#333121)	3 days' duration, February 2020	Chapters 13 and 17 and jointly responsible for Chapter 21.
GE21	Fábio Valério Câmara Xavier, MAIG, (#5179)	5 days' duration in July 2018	Jointly responsible for Chapters 4, 5, 6, 7, 8, 9, 10, 11 and 12.
BNA	Dr. Beck (Alizeibek) Nader, FAIG (#4472)	n/a – unable to visit due to Covid-19 restrictions resulting in postponed site visit	Chapters 15, 16 and 18 and jointly responsible for Chapter 21.
GE21	Dr. Augusto Ferreira Mendonça, RM SME (4053401RM)	n/a – unable to visit due to Covid-19 restrictions resulting in postponed site visit	Chapter 20.

(*) Each QP was also responsible for the corresponding sections within Chapters 1, 25 and 26 related to stated Chapters of responsibility.

2.3 MAIN SOURCES OF INFORMATION

In addition to the personal inspection of the MCSA Mining Complex performed by certain Qualified Person during the period noted in the table above, GE21 and BNA were involved in multiple discussions with the MCSA team regarding processes and procedures including surveying, sampling, QA/QC, and mineral resource and mineral reserve estimation methods – including the design and integration of the Deepening Extension Project. The results presented in this Report have been generated from information provided and compiled by MCSA through data organized in spreadsheets, internal and third-party technical reports, as well as supplemental information obtained from the MCSA technical team. GE21 and BNA have made all necessary inquiries to determine the integrity and authenticity of the information provided and identified herein.

2.4 EFFECTIVE DATE

The Effective Date of this Technical Report is October 1, 2020.

2.5 UNITS OF MEASUREMENT

Unless otherwise stated, the units of measurement in this Report are all metrics in the International System of Units ("SI"). All monetary units are expressed in BRL or United States Dollars ("US$" or "USD"), unless otherwise indicated. Although substantively all costs are incurred in BRL, where applicable, these amounts have been converted to USD for presentation and assembly of the economic analysis.

The UTM projection, Zone 24 South, SIRGAS2000 datum was adopted as a spatial reference for all mines and projects within the Curaçá Valley with the exception of the Pilar UG Mine, where Local Coordinates were adopted as the spatial reference.

3 RELIANCE ON OTHER EXPERTS

The authors of this report are Qualified Persons as defined under NI 43-101, with relevant experience in mineral exploration, data validation, mine planning and mineral resource and mineral reserve estimation.

The information presented regarding the tenure, status and work permitted by permit type within the MCSA Mining Complex in Chapter 4 – Property Description and Location, is based on information published by the ANM of Brazil as at the Effective Date.

The copper market conditions and key contracts as of the Effective Date included in Chapter 19 – Market Studies and Contracts and environmental licensing status information and work plans related to community and social outreach included in Chapter 20 – Environmental Studies, Permitting and Social or Community Impact, were prepared by MCSA and Ero Copper and reviewed by GE21. GE21 determined that the economic factors used in the determination of specific technical parameters of this Report, including copper, gold, silver and the USD:BRL assumptions used were in-line with industry norms, broader market consensus and are acceptable for use in the current mineral resource estimate, current mineral reserve estimate, and in the economic analysis presented herein. The author is of this Report have not identified any significant risks in the underlying assumptions.

The forecast capital expenditures and operating costs as well as future tax and royalty obligations included in Chapter 21 – Capital and Operating Costs and incorporated into the economic analysis were prepared by MCSA and Ero Copper based on the extensive operating history of the operations and ongoing nature of the operations. The forecasts were reviewed against historic information and deemed to be reasonable and adequate for the purposes of NI 43-101 by the authors of this Report.

4 PROPERTY DESCRIPTION AND LOCATION

4.1 PROPERTY LOCATION

MCSA currently has two primary mining operations located within the Curaçá Valley in northeastern Bahia State, Brazil: the Caraíba Mine and the Vermelhos UG Mine. The Caraíba Mine, containing the Pilar UG Mine and the fully integrated Caraíba Mill are located approximately 385 km north-northwest of the capital city of Salvador and 90 km southeast of the dual-cities of Petrolina and Juazeiro (combined population of approximately 500,000), States of Pernambuco and Bahia on the São Francisco River (Figure 4-1). The Vermelhos UG Mine is located 83 km north-northwest of the Pilar UG Mine. Ore is transported from the Vermelhos UG Mine to the Caraíba Mill complex via the Curaça Valley Haul Road, which passes adjacent to the Surubim Mine in the central portion of the Curaçá Valley, over a total transport distance of approximately 80 kilometers. The Caraíba Mine is located at 9°52'04"S and 39°52'18"W and the Vermelhos UG Mine is located at 9°18'28"S and 39°56'14"W. The Pilar and Vermelhos Districts, which encompass these operations as well as neighboring mineral resources, mineral reserves and exploration targets are located at the southern and northern ends of the Curaçá Valley, respectively.

The Pilar District, containing the Pilar UG Mine and Caraíba Mill, includes two additional projects containing mineral resources and reserves which include R75, located at 9°51'10"S and 39°52'6"W and Suçuarana located at 9°59'34"S and 39°54'3"W. The Vermelhos District, containing the Vermelhos UG Mine, also includes the N8/N9 OP Mine, centred at 9°18'15"S and 39°56'18"W, the Vermelhos North project, located at 9°17'6"S and 39°56'3"W and the Siriema OP Mine, located at 9°19'20"S and 39°56'38"W.

Additionally, the Surubim District, containing the Surubim OP Mine and Surubim UG Mine, located at 9°34'12"S and 39°51'52"W, also includes the C-12 OP/UG Mine, located at 9°34'44"S and 39°52'27"W, the Lagoa da Mina project, located at 9°30'13"S and 39°47'48"W adjacent to the past producing Angicos Mine, the Cercado Velho project, located at located at 9°30'36"S and 39°47'52"W and the Terra do Sal project, located at 9°38'1"S and 39°49'6"W.

The primary access to the properties from the Petrolina Airport, featuring daily flights to Salvador and São Paulo, is via federal and state highways. From the Petrolina Airport it is approximately 125 km to the main access road of the Caraíba Mine. The nearest town of Pilar (population of approximately 10,000 people) is located approximately 15 km from the Caraíba Mine entrance and mine administration offices. The town features two hotels, community centers, a hospital, and housing for mine employees and their families. Daily bus service transports employees from Pilar to the mine entrance. The three principal mineral districts contained within the Curaçá Valley in relation to major cities in Bahia State are shown in the two figures below.

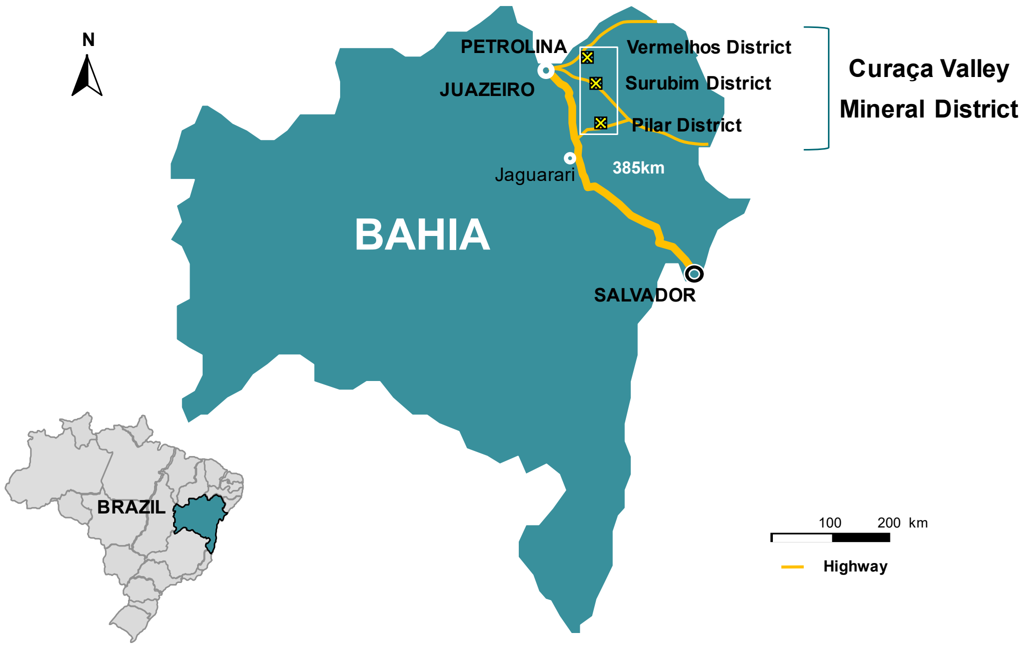


Figure 4-1: Location of the Primary Mineral Districts, MCSA Mining Complex, Bahia State, Brazil (Ero Copper, 2018)

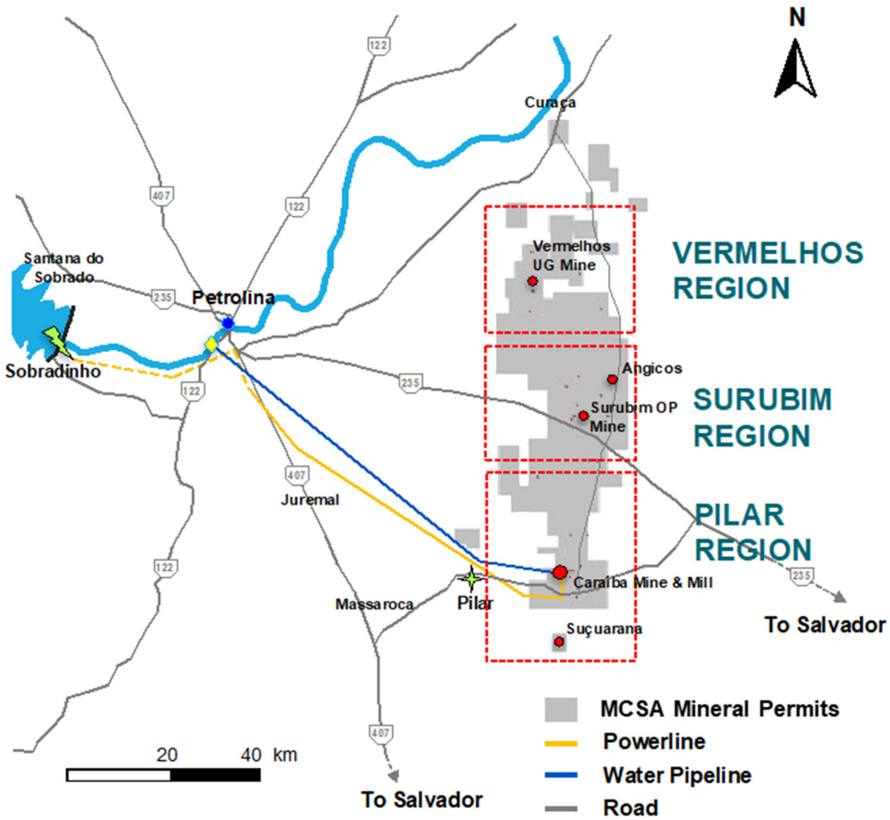


Figure 4-2: Detailed Map of MCSA Mining Complex, Curaçá Valley, Bahia State, Brazil (Ero Copper, 2018)

4.2 MINERAL TITLE IN BRAZIL

Mining legislation as it relates to mineral title in Brazil has been in place since 1967, and the last significant amendment took place in 1996. In 2017, there were changes to the institutional framework and to the statutory royalty (Compensação Financeira pela Exploração de Recursos Minerais, "CFEM") legislation. Institutionally, a new National Mining Agency (Agência Nacional de Mineração, "ANM") was created to replace the National Department for Mineral Production (Departamento Nacional de Produção Mineral, "DNPM"). As it relates to the statutory royalty, new legislation enacted in December 2017 established new rates for mineral commodities and excluded certain deductions previously allowed, such as transportation and insurance costs. The royalty on copper producers remained the same at 2% of the gross revenue from sales. These changes have been reflected in the economic projections of the assets, as more fully described in this section and captured in Chapter 22 – Economic Analysis.

In addition to the changes in legislation described above, in June 2018, the Federal Government enacted new regulations to the Mining Code. The purpose of the new regulations was to modernize parts of the previous legislation that do not require legislative action (i.e. no amendments to the Mining Code are required). These changes do not affect the methods for granting mineral rights, nor establish investment commitments per license, but rather seek to ease the transition process from Exploration to Mining Licenses in as much as the Mining Code allows, particularly as it relates to supplementary work performed after the submission of a final exploration report. As of the date of this Report, the authors do not anticipate any significant change in Brazil's mining legislation that would adversely impact the operations of the Company.

4.3 MINING LEGISLATION, ADMINISTRATION, AND RIGHTS

The primary mining legislations in Brazil are the 1988 Federal Constitution and the 1967 Federal Mining Code (Decree-law No. 227), as amended over time. Minerals on the ground are a property of the Federal Government, and, therefore, mining legislation can only be enacted at the federal level. The ANM is the federal agency entitled to manage, regulate and supervise mining activities in Brazil, along with the Ministry of Mines and Energy ("MME"). By definition, exploration rights are granted by the ANM and, in most of the cases, mining concessions are granted by the MME.

Landowners and governments (municipal, state and federal) are entitled to a royalty. The CFEM rate varies from 1% to 3.5%, depending on the commodity. If any minerals are extracted from private lands that are not owned by the titleholder, the landowner is entitled to a royalty equal to 50% of the statutory CFEM royalty. Mining activities are subject to both federal and state level environmental licensing. MCSA's operations for copper (in the Curaçá Valley) are subject to a 2% royalty on gross concentrate sales net of taxes levied on sales.

Exploration license holders are entitled to access their license area and work on it whether it is public or privately held, but such holders must compensate the owner of the surface rights for losses caused by the work and for the occupation of the land (typically in the form of rent). Compensation may be negotiated on a case-by-case basis, but the Mining Code provides that, should a court of law be required to set the amounts, the rent for occupation of the land cannot exceed the maximum net income that the owner would earn from its agricultural-pasture activity in the area of the property to be explored, and the losses caused by the work cannot exceed the assessed value of the area of the property intended for exploration.

In response to the Brumadinho disaster, new regulations and laws regarding the design, operation and monitoring of tailings dams in Brazil were passed. Specifically, on October 1, 2020. Law No 14,066/2020, which amended the National Dam Safety Policy, was enacted. As at the date of this Report, the Company continues to work with the ANM and state agencies to evaluate any potential operational changes and or additional monitoring or reporting requirements for its tailings facilities that may be required. The authors of this Report have reviewed the new legislation requirements, and have not identified any material risk factors associated with compliance within the new legislation nor any potential adverse impact on the Company's ability to extract the current mineral reserves.

4.4 EXPLORATION LICENSES

Exploration licenses are granted for up to three-year periods and may be renewed for another three years on the approval of an ANM inspection and satisfaction of certain environmental requirements. The size of an individual license area ranges from 50 ha to 10,000 ha depending on the state and the commodity.

4.5 ANNUAL FEES AND REPORTING REQUIREMENTS

Annual license fees for Exploration Licenses are based on size and are calculated at R$3.55/ha for the first license term and R$5.33/ha in subsequent terms. Each license holder must submit an exploration plan, budget and timeline, although there is no work or expenditure requirement. Licenses require an interim report two-months prior to license expiration (if an extension is to be applied for), describing exploration results, interpretation and expenditures. The renewal of a license may be granted at the discretion of the ANM considering the exploration works undertaken by the holder. A final report is due at the end the term or on relinquishment of the license.

4.6 MINERAL TITLES

Mining rights in Brazil are governed by the Mining Code Decree Number 227, dated February 27, 1967 and via subsequent rules and amendments enacted by the ANM. As of the Effective Date, MCSA holds, has applications in process, or has negotiated with third-parties for 117 mineral rights in the Bahia State, shown by type in the table below and graphically in Figure 4-3.

Table 4-1: MCSA Mining Rights Within the Curaçá Valley

Permit Holder	Mineral Permit Type	Permits-Licenses Held	Hectares (ha)
Mineração Caraíba S.A.	Exploration*	110	160,111.81
	Mining	6	3,299.61
	Mining Application	1	966.27
Total		**117**	**164,377.69**

*includes Exploration permits under application and agreements with third-parties in place as of the Effective Date

There are no time constraints provisioned with the mining concessions; however, operating permits and licenses are extended and renewed in normal course of business according to the nature of each permit and requirements therein. MCSA has all necessary licenses, permits, surface ownership and right of way where appropriate in place to conduct its current operations.

The table below shows the overall status, as of the Effective Date, of the Mining Permits and Mining Application Permit in which the Caraíba Mine, R22W Mine, Surubim OP Mine, Vermelhos UG Mine, Angicos Mine and the Suçuarana Mine are located.

Table 4-2: Status of MCSA Mining Permits in the Curaçá Valley

ANM Issue ID	Permit Status	Holder	MCSA Project
000737/1940	MiningPermit	Mineração Caraíba S.A.	Caraíba Mine
000619/1964	Mining Permit	Mineração Caraíba S.A	Surubim OP Mine
812998/1973	Mining Permit	Mineração Caraíba S.A	R22W Mine
870347/1984	Mining Permit	Mineração Caraíba S.A	Vermelhos UG Mine
873648/2006	Mining Permit	Mineração Caraíba S.A	Angicos Mine
871263/2011	Mining Permit	Mineração Caraíba S.A	Suçuarana Mine

See Appendix E to the Report for a complete list of Mineral Permits.

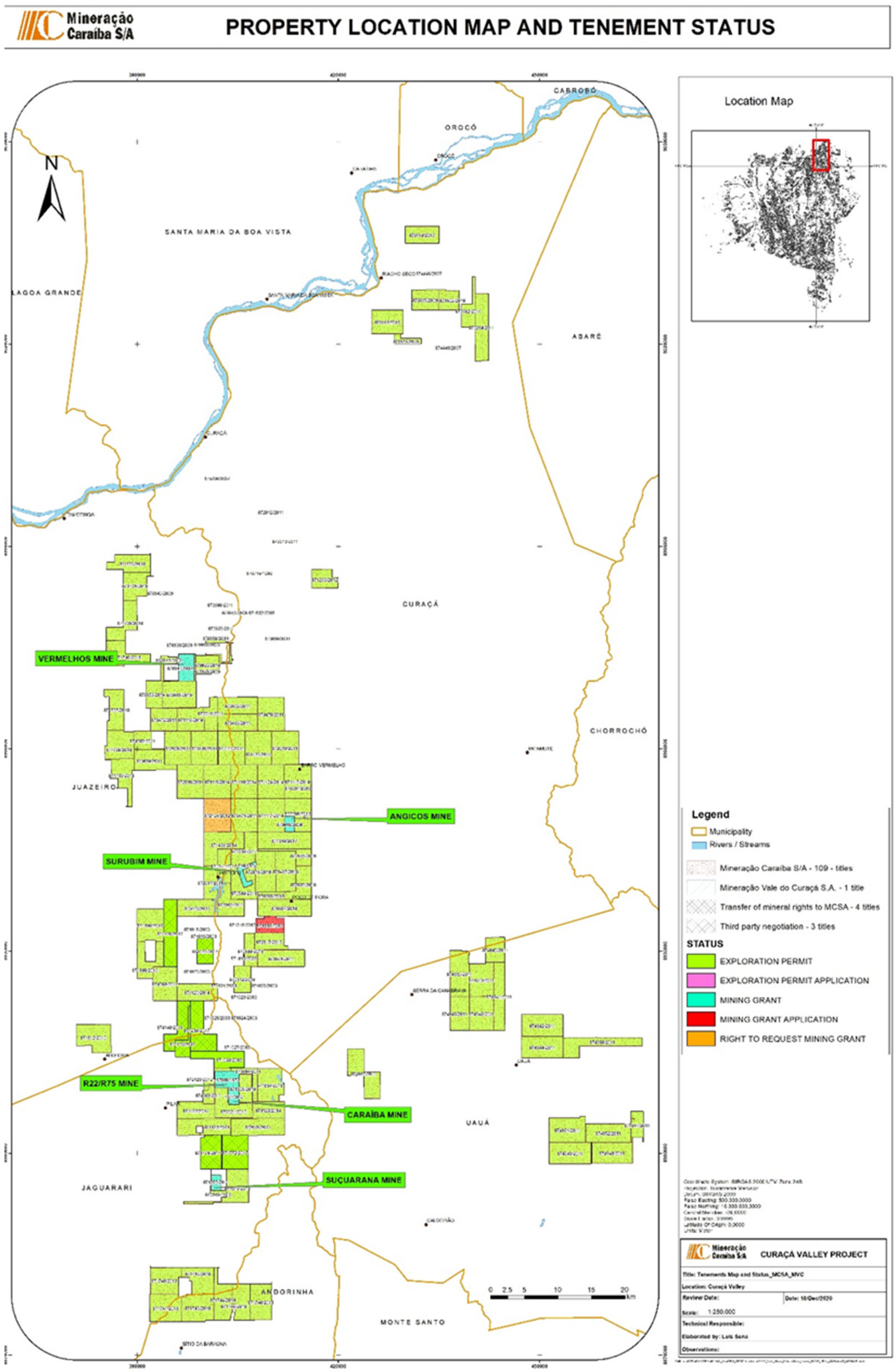


Figure 4-3: Location of the MCSA Mining & Exploration Rights in the Curaçá Valley (MCSA, 2020)

*Mineração Vale do Curaçá S.A. was a former subsidiary of MCSA and merged into MCSA in or about 2013.

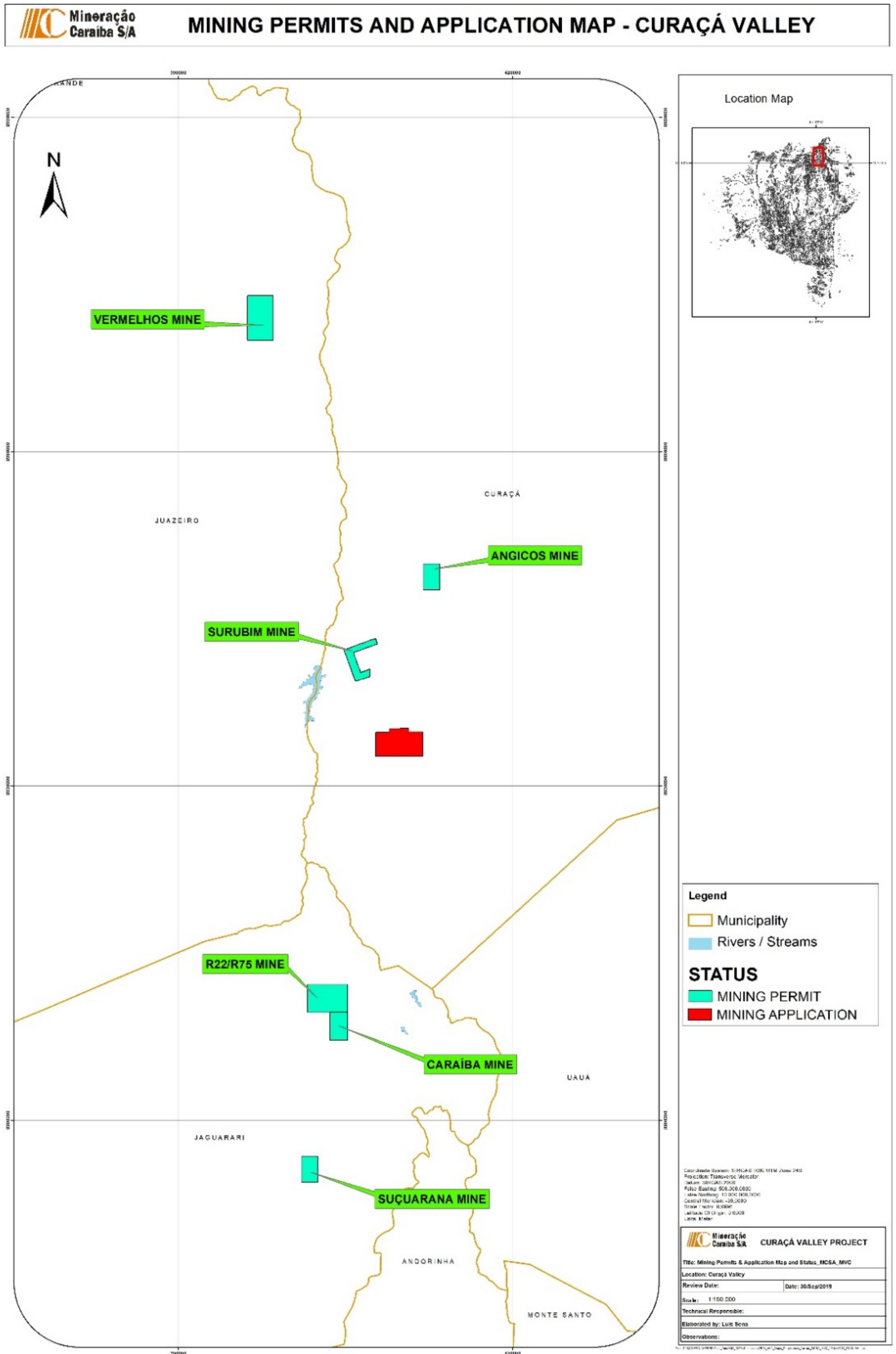


Figure 4-4: Status of the Mining Rights Related to the Vermelhos UG Mine, Surubim Mine, Angicos Mine, R22/R75 Mine, Caraíba Mine and the Suçuarana Mine (MCSA, 2020)

5 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 ACCESSIBILITY

MCSA's properties are located in the Curaçá Valley in the northern part of the State of Bahia, Brazil. The closest major cities are Petrolina, located in the State of Pernambuco on the northern side of the São Francisco River, and Juazeiro, in the State of Bahia located on the southern side of the river. The combined population of the two cities is approximately 500,000 people. The Caraíba Mine can be accessed from Petrolina or Juazeiro via BR407 south for 80km to the village of Barrinha. From Barrinha, east on BA314 for 45km and the mine access road intersects BA314. Both BR407 and BA314 are paved roads. Mine employees live in the town of Pilar (population of approximately 10,000) located approximately 15km from the mine entrance. Daily bus service transports MCSA employees from Pilar to the Caraíba Mine main gate.

The Surubim OP Mine can be accessed from the Caraíba Mine via BA314 east 34km to the intersection with BR235, an unpaved road. From this intersection, the Surubim OP Mine is 33km northwest along BR235, immediately beyond the village of Poço de Fora.

The Vermelhos UG Mine property lies approximately 83km north-northwest of the Caraíba Mine and can be accessed from Petrolina or Juazeiro by following BR407 15km to the intersection with BR235. BR235 intersects the Curaçá Valley Haul Road near the Surubim OP Mine in the center of the Curaçá Valley. The Vermelhos UG Mine can be accessed by following the haul-road north for approximately 40km.

Construction of a permanent haul-road from Vermelhos UG Mine to the Surubim OP Mine occurred in late 2018 joining the previously constructed haul-road between the Caraíba Mill and the Surubim OP Mine, which was constructed prior to Ero Copper. The Curaçá Valley Haul Road facilitates transport of ore from the Vermelhos UG Mine to the Caraiba Mill and is wide enough to accommodate two-direction traffic. While the majority of the Curaçá Valley Haul Road is dirt, portions of the road located near small communities are paved, primarily for dust control. The nearest town to the Vermelhos UG Mine property is the town of Curaçá (population of approximately 30,000). Daily bus service transports MCSA employees working at the Vermelhos UG Mine from the town of Curaçá to the Vermelhos property.

5.2 PHYSIOGRAPHY

The Curaçá Valley can be characterized as a plain featuring scattered elongated ridges, isolated rock outcrops and inselbergs. The elevation ranges from 400m to 600m above mean sea level. The presence of inselbergs is indicative of an advanced erosional cycle, developed under arid to semi-arid conditions. The inselbergs within the Curaçá Valley have peak elevations of up to 600m, approximately 100m to 200m above the valley floor.

Drainage is from south to north by the Curaçá River, a tributary of the São Francisco River. Two important tributaries of the Curaçá River are the Esfomeado and Vaca Creeks, which drain the west side of the valley. The drainage pattern is reticular and largely fault controlled.

5.3 CLIMATE

The region is classified as arid to semiarid, or BSh per the Köppen climate classification system. Within the mining and development properties, temperatures range from a low of 20°C in the winter months to a high of 40°C in the summer months. Summer average temperatures are 29°C while winter averages are 23°C. Annual rainfall is erratic and has a range of 100 to 900 millimetres ("mm"). On average, total annual rainfall is less than 700mm. Most precipitation occurs during the rainy season, December to March, in isolated high rainfall events associated with thunderstorm activity. The limited seasonal rainfall and temperate climate permit a year-around operating season for all activities of the Company including but not limited to mining, processing, transportation of ore on the Curaçá Valley Haul Road, shipments of final concentrate and all ongoing exploration programs.

5.4 VEGETATION

Northeastern Bahia is called the Sertão and can be characterized as having Caatinga-type vegetation, of low thorny plants and bushes adapted to the extreme arid climate. Predominant plants in the mining and development areas include cacti such as the mandacarú and xique-xique, as well as baraúna and umburana trees and bromeliads. The Curaçá Valley Caatinga vegetation ranges from shrubby, sparsely vegetated type to rocky, savanna type and typically ranges from 10% to 60% cover with lesser coverage typically associated in areas of goat farming activity.

5.5 INFRASTRUCTURE AND LOCAL RESOURCES

Except for a short period in 2016, the Caraíba Mine has been in continuous operation since 1979 and has all of the necessary infrastructure and skilled mine and processing personnel for continued operation.

During construction of the Caraíba Mine, the town of Pilar was constructed to house mine employees and to provide logistical support for mining activities. Initially, Pilar consisted of approximately 1,800 houses with fresh water supply, electrical power, and a sewage system. Today, Pilar has a population of approximately 10,000 people providing support for MCSA and its personnel in the form of outsourced labor and small local businesses. This district also has banks, a hospital and a health center, schools, a post office, a town hall and recreational facilities including clubs and sports stadiums. All of the streets are paved and the district has a reliable phone system. Daily bus service takes MCSA employees from the center of Pilar to the Caraíba Mine main entrance.

The main water supply for Pilar and the Caraíba Mine is brought from the São Francisco River via an 86 km pipeline that was constructed by and is owned and maintained by MCSA. Electrical power is obtained from CHESF via a 13.8 kV substation connected to a 230 kV power transmission line.

In the Brazilian northeast, MCSA is the largest primary copper mining company. Throughout its operating history, a robust social and logistics infrastructure framework has been developed, sufficient to supply all of the industrial and labor needs related to the production of copper from the MCSA Mining Complex.

6 HISTORY

The first documented occurrence of copper in the Curaçá Valley was located at Serra da Borracha, Curaçá County in 1782. Samples were taken to Salvador for tests and were reported to contain "pure" copper. The information about the discovery was delivered to the Portuguese Crown in Lisbon. The then governor of Bahia authorized a company to exploit copper, but the company never began commercial production of copper. It would be another 180 years before a formal exploration program occurred on the property.

In 1874, engineer A. M. de Oliveira Bulhões reported copper occurrences in the vicinity of the Caraíba Mine in a series of documented accounts. Mr. Bulhões made this observation while he was working for the São Francisco Railroad and wrote "copper exists in abundance and in many places the mineral can be seen on top of the soil". No formal copper exploration was completed on the property.

In 1915, the International Ore Corporation and the then landowner of the Caraíba Mine property signed a purchase option contract. No further work was done under the terms of the contract and very little exploration activity occurred beyond a preliminary test pit in 1915 and a surface sample program in 1938.

In 1962, the DNPM conducted a regional exploration program in the Curaçá Valley and made a preliminary resource estimate based on that work. Mineral permits were obtained by the Pignatari Group in 1966 and the first feasibility studies were completed on the project in 1969 by Mr. Francisco Pignatari. In 1974, the investment branch of the Brazilian National Economic and Social Development Bank ("BNDESPAR") took control of the property, and between 1974 and 1978, the property was developed by the Brazilian State-owned company Caraíba Metais S.A. Exploration work in support of the design and development of the mine was performed by Companhia Vale do Rio Doce ("CVRD"). The Caraíba Mine began commercial production in 1979. In addition to construction of mine and processing facilities, a smelter was constructed for refining copper concentrate into copper metal. Underground operations started in 1986 at the Pilar UG Mine and were conducted concurrently with open pit operations. The original open pit mine was depleted in 1998, but underground mining continued and is still in operation today.

In 1988, the smelting and mining operations were split into two separate business units to simplify privatization. The smelting unit was privatized under the name Caraíba Metais S.A. and was later sold to Eluma S.A. Industria e Comercio ("Eluma"), a part of the Paranapanema Group in 1992. The mining and processing units remained State owned and operated under the name MCSA until 1994, when MCSA was placed in the National Privatization Program and later sold to Eluma as well.

Between 1997 and 2004, under new ownership, MCSA did not invest in new acquisitions or expansions. Beginning in 2004, MCSA began a modest expansion and exploration effort within the Curaçá Valley. This resulted in the transfer of R22W Mine to MCSA in 2005 from DOCEGEO, the exploration division of CVRD, and the formation of the Codelco JV joint venture in 2004 for further exploration of known copper occurrences within Curaçá Valley. In February 2008, Codelco withdrew from the joint venture and received payment of R$5.6 million from MCSA. In 2012, Swiss-based Glencore International acquired a 28.5% equity interest in MCSA.

In December 2016, Ero Copper acquired approximately 85.0% interest in MCSA. In June 2017, Ero acquired an additional 14.5% by way of capital increase, for a total interest in MCSA of approximately 99.5%. In December 2017, the Company acquired additional shares of MCSA, increasing its ownership interest in MCSA to 99.6%.

Ero Copper commenced trading on the Toronto Stock Exchange under the stock symbol "ERO" on October 19, 2017 following completion of the Company's initial public offering.

Historic mineral resource and reserve estimates are further detailed in subsequent sections for reference purposes only. Ero Copper is not treating any of the historic estimates as current mineral resources or mineral reserves.

6.1 HISTORIC MINERAL RESOURCE AND RESERVE ESTIMATES

6.1.1 2017 Mineral Resource and Reserve Estimate

Throughout MCSA's operating history, many internal and third-party technical reports have been prepared for mine planning, development and estimation purposes. In 2017 Ero Copper released a mineral resources and mineral reserves estimate for the mineral deposits of the Curaçá Valley in a report titled "2017 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated September 7, 2017 with an effective date of June 1, 2017, prepared by Rubens José de Mendonça, MAusIMM, of SRK Consultores do Brasil Ltda. ("SRK" or "SRK Brazil") as at the date of the report (now of Planminas – Projetos e Consultoria em Mineração Ltda. ("Planminas")), and Porfirio Cabaleiro Rodrigues, MAIG, Mário Conrado Reinhardt, MAIG, Fábio Valério Xavier, MAIG, and Bernardo H.C. Viana, MAIG, all of GE21 (the "2017 Technical Report"). Each of Rubens José de Mendonça, MAusIMM, Porfirio Cabaleiro Rodrigues, MAIG, Mário Conrado Reinhardt, MAIG, Fábio Valério Xavier, MAIG, and Bernardo H.C. Viana, MAIG, were a "qualified person" and "independent" of the Company within the meanings of NI 43-101.

SRK carried out the appropriate review to satisfy that the mineral reserve could be technically and profitably extracted through to the production of copper concentrate. Consideration was given to all technical areas of the operations, the associated capital and operating costs, and relevant factors including marketing, permitting, environmental, land use and social factors. SRK was satisfied that the technical and economic feasibility had been demonstrated.

The detailed economic, geotechnical and engineering parameters used for the mineral reserves estimates are described in detail in the 2017 Technical Report. The 2017 historical mineral resource and mineral reserve estimate has been provided for reference purposes only. Ero Copper is not treating this 2017 estimate as current mineral resources or mineral reserves.

Table 6-1: 2017 Mineral Resource Estimate

District / Mine	Resource Classification	Tonnes (kt)	Cu (%)	Contained Cu (kt)
Pilar UG Mine	Measured	10,778	1.52	163.4
	Indicated	6,452	2.67	172.5
	Measured & Indicated	**17,230**	**1.95**	**335.9**
	Inferred	1,514	2.45	37.2
R22W Mine	Measured	306	0.54	1.7
	Indicated	2	0.79	0.0
	Measured & Indicated	**308**	**0.54**	**1.7**
	Inferred	-	-	-
Vermelhos UG Mine	Measured	1,341	6.91	92.7
	Indicated	1,201	2.40	28.8
	Measured & Indicated	**2,541**	**4.78**	**121.5**
	Inferred	2,189	1.52	33.3
Surubim OP Mine (Oxides)	Measured	-	-	-
	Indicated	6	0.35	0.02
	Measured & Indicated	**6**	**0.35**	**0.02**
	Inferred	1	0.34	0.0
	Measured	18	0.53	0.1

Surubim OP Mine (Sulphides)	Indicated	394	0.89	3.5
	Measured & Indicated	**411**	**0.88**	**3.6**
	Inferred	79	1.02	0.8

1. Effective date of March 31, 2017.
2. Presented mineral resources inclusive of mineral reserves. All figures have been rounded to reflect accuracy of the estimates. Summed amounts may not add due to rounding.
3. Cut-off grade of 0.68% copper for underground resources and 0.18% copper for open pit resources based on 2015 operating costs (the last full year of operation prior to the 2017 Technical Report)
4. Resources estimated by ordinary kriging inside varying block sizes by deposit.

Mineral resources which are not mineral reserves do not have a demonstrated economic viability.

Table 6-2: 2017 Mineral Reserve Estimate

Mine	Category	Tonnes (kt)	Cu (%)	Contained Cu (kt)
Pilar UG Mine	Proven	2,841	1.47	41.8
	Probable	3,350	2.28	76.3
	Proven & Probable	**6,191**	**1.91**	**118.1**
Vermelhos UG Mine	Proven	1,743	4.84	84.4
	Probable	676	2.37	16.0
	Proven & Probable	**2,418**	**4.15**	**100.4**
Surubim OP Mine	Proven	11	0.51	0.1
	Probable	248	0.80	2.0
	Proven & Probable	**259**	**0.79**	**2.1**
TOTAL	**Proven**	**4,595**	**2.75**	**126.3**
	Probable	**4,274**	**2.21**	**94.3**
	Proven & Probable	**8,868**	**2.49**	**220.5**

1. Effective Date of June 1, 2017.
2. Mineral reserves included within stated mineral resources. All figures have been rounded to reflect the relative accuracy of the estimates. Summed amounts may not add due to rounding.
3. The mineral reserve estimates are prepared in accordance with the CIM Definition Standards, and the CIM Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate for the deposit. Mineral reserves are based on a long-term copper price of US$2.75 per lb, and a USD:BRL foreign exchange rate of 3.20.
4. Mineral reserves are the economic portion of the Measured and Indicated mineral resources. Mineral reserve estimates include mining dilution at zero grade. Mining dilution and recovery factors vary for specific mineral reserve sources and are influenced by factors such as deposit type, deposit shape, stope orientation and selected mining method.

6.1.2 2018 Mineral Resource and Reserve Estimate

In 2018, Ero Copper released an updated mineral resources and mineral reserves estimate for the mineral deposits of the Curaçá Valley in a report titled "2018 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated October 17, 2018 with an effective date of August 1, 2018, prepared by Rubens José De Mendonça, MAusIMM, of Planminas, and Porfirio Cabaleiro Rodrigues, MAIG, Fábio Valério Cãmara Xavier, MAIG, and Bernardo Horta de Cerqueira Viana, MAIG, all of GE21 (the "2018 Technical Report"). Each of Rubens José De Mendonça, MAusIMM, Porfirio Cabaleiro Rodrigues, MAIG, Fábio Valério Cãmara

Xavier, MAIG, and Bernardo Horta de Cerqueira Viana, MAIG was a "qualified person" and "independent" of the Company within the meanings of NI 43-101.

The detailed economic, geotechnical and engineering parameters used for the mineral reserves estimates are described in detail in the 2018 Technical Report. The 2018 historical mineral resource and mineral reserve estimate has been provided for reference purposes only. Ero Copper is not treating this 2018 estimate as current mineral resources or mineral reserves.

Table 6-3: 2018 Mineral Resource Estimate

Mineral Resources	Category	Tonnage (000 tonnes)	Grade (Cu %)	Contained Cu (000 tonnes)
Pilar UG Mine	Measured	15,595	1.92	300.2
	Indicated	9,254	1.85	171.5
	Measured & Indicated	**24,849**	**1.90**	**471.6**
	Inferred	1,761	2.07	36.4
Vermelhos UG Mine	Measured	3,039	4.12	125.1
	Indicated	1,523	1.97	30.1
	Measured & Indicated	**4,562**	**3.40**	**155.2**
	Inferred	1,995	1.19	23.6
Vermelhos West OP	Measured	5,502	0.60	33.0
	Indicated	2,645	0.60	15.9
	Measured & Indicated	**8,147**	**0.60**	**48.9**
	Inferred	2,490	0.83	20.7
Surubim Mine	Measured	4,064	1.03	41.9
	Indicated	497	1.03	5.1
	Measured & Indicated	**4,561**	**1.03**	**47.0**
	Inferred	83	0.85	0.7
R22W OP	Measured	306	0.54	1.7
	Indicated	2	0.79	0.0
	Measured & Indicated	**308**	**0.54**	**1.7**
	Inferred	-	-	-
Total Resources	Measured	**28,506**	**1.76**	**501.8**
	Indicated	**13,921**	**1.60**	**222.6**
	Measured & Indicated	**42,428**	**1.71**	**724.4**
	Inferred	**6,328**	**1.29**	**81.4**

1. Mineral resource effective date of July 1, 2018 for the Pilar UG and Surubim Mines, and May 31, 2018 for the Vermelhos UG Mine, Vermelhos West OP and R22W OP.
2. Presented mineral resources inclusive of mineral reserves. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
3. Mineral resource copper cut-off grades of 0.68% copper for underground mineral resources and 0.18% for open pit mineral resources. Mineral resources have been estimated using ordinary kriging inside 5m by 5m by 5m block sizes. The mineral resource estimates were prepared in accordance with CIM Standards and CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate to the deposit.

Mineral resources which are not mineral reserves do not have a demonstrated economic viability.

Table 6-4: 2018 Mineral Reserve Estimate

Mineral Reserves	Category	Tonnage (000 tonnes)	Grade (Cu %)	Contained Cu (000 tonnes)
Pilar UG Mine	Proven	6,969	1.71	119.3
	Probable	3,998	1.74	69.4
Vermelhos UG Mine	Proven	3,394	3.30	112.1
	Probable	528	2.36	12.5
Vermelhos West OP	Proven	815	0.70	5.7
	Probable	269	0.69	1.9
Surubim Mine	Proven	2,130	0.95	20.2
	Probable	3	0.80	0.0
R22W OP	Proven	283	0.53	1.5
	Probable	47	0.46	0.2
	Proven	**13,591**	**1.90**	**258.8**
Total	**Probable**	**4,846**	**1.73**	**84.0**
	Proven & Probable	**18,437**	**1.86**	**342.8**

1. Mineral reserve effective date of August 1, 2018.
2. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
3. Mineral reserve estimates were prepared in accordance with the CIM Standards and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate for the deposit.
4. Mineral reserves are based on a long-term copper price of US$2.75 per lb, and a USD:BRL foreign exchange rate of 3.20. Mineral reserves are the economic portion of the Measured and Indicated mineral resources. Inferred mineral resources, where unavoidably included within a defined mining shape, have been included in the mineral reserves estimate at zero grade.
5. Mineral reserve estimates include mining dilution at zero grade.
6. Mining dilution and recovery factors vary for specific mineral reserve sources and are influenced by factors such as deposit type, deposit shape, stope orientation and selected mining method.

6.1.3 2019 Mineral Resource and Reserve Estimate

In 2019, Ero Copper released an updated mineral resources and mineral reserves estimate for the mineral deposits of the Curaçá Valley in a report titled "2019 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated November 25, 2019 with an effective date of September 18, 2019, prepared by Rubens José De Mendonça, MAusIMM, of Planminas, Porfirio Cabaleiro Rodrigues, MAIG, Leonardo de Moraes Soares, MAIG, and Bernardo Horta de Cerqueira Viana, MAIG, all of GE21 (the "2019 Technical Report"). Each of Rubens José De Mendonça, MAusIMM, Porfirio Cabaleiro Rodrigues, MAIG, Leonardo de Moraes Soares, MAIG, and Bernardo Horta de Cerqueira Viana, MAIG was a "qualified person" and "independent" of the Company within the meanings of NI 43-101.

The detailed economic, geotechnical and engineering parameters used for the Mineral Reserves estimates are described in detail in the 2019 Technical Report. The 2019 historical mineral resource and mineral reserve estimate has been provided for reference purposes only. Ero Copper is not treating this 2019 estimate as current mineral resources or mineral reserves.

Table 6-5: 2019 Mineral Resource Estimate

Mineral Resources	Category	Tonnage (000 tonnes)	Grade (Cu %)	Contained Cu (000 tonnes)
Pilar District, Underground	Measured	19,155	1.83	351
	Indicated	14,260	1.36	194
	Measured & Indicated	**33,414**	**1.63**	**546**
	Inferred	7,456	1.17	87
Vermelhos District, Underground	Measured	3,513	3.25	114
	Indicated	2,875	1.22	35
	Measured & Indicated	**6,388**	**2.33**	**149**
	Inferred	9,122	0.90	83
Surubim District, Underground	Measured	2,809	1.03	29
	Indicated	2,104	0.92	19
	Measured & Indicated	**4,913**	**0.98**	**48**
	Inferred	5,501	0.89	49
Total Resources, Underground	Measured	25,476	1.94	494
	Indicated	19,239	1.29	249
	Measured & Indicated	**44,715**	**1.66**	**743**
	Inferred	22,079	0.99	219
Pilar District, Open Pit	Measured	2,841	0.49	14
	Indicated	462	0.44	2
	Measured & Indicated	**3,303**	**0.48**	**16**
	Inferred	1,276	0.45	6
Vermelhos District, Open Pit	Measured	4,464	0.63	29
	Indicated	14,521	0.62	72
	Measured & Indicated	**18,985**	**0.53**	**101**
	Inferred	1,397	0.72	10
Surubim District, Open Pit	Measured	2,217	0.80	18
	Indicated	2,2401	0.68	16
	Measured & Indicated	**4,618**	**0.74**	**34**
	Inferred	1,452	0.49	7
Total Resources, Open Pit	Measured	9,522	0.64	61
	Indicated	17,384	0.52	91
	Measured & Indicated	**26,907**	**0.56**	**151**
	Inferred	4,125	0.56	23

1. Mineral resource effective date varies by deposit, with an effective date of July 9, 2019, except for Vermelhos N8/N9 (July 31, 2019) and Baraúna and Siriema (September 15, 2019).
2. Presented mineral resources inclusive of mineral reserves. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding. Mineral resources which are not mineral reserves do not have demonstrated economic viability.
3. Mineral resources have been modeled within a 0.20% copper grade shell using a 0.68% copper cut-off grade for underground deposits and a 0.18% copper cut-off grade for open pit deposits. Mineral resources have been estimated using ordinary kriging inside 5m by 5m by 5m block sizes. The mineral resource estimates were prepared in accordance with the CIM Standards and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate to the deposit.

Table 6-6: 2019 Mineral Reserve Estimate

Mineral Reserves	Category	Tonnage (000 tonnes)	Grade (Cu %)	Contained Cu (000 tonnes)
Pilar District, Underground	Proven	6,339	1.54	98
	Probable	7,678	1.37	105
Vermelhos District, Underground	Proven	3,787	2.57	97
	Probable	1,269	1.24	16
Surubim District, Underground	Proven	1,875	0.91	17
	Probable	269	0.93	2
Total, Underground	**Proven**	**12,001**	**1.77**	**212**
	Probable	**9,126**	**1.35**	**123**
	Proven & Probable	**21,127**	**1.59**	**335**
Pilar District, Open Pit	Proven	1,623	0.42	7
	Probable	328	0.46	2
Vermelhos District, Open Pit	Proven	3,992	0.67	27
	Probable	9,558	0.56	53
Surubim District, Open Pit	Proven	798	1.03	8
	Probable	548	0.81	4
Total, Open Pit	**Proven**	**6,408**	**0.65**	**42**
	Probable	**10,434**	**0.57**	**59**
	Proven & Probable	**16,843**	**0.60**	**101**

1. Mineral Reserve effective date of September 18, 2019.
2. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
3. Mineral Reserve estimates were prepared in accordance with the CIM Standards and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate for the deposit.
4. Mineral Reserves are based on a long-term copper price of US$2.75 per lb, and a USD:BRL foreign exchange rate of 3.70. Mineral reserves are the economic portion of the Measured and Indicated mineral resources. Inferred mineral resources, where unavoidably included within a defined mining shape, have been included in the mineral reserves estimate at zero grade.
5. Mineral reserve estimates include mining dilution at zero grade.
6. Mining dilution and recovery factors vary for specific mineral reserve sources and are influenced by factors such as deposit type, deposit shape, stope orientation and selected mining method.

7 GEOLOGICAL SETTING AND MINERALIZATION

7.1 REGIONAL GEOLOGY

The MCSA Mining Complex's active mining and development projects are within the Curaçá Valley mafic-ultramafic complex, located within the Curaçá high-grade metamorphic gneissic terrain, a part of the Salvador-Curaçá orogen, a northern extension of the Atlantic Coast Granulite Belt in the São Francisco Craton. The São Francisco Craton is made up of four Archean to Paleoproterozoic crustal segments ranging in age from 3.4 billion years ("Ga") in the western Gavião block of tonalite-trondhjemite-granodiorites ("TTG's"), to 3.0 Ga in the Jequié and Serrinha blocks comprising orthogneiss and migmatites and rift-related volcanic and sedimentary rocks dated between 2.5 to 2.1 Ga. The Itabuna-Salvador-Curaçá belt is characterized by deformed TTG's dated at 2.6 Ga (figure below). A suite of low-K calc-alkaline plutonic rocks intruded the Itabuna–Salvador–Curaçá belt and extends from southeast Bahia through Salvador along the Atlantic coast and then inland to northeast Bahia. The Proterozoic Transamazonian orogenesis occurred at approximately 2.0 Ga when the four crustal segments that make up the São Francisco Craton collided, resulting in mountain building and a regional metamorphic event (Barbosa and Sabatí, 2004).

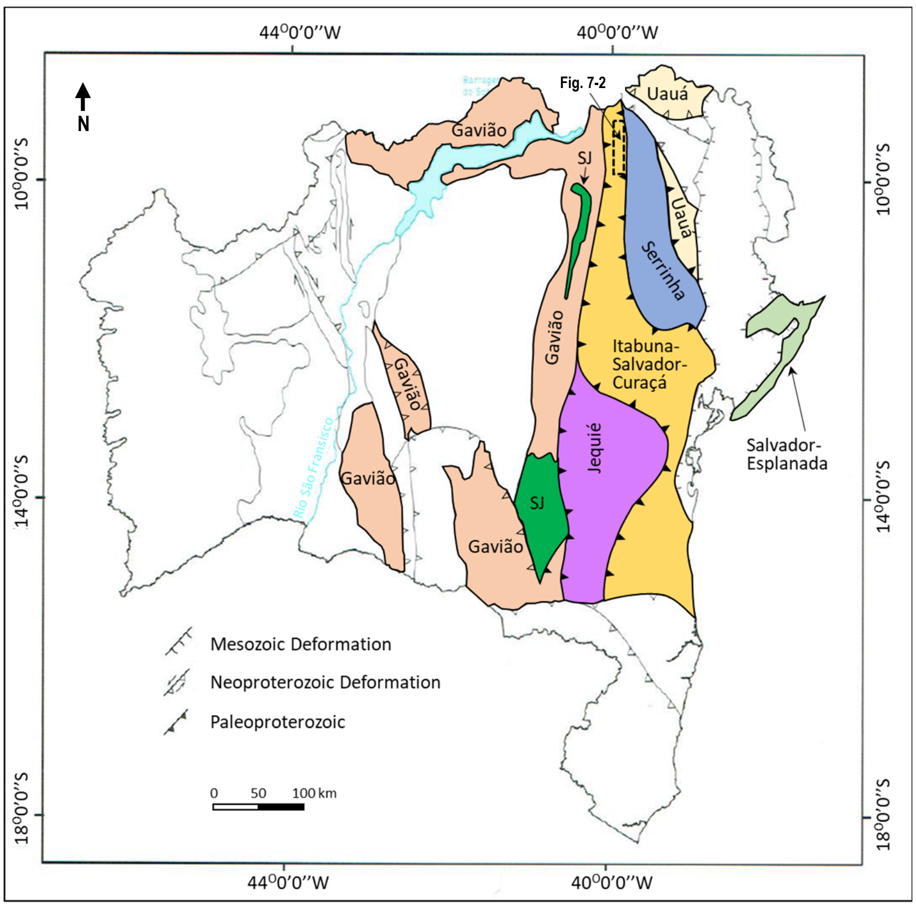


Figure 7-1: Simplified map showing the Archean to Paleoproterozoic Gaviao, Serrinha, Jequié and Itubuna-Salvador-Curaça blocks. Modified from Silveira (2015). The approximate location of Figure 7-2 is also shown.

The Curaçá high-grade gneiss terrain hosts copper-bearing mafic-ultramafic rocks that were intruded into a deformed supracrustal sequence now represented by granulite facies tonalite, granodiorite and banded gneiss (Caraíba Gneiss), by banded gneisses (Surubim Gneiss), by graphite gneiss, possible iron formation, calc-silicate rocks and alumina-rich gneisses (Bom Despacho Banded Gneiss), and by biotite hornblende-bearing quartz-feldspar gneiss with minor amphibolites and quartzites (Arapuá Banded Gneiss) (Oliveira,1995, Oliveira et al., 2004). The Curaçá Valley is bordered to the East by the Itiúba syenite (Figure 7-2)

Mafic-ultramafic units occur within the charnockite and biotite gneisses as lenses or sills with thicknesses generally less than 50m. The mafic-ultramafic lenses are composed of hypersthenite (pyroxenite), norite, gabbro-norite, gabbro and rarely, anorthosite that are less than 1m thick. Extensive pyroxenite has been described within the mafic-ultramafic lenses at the Caraíba Mine and the Vermelhos UG Mine, whereas to date pyroxenite reportedly occurs as a minor part of the mafic-ultramafic lenses at the R22W Mine, Surubim OP Mine and the Angicos Mine. Biotite schist and amphibolite occur in shear zones, in contact with granite, or as isolated lenses within gneiss.

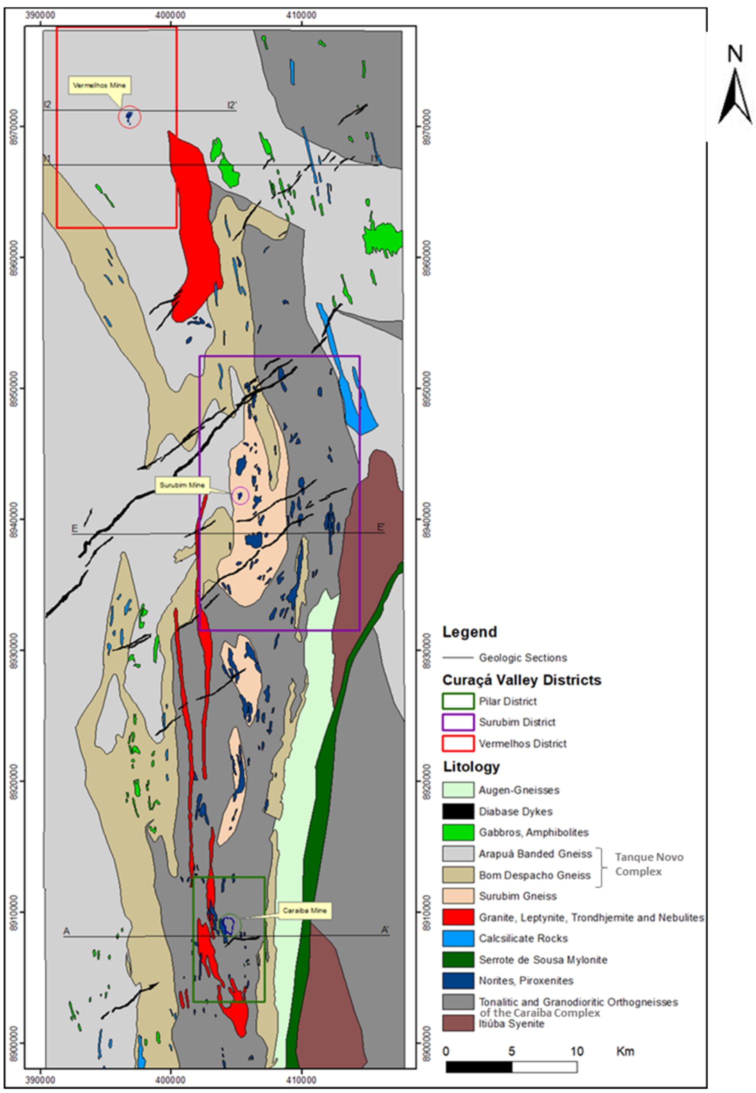


Figure 7-2: Regional geologic map of the Curaçá Valley and location of the Caraíba mine, Surubim, OP mine, Vermelhos UG mine. Note location of regional cross sections (AA', EE', I1I1' and I2I2') (prepared by Frugis 2017, modified by MCSA, 2018)

7.2 LOCAL GEOLOGY

The geology of the north portion of the Curaçá Valley is divided into two major lithological complexes namely the Tanque Novo-Ipirá Complex to the west and the Caraíba Complex to the east. Several mafic-ultramafic intrusions and paleoprotozoic granitoid bodies intrude the deformed rock units of both complex.

The Caraíba Complex is composed of orthogneisses and migmatites metamorphosed to upper amphibolite and granulite facies (Figure 7-3). More specifically, the rock units are represented by hypersthene-gneiss tonalites, hypersthene-gneiss diorites, hypersthene-gneiss trondhjemites, monzodioritic gneisses and quartz diorites (Teixeira, 1997). Geochemical studies suggest that these rocks are a product of recycled igneous crust (active continental margin) with varied levels of participation of sedimentary material (Teixeira, 1997). Igneous crystals of zircon in enderbitic orthogneiss yielded an age of 2695 Ma and an age of 2634 Ma from the charnockitic orthogneiss. Peak granulitic metamorphism is estimated at 2072 Ma (Silva et al., 1997).

Figure 7-3: Orthogneissic migmatite - Amphibolite-clinopyroxene-biotite gneiss migmatite with magnetite (Frugis, 2017)

The Tanque Novo Complex is divided into two formations, namely the Bom Despacho Formation located immediately to the west of the Caraíba Complex and the Arapuá Formation located further to the west (Figure 7-4). The Bom Despacho Formation is composed of quartz-feldspathic gneiss containing biotite-rich zones. Also common within Bom Despacho are calcsilicate-rich zones, mafic rocks (amphibolites, norites) and possible iron formation (Figure 7-5). The rock units of this Formation are crosscut by many pegmatite dikes and intruded by granitic bodies.

Figure 7-4: Bom Despacho Gneiss: Qtz-feldspathic Gneiss (Paragneiss) with intercalated sub-meter amphibolite bands and greenish calcsilicate rock (rich in diopsíde) (Frugis, 2017)

The Arapuá Formation is composed of quartz-feldspathic gneiss that is phlogopite-poor and presents rhythmic bands of amphibolite. The rock units of this formation are cut by pegmatite dikes and intruded by granitic bodies. It differs from Bom Despacho Formation by the absence of calc-silicate rocks and possible iron formation.

Figure 7-5: Arapuá Gneiss - Quartzo-feldspathic gneiss and levels of phlogopite-plagioclase-quartz gneiss with bands of amphibolite (Frugis, 2017)

The Mafic-Ultramafic bodies were intruded into the Caraíba Complex, the Surubim gneiss, as well as into the Bom Despacho and Arapuá formations. The bodies are generally elongated N-S and vary in geometry and dimension. They have been described to contain pyroxenite, norites and gabbro-norites by Teixeira et al., 2010. Some contain sulphide copper mineralization mainly in the form of chalcopyrite and bornite, local nickel mineralization in pentlandite as well as Platinum Group Element ("PGE") mineralization. Recent field and underground observations indicate that at least some norite and gabbro units are foliated and pre-date the pyroxenite intrusions (Figure 7-6). Igneous crystals of zircon in one norite unit intruded by pyroxenite, located in the northern part of the Pilar pit, yielded two main populations at 2580 ± 10 million years ("Ma") and 2103 ± 23 Ma respectively (Oliveira et al., 2004). The 2580 Ma age represents the age of the norite whereas metamorphic overgrowths on zircon result that returned a date of 2103 ± 23 Ma, interpreted to be a high-grade metamorphic event or could alternately be interpreted as the age of the pyroxenite dykes (Figure 7-6). Additional detailed mapping, geochemical characterization work, and additional age dating are needed to document the exact significance of the age dates.

The Augen Gneiss is a grey unit displaying a mylonitic (nebulitic) anastomosed fine foliation. It occurs with mafics and pockets of pegmatitic rocks with monolithic foliation and represent a late feature in the valley (Figure 7-7).

Syn to late and post-tectonic granitoids of various dimensions were intruded into the gneissic rock units (Figure 7-8) (Teixeira et al., 2010). The Itiúba Syenite is approximately 150 km in length, has a N-S orientation and is spatially associated with a NNE-striking shear zone. Zircon crystals yielded a SHRIMP U-Pb zircon age of 2084 ± 9 Ma (Oliveira et al., 2004).

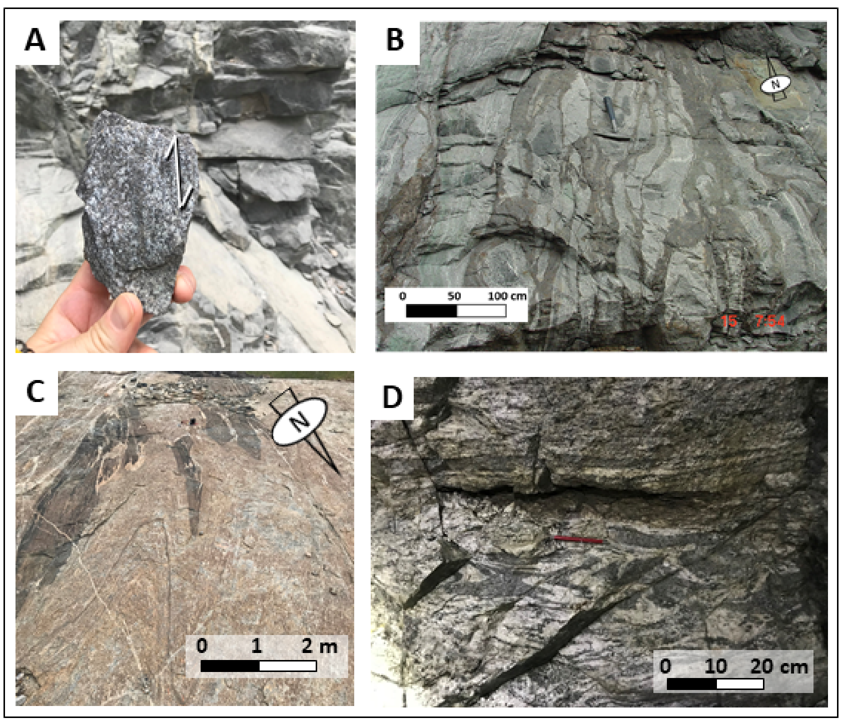


Figure 7-6: Photos of deformed norite and gabbro units, locally injected by pyroxenite dykes. A) Foliated norite in Pilar open pit, north wall, B) Pyroxenite dykes injecting foliated norite and gneiss, Pilar open pit, north wall, C) Deformed gabbro in gneiss at airport outcrop, D) deformed gabbro units in gneiss at Vermelhos mine (MCSA, 2018)

Figure 7-7: Augen Gneiss – Grey mylonític (nebulític), granitic-gneiss with finely anastomosing, monolithic foliation (Frugis, 2017)

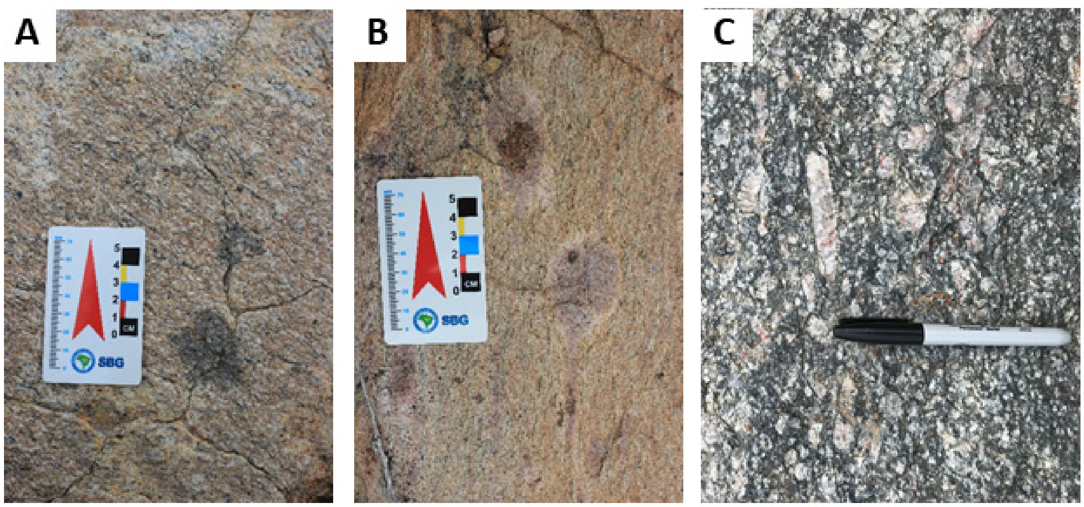


Figure 7-8: Granitoid or "Granite G3" – A) Reddish grey biotite granite containing tourmaline and B) Granite with garnet xenoliths and C) Itiúba syenite (Frugis, 2017)

7.3 REGIONAL STRUCTURE

The Cu-rich deposits are hosted within irregular-shaped intrusive bodies of pyroxenite (hypersthenite) and minor gabbro-norite that were intruded into granulite facies gneiss and migmatite at the northern margin of the São Francisco Craton. The geometry of the pyroxenite intrusions has been interpreted as either deformed sill-like bodies (Silva et al, 1996), irregular shaped intrusion into an anastomosing shear zone (Caraíba Exploration team and Frugis, 2017), or more recently as later intrusions injected into deformed gneiss (Desrochers, 2019).

The gneiss units in the valley have experienced at least 3 phases of deformation (Silva, 1984). The first phase of deformation produced a composite tectonic foliation (S_0-S_1) characterized by centimetric quartz, k-spar and plagioclase bands alternating with centimetric hornblende, plagioclase, biotite, and pyroxene bands. The S_0-S_1 foliation occurs frequently as centimetric intrafolial folds between the stronger S_2 foliation planes (Figure 7-9).

The second phase of deformation (D_2) produced a variably oriented foliation (S_2) that trends NW-SE to E-W to NE-SW with a shallow dip to the south in sectors where it is less affected by the D_3 event. It is also characterized by alternating leucocratic and melanocratic centimetric bands. A series of deformed granodiorite and tonalite are interpreted to have been intruded during the D_2 deformation event (Silva, 1984).

The third phase of deformation (D_3) produced a steep westerly dipping, northerly-striking, foliation that re-oriented the S_0-S_1 and S_2 foliation into gentle to tight folds of centimetric to kilometric scale. Locally the S_0-S_1 and S_2 foliations become parallel to the S_3 foliation. The S_3 foliation is composed quartz, plagioclase, biotite, and hornblende. The superposition of the D_2 and D_3 phases of deformation created interference pattern of the type 2 of Ramsay (1967) (Figure 7-10).

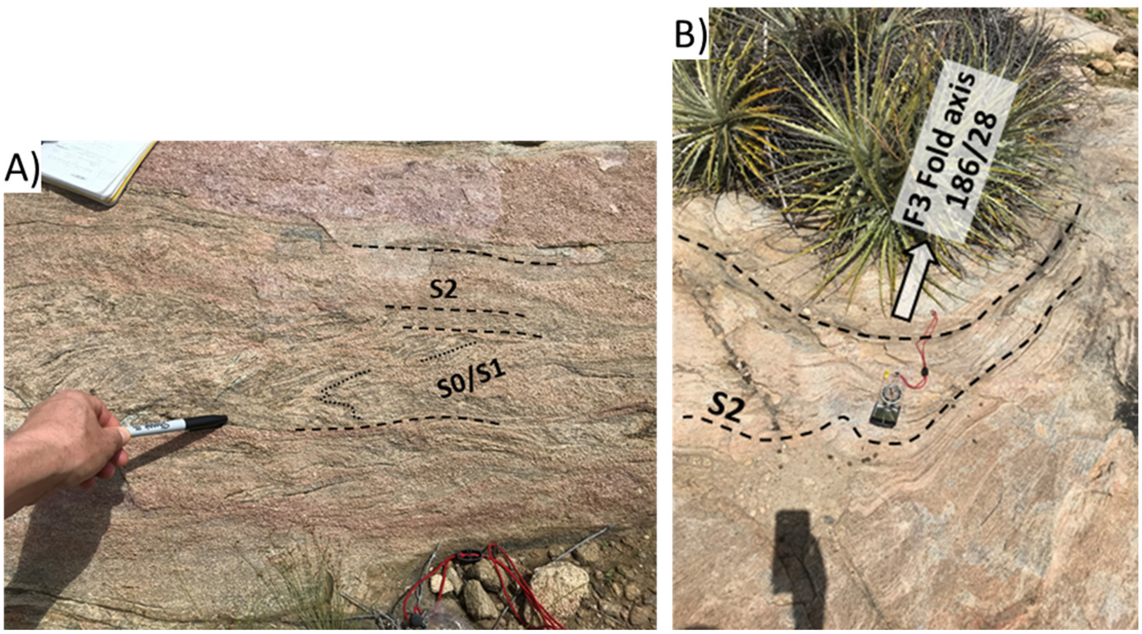


Figure 7-9: Outcrops of gneiss showing the tectonic foliations and folds. A) the composite S0-S1 foliation forms intrafolial folds between NW-striking S2 foliation planes; B) the S2 foliation is folded by F3 fold plunging gently southerly (Desrochers, 2019)

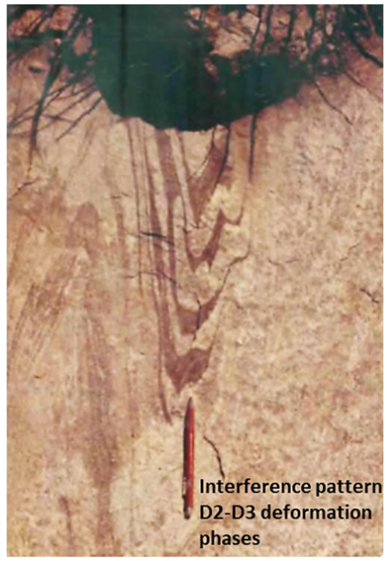


Figure 7-10: Interference pattern of type 2 (Ramsay, 1967) highlighted by the deformed mafic units. Photo from Silva (1984), airport outcrop, north of the Pilar UG Mine

Gabriela Frugis (2017) interpreted the geometry of structures in the northern portion of the Curaçá Valley as related to a transpressional flower structure characterized by west-vergent thrust faults to the west and east-verging thrusts to the east. Folds tend to be tighter with vergences to the east and to the west in the internal portions the flower structure.

According to field mapping, the predominant fabric in the region is S_3 which is associated with N-S trending D_3 axial plane folds. These folds affected D_2 folds and the S_2 fabric in a roughly orthogonal compressive system (Figure 7-11). A dextral shearing component is associated with the D_3 deformation. D_3 and associated S_3 exhibit anastomosed (directions that vary from NW-SE to the NE-SW) subvertical folding, with angles that vary from ~65 to 90 degrees plunging to the east and to the west where the steeper dips tend to concentrate in the center of the flower structure. D_2 and associated S_2 foliation is visible in the migmatitic gneiss outcrops where it occurs folded with sheared limbs that are transposed by the S_3 foliation.

D_4 is minor and causes flexures of the S_3 foliation from N-S towards NE-SW. Evidence of D_4 are visible in the north portion of the valley, near Vermelhos.

The pyroxenite units appear to be late-tectonic as they are generally not foliated, except in shear zones, and were intruded into the folded gneiss sequence after the D3 deformation phase (Figure 7-12). The shape of the intrusions appears, at least in part, to be controlled by preexisting structures.

Geologic Section AA' – Pilar District

- S_3 subvertical foliation with NNE-SSW primary direction.
- S_2 foliation with medium angles, folded, with B axis constructed oriented to the NE (axis B measured oriented NE and to the South).
- Main vergence of the folds to the west within the flower structure.
- Towards the limits of the transpressional flower, folds are more open and with vertical axial planes.

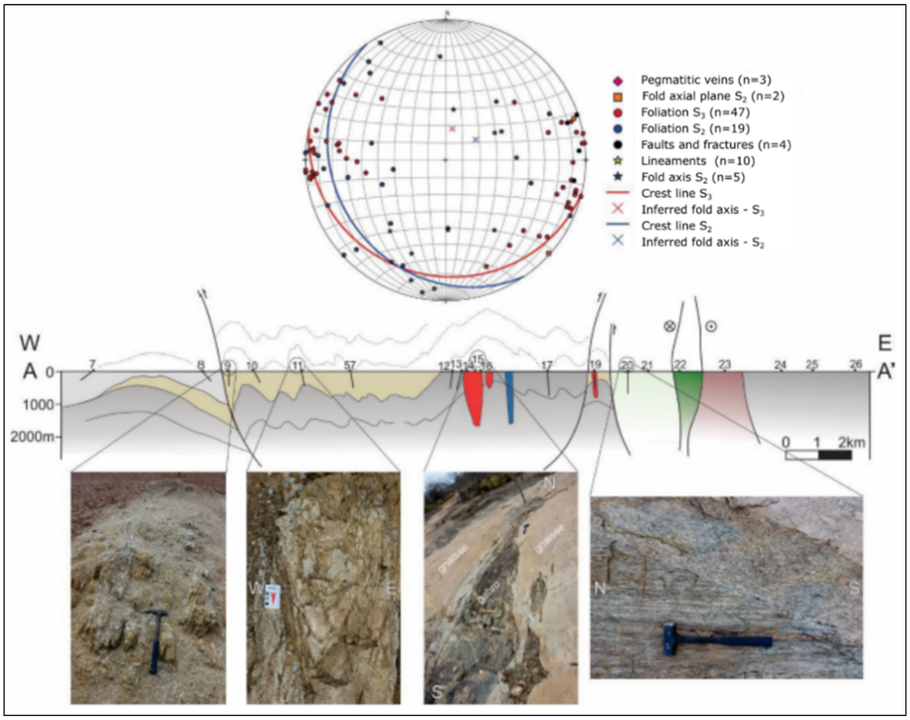


Figure 7-11: Geological section A-A' in the south portion of the Curaçá Valley (Frugis, 2017)

Geological Section E-E' – Surubim District

- Tighter folds in the interior of a flower-like structure.
- Main vergence of the folds to the west.
- More open and smooth folds to the west of the flower-like structure.
- S_3 subvertical foliation with a principal NE-SW direction.
- S_2 fold foliation with B axis dipping to the SSW

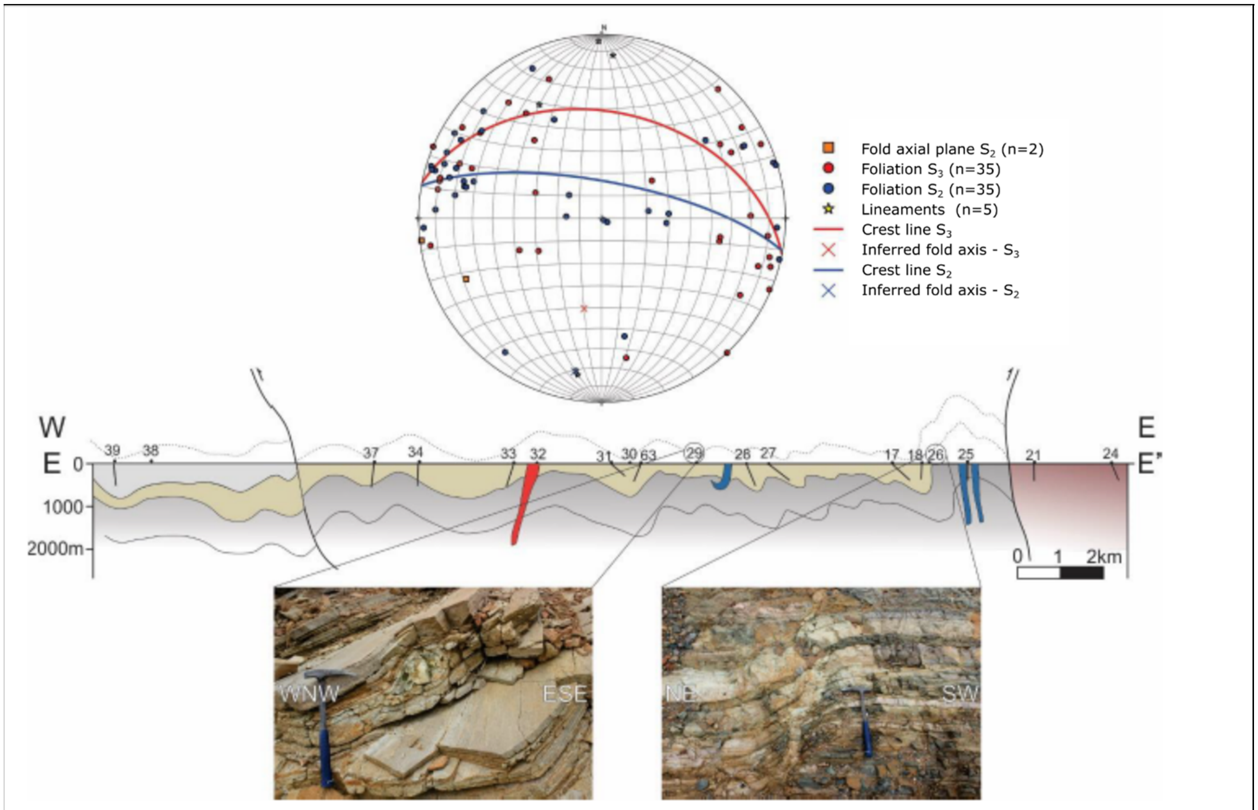


Figure 7-12: Geologic section E-E' in the central portion of the Curaçá Valley (Frugis, 2017)

Geologic Section I-I' – Vermelhos District

Geologic Section I-I' is shown as two parallel EW cross sections: I1-I1' (to the south) and I2-I2' (to the north),

- Main vergence of the structures towards the west, with a few folds showing vergence to the east.
- S_3 foliation with a preferential direction to the NNE-SSW.
- Mineral lineation dipping preferentially to the S-SSE.
- Mylonitic foliation parallel to S_3.
- Here the Sergipe section unconformably overlies the Bom Despacho formation, of Salvador-Curaçá Orogen, probably in the form of klippe.

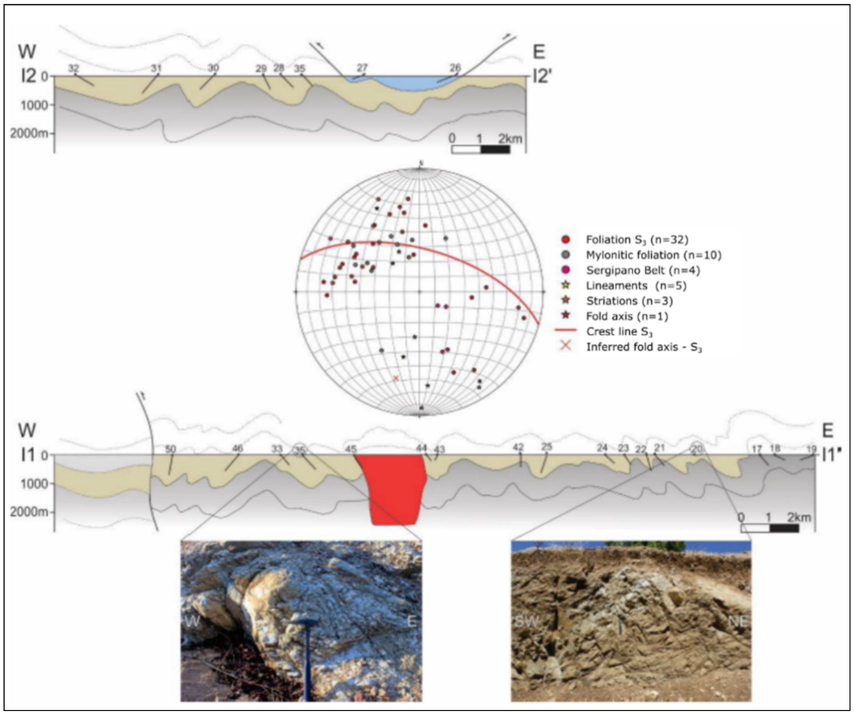


Figure 7-13: Geologic sections I1-I1' and I2-I2' in the north portion of the Curaçá Valley (Frugis, 2017)

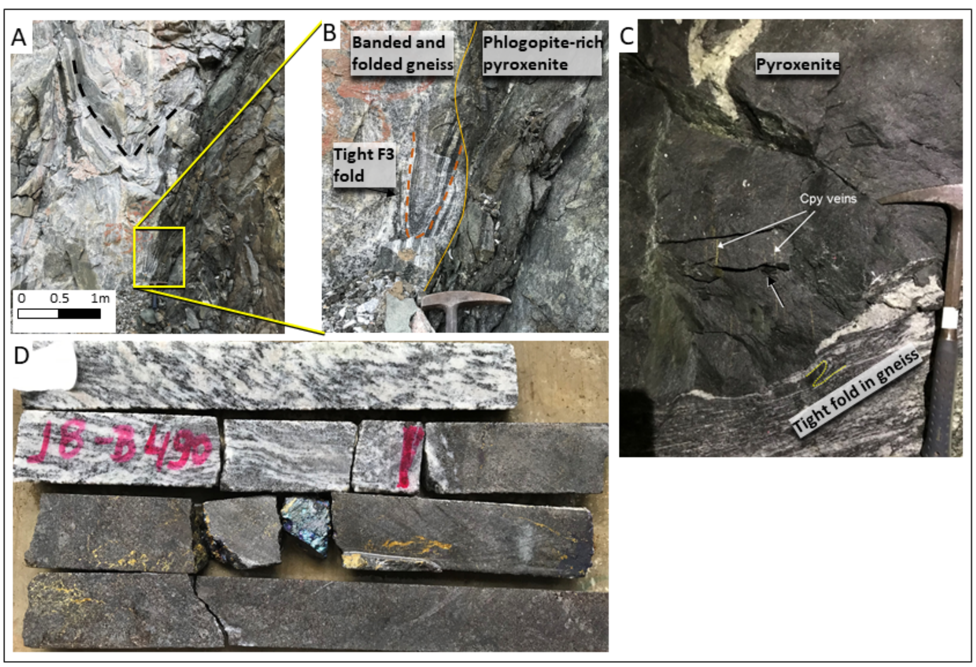


Figure 7-14: Contact relationships between pyroxenite dykes and folded gneiss. A) P3 folds cross-cut at angle by the phlogopite-rich pyroxenite unit in the Suçuarana pit; B) detailed of the lower fold of figure A); C) unfoliated mineralized

pyroxenite cross-cutting a tight fold in gneiss, and D) mineralized pyroxenite dyke cross-cutting foliation in gneiss at high angle, Pilar mine (drillhole FC4989 at 289.0m) (Desrochers et al., 2019)

7.4 GEOCHRONOLOGY

Table 7-1 summarizes age dates obtained on samples from various units of the Curaçá Valley.

Silva et al. (1997) dated enderbitic orthogneiss (2695 ± 12 Ma), charnockites (2634 ± 19 Ma), and deformed norites (2580 ± 10 Ma) with U-Pb on zircon method (SHRIMP). These rock units represent the oldest rocks dated in the valley (Figure 7-15).

The first phase of deformation is estimated to have occurred between 2.35-2.28 Ga (Silva et al., 1996) and reached amphibolite facies as preserved in local boudins of metamorphosed mafic rocks. The second phase of deformation occurred around 2.25 Ga and was coeval with intrusions of G2 tonalite in the Curaçá valley (2248+-36 Ma, D'el-Rey Silva et al. 1996). The east-west gneissic foliation, including cordierite-sillimanite-garnet-biotite assemblage with local sapphirine, was developed at high temperature under granulite conditions (possibly as high as 900^{o}C; Barbosa et al., 2016). The third phase of deformation (D3) occurred around 2.10 Ga (2103+-23 Ma, Oliveira et al., 2004) during a continent-continent collision involving the Gavião, Jequié, and Serrinha blocks, and the Itabuna-Salvador-Curaçá belt. The northerly-trending D3 foliation is marked locally by biotite and hornblende which indicates amphibolite metamorphic conditions. The superposition of the D3 on D2 deformation produced fold interference patterns of type 2 (Ramsay, 1967).

The Itiuba syenite is located to the east of the Valley and was dated at 2084+-9 Ma (Oliveira et al., 2004). A later magmatic event includes the undeformed G3 granites at the Caraíba mine (2044.5 +- 2.5 Ma in Garcia, 2017), a pyroxenite unit at Barauna south of Pilar (2056+-9.2 Ma in Garcia, 2017), and a norite at the Surubim mine (2047 +- 11 Ma in Garcia et al., 2018). Zircon from quartz-microcline metasomatite in Caraíba mine, which returned similar ages (2042 +- 15 Ma in Garcia, 2013), may represent partial melts related intrusion of orthopyroxenite and sulphide concentration or alteration events related to external fluids. The reported ages appear to reflect broadly contemporaneous mafic/ultramafic intrusions, partial melts or alteration related to their emplacement, and granites all of which cut fabrics related to the major deformation events in the gneiss. It is likely that this also represents the age of the primary Cu-Ni mineralization in the Curaçá valley.

Dating of phlogopite by Ar-Ar methods returned younger ages between 1.95 and 2.01 Ma (2011+-16 Ma and 1952+-15 Ma, Teixeira et al., 2010) that may reflect late alteration events, or cooling during initial exhumation. Late alteration may have introduced or remobilized copper but currently there is no direct evidence to document a specific event.

Table 7-1: Geochronologic synthesis of the Curaçá Valley and north portion of OISC (Orogeno Itabuna-Salvador-Curaçá). The ages of Vlach & Del Lama (2002) were extracted from Teixeira et al., 2010.

Synthesis of Geochronology of Vale do Curaçá and north portion of OISC						
Unit	**Lithology**	**Location of Sample**	**Method**	**Age Date**	**Interpretation**	**Author**
Caraíba Complex	Orthogneiss TTG	Mina da Caraíba	U-Pb SHRIMP	2695 ± 12 Ma	Magmatism	Silva et al., 1997
Caraíba Complex	Orthogneiss Charnockite	Mina da Caraíba	U-Pb SHRIMP	2634 ± 19 Ma	Magmatism	Silva et al., 1997
Caraíba Complex	Orthogneiss Granulite	São José de Jacuípe	U-Pb SHRIMP	2089 ± 11 Ma	Metamorphism	Silva et al., 1997
Ultramafic Bodies	Norite	Mina da Caraíba	U-Pb SHRIMP	2580 ± 10 Ma	Magmatism	Oliveira et al., 2004
Corpos ultramáficos	Norite	Mina da Caraíba	U-Pb SHRIMP	2103 ± 23 Ma	Metamorphism	Oliveira et al., 2004
Itiúba Syenite	Syenite	Itiúba	U-Pb SHRIMP	2084 ± 9 Ma	Magmatism	Oliveira et al., 2004
Caraíba Complex	Enderbite	Riachão de Jacuípe	U-Pb SHRIMP	2785 ± 11 Ma	Xenocryst or Magmatism?	Silva et al., 2002
Caraíba Complex	Enderbite	Riachão de Jacuípe	U-Pb SHRIMP	2215 ± 11 Ma	Magmatism	Silva et al., 2002
Caraíba Complex	Enderbite	Riachão de Jacuípe	U-Pb SHRIMP	2150 ± 18 Ma	Metamorphism	Silva et al., 2002
Caraíba Complex	Enderbite	Riachão de Jacuípe	U-Pb SHRIMP	2028 ± 13 Ma	Migmatization	Silva et al., 2002
Jacurici Complex	Pegmatite	Vale do Jacurici	U-Pb SHRIMP	2084 ± 6 Ma	Crystalization	Marques et al., 2010
Caraíba Complex	Charnockite	Itatim	U-Pb LA ICP-MS	2664 ± 27 Ma	Magmatism	Corrêa-Gomes et al., 2012
Caraíba Complex	Charnockite	Itatim	U-Pb LA ICP-MS	2029 ± 21 Ma	Orogenic Collapse	Corrêa-Gomes et al., 2012
Caraíba Complex	Amphibolite	Aeroporto de Pilar	U-Pb TIMS	2,08-2.05 Ga	Metamorphism	D'el-Rey Silva et al., 2007
Caraíba Complex	Diorite	Mina da Caraíba	U-Pb TIMS	2235 Ma	Magmatism	D'el-Rey Silva et al., 1996
Caraíba Complex	Tonalite	Mina da Caraíba	U-Pb TIMS	2248 ± 36 Ma	Magmatism	D'el-Rey Silva et al., 1996
Caraíba Complex	Tonalite	Mina da Caraíba	U-Pb TIMS	2051 ± 16 Ma	Metamorphism	D'el-Rey Silva et al., 1996
Caraíba Complex	Aluminous Granulite		Th-U-Pb microprobe	2,07-2,08 (±0,02 Ga)	Metamorphism	Vlach & Del Lama, 2002
Caraíba Complex	Orthogneiss Charnockite	~7,5 km a SE de Tanquinho	Pb-Pb Evaporation	2096 ± 3 Ma	Metamorphism	Barbosa et al., 2008
Caraíba Complex	Norite	Mina da Caraíba	Sm-Nd (TDM)	2,82/2,85/2,86 Ga	Primary Extraction	Oliveira et al., 2004
Caraíba Complex	Granito G3 "Pinions"	Pinhões	Sm-Nd (TDM)	2,90 Ga	Primary Extraction	Oliveira et al., 2004
Caraíba Complex	Waldemar Metapelite		Sm-Nd (TDM)	2,72 Ga	Primary Extraction	Oliveira et al., 2004
Caraíba Complex	Caraíba migmatite	Mina da Caraíba	Sm-Nd (TDM)	2,65 Ga	Primary Extraction	Oliveira et al., 2004
Caraíba Complex	Granodiorite G2		Sm-Nd (TDM)	2,44 Ga	Primary Extraction	Oliveira et al., 2004
Sienito de Itiúba	Syenite	Serra de Itiúba	Sm-Nd (TDM)	2,85 Ga	Primary Extraction	Oliveira et al., 2004
Sienito de Itiúba	Syenite	Serra de Itiúba	Sm-Nd (TDM)	2,70 Ga	Primary Extraction	Oliveira et al., 2004
Post-tectonic Granite	Granitoid		Rb-Sr - whole rock	1915 Ma	Magmatism	Otero & Conceição, 1996
Post-tectonic Granite	Granitoid		Rb-Sr - whole rock	1897 Ma	Magmatism	Otero & Conceição, 1996
Ultramafic Bodies	Mafic Ultramafic rocks	Vale do Jacurici	Re-Os	Pyrrhotite 2084 ± 0,9 Ma	Metamorphism	Marques & Carlson, 2008
Ultramafic Bodies	Mafic Ultramafic rocks	Caraíba	Ar-Ar - phlogopite	2011 ± 16 Ma	Early Metasomatism	Teixeira et al., 2010
Ultramafic Bodies	Mafic Ultramafic rocks	Caraíba	Ar-Ar - phlogopite	1952 ± 15 Ma	Late Metasomatism	Teixeira et al., 2010

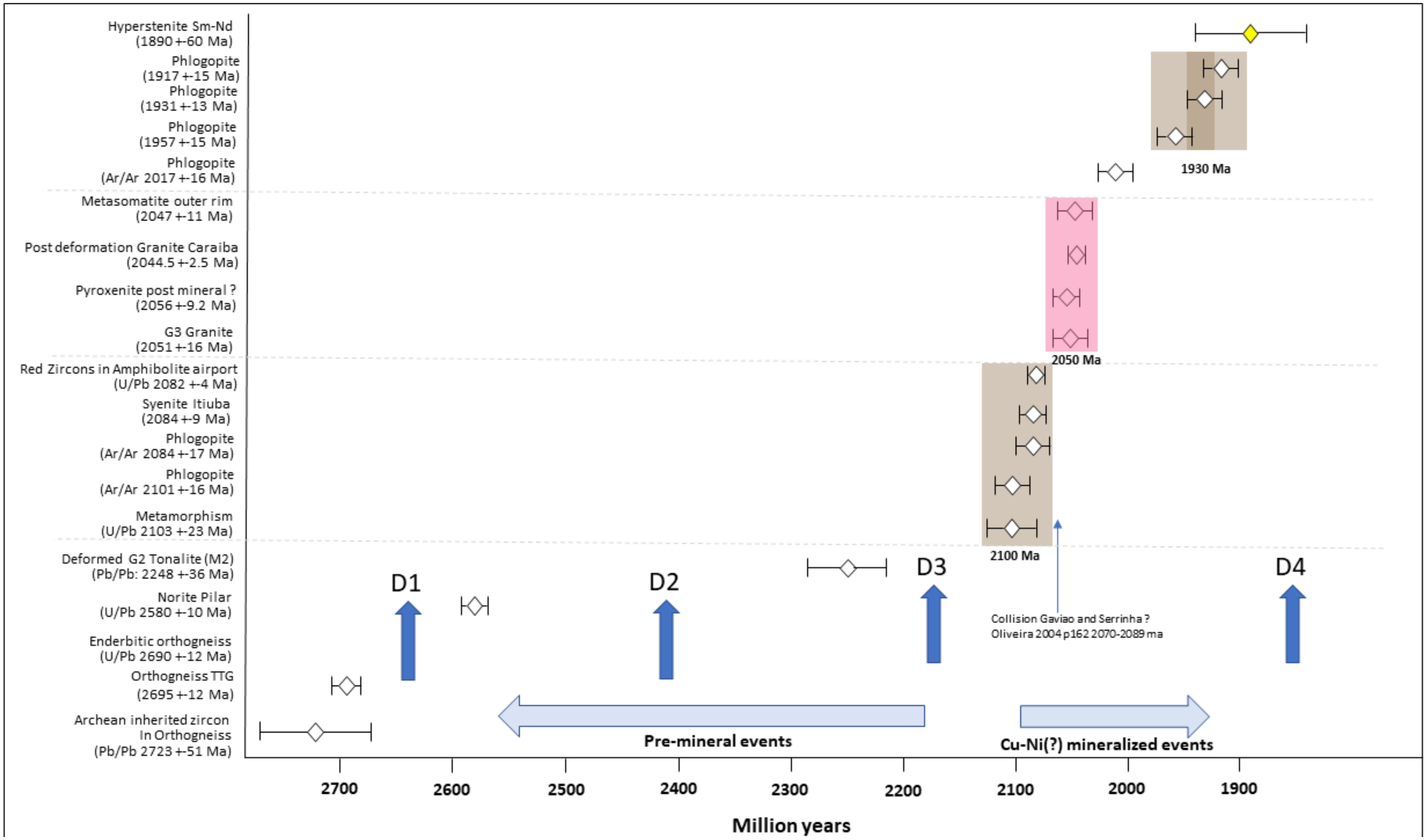


Figure 7-15: Chart of age dates from the Curaçá Valley showing main episodes of magmatism and alteration/metamorphism (Desrochers et al., 2019)

7.5 LOCAL GEOLOGY OF THE PILAR MINE

7.5.1 Lithology, Structure, and Alteration

The Pilar Mine is located in the southern part of the MCSA Mining Complex within the Curaçá Valley (Figure 7-2). The geology of the mine consists of a high-grade metamorphic terrain, composed of gneiss and migmatite of the Caraíba Complex that were intruded by mafic, ultramafic and late granitic rocks (Figure 7-16). The mafic and ultramafic intrusions are mainly composed of pyroxenite, norite, and gabbro. The melanorite is a term used for logging purpose to describe a host rock, either a gneiss, a gabbro or a norite, that is intruded by several mafic-ultramafic dykes that are too small individually to be logged separately (Figure 7-6, B).

The gneissic country rocks have gone through 3 phases of deformation and show fold-interference patterns. The ultramafic units as well as the late granitic and pegmatite intrusions were emplaced after the 3 phases of deformation in the gneiss and generally dip steeply to the west and strike northerly (Figure 7-16 and Figure 7-17). Recent underground mapping indicates that some of the pegmatite dykes were emplaced along faults (MCSA, 2020). The NW-striking diabase dykes and quartz veins crosscut the metamorphic and intrusive units. A series of shear zones, oriented NNE and NNW with moderate westerly dip, represent a late deformation event but their relative displacement is not well documented (D'El Rey Silva, 1984, Frugis, 2017). Finally, a series of late faults, oriented NE to ENE and NW, are also reported by D'El Rey Silva (1984) but with unclear sense and amount of displacement.

The gneiss and migmatites, together with some intrusive bodies are affected by various alteration assemblages including potassic (phlogopite and K-feldspar), sodic (albite), calcsilicate (diopside), carbonate, as well as epidote and lesser garnet (Figure 7-18). The alteration variably overprints the original texture of the rock units and it obliterates the gneissic foliation where the alteration is more intense. The phlogopite was generally developed later than the k-feldspar and the diopside alteration and is frequently associated with the copper mineralization.

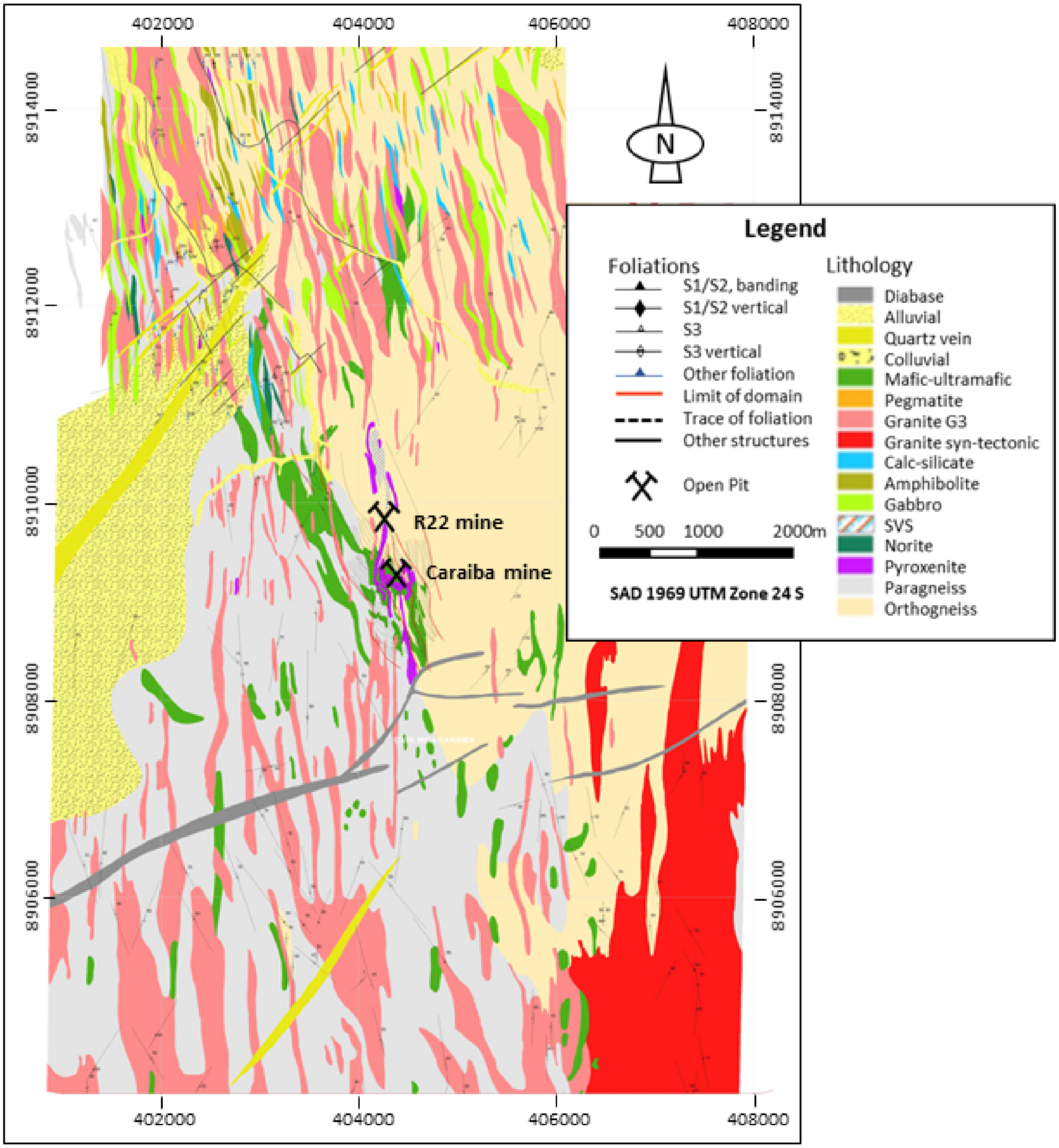


Figure 7-16: Surface geology map of Pilar Mine sector (MCSA, 2017)

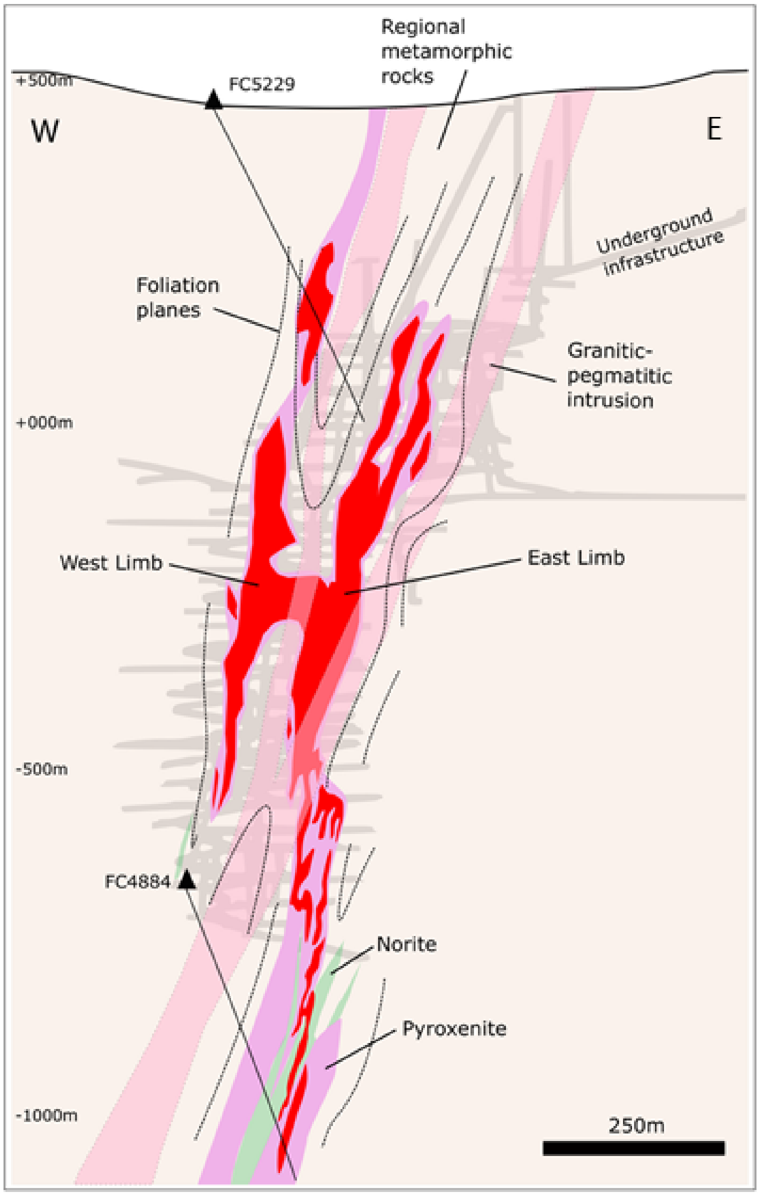


Figure 7-17: Vertical cross-section of the Pilar Mine. Looking north (MCSA, 2019)

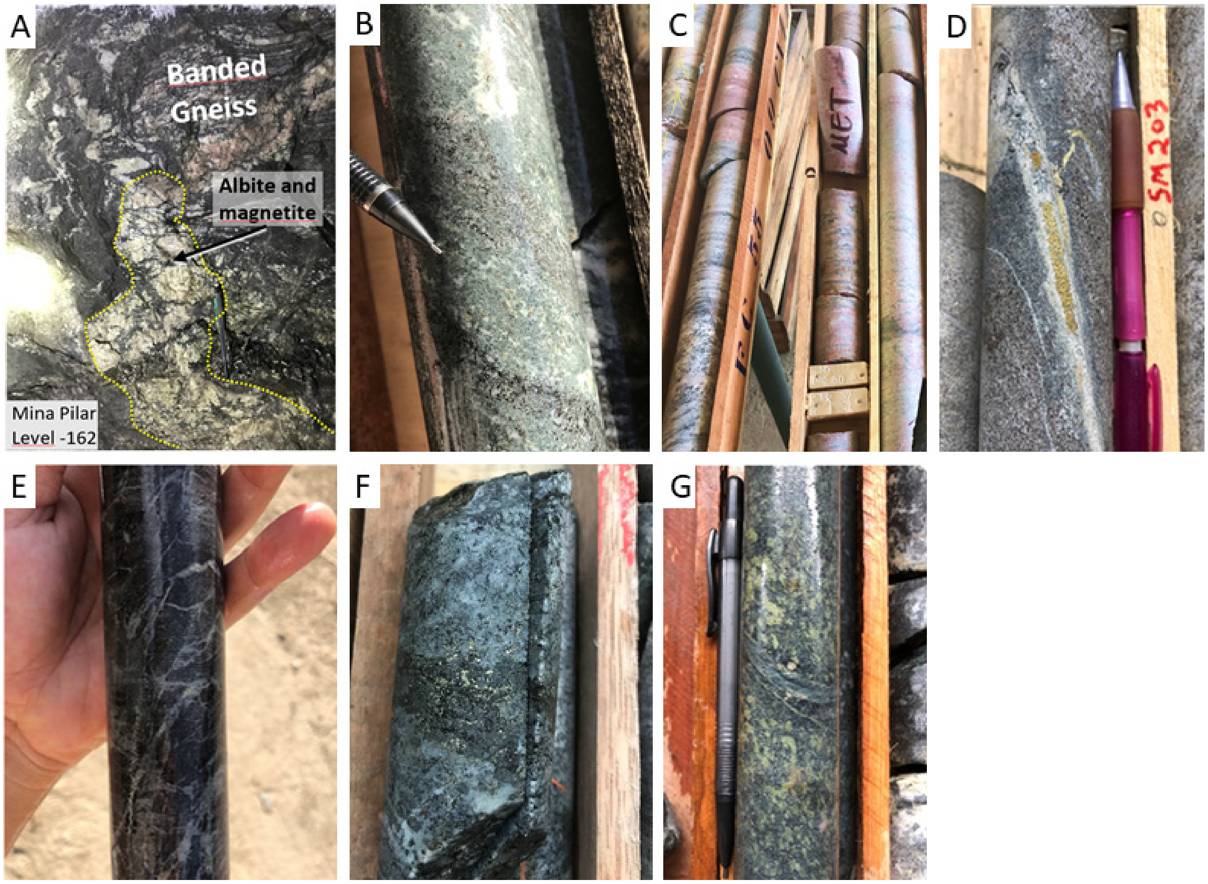


Figure 7-18: Photo of the types of alteration at the Pilar mine: A) albite and magnetite cross-cutting the gneissic fabric; B) Diopside alteration overprinting gneissic fabric; C) K-feldspar alteration; D) carbonate in halo of chalcopyrite veinlet; E) serpentinization; F) Phlogopite band associated with chalcopyrite mineralization; G) epidote alteration (MCSA, 2018)

7.5.2 Mineralization

Mineralization at the Pilar Mine is composed of copper sulphides in the form of chalcopyrite, bornite and rarely chalcocite that occur in four different styles: disseminated, veins, massive, and brecciated (Figure 7-19, A-E). Other sulphide minerals include millerite, pyrite and pyrrhotite. Magnetite is the dominant oxide mineral and occurs intergranular together with chalcopyrite and bornite (Tappert, 2020 and Figure 7-19, F). The sulphides are heterogeneously distributed in the pyroxenite units in the form of lenses that trend N-S, dip steeply to the west and range from less than 1 meter to 20 meter thick. The mineralized bodies occur in sharp contact with migmatites and at variable angle to the main foliation of the host-rock. Strongly foliated sub-vertical anastomosing shears as well as brittle faults cross-cut and locally displace the mineralization.

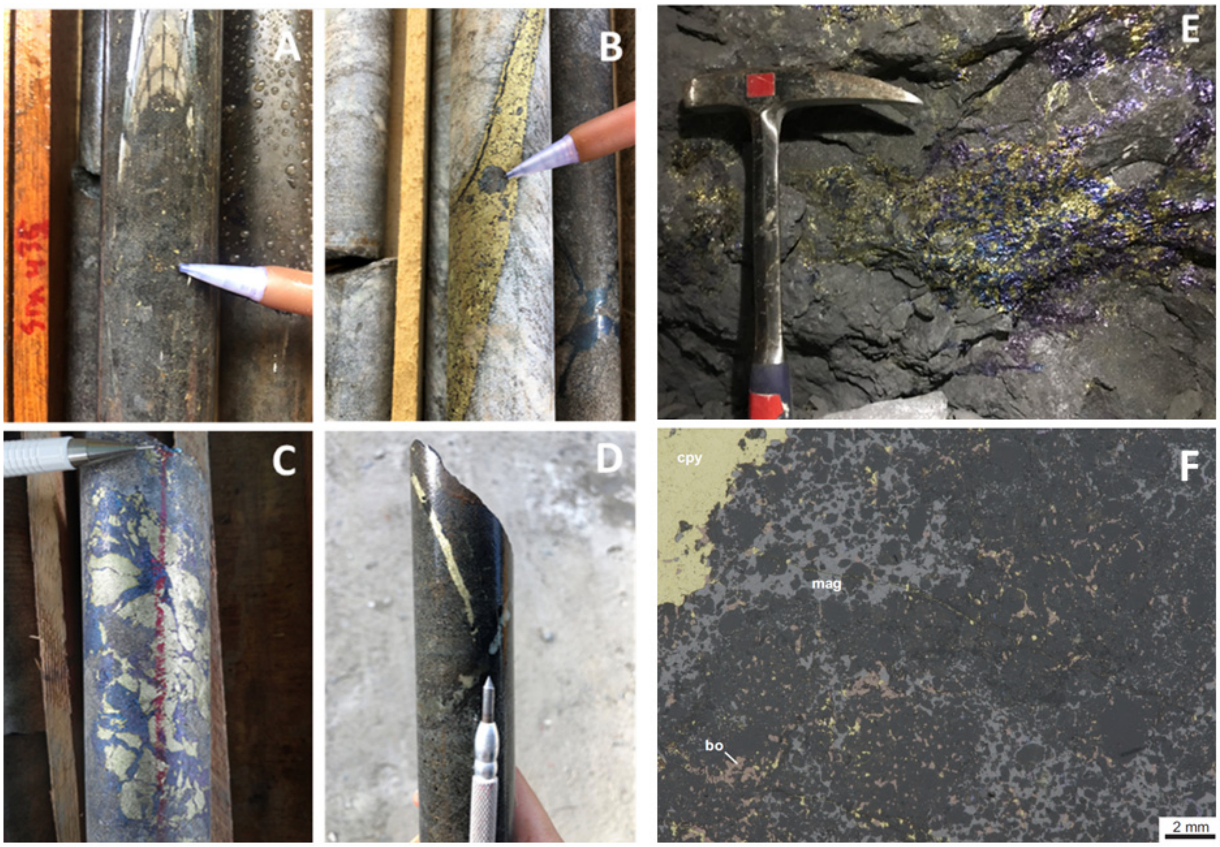


Figure 7-19: Mineralization styles: A) Pyroxenite showing primary disseminated chalcopyrite; B) Vein of chalcopyrite cross-cutting gneiss; C) Massive chalcopyrite and bornite; D) Pyroxenite with phlogopite; E) Mining front with chalcopyrite and bornite in the pyroxenite (MCSA, 2018) and F) Polished section showing abundant intergranular magnetite (mag), bornite (bo), and minor chalcopyrite in contact with massive chalcopyrite vein (cpy) (Tappert, 2020)

7.6 LOCAL GEOLOGY OF THE SUÇUARANA DEPOSIT

7.6.1 Lithology, structure, and alteration

The Suçuarana copper deposit is located in the southern part of the Curaçá Valley and 14 km to the SSW of the Pilar Mine (Figure 7-2). The copper mineralization is associated with a regionally interpreted steep westerly dipping, northerly trending, 100-meter-wide amphibole-rich unit that extends for over 1.35 kilometers in a N-S direction (Figure 7-20). This unit represents most probably a series of sub-parallel mafic and ultramafic dykes that are strongly altered. The amphibolite unit is hosted in gneiss and migmatites that are intruded by late granite and pegmatite dykes.

A series of phlogopite-rich units, that possibly represent altered mafic-ultramafic units, trend northerly and cross-cut the folded gneiss (Figure 7-21, A, B). At the local scale, the phlogopite-rich units are injected in an anastomosed pattern with dominant vertical and horizontal contacts (Figure 7-21, C).

Alteration consists of green hornblende and intense brown phlogopite flakes that are generally randomly oriented.

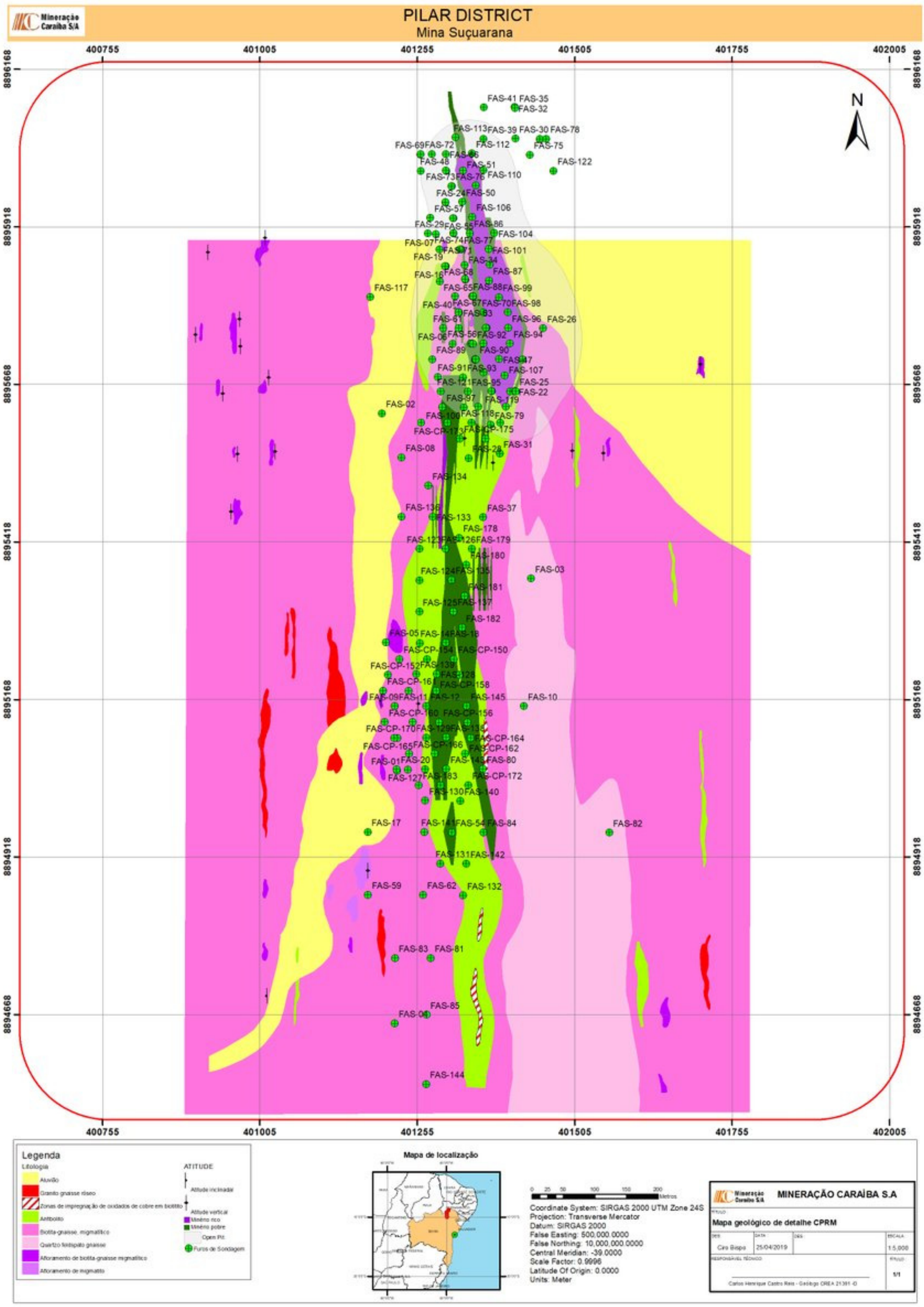


Figure 7-20: Surface geology map of the Suçuarana mine sector (MCSA, 2019)

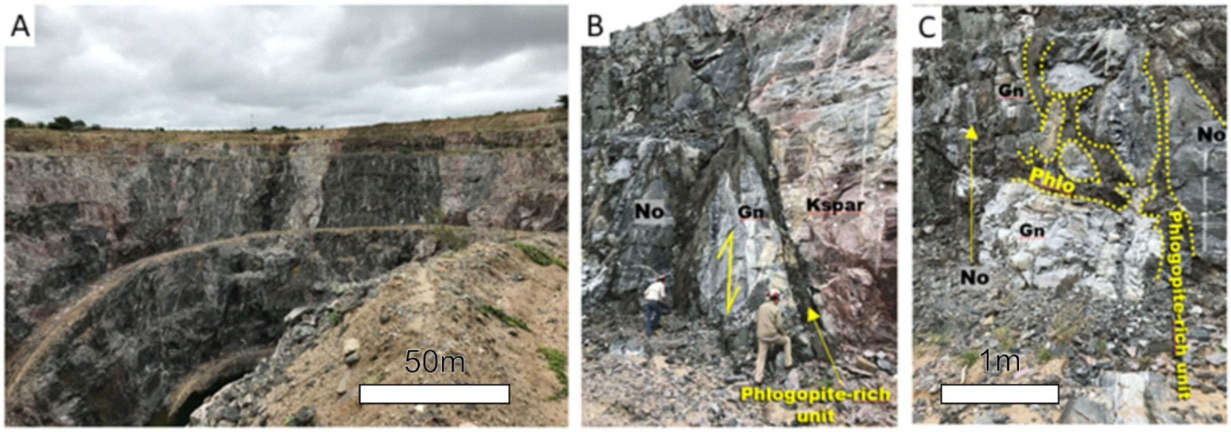


Figure 7-21: Photos of the geology of the Suçuarana Open Pit. A) general view of the historical open pit with altered mafic-ultramafic rock units injected into partly k-feldspar altered gneiss, looking south; B) Phlogopite-rich unit that cross-cuts the foliated gneiss, a norite, and a k-feldspar altered gneiss; C) Irregular injection of the phlogopite-rich unit that cross-cuts the gneiss and norite. (Desrochers et al. 2019)

7.6.2 Mineralization

The known copper mineralization extends over 2.0 km, including mineralization of the historical Suçuarana pit. Mineralization is dominated by chalcopyrite with minor bornite that is mostly associated with the phlogopite-rich units.

7.7 LOCAL GEOLOGY OF THE SURUBIM DISTRICT (SURUBIM MINE, C12, CERCADO VELHO, LAGOA DA MINA, TERRA DO SAL)

7.7.1 Lithology, structure, and alteration

The Surubim district is located in the central part of the Curaçá Valley (Figure 7-2). The C12 deposit is located 1.2 km to the SW of the Surubim mine. The Cercado Velho and Lagoa da Mina deposits are at approximately 10 km to the NE of Surubim whereas the Terra do Sal deposit is situated 8 km to the SE of Surubim. The Surubim and C12 deposits are hosted in the Surubim gneiss (alternating tonalitic and granorioditic bands with gabbro and diorite bands) whereas the other three deposits are hosted in the Caraíba gneissic complex (biotite orthogneiss with local migmatite). The geology of the Surubim and C12 deposits consists of large gabbro-dominant units with minor pyroxenite units and remnants of gneiss that are at least 400mwide (Figure 7-22 and Figure 7-23). In both deposits, the mafic-ultramafic units are intruded by late north-striking granite and pegmatite dykes. The geology of the Cercado Velho, Lagoa da Mina and Terra do Sal consist of orthogneiss and migmatites intruded by ultramafic units measuring a few centimeters up to 15mthick.

In all the deposits, the mafic-ultramafic lithological units are generally northerly oriented, and they dip steeply to moderately the west (Figure 7-24, A, B). Two main systems of easterly dipping anastomosing faults occur at the Surubim mine and are oriented NNE-SSW and NNW-SSE respectively. The movements along those faults, and their importance to the copper mineralization, are not well documented.

The mafic-ultramafic intrusive rocks and the gneiss were subjected to variable alteration, including phlogopite, silica, chlorite, K-feldspar, epidote, serpentine, and carbonate. Moderate to intense phlogopite alteration is characteristic of the Surubim deposit whereas k-feldspar, diopside and silica alteration zones are dominant in the Cercado Velho and Lagoa da Mina deposits (Figure 7-25 and Figure 7-26).

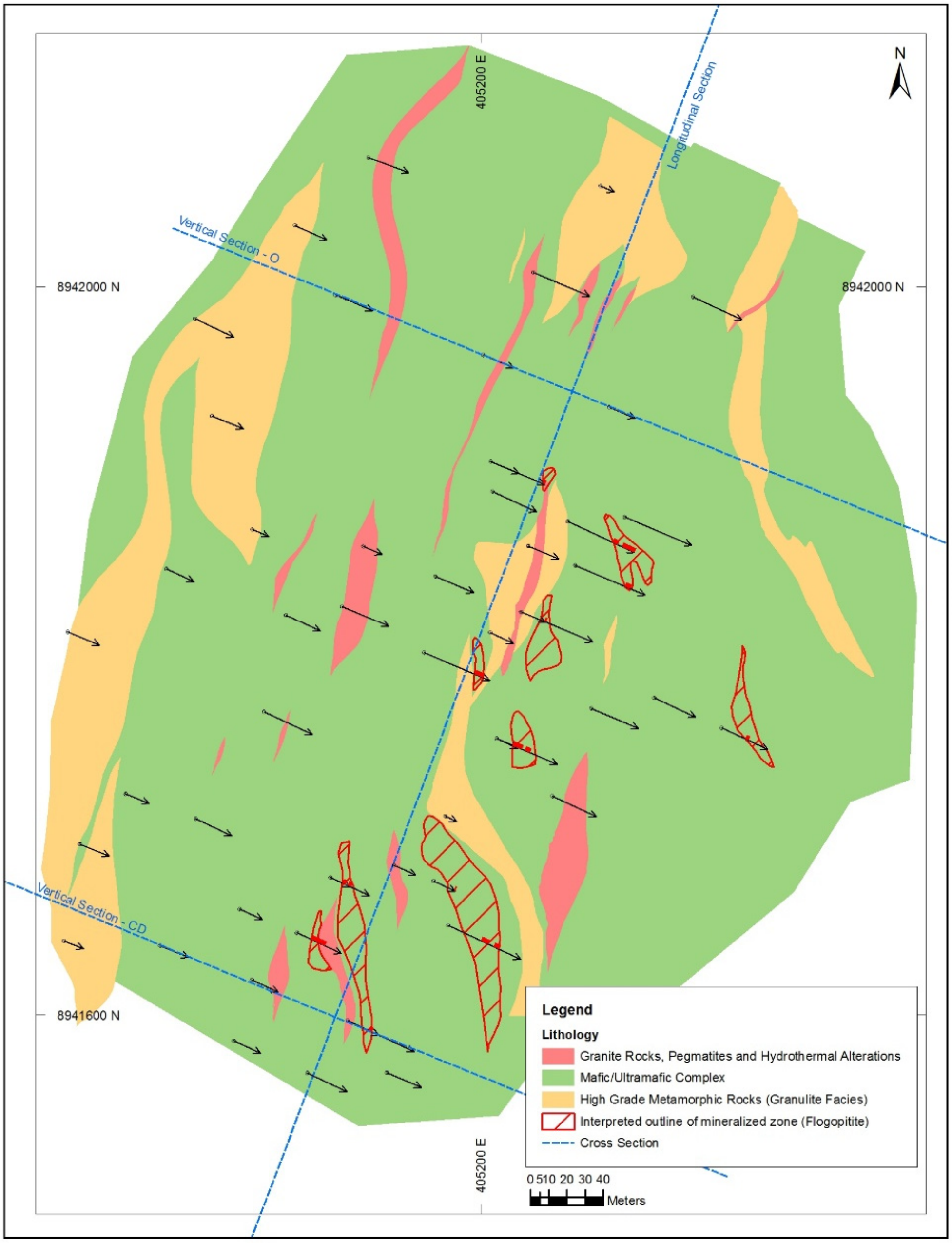


Figure 7-22: Level plan, +400 m Level, Surubim Mine (MCSA, 2018)

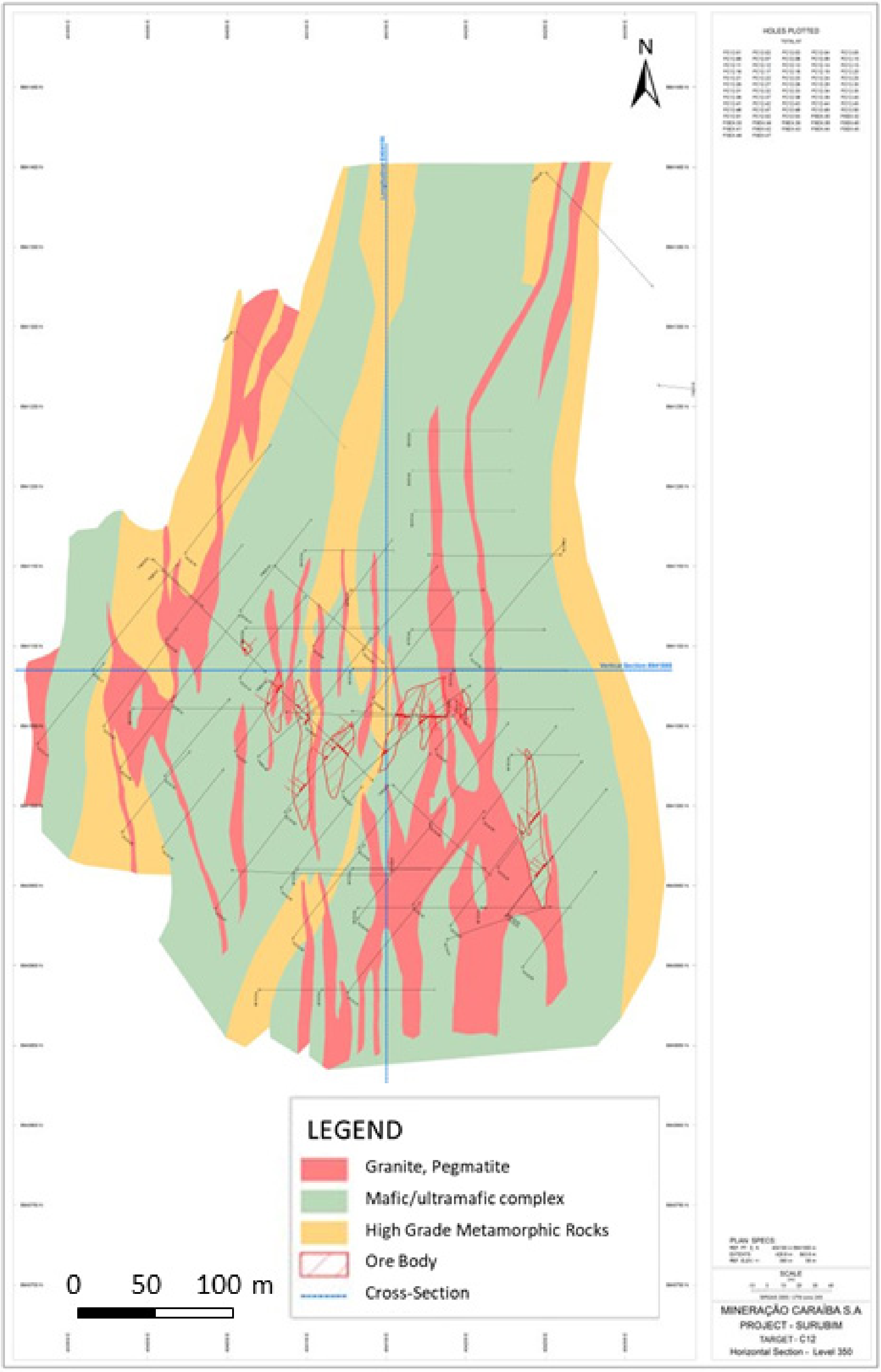


Figure 7-23: Level plan of the C12 deposit. Level 350 (MCSA, 2018)

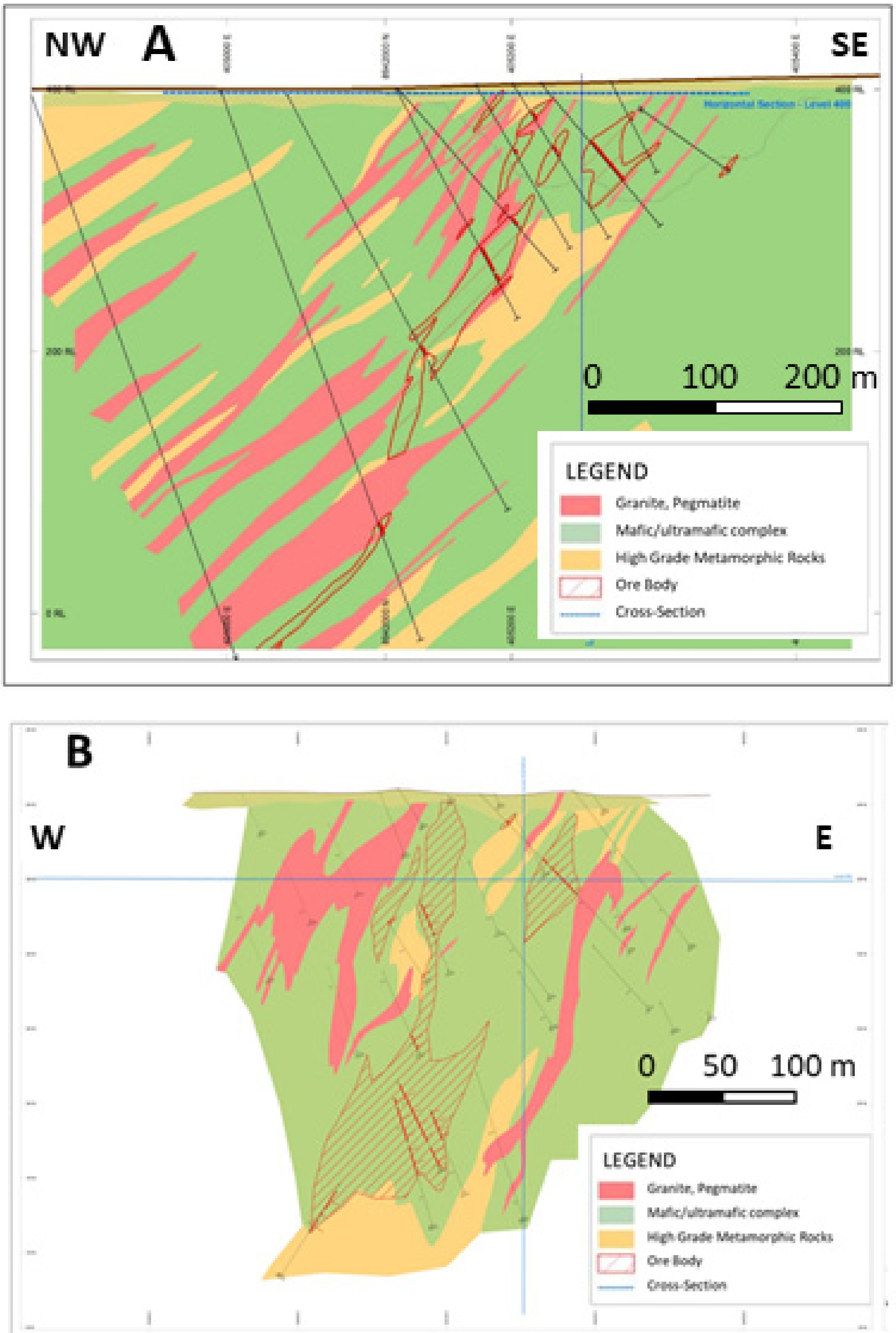


Figure 7-24: A) Vertical cross-section of the Surubim deposit B) vertical cross-section of the C12 deposit (MCSA, 2018)

7.7.2 Mineralization

The copper mineralization at the Surubim and C12 deposits occurs as lenses that are hosted by phlogopite-altered gabbro injected by pyroxenite dykes. Sulphide minerals are chiefly chalcopyrite and bornite in a ratio of 4:1 that mainly occur as disseminations and veins (Figure 7-27). Chalcocite, covellite and cubanite also occur as minor sulphides associated with the mineralization surrounding the Surubim Mine. Magnetite and minor pyrite and pyrrhotite are also associated with the mineralization with pyrrhotite being an important sulphide at the Lagoa da Mina and Cercado Velho deposits. The Terra do Sal deposit is characterized by disseminated and veinlets of pyrrhotite, chalcopyrite with minor bornite, pyrite and pentlandite.

In the deposits, the copper mineralization lenses are oriented N-S to NW-SE and dip moderately to steeply to the west and follows the general trends of the lithological units but with an overall steeper westerly dip (Figure 7-24, A, B).

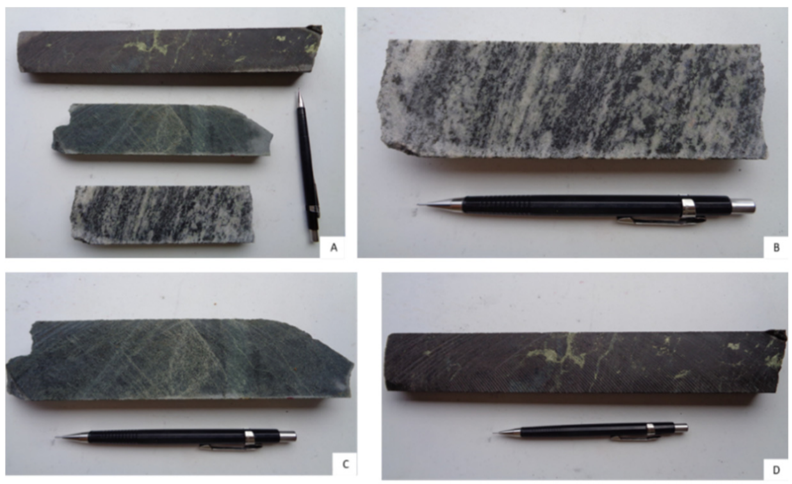


Figure 7-25: A) Main hydrothermal alteration styles associated in the mineralization. B) Silicified/albitized gneiss; C) Calcite epidote gabbro D) Phlogopite schist with chalcopyrite veinlets (MCSA, 2018)

Figure 7-26: K-feldspar alteration of the ultramafic unit, south wall of the Cercado Velho open pit (Jacutinga, 2020)

Figure 7-27: A) Chalcopyrite in veinlets; B) Disseminated chalcopyrite; C) Disseminated bornite and Massive chalcopyrite veins (MCSA, 2018)

7.8 LOCAL GEOLOGY OF THE VERMELHOS DISTRICT (SIRIEMA DEPOSIT, VERMELHOS MINE, N8/N9 DEPOSITS)

7.8.1 Lithology, Structure and Alteration

The Vermelhos District is located 60 km north of the Caraíba Mine (Figure 7-2). In this district, copper mineralization has been identified over 2.6 km in a NNW direction including the Siriema deposit, the Vermelhos Mine, and the N8 and N9 deposits (Figure 7-28). Current exploration has identified copper mineralization over 10km in a NNW direction (please refer to Figure 9-16).

The Vermelhos Mine area is largely covered by quartz-rich colluvium with rare outcrops occurring along drainages. Geological relationships at the Vermelhos mine are shown on Figure 7-28, Figure 7-29 and Figure 7-30. Geology of the N8 deposit is shown on Figure 7-31.

The deposits are located within the gneiss of Tanque Novo Complex, comprising orthogneiss (enderbites and tonalites gneiss) and paragneiss which have undergone granulite facies metamorphism and were cross-cut by mafic to ultramafic intrusions. The mafic rocks are composed of the norites, gabbros, and gabbro-norites. The ultramafic rocks are the main ore host of the copper mineralization and are composed by the pyroxenites and melanorites (Figure 7-29, Figure 7-30 and Figure 7-31). The gneiss and mafic-ultramafic rocks are cross-cut by late, steep westerly-dipping, N-S to NNE-SSW trending, granite and pegmatite dykes measuring a few centimeters up to 40m thick. The pegmatite dykes extend from the Siriema deposit to the N8 deposit. Minor late quartz veins and diabase dykes cross-cut all lithologies.

The gneissic country rocks show a migmatitic texture with a fabric that is moderately northerly dipping (45° to 30º) grading to sub-horizontal gneissic banding. The mineralized mafic-ultramafic rock units in the four deposits are trending generally N-S to NNE-SSW and dip steeply to the west. However, in the Sombrero (Chapéu) and the Tobogan sector of the Vermelhos mine, the ultramafic units dip moderately to the East and the West respectively in a synform shape and contains generally higher grade and thicker copper mineralization, together with local elevated Ni grade (Figure 7-29). A series of sub-vertical N-S, NW-SE and NE-SW faults and mylonitic shear zones occur in the Vermelhos district. These faults and shear zones may represent structures developed during the D_3 deformation phase described by Frugis (2017) or later structures that locally displace the mineralization with minor movements.

Similar alteration mineralogy to the Pilar mine is present in the Vermelhos district and include potassic (phlogopite and K-feldspar), sodic (albite), carbonate (calcite), calcsilicate (diopside), serpentine, as well as silica and garnet. The alteration also variably obliterates and locally cross-cuts the gneissic banding. An important silica alteration zone overprints the large pegmatite unit to the east of the mine and contains disseminated chalcopyrite (Figure 7-29 and Figure 7-32). Silica is also an important alteration phase in the deepest parts of the Siriema deposit.

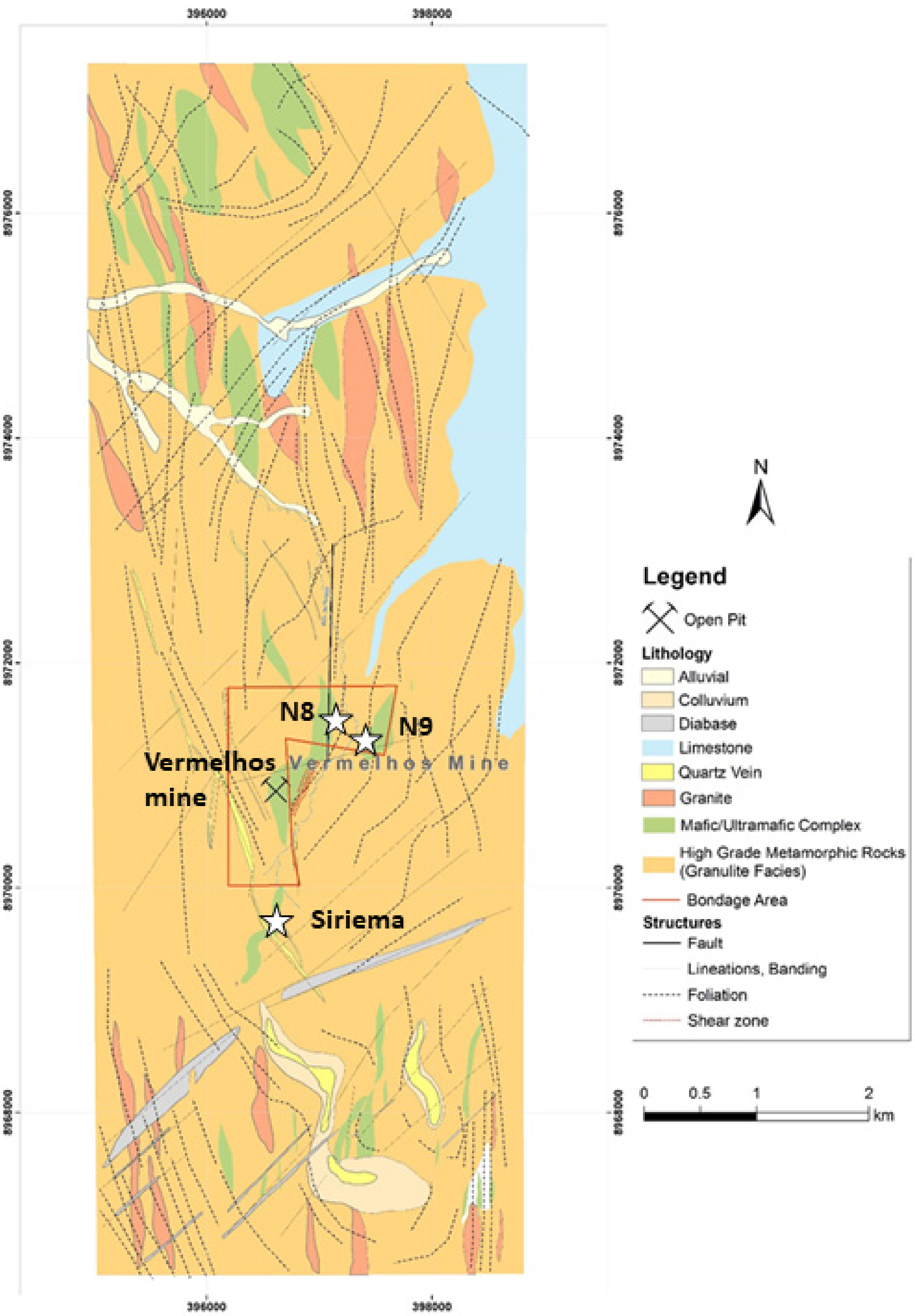


Figure 7-28: Geology map of the Vermelhos district showing the distribution of the deposits (MCSA, 2018)

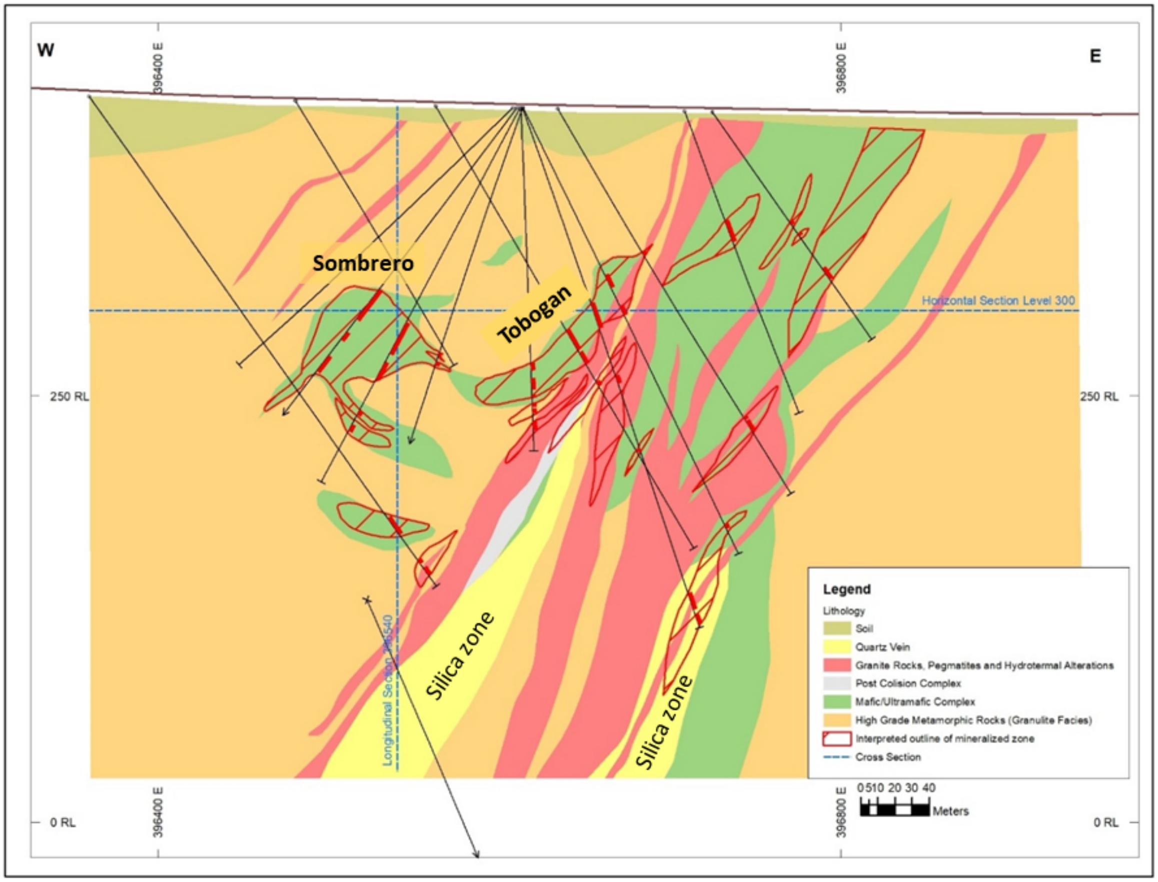


Figure 7-29: Vertical cross-section of the Vermelhos deposit. Looking North (MCSA, 2018)

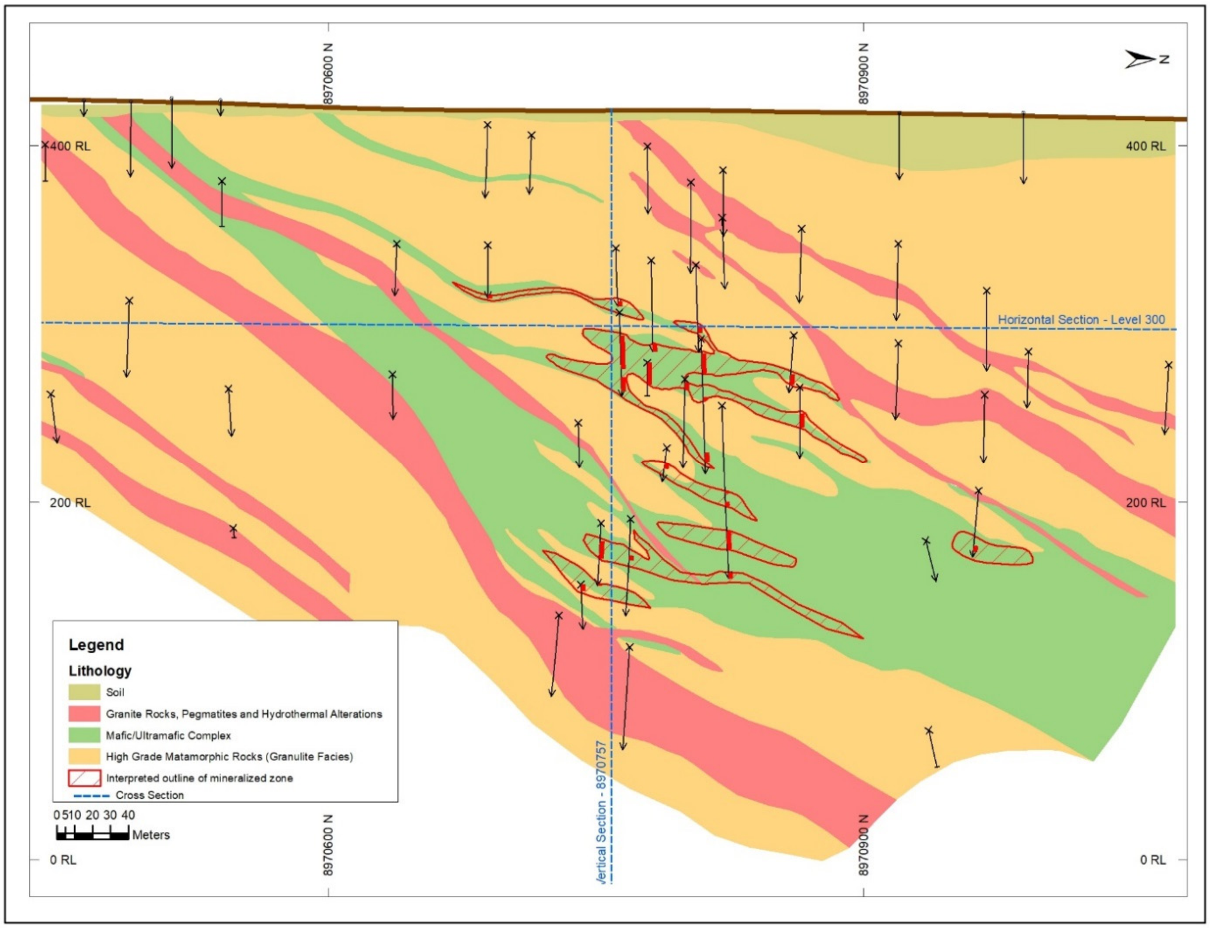


Figure 7-30: Vertical Long section of the Vermelhos deposit. Looking West (MCSA, 2018)

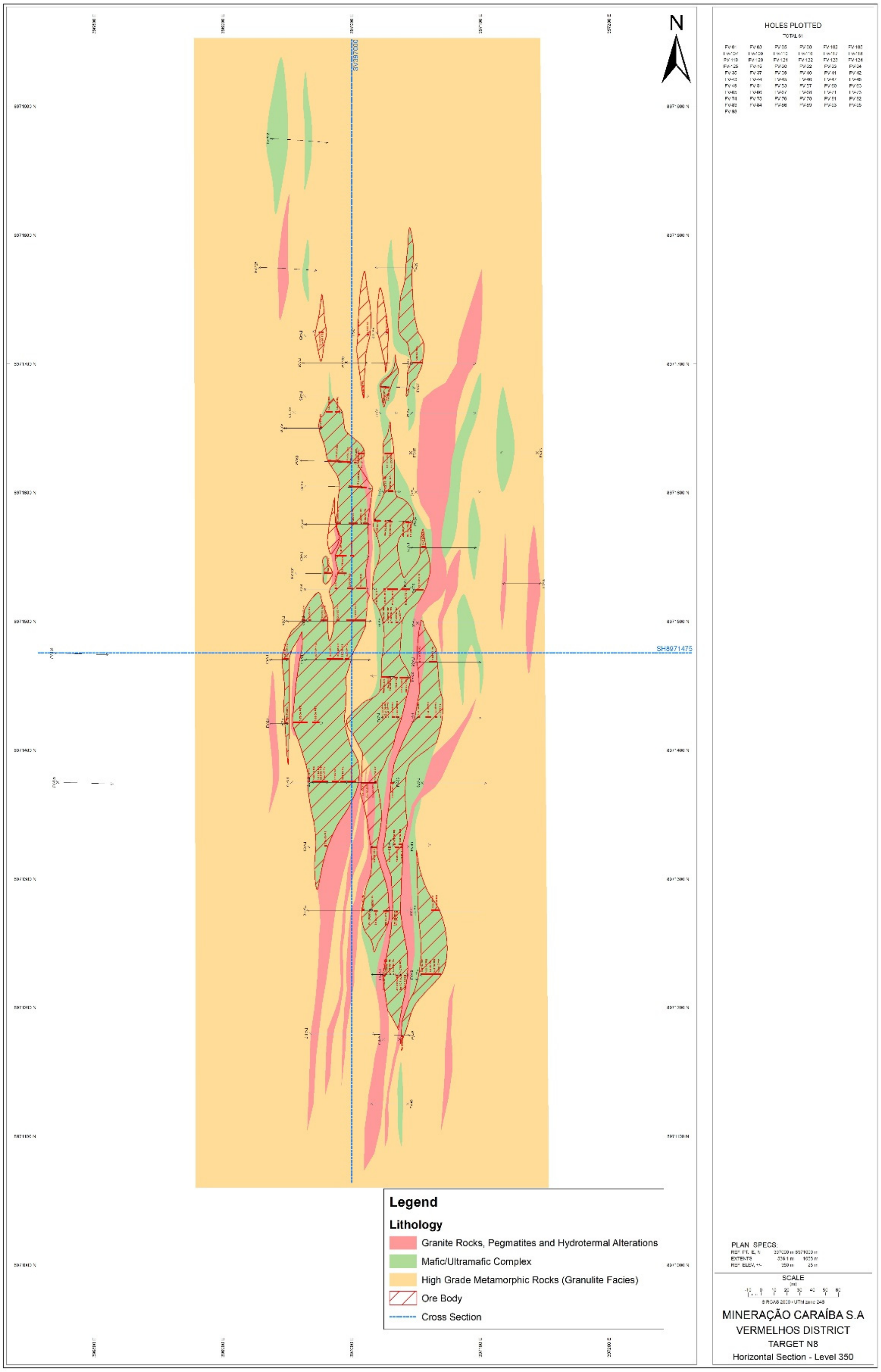


Figure 7-31: Geology map of the N8 deposit. Level 350. Mineralized intervals related to mafic-ultramafic rock units (MCSA, 2018)

Figure 7-32: Alteration facies at Vermelhos mine. A) K-feldspar alteration overprinting gneissic fabric; B) Dark serpentinite alteration of ultramafic unit; C) Intense garnet alteration; D) Silica alteration on East side of the Vermelhos deposit overprinting the pegmatite unit; D) Silica alteration on East side of the Vermelhos deposit with disseminated chalcopyrite; and F) Phlogopite-rich alteration (darker) and pyroxenite (grey) with chalcopyrite veinlet (MCSA, 2019)

7.9 MINERALIZATION

The main sulphides of the deposits in the Vermelhos district consist of chalcopyrite (approximately 70 to 75%), bornite (20 to 25%) and minor chalcocite. The chalcopyrite contains low concentration of nickel impurities (Tappert, 2020). Copper sulphides are associated with minor pyrite, pyrrhotite, pentlandite as well as chromite and magnetite. Sulphide textures include interstitial, net-textured, stringer and sulphide-rich matrix breccias (Figure 7-33 to Figure 7-36). Evidence throughout the Curaçá Valley of sulphide zonation, characterized as pyrrhotite +/- pentlandite zoning to pyrrhotite +/- pentlandite plus chalcopyrite and finally to chalcopyrite plus bornite is more common in the Vermelhos District (Figure 7-35, B), both within the Vemelhos UG Mine and at Siriema. High-grade mineralization in the Vermelhos District is often closely associated with phlogopite enrichment. Copper mineralization can also occur in altered zones in the gneiss, in pegmatites and silica altered zones (Figure 7-32, E). The nickel, cobalt and PGE content tends to be higher in the Siriema deposit than in Vermelhos and the N8 and N9 deposits but further analytical work is needed to confirm these observations. The detailed textures observed on polished slabs of sulphides show intergrowths of chalcopyrite, pentlandite, chromite, pyrrhotite and bornite (Figure 7-37). Oxidized mineralization occurs as malachite (Figure 7-36) and chrysocolla within the weathered zone that occurs from 15 m to 40 m depth and, to date, is only associated with mafic-ultramafic rocks in the Vermelhos District.

Figure 7-33: Typical disseminated chalcopyrite and bornite mineralization in pyroxenite grading to norite (right of the photo) (MCSA, 2019)

Figure 7-34: Typical brecciated mineralization showing angular pyroxenite clasts within a chalcopyrite matrix (MCSA, 2019)

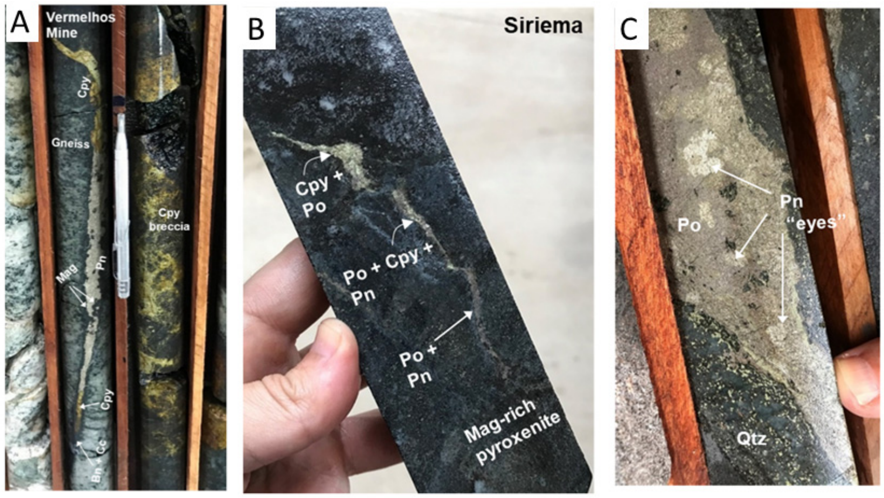


Figure 7-35: Sulphide zonation within the Vermelhos District. A) Vermelhos UG Mine and B) and C) Siriema deposit (MCSA, 2019)

Figure 7-36: Malachite, typical copper mineralization in weathered zone (MCSA 2019)

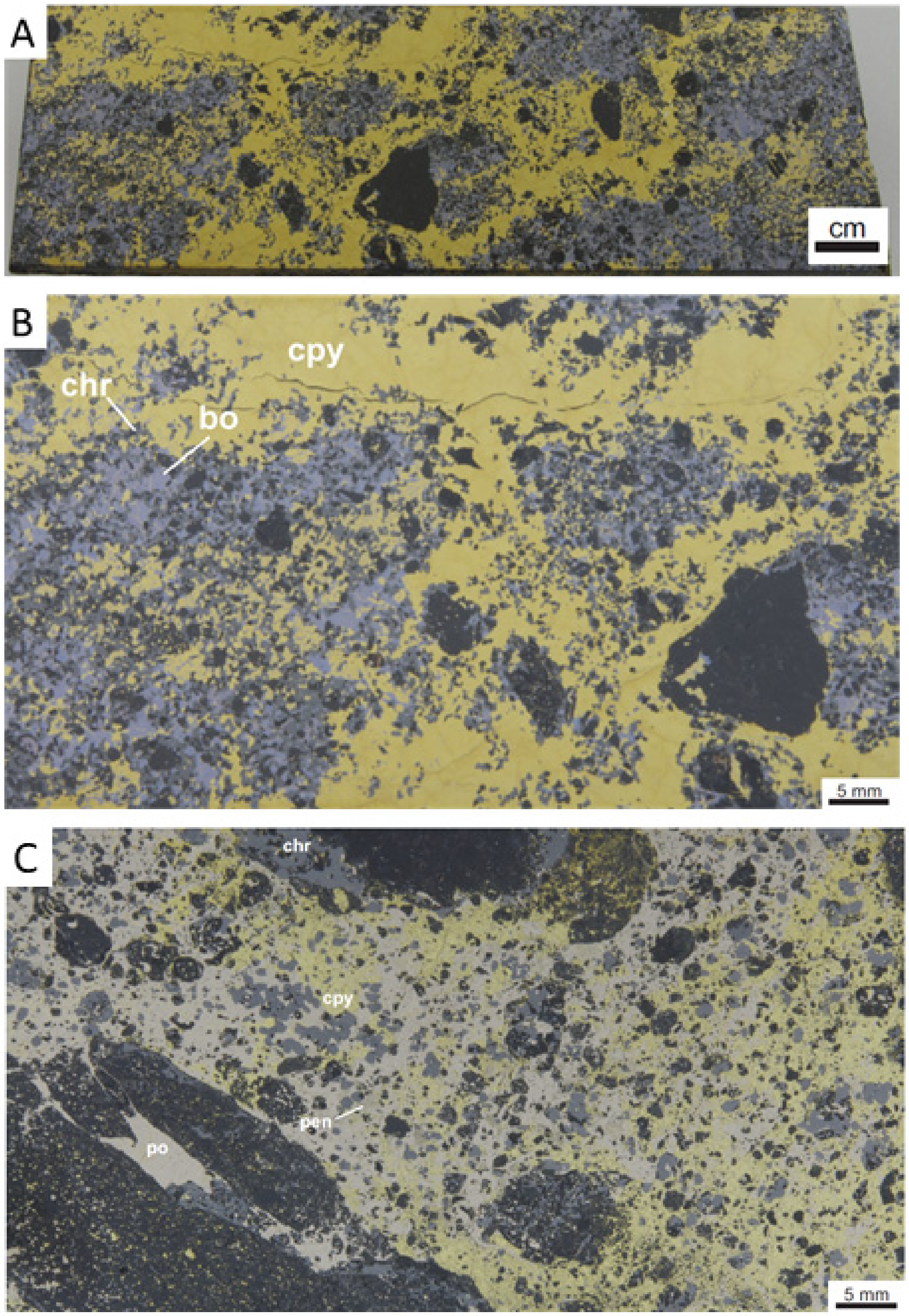


Figure 7-37: Polished slab of Vermelhos mineralization. A) Massive chalcopyrite in diffuse veins containing ultramafic country rock clasts and segregations of chromite and bornite in drillhole FVS-163 at 157.8 m at Vermelhos deposit; B) Detail of polished slab in FVS-163 at 157.8 m; and C) Dispersed chromite in massive chalcopyrite and pyrrhotite. Pyrrhotite contains some pentlandite (Tappert 2020)

8 DEPOSIT TYPES

The Curaçá valley deposits are complex with features that do not conform to conventional deposit models (this section is modified from *Desrochers et al., 2020*). The strong spatial association of mineralization in the Curaçá valley deposits with mafic-ultramafic bodies, dominated by orthopyroxenite, and the common occurrence of some of the sulphide interstitial ("intercumulus") to orthopyroxene, led several researchers to conclude that mineralization formed through orthomagmatic processes (e.g., Maier and Barnes, 1996), and hence invoked a modified magmatic sulphide model. A number of features, however, are unusual for magmatic sulphide deposits including the high Cu/Ni ratio (virtual absence of Ni in many deposits); significant amounts of bornite in many deposits; significant amounts of magnetite, most of which contains elevated Al, Cr, V, Ni and Zn; the abundance of phlogopite in the orthpyroxenite and wall rocks locally associated with sulphides and in some cases also containing concentrations of apatite and zircon; as well as the low S/Se ratio in sulphides. Maier and Barnes (1996) suggest various mechanisms to explain some of these features including sulfur loss resulting in the abundance of magnetite and the low S/Se ratio.

There are number of potential analogues for the Curaçá valley deposits, depending on the preferred deposit model but the most similar analogue is the O'okiep district, Cape Province, South Africa. The O'okiep deposits are also associated with orthopyroxenites and have high bornite and magnetite contents, and low S/Se in sulphides (Clifford and Barton, 2012; Born et al., 1994; Cawthorn and Meyer, 1993). Born et al. (1994) and Cawthorn and Meyer (1993) suggested that oxidation and desulfurization of a primary pyrrhotite-chalcopyrite resulted in the magnetite-bornite assemblage. This is not consistent, however, with the magnetite compositions in the Curaçá valley deposits (elevated Cr, Ti and V), lack of hematite, and limited evidence for widespread replacement of pyrrhotite by magnetite (Maier and Barnes, 1996), and similar lack of evidence for chalcopyrite by bornite (observed in complex intergrowths in petrography). Regardless, any model for the Curaçá valley deposits must be broadly applicable to the O'okiep district given the number of similarities.

In addition to phlogopite, potentially of more than one generation, extensive hydrothermal alteration has been recognized in some of the deposits in the Curaçá valley, and in structures throughout the district. Alteration includes zones of feldspar +/- biotite (K-alteration) and albite-diopside (Na-Ca alteration), and siliceous alteration particularly in structures. The style of alteration and its local association with mineralization has been used as evidence for a potential iron oxide copper gold ("IOCG") affiliation for deposits in the Curaçá valley (Garcia et al., 2018; Teixeira et al., 2010). In addition, the presence of two generations of magnetite, reported scapolite, and elevated light rare earth elements ("LREE") support a potential IOCG model (Teixeira et al., 2010). It is important to note that Ni-rich IOCG deposits are recognized in the Carajás district and thus Ni is not a discriminant between magmatic sulphide and IOCG deposits.

As with the magmatic model, there are features in the Curaçá valley that are not consistent with the IOCG model, particularly the spatial association of the majority of known mineralization with orthopyroxenites, the relatively restricted alteration compared to major IOCG districts and the uncertain timing relationship of alteration with mineralization, and the lack of a multi-signature that is characteristic of IOCG mineralization (e.g., U, Ba, F, REE in addition to Cu-Au-Ni-Co). In the Curaçá valley, the majority of the magnetite contains highly elevated Al, Cr, Ti and V which is characteristic of magmatic magnetite (possibly reflecting crystallization under high pressures), while the second generation of magnetite contains very low concentrations of these elements. The second generation of magnetite occurs in veins, locally with bornite (Vazelhes, 2018) and is typical of hydrothermal magnetite. Multiple generations of magnetite with varying Ti+V contents have been documented in several IOCG deposits (e.g., Mustafa et al., 2020), but the concentration of these trace elements is significantly lower than first generation magnetite from the Curaçá valley.

Phlogopite is common in orthopyroxenite units in general and is abundant with sulphide both in orthopyroxenite and in gneissic wall-rocks. Phlogopite occurs with orthpyroxene without any indication of replacement, and is present in sulphide clots, where it also appears to be in equilibrium with chalcopyrite and bornite (Maier and Barnes, 1996). Phlogopite therefore appears to have a close relationship to late or post-crystallization processes and sulphide concentration in orthopyroxenite, and as currently understood, is distinct from K-alteration zones in gneiss. It is not clear, therefore, if phlogopite is indicative of a variant of the magmatic or IOCG models. As noted above, it is a feature of both the Curaçá valley and the O'okiep deposits and therefore a common origin is likely.

The setting of the Curaçá valley is further complicated by the presence of significant alkaline intrusions. The most important is the Itiúba syenite complex located to the east of the main concentration of deposits in the Curaçá valley at the boundary between the Serrinha block and the Itabuna-Salvador-Curaçá belt. Alkaline intrusions of various types are known to host copper mineralization and generate fluids that may produce extensive K-Ca-Na-rich alteration similar to that found in IOCG districts. Limited available geochronology suggests that the Itiúba complex is approximately 30 Ma older than the Curaçá valley deposits, and therefore is an unlikely source of fluids and metals in the district. Syenitic intrusions, however, occur throughout the Curaçá valley and while they may be related to the Itiúba complex, currently there are no geochronological or petrological data to confirm this. If an alkaline intrusion is the source of fluids that generated K- and Na-Ca-rich alteration, the same arguments for and against an IOCG model will apply, particularly the importance of the orthopyroxenite and the relationship between alteration and mineralization.

The depth of formation of the Curaçá valley deposits has important implications for ore forming processes and deposit models. The gneissic units have undergone granulite facies metamorphism and three deformation events. Granulite metamorphic mineralogy imply temperatures above 850^{o}C and pressures above 7 kbar (>25 km) at approximately 2.07-2.08 Ga (Barbosa, 2002; Barbosa et al, 2016). The mafic-ultramafic intrusions, dominated by orthopyroxenites, postdate most of the deformation and presumably peak metamorphism, however there are no clear constraints on pressure and temperature ("P-T") conditions. Both orthpyroxene and magnetite mineral chemistry suggest elevated P-T, but existing data do not define precise conditions. If P-T conditions are elevated, there are potential implications for conventional magmatic sulphide and IOCG deposit models.

IOCG deposits have been interpreted to form over a considerable range of depths (Hayward and Skirrow, 2010). The character of mineralization and alteration varies considerably with depth of formation with deep deposits being characterized by magnetite, garnet, pyroxene, actinolite, albite, K-feldspar, Fe-Mg carbonate, and scapolite mineral assemblages. Structural control is important with less lithological control and breccia formation at depth compared to shallow deposits. As a result, exploration criteria require some modification compared to shallow, breccia-dominated IOCG deposits.

There are a variety of potential magmatic processes to explain for the Cu-dominant mineralization. The current working hypothesis invokes low degree partial melts, but regardless, protracted sulphide fractionation under regional high P-T metamorphic conditions was a probable mechanism for further separation of Cu, Ni and PGE-Au. Volatiles were clearly important in this process, explaining the abundance of phlogopite-carbonate. In additional, fluids may have been generated by granite-pegmatites and syenites in the region, at least some of which appear to be contemporaneous with mafic-ultramafic magmatism and sulphide crystallization. These fluids may have modified, remobilized, and added mineralization.

Given uncertainties with the most likely deposit models for the Curaçá valley copper deposits, it is quite possible that previously undocumented processes were responsible for mineralization and a new deposit model is required. This might be a variant of the magmatic sulphide or IOCG models, a hybrid model with magmatic and hydrothermal processes, or something different.

9 EXPLORATION

The first well documented accounts of copper mineralization in the Curaçá Valley date back to 1871 and 1874 (Projeto Especial Caraíba, Relatório Final, Docegeo 1978). However, exploration work was not conducted until 1944 by the DNPM. Results from these programs were published in 1964 (J.L. Melo Jr. and Ernesto B. Pouchain, 1964) who provided a historic estimate of 10,795 tonnes grading 1.0% Cu at the Caraíba Mine. The parameters and assumptions used to determine this estimate are unknown. Additionally, this material was most likely contained within the mined-out open pit. Accordingly, Ero Copper is not treating this historical estimate, nor any portions of it, as relevant to the current mineral resources.

From 1952 to 1953, Northfield Mining Inc. conducted trenching and drilling at the Caraíba Mine and in 1960, the Pignatari Industrial Group conducted systematic exploration work over the Caraíba Mine in association with T. Janer and Mitsubishi Metal Mining. In parallel, systematic investigations were carried throughout the Curaçá Valley by the DNPM (Projeto Especial Caraíba, Relatório Final, Docegeo 1978).

In 1965, the "Projeto Cobre do Vale do Curaçá" was created by the DNPM and in 1974 the "Financiamento de Insumos Basicos SA" assumed control of the concessions and created the "Caraíba Project". In 1975 Docegeo was contracted for the planning and execution of exploration of the area.

Once open pit operations began in 1979, very little exploration work was conducted outside of the main Caraíba Mine area. The open pit operated until 1998 and underground operations began in 1986.

The Caraíba operation was privatized in 1994 and again, between 2004 and 2007, very little formal exploration work was conducted until the Codelco JV. Codelco conducted work on several prospects outside the Pilar UG Mine area including an airborne VTEM geophysical survey over the Vermelhos District. Oxide leach operations started in 2006 and operated continuously from 2007 to 2015. Most of the exploration work was focused on (i) replacing mined reserves annually, and (ii) where they were performed regionally, they were focused on individual properties to maintain tenure ownership.

Details of the exploration work and programs conducted at the MCSA Mining Complex by the Company since its acquisition of MCSA in December, 2016 are set out in subsections below.

9.1 GEOCHEMICAL SURVEYS

Near-surface copper mineralization in the Curaçá Valley is well-defined by geochemical sampling techniques including drainage and soil surveys. Mineralized ultramafic-mafic intrusions show anomalous Cu, Ni, Co, Cr, and Mg. Several drainage and soil geochemical surveys were conducted along the Curaçá Valley. Over 50,000 drainage and soil samples were collected during the various exploration campaigns.

In 2017, Ero Copper engaged Infotierra, specialists in geo-focused remote sensing and database management, to compile and validate geochemical data from the various surveys. Heberlein Geoconsulting, specialists in exploration geochemistry, were then contracted by Ero Copper in 2017 to further validate and perform levelling analysis on the historical soil and drainage sediment geochemistry datasets.

Given the long history of the sampling programs, interpretation of anomalies and targets would not be possible without appropriate data levelling to remove artifacts caused by differences in laboratories and analytical methods across discrete surveys. The reinterpretation of copper results in soil based on historic geochemical surveys after z-score levelling has been performed.

In 2020, Ero Copper engaged Alexandre Rocha da Rocha (via FUNCERN), specialist in geochemical exploration in tropical terrains, to execute a multi-element soil sampling campaign in the Curaçá Valley and interpret the results. The program consisted of just over 20,000 samples collected dominantly in the Surubim district from March to September 2020. Data processing and interpretation included factor analysis to support the target generation process. Figure 9-1 shows the Cu-Bi-Te factor coefficients from new multi-element soil geochemistry.

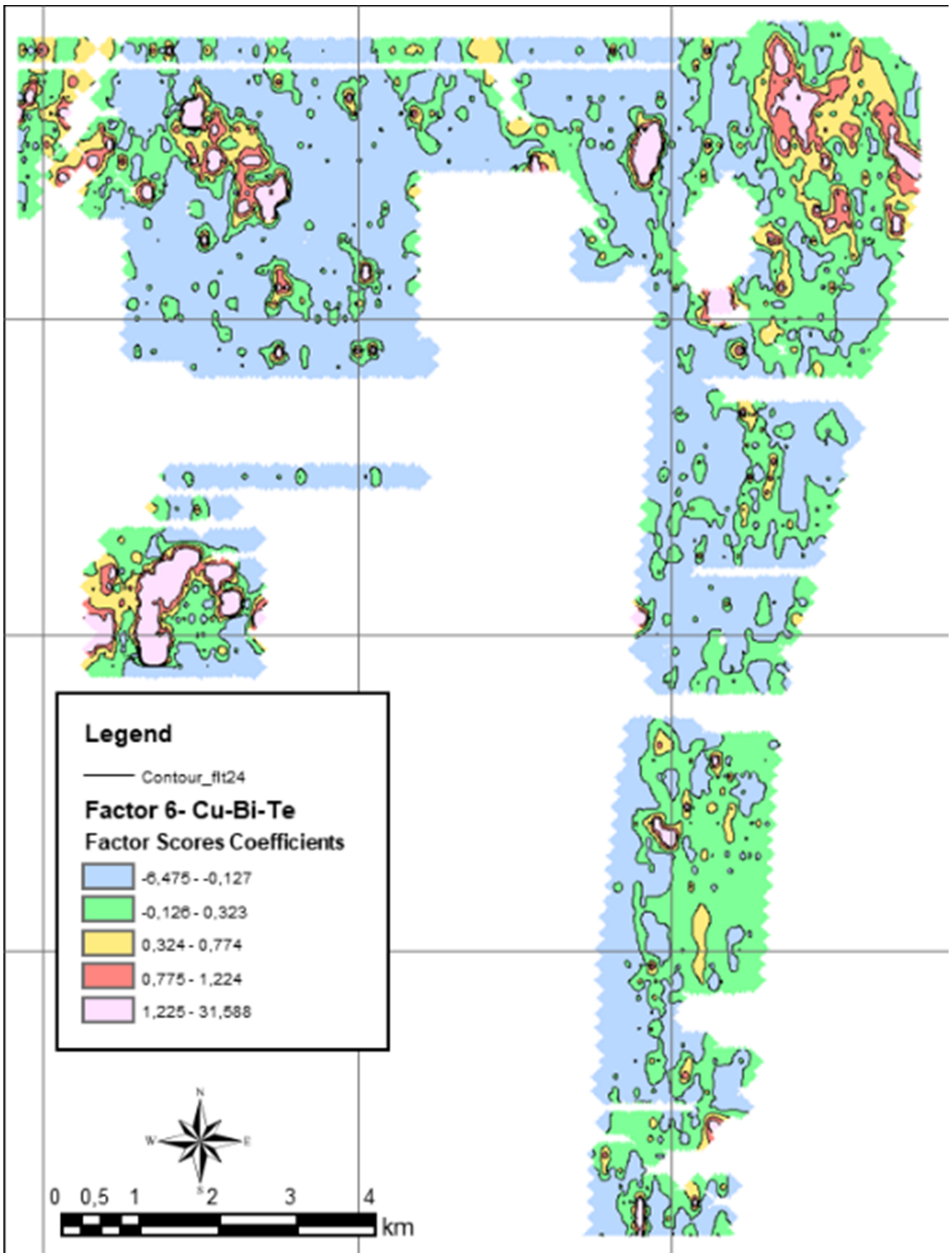


Figure 9-1: Image of Cu-Bi-Te Factor Coefficients from Soil Geochemical Results on the Surubim District (MCSA, 2020)

Geophysical Surveys

In addition to geochemical surveys, several geophysical surveys have been carried out along the Curaçá Valley prior to Ero Copper's acquisition of MCSA. Most surveys were conducted on specific targets or properties. These surveys included ground magnetic, gravity and Induced Polarization ("IP") surveys. Historic regional airborne geophysical surveys included a magnetic and radiometric survey that was flown by the CBPM ("Companhia Baiana de Pesquisa Mineral"). An airborne VTEM survey was flown over the Vermelhos District by Codelco who also conducted follow-up Ground EM and BHEM. The EM survey data is currently being analyzed and re-processed. MCSA also conducted ground surveys of gravity, magnetics and induced polarization over the years as shown in Table 9-1, Figure 9-2, Figure 9-3 and Figure 9-4.

In 2020, Ero Copper/MCSA increased the IP and ground gravity survey coverage to improve target generation and prioritization coupled with the multi-element soil sampling results.

Mineralized mafic-ultramafic intrusions respond well to gravity, IP, EM and BHEM. As of the Effective Date, Ero Copper was conducting physical property surveys of drill core from the Pilar, Vermelhos and Surubim Districts in order to better characterize ore types and optimize geophysical detection methods for use in re-interpretation of historic results and in guiding future geophysical and exploration surveys.

Table 9-1: Summary of all surveys executed in the Curaçá Valley, December 2020 (MCSA, 2020)

Regional Projects	Soil	Stream Sediments	Ground Gravity	Ground Magnetometry	IP
	Total Samples	Total Samples	Line meters (m)	Line meters (m)	Line meters (m)
Curaçá Valley South	4225	436	717850	438150	291450
Curaçá Valley Center	18801	709	802235	385500	376200
Curaçá Valley North	11833	521	749180	583300	280400
Total Curaçá Valley	34859	1666	2269265	1406950	948050

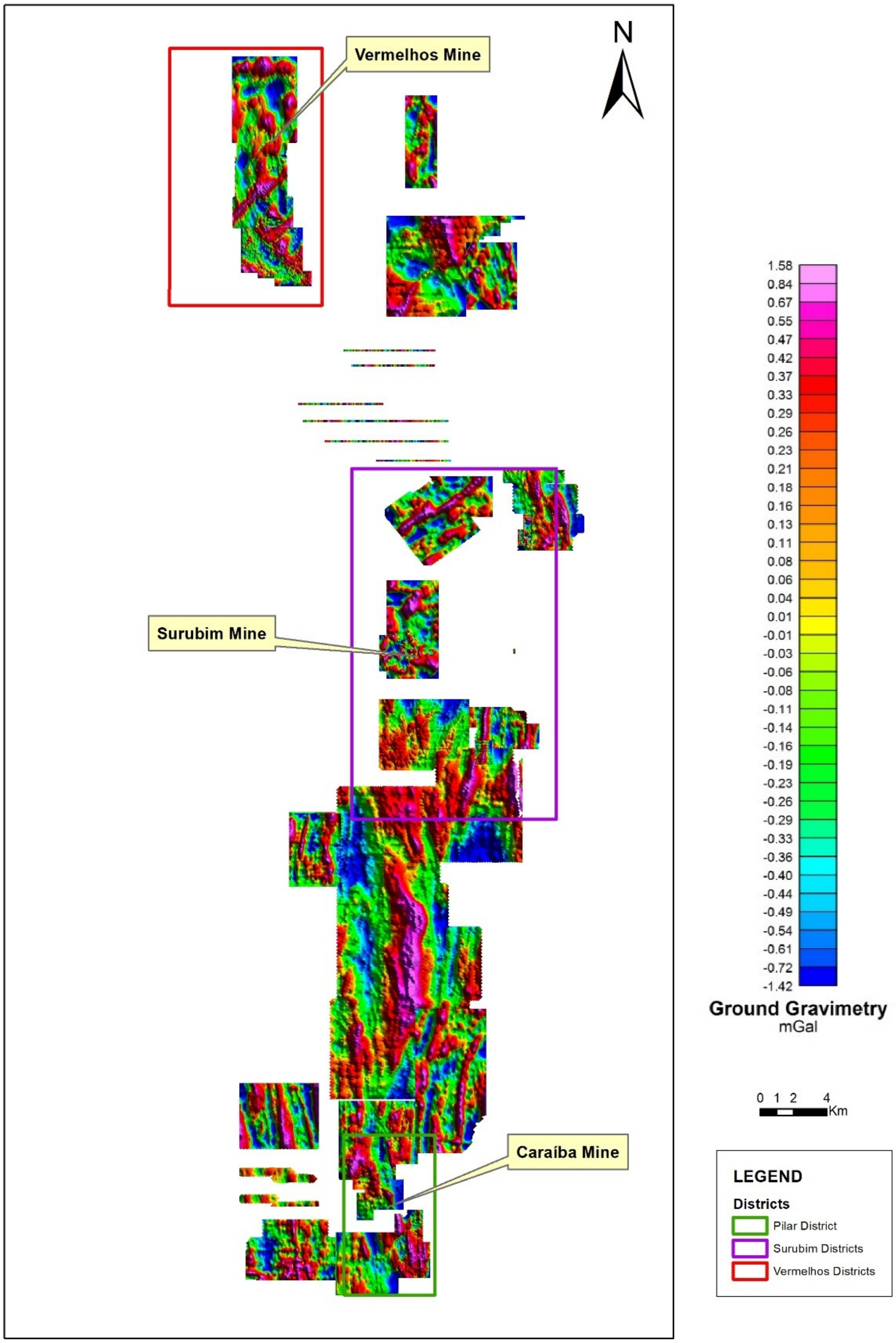


Figure 9-2: Map of the main gravimetric anomalies of the main gravimetric anomalies of Curaçá Valley (MCSA, 2020)

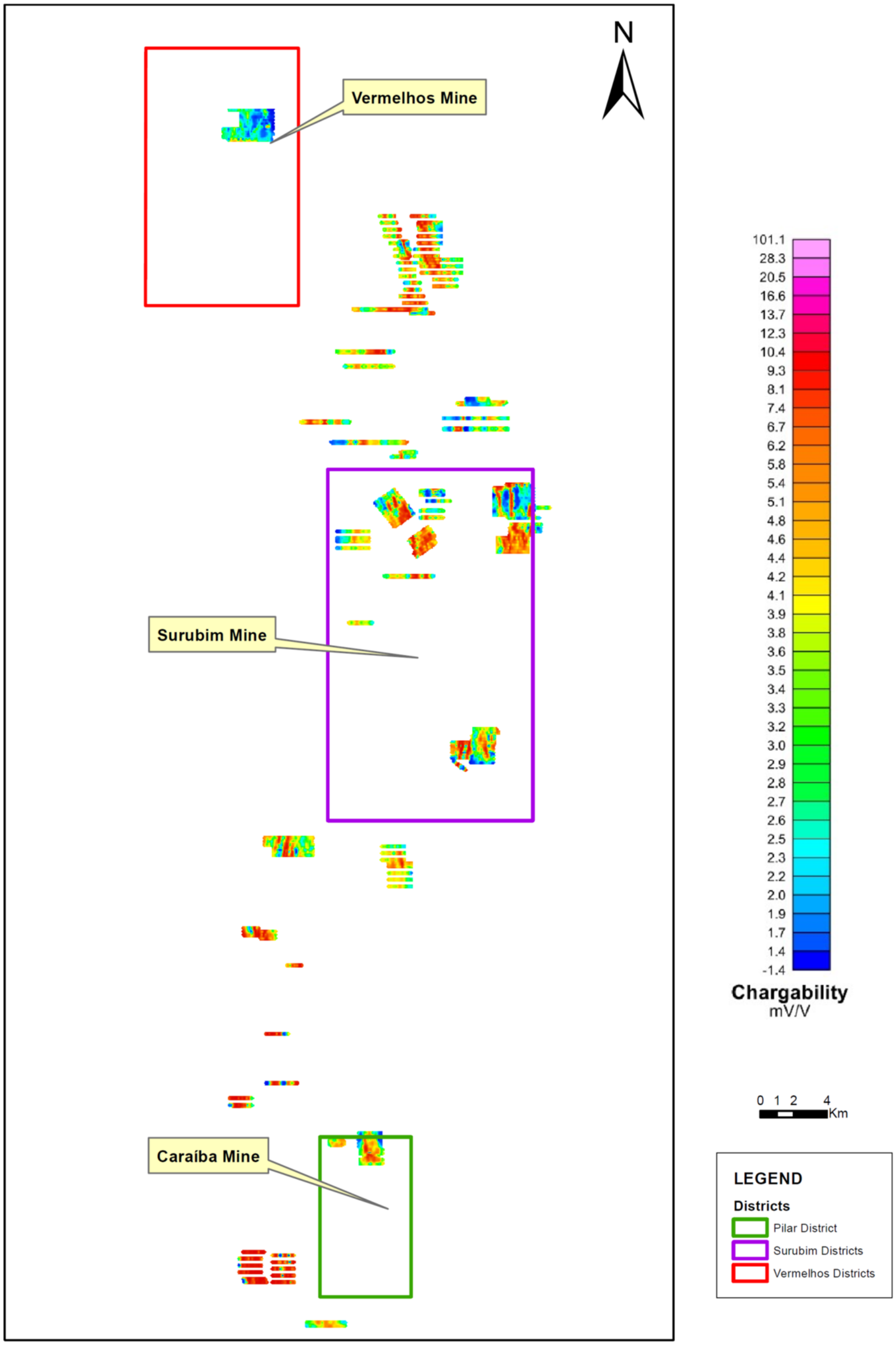


Figure 9-3: Regional Induced Polarization (IP) map of the Curaçá Valley in 2020 (MCSA, 2020)

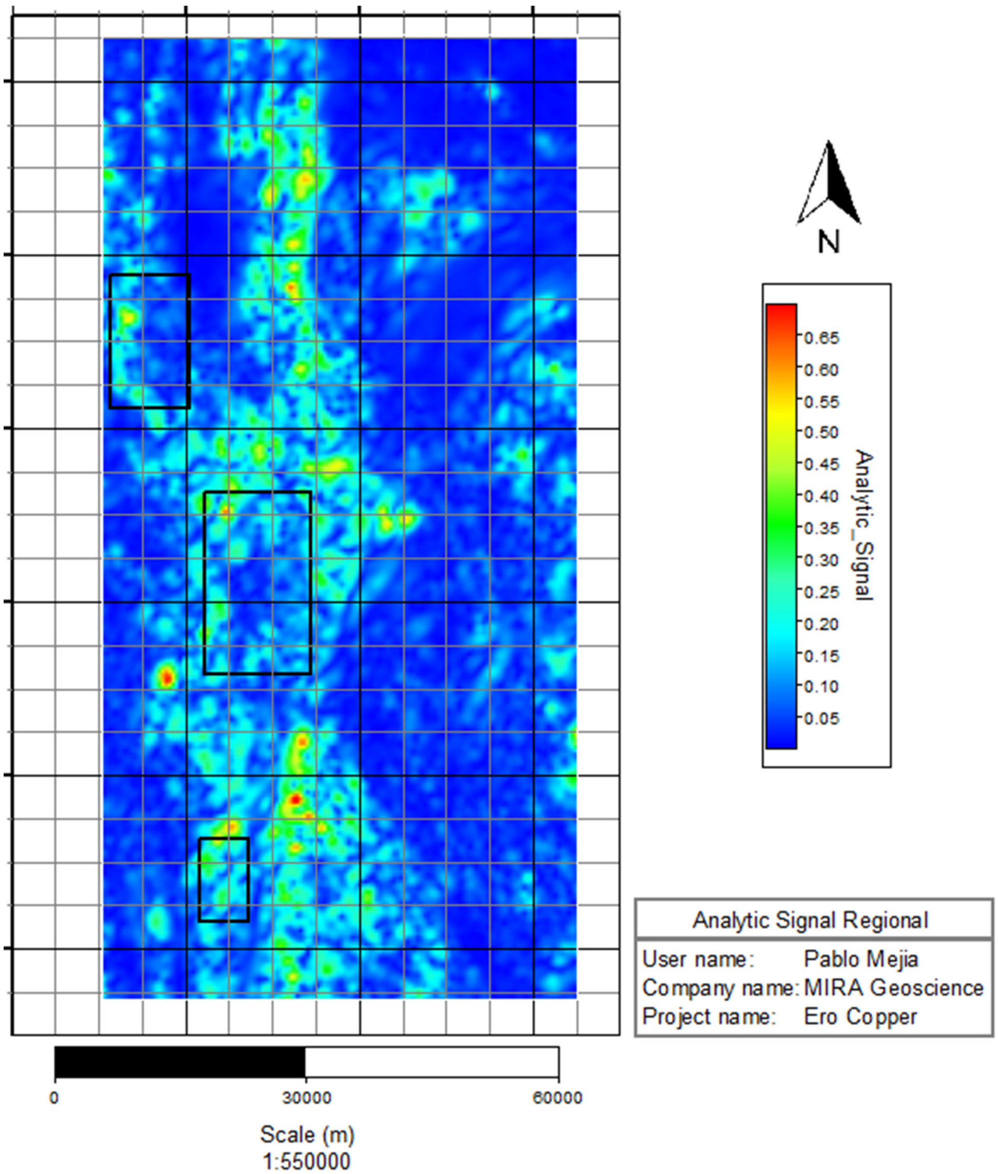


Figure 9-4: Regional analytical signal map of the Curaçá Valley (Mira Geoscience, 2017)

9.2 EXPLORATION PROGRAMS

A series of drill programs have been conducted throughout the years. The bulk of the drilling is related to the Caraíba Mine open pit and Pilar UG Mine where, in total, over 800,000m have been drilled in over 5,650 holes. Outside of the Caraíba Mine, in the rest of the Curaçá Valley, a total of almost 530,000m has been drilled in more than 2,650 holes, most of which were drilled in the Vermelhos District. Drilling conducted outside Caraíba and Vermelhos Districts was previously focused on defining shallow open pit mineralization to feed the plant following closure of the historic Pilar open pit mine in 1998 and for exploration permit renewal purposes.

In 2007, MCSA acquired mineral rights and previously collected historic drill data adjacent to the Caraíba Mine from Vale S.A ("Vale"). There is no drill core available for the Vale drill holes making it impossible for the authors of this

Report to independently verify the information. As such, restrictions were applied to this information, whereby the geological coding from these holes has been allowed to inform the geological model wireframes, but all recorded assays from the Vale drill holes have been excluded from the current mineral resources and mineral reserves estimate.

In addition to the Vale holes, any historic drill holes that could not be sufficiently verified through well defined QA/QC procedures were removed from the database for the purposes of the current mineral resource and mineral reserve estimate. Between June 2018 and September 2019, some old drill holes were reviewed and re-assayed (under a post-mortem QA/QC process). Upon verification by the authors of this Report, these holes were included into the database for the purposes of the current mineral resource and mineral reserve estimate.

9.2.1 **Curaçá Valley Regional Exploration**

Since the acquisition of MCSA by Ero Copper, and for the first time in the property's history, a list of regional priority exploration targets has been developed following compilation and comparative analysis of historic data throughout the Curaçá Valley. Priority targets tend to cluster in three main Districts: the Pilar District, the Vermelhos District and the Surubim District, as shown in the figure below.

To enhance the effectiveness of priority targeting, Ero Copper commissioned two airborne geophysical surveys utilizing single sensor electromagnetic and gravimetric methods. These surveys covered approximately 24,000 line-km and were performed by Aerocientifica (responsible for the logistics of the survey); Skytem (responsible for the Airborne EM method) and Sanders (aerogravimetric surveys). Aerocientifica, Skytem and Sanders are independent of the Company as such term is defined under NI 43-101. The surveys were concluded in August of 2018. The data processing was finished simultaneously with the conclusion of the survey by Mira Geoscience, also independent of the Company as such term is defined under NI 43-101. The analysis and prioritization of drill targets remains ongoing and several of the first drill tested targets have led to promising results, like the Siriema discovery, announced in July of 2019.

Commencing in 2018, BHEM surveys were used in all of the exploratory drilling holes surrounding the main mining and exploration areas with the objective of identifying continuity of high-grade mineralization and/or the discovery of new mineralization within the vicinity of the drill holes. This remains a key exploration focus area of the Company and systematic BHEM surveys are ongoing.

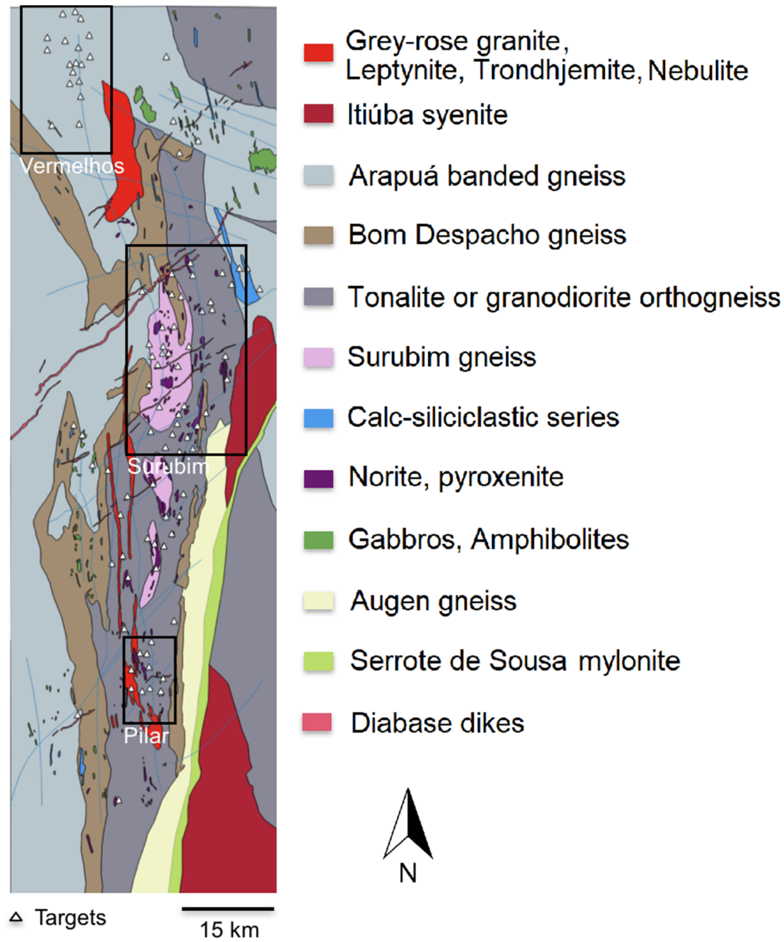


Figure 9-5: Curaçá Valley regional exploration targets shown generated via surface mapping (modified from MCSA, 2015)

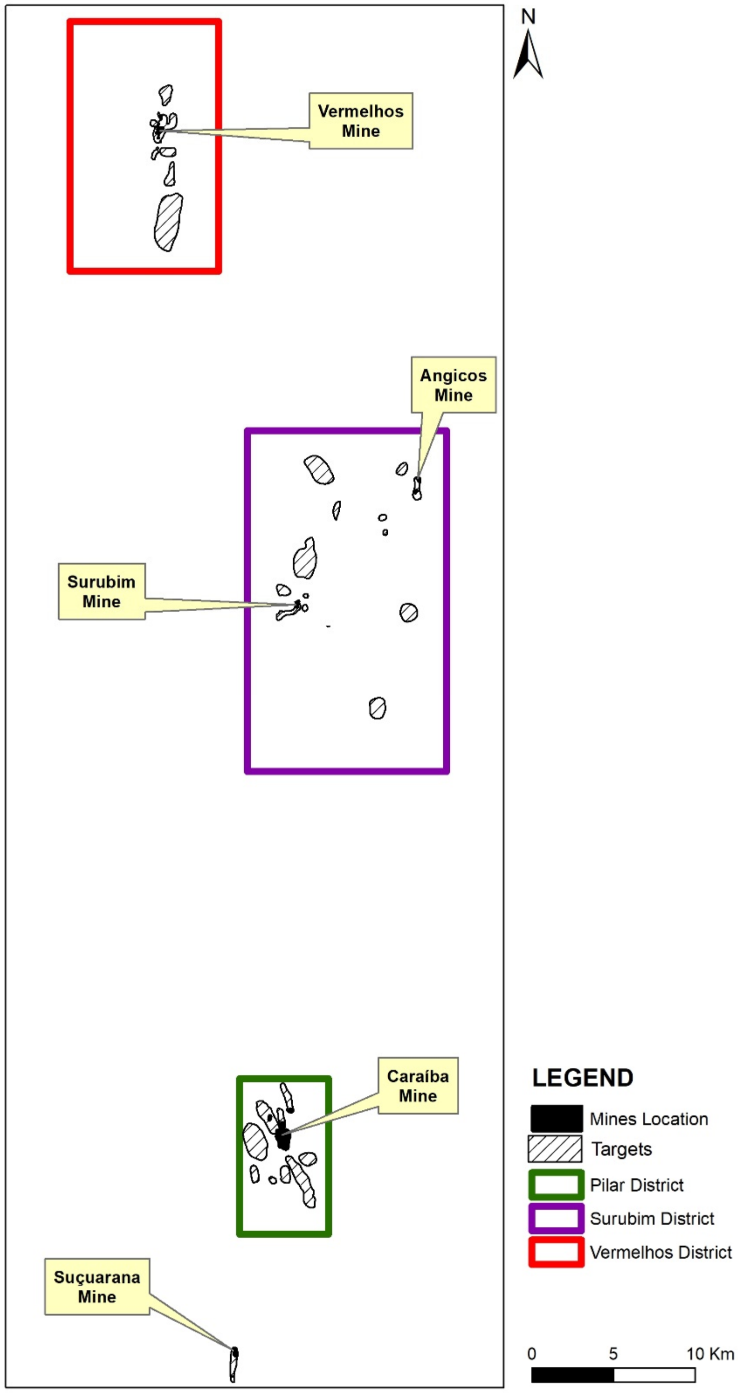


Figure 9-6: Location Map of the main targets of investigation in the Curaçá Valley. The targets were generated by the integration of geochemical, gravimetric, magnetometric, IP, results of the drilling and mapping of mafic/ultramafic rocks (MCSA, 2018)

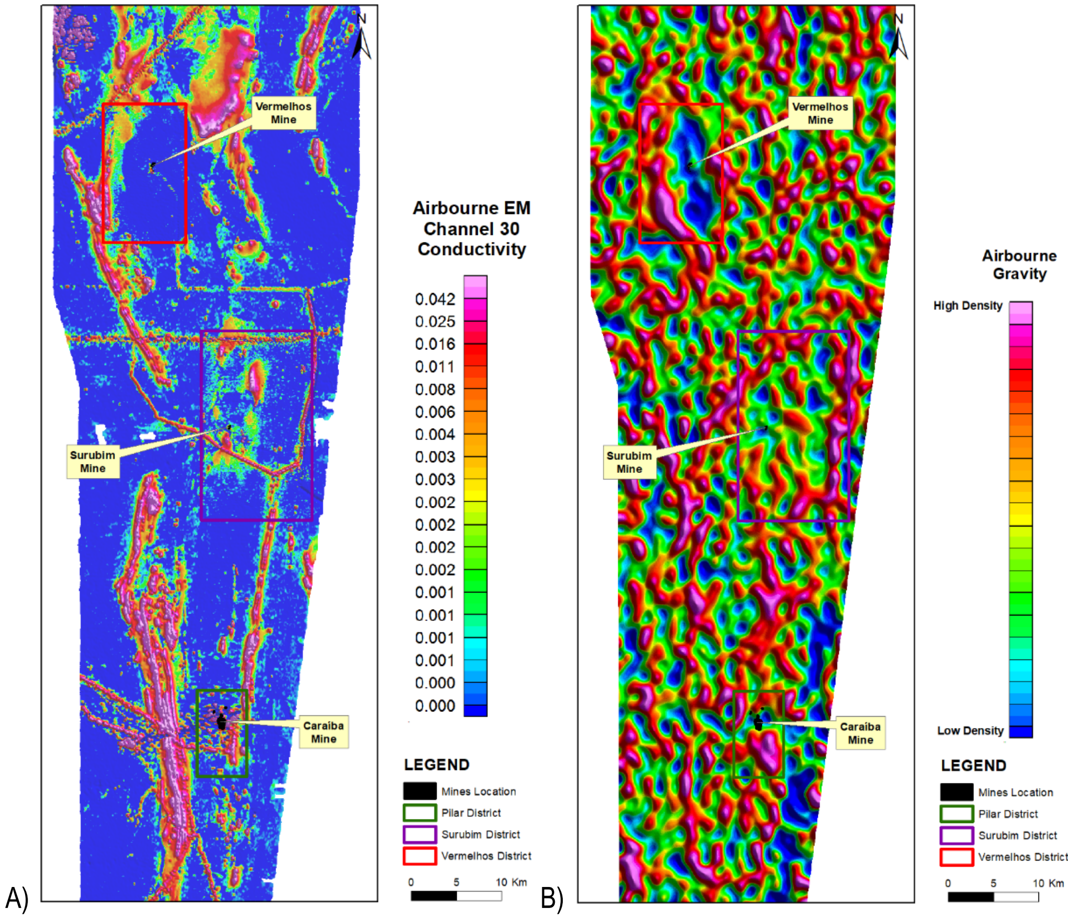


Figure 9-7: Airborne Electromagnetic, channel 30 (A) and Gravity Bouguer with a high pass filter of 10 km (B) Surveys on Curaçá Valley concluded in 2018 (Mira Geoscience, 2018)

9.3 EVOLUTION OF MINERAL RESOURCES AND MINERAL RESERVES

Since the acquisition of MCSA in late 2016, Ero Copper has been working with MCSA to compile, organize, validate, analyze and interpret the various historical data sets. A list of exploration targets has been created and is continually updated and prioritized. Priority targets occur in three main clusters or "Districts": Pilar, Vermelhos and Surubim. A systematic review of all targets within the Curaçá Valley commenced and in early 2019 the first of these regional "greenfield" targets was drill tested – resulting in the Siriema discovery. Several additional targets throughout the Curaçá Valley are under investigation through both ground geophysical and geochemical studies as well as drilling. Regional exploration efforts were slowed in 2020 as a result of the COVID-19 pandemic.

Through ongoing drill programs conducted from 2017 to 2020, Ero Copper has been able to incrementally increase the known resources of the Curaçá Valley, with a notable increase in the 2020 updated mineral resource and mineral reserve estimate as a result of the discovery of and delineation of the Deepening Extension Zone of the Pilar Mine prior to the Effective Date. A summary of the incremental contained copper, as compared to the 2019 Technical Report:

- Within the Pilar Mine, relative to the 2019 Technical Report, Proven mineral reserves decreased by 16%, Probable mineral reserves increased by 98%, while Measured mineral resources increased by 15%, Indicated mineral resources increased by 52%, and Inferred mineral resources increased by 155%. The mineralized extent of the Deepening Extension Zone has yet to be fully defined and remains open to the north, east and to depth.

- Within the overall Curaçá Valley, relative to the 2019 Technical Report, Proven mineral reserves decreased by 10%, Probable mineral reserves increased by 69%, Measured mineral resources increased by 12%, Indicated mineral resources increased by 56% and Inferred mineral resources increased by 62%, inclusive of the Deepening Extension Zone.

A summary of the relative year-on-year changes in mineral resource and mineral reserve as a result of these exploration efforts is shown below for reference purposes. Please refer to the additional technical and scientific information for the current mineral resource and reserve estimate in Chapter 14 and Chapter 16 of this Report. Information on the 2019 Technical Report is further detailed in Chapter 6 – History. Mineral resources which are not mineral reserves do not have demonstrated economic viability.

Table 9-2: Year-on-Year changes in contained copper within the Curaçá Valley (Ero Copper, 2020)

	Summary, 2020 Update[1,2]			Year-on-Year Change	
	Tonnes (000s)	Grade (Cu %)	Contained Cu (kt)	Contained Cu (kt)	(%)
Deepening Extension Zone, Pilar Mine					
Mineral Reserves					
Proven	-	-	-	-	n/a
Probable	7,432	1.68	125	101	421%
Proven & Probable	**7,432**	**1.68**	**125**	**101**	**421%**
Mineral Resources					
Measured	-	-	-	-	n/a
Indicated	7,527	1.86	140	110	373%
Measured & Indicated	**7,527**	**1.86**	**140**	**110**	**373%**
Inferred	*4,476*	*2.12*	*95*	*70*	*284%*
Pilar Mine (including Deepening Extension Zone)					
Mineral Reserves					
Proven	5,835	1.41	82	(15)	(16%)
Probable	15,157	1.38	209	103	98%
Proven & Probable	**20,992**	**1.39**	**291**	**88**	**43%**
Mineral Resources					
Measured	26,829	1.50	401	52	15%
Indicated	21,518	1.37	295	101	52%
Measured & Indicated	**48,347**	**1.44**	**696**	**153**	**28%**
Inferred	*17,266*	*1.20*	*206*	*126*	*155%*
Curaçá Valley, Total (including Pilar Mine)					
Mineral Reserves					
Proven	21,464	1.06	228	(26)	(10%)
Probable	28,990	1.06	308	126	69%
Proven & Probable	**50,454**	**1.06**	**536**	**100**	**23%**
Mineral Resources					
Measured	49,158	1.27	624	69	12%
Indicated	53,627	0.99	531	192	56%
Measured & Indicated	102,786	1.12	1,155	**260**	**29%**
Inferred	*39,201*	*1.00*	*391*	149	*62%*

Notes to Summary Table:

1. Presented mineral resources inclusive of mineral reserves. Mineral resources that are not mineral reserves do not have a demonstrated economic viability. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.

Underground Mineral Resource Notes:

1. Mineral resource effective date varies by deposit, with an effective date of August 8, 2020 except for P1P2 (July 24, 2020), R75 (July 9, 2019) and Suçuarana (July 3, 2020) within the Pilar District; Vermelhos Mine (July 29 2020), Siriema and N8 (July 4, 2020), N9 (July 9, 2019) within the Vermelhos District; and Surubim District effective date of July 9, 2019 except for Terra do Sal (July 3, 2020).
2. Presented mineral resources inclusive of mineral reserves. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
3. Mineral resources have been constrained within newly developed 3D lithology models applying a 0.45% and 0.20% copper grade envelope for high and marginal grade, respectively. Within these envelopes, mineral resources for underground deposits were constrained using varying stope dimensions of up to 20m by 10m by 35m applying a 0.51% copper cut-off grade, as well as a 0.32% copper marginal cut-off grade. Mineral resources have been estimated using ordinary kriging inside 5m by 5m by 5m block sizes. The mineral resource estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate to the deposit.

Open Pit Mineral Resource Notes:

1. Mineral resource effective date varies by deposit, with an effective date of August 8, 2020, except for Suçuarana (July 3, 2020), R22W and R75 (July 9, 2019) within the Pilar District; Siriema and N8 (July 4, 2020), N9 and Vermelhos North (July 9, 2019) within the Vermelhos District; and an effective date of July 9, 2019 for the Surubim District except Terra do Sal (July 3, 2020). Presented mineral resources inclusive of mineral reserves. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
2. Mineral resources have been constrained within newly developed 3D lithology models using a 0.21% copper cut-off grade for open pit deposits. Mineral resources have been estimated using ordinary kriging inside 5m by 5m by 5m block sizes. The mineral resource estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate to the deposit.

Mineral Reserve Notes:

1. Mineral reserve effective date of October 1, 2020. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
2. Mineral reserve estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate for the deposit. Mineral reserves are based on a long-term copper price of US$2.75 per lb, and a USD:BRL foreign exchange rate of 4.27, except for the C12 (Surubim District) and Suçuarana (Pilar District) open pit mines, whose design was not changed since 2019, and continued to assume a 3.70 USD:BRL foreign exchange rate. Mineral reserves are the economic portion of the Measured and Indicated mineral resources. Mining dilution and recovery factors vary for specific mineral reserve sources and are influenced by factors such as deposit type, deposit shape, stope orientation and selected mining method. Inferred resource blocks, where unavoidably mined, were assigned zero grade.

9.3.1 Pilar UG Mine Exploration

Exploration in the immediate Pilar UG Mine area is currently focused on extending known mineralization to depth, following a high-grade interpreted trend of mineralization which has been based upon a review of historical data and new drilling that intercepted mineralization above 8.0% copper, including in previously mined areas. Using this information, the Company has developed an interpolated north-plunging structural zone of high-grade potential extending to depth, as shown in Figure 9-8: Longitudinal Section of the Pilar UG Mine Showing Primary Exploration Target Area Projected from the Deepening Extension Zone (MCSA, 2020). Drilling from underground and surface utilizing directional drilling technology is currently underway to better evaluate mineralized continuity of this high-grade target area. Additional exploration drilling is underway to further upgrade the Inferred mineral resources within the Deepening Extension Zone.

Additional exploration activities are planned to the south in the upper levels of the mine (Baraúna and MSB South) as well as at the northern limits of the Pilar UG Mine, near-surface, testing new extensions of the West Limb beneath the historic R22 OP Mine.

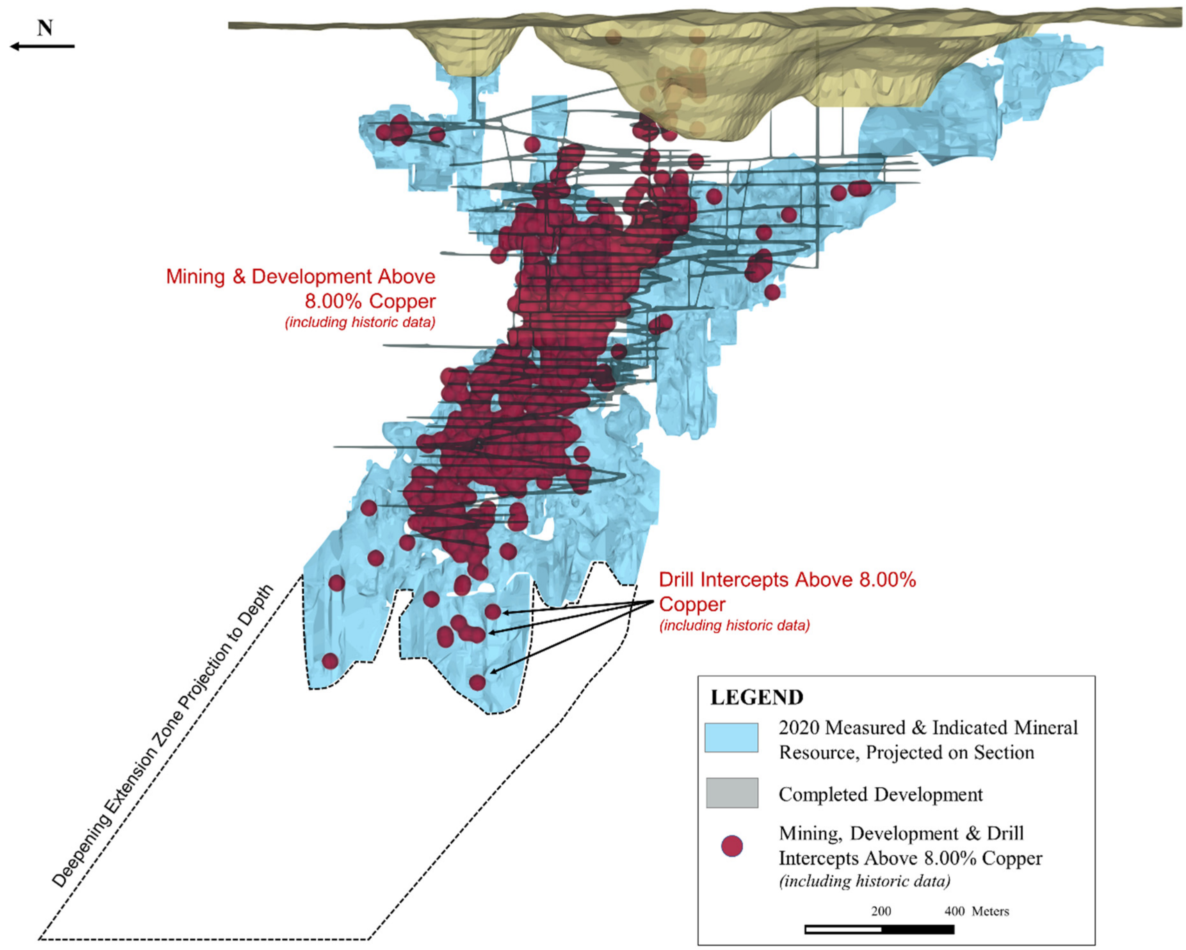


Figure 9-8: Longitudinal Section of the Pilar UG Mine Showing Primary Exploration Target Area Projected from the Deepening Extension Zone (MCSA, 2020)

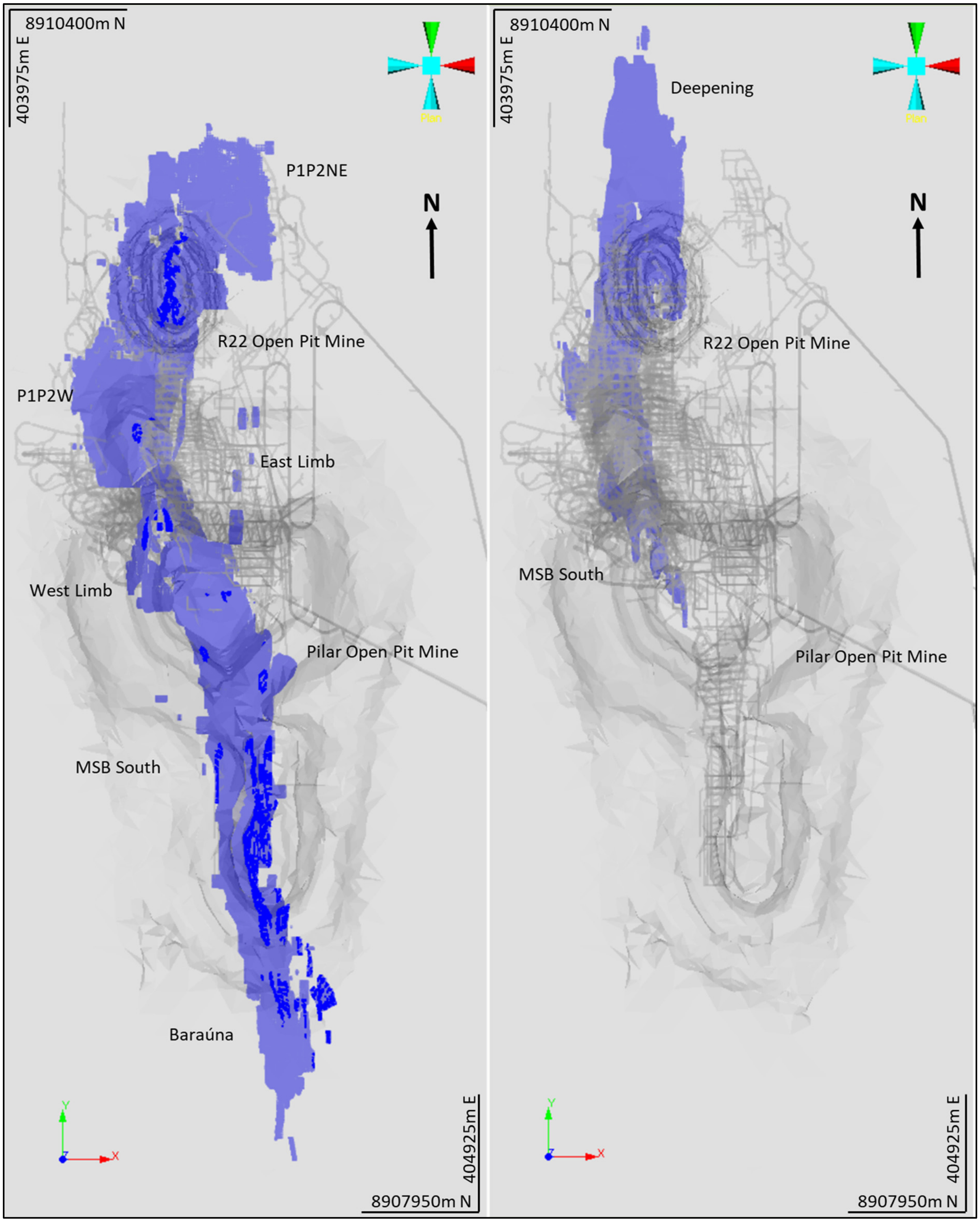


Figure 9-9: Plan view of the Pilar UG Mine mineral resource bodies (shown in blue) above L-600(left) and below L-600 (right), inclusive of reserves, and the infrastructure of the mine (MCSA, 2020)

9.3.2 Pilar District Exploration

Data compilation work suggests that the Pilar District is 5 km long by 1.5 km to 3 km wide centered upon the Pilar UG Mine. Priority drill targets, detailed in the figure below, occur where data integration work shows coincident magnetic, gravity, IP and soil geochemical anomalies. Drill testing is planned for anomalies along the northwest corridor, to the northwest of the R22W Mine, and along the southeast corridor, southeast of the mine Caraíba towards S10 and S5 (Figure 9-10 and Figure 9-11).

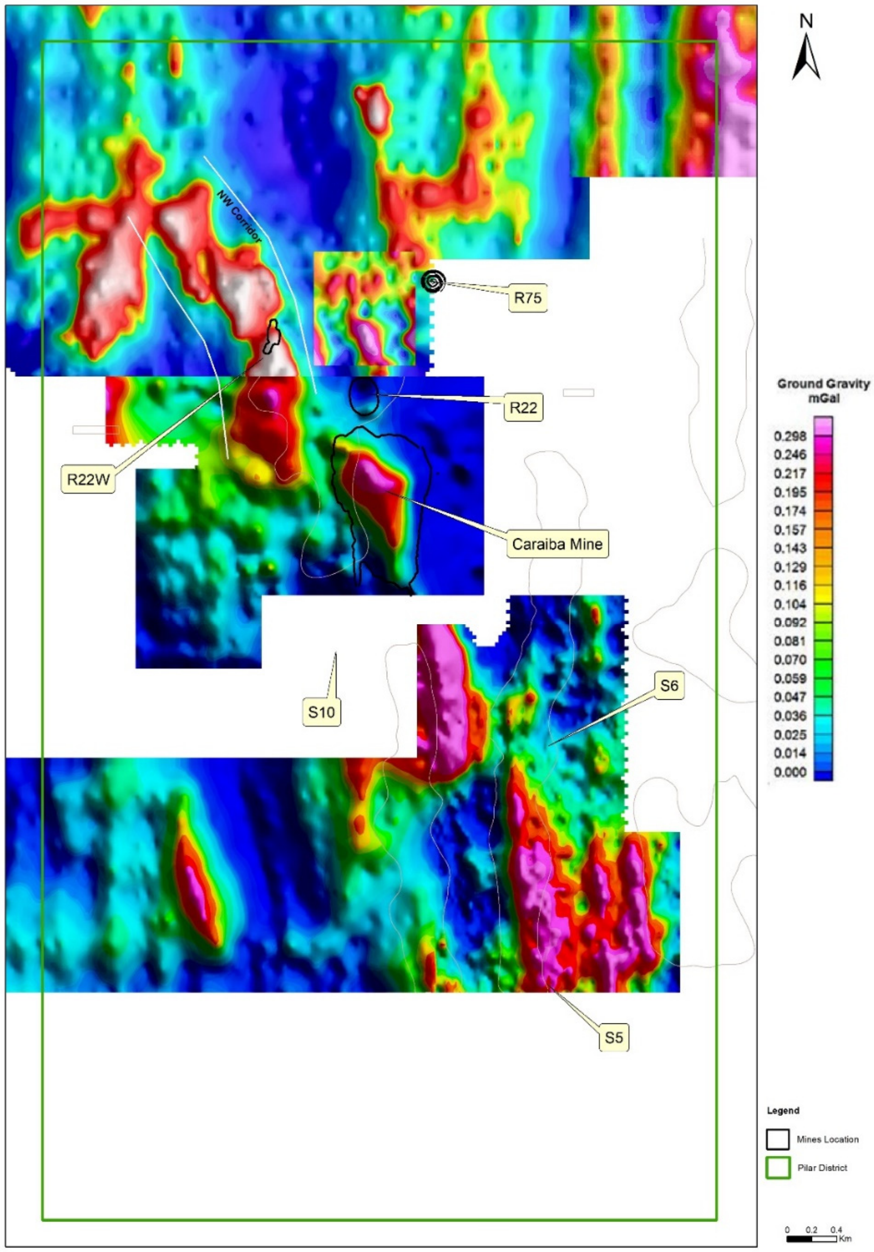


Figure 9-10: Residual gravity of the Pilar District showing anomalies of interest (MCSA, 2019)

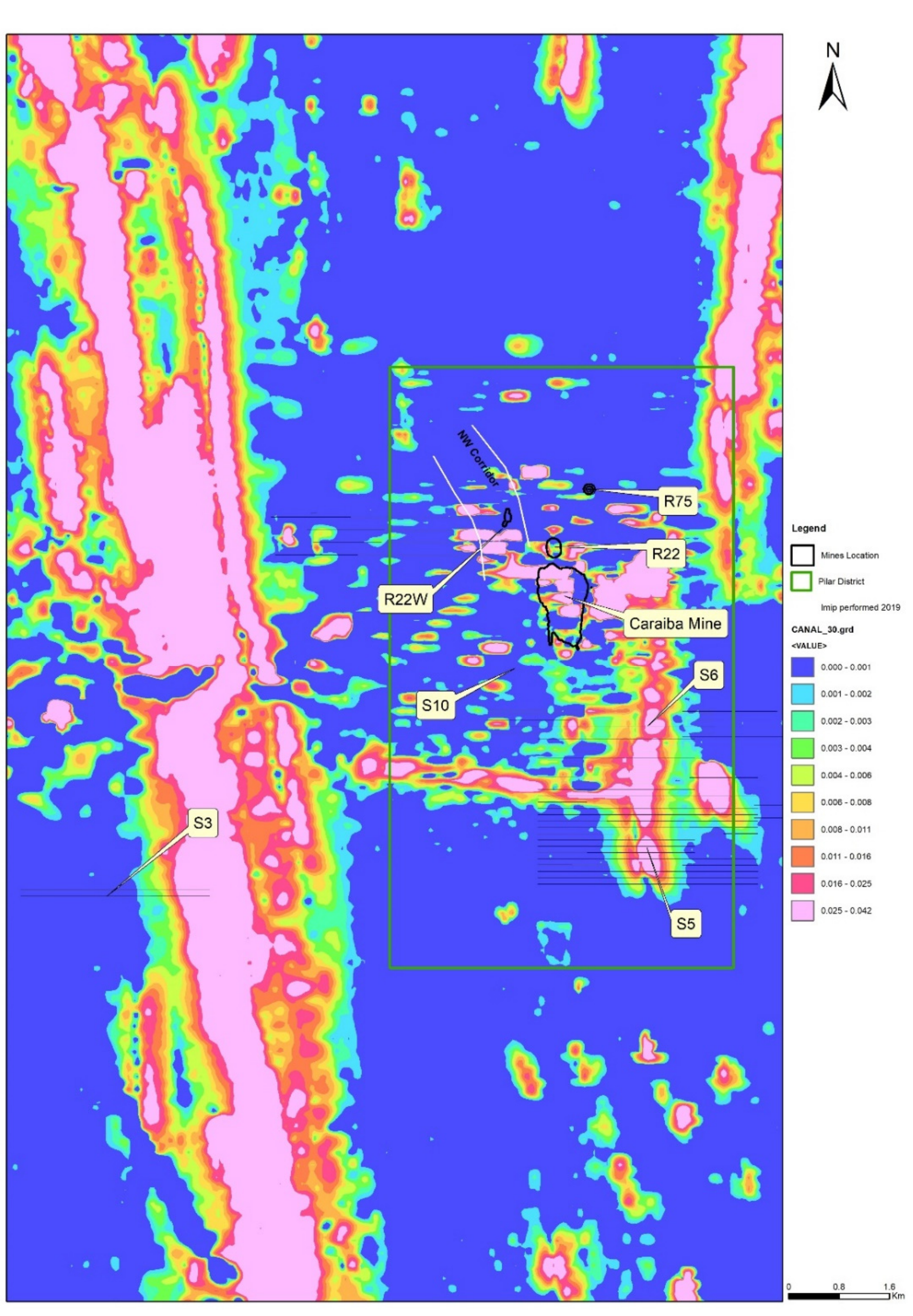


Figure 9-11: Preliminary airborne EM map of the Pilar District showing EM anomalies associated with targets defined by historic surveys (MCSA, 2019)

9.3.3 Surubim District Exploration

The data compilation work suggests that the district of Surubim has a north-south length of approximately 20 km and a width of approximately 12 km. Exploration targets such as those extending from the past producing Angicos and Surubim Mines as well as new areas including C6, C12, C15, C14, Carcará and Pau Ferro are all priorities within the District, as detailed in Figure 9-12, Figure 9-13 and Figure 9-14. Data integration work, target prioritization and initial drill testing in the Surubim District remains ongoing.

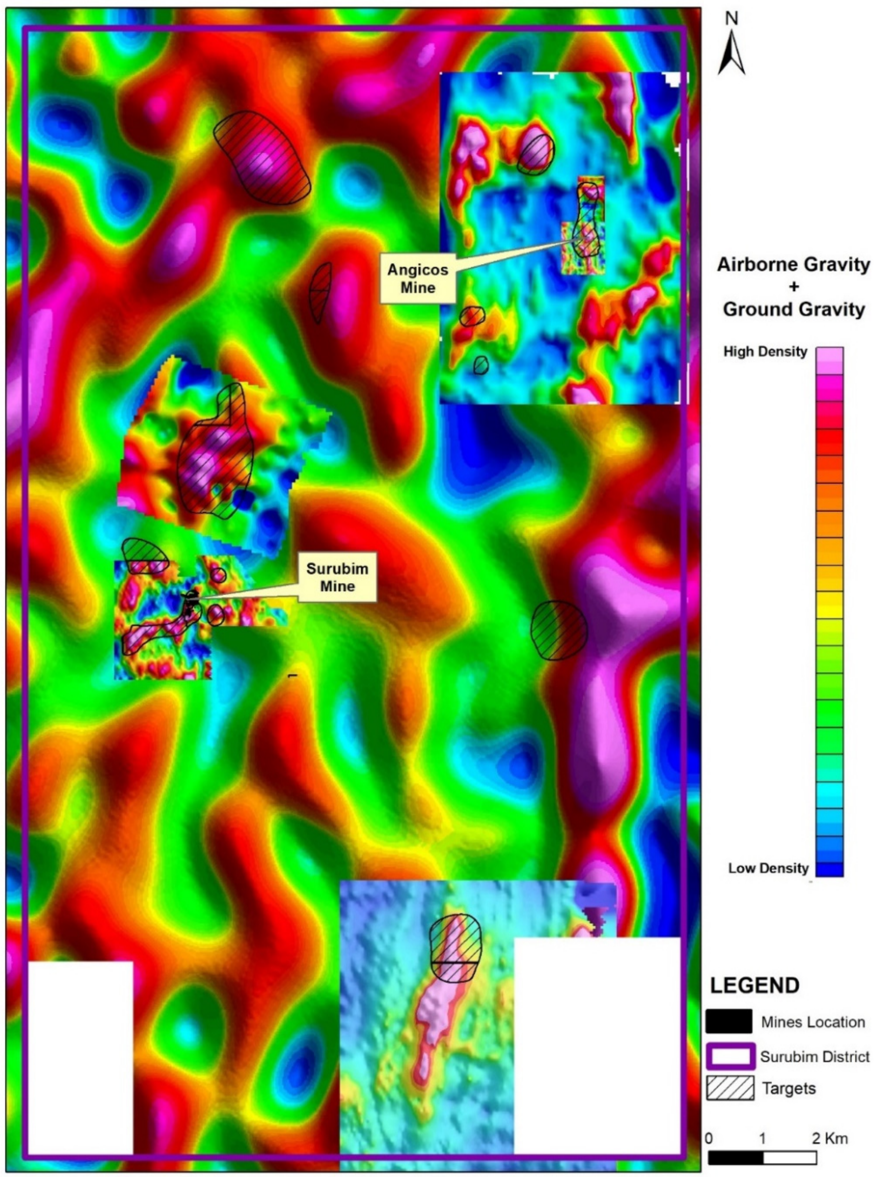


Figure 9-12: Preliminary airborne gravity map integrated with ground gravity of targets within the Surubim District highlighting anomalies associated with targets defined by historic surveys (Mira Geoscience, 2018)

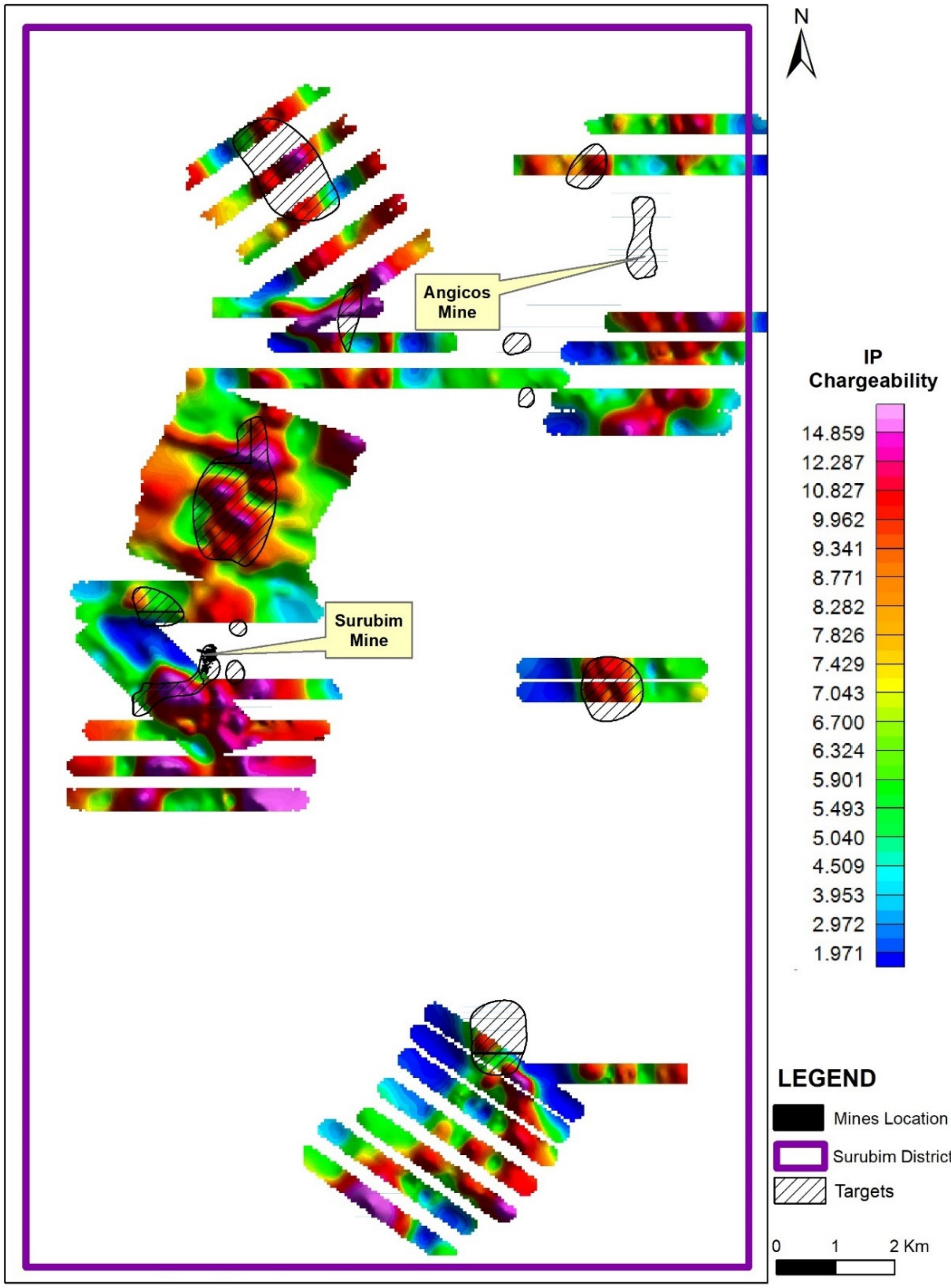


Figure 9-13: Induced polarization (2017) of the Surubim District showing IP anomalies (chargeability) associated with targets defined by historic surveys (MCSA, 2017)

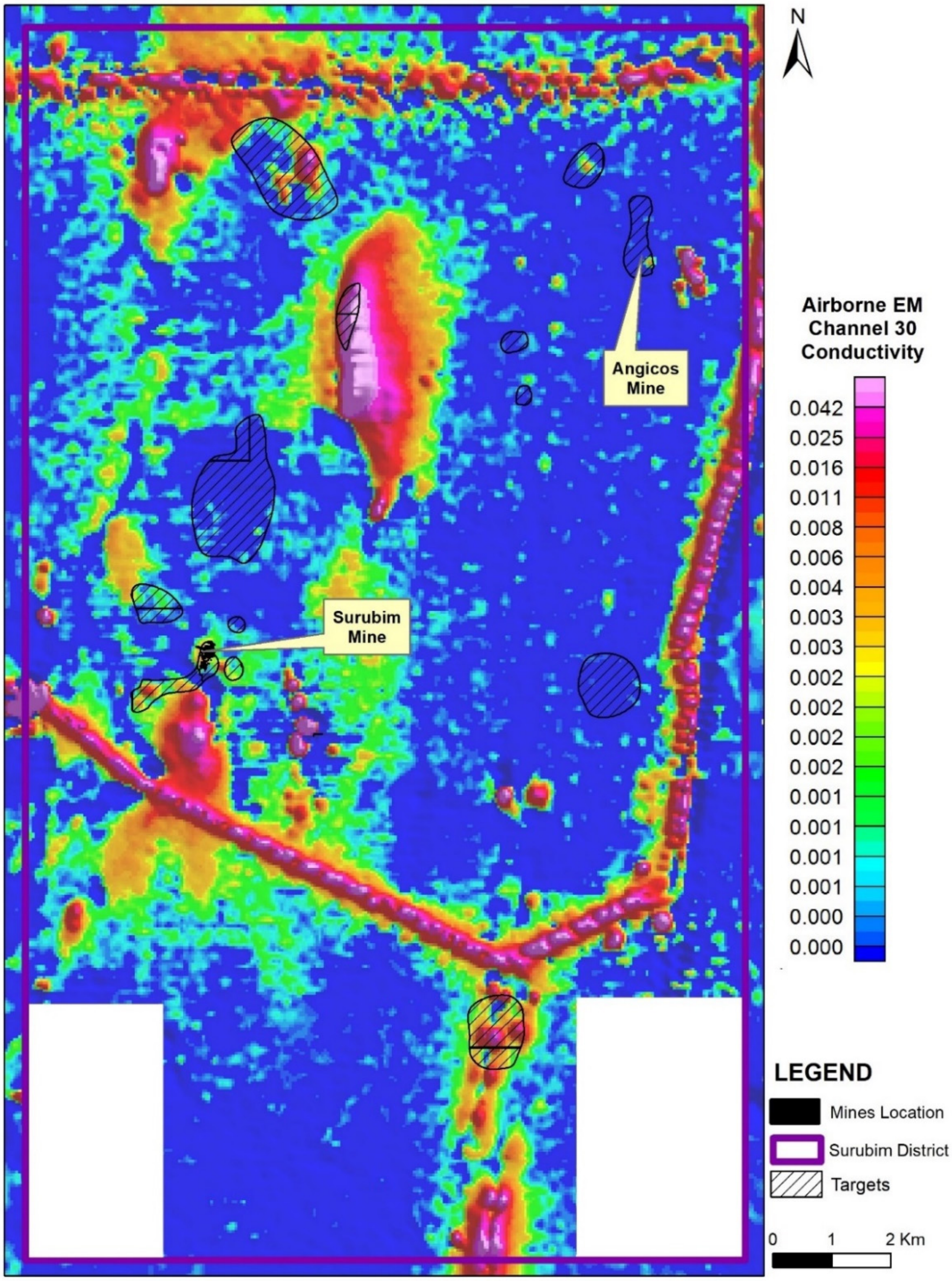


Figure 9-14: Preliminary airborne EM map (2018) of the Surubim District showing EM anomalies associated with targets defined by historic surveys (Mira Geoscience, 2018)

9.3.4 **Vermelhos UG Mine Exploration**

In 2020, a new near-mine target area was identified near the Vermelhos UG Mine, known as the "Southern Vermelhos Corridor" which extends from Siriema to the UG1 mining area, located at the southern limits of the Vermelhos UG Mine. The target zone has a north-south strike length of approximately 700 meters and remains open. Subsequent to the Effective Date of this report, the Company mobilized 7 exploration drill rigs to further evaluate continuity of mineralization within this target zone. A map of this target zone, including recent drilling subsequent to the Effective Date is shown in Figure 9-15.

Exploration potential within the Vermelhos UG Mine itself is primarily focused on extensions of known mineralization down plunge to the north as well as beneath the main orebodies of the Vermelhos mine. Drilling is underway and continues to demonstrate positive results highlighted recently by the Company's drilling in the area beneath the Vermelhos ramp and at the Siriema deposit within the Southern Vermelhos Corridor as part of this program. Additionally, the Company continues to conduct systematic BHEM beneath the Vermelhos main orebodies.

The Vermelhos UG Mine is producing within the main orebodies of Toboggan and Sombrero. Development is underway to commence production from the recently announced Vermelhos East Zone at depth. Mineralization of the Vermelhos UG Mine remains open to depth and along strike to the north and the south over a 5.5km trend extending from the N8/N9 OP Mine to the Siriema OP Mine to the south. Figure 9-17 shows coincident gravity, IP and chargeability anomalies located in this area, depicting the potential targets close to the main infrastructure of the mine that warrant additional exploration drilling.

Additional work in the Vermelhos District has been highlighted in Section 9.3.5.

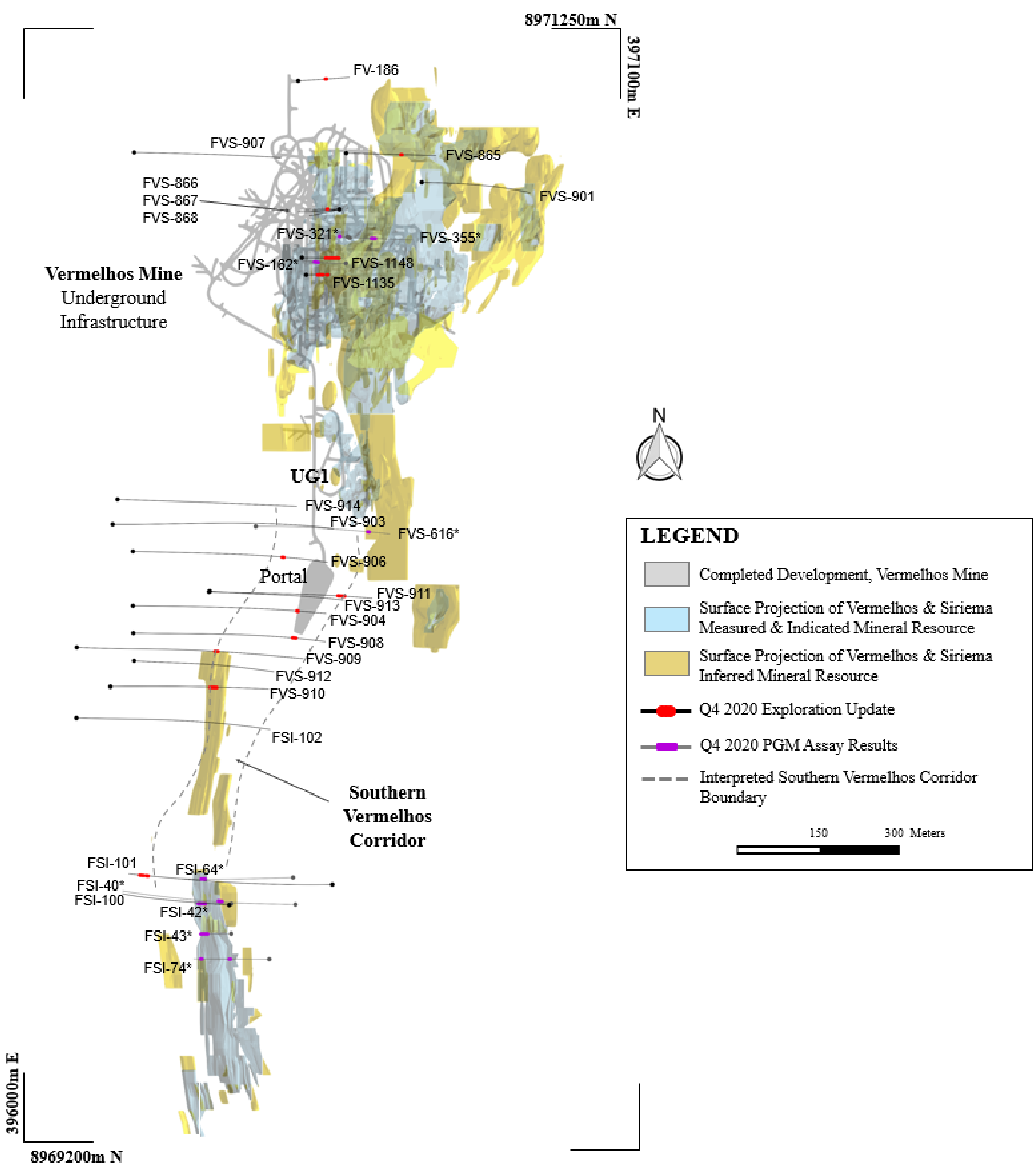


Figure 9-15: Plan map of the Southern Vermelhos Corridor, Vermelhos Mine (Ero Copper, December 2020)

9.3.5 Vermelhos District Exploration

Data compilation work shows that the Vermelhos District is over 10km in strike length along a north-south trending zone (Figure 9-16) of coincident IP and soil geochemistry, which includes several anomalies and high-priority drill targets that remain to be tested (collectively, the "Vermelhos System") as shown in in Figure 9-17. Exploration drilling in the Vermelhos District is primarily focused on the Southern Vermelhos Corridor; however, additional drilling throughout the Vermelhos System remains ongoing.

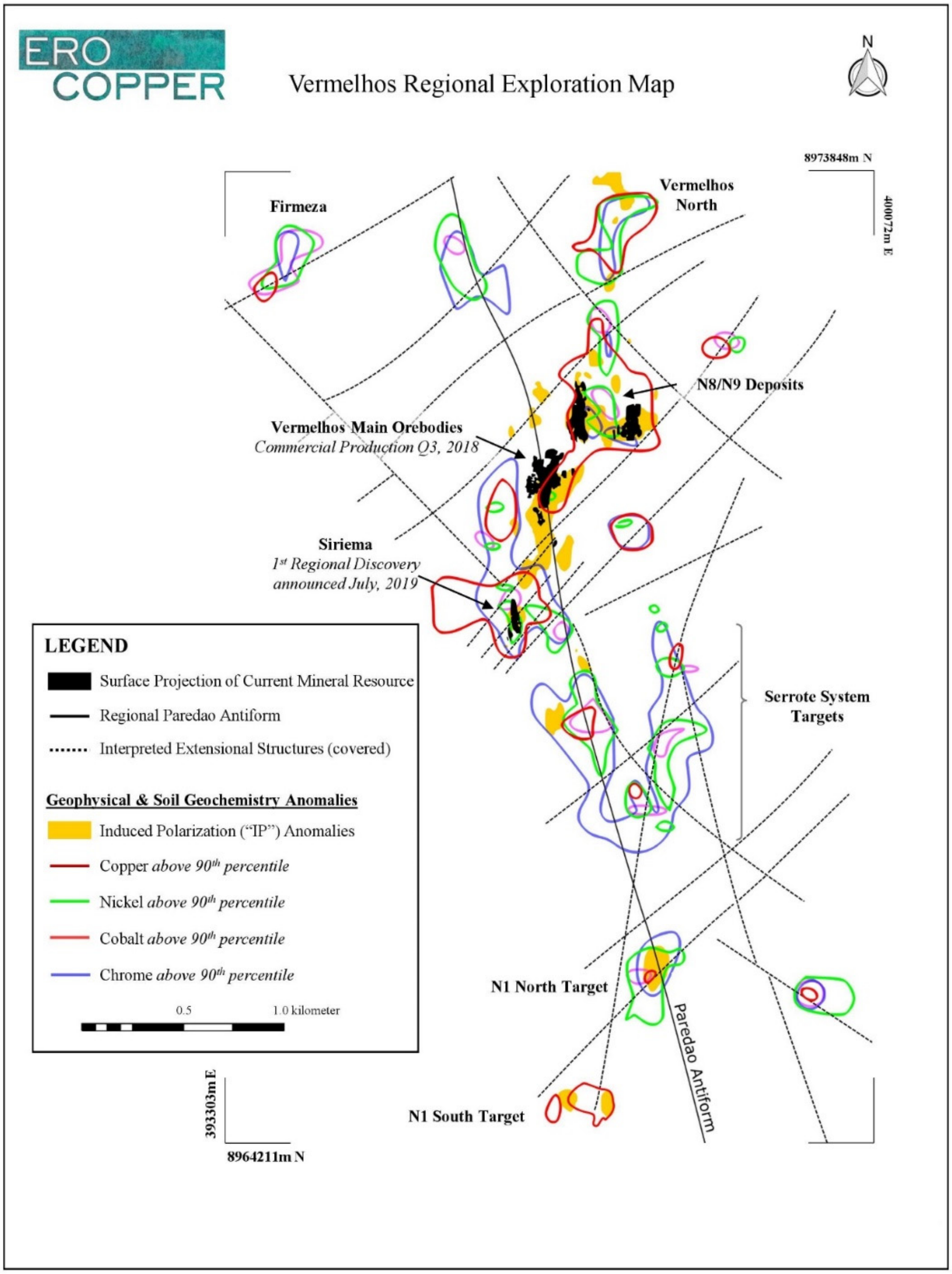


Figure 9-16: Vermelhos System plan map showing IP and soil geochemistry anomalies. Drilling to date has been primarily focused within the Vermelhos UG Mine area (Ero Copper, 2019)

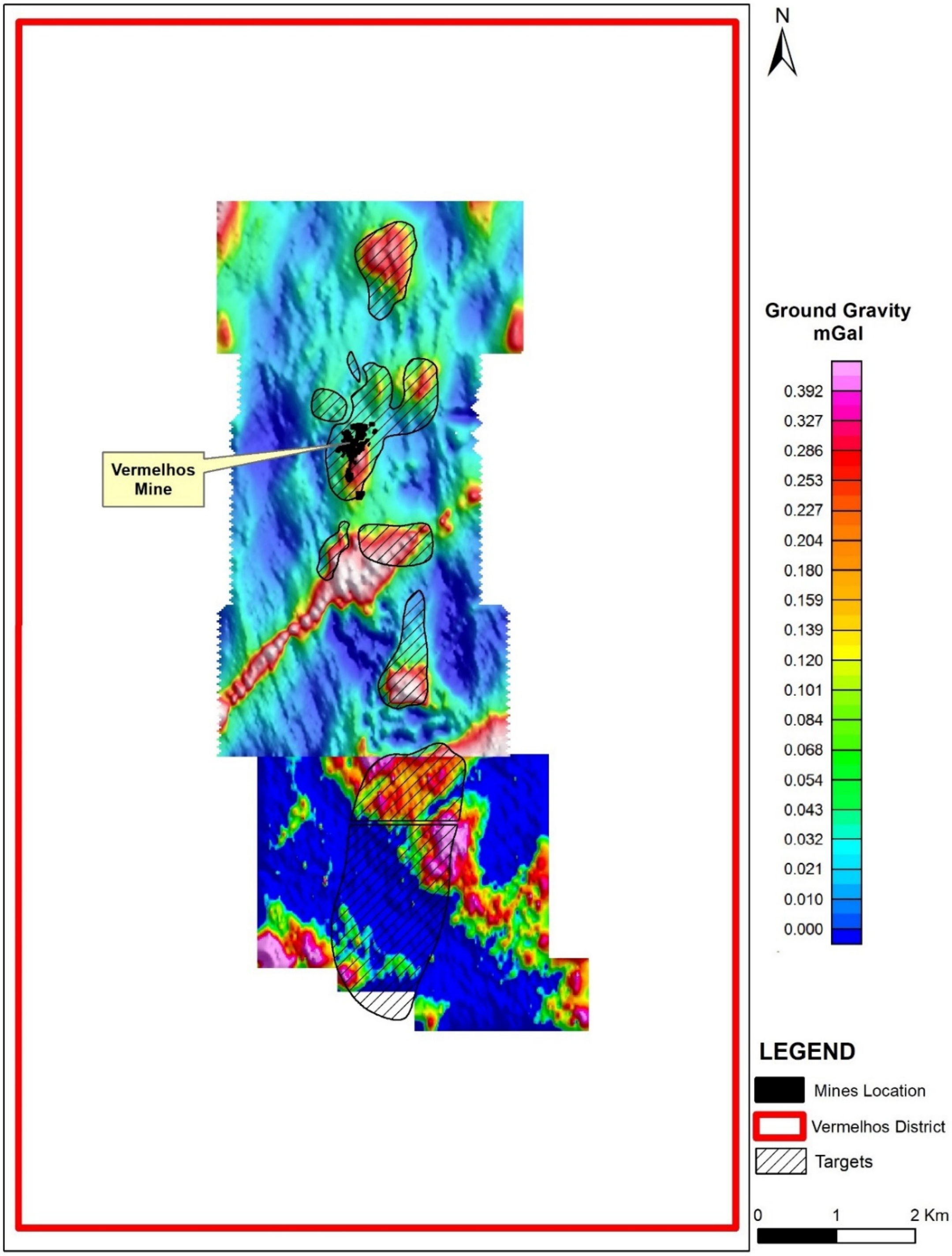


Figure 9-17: Vermelhos District showing residual gravity anomalies. Drilling to date has been primarily focused within the Vermelhos UG Mine area (MCSA, 2018)

There are currently seven main exploration targets within the Vermelhos System trend including extensions of the known N8/N9, Siriema, Vermelhos Mine.

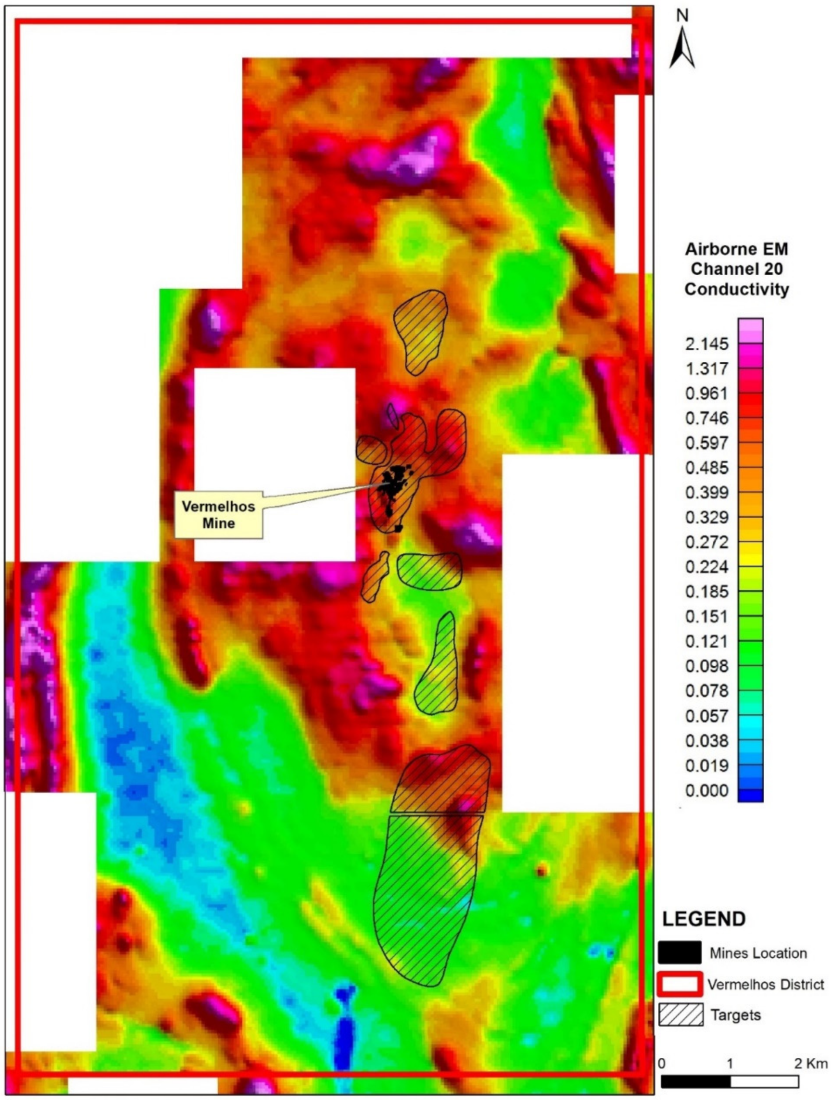


Figure 9-18: Preliminary airborne EM map of the Vermelhos District showing EM anomalies associated with targets defined by historic surveys (Mira Geoscience, 2018)

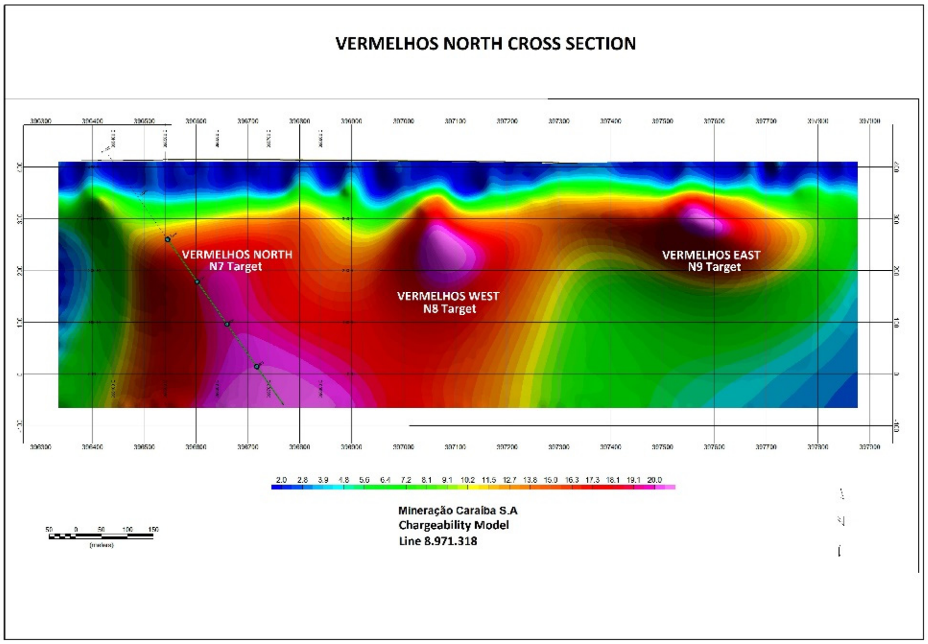


Figure 9-19: Cross-section through the N8/N9 OP Mine, looking north, highlighting chargeability anomalies in the north part of the Vermelhos System (MCSA, 2019)

10 DRILLING

MCSA has conducted surface and subsurface drilling with its own drill machines and employees as well as with the following third-parties:

- Geosol Geologia e Sondagem Ltda. ("Geosol");
- Geoserv, based in Rio de Janeiro;
- Congel, based in Senhor do Bonfim;
- Bahia and Drillgeo, based in Salvador, Bahia;
- Layne do Brasil Sondagens, based in Rio de Janeiro;
- McKay Drilling, Inc.;
- Tamarama Sondagens Ltda.; and,
- Major Drilling based in Belo Horizonte.

Drill pad locations are located on a grid map and sited on the ground by an MCSA geologist. The planned drill sites are located using a portable GPS.

When drill holes are completed, they are sealed with cement and an aluminum plate is set showing the drill hole number, azimuth, angle, depth and date. The cement marker is surveyed to give the final location of the drill hole.

1.875-inch diameter drill holes ("NQ") are used for surface drilling and in underground exploration while 1.433-inch diameter drilling ("BQ") is commonly used for short term stope definition (production drilling) in the underground mines.

Figure 10-1: Surface drill-hole being performed by third-party contractor (MCSA, 2017)

Figure 10-2: Underground drill-hole being performed by MCSA personnel (MCSA, 2017)

Drill core recoveries are measured by the drilling contractor, when drilling is not being performed by MCSA's own drill rigs and is checked by an MCSA technician. Core recoveries are generally good, averaging approximately 90%.

For inclined surface holes, stakes are set in the ground marking the azimuth and the drill rig is then aligned with the stakes. The drill supervisor uses an inclinometer to ensure the drill mast is aligned with the intended angle of the drill hole.

Throughout the Curaçá Valley, drilling to achieve indicated mineral resource drill spacing is generally set on approximately 45m centers whereas the measured mineral resource grid is approximately 22.5m on center. Infill drilling for mine planning is typically set on approximately 12.5m centers. Due to the dominant orientation of the mineralization, sections are east-west oriented and drill angles are arranged in a fan position targeting perpendicular intersection, to the extent possible, along the north–south trending mineralization.

In support of the current mineral resource and mineral reserve estimate, a total of 857,589 m of diamond core drilling was used. The allocation of meters for each mineral district is set out in the table below.

Table 10-1: MCSA Drilling in Support of Mineral Resource and Mineral Reserve Estimate

Mineral Districts	Diamond Drilling	
	Qty	Meters
Vermelhos	1,050	244,050
Surubim	391	56,240
Pilar	3,141	557,309

For all diamond drilling, deviation surveys are conducted using Giro Master equipment at 3.0m intervals, and later analyzed using SPT Survey software following the completion of the survey. Two measurements are performed in the upper movement (out) to validate the readings, with a 3.0% deviation between measurements admitted as the maximum permissible deviation according to the Company's adopted standard operating procedures.

Figure 10-3: Maxibor equipment preparing for drill hole deviation readings (MCSA, 2018)

Figure 10-4: Giro Master equipment preparing for drill hole deviation readings (MCSA, 2019)

Diamond drill core is stored in wooden and plastic core boxes with 4m or 5m of capacity (for BQ diameter core considering running with 100% recovery). All drill core is photo registered. Photos are stored in a centralized database. The wooden plastic boxes are stored in steel shelves specially built for the purpose within the MCSA core shed, where they are identified with permanent aluminum tags affixed to each box.

Core logging is performed by the MCSA geology team according to industry best practices and follows well-defined standard operating procedures.

The following information is registered by the MCSA geology team for each drill log:

- main lithology;
- geological contacts, including recorded angles if possible measured with a protractor;
- presence of magnetism;
- presence of carbonate material performed using hydro-chloric acid ("HCL") of 10%;
- presence of foliation, including recorded angles if possible;
- any other geological structures such as faults, folds, shearing and banding;
- fractured zones or faults and their representation in the drill core; and
- presence of copper or other elements, indicating the sampling interval used for chemical analysis (50 centimeters ("cm") to 150cm within mineralized zones, defined by prevalent geologic features).

Drill hole logs are organized in MCSA's geology file room in physical form and are also stored in the GEOEXPLO geological database management software. Information available in the geological database system includes drill hole coordinates, deviation survey, logging, density, recovery data, photos and all chemical analyses.

10.1 DENSITY

Rock density is determined using the Arquimedes method. The standard operating procedures for the method are detailed below in Figure 10-5:

- selection of core interval for testing;
- length measurement (10 cm to 14 cm) and project association;
- lithology logging, mineralization and mineral type;
- record dry core weight in air – defining the Mass in Air ("MRxAR");
- submerge core in melted paraffin to create a thin waterproof layer;
- repeat core weighing to calculate mass of paraffin coating ("MParaf");
- core underwater weighing (the difference between the mass of the paraffin coated sample in air and mass of the paraffin coated sample in water corresponds to the mass of the water displaced by the core or the volume of the core sample); and
- the procedure considers the paraffin effect on the measurement (specific density ±0.9). For high precision, the following formula is used:

$$\text{Density} = \frac{M_{RxAr}}{(M_{R\ x\ Paraf\ .Air} - M_{R\ x\ Paraf\ .\ water}) - (M_{Paraf.} / 0{,}9)}$$

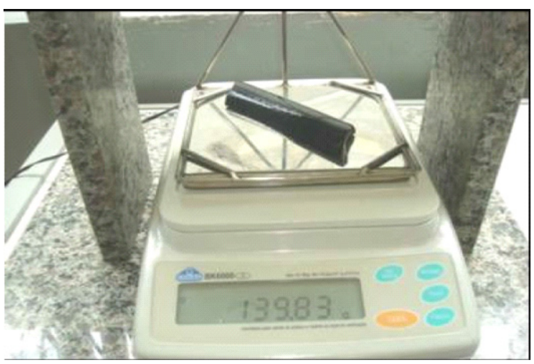
	
Sample weighing in air	Paraffin to waterproof the sample
	
Sample weighing w/ paraf. In air	Waterproofed sample weighing submerged

Figure 10-5: Density testing procedure (MCSA, 2017)

11 SAMPLE PREPARATION, ANALYSES AND SECURITY

Sampling procedures in MCSA installations, both Pilar and Vermelhos, are executed in accordance with mining industry best practices and well-defined standard operating procedures.

Core boxes are transported to the core shed by an MCSA technician or a designated representative from the drilling company. After the drill hole and meterage are confirmed by an MCSA geology technician and logging is performed by an MCSA geologist, all core boxes are photographed. The intervals and the sample numbers are clearly labeled on all core boxes. A diamond core saw is used to split the drill cores in half lengthwise as shown in the figure below. A spatula is used in core sections where the rock has deteriorated due to intense alteration or is highly fractured. Sample intervals are between 50cm and 150cm within the mineralized zone as defined by geological features. The only exception to this rule was within the Surubim OP Mine deposit where three-meter sample intervals were adopted within the near-surface oxidized zones.

Once the core has been cut, half of the drill core is placed in plastic bags and sent to the MCSA laboratory for physical preparation and chemical analysis, as shown in the figure below. The remaining half-core is retained for storage in MCSA's core shed.

Due to the limited size of the drill core shed, MCSA must regularly discard older drill core sample material. The criteria for selecting core for disposal is well defined and limited to:

- drill core from areas of the deposit that have already been mined; and
- drill core obtained from duplicated zones via fan drilling for production definition are discarded, provided that a confirmed representative drill core from each mineralized zone is kept.

Figure 11-1: Core Sampling Procedures (MCSA, 2017)

Figure 11-2: Transportation and Storage of Drill Core Samples (Surubim District) (MCSA, 2017).

The following standard operating procedures are undertaken at the MCSA on-site laboratory for completion of the physical preparation and chemical analysis of the core samples:

Physical Preparation:

- arrival, verification and logging of samples;
- crushing and drying of the samples in an oven at 105°C;
- crushing of the samples in a ½" jaw crusher;
- further crushing in a cone crusher to a particle size of minus #6 mesh;
- homogenization and quartering of the material in a rotary splitter. Half of the sample is utilized in the process and half is sent to be stored in the core shed;
- the half used in the process is sent to a disk mill to be milled to minus 20 mesh;
- the material is then homogenized and quartered to ±70g;
- the material is then pulverized in a pan mill to minus 150 mesh;

Quantitative Determination:

- weigh 0.250g using an analytical scale and transfer the material to a 250 milliliter ("ml") beaker; weigh one duplicate sample for every five samples weighed;
- apply an acid mixture to the material (5 ml of HNO_3 and 10 ml of HCl);
- heat the solution on a hotplate for 10 minutes;
- after 10 minutes, the solution is removed from the hotplate and 25 ml of distilled water is added. The solution is then allowed to cool for about five minutes until it reaches room temperature;

- filter paper, held in place by a retention band, is used to filter the solution and the filtered material is then homogenized; and
- the analysis for copper and nickel is conducted using an atomic absorption spectrometer ("AAS").

MCSA has recently installed and implemented the use of multi-element Inductively Coupled Plasma - Optical Emission Spectrometry ("ICP-OES") and X-ray Diffraction ("DRX") analysis that are being used primarily to further evaluate the recently observed presence of platinum group metals and for use in ongoing geometallurgical studies.

GE21 has evaluated the sample collection, analysis and security procedures, as well as the procedures that were executed by MCSA's internal laboratory, and found them to be sound, having been executed in accordance with industry best practices. Verification procedures, results of verification analysis and detailed comments are addressed in Chapter 12 – Data Verification of this Report.

11.1 QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

MCSA began to implement routine QA/QC procedures in its activities in 2007. Thereafter, MCSA has been perfecting these procedures based on continuous improvement initiatives implemented by MCSA personnel and recommendations from external consultants.

The QA/QC program covers each chemical analysis performed on drill core samples with the aim of:

- avoiding the use of poor-quality information during the construction of geological models and the execution of resource estimates; and
- promoting procedures for controlling and guaranteeing the quality and reliability of the samples that are prepared and of the chemical analytical result that are obtained in the laboratory.

GE21 conducted the validation of QA/QC data generated in the period from August 1, 2018 to current Effective Date, including data presented in the 2019 Technical Report. Prior QA/QC data was validated by GE21, as detailed in prior technical studies including in the 2018 Technical Report and 2017 Technical Report.

And for samples pre-dating the 2007 implementation of QA/QC procedures, a post-mortem analysis was conducted that involved re-analyzing a minimum of 10% of the total number of samples with no corresponding QA/QC data that would be used in the resource and reserve grade estimation to validate the historic assays (before 2007). Details of post-mortem are included in the 2017 Technical Report.

The current validation included:

- Blanks
- Standards
- Pulverized Duplicates
- Coarse Tailings Duplicates
- Field Duplicates
- Secondary Laboratory

11.1.1 Blank Samples

Mafic gneiss samples that are pulverized to minus 150 mesh at MCSA's laboratory are used as blank control samples. These samples are included with the aim of verifying the quantitative analysis undertaken by the laboratory. The blank samples are sent at an interval of one blank sample for every 10 samples within each batch (a rate of 10%). The figure below presents the statistics and results associated with the blank control samples for period between August 1, 2018 to the Effective Date. Results from samples that underwent these quality control procedures, and are within the quality control limits, are considered acceptable.

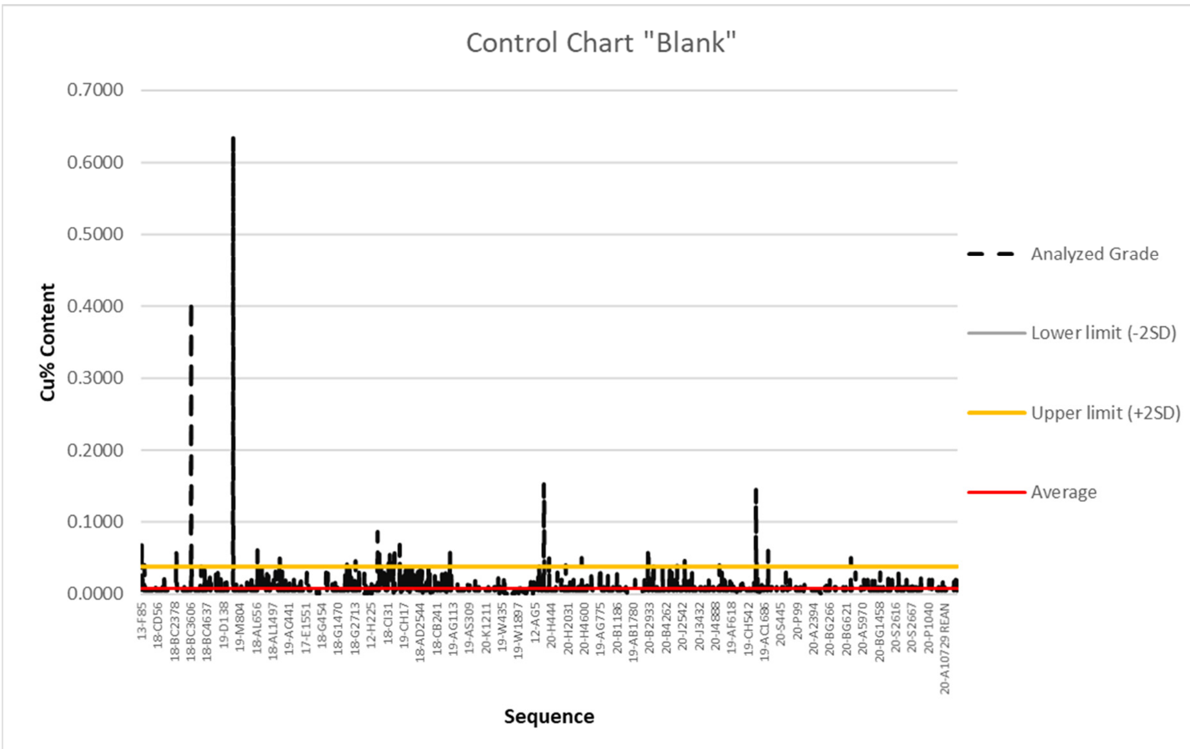


Figure 11-3: Result of the Analysis of Blank Samples (MCSA, 2020)

11.1.2 Standard Samples

MCSA uses standard samples to verify the laboratory's accuracy. One CRM control sample is inserted at every 10 samples (a rate of 10%), within the batch of duplicates. The CRM samples used, ranged from low to high copper grades. MCSA contracted ITAK to prepare and certify the CRM standards produced from the Curaçá Valley.

Based on internal controls, MCSA has established that 90% of the tested samples should be within the minimum and maximum limits, defined as within two standard deviations of the CRM certified value (or 95% confidence limits). The values of these limits are presented in the table below.

Figure 11-4 to Figure 11-20 shows the results of the QA/QC analysis of the CRM over the period from August 1, 2018 to July 4, 2020.

Table 11-1: MCSA CRM Evaluation Criteria

CRM ID	Certified value (%)	Lower Limit (%)	Upper Limit (%)
		95% Confidence	
ITAK-809	0.36	0.34	0.38
ITAK-814	0.45	0.43	0.47
ITAK-821	0.36	0.35	0.38
ITAK-823	0.87	0.82	0.92
ITAK-824	2.68	2.54	2.81
ITAK-825	5.76	5.54	5.98
ITAK-833	1.57	1.50	1.65
ITAK-842	1.56	1.51	1.62
ITAK-843	0.80	0.76	0.83
ITAK-844	0.32	0.30	0.35
ITAK-847	0.42	0.41	0.44
ITAK-848	0.64	0.62	0.65
ITAK-849	1.06	1.03	1.09
ITAK-850	3.55	3.43	3.68
ITAK-851	6.98	6.40	7.56
GBM-306-14	1.67	1.55	1.79
GBM-907-14	0.82	0.75	0.89

Type of Control	Standard
Reference	ITAK809
Variable	Cu%
Number of analysis	4

Code	Cu%
Reference Value	**0.359**
Standard desviation	**0.010**
Upper limit (+2SD)	0.380
Lower limit (-2SD)	0.340

Minimum	0.34
Maximum	0.37
Average	0.35
Median	0.35
Bias	-1.79%

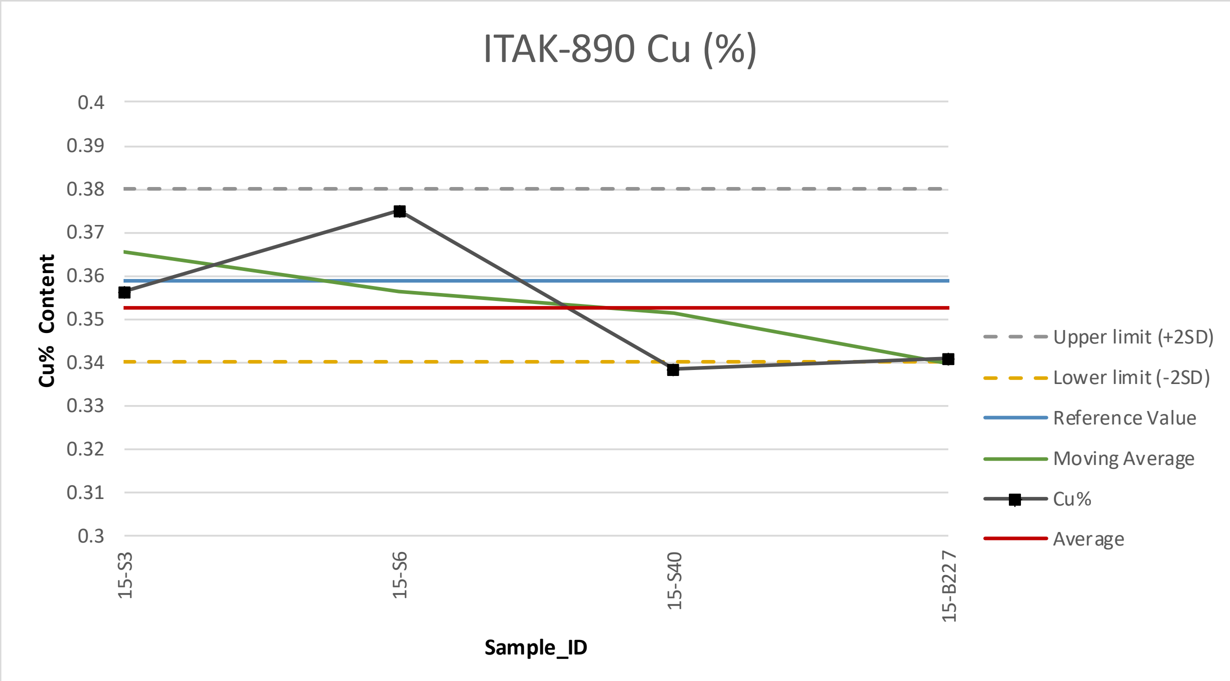


Figure 11-4: Result of the QA/QC Analysis of CRM ITAK 809 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK814
Variable	Cu%
Number of analysis	90

Code	Cu%
Reference Value	**0.451**
Standard desviation	**0.010**
Upper limit (+2SD)	0.470
Lower limit (-2SD)	0.430

Minimum	0.42
Maximum	0.51
Average	0.46
Médian	0.46
Bias	1.81%

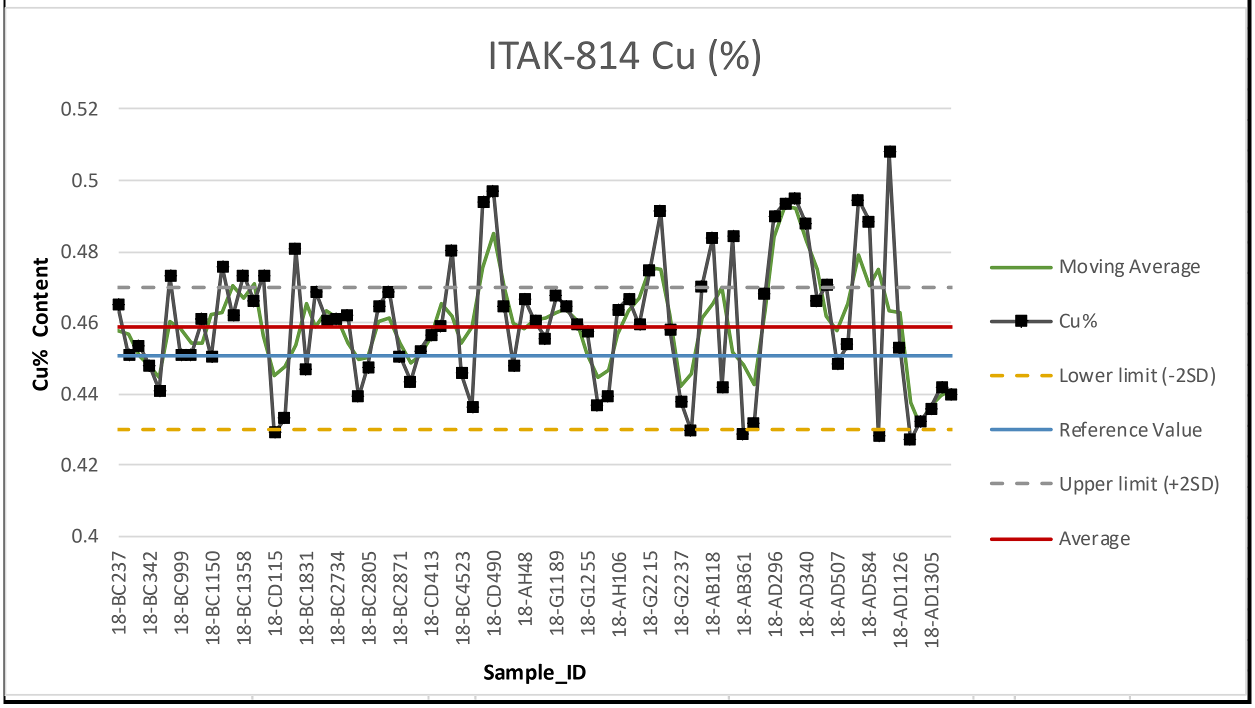


Figure 11-5: Result of the QA/QC Analysis of CRM ITAK 814 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK821
Variable	Cu%
Number of analysis	116

Code	Cu%
Reference Value	0.362
Standard desviation	0.009
Upper limit (+2SD)	0.380
Lower limit (-2SD)	0.350

Minimum	0.32
Maximum	0.42
Average	0.37
Médian	0.36
Bias	0.96%

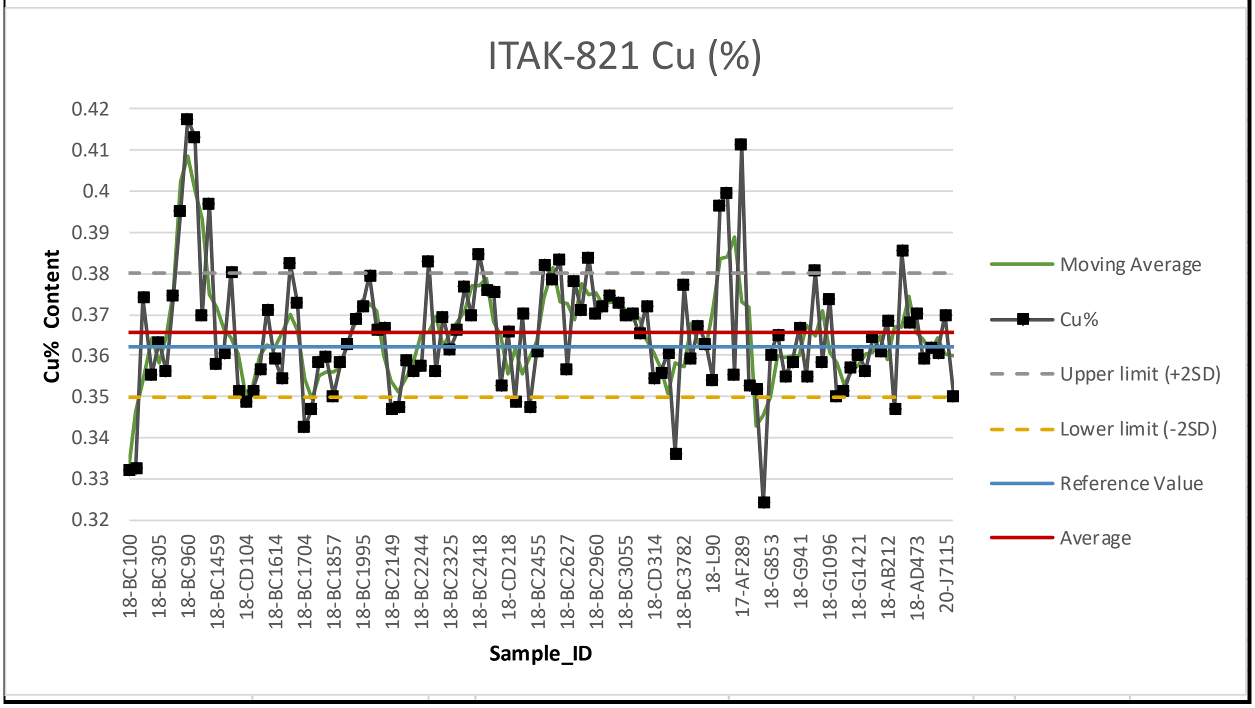


Figure 11-6: Result of the QA/QC Analysis of CRM ITAK 821 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK823
Variable	Cu%
Number of analysis	134

Code	Cu%
Reference Value	0.874
Standard desviation	0.020
Upper limit (+2SD)	0.920
Lower limit (-2SD)	0.820

Minimum	0.74
Maximum	0.97
Average	0.86
Médian	0.86
Bias	-1.41%

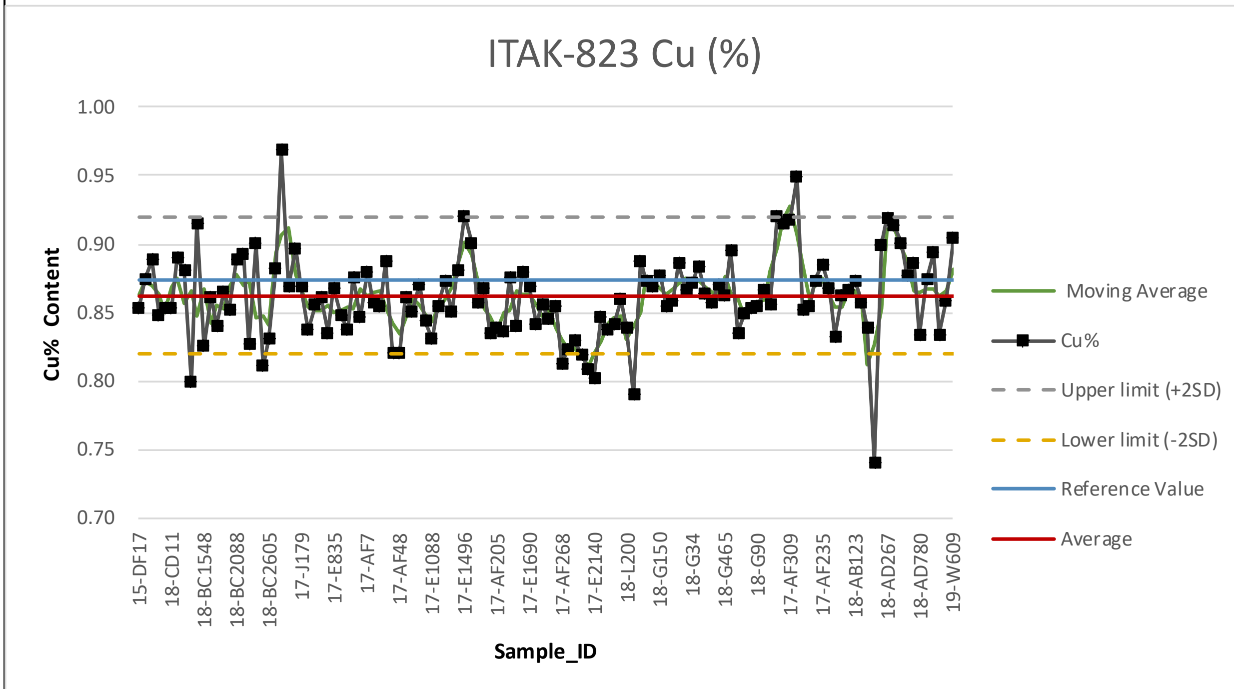


Figure 11-7: Result of the QA/QC Analysis of CRM ITAK 823 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK824
Variable	Cu%
Number of analysis	94

Code	Cu%
Reference Value	**2.678**
Standard desviation	**0.066**
Upper limit (+2SD)	2.810
Lower limit (-2SD)	2.540

Minimum	2.31
Maximum	2.79
Average	2.62
Médian	2.62
Bias	-2.32%

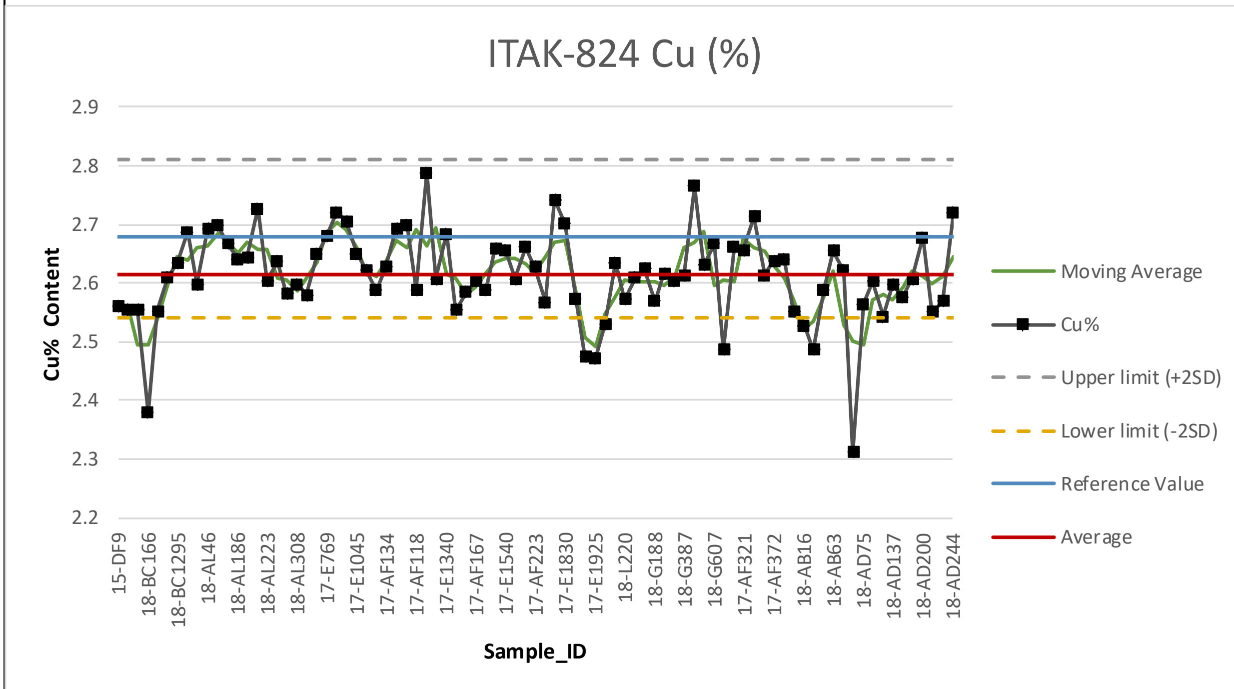


Figure 11-8: Result of the QA/QC Analysis of CRM ITAK 824 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK825
Variable	Cu%
Number of analysis	63

Code	Cu%
Reference Value	**5.760**
Standard desviation	**0.110**
Upper limit (+2SD)	5.980
Lower limit (-2SD)	5.540

Minimum	5.05
Maximum	6.33
Average	5.51
Médian	5.50
Bias	-4.31%

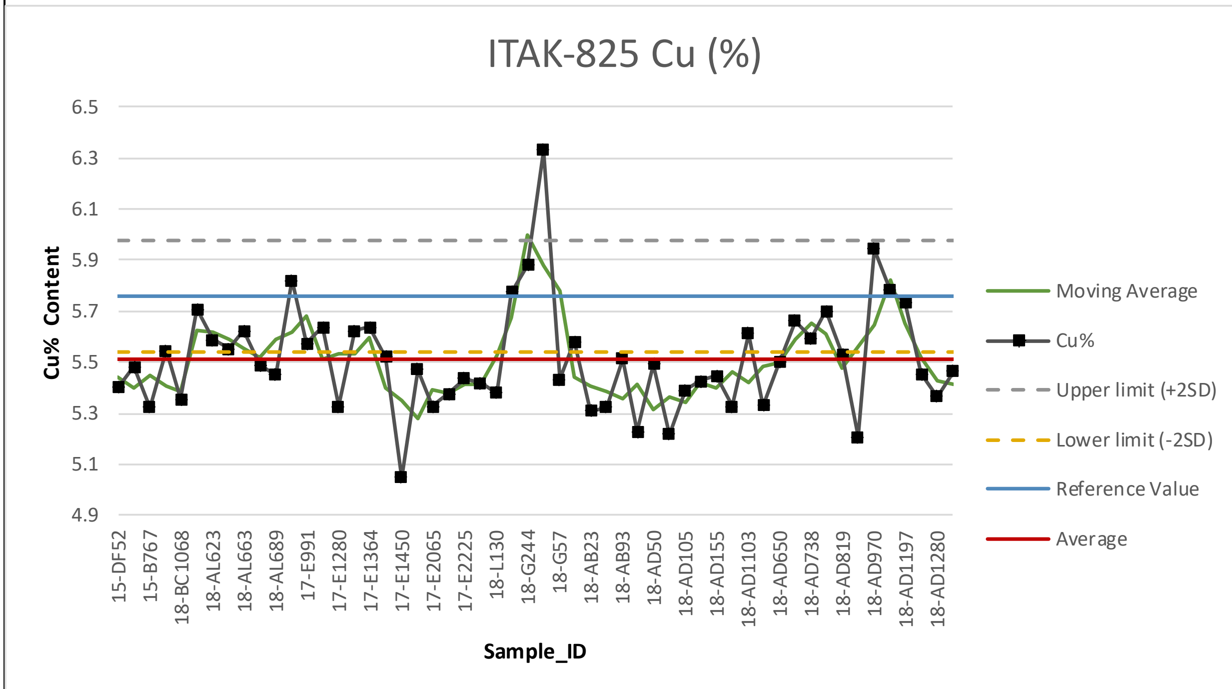


Figure 11-9: Result of the QA/QC Analysis of CRM ITAK 825 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK833
Variable	Cu%
Number of analysis	83

Code	Cu%
Reference Value	1.571
Standard desviation	0.004
Upper limit (+2SD)	1.650
Lower limit (-2SD)	1.500

Minimum	1.44
Maximum	1.67
Average	1.54
Médian	1.54
Bias	-2.19%

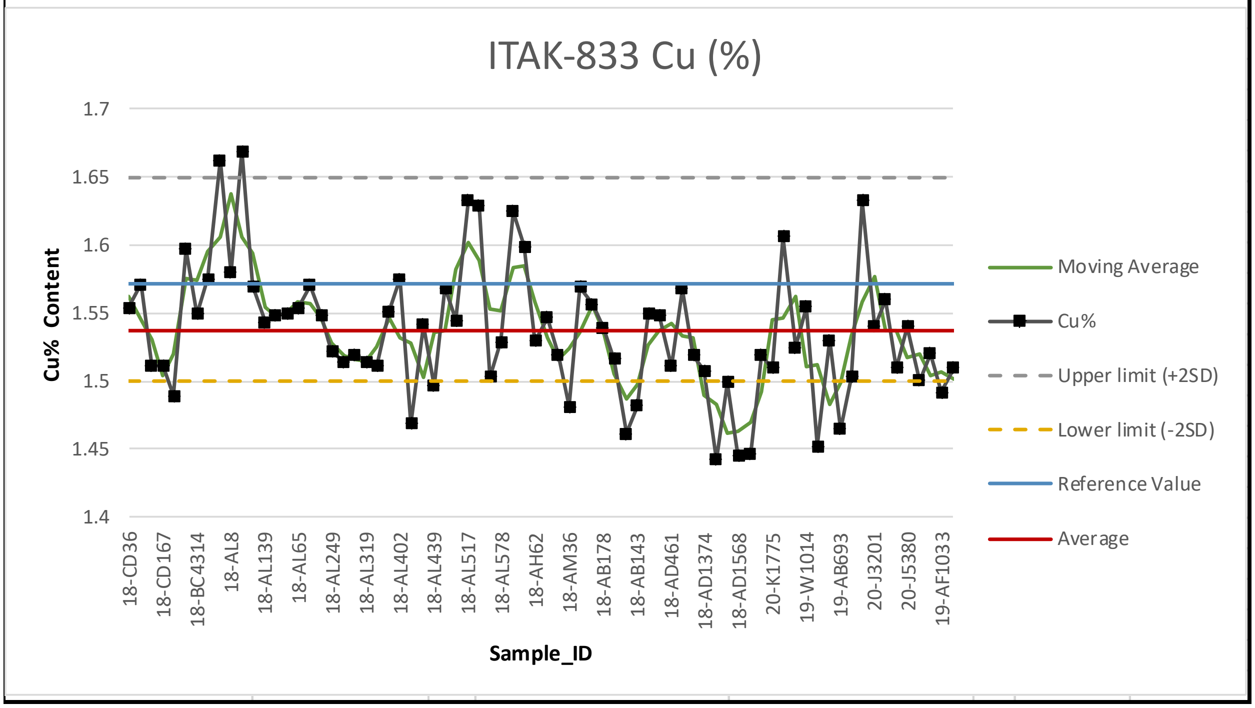


Figure 11-10: Result of the QA/QC Analysis of CRM ITAK 833 (MCSA, 2020)

Type of Control	Standard	**Code**	Cu%	Minimum	1.37
Reference	ITAK842	**Reference Value**	**1.562**	Maximum	1.68
Variable	Cu%	**Standard desviation**	**0.030**	Average	1.56
Number of analysis	221	Upper limit (+2SD)	1.620	Médian	1.56
		Lower limit (-2SD)	1.510	Bias	0.05%

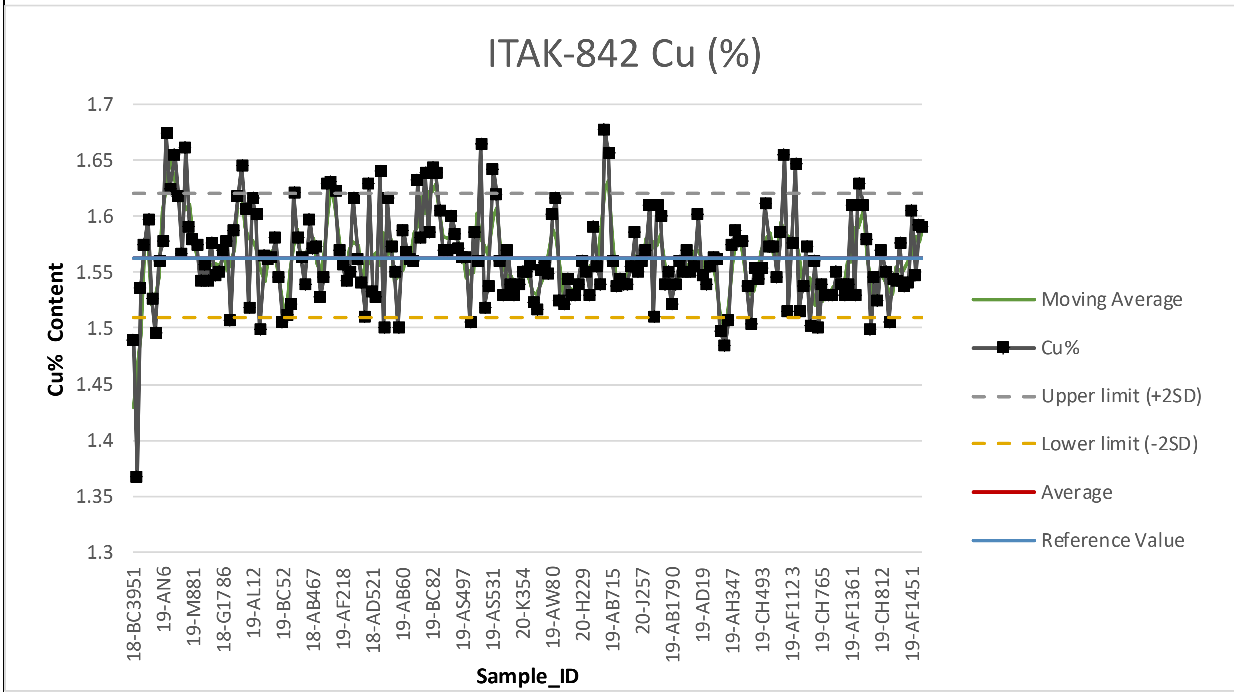


Figure 11-11: Result of the QA/QC Analysis of CRM ITAK 842 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK843
Variable	Cu%
Number of analysis	384

Code	Cu%
Reference Value	0.796
Standard desviation	0.030
Upper limit (+2SD)	0.860
Lower limit (-2SD)	0.730

Minimum	0.64
Maximum	1.05
Average	0.81
Médian	0.81
Bias	1.39%

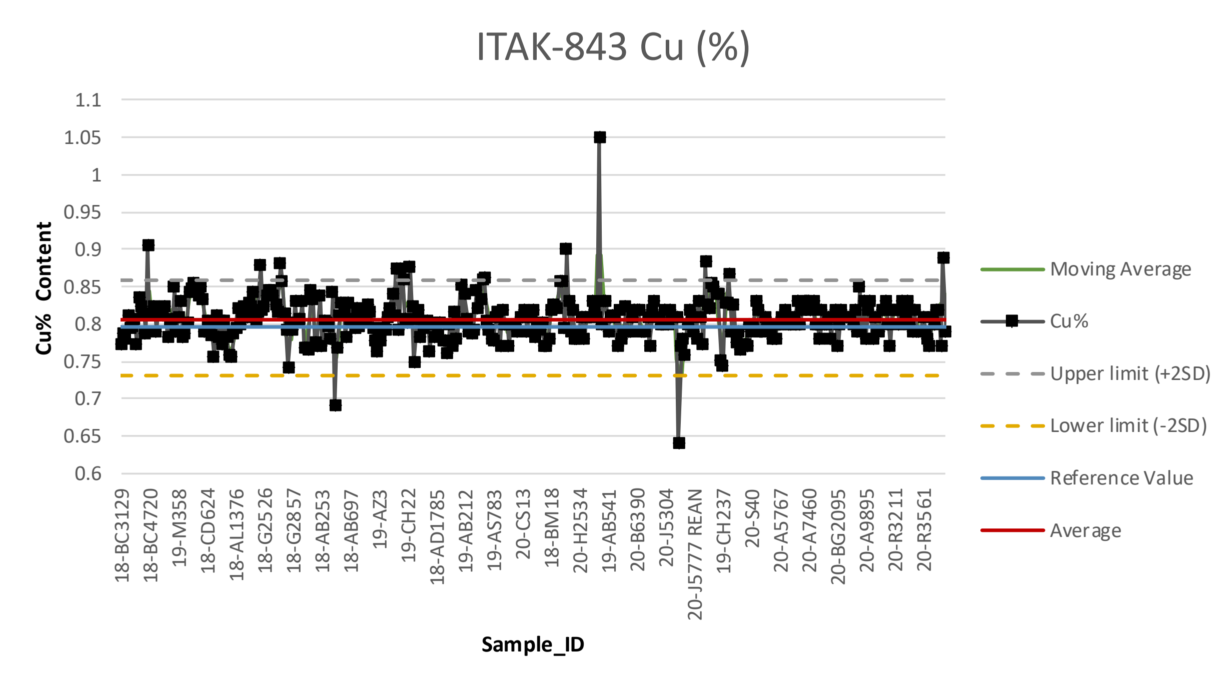


Figure 11-12: Result of the QA/QC Analysis of CRM ITAK 843 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK844
Variable	Cu%
Number of analysis	590

Code	Cu%
Reference Value	**0.323**
Standard desviation	**0.015**
Upper limit (+2SD)	0.350
Lower limit (-2SD)	0.300

Minimum	0.26
Maximum	0.42
Average	0.33
Médian	0.33
Bias	1.22%

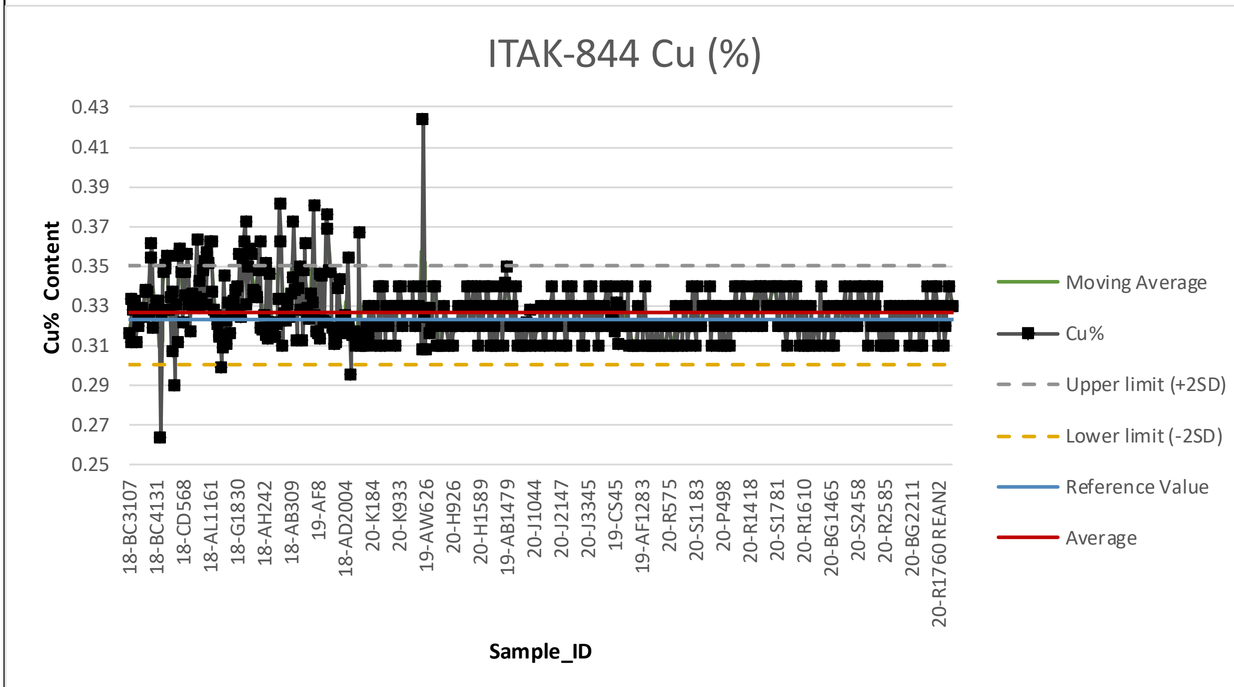


Figure 11-13: Result of the QA/QC Analysis of CRM ITAK 844 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK847
Variable	Cu%
Number of analysis	413

Code	Cu%
Reference Value	**0.422**
Standard desviation	**0.010**
Upper limit (+2SD)	0.440
Lower limit (-2SD)	0.410

Minimum	0.20
Maximum	1.08
Average	0.42
Médian	0.42
Bias	0.38%

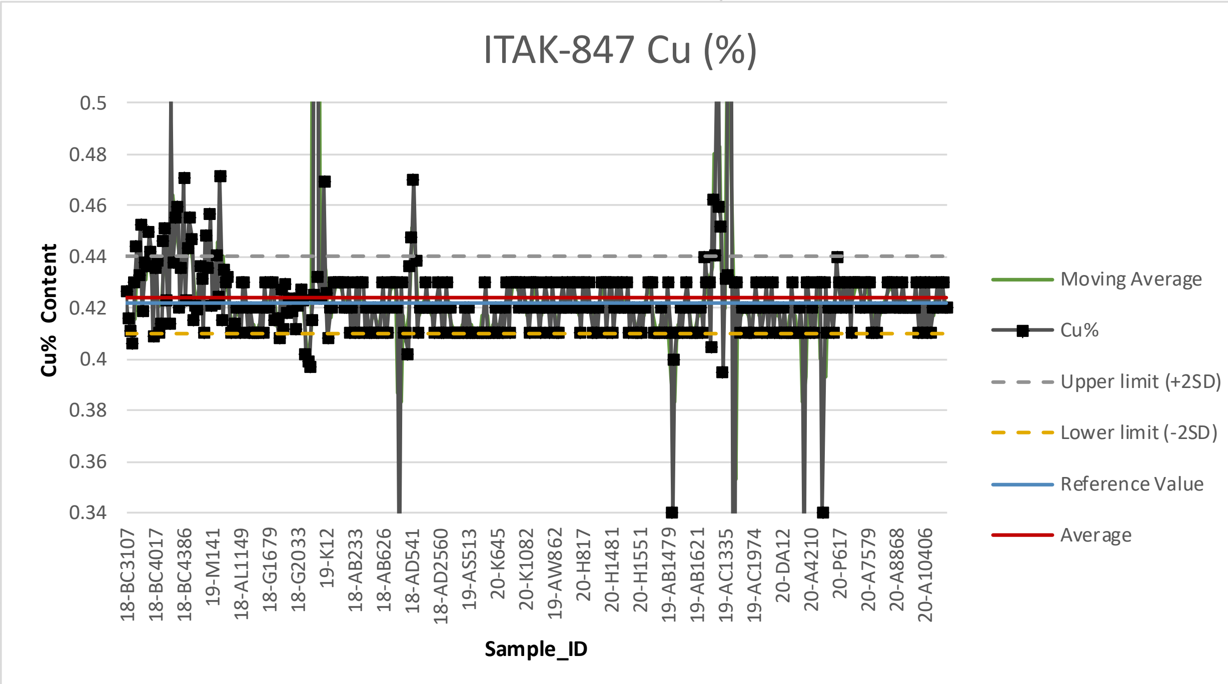


Figure 11-14: Result of the QA/QC Analysis of CRM ITAK 847 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK848
Variable	Cu%
Number of analysis	262

Code	Cu%
Reference Value	0.636
Standard desviation	0.007
Upper limit (+2SD)	0.650
Lower limit (-2SD)	0.620

Minimum	0.59
Maximum	0.74
Average	0.64
Médian	0.64
Bias	0.59%

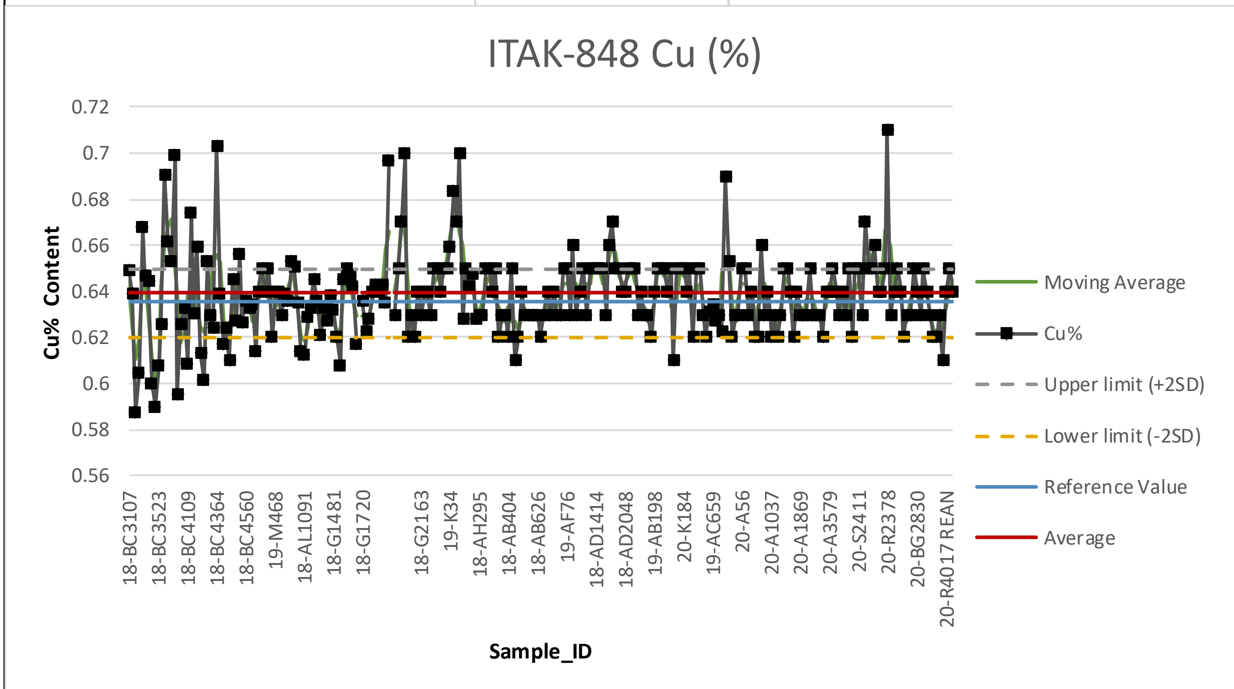


Figure 11-15: Result of the QA/QC Analysis of CRM ITAK 848 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK849
Variable	Cu%
Number of analysis	444

Code	Cu%
Reference Value	1.062
Standard desviation	0.014
Upper limit (+2SD)	1.090
Lower limit (-2SD)	1.030

Minimum	0.95
Maximum	1.16
Average	1.06
Médian	1.06
Bias	-0.38%

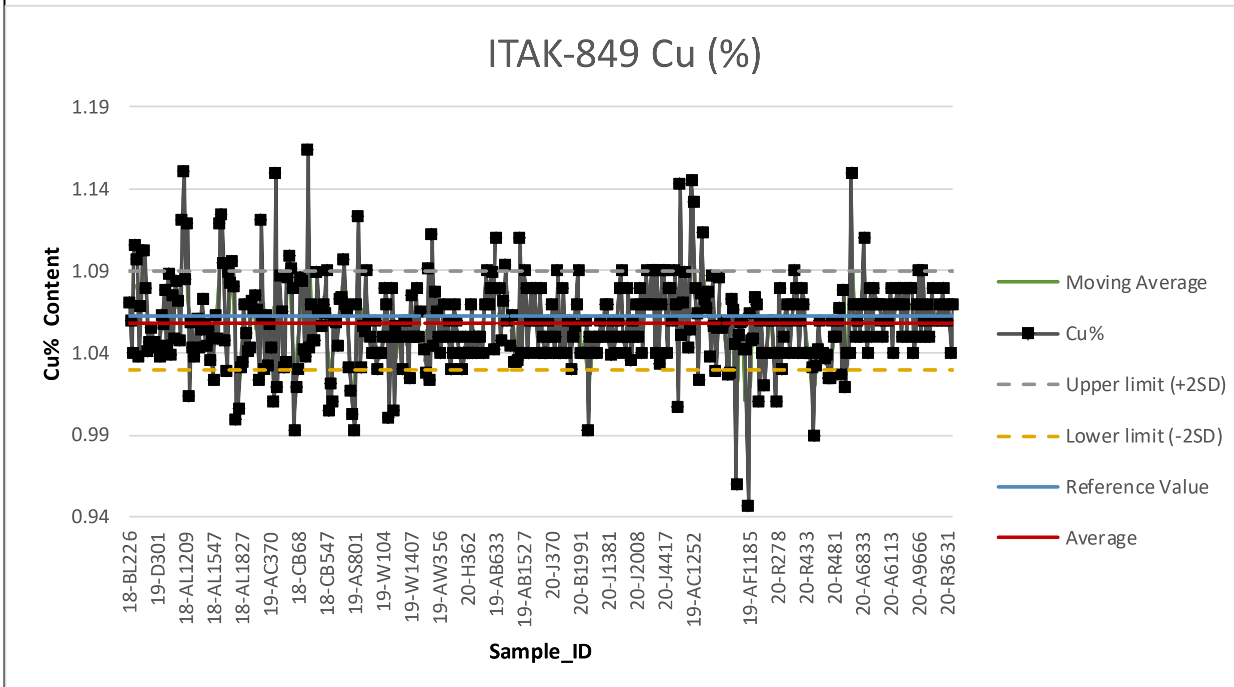


Figure 11-16: Result of the QA/QC Analysis of CRM ITAK 849 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK850
Variable	Cu%
Number of analysis	370

Code	Cu%
Reference Value	**3.554**
Standard desviation	**0.064**
Upper limit (+2SD)	3.680
Lower limit (-2SD)	3.630

Minimum	3.19
Maximum	3.76
Average	3.53
Médian	3.53
Bias	-0.67%

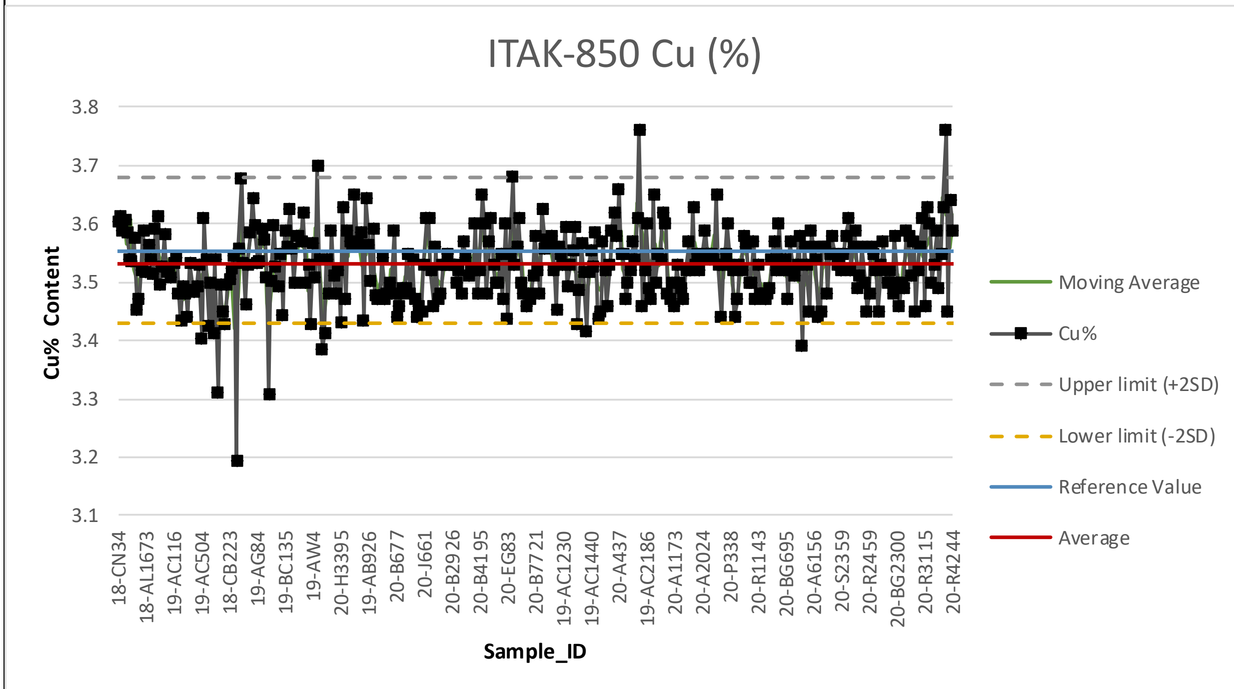


Figure 11-17: Result of the QA/QC Analysis of CRM ITAK 850 (MCSA, 2020)

Type of Control	Standard
Reference	ITAK851
Variable	Cu%
Number of analysis	113

Code	Cu%
Reference Value	6.980
Standard desviation	0.290
Upper limit (+2SD)	7.560
Lower limit (-2SD)	6.400

Minimum	5.97
Maximum	7.48
Average	6.90
Médian	6.91
Bias	-1.21%

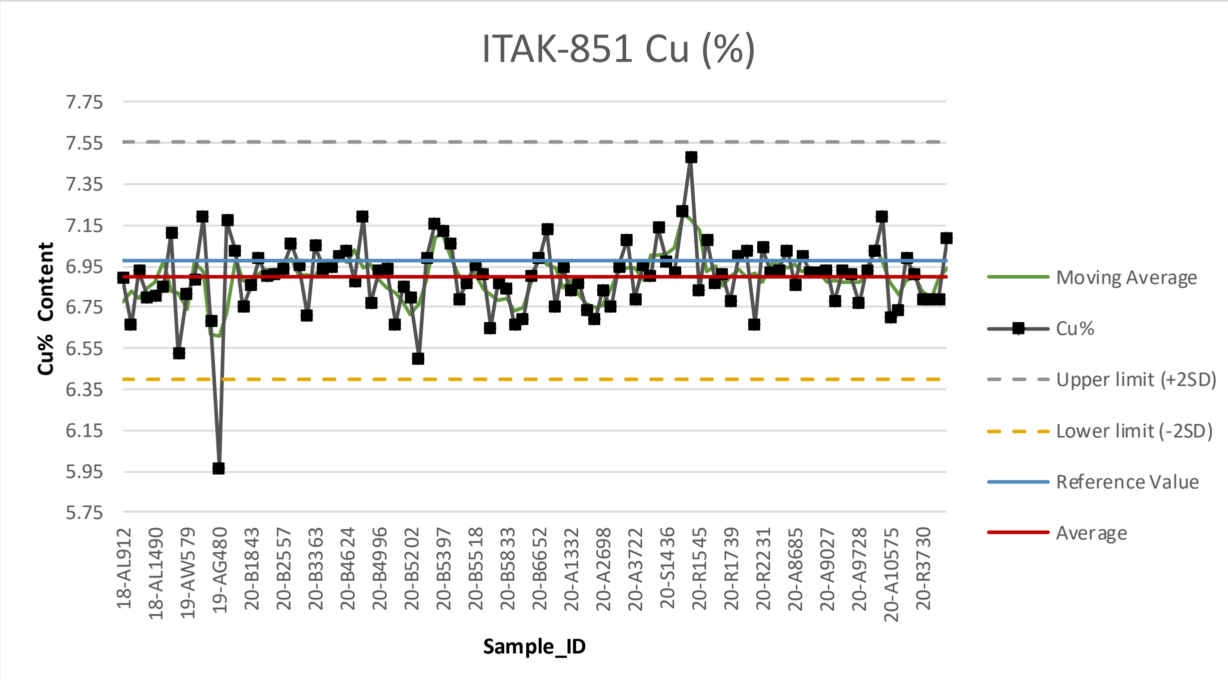


Figure 11-18: Result of the QA/QC Analysis of CRM ITAK 851 (MCSA, 2020)

Type of Control	Standard
Reference	GBM-306-14
Variable	Cu%
Number of analysis	24

Code	Cu%
Reference Value	**1.671**
Standard desviation	**0.060**
Upper limit (+2SD)	1.790
Lower limit (-2SD)	1.550

Minimum	1.47
Maximum	1.79
Average	1.62
Median	1.62
Bias	-2.88%

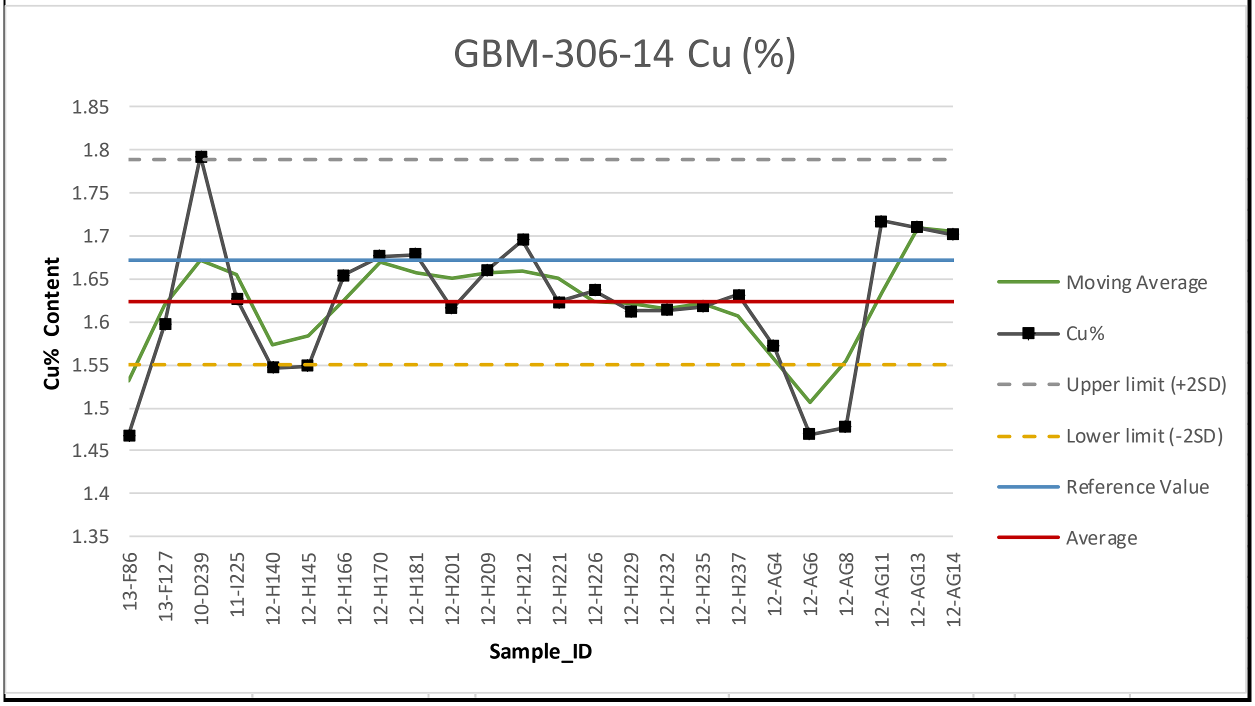


Figure 11-19: Result of the QA/QC Analysis of CRM CBM-306-14 (MCSA, 2020)

Type of Control	Standard
Reference	GBM-907-14
Variable	Cu%
Number of analysis	15

Code	Cu%
Reference Value	0.817
Standard desviation	0.037
Upper limit (+2SD)	0.890
Lower limit (-2SD)	0.750

Minimum	0.75
Maximum	0.89
Average	0.80
Médian	0.81
Bias	-1.63%

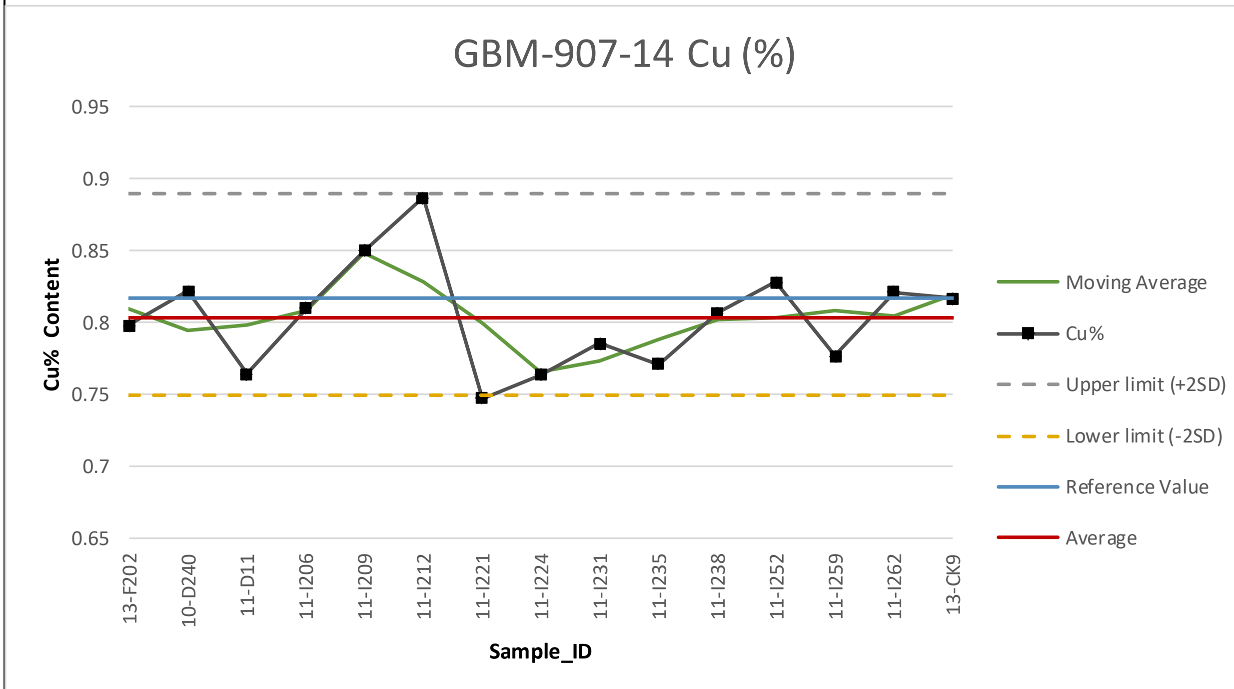


Figure 11-20: Result of the QA/QC Analysis of CRM GBM-907-14 (MCSA, 2020)

Based upon the analysis of the QA/QC results it can be observed that the MCSA laboratory provides good levels of accuracy at lower copper grades and. Accuracy, in general, decreases as grades increase in part due to lower sample density. It was observed throughout the course of the GE21 review period, that the MCSA laboratory continues to display a tendency to underestimate the copper values when using CRM ITAK 825; however, the results for CRM ITAK 851, which has similar Cu grade range to that of CRM ITAK 825, demonstrates better reproducibility.

GE21 recommends a validation of the certified grade for CRM ITAK 825 due to the observed inconsistencies with the analysis in the MCSA laboratory, which is in contrast with the consistent results obtained when utilizing CRM ITAK 851, which has a similar Cu grade range.

11.1.3 Duplicate Samples

The typical QA/QC program implemented at MCSA involves sending duplicate batches of 2 millimeter ("mm") coarse samples and pulverized 150 mesh samples to the laboratory. Samples are chosen so as to be representative of the sampling data. One sample is selected from the original batch of material at an interval of at least every 20 samples (a rate of 5%).

In analyzing the results of duplicate samples, the authors considered the following limits of acceptability: 20% of the relative difference for the coarse reject duplicates and 10% of the relative difference for the pulverized duplicates.

Overall, the evaluation of MCSA's QA/QC procedures and lab results show good / acceptable results for period from August 1, 2018 to July 4, 2020 as illustrated in the two figures below.

Target	All core samples
Reference	Crushed
Variable	Cu_pct
Accuracy limit	20%
Number of pairs	6735

	Sample	Duplicate
Minimum	0.001	0.001
Maximum	29.17	30.15
Average	0.862	0.86
Median	0.28	0.282
HARD median		7.4

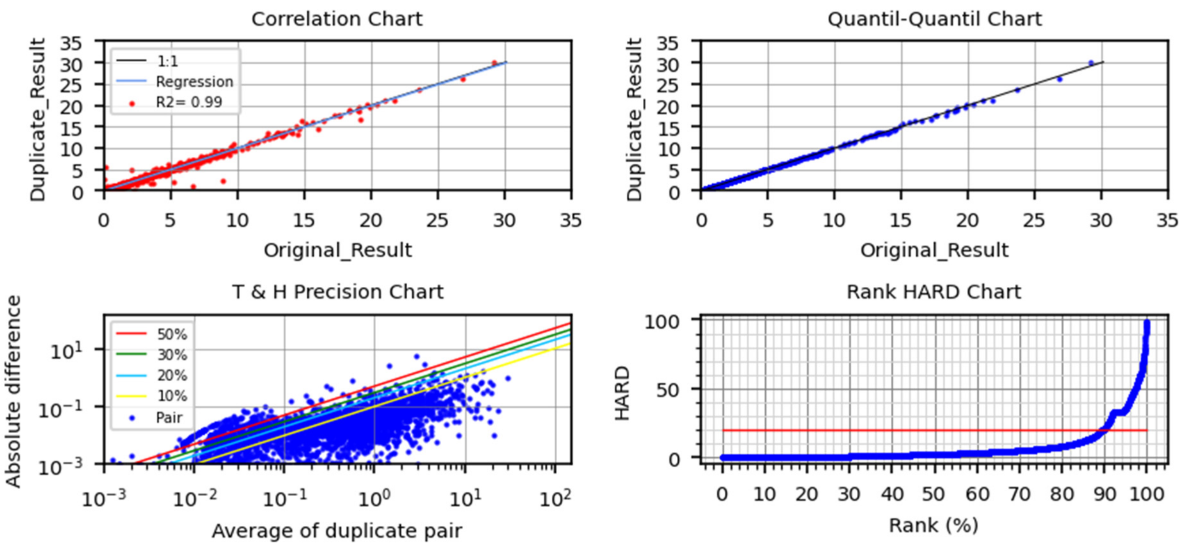


Figure 11-21: Analytical Result of the Crushed Duplicate Samples (MCSA, 2020)

Target	All core samples
Reference	Pulp
Variable	Cu_pct
Accuracy limit	10%
Number of pairs	8015

	Sample	Duplicate
Minimum	0.001	0.0
Maximum	37.38	37.43
Average	0.898	0.895
Median	0.29	0.286
HARD median		6.5

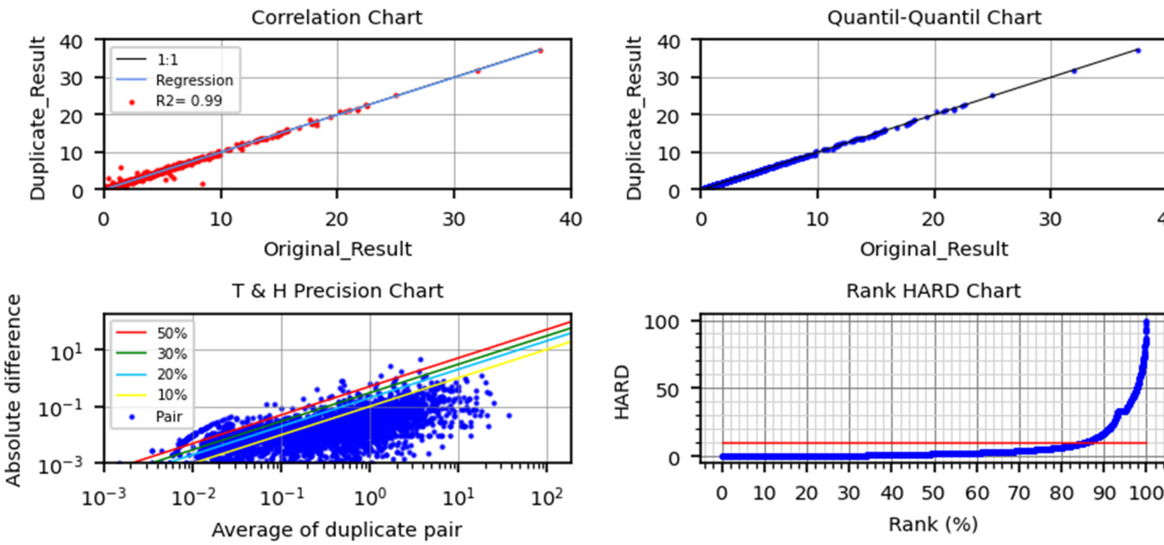


Figure 11-22: Analytical Result of the Pulverized Duplicate Samples (MCSA, 2020)

11.1.4 Check-Assay / Third-Party Laboratory

Check-assay analysis of copper grades by a third-party laboratory was implemented as part of MCSA's QA/QC program. This control involves sending duplicate batches of pulverized samples to ALS Brasil Ltda.'s facility located in Vespasiano, Minas Gerais, Brazil. ALS Brasil Ltda. is a subsidiary of ALS Limited and is independent of the Company as such term is defined under NI 43-101. At a minimum, one sample is selected from the original batch of material at an interval of at least every 40 samples (a rate of 2.5%), with a target rate of approximately 5.0% under the program. In analyzing the results of duplicate check-assay samples, the authors considered 15% of the relative difference as within acceptable limits.

Overall, the evaluation of MCSA's QA/QC procedures and lab results show good / acceptable results as illustrated in the figure below for period from September 18, 2019 to July 4, 2020. While it should be noted that only 70% of the samples during this period exhibited a relative difference within the acceptable limit, the authors note (as evidenced in the T&H precision graph) that the largest relative differences occur within the lowest grade ranges. GE21 recommends continuing this control and implementation of a continuous assessment program to reduce relative differences in the future.

Target	All core samples
Reference	Secondary Lab
Variable	Cu_pct
Accuracy limit	15%
Number of pairs	1111

	Sample	Duplicate
Minimum	0.0	0.001
Maximum	13.91	13.455
Average	0.326	0.318
Median	0.023	0.023
HARD median		15.9

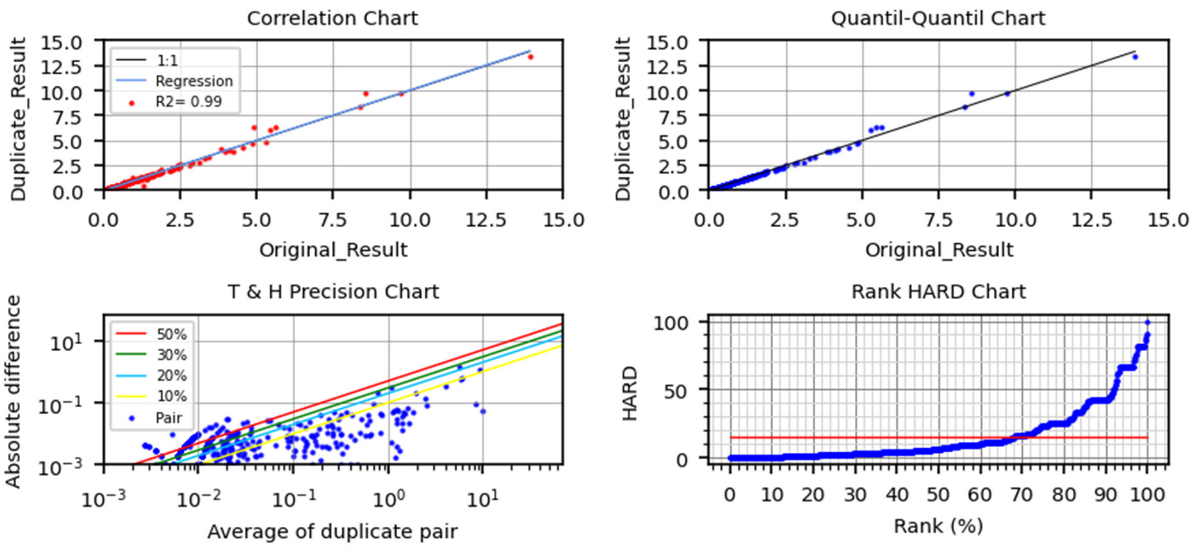


Figure 11-23: Analytical Result of the secondary laboratory (MCSA, 2020)

11.2 OPINION OF THE QUALIFIED PERSONS

GE21 performed the evaluation of data generated and concludes that the QA/QC procedures undertaken by MCSA, and in support of the current mineral resource estimate are being followed according to industry best practice. GE21 considers the QA/QC procedures to be in accordance with mining industry norms and valid for use in the current mineral resource estimate.

GE21 recommends the following work program to improve MCSA's QA/QC program:

- It was observed throughout the course of the review period that the MCSA laboratory continues to display a tendency to systematically underestimate the copper values when using CRM ITAK 825; however, the results for CRM ITAK 851, which has similar Cu grade range, demonstrates better reproducibility. GE21 recommends a validation of the certified grade for CRM ITAK 825 due to the observed inconsistencies with the analysis in the MCSA laboratory, which is in contrast with the consistent results obtained when utilizing CRM ITAK 851, which has a similar Cu grade range.

- While only 70% of the samples during the period from September 18, 2019 to July 4, 2020 exhibited a relative difference within the acceptable limit, the authors note (as evidenced in the T&H precision graph) that the largest relative differences occur in the lowest grades. GE21 recommends continuing this control and implementation of a continuous assessment program to reduce relative differences in the future.

12 DATA VERIFICATION

Professionals from GE21, including the majority of the authors of this Report, have conducted periodic field visits to the Company's operations in the Curaçá Valley, since 2017, to personally inspect the site infrastructure, the procedures used in data collection and resource estimation and the results that are obtained from the activities carried out by MCSA personnel.

Eng. Porfirio Rodriguez of GE21 has conducted field visits since 2006. Since then, Mr. Rodriguez has been involved with MCSA and Ero Copper personnel in the development of the resource estimation procedures that have been implemented by the MCSA staff and are used currently.

For the 2020 updated mineral resource and mineral reserve estimate, a site visit was conducted in February 2020 that included Bernardo Viana and Porfirio Rodriguez (February 17 to 19, 2020) and Paulo Bergmann (February 18 to 20, 2020). Although planned, additional site visits that would have included Dr. Beck (Alizeibek) Nader and Dr. Augusto Ferreira Mendonça, were not conducted due to the COVID-19 pandemic.

GE21 is of the opinion that the exploration data is adequate for use in the mineral resource and mineral reserve estimate. What follows below are some observations that were recorded by GE21 personnel during the course of visits as it relates to the generation, collection, control and storage of exploration data on site at MCSA:

- Drill hole logging: this task is considered to be best industry practice. The Company implemented electronic core logging, which has been standardized at MCSA by Ero Copper since 2018. GE21 performed a review of logging procedures for randomly selected drill core and verified the completeness of the logs. Of the samples reviewed, not all drill holes recorded standard lithological codes and some geologic features were omitted from the logs; however, considering the small number of omissions among the data set reviewed, MCSA has demonstrated that it understands the geology and these omissions are not considered to be material.

- Laboratory and chemical analyses: standardized QA/QC procedures were found to be complete and in-line with standard industry practice as more fully described in Chapter 11 – Sample Preparation, Analyses, and Security. Information collected before the current QA/QC procedures were put in place has been verified via a post-mortem validation. Data from drill holes that could not be validated were omitted from the mineral resource estimate.

- Database: recent data is stored in a standard commercial database. Historical records are well managed and, where applicable, have been migrated to the database. Data storage procedures at MCSA are considered standard industry practice. As part of the validation process, GE21 verified 377 holes totaling 96,417m of drilling. Database validation was conducted with the help of MCSA staff according to standard validation procedures including review of collar locations, drill hole deviations and database check-assay review. No inconsistencies were found in the database.

- Density: There is considerable density information available for the Curaçá Valley due to the operating history of the mine(s). The process for determining density is considered in-line with standard industry practice. The table below shows the density determined for each lithological unit.

Table 12-1: Summary of Density Estimates by Lithology

Lithology	Density (g/cm³)			Deviation	Number of Samples
	Max	Min	Mean		
Amphibolite	3.06	2.96	3.01	0.1	55
Biotite Gneiss	3.2	2.88	2.7	0.14	2,894
Biotite	3.85	3.20	3.38	0.11	141
Calcium-silicate	4.14	3.00	3.39	0.15	117
Phlogopite	3.28	3.21	3.25	0.13	102
Gabbro	3.07	2.96	3.01	0.06	140
Gabbronorite	3.05	2.99	3.02	0.04	226
Gneiss Q-F	2.76	2.71	2.74	0.1	247
Tonalitic Gneiss	2.74	2.69	2.72	0.04	577
Granite	2.69		2.69	0.05	49
Gneissic granite	2.81	2.75	2.78	0.02	51
Melanorite	3.5	3.14	3.32	0.18	1,204
Metasomatite	2.91	2.76	2.82	0.13	877
Migmatite	2.91	2.75	2.83	0.12	181
Mylonite	3.38	2.92	3.1	0.19	26
Norite	3.32	2.99	3.15	0.15	1,054
Pegmatite	3.08	2.7	2.86	0.12	126
Pyroxenite	3.7	3.33	3.52	0.24	758
Serpentinite	3.6	3.03	3.3	0.18	322
Tonalite	2.7	2.48	2.6	0.03	8
Quartz vein	2.76		2.76	-	1
TOTAL					**9,153**

13 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 INTRODUCTION

Since operations were restarted by the Company in February of 2017, a notable increase in metallurgical recoveries has been observed as a result of both ongoing plant improvement initiatives and the increased contribution from the Vermelhos UG Mine. The results of these initiatives have resulted in metallurgical recoveries improving from approximately 86% in 2017 and 2018 to in excess of 90% by 2019. Optimization work remains ongoing as well as commissioning and feed system integration of the recently installed HIG Mill.

Table 13-1: Mill Performance

	2017 (Feb – Dec)	2018	2019	2020 (Jan – Sep 30)
Ore Processed (kt)	1,771.2	2,257.9	2,424.6	1,778.2
Copper Grade (%)	1.31	1.56	1.93	2.03
Metallurgical Recovery (%)	86.8	86.3	90.5	90.2

For the LOM plan, forecast metallurgical recoveries for zones within the underground mines have been based on grade-recovery regression curves derived from analyses performed in MCSA's laboratory. Open pit operations have assumed the average historical metallurgical recovery of the Curaçá Valley open pit operations of 86.0%. A 3.0% increase in metallurgical recoveries has been included in the forecast to reflect the improvement resulting from the installation of the HIG Mill circuit, which was commissioned during the third quarter of 2020. Feed system integration work remains ongoing as at the time of this Report. A description of the test-work related to the HIG Mill recovery improvement is included in Section 13.2 – HIG Mill Recovery Improvements, and the underlying grade-recovery curve data for the underground mines is outlined in greater detail in Section 13.3 – Metallurgical Recovery Curves, below. Where applicable, such laboratory tests were designed to mimic the residence time, grind size and reagent scheme of the processing operations in practice to simulate recoveries in the Caraíba Mill.

Samples used to generate the forecast metallurgical recoveries, and in the HIG Mill analyses are representative of the expected mineral composition of the production plan and consistent with the operating history of the Caraíba Mill.

13.2 HIG MILL FORECAST RECOVERY IMPROVEMENT

In September 2018, the Company initiated an optimization program aimed at improving metallurgical recoveries. This work included updated mineralogical characterization of the Company's concentrate and final tailing, as well as grind size and liberation analyses performed by SJT MetMin Services (Pty) Ltd. ("SJT MetMin") in South Africa. Upon completion of this initial characterization program, a series of composite samples collected from the oversize fraction of the Company's Derrick screens during plant operations in late 2018 was subjected to particle size characterization and grind vs. recovery testwork at Mintek's testing facility in Randburg, South Africa. SJT MetMin and Mintek are independent of the Company as such term is defined under NI 43-101.

Additional verification testwork was conducted by MCSA using a composite generated over six fill operating days in March 2019 to validate the expected improvements in recovery at the target grind size of 80% passing 75 microns. The authors of this Report have reviewed the following testwork, results and conclusions and found them to be in accordance with industry best practices, and appropriate for use in support of this Report.

13.2.1 Mineralogical Characterization Testwork

Characterization testwork of a final copper concentrate and final tailings sample from the Caraíba Mill, each weighing 0.5 kg, collected in late 2018 following commissioning of the Vermelhos UG Mine, were performed by SJT MetMin.

Mineralogical characterization work included chemical analysis for total copper and trace elements, XRD, Scanning Electron Microscopic Dispersive Spectrometric ("SEM-DES") analysis and phase quantification of liberation and mineralogical composition.

A complete table highlighting the chemical composition of the final concentrate and tailings samples used in the analysis is shown below.

Table 13-2: Chemical Analysis and Trace Element Composition (%)

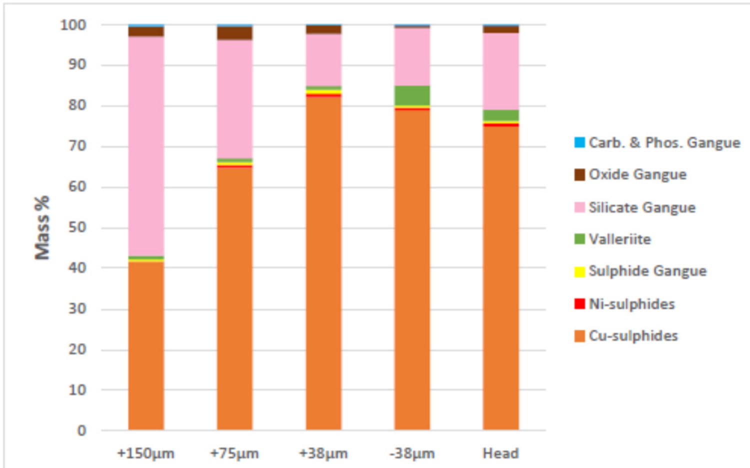
Element	Concentrate			Tailings		
	Analysis A	Analysis B	Avg.	Analysis A	Analysis B	Avg.
SiO_2	10.10	10.20	**10.15**	54.80	54.60	**54.70**
Al_2O_3	2.32	2.20	**2.26**	13.56	13.18	**13.37**
Fe_2O_3	27.26	27.46	**27.36**	12.17	12.13	**12.15**
TiO_2	0.29	0.29	**0.29**	1.06	1.07	**1.06**
CaO	1.17	1.11	**1.14**	4.99	5.01	**5.00**
MgO	3.99	3.79	**3.89**	9.99	9.91	**9.95**
K_2O	0.17	0.15	**0.16**	1.52	1.44	**1.48**
MnO	0.05	0.05	**0.05**	0.14	0.15	**0.14**
P	0.066	0.054	**0.060**	0.122	0.124	**0.123**
Ba	0.005	0.005	**0.005**	0.059	0.059	**0.059**
Co	0.026	0.025	**0.026**	0.007	0.005	**0.006**
Cr	0.114	0.108	**0.111**	0.135	0.126	**0.131**
Cu	37.10	37.60	**37.35**	0.23	0.23	**0.23**
Ni	0.410	0.406	**0.408**	0.044	0.043	**0.044**
Pb	0.056	0.059	**0.058**	bdl	bdl	**bdl**
Sn	0.047	0.037	**0.042**	0.086	0.082	**0.084**
Sr	0.007	0.006	**0.007**	0.039	0.039	**0.039**
V	0.004	0.004	**0.004**	0.025	0.024	**0.025**
Zn	0.033	0.034	**0.034**	0.017	0.016	**0.017**
Moisture	0.02	0.02	**0.02**	0.12	0.08	**0.10**
LOI	7.57	7.46	**7.52**	1.18	1.20	**1.19**

LOI = Loss On Ignition; bdl = blow detection limit

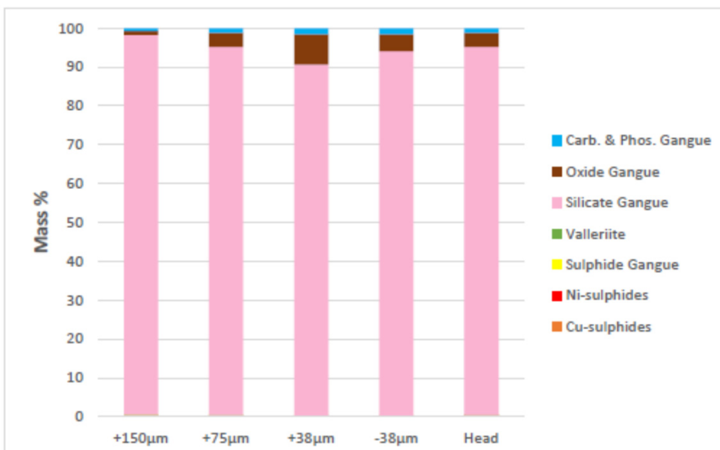
XRD analysis indicated that the main copper-bearing phases in the concentrate sample are chalcopyrite, bornite and cubanite, while that of the tailings sample detected primarily chalcopyrite as the copper-bearing phase, with minor bornite. Gangue minerals in both the concentrate and tailings sample were pyroxene, plagioclase, talc, quartz and mica (biotite/phlogopite). Particle size analysis performed on both samples highlighted the ratio of coarse particles (+150 micrometers ("micron" or "µm")) in the tailings sample as compared to the final concentrate. This coarse size fraction only accounted for approximately 3% of the final concentrate by mass, but approximately 30% of the tailings, indicating a preferential reporting of coarse particles to tailings.

Polished sections of the samples were analyzed to evaluate quantitative mineralogical compositions of both samples. SEM-EDS analysis of both samples confirmed the primary copper-bearing phases of chalcopyrite, cubanite and bornite, with trace amounts of chalcocite, digenite and covellite. The gangue phases in the concentrate sample were predominately present in the -75/+150 micron fractions, indicating insufficient liberation of gangue minerals from the copper-bearing sulphide minerals. The composition, by mass percent, is shown in Figure 13-1.

Calculated copper grades (determined using the mineralogical composition) showed that the highest copper grade of the concentrate sample was in the +38/-75 micron size fraction (containing approximately 43% of total contained copper), while the grade was lower in the +75/-150 micron size fraction (containing approximately 32% of total contained copper) and lowest in the +150 micron size fraction (containing approximately 20% of total contained copper). This distribution, again, demonstrated the presence of un-liberated gangue in the coarser size fractions of the concentrate sample. This relationship was inversely mirrored in the tailings sample, confirming the presence of un-liberated copper-bearing sulphide minerals in the coarser size fractions, as shown in Figure 13-2.



(a)



(b)

Figure 13-1: Mineralogical Composition, by Size Fraction for Concentrate (a) and Tailings (b) Samples (SJT MetMin, 2018)

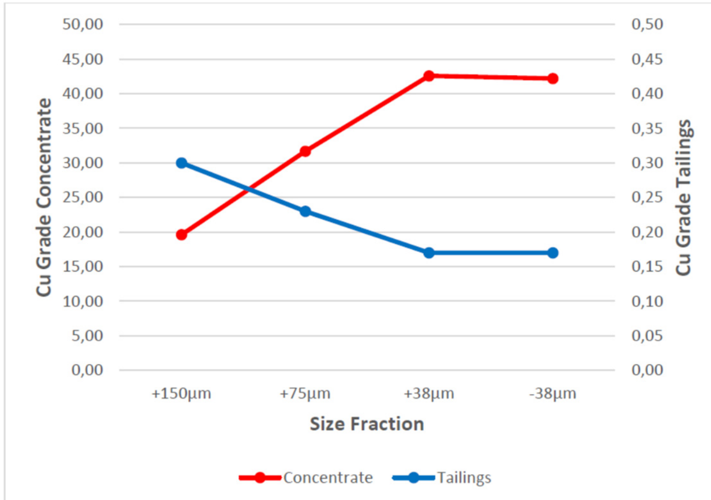


Figure 13-2: Calculated Copper Grades for the Concentrate and Tailings Sample, by Size Fraction (SJT MetMin, 2018)

Liberation analysis of the concentrate sample, which had a grade of 37.35% copper, showed that the copper-bearing sulphide minerals were well liberated; however, additional grinding of the +75 micron particles would further improve liberation. The coarse size fraction represented approximately 29% of the concentrate sample mass and had a calculated grade of 30.34% copper, whereas the -75 micron fraction had a calculated copper grade of 42.35%. It is expected that a regrind of the +75 micron fraction followed by additional cleaning flotation could improve concentrate grade without resulting in a significant copper loss.

In the tailings sample, which had a grade of 0.23% copper, most of the copper-bearing sulphide minerals were within locked or middling particles, except for the occasional fully-liberated copper-sulphide grain in the -38 micron fraction. The +75 micron size fraction represented approximately 62% of the tailing sample mass and had a calculated copper grade of 0.26% compared to the -38 micron size fraction which had a copper grade of only 0.17%. The +150 micron size fraction represented approximately 30% of the tailing sample mass and had a calculated grade of 0.30% copper. Similarly, the liberation analysis of the tailings sample, pointed to a significant potential improvement in overall liberation and recoveries with re-grinding the +75 micron size fraction.

13.2.2 **Grind Size & Rougher Flotation Testwork**

Based on the mineralogical characterization work, a review of potential circuit improvements to retrofit and/or replace the Company's existing Vertimill to improve overall grind size was conducted. The Company selected to further evaluate Outotec's HIG Mill based on superior grinding performance characteristics for the ore of the Curaçá Valley. A composite sample of Derrick screen oversize material was prepared for testing during the operating days of September 20th to September 22nd, 2018. The composite slurry sample, consisting of one 200-liter drum, was tested in both Mintek's laboratory and a sub-sample was provided to Outotec for HIG Mill sizing characterization. The table below shows the product particle size distribution as a function of energy input from the HIG Mill test results conducted by Outotec. Outotec is independent of the Company as defined under NI 43-101.

Table 13-3: HIG test results

Size *micron*	**Feed**	**6.4** kWh/t	**12.8** kWh/t	**19.6** kWh/t	**26.3** kWh/t	**33** kWh/t
600	100	100	100	100	100	100
425	98	100	100	100	100	100
300	86	99	100	100	100	100
212		99	99	100	100	100
150	32	96	97	99	99	100
106	21	89	94	97	99	99
75	16	80	89	94	97	98
45	11	61	74	83	90	93
20	8	41	51	59	71	74
D80	**284**	**75**	**56**	**41**	**30**	**26**

A sub-sample of the composite was milled using a laboratory batch stirred test mill to achieve target grind size for rougher flotation testwork. Rougher flotation tests were conducted in a 10-litre Denver flotation cell operating at 1,200 revolutions per minute ("rpm") with an air rate of 60 l/min. The mass of solids used in each test was 2.0kg at a target slurry density of 30% to 33% solids. Concentrates were collected and sampled at 1, 3, 7 and 15 minutes. Flotation concentrate and final tail samples were assayed using ICP-OES. Reagents and dosages included lime (360g/t), Aero4377 (35gpt), PAX (5pgt), MIBC (0.02g + 1 drop), plus 2 drops of MIBC and a second 5g/t dose of Aero3477 after 3 minutes. A second 5g/t dose of PAX was added after 7 minutes in each test.

Rougher flotation testing was conducted at varying grind sizes and, as a base-line, with no regrinding. The size fractions tested were as follows:

- 80% passing 280 microns (baseline with no regrind)
- 80% passing 150 microns
- 80% passing 125 microns
- 80% passing 106 microns
- 80% passing 75 microns
- 90% passing 53 microns

The results, shown in the figure below, highlighted that any degree of regrinding does improve rougher performance and showed improved rougher recovery as compared to the baseline no regrind sample. Grinds of 80% passing 150 microns to 106 microns resulted in similar recoveries of approximately 78% to 80%, while grinding to 80% passing 75 microns improved the overall recovery to around 84%, a 6% to 8% improvement. Regrinding to 53 microns improved rougher recovery further to approximately 86%, but rougher concentrate grades were lower as compared to the 80% passing 75 micron grind sample.

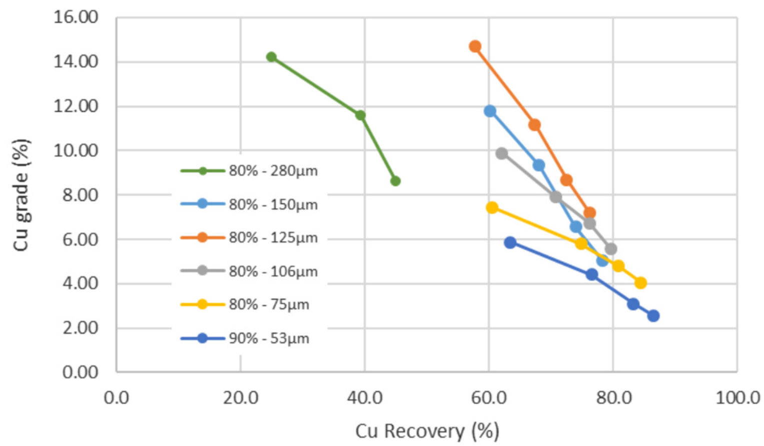


Figure 13-3: Rougher Concentrate Grade vs. Recovery Curves at Various Grind Sizes

13.2.3 MCSA Validation Testwork

Additional testwork, undertaken by MCSA in March of 2019, sought to validate and further quantify the expected improvement in recovery with a finer grind of the Derrick oversize material, which constitutes feed for the regrind circuit. Over the period of 6 operating days with the Caraíba Mill operating at close to its current installed capacity (of approximately 9,600 tpd), representative samples of mill feed, Derrick screen oversize and Derrick screen undersize were collected for additional testing. The samples, which ranged in copper head-grade from 1.45% copper to 2.38% copper, were tested for rougher flotation recoveries before and after regrinding the oversize fraction to 80% passing 74 microns.

The laboratory rougher flotation testwork sought to simulate the residence time, reagent types and dosages of the rougher flotation cells currently in use in the Caraíba Mill. The results, shown in Table 13-4 below, highlight an average 16.1% increase in rougher recovery for the Derrick oversize fraction, resulting in a total increase in metallurgical recovery of between 3.7% and 4.9% copper. A 3.0% increase in metallurgical recoveries has been forecast for the purposes of this Report commencing from 2021, commensurate with commissioning and integration of the HIG Mill.

Table 13-4: Results of MCSA Validation Testwork

	Copper Grade (Cu%)			Cu Recovery Without Regrind			Cu Recovery with Regrind of O/S				Improvement
Sample	Feed	Oversize	Undersize	Oversize	Undersize	Total	Oversize	Undersize	Total		Total Rec.
Mar 22, 2019	1.45%	1.05%	1.64%	72.3%	95.0%	89.6%	92.7%	95.0%	94.5%		**4.9%**
Mar 25, 2019	1.89%	2.34%	1.68%	82.0%	94.6%	89.5%	92.7%	94.6%	93.9%		**4.3%**
Mar 26, 2019	2.10%	2.25%	2.03%	90.4%	95.0%	90.4%	92.4%	95.0%	94.1%		**3.6%**
Mar 27, 2019	2.38%	1.85%	2.65%	78.0%	94.2%	90.0%	92.7%	94.2%	93.8%		**3.7%**
Mar 28, 2019	2.31%	0.91%	2.99%	64.6%	93.8%	90.0%	92.8%	93.8%	93.7%		**3.7%**
Mar 29, 2019	1.49%	0.93%	1.77%	72.0%	94.0%	89.4%	92.6%	94.0%	93.7%		**4.2%**

13.2.4 Operating HIG Mill Results in 2020

Installation of the HIG Mill was completed at the end of the third quarter of 2020 with commissioning and feed system integration work continuing into the fourth quarter of 2020. Preliminary operational performance data from September 2020 prior to the Effective Date is shown in the figure below. Following one month of operational data, the Company has seen an average increase in plant recoveries of approximately 4.5% when the HIG Mill is in operation, across a wide range of copper grades. While preliminary in nature, this serves to validate the assumed 3% recovery shown in the preliminary testwork and assumed in the current LOM plan from 2021 onwards. This improvement was not applied in the estimation parameters of the current mineral reserve estimate. Feed system integration and data collection are ongoing.

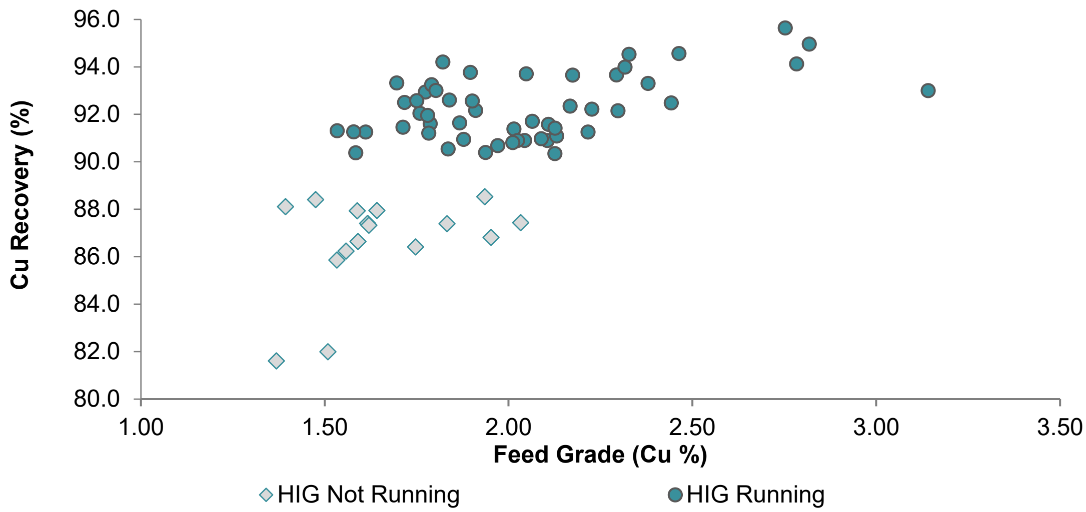


Figure 13-4: September 2020 Plant Recoveries vs. HIG Mill Operation (MCSA, 2020)

13.3 PILAR UG MINE METALLURGICAL RECOVERY

Drill hole composites from each area within Pilar UG Mine and Vermelhos UG Mine are routinely tested for metallurgical performance and characterization by MCSA's process engineering team and laboratory personnel. The test work consists of sample preparation, mineralogical characterization, grind studies, rougher and cleaner flotation tests. The objective of this work is to predict the recoveries of the ores in the various regions of the underground and open pit mines for planning purposes and to develop optimal process parameters for each ore type. The following sections detail the results of these studies.

13.3.1 Deepening Extension

Flotation tests were carried out with metallurgical composites from 94 drill holes representing 2,078 samples in the composite test work. Recoveries as a function of copper grade are shown in the figure below.

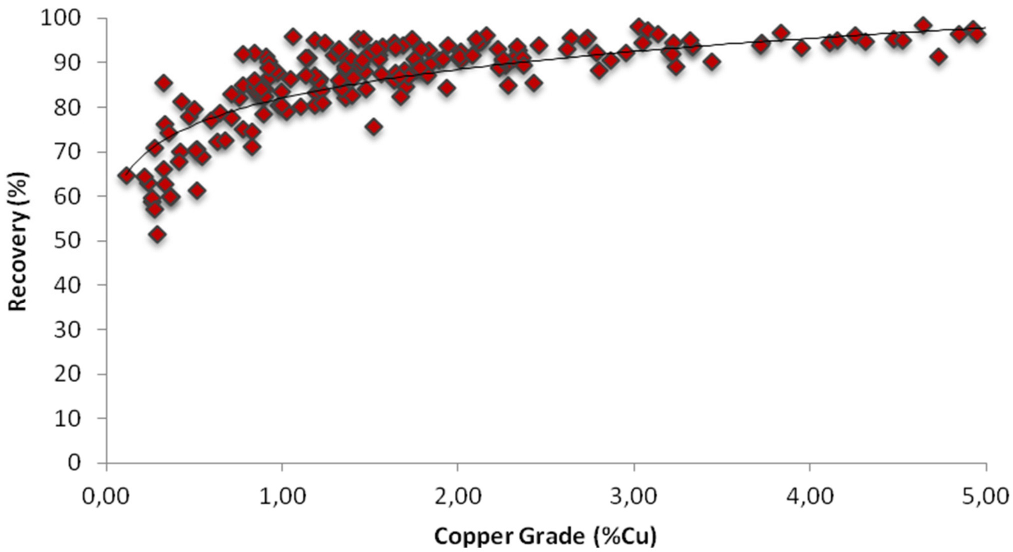


Figure 13-5: Metallurgical Test Work Results for Pilar UG Mine Zone: Deepening (MCSA, 2019)

13.3.2 P1P2NE

Flotation tests were carried out with metallurgical composites from 17 drill holes representing 573 samples in the composite test work. Recoveries as a function of copper grade are shown in the figure below.

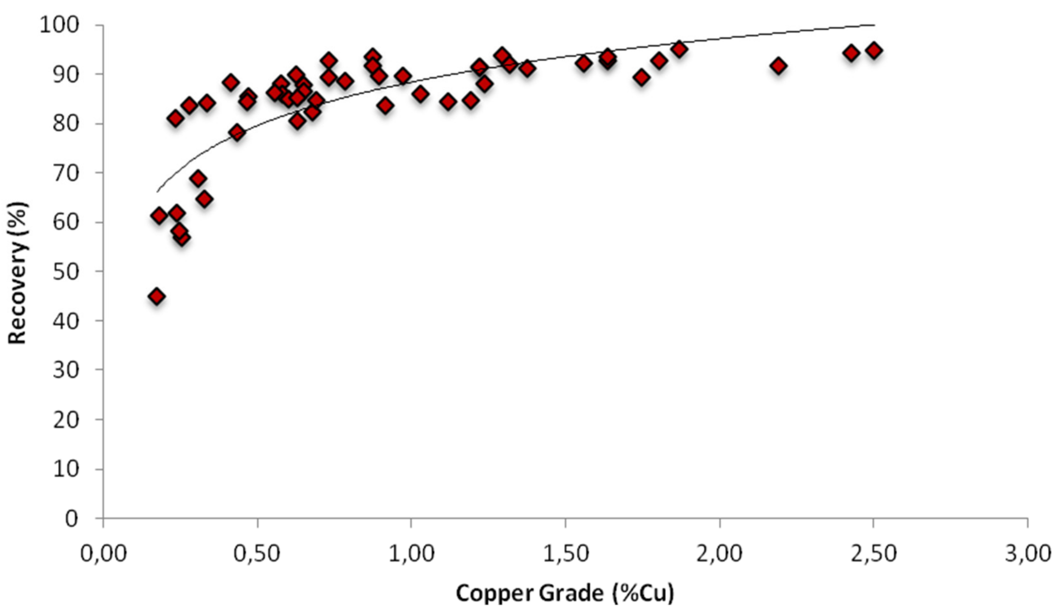


Figure 13-6: Metallurgical Test Work Results for Pilar UG Mine Zone: P1P2NE (MCSA, 2019)

13.3.3 P1P2W (part of the "West Limb")

Flotation tests were carried out with metallurgical composites from 10 holes representing 201 samples in the composite test work. Recoveries as a function of copper grade are shown in the figure below.

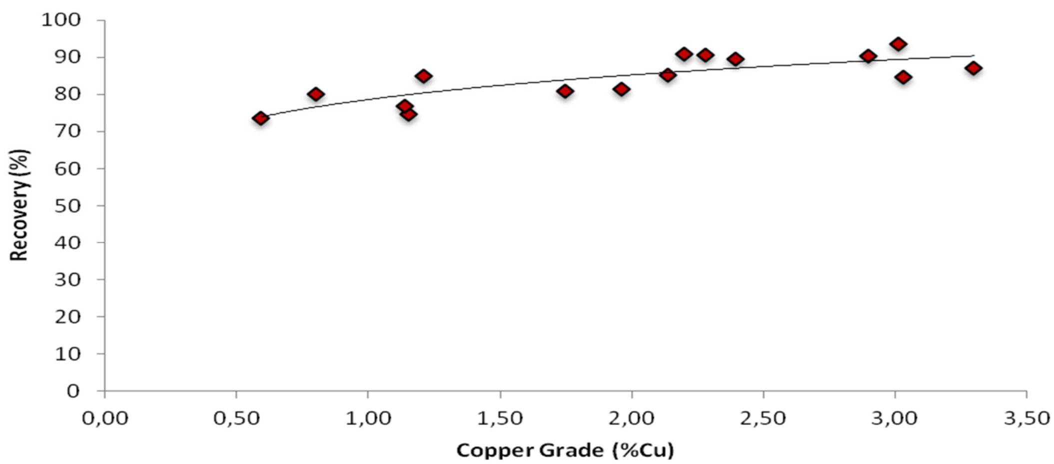


Figure 13-7: Metallurgical Test Work Results for Pilar UG Mine Zone: P1P2W (MCSA, 2019)

13.3.4 MSB South (MSBS)

Ore from MSBS mine area has been processed by the plant. Actual plant performance serves as the guide for forecast metallurgical results. Recoveries as a function of copper grade are shown in the figure below.

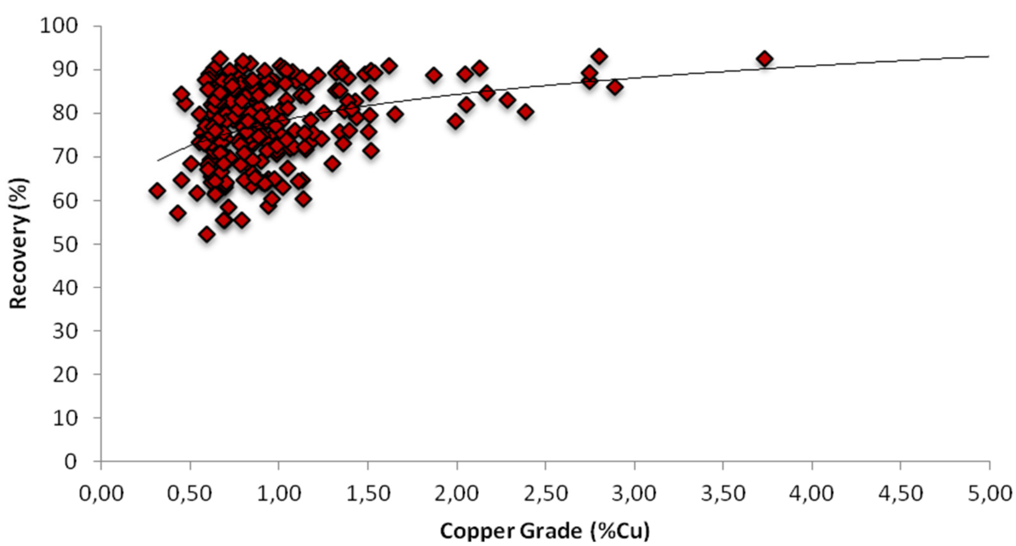


Figure 13-8: Metallurgical Test Work Results for Pilar UG Mine Zone: MSBS (MCSA, 2019)

13.3.5 **GO2040 + Piloto 1**

Ore from GO20140 & Pilar Upper Level mine areas have been processed by the plant. Actual plant performance serves as the guide for forecast metallurgical results. Recoveries as a function of copper grade are shown in the figure below.

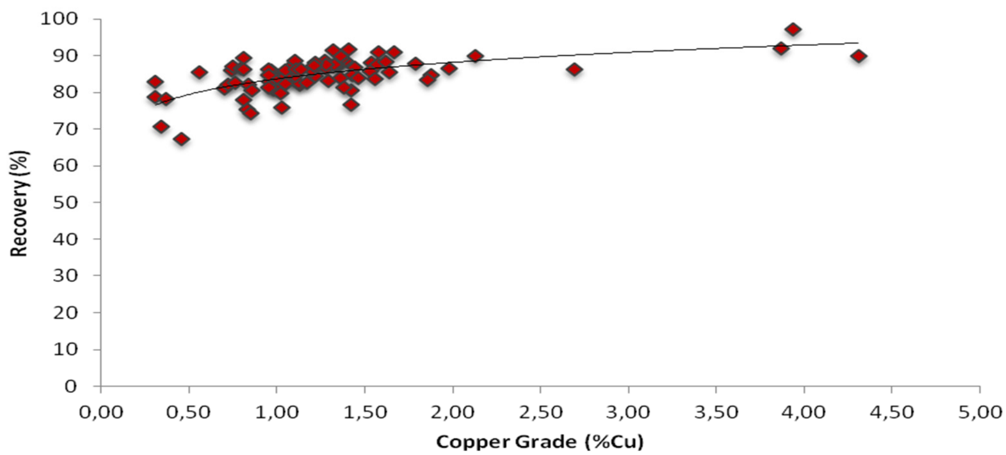


Figure 13-9: Metallurgical Test Work Results for Pilar UG Mine Zone: GO2040 & Pilar Upper Levels (MCSA, 2019)

13.3.6 **Sill Pillar**

Ore from the Sill Pillar mine area has been processed by the plant. Actual plant performance serves as the guide for forecast metallurgical results. Recoveries as a function of copper grade are shown in the figure below.

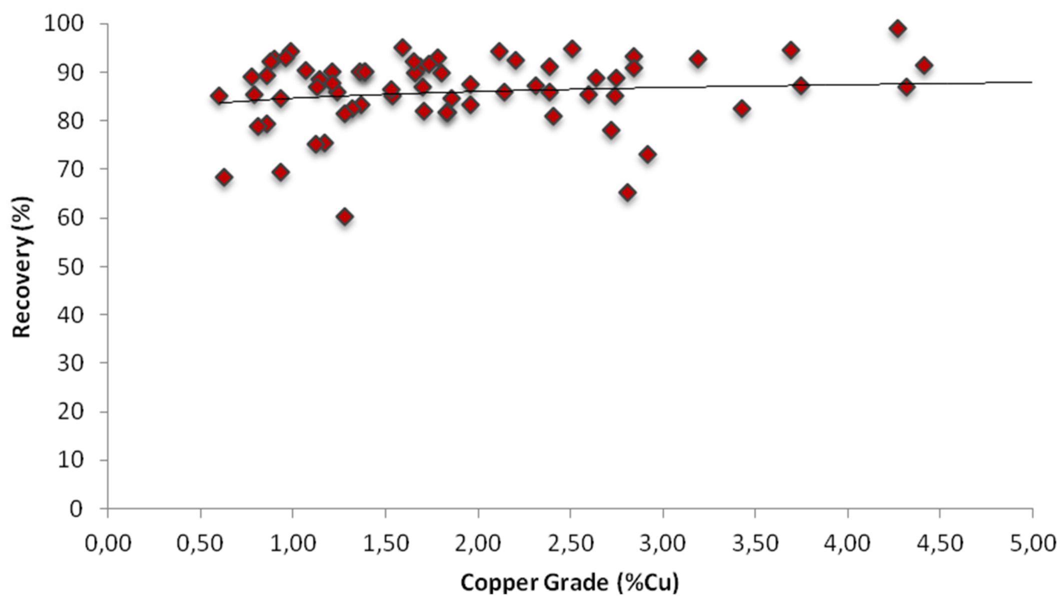


Figure 13-10: Metallurgical Test Work Results for Pilar UG Mine Zone: Sill Pillar (MCSA, 2019)

13.4 VERMELHOS UG MINE METALLURGICAL RECOVERY

Ore from the Vermelhos UG Mine has been processed by the Caraíba Mill previously. Actual plant performance serves as the guide for forecast metallurgical results. Recoveries as a function of copper grade are shown in the figure below.

Metallurgical performance within the mine can be further separated into mineralization derived from the main central orebodies of Toboggan and Sombrero and that of the previously mined area of UG1. UG1 was mined in 2018 and early 2019 and is generally characterized as having elevated phlogopite and alteration, which at lower grades, necessitates a decline in recoveries to maintain concentrate grades at 35% when compared to the main orebodies. In late 2019, improvements to the Company's CMC dosing unit operations were made resulting in improved metallurgical recoveries for highly altered zones, such as UG1.

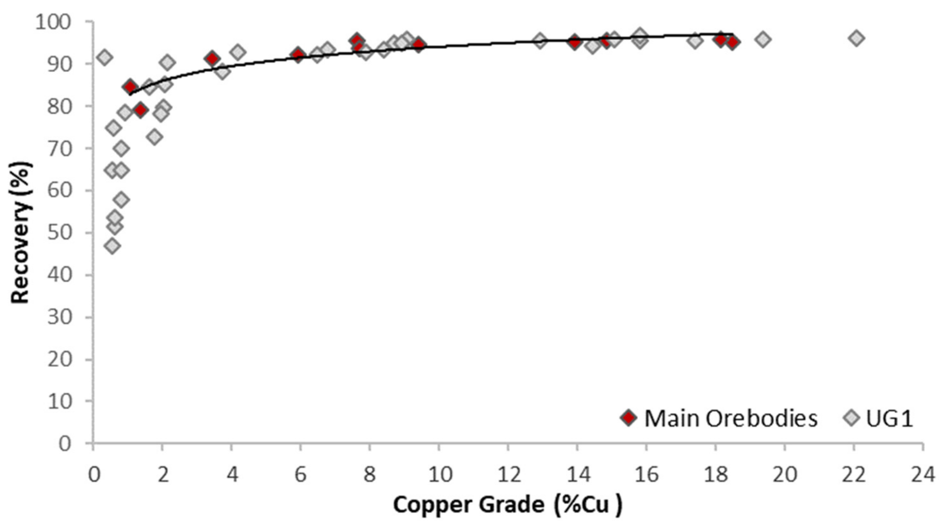


Figure 13-11: Metallurgical Test Work Results for Vermelhos UG Mine (MCSA, 2019)

13.4.1 Vermelhos Geometallurgical Test Program

Geometallurgical testwork commenced in 2018 on the main mining areas of Vermelhos UG Mine, as currently defined, to test varying metallurgical responses between the main orebodies and the northern and the southern satellite bodies (namely UG2 and UG1, respectively).

GE21 analyzed the geometallugy data from three main areas, incorporating 77 samples comprised of both drill hole composites from the main orebody and stockpile material from the UG1 deposit. The classification ID and number of samples comprising each sub-group area as follows:

- CNT (Toboggan and Sombrero) = 33 samples
- UG1 = 35 samples
- UG2 = 9 samples

GE21 observed that the UG1 zone exhibited lower recovery, greater recovery dispersion and lower copper enrichment factors when compared to both CNT and UG2, consistent with plant performance in this zone over the period that UG1 was mined. The figure below presents the different sample behavior according to mining area.

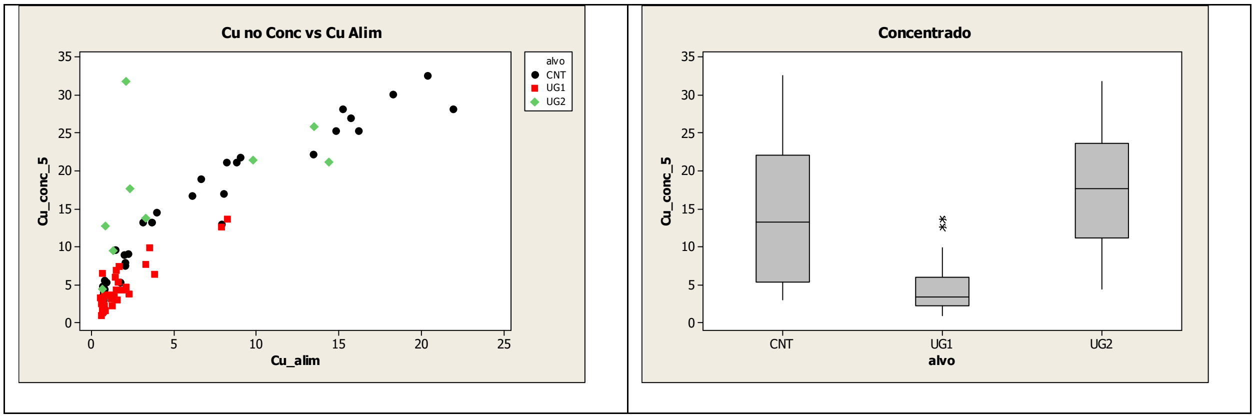


Figure 13-12: Sample behavior According to Feed Source (GE21, 2019)

Based on the geometallurgical analysis performed, it is believed that the sub-optimal recoveries realized in UG1 are predominantly as a result of the presence of MgO bearing minerals such as serpentine (Mg, Fe)$_3$Si$_2$O$_5$(OH)$_4$), and K2O bearing minerals such as phlogopite (KMg $_3$(AlSi$_3$O$_{10}$)(F, OH)$_2$), as shown in the two figures below.

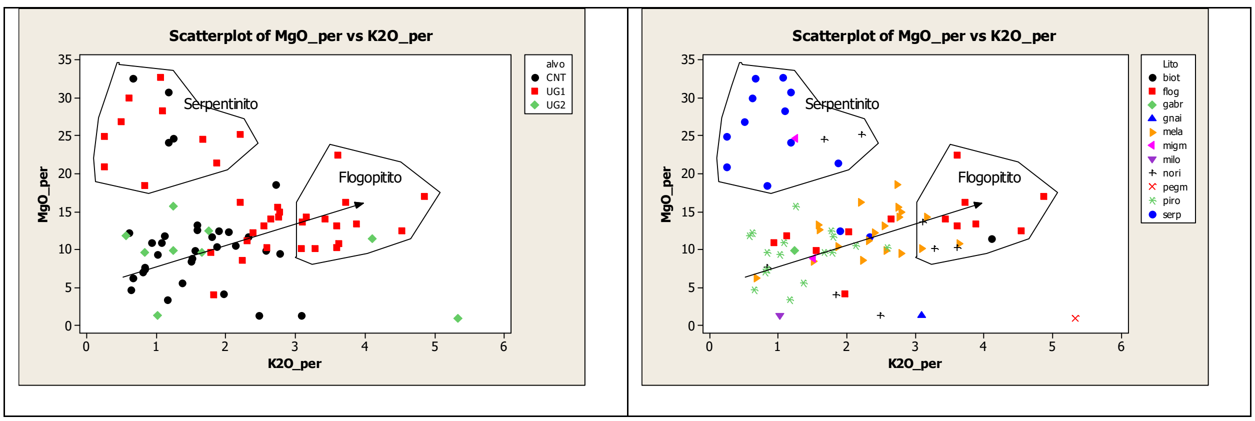


Figure 13-13: Mineral Association on UG1 (GE21, 2019)

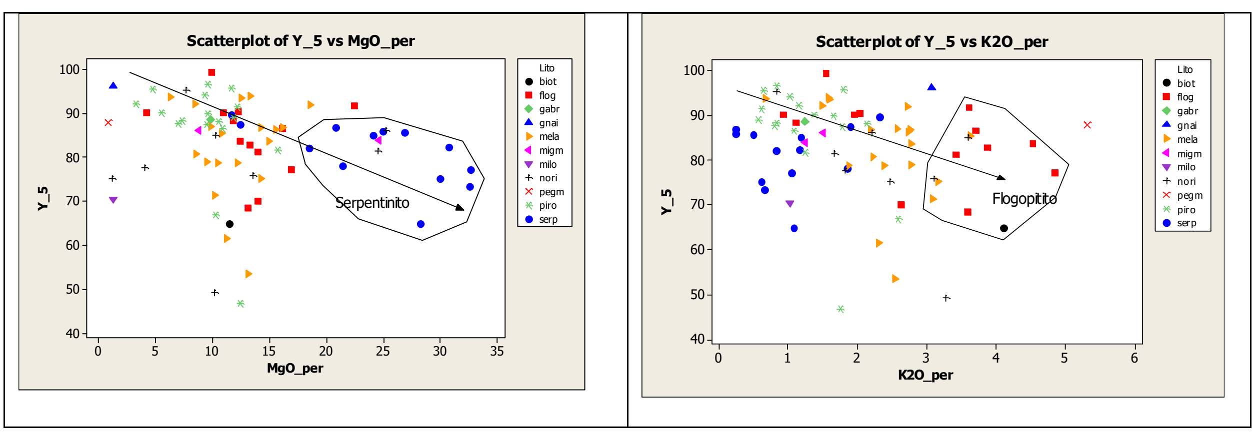


Figure 13-14: Relation Between MgO and K$_2$O Bearing Lithology and Copper Recovery (GE21, 2019)

As evidenced in the above classification, and as observed in actual plant performance, CNT, UG1, and UG2 areas represent different geological domains that influence copper recovery.

Overall, lower recoveries should be expected when copper mineralization is hosted in heavily altered rocks (with strong association of phlogopites and serpentinites), as is the case with UG1. There was no observed recovery difference between the primary host lithologies for copper mineralization (pyroxenite, norites and melanorites) at the Vermelhos UG Mine.

13.5 ORE SORTING

As part of ongoing optimization efforts, and in recognition of the heterogeneous nature of the mineralization of the Curaçá Valley, the Company undertook testwork in early 2019 to evaluate the potential of XRF ore-sorting to upgrade copper content of mined ores. To evaluate this potential, three bulk samples weighing approximately 300kg each, 900kg in total, were collected from several locations within the Surubim mine. The sampling program sought to create representative high-grade, medium-grade and waste bulk composite sample from exposed ore in a recently mined open pit to form approximately one tonne of material grading approximately one percent copper. These samples were crushed, screened, and delivered to Metanza Mineral Processors (Pty) Ltd. outside of Johannesburg South Africa in six drums. Particle sizes of the bulk samples ranged between 30mm and 75mm. Metanza Mineral Processors (Pty) Ltd. is independent of the Company as such term is defined under NI 43-101.

These samples were passed through a XRF machine in normal operation mode to analyze the particles as they fell past the XRF sensor, which was set to record the relative values of copper, iron, nickel, and calcium. Relative values were normalized to develop optimal sorting conditions based on the normalized values of copper, nickel, and iron. A 24 product factorial approach was then used to evaluate the cumulative performance throughout the selectivity range for each composite sample. Each of the sort products were pulverized and sent to ALS laboratories in Johannesburg to determine copper, nickel, iron, and calcium contents using four-acid digestion and inductively coupled plasma atomic emission spectroscopy ("ICP-AES"). ALS laboratories is independent of the Company.

The results of this test program demonstrated that XRF ore-sorting could be used to upgrade the copper content of these samples with minimal copper loss. The combined result showed that a sample weighing approximately 900kg and grading 1.00% copper could be sorted to approximately one-half of its original mass, while only losing 5% of the contained copper. The results of the testwork program are shown below for the XRF selectivity setting that maximized copper recovery.

Table 13-5: XRF Test Results

Sample ID	Sample head-grade (Cu %)	Sort Concentrate Mass (%)	Sort Concentrate Grade (Cu %)	Reject Grade (Cu %)	Copper Recovery (%)
High-grade	1.69%	66.8%	2.41%	0.24%	95.3%
Medium-grade	1.38%	79.0%	1.68%	0.26%	96.2%
Waste	0.04%	3.20%	0.62%	0.02%	49.6%
Total Bulk	**1.00%**	**47.9%**	**1.98%**	**0.10%**	**95.0%**

Total Bulk sample mass of 912.9kg comprised of 292.3kg of high-grade, 292.9kg of medium-grade and 327.7kg of waste sample. Cumulative performance up to the selectivity range for maximum copper recoveries shown.

Following this testwork, the Company elected to run a comprehensive trial ore sorting campaign using a XRF machine. An ore sorting pilot plant was constructed at the Pilar Mine consisting of a single XRF sorting machine. Construction of the pilot plant was completed in the fourth quarter of 2019 and testwork began in early 2020. From early 2020 through September 2020, a total of approximately 29,000 tonnes of material from eight different sources of material throughout the Curaçá Valley were run at commercial throughput rates through the ore sorting pilot plant.

For each deposit tested, and for material from the Angicos Mine stockpile, material was crushed and screened to between 30 mm and 90 mm and fed into the XRF sorting unit at a rate of approximately 20 tonnes per hour using a belt feeder to provide a consistent feed rate. Minus 30 mm material and fines generated during the crushing process were screened away from the ore sorting feed and sent directly to the mill. For each source tested, the trial campaign sought to model sorting performance at a variety of selectivity ranges (or 'set points') to determine the unique performance characteristics throughout the selectivity curve. Optimal mass yield, defined as the amount of material that is upgraded in the sort product, is based on maximizing the upgrade ratio, defined as sort product copper grade divided by feed grade, while minimizing copper loss of the sort product. Samples of both the sort product and sort reject were collected at routine intervals and assayed for total copper at the Company's on-site laboratory. Prior to changing selectivity set points and between each of the sources tested, the crushing and XRF sorting unit were cleaned to prevent contamination of results.

Upgrade ratios were determined across a range of mass yields using the selectivity curves generated for each source. Results of the program across a range of mass yields are further detailed in the table below.

Table 13-6: Ore Sorting Trial Campaign Results at Varying Mass Yields

Tested Mine / Source	Sample Tested (Tonnes)	Sample Head Grade (Cu %)	Results at Selected Ore Sorting Mass Yield[1] 20%	40%	60%	80%
Vermelhos HG Sample	**4,569**	**2.71**				
Sort Product Grade (Cu%)			12.22	6.39	4.37	3.34
Upgrade Ratio (Sort Product Grade/Feed Grade)			4.50x	2.35x	1.61x	1.23x
Calculated Copper Loss (%)			9.8%	5.7%	3.2%	1.4%
Vermelhos MG Sample	**4,246**	**1.21**				
Sort Product Grade (Cu %)			5.46	2.85	1.95	1.49
Upgrade Ratio (Sort Product Grade/Feed Grade)			4.52x	2.36x	1.61x	1.23x
Calculated Copper Loss (%)			9.8%	5.7%	3.2%	1.4%
Vermelhos LG Sample	**9,109**	**0.80**				
Sort Product Grade (Cu %)			3.61	1.89	1.29	0.99
Upgrade Ratio (Sort Product Grade/Feed Grade)			4.49x	2.35x	1.61x	1.23x
Calculated Copper Loss (%)			9.8%	5.7%	3.2%	1.4%
Pilar Mine HG (Deepening)	**1,161**	**1.97**				
Sort Product Grade (Cu %)			8.86	4.64	3.17	2.43
Upgrade Ratio (Sort Product Grade/Feed Grade)			4.49x	2.35x	1.61x	1.23x
Calculated Copper Loss (%)			10.0%	5.8%	3.3%	1.5%
Pilar Mine LG Development	**904**	**0.33**				
Sort Product Grade (Cu %)			1.08	0.65	0.48	0.39
Upgrade Ratio (Sort Product Grade/Feed Grade)			3.33x	1.99x	1.48x	1.20x
Calculated Copper Loss (%)			34.4%	21.4%	12.5%	5.7%
Surubim Mine	**940**	**0.30**				
Sort Product Grade (Cu %)			0.97	0.59	0.44	0.35
Upgrade Ratio (Sort Product Grade/Feed Grade)			3.20x	1.93x	1.43x	1.16x
Calculated Copper Loss (%)			35.0%	21.8%	12.8%	5.8%
Suçuarana Mine	**3,753**	**0.27**				
Sort Product Grade (Cu %)			0.69	0.46	0.36	0.31
Upgrade Ratio (Sort Product Grade/Feed Grade)			2.59x	1.73x	1.36x	1.15x
Calculated Copper Loss (%)			48.8%	31.7%	19.2%	8.9%
Angicos Mine Stockpile	**4,216**	**0.38**				
Sort Product Grade (Cu %)			1.04	0.67	0.52	0.44
Upgrade Ratio (Sort Product Grade/Feed Grade)			2.73x	1.77x	1.37x	1.15x
Calculated Copper Loss (%)			45.5%	29.2%	17.5%	8.1%

Based on the success of the trial campaign and economic evaluations, ore sorting has been integrated into the LOM plan update with a focus on implementing the technology within the Vermelhos District because of the excellent response to ore sorting and expected savings in transport costs.

The resulting mill feed with the implementation of ore sorting on open pit production, commencing in 2023, is presented in the table below.

Table 13-7: Vermelhos Open Pit Mill Feed using XRF Sorting on Open Pit Mine Production

	Q4 2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Ore Sorting Operations															
Vermelhos District, Open Pit															
Ore Crushed & Sorted (kt)	-	-	-	635	840	1,140	1,755	2,681	4,046	3,777	1,920	3,175	-	-	19,968
Grade Crushed & Sorted (% Cu	-	-	-	0.62	0.74	0.55	0.66	0.74	0.59	0.52	0.52	0.36	-	-	0.56
Sort Product, Vermelhos District															
Sorted Ore to Mill (kt)	-	-	-	302	399	542	834	1,273	1,922	1,794	912	914	-	-	8,891
Sorted Grade to Mill (% Cu)	-	-	-	1.23	1.47	1.09	1.31	1.47	1.17	1.02	1.03	1.03	-	-	1.18

Ore-sorting assumed to commence in 2023. The effects of stockpiling were not considered. 30% of crushed open pit feed assumed to be fines generated from mining, hauling, and crushing and therefore not amenable to upgrading.

13.6 FORECAST METALLURGICAL RECOVERIES

Forecast plant performance for the LOM plan through 2033 is shown in the table below.

Table 13-8: Forecast Caraíba Milling Operations

	Q4 2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Caraiba Mill															
Mill Throughput (kt)	482	2,722	3,196	3,686	4,162	4,129	4,007	3,940	3,959	3,555	2,808	1,311	664	757	39,378
Copper Grade (Cu%)	2.07	1.70	1.46	1.34	1.29	1.23	1.26	1.22	1.27	1.17	1.04	1.28	1.98	2.42	1.33
Metallurgical Recovery (%)	92.49	92.79	92.01	91.53	91.29	91.07	91.19	91.03	91.23	90.80	90.19	91.28	93.49	94.53	91.54
Copper Production (kt)	9.2	43.0	42.9	45.1	48.9	46.3	46.2	43.9	46.0	37.8	26.3	15.3	12.3	17.3	480.8
Concentrate Grade (Cu%)	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5
Dry Concentrate Production (kt	26.8	124.7	124.5	130.7	141.8	134.3	133.9	127.2	133.3	109.7	76.4	44.5	35.6	50.3	1,393.6

14 MINERAL RESOURCE ESTIMATES

14.1 INTRODUCTION

This chapter describes the work undertaken by GE21 and key assumptions and parameters used to prepare the mineral resource models for the three districts (or regions) within the Curaçá Valley: Pilar District (South Curaçá Valley), the Vermelhos District (North Curaçá Valley), and the Surubim District (Central Curaçá Valley), together with appropriate commentary regarding the merits and possible limitations of such assumptions. The three main mineral districts were divided into 8 target zones or deposits (or "domains"), which were the object of specific analysis as it relates to the current mineral resource estimate. For the 2020 mineral resource update, there are several domains for which no additional drilling or mining activity took place between the effective date of the 2019 Technical Report and the Effective Date of this Report. These domains include: the East Limb, West Limb, and R75 of the Pilar UG Mine, Surubim, C12, Cercado Velho and Lagoa da Mina within the Surubim District, and the N9 Deposit and Vermellhos North (N10) deposit within the Vermelhos District. In these instances, the authors of the report reviewed the mineral resource wireframes, drill hole databases and prior mineral resource estimates, which were prepared by GE21 in connection with the 2019 Technical Report for validation and inclusion in the current mineral resource estimate. Additional technical information pertaining to the resource estimation parameters for these domains, which remain unchanged from 2019, is detailed in Section 14.9.

MCSA's technical team prepared the geological models and grade interpolation shells using Datamine software and performed the statistical and variography analysis, supported by Geovariance team, using Isatis software. GE21 validates the database and estimates by MCSA and elaborated a comparative model to assess the level of confidence in MCSA models, using implicit modelling by Leapfrog Edge software.

The authors of this Report are not aware of any environmental, permitting, legal, title, taxation, socio-economic, marketing, political or other relevant factors which could materially affect the current mineral resource estimate.

GE21 is of the opinion that the current drilling information is sufficiently reliable to interpret with confidence the boundaries of the higher-grade mineralization domains and that the assaying data is sufficiently reliable to support estimating mineral resources.

14.2 MINERAL RESOURCE DATABASE

The Curaça Valley property database was provided by MCSA in Datamine formats, including drill hole collar survey, geology, assay results and density estimates. The current drill hole database consists of over 1 million meters of drilling. The current mineral resource model incorporates a total of 389,786 individual assay samples. The table below shows a summary of the drill hole database by mine and domain. Where relevant, to assist the reader, the exploration target ID has been included - Siriema (N5) as an example whereby N5 is the exploration target area corresponding to the Siriema deposit. The drilling and assay data were loaded on a Geoexplo Database Manager software, and later converted to a Datamine software format, as well as Leapfrog for estimation and validation procedures. The validation procedures include:

- validation of data that was either duplicated or entered incorrectly;
- identification of any missing data;
- verification of the consistency of the "from – to" intervals (elimination of any gaps and overlaps)

Table 14-1: Summary of the Database Used in 2020 Mineral Resource Estimation

District / Domain	Number of Drill Holes	Number of Assay Samples
Pilar District		
Deepening	1,103	143,499
MSB Sul/ Barauna	557	21,343
P1P2	432	9,838
Suçuarana	204	24,154
R75*	63	3,877
East Limb*	7	42
West Limb*	42	2,041
Surubim District		
Surubim*	201	6,397
C12*	110	10,645
Lagoa da Mina*	68	5,651
Cercado Velho*	50	3,250
Terra do Sal	61	4,684
Vermelhos District		
Vermelhos UG Mine (N7)	896	101,938
N8 (Vermelhos West)	161	31,870
N9 (Vermelhos East)*	36	1,400
Vermelhos North (N10)*	4	81
Siriema (N5)	101	19,076
Total	**4,096**	**389,786**

(*) Denotes domains within the Curaçá Valley where no additional drilling or mining was performed since the effective date of the 2019 Technical Report. Please refer to Section 14.9 for additional information.

14.3 2020 GEOLOGICAL MODELLING

14.3.1 Pilar District, 2020 Update

For the preparation of the updated mineral resource estimate in 2020, the Pilar District, containing the Pilar UG Mine, was further sub-divided into 4 discrete geologic domains for which new drilling and mining activities took place subsequent to the effective date of the 2019 Technical Report. The separation of the domains was based on continuity of mineralization and expected mine production and overall planning purposes, based, in part, on MCSA's knowledge of the Curaça Valley deposits and operational experience.

A 3D grade shell model was constructed from east-west cross-sections interpreted with the Datamine, using 22.5 m by 22.5 m and 45 m by 45 m drill spacing grids. Contacts of mineralized intervals were adjusted, using drill hole assay data and logged lithology information. The interpolation across adjacent cross-sections was used to create 3D solids for each of the domains. Solids were prepared within a wireframe "linking adjacent" tool, to plot the continuous mineralized solids.

Figure 14-1 details the updated 3D models of the Pilar UG Mine. The model corresponds to the local coordinate grid, used for the Pilar UG Mine and updated domains. Figure 14-2 presents the grade shell 3D model of Suçuarana, using Datamine software.

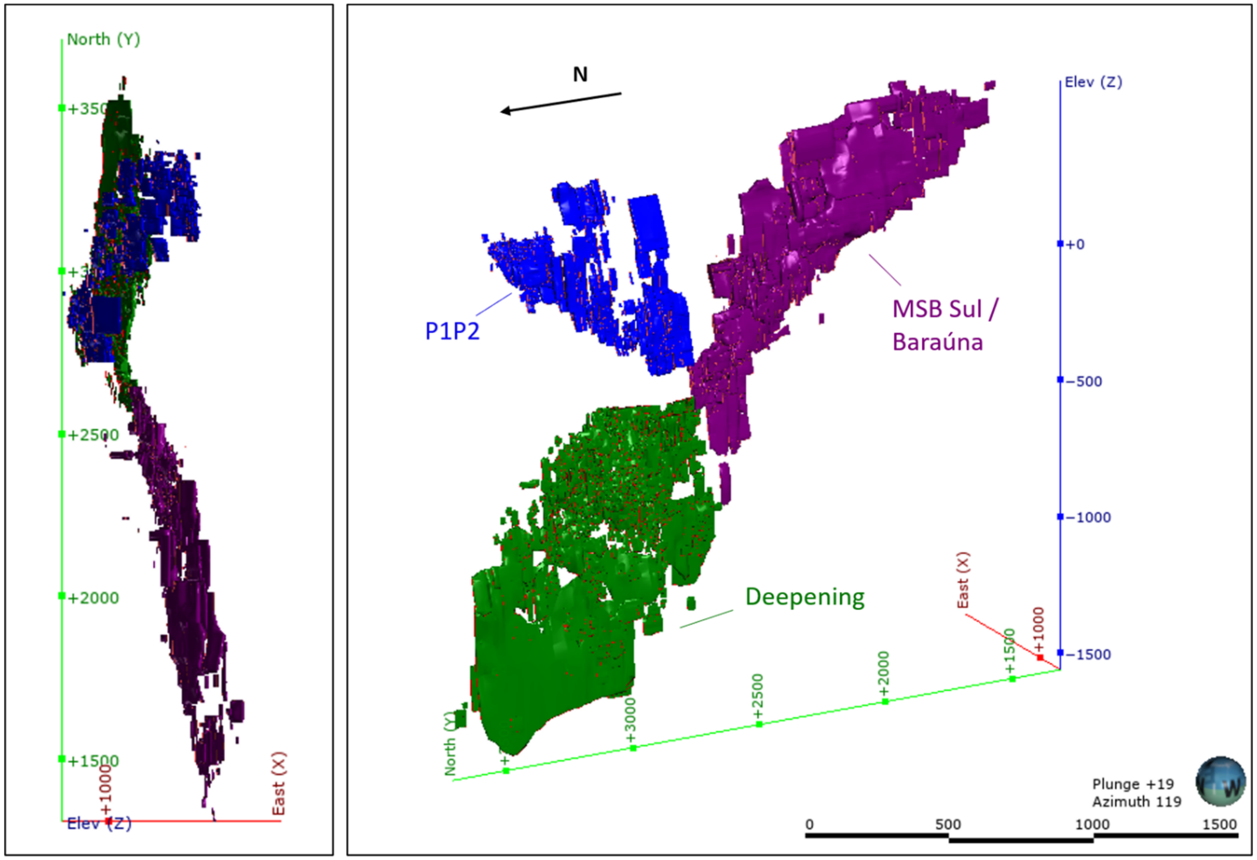


Figure 14-1: 3D high-grade models of the domains of the Pilar UG Mine shown on local coordinate system (MCSA, 2020)

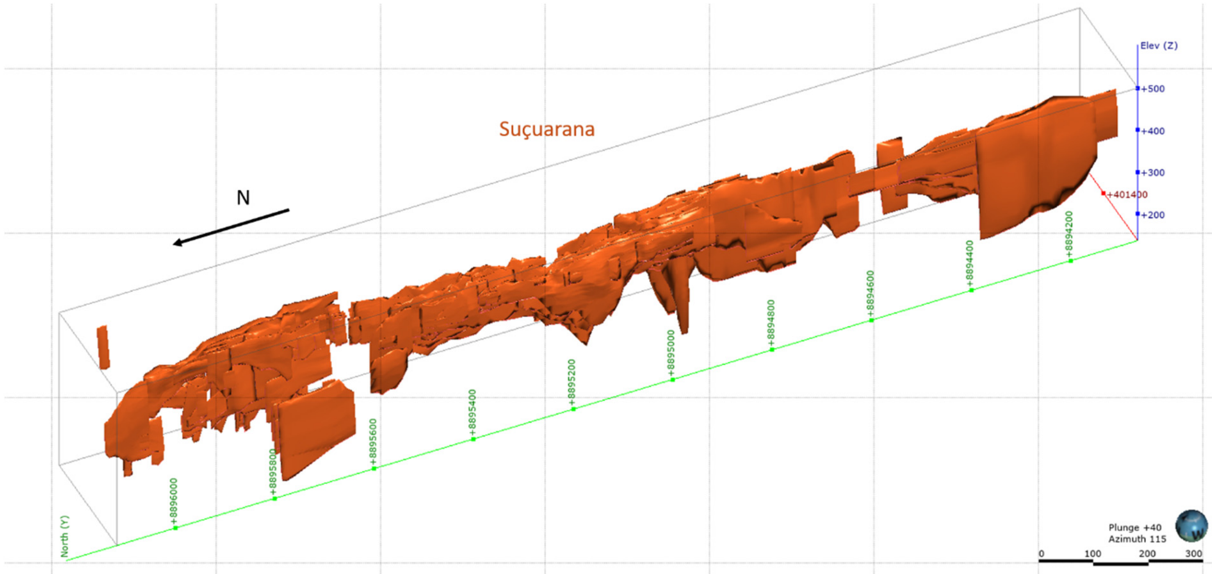


Figure 14-2: 3D model of Suçuarana domain (Sirgas 2000 – UTM coordinate system) (MCSA, 2020)

14.3.2 Vermelhos District

Within the Vermelhos District, known occurrences of mineralization occur, most commonly, as flat planar structures and as sub-vertical stacked mineralized lenses, generally trending north-south, dipping to the west and plunging to the north. The 3D model of the Vermelhos District mineralized lenses are based on the geological interpretations, using vertical cross-sections constructed using a 25 m by 25 m and 50 m by 50 m drill spacing grid. The resource estimation model considers sample intervals composited to one meter, a grade-shell value of 0.20% Cu to delineate near-surface low-grade mineralized lenses and a grade-shell value of 0.45% Cu to delineate higher grade lenses for the purposes of generating higher-grade estimation volumes.

The figure below presents the 3D models of the updated domains located within the Vermelhos District. The geological models of the domains for the Vermelhos UG Mine (Vermelhos South - N7) and Siriema (N5) were prepared by the MCSA geology team, using Datamine under the supervision of GE21. The Vermelhos West (N8) 3D model and grade shell was developed by GE21, using Leapfrog. Each of the domain models were developed together and verified within the 3D geological model or grade shell by GE21, using Leapfrog software. The modelling considered different lithologies, including gneisses, mafic and ultra-mafic lithotypes as well as pegmatite dikes.

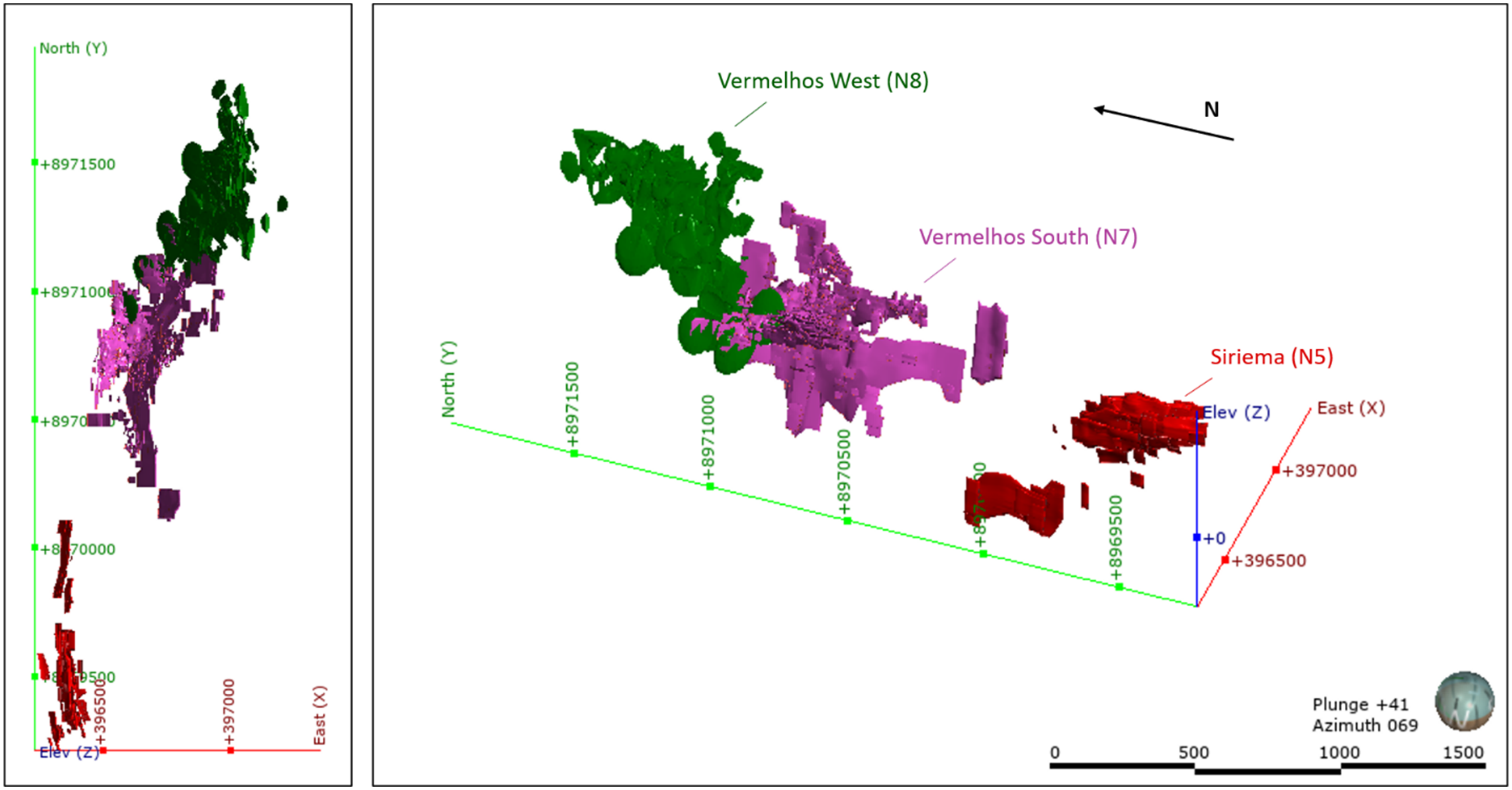


Figure 14-3: 3D grade shell model of North Curaça district (Sirgas 2000 – UTM coordinate system) (MCSA, 2020)

14.3.3 Surubim District

Within the central Surubim District, known occurrences of mineralization occur most commonly along a NNE trending corridor of mafic and ultramafic rocks (norites and pyroxenites) that exhibit alteration to phlogopite throughout the district, with localized zones of intense alteration. The geometry and volume of the mineralized lenses of the Terra do Sal domain was estimated using vertical geologic cross-sections, and copper grade distributions. The occurrence of waste rock zones, often between 2m to 5m in thickness, within the mineralized envelopes are common in in this region, including in the Terra do Sal Domain. These waste zones were incorporated into the mineralized envelopes to provide appropriate dilution considerations for mine planning and mineral reserve estimation. Continuous stratums (observed between sections) of un-mineralized or low-grade gneiss were classified as waste rock in the models. The figure below presents the Terra do Sal domain grade shell model, constructed by MCSA technical team, using Datamine software.

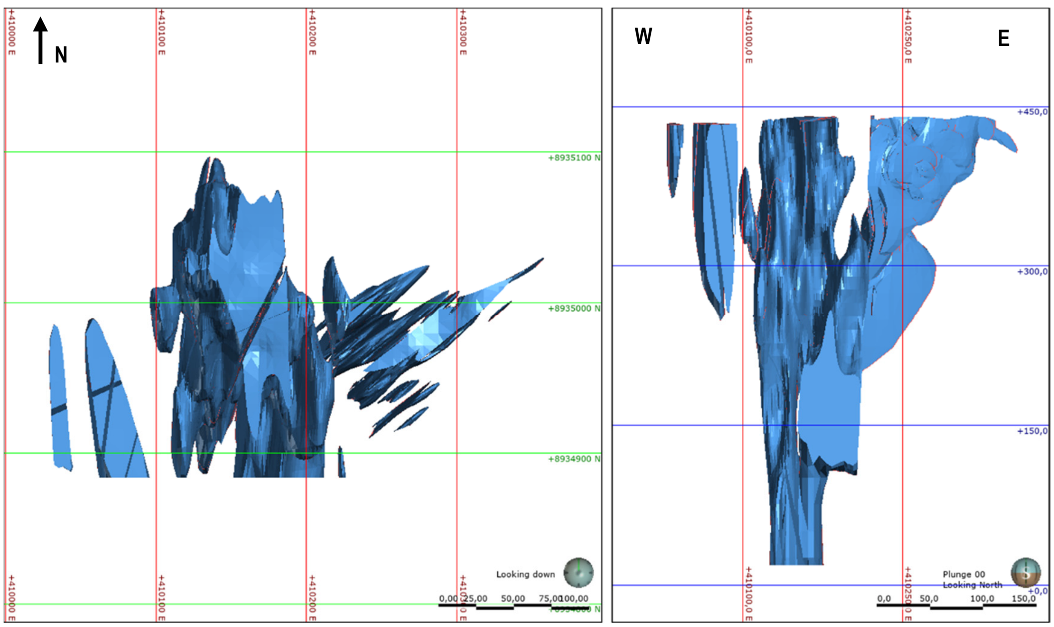


Figure 14-4: 3D grade shell model of Terra do Sal in the Surubim District in plan (left) and cross section (right) (MCSA, 2020)

14.4 2020 COMPOSITING

For the 2020 update, sample composites were constructed to standardize sample size and decrease population variance. The procedure was performed starting from the boundaries of modelled domains as previously described. Sample assays were composited to 1.0 m in length corresponding to the most frequently sampled core interval of 1.0 m. The table below shows a summary of basic statistics of sample size for each domain.

Table 14-2: Basic statistics of sample interval size, 2020 Updated Domains

District	Domain	N Samples	Q25%	Mediana	Q75%
Pilar District	Deepening	37,515	0.34	0.85	1.00
	MSB Sul / Barauna	21,342	0.80	1.00	1.00
	P1P2	9,838	0.74	1.00	1.00
	Suçuarana	24,154	0.63	1.00	1.00
Surubim District	Terra do Sal	4,684	1.00	1.00	1.00
Vermelhos District	Vermelhos UG Mine (N7)	13,356	0.60	1.00	1.00
	N8 (Vermelhos West	9,383	0.22	0.65	1.00
	Siriema (N5)	2,168	0.44	0.90	1.00

14.5 EXPLORATORY DATA ANALYSIS , 2020 UPDATE

The study included an Exploratory Data Analysis (EDA) of all mineralized domains within each District. The figure below illustrates the EDA results for N8 Deposit. The table below includes the statistics of all targets and domains, expressed in total copper content ("CuT") in percent.

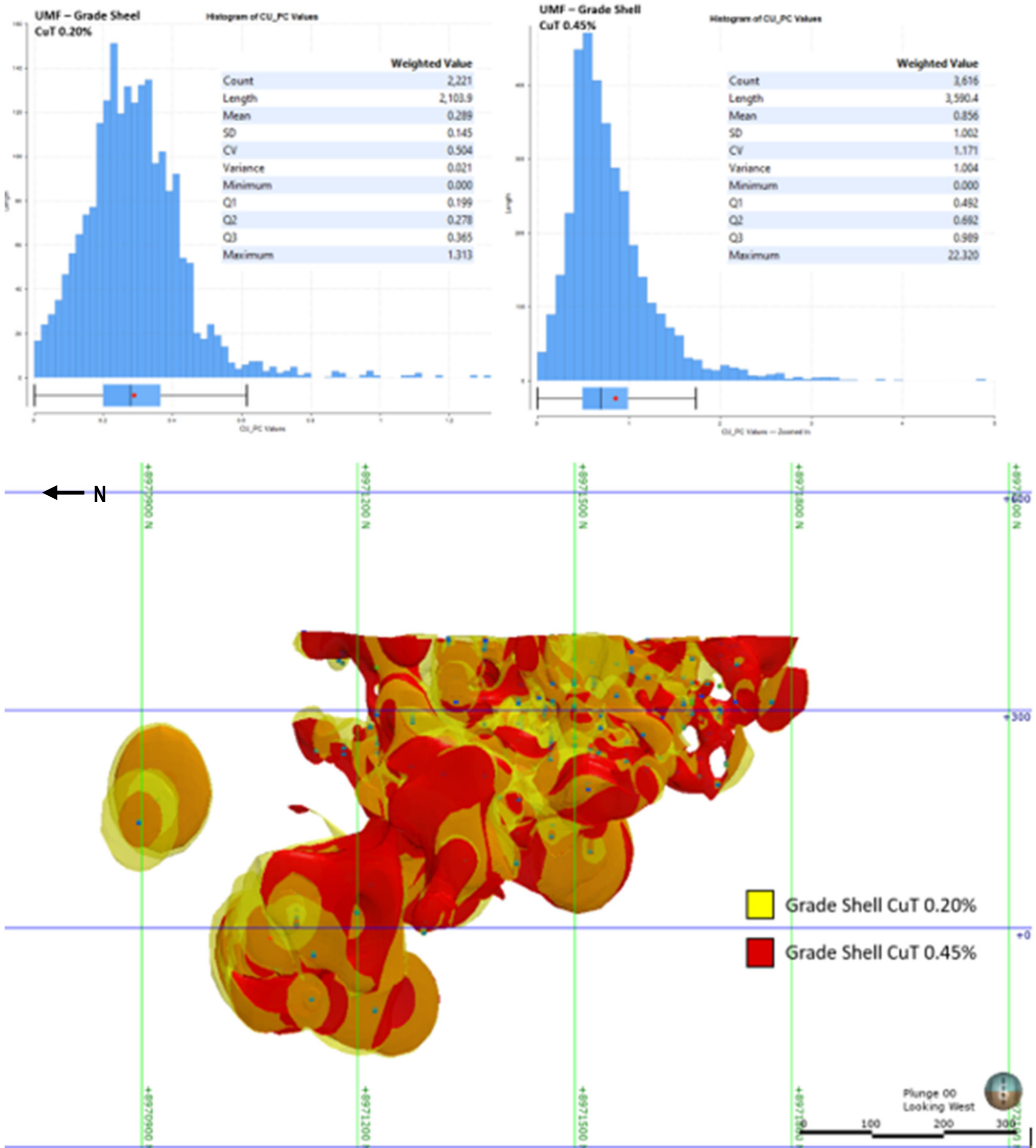


Figure 14-5: EDA – Cu grade composited samples for the N8 Deposit (MCSA, 2020)

Table 14-3 Summary Statistics of Total Cu (CuT, %) by domain, 2020 Updated Domains

Domain	Sub-domain	N° Samples	Minimum	Maximum	Mean	Variance	CV
Deepening	2004	17812	0.00	30.00	3.05	11.49	111.22
	2005	3746	0.00	10.60	2.25	4.08	89.98
	5005	6589	0.00	8.60	0.87	0.53	83.74
	6006	844	0.01	17.75	0.88	1.48	138.22
MSB Sul / Barauna	3001	9487	0.01	9.00	1.23	1.03	82.40
	3002	8869	0.00	3.90	0.66	0.20	67.91
	6006	224	0.01	2.30	1.25	0.36	48.08
P1P2	1001	84	0.01	1.20	0.68	0.10	47.33
	1002	1196	0.01	3.60	1.15	0.52	62.75
	1003	3795	0.01	8.30	2.13	2.91	80.13
	1004	210	0.05	1.50	0.76	0.10	41.76
	1005	841	0.01	2.50	1.02	0.29	52.27
	1006	1539	0.01	4.90	1.52	0.80	58.95
	6006	681	0.02	2.90	1.28	0.58	59.82
Suçuarana	560	2395	0.00	1.18	0.36	0.06	64.95
	570	1005	0.01	0.50	0.31	0.02	43.84
	580	2343	0.00	1.25	0.54	0.09	56.08
Surubim District							
Terra do Sal	100	199	0.09	3.30	1.31	0.20	33.95
	110	389	0.01	1.00	0.67	0.04	28.55
	120	409	0.00	0.50	0.21	0.03	75.70
	130	814	0.00	0.20	0.05	0.00	115.45
	200	51	0.03	2.20	1.53	0.24	31.89
	210	167	0.01	0.90	0.61	0.04	30.78
	220	188	0.00	0.70	0.30	0.04	62.19
	230	240	0.00	0.20	0.07	0.01	107.79
Vermelhos District							
Vermelhos UG Mine (N7)	100	1151	0.01	7.00	0.74	0.35	79.70
	200	1871	0.00	15.00	1.57	4.19	130.13
	300	4136	0.01	25.00	3.38	21.77	138.17
	400	1880	0.01	26.00	3.70	26.07	137.96
	450	757	0.00	12.00	1.06	1.54	116.97
	500	1033	0.01	8.00	1.09	1.24	101.74
	6006	200	0.01	6.32	1.62	1.13	65.76
Vermelhos West (N8)	100	3126	0.01	3.80	0.81	0.21	56.70
	110	1279	0.01	2.00	0.37	0.05	57.61
	120	5093	0.00	1.20	0.09	0.02	172.09
	210	156	0.01	1.50	0.46	0.09	65.65
	310	594	0.00	1.70	0.54	0.13	67.78
	320	20375	0.00	1.60	0.02	0.01	405.88
Siriema (N5)	100	557	0.01	12.00	0.62	2.10	233.55
	200	981	0.00	12.92	1.00	1.94	139.10

14.6 OUTLIER ANALYSIS, 2020 UPDATE

Block grade estimates may be unduly affected by high-grade assays, which are common within the deposits of the Curaçá Valley, and as a result - all assay data was evaluated to identify high-grade outliers within each domain.

Outlier values were defined by breaks in the distribution probability curves. In order to limit their influence on the estimation, copper grades were capped at the corresponding value for grade estimation of any given block volume within the corresponding domain. Additionally, a high-grade search ellipse restriction was applied to those values in order improve swath plots resulting from the resource estimation. For the purposes of the 2020 mineral resource estimate, the outlier analysis was performed by the MCSA technical team for each domain and reviewed by GE21. The table below presents the results of outlier analysis for each of the updated domains, and the corresponding cap placed on Cu assay values in the estimation process.

Table 14-4 Summary of Outlier Analysis, 2020 Updated Domains

Domain	Sub-domain	Cap - CuT	Domain	Sub-domain	Cap - CuT
Pilar District			**Surubim District**		
Deepening	2004	30.00%	**Terra do Sal**	100	3.30%
	2005	10.60%		110	1.00%
	5005	8.60%		120	0.50%
	6006	0.45%		130	0.20%
	7001	1.00%		200	2.20%
MSB Sul / Barauna	3001	9.00%		210	0.90%
	3002	3.90%		220	0.70%
	6006	2.30%		230	0.20%
	7001	1.00%	**Vermelhos District**		
P1P2	1001	1.00%	**Vermelhos UG Mine (N7)**	100	7.00%
	1002	4.20%		200	15.00%
	1003	13.00%		300	25.00%
	1004	1.70%		400	26.00%
	1005	3.30%		450	12.00%
	1006	4.00%		500	8.00%
	6006	2.95%		600	1.00%
	7001	1.00%		6006	na
Suçuarana	560	1.18%		7001/ 7002 /7003/ 7004/ 7005/ 7006/ 7007/ 7008	1.00%
	570	0.50%	**Vermelhos West (N8)**	HG	4.00%
	580	1.25%		LG	0.80%
			Siriema (N5)	100	1.70%
				200	6.70%

14.7 VARIOGRAPHY, 2020 UPDATE

The MCSA technical team, in collaboration with Geovariance, supervised and reviewed by GE21 conducted a work program to prepare new variograms and models for each of the domains (and sub-domains) for the 2020 update. For N8 Deposit, the GE21 directly prepared the new variograms and models.

Figure 14-6 and Figure 14-7 illustrate, respectively, the variographic analysis results of the main high-grade ("Sub-Domain 300" and "400") portion of the Vermelhos UG Mine (N7). Complete variographic information is presented in Table 14-5 and Table 14-6.

GE21 considers the variograms generated to be of moderate robustness. Similarities between the variographic models are commonly observed between the various deposits and domains throughout the Curaçá Valley. Variations between deposits and domains are mainly observed in the orientation in the anisotropic ellipsoid.

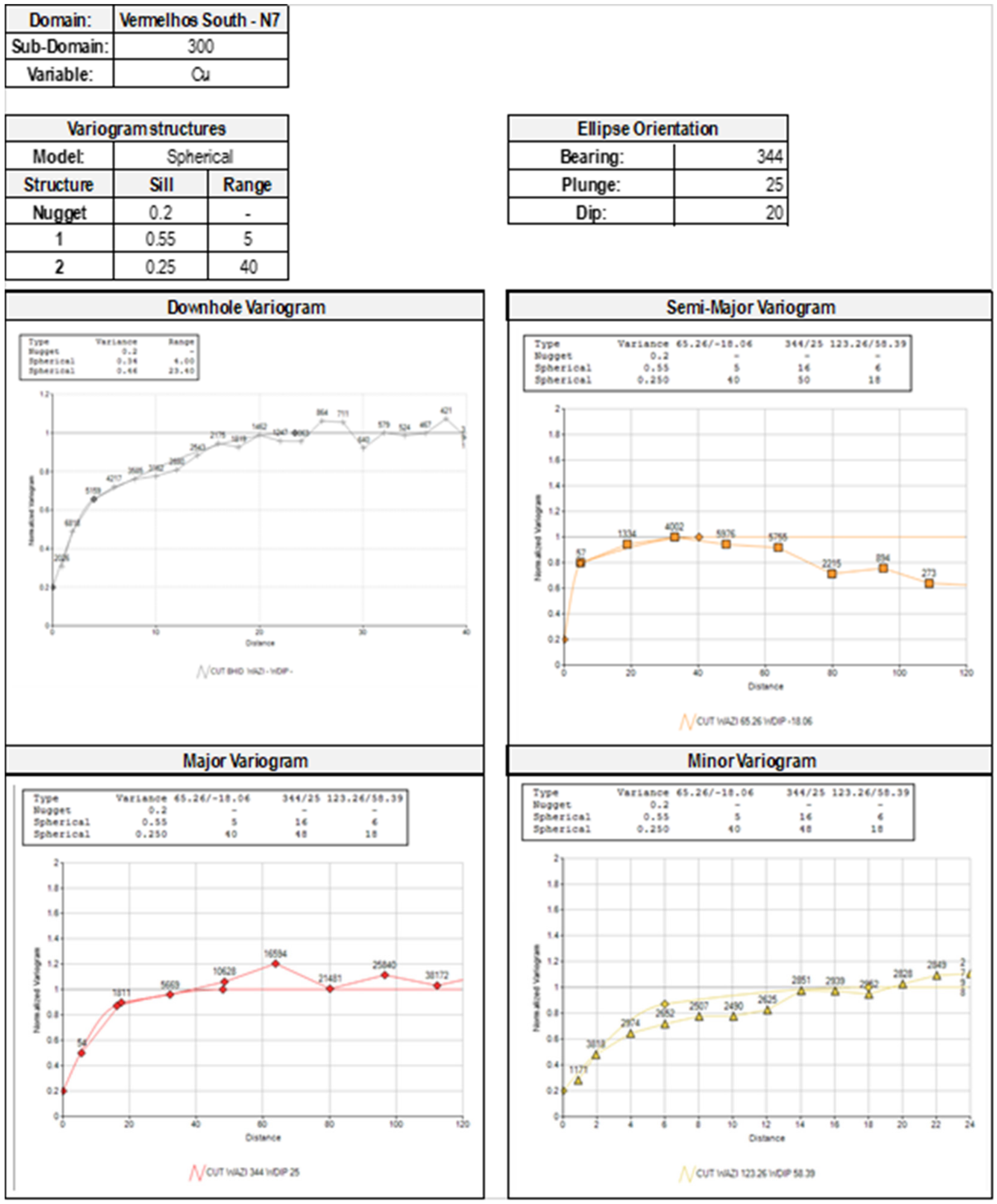


Figure 14-6: Example of Variographic analysis – Vermelhos UG Mine (N7) – High-Grade Sub-Domain 300 (MCSA, 2020)

Domain:	Vermelhos South - N7
Sub-Domain:	400
Variable:	Cu

Variogram structures		
Model:	Spherical	
Structure	Sill	Range
Nugget	0.2	-
1	0.25	27
2	0.55	45

Ellipse Orientation	
Bearing:	97
Plunge:	36
Dip:	7

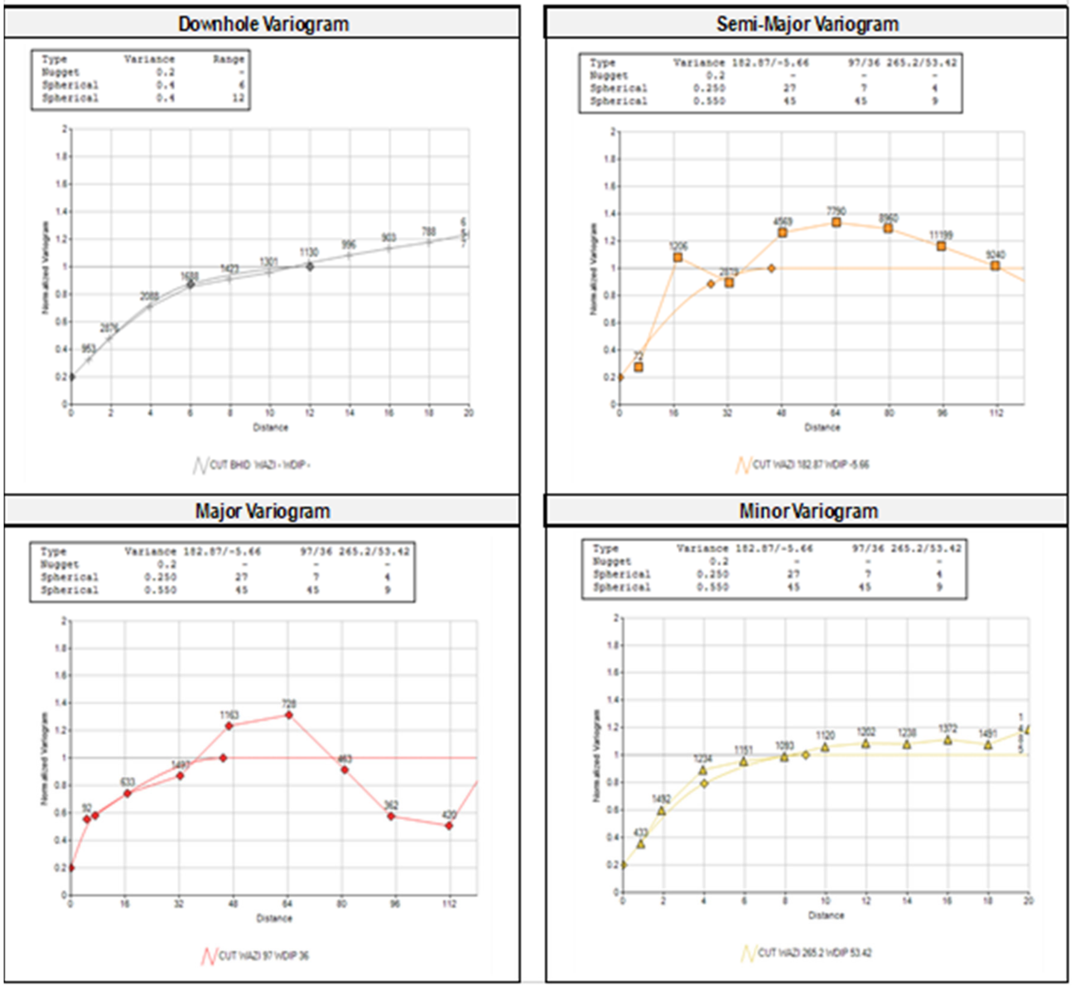


Figure 14-7: Example of Variographic analysis – Vermelhos UG Mine (N7) – High-Grade Sub-Domain 400 (MCSA, 2020)

Table 14-5: Summary of Variographic Analysis – Structures and Anisotropy, 2020 Update

Domain	Sub-Domain	C0	C1	C2	C3	A1 Major	A1 Semi Major	A1 Minor	A2 Major	A2 Semi Major	A2 Minor	A3 Major	A3 Semi Major	A3 Minor
Pilar District														
Deepening	2004	0.5	6	3.23		4	1	3.5	35	20	10			
	2005	0.1	1.9	9		50	30	1	80	70	9			
	5005	0.1	0.19	0.231		17	12	0.5	40	17	1.2			
MSB Sul / Barauna	3001	0.2	0.6	0.43		15	14	3	30	20	10			
	3002	0.04	0.094	0.073		57	20	4	65	50	20			
P1P2	1001/ 1002/ 1003	0.03	0.45	0.3	0.21	4	1.2	2	25	10	35	120	58	35
	1004/ 1005/ 1006	0.1	0.55	0.25	0.1	8	4	12	22	12	14	45	40	20
Suçuarana	560/ 570/ 580	0.2	0.42	0.38		26	32	11	49	44	22			
Surubim District														
Terra do Sal	100/ 110/ 120/ 130	0.2	0.2	0.6		25	25	5	40	75	15			
	200/ 210/ 220/ 230	0.2	0.4	0.4		15	25	46.7	50	70	93.3			
Vermelhos District														
Vermelhos UG Mine (N7)	100/ 200/ 500	0.5	2.1	0.98		35	10	7	100	50	30			
	300	0.2	0.55	0.25		5	16	6	50	40	18			
	400	0.2	0.25	0.55		27	7	4	45	45	9			
N8 (Vermelhos West)	UMF	0.2	0.4	0.4		30	30	15	80	80	40			
Siriema (N5)	100	0.01	0.0185	0.0155		25	18	14	100	20	15			
	200	0.025	0.042	0.047		50	15	5	90	100	12			
	200+300	0.025	0.035	0.034		40	10	4	100	60	10			

Table 14-6: Summary of Variographic Analysis – Ellipsoid Orientation, 2020 Update

District	Domain	Sub-Domain	Azimuth	Dip	Pitch
Pilar District	Deepening	2004/ 2005/ 5005	N0	90	47
	MSB Sul/ Barauna	3001/3002	N0	90	47
	P1P2	1001/ 1002/ 1003	180	70	-180
		1004/ 1005/ 1006	180	60	-180
	Suçuarana	560/ 570/ 580	-90	80	-10
Surubim District	Terra do Sal	100/ 110/ 120/ 130	55	-40	89
		200/ 210/ 220/ 230	180	25	89
Vermelhos District	Vermelhos UG Mine (N7)	100/ 200/ 500	-90	0	-110
		300	344	25	20
		400	97	7	36
	N8 (Vermelhos West)	UMF	270	60	10
	Siriema (N5)	100/200/300	N5	90	20

14.8 BLOCK MODEL, 2020 UPDATE

Separate block models were constructed for each domain, as detailed in Table 14-7. The block model attributes are presented in Table 14-8. Any overlaps in the block models between domains were adjusted by assigning null value to overlapping blocks.

Table 14-7: Block Model Dimensions Summary

Domain	Coordinate	Origin	Maximum
Pilar District			
Deepening	X	847.5	1247.5
	Y	2327.5	3617.5
	Z	-1560.5	-395.5
MSB Sul / Baraúna	X	942.5	1442.5
	Y	1282.5	2644.5
	Z	-1210.5	460.5
Suçuarana	X	401247.5	401501.88
	Y	8894057.5	8896142.5
	Z	120	474.38
P1P2	X	822.5	1337.5
	Y	2666	3462.5
	Z	-249.5	452.5
Surubim District			
Terra do Sal	X	409982.5	410462.5
	Y	8934832.5	8935187.5
	Z	2.5	441.88
Vermelhos District			
Vermelhos UG Mine (N7)	X	396417.5	396997.5
	Y	8970082.5	8971286.5
	Z	-336.5	426.5
N8 (Vermelhos West)	X	396760	397300
	Y	8971070	8971870
	Z	-200	500
Siriema (N5)	X	396182.5	396522.5
	Y	8969102.5	8970197.5
	Z	-297.5	447.5

Block dimensions: 5 m x 5 m x 5 m (sub-blocks: 1.25 m x 1.25 m x 1.25 m); unrotated blocks.
UTM Coordinates, except UG Mine (Deepening, MSB Sul/Baraúna, P1P2) presented in local coordinates.

Table 14-8: Block Model Attributes Summary

Variable Name	Type	Description
CuT	Numeric	Estimated copper grade, recorded in total copper content (%Cu)
Density	Numeric	Estimated density
Resource	Numeric	Classified resources (1 = Measured, 2 = Indicated, 3 = Inferred)
Rock type	Numeric	Domains

GE21 and MCSA, under the supervision of GE21, conducted a validation of all of the block models, comparing the geological wireframes and the block grade models, with a visual check and volumetric assessment. The validation indicated a satisfactory volumetric ratio, defined as the wireframe volume/block model volume. The results were within an acceptable limit of variation below 3.0%.

14.9 ESTIMATION PARAMETERS, UNCHANGED 2019 DOMAINS

For 9 domains within the Curaçá Valley, no new drilling or new mining activity occurred subsequent to the determination of the mineral resources as outlined in the 2019 Technical Report, which were prepared previously by GE21. These domains include: the East Limb, West Limb and R75 of the Pilar District; Surubim, C12, Cercado Velho and Lagoa da Mina of the Surubim District; and the N9 and N10 deposits of the Vermelhos District. A brief description of the variogram and block model parameters are set forth below. As part of the validation process for the 2020 update, GE21 reviewed the database and mineral resource estimates prepared previously by GE21 for these domains for validation purposes and inclusion in the current mineral resource estimate. Additional information, including swath plots for these domains and additional EDA, can be found in the 2019 Technical Report.

Table 14-9: Summary of Variographic Analysis, Unchanged 2019 Domains

Domain	Sub-Domain	c0	c1	a1	c2	a2	Bearing	Plunge	Dip	MM	MSM
Pilar District											
East Limb	*insufficient samples to fit variograms*						196	-70	-10	1	2
West Limb	590	0.3	0.4	26	0.3	48	270	-80	-10	1	2.5
R75	550	0.2	0.44	26	0.36	46	253	-58	19	1.1	2.3
Surubim District											
Surubim	1000/1001/1002	0.2	0.4	33	0.4	85	295	-70	14	1.7	21
C12	1001/1002/1003	0.35	0.32	16	0.33	60	348	-40	72	1.1	3.8
Lagoa da Mina	High/Median	0.27	0.13	84	0.6	99	270	-70	0	1.3	3.8
Cercado Velho	Main	0.12	0.47	15	0.42	100	100	-75	0	1.29	13
	Potential	0.12	0.35	44	0.53	110	280	-75	0	1.29	13
Vermelhos District											
N9 (Vermelhos East)	100/200	0.2	0.35	80	0.45	90	0	-30	85	2	8.2
N10 (Vermelhos North)	*insufficient samples to fit variograms*										

Table 14-10: Block Model Summary, Unchanged 2019 Domains

Domain	Coordinate	Origin	Maximum		Domain	Coordinate	Origin	Maximum
Pilar District					**Surubim District**			
East Limb	X	1100	1300		Surubim	X	404900	405400
	Y	2400	2880			Y	8941300	8942200

	Z	-150	200		Z	-100	450
West Limb	X	950	1100	C12	X	403900	404400
	Y	2425	2700		Y	8940800	8941300
	Z	-70	290		Z	-150	450
R75	X	404657	405017	Lagoa da Mina	X	412050	413065
	Y	8910534	8911030		Y	8948938.024	8949843
	Z	120	510		Z	62	447
				Cercado Velho	X	411783	413213
					Y	8947592.869	8949268
					Z	60	455
				Vermelhos District			
				N9 (Vermelhos East)	X	397000	397900
					Y	8970800	8971850
					Z	0	450
				Vermelhos North (N10)	X	397200	397600
					Y	8973000	8973900
					Z	100	425
Block dimensions: 5 m x 5 m x 5 m (sub-blocks: 1.25 m x 1.25 m x 1.25 m); unrotated blocks.							

Table 14-11: Summary of grade estimate steps – distance (meters) and anisotropy, Unchanged 2019 Domains

Domain	Sub-Domain	Estimation Steps (meters)					Anisotropy	
		Step 1	Step 2	Step 3	Step 4	Step 5	Major/ Minor	Major/ Semi-major
Pilar District								
East Limb*		10	20	160	>160	-	1	2
West Limb	590	16	32	48	72	>72	1	2.5
R75	550	15	31	46	70	>70	1.1	2.3
Surubim District								
Surubim	1000/1001/1002	19	57	80	128	>128	1.7	21
C12	1001/1002/1003	20	40	60	90	>90	1.1	3.8
Lagoa da Mina	High/Median	30	65	100	150	>150	1.3	3.8
Cercado Velho	Main	30	65	100	150	>150	1.29	13
	Potential	30	65	100	150	>150	1.29	13
Vermelhos District								
N9 (Vermelhos East)	100/200	30	60	75	135	>135	2	8.2
Vermelhos North (N10)*		75	150	300	600	>600	1	1

(*) Targets where grade estimate methodology was IDW

GE21 and MCSA, under the supervision of GE21, conducted a validation of all of the block models from the unchanged 2019 domains, comparing the geological wireframes and the block grade models, with a visual check and volumetric assessment. The validation indicated a satisfactory volumetric ratio, defined as the wireframe volume/block model volume. The results were within an acceptable limit of variation of less than 3.0%

14.10 MINERAL RESOURCE ESTIMATION METHODOLOGY, 2020 UPDATE

The ordinary kriging method was used for copper grade estimation in mineralized bodies of the Curaçá Valley.

The mineral resources estimation observed orientation, type and continuity of the mineralization and the drill grid spacing, within each domain and mineralized sub-domain. Estimation of CuT (%) was conducted for the each of the block models, taking into consideration the results of variographic analysis. A high-grade restriction method was applied to the composite copper grades to restrict the influence of the population outliers used in the ordinary kriging method. Outlier copper grades were determined for each domain and a limited search radius was applied for composite samples where the copper grade exceeded the outlier grade for each domain. Grades within these composites were capped to the outlier copper grade value on the first step. Applying a reduced search radius to outlier copper grades produced better results in local estimates as observed on the swath plots.

Kriging involved five steps, based on the maximum variographic range distance and the variographic anisotropic distances for each domain. The first step, (applied grade restriction), used approximately 1/3 of maximum variographic range; the second step: approximately 2/3 of maximum variographic range and third step equaled the maximum variographic range. The fourth step used 150% of the maximum variographic range. The last step included any blocks that were not considered in steps one, two or three. Neighborhood search strategy for grade estimation applied restrictions on the minimum number of samples (4), maximum number of samples (12) and maximum number of samples by any single drill hole as (2).

An outlier capped value was not applied in domains where individual assay-values significantly above the mean are not frequent. In those domains, ordinary kriging estimation steps were applied without any outlier treatment honoring the variographic output for those domains.

The table below summarizes steps of grade estimation. The first step has no anisotropy applied. Orientation of anisotropy ellipsoids for steps 2 to 4 is based on results of variographic analysis.

Table 14-12: Summary of grade estimate steps – distance and anisotropy, 2020 Update

Domain	Sub-Domain	Estimation Steps (meters)					Anisotropy	
		Step 1	Step 2	Step 3	Step 4	Step 5	Major/ Semi-Major	Major/ Minor
Pilar District								
Deepening	2004	12	23	35	53	>53	1.8	3.5
	2005	27	53	80	120	>120	1.1	8.9
	5005	13	27	40	60	>60	2.4	33.3
MSB Sul / Barauna	3001	10	20	30	45	>45	1.5	3.0
	3002	22	43	65	98	>98	1.3	3.3
P1P2	1001/ 1002/ 1003	40	80	120	180	>180	2.1	3.4
	1004/ 1005/ 1006	15	30	45	68	>68	1.1	2.2
Suçuarana	560/ 570/ 580	16	33	49	74	>74	1.1	2.2
Surubim District								
Terra do Sal	100/ 110/ 120/ 130	23	47	70	106	>106	1.9	5.0
	200/ 210/ 220/ 230	25	50	75	113	>113	1.4	0.8
Vermelhos District								
Vermelhos UG Mine (N7)	100/ 200/ 500	33	67	100	150	>150	2.0	3.3
	300	17	33	50	75	>75	1.3	2.8
	400	15	30	45	68	>68	1.0	5.0
N8 (Vermelhos West)	UMF	27	53	80	120	>120	1.0	2.0
Siriema (N5)	100	33	67	100	150	>150	5.0	6.7
	200	33	67	100	150	>150	1.1	8.3
	200+300	33	67	100	150	>150	1.7	10.0

14.10.1 Local Bias Validation via Swath Plot Method, 2020 Update

Local validation via the Swath Plot method was performed to analyze the occurrence of any localized biases. The method sought to compare the average in estimated grades for the mineral resources model obtained using the ordinary kriging methodology, with the grades that were estimated using the Nearest Neighbor ("NN") method for the same x, y or z coordinates. Grade scatter plots were developed for copper grades versus coordinates, and no significant localized biases were observed when comparing the ordinary kriging to NN methods for the Measured and Indicated mineral resource estimate. See Appendix A to the Report for Swath Plot and NN analysis results for the updated 2020 mineral resource models.

Figure 14-8 to Figure 14-10 provide example swath plots for the Deepening Domain ("N_SAMPS"=number of samples; "N_CELLS/50"=number of blocks; "S_CUT"=Cu sample, "M_CUT"=Cu estimated by Ordinary Kriging; "M_CUNN" Cu estimated by Nearest Neighbor). The local bias in the x-axis estimate was not material.

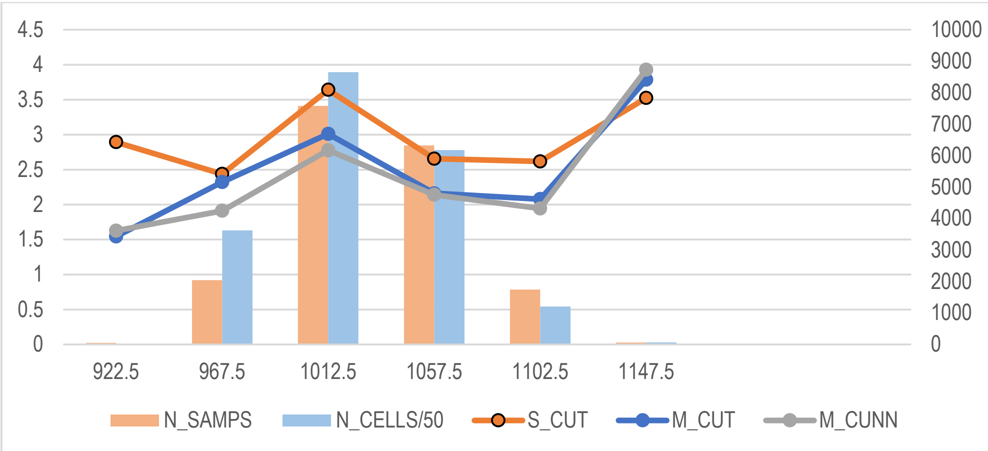


Figure 14-8: Swath Plot X CuT (%) – Deepening Domain (MCSA, 2020)

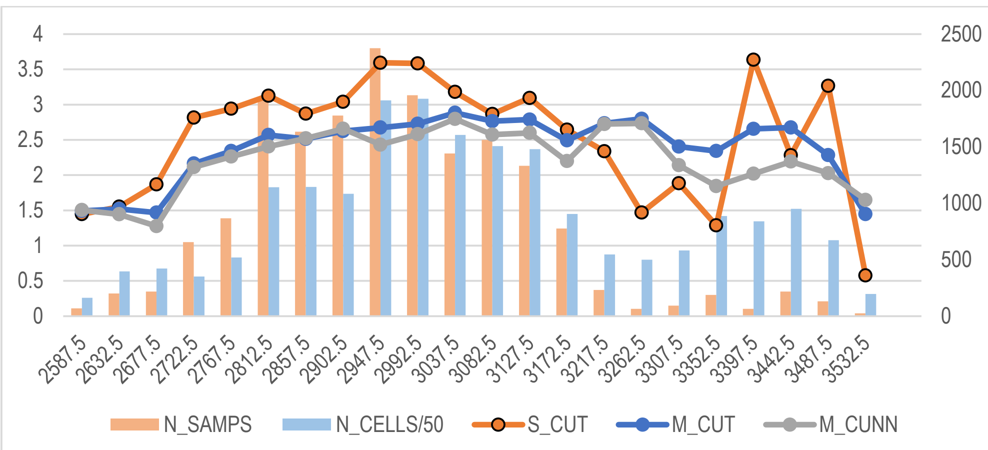


Figure 14-9: Swath Plot Y CuT (%) – Deepening Domain (MCSA, 2020)

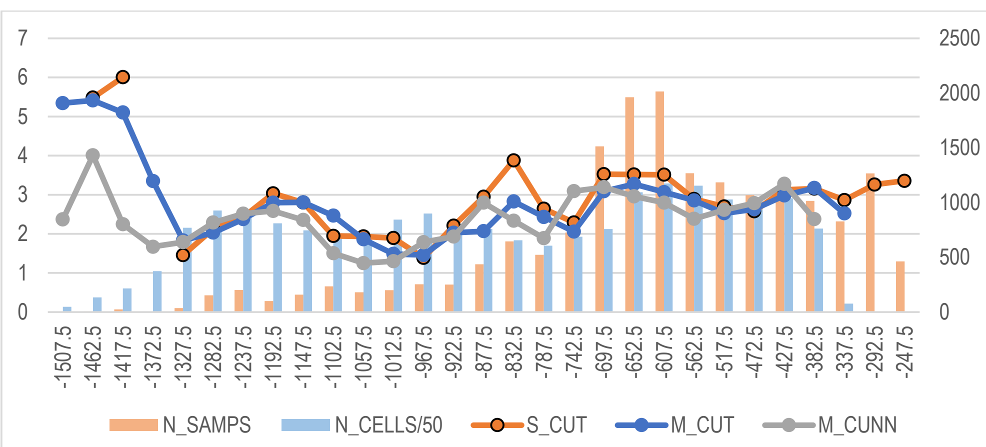


Figure 14-10: Swath Plot Z CuT (%) – Deepening Domain (MCSA, 2020)

14.11 MINERAL RESOURCE CLASSIFICATION, 2020 UPDATE

Implementing the use of grade shells is an acceptable approach for defining mineralization that can be mined underground. In the case of the MCSA Mining Complex, a grade shell based approach incorporating a neighborhood spatial analysis was used to verify the economic extraction of material via underground methods. In both cases, application of cut-off grades for underground and open pit mineral resources considered estimated costs of extraction to ensure reasonable prospects for economic extraction.

A 0.51% Cu cut-off was applied for the MCSA Mining Complex's mineral resources amenable to underground mining methods and a 0.21% Cu cut-off was applied for mineral resources amenable to open pit mining. These cut-off grades were considered jointly with currently available mineral rights and a mathematical optimization to demonstrate a Reasonable Prospects for Eventual Economic Extraction ("RPEEE") threshold for the current mineral resources estimate. The location of the samples and the assay data are sufficiently reliable to support resource evaluation. The sampling information was acquired primarily by core drilling on sections spaced, on average, at approximately 25 m x 25 m to 12.5 m x 12.5 m spacing. GE21 considers that deposits with regular sampling grids and sufficient samples in mineralized zones to perform variographic analysis, as well as RPEEE thresholds, satisfied the definition of Indicated and Measured mineral resources as defined by CIM.

In considering the overall quality and quantity of data that was utilized in the mineral resource estimate, the estimate was classified as Measured, Indicated and Inferred according to the number of passes in the ordinary kriging method, as shown below, and using local geometric restrictions to guarantee the spatial continuity of classification.

Classification based on steps of estimate:

- Measured resources – Blocks estimated on Estimate Pass 1 and 2;
- Indicated resources – Blocks estimated on Estimate Pass 3 or 4; and
- Inferred resources – Blocks estimated on Estimate Pass 5

14.12 MINERAL RESOURCE ESTIMATE, 2020 UPDATE

To determine material within the defined mineralized shapes offering RPEEE, GE21 applied the Lerchs-Grossman method to evaluate deposits amenable to open pit mining and implemented a copper grade cut-off approach for deposits subject to underground mining. In both the open pit and underground cases, the costs for the extraction of copper from the mineralized volumes was considered as the foundation for the RPEEE analysis.

Mineral resources have been constrained within developed 3D grade-shells and lithology models applying a 0.45% and 0.20% copper grade envelope for high and marginal grade, respectively. Within these envelopes, mineral resources for underground ("UG") deposits were constrained to those volumes ensuring RPEEE after application of a 0.51% copper cut-off grade, as well as a 0.32% copper marginal cut-off grade. For open pit ("OP") deposits a cut-off grade of 0.21% copper was applied.

The low-grade envelope using a cut-off grade of 0.20% copper for UG deposits was used to develop a dilution envelope and development block model to better define the grade of blocks within the dilution envelope in the planning and design of underground stopes and planned development within the mineral reserve estimates and LOM production plan.

The main parameters used to define the underground stopes and open pit shells for purposes of mineral resource estimation are detailed in tables presented below. The results from the cut-off grade methodology detailed below for both open pit and underground domains, were used solely for the purpose of testing RPEEE and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a mineral resource estimate. Only the blocks within the conceptual pit envelope or selected RPEEE stopes for underground domains were considered as current mineral resource.

Table 14-13: Open Pit Mining Optimization Pit Parameters

COSTS	Unit.	C6 OP	Suçuarana OP	N5 OP	N8 OP
Total Mining Costs	USD/t handled	3.10	3.10	3.10	3.10
Transportation Costs	USD/t process	4.61	2.73	8.91	8.91
Ore Sorter Costs	USD/t process	1.00	1.00	1.00	1.00
Processing Costs	USD/t process	5.65	5.65	5.65	5.65
G&A Costs	USD/t process	2.66	2.66	2.66	2.66

FINANCIAL INPUTS	Unit.	C6 OP	Suçuarana OP	N5 OP	N8 OP
Copper Price	USD/t.	6 400	6 400	6 400	6 400
Exchange Rate	BRL/USD	4.80	4.80	4.80	4.80
Net Smelter Return	%	94.53%	94.53%	94.53%	94.53%

PHYSICAL INPUTS	Unit.	C6 OP	Suçuarana OP	N5 OP	N8 OP
Blocks Dimensios	X, Y, Z (m)	5 x 5 x 5	5 x 5 x 5	5 x 5 x 5	5 x 5 x 5
Resources	Class	Mea + Ind + Inf	Mea + Ind + Inf	Mea + Ind + Inf	Mea + Ind + Inf
Mining Recovery	%	100%	100%	100%	100%
Mining Dilution	%	0%	0%	0%	0%
Pre Concentration (Ore Sorter)	%	50%	50%	50%	50%
Metallurgical Recovery	%	90.70%	90.70%	90.70%	90.70%
Slope Angle	degrees	60	60	60	60

Table 14-14: Underground Mining Optimization Stope Parameters

Pass	1		2		3		4	
Inputs	**Value**	**Unit**	**Value**	**Unit**	**Value**	**Unit**	**Value**	**Unit**
Stope Dimension	20x10x35	m	20x10x25	m	20x5x15	m	5x5x5	M
Copper Price	6 400	US$/t	6 400	US$/t	6 400	US$/t	6 400	US$/t
Mining Cost	17.30	US$/t	17.30	US$/t	12.12	US$/t	12.12	US$/t
Processing Cost	5.70	US$/t	5.70	US$/t	5.70	US$/t	5.70	US$/t
G&A	5.20	US$/t	5.20	US$/t	-	US$/t	-	US$/t
Selling Cost	-	US$/t	-	US$/t	-	US$/t	-	US$/t
Mining Recovery	100	%	100	%	100	%	100	%
Dilution	-	%	-	%	-	%	-	%
Cut-off Grade	0.51	%	0.51	%				
Marginal Cut-off Grade					0.32	%	0.32	%
PCAF	1		1		1		1	
MCAF	1		1		1		1	
Metallurgical Recovery	90.70	%	90.70	%	90.70	%	90.70	%
Solution Quality	70.00	%	70.00	%	70.00	%	70.00	%
NSR	94.53	%	94.53	%	94.53	%	94.53	%

As a result of this work and application of RPEEE criteria, Table 14-15 and Table 14-16 further detail the underground and open pit mineral resources that constitute the mineral resources of the Curaçá Valley as at the Effective Date.

Table 14-15: Underground Mineral Resources

Underground Mine / Deposit	Classification	Tonnage (000 tonnes)	Grade (Cu %)	Cu Contained (000 tonnes)
Deepening Extension Zone, Pilar Mine *(Pilar Mine below Level -965)*	Measured	-	-	-
	Indicated	7,527	1.86	140.0
	Measured & Indicated	**7,527**	**1.86**	**140.0**
	Inferred	4,476	2.12	94.8
Pilar Mine Ex-Deepening Extension Zone *(Pilar Mine above Level -965)*	Measured	26,829	1.50	401.3
	Indicated	13,991	1.11	154.8
	Measured & Indicated	**40,820**	**1.36**	**556.0**
	Inferred	12,790	0.87	111.6
Pilar District, Other Underground *(R75, Sucuarana)*	Measured	816	0.72	5.9
	Indicated	1,045	0.89	9.3
	Measured & Indicated	**1,861**	**0.82**	**15.2**
	Inferred	742	0.60	4.5
Pilar District Underground Total	Measured	27,645	1.47	407.2
	Indicated	22,563	1.35	304.2
	Measured & Indicated	**50,208**	**1.42**	**711.3**
	Inferred	18,008	1.17	210.9
Vermelhos Mine	Measured	3,389	2.80	94.9
	Indicated	4,514	1.19	53.7
	Measured & Indicated	**7,903**	**1.88**	**148.6**
	Inferred	4,128	0.86	35.5
Vermelhos District, Other Underground *(Siriema, N8/N9)*	Measured	1,465	0.79	11.6
	Indicated	4,153	0.80	33.4
	Measured & Indicated	**6,676**	**0.91**	**61.1**
	Inferred	7,689	0.88	67.9
Vermelhos District Underground Total	Measured	4,402	2.33	102.4
	Indicated	8,667	1.00	87.1
	Measured & Indicated	**13,069**	**1.45**	**189.5**
	Inferred	13,781	0.93	127.6
Surubim District, Other Underground *(Surubim, C12, Cercado Velho, Lagoa da Mina, Terra do Sal)*	Measured	1,841	0.96	17.7
	Indicated	3,062	0.96	29.3
	Measured & Indicated	**4,904**	**0.96**	**47.0**
	Inferred	4,482	0.92	41.3
Surubim District Underground Total	Measured	1,841	0.96	17.7
	Indicated	3,062	0.96	29.3
	Measured & Indicated	**4,904**	**0.96**	**47.0**
	Inferred	4,482	0.92	41.3
Total, Underground	Measured	33,888	1.56	527.3
	Indicated	34,292	1.23	420.6
	Measured & Indicated	**68,180**	**1.39**	**947.9**
	Inferred	36,271	1.05	379.8

Underground Mineral Resource Notes:

1. Mineral resource effective date varies by deposit, with an effective date of August 8, 2020 except for P1P2 (July 24, 2020), R75 (July 9, 2019) and Suçuarana (July 3, 2020) within the Pilar District; Vermelhos Mine (July 29 2020), Siriema and N8 (July 4, 2020), N9 (July 9, 2019) within the Vermelhos District; and Surubim District effective date of July 9, 2019 except for Terra do Sal (July 3, 2020).
2. Presented mineral resources inclusive of mineral reserves. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
3. Mineral resources have been constrained within newly developed 3D lithology models applying a 0.45% and 0.20% copper grade envelope for high and marginal grade, respectively. Within these envelopes, mineral resources for underground deposits were constrained using varying stope dimensions of up to 20m by 10m by 35m applying a 0.51% copper cut-off grade, as well as a 0.32% copper marginal cut-off grade. Mineral resources have been estimated using ordinary kriging inside 5m by 5m by 5m block sizes. The mineral resource estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate to the deposit.

Mineral resources which are not mineral reserves do not have demonstrated economic viability.

Table 14-16: Open Pit Mineral Resources

Open Pit Mine / Deposit	Classification	Tonnage (000 tonnes)	Grade (Cu %)	Cu Contained (000 tonnes)
Pilar District, Open Pit *(R22W, Suçuarana, R75)*	Measured	3,172	0.49	15.4
	Indicated	365	0.45	1.6
	Measured & Indicated	**3,537**	**0.48**	**17.0**
	Inferred	351	0.47	1.6
Pilar District Open Pit Total	Measured	3,172	0.49	15.4
	Indicated	365	0.45	1.6
	Measured & Indicated	**3,537**	**0.48**	**17.0**
	Inferred	351	0.47	1.6
Siriema Deposit	Measured	-	-	-
	Indicated	2,956	0.92	27.1
	Measured & Indicated	**2,956**	**0.92**	**27.1**
	Inferred	187	0.99	1.9
N8/N9 Deposits	Measured	7,420	0.55	41.1
	Indicated	13,562	0.48	64.9
	Measured & Indicated	**20,982**	**0.51**	**106.0**
	Inferred	858	0.40	3.4
Vermelhos North	Measured	-	-	-
	Indicated	-	-	-
	Measured & Indicated	**-**	**-**	**-**
	Inferred	121	0.88	1.1
Vermelhos District Open Pit Total	Measured	7,420	0.55	41.1
	Indicated	16,518	0.56	92.0
	Measured & Indicated	**23,938**	**0.56**	**133.1**
	Inferred	1,166	0.55	6.4
Surubim Mine	Measured	2,340	0.93	21.7
	Indicated	73	0.84	0.6
	Measured & Indicated	**2,413**	**0.92**	**22.3**
	Inferred	3	0.80	0.0
C12 Deposit	Measured	1,272	0.94	11.9
	Indicated	942	0.70	6.6
	Measured & Indicated	**2,214**	**0.84**	**18.6**
	Inferred	154	0.56	0.9
Surubim District, Other Open Pit *(Cercado Velho, Lagoa da Mina, Terra do Sal)*	Measured	1,067	0.61	6.5
	Indicated	1,436	0.67	9.6
	Measured & Indicated	**2,503**	**0.64**	**16.1**
	Inferred	1,255	0.15	1.9
Surubim District Open Pit Total	Measured	4,678	0.86	40.1
	Indicated	2,452	0.69	16.8
	Measured & Indicated	**7,130**	**0.80**	**56.9**
	Inferred	1,413	0.20	2.8
Total, Open Pit	Measured	15,270	0.63	96.6
	Indicated	19,335	0.57	110.5
	Measured & Indicated	**34,605**	**0.60**	**207.0**
	Inferred	2,930	0.37	10.8

Open Pit Mineral Resource Notes:

1. Mineral resource effective date varies by deposit, with an effective date of August 8, 2020, except for Suçuarana (July 3, 2020), R22W and R75 (July 9, 2019) within the Pilar District; Siriema and N8 (July 4, 2020), N9 and Vermelhos North (July 9, 2019) within the Vermelhos District; and an effective date of July 9, 2019 for the Surubim District except Terra do Sal (July 3, 2020). Presented mineral resources inclusive of mineral reserves. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
2. Mineral resources have been constrained within newly developed 3D lithology models using a 0.21% copper cut-off grade for open pit deposits. Mineral resources have been estimated using ordinary kriging inside 5m by 5m by 5m block sizes. The mineral resource estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate to the deposit.

Mineral resources which are not mineral reserves do not have demonstrated economic viability.

14.13 QUALIFIED PERSONS OPINION

The QP responsible for the current mineral resource estimate is Sr. Porfírio Cabaleiro Rodriguez, a mining engineer with over 40 years of experience in the mining sector and extensive experience in mineral resource and mineral reserve estimation. Sr. Rodriguez is a member of the Australian Institute of Geoscientists ("MAIG"), and was responsible as lead QP, for the direct supervision of the work performed by the GE21 technical team involved in the resource estimation process.

GE21 supervised and validated the current mineral resource estimate prepared by MCSA through comparative estimates and validation tools as previously described. Comparative estimates were prepared from the MCSA drilling database which was validated by GE21. In addition, an independent model was prepared using Leapfrog Geo software using implicit modelling and a similar strategy of that applied by MCSA personnel to define geological domains as a cross-check. The variograms prepared by MCSA were reproduced and applied in an independent grade estimate using Leapfrog Edge software. Resource classification based on "pass of estimate" was used to compare the tonnage, grade and contained metal content for each domain. GE21 assumed differences between the current mineral resource estimate and the cross-check performed by GE21 less than 5% of contained metal within each domain as acceptable. This cross-check validation performed by GE21 resulted in no material differences.

The authors of this Report agree with the mineral resource estimate and did not identify any overall or local grade biases, as demonstrated by Swath Plot validation performed. The authors found that the quality of the data is appropriate for the classification of the current mineral resource, in accordance with CIM Standards and CIM Guidelines. A confidence level analysis for the quality of the exploration data is summarized in the table below.

Table 14-17: Analysis of Criterion Used for the Mineral Resource Classification

Items	QP Comments	Confidence Level
Drilling techniques	Majority of drill holes used diamond drill-core, considered a high-quality reference.	High
Core logging	Core logging procedures are of good quality in general. Recent electronic logging (using iPads) has increased quality of the recent drill programs since Ero Copper became involved.	Moderate to high
Core recovery	Core recovery is closely monitored by the MCSA geology team and are in general very good due to the competent nature of the rock.	High
Sample preparation	Sample preparation procedures were verified. The procedures were discussed and are well documented by MCSA.	Moderate to high
Analysis of data quality	MCSA has a well-coordinated QA/QC program; GE21 recommends the implementation of additional blank standards and a more complete elemental analysis, mainly for nickel, platinum group elements and gold.	High
Drilling survey	MCSA procedures conform with industry best practices.	High
Core sampling density	The sampling plan is based on geological logging, resulting in localized gaps in sampling, which can cause localized difficulties in defining continuity of mineralization.	Moderate
Data Bank Integrity	Database management is validated by certified software; however, not all historic information has been registered. The recovery of the historic information is in progress.	Moderate
Density	Density estimate procedures follow industry practices; however, the density measurement is not routinely performed across all mineral deposits and domains. GE21 recommends adoption of a QA/QC program for density measurements.	High to moderate

Items	QP Comments	Confidence Level
Modelling and grade estimates	The mineralization (grade shell) model shows adequate adherence in higher drilling density areas. The block model is sub-blocked accordingly and grade was estimated within the blocks. Outlier treatment was adequate. Grade estimate by ordinary kriging is the best suited for these deposits, which have enough samples for variography and kriging; and while some variograms did not present high confidence for current sample density, the estimation strategy used is adequate as demonstrated in the validation check methods employed. The local bias in the x-axis estimate was not material.	High

15 MINERAL RESERVE ESTIMATES

The Mineral Reserves for Pilar District, Surubim District and Vermelhos District are based on the Measured and Indicated mineral resources defined within the current resource block model, as more fully described in Chapter 14 of this Report. Inferred mineral resources, where unavoidably included within a defined mining shape for both open pit and underground mines were assigned zero grade. The geotechnical considerations and parameters used for mine optimization and design are described in item 16.5. The regional hydrogeological considerations are described in item 16.6.

Mineral Reserves were classified according to the CIM Standards and the CIM Guidelines by Dr. Beck Nader of BNA, an independent Qualified Person as such term is defined under NI 43-101. It is the opinion of the QP that there is no known mining, metallurgical, infrastructure, permitting, legal, political, environmental, title, taxation, socio-economic, marketing or other relevant factors that could materially affect the potential development of the stated mineral reserves.

15.1 MINERAL RESERVES SUMMARY

Mineral reserve cost assumptions are based on actual operating cost data during the 18-month period from January 1, 2019 to June 30, 2020. The USD:BRL rate of 4.27 was selected based on the average exchange rate over this same period.

A summary of the mineral reserve estimation parameters is provided below:

Table 15-1: Mineral Reserve Estimation Parameters

Mining Costs (US$/tonne ore mined)	
Pilar UG Mine	$23.52
Vermelhos UG Mine	$21.95
C12 UG Mine	$18.66
Surubim OP Mine	$2.65
Suçuarana & C12 OP Mine	$3.06
N8/N9 & Siriema OP Mines	$2.17
Transportation Costs (US$/tonne to mill)	
Pilar Mine	(none)
Vermelhos Mine	$10.96
Surubim OP Mine	$5.48
C12 OP/UG Mine	$5.98
Suçuarana mine	$3.54
Processing Costs (US$/tonne milled)	
Pilar & Vermelhos Mines	$7.41
Suçuarana & C12 OP/UG Mine	$7.90
Surubim, Siriema & N8/N9 OP Mines	$4.12
Metallurgical Recovery (average)	
Pilar UG Mine	90.39%
Vermelhos UG Mine	91.49%
N8/N9, Siriema, Suçuarana & C12 OP/UG Mines	89.0%
Surubim OP Mine	85.0%

LME Copper Price (US$/lb)	**$2.75**
Net Smelter Return	**94.53%**
Transport & Sales Costs (US$/tonne copper)	**$82.15**
CFEM Royalty (after tax)	**1.58%**
Foreign Exchange Rate (USD:BRL)	*4.27*

Reserve Parameters Note

All road-maintenance costs associated with the Curaçá Valley haul road have been allocated to Vermelhos. Calculated differences between open pit mining and processing costs are a result of additional incurred costs related to contract mining vs. employee operated and allocation of mining and processing administrative / fixed costs between mines. Metallurgical recoveries vary by area as outlined. G&A costs of US$4.16 per tonne were applied to the current operating underground mining operations of Pilar and Vermelhos. USD:BRL foreign exchange rate of 4.27 applied to all mines, except Suçuarana and C12 OP/UG mines, as the mine designs did not change from 2019, thus remain based on a USD:BRL foreign exchange rate of 3.70.

Other modifying factors considered in the determination of the mineral reserve estimate include:

- 10% dilution has been applied to all mines, with the exception of the Pilar UG Mine which varies with stope height. For planned stopes within the Pilar UG Mine with a height above 35 meters, dilution of 15% has been applied, while for planned stopes with a height of 26 meters, dilution of 7% has been applied.

- Maximum bench height of 15m for open pit mines. Maximum underground stope dimensions based on geotechnical assessments from previous studies and past operating experience within each mining area, combined with evaluation of induced stresses and the RMR.

- VRM method with cemented paste fill was selected for the Pilar UG Mine, where the method is currently in use. For the Vermelhos UG Mine, Sublevel with CRF is the mining method currently in use on consideration of the dip, plunge and thickness of the ore-bodies, the RQD and overall competence of the host rock.

- Mining recovery of 100% has been applied for open pit mines. The Pilar UG Mine and Vermelhos UG Mine assume 96% and 95% mine recovery, respectively.

- Within designed stopes, all contained material was assumed to be mined with no selectivity. Inferred mineral resources, where unavoidably included within a defined mining shape have been included in the mineral reserves estimate at zero grade. Mining dilution resulting from Measured and Indicated blocks was assigned the grade of those blocks captured in the dilution envelope using the estimated grade within the blocks of the dilution and development model.

The 2020 updated mineral reserve estimate for the underground and open pit deposits and mines of the Curaçá Valley are shown in the table below.

Table 15-2: Mineral Reserves

	Classification	Tonnage (000 tonnes)	Grade (Cu %)	Cu Contained (000 tonnes)
Reserves, Underground				
Deepening Extension Zone, Pilar UG Mine	Proven	-	-	-
(Pilar Mine below Level -965)	Probable	7,432	1.68	125
Pilar UG Mine Ex-Deepening Extension Zone	Proven	5,835	1.41	82
(Pilar Mine above Level -965)	Probable	7,725	1.09	84
Vermelhos UG Mine	Proven	3,359	2.09	70
	Probable	1,844	1.23	23
Surubim District, Underground	Proven	513	1.09	6
(C12 Underground)	Probable	515	0.83	4
Total Proven		**9,707**	**1.63**	**158**
Total Probable		**17,516**	**1.34**	**236**
Total Proven & Probable, Underground		**27,224**	**1.45**	**394**
Reserves, Open Pit				
N8/N9 OP Mine	Proven	7,355	0.55	40
(Vermelhos District)	Probable	8,012	0.54	44
Siriema OP Mine	Proven	-	-	-
(Vermelhos District)	Probable	3,011	0.88	26
Surubim District, Open Pit	Proven	2,778	0.82	23
(Surubim & C12)	Probable	123	0.55	1
Suçuarana South OP Mine	Proven	1,623	0.42	7
(Pilar District)	Probable	328	0.46	2
Total Proven		**11,757**	**0.60**	**70**
Total Probable		**11,474**	**0.63**	**72**
Total Proven & Probable, Open Pit		**23,230**	**0.61**	**142**

Mineral Reserve Notes:

1. Mineral reserve effective date of October 1, 2020. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding.
2. Mineral reserve estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate for the deposit. Mineral reserves are based on a long-term copper price of US$2.75 per lb, and a USD:BRL foreign exchange rate of 4.27, except for the C12 (Surubim District) and Suçuarana (Pilar District) open pit mines, whose design was not changed since 2019, and continued to assume a 3.70 USD:BRL foreign exchange rate. Mineral reserves are the economic portion of the Measured and Indicated mineral resources. Mining dilution and recovery factors vary for specific mineral reserve sources and are influenced by factors such as deposit type, deposit shape, stope orientation and selected mining method. Inferred resource blocks, where unavoidably mined, were assigned zero grade. Dilution occurring from Measured & Indicated resource blocks was assigned grade based upon the mineral resource grade of the blocks included in the dilution envelope.

15.2 MINERAL RESERVE ESTIMATION METHODOLOGY, OPEN PIT

The N8/N9 and Siriema OP Mines are comprised of two adjacent open pits, encompassing three orebodies, located approximately 80 km north of the Pilar UG Mine and Caraíba Mill. The center of the mineralized bodies comprising the N8/N9 is located approximately 1.1 km to the north north-east of the main Vermelhos UG Mine, and the Siriema OP Mine is located approximately 700m south of the main Vermelhos UG Mine.

The mineral reserve estimates as they relate to the Vermelhos District and exploration target areas as outlined by the Company are in continued growth phase. The most significant recent increases in contained copper for the updated mineral reserves within the Vermelhos District occurred within the N8/N9 deposit and Siriema, both near-surface and to depth.

The Surubim and C12 OP mines are currently undergoing a restart operating activities. These operations are located at the center of the Surubim District distant approximately 33km north of the Pilar UG Mine and Caraíba Mill. The Suçuarana OP Mine is located at the Pilar District, approximately 20 km south of the Pilar UG Mine.

Ore mined from open pit operations throughout the Curaçá Valley is processed using conventional crushing and flotation at the Caraíba Mill, located adjacent to the Pilar UG Mine. As an interim processing step, ore sorting will be integrated into the Company's operations within the Vermelhos District and applied to the open pit deposits of N8/N9 and Siriema to reduce waste material sent to the mill, thereby improving mill head-grades and reduce transport and processing costs. As an added benefit, the operations are expected use less water and power and generate significantly less flotation tailings which is well aligned with the Company's sustainability commitments in the region.

15.2.1 Pit Optimization

Vermelhos District: N8/N9 OP Mine & Siriema OP Mine

For the N8/N9 OP Mine & Siriema OP Mine pit optimization was performed based on all available Measured and Indicated mineral resources. A series of pit optimization analyses were completed to select the optimal pit. The final pit, incorporating geotechnical design constraints, was optimized using NPV scheduler software. The stated mineral reserves are derived from the Measured and Indicated mineral resources as defined within the resource block models following the application of economic and modifying factors as well as densities (pre- and post-swelling) as further described below. Mineral reserve estimation parameters are described in Table 15-1.

Table 15-3: Density Parameters for Vermelhos District Pit Optimization

Technical Parameters	Value
Ore Density	2.98 g/cm³
Waste Density in-situ	2.89 g/cm³
Swelled Waste Density	1.86 g/cm³
Density Saprolite	2.50 g/cm³

For open pit design optimization, a pit slope criteria was applied for each geotechnical sector of the N8/N9 OP Mine & Siriema OP Mine. For all geotechnical sectors, the slopes used in the optimization model were flattened from the geotechnical design inter-ramp angle to account for the placement of haulage ramps in the final pit design. These adjustments were based on operational experience of the Curaçá Valley open pit mines.

With these assumptions it was possible to generate an economic mineral reserve cut-off grade based upon the long-term copper price ("LME"), using the following equation:

General Cut-off grade = (Plant cost + Transport cost + Mine cost) / (LME x NSR x Rec) x 100

For the copper price and exchange rate defined by the Company of US$6,614 per tonne copper and 4.27 BRL/USD, respectively, the cut-off grade for mineral reserves is 0.21% copper and for marginal material it is 0.16% copper.

For the purposes of the current LOM production plan as outlined, marginal material mined throughout each of the pit designs was treated as waste; however, by design this material will be placed in near-mine stockpiles adjacent to the pit for potential future processing.

The results of the open pit optimization scenarios are presented below. These scenarios examine open pit size at different revenue factors. Low revenue factors represent small pits that would be economic at low metal prices, consisting of either high grade selective mining, low strip ratios, or both. Higher revenue factor pits will generally be larger in size since higher metal prices can make lower grade material more economic, and the design more accommodative of increased stripping, thereby expanding the size of the pit. As shown in the figures below, the open pit scenario generating the highest NPV was selected for further design and in further defining the current mineral reserves.

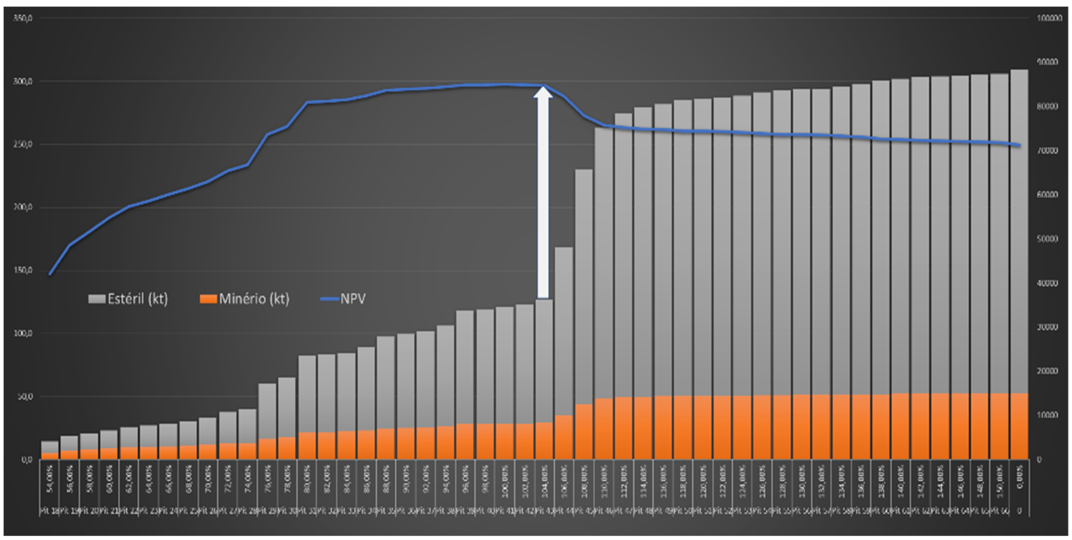


Figure 15-1: N8 Pit Optimization Results (MCSA, 2020)

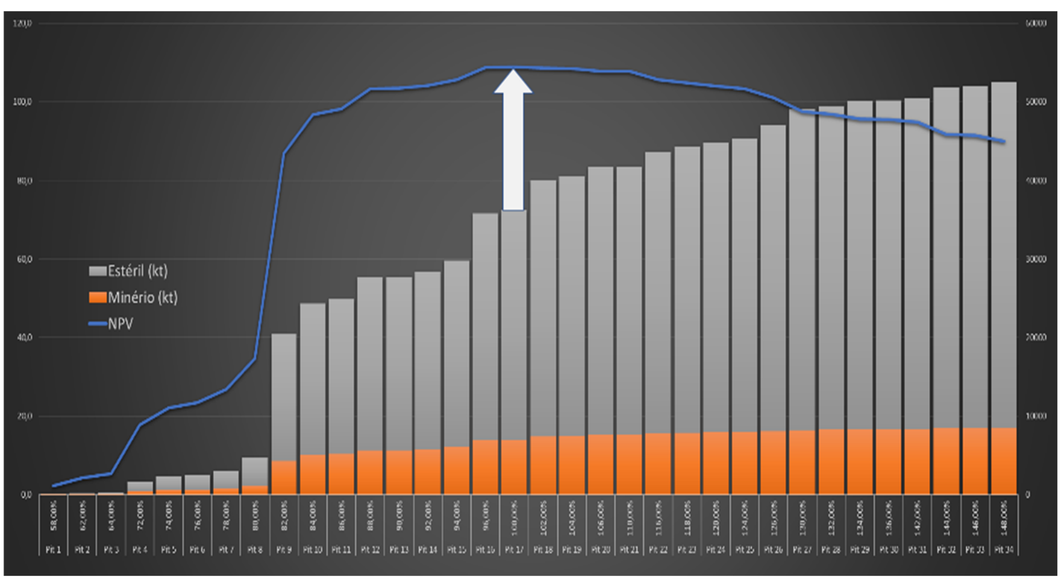


Figure 15-2: N9 Pit Optimization Results (MCSA, 2020)

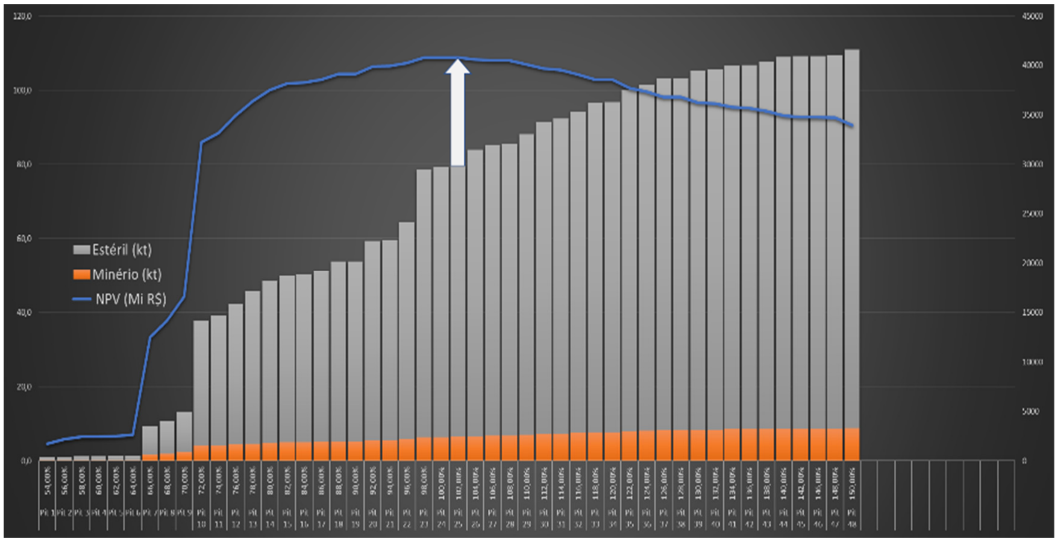


Figure 15-3: Siriema Pit Optimization Results (MCSA, 2020)

Surubim District: Surubim & C12 OP Mines

For the adjacent Surubim & C12 OP Mines pit optimization was performed based on all available Measured and Indicated mineral resources. A series of pit optimization analyses were completed to select the optimal pit. The final pit, incorporating geotechnical design constraints, was optimized using NPV scheduler software. The stated mineral reserves are derived from the Measured and Indicated mineral resources as defined within the resource block models following the application of economic and modifying factors as well as densities (pre- and post-swelling) as further described below. Mineral reserve estimation parameters are described in Table 15-1.

Table 15-4: Density Parameters for Surubim & C12 OP Mines Pit Optimization

Technical Parameters	Value
Ore Density	3.02 g/cm³
Waste Density in-situ	2.98 g/cm³
Swelled Waste Density	1.92 g/cm³
Density Saprolite	2.10 g/cm³

For open pit design optimization, a pit slope criteria was applied for each geotechnical sector of the Surubim & C12 OP Mine. For all geotechnical sectors, the slopes used in the optimization model were flattened from the geotechnical design inter-ramp angle to account for the placement of haulage ramps in the final pit design. These adjustments were made based on prior operational experience of the Curaçá Valley open pit mines.

With these assumptions it was possible to generate an economic mineral reserve cut-off grade based upon the LME, using the following equation:

General Cut-off grade = (Plant cost + Transport cost + Mine cost) / (LME x NSR x Rec) x 100

For the copper price and exchange rate defined by the Company of US$6,614 per tonne copper and 4.27 BRL/USD, respectively, the cut-off grade for mineral reserves is 0.21% copper and for marginal material it is 0.16% copper.

For the purposes of the current LOM production plan as outlined, marginal material mined throughout each of the pit designs was treated as waste; however, by design this material will be placed in near-mine stockpiles adjacent to the pit for potential future processing.

The results of the open pit optimization scenarios are presented below. These scenarios examine the pit size at different revenue factors. Low revenue factors represent small pits that would be economic at low metal prices, consisting of either high grade selective mining, low strip ratios, or both. Higher revenue factor pits will generally be larger in size since higher metal prices can make lower grade material more economic, and the design more accommodative of increased stripping, thereby expanding the size of the pit. As shown in the table below, the open pit scenario generating the highest accumulated operational cash flow was selected for further design and defining the current mineral reserves, corresponding to Pit #3, as outlined.

Table 15-5: Pit Optimization Results Surubim OP

PIT	Total Ore Mined		Contained Cu	Accumulated Swelled Waste	Total Waste In-Situ	Strip Ratio	Total Tonnes	Accumulated Operational Cash Flow
PIT	t	Cu (%)	t	t	t	waste:ore	t	('000 BRL)
P01	156,742	0.77	1,077	13,590	406,855	2.68	577,188	17,000
P02	212,832	0.73	1,385	19,135	715,347	3.45	947,314	19,105
P03	**2,633,846**	**0.80**	**18,691**	**3,653,048**	**24,287,280**	**10.61**	**30,574,175**	**75,813**
P04	3,011,828	0.81	21,715	3,978,781	30,026,820	11.29	37,017,429	72,193
P05	3,173,089	0.81	22,839	4,092,386	32,349,872	11.48	39,615,347	67,666
P06	3,376,151	0.81	24,390	4,280,709	36,127,559	11.97	43,784,419	55,687
P07	3,532,364	0.81	25,465	4,418,674	39,107,949	12.32	47,058,988	42,419
P08	3,634,678	0.81	26,203	4,510,082	41,441,914	12.64	49,586,674	30,301
P09	3,699,989	0.81	26,589	4,562,603	42,729,435	12.78	50,992,027	22,578
P10	3,804,122	0.81	27,269	4,679,085	45,236,938	13.12	53,720,145	6,592
P11	3,845,760	0.81	27,599	4,751,117	46,551,791	13.34	55,148,668	-1,937
P12	3,867,810	0.81	27,734	4,774,642	47,123,063	13.42	55,765,515	-6,019
P13	3,867,810	0.81	27,734	4,774,642	47,123,063	13.42	55,765,515	-6,019

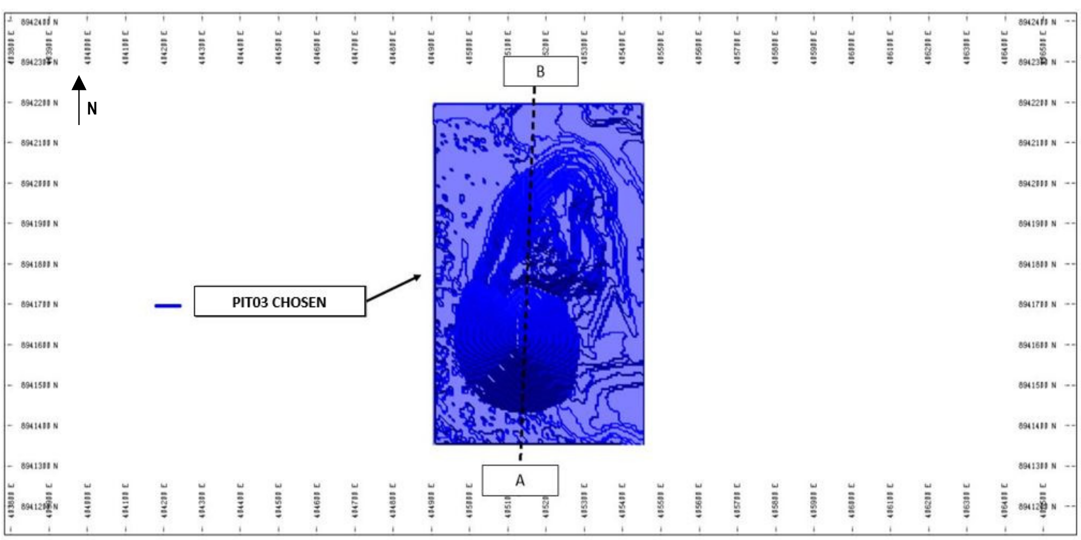


Figure 15-4: Final Surubim Pit Chosen (MCSA, 2020)

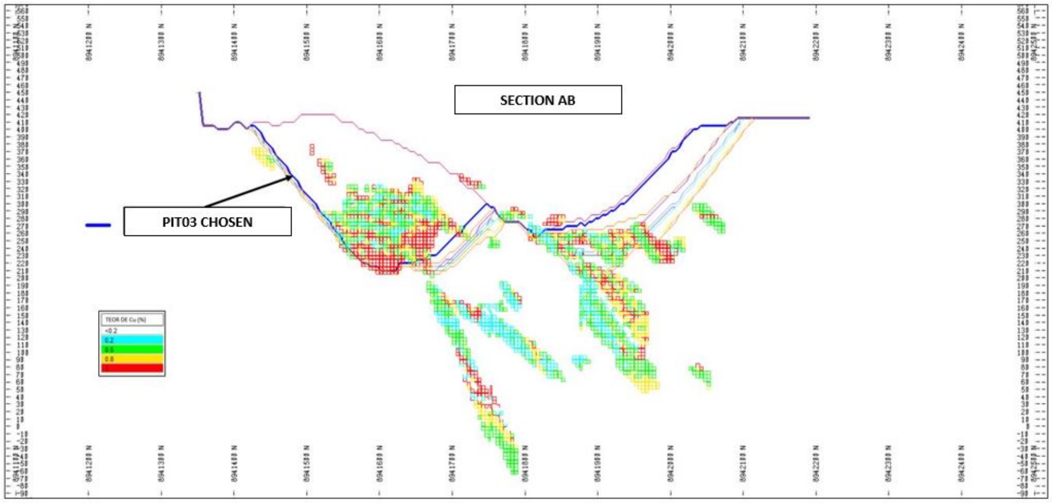


Figure 15-5: Cross Section of the Final Surubim Pit (MCSA, 2020)

The final design pit for the C12 OP Mine remained unchanged from 2019. The design was based on incorporating geotechnical design constraints, and optimization was performed using the Lerchs-Grossmann algorithm as well. The design pit selected resulted in the highest accumulated NPV. Following completion of the open pit, the C12 UG Mine operation is expected to commence, as shown the following figure.

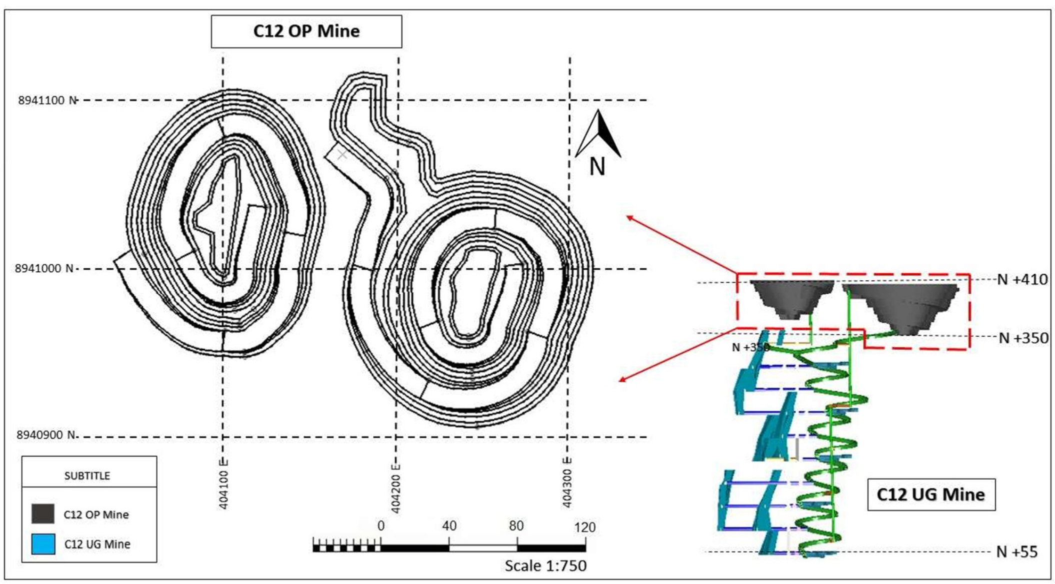


Figure 15-6: Final Pit Chosen C12 OP Mine with UG Mine Component Shown (MCSA, 2019)

<u>Pilar District: Suçuarana OP Mine</u>

The mineral reserves were estimated considering the technical and economic parameters needed to define the final pit selected to mine the available Measured and Indicated resource mineralized lenses. The final design pit was optimized with Datamine software applying the Lerchs-Grossmann algorithm. The design pit selected resulted in the highest accumulated NPV. The definition of the economic and geotechnical parameters, were based on the actual operating performance of the operation (last mined in 2017) and the following density parameters. Mineral reserve estimation parameters are described in Table 15-1.

Table 15-6: Density Parameters for Suçuarana South OP Mine Pit Optimization

Technical Parameters	Value
Ore Density	3.16 g/cm³
Waste Density in-situ	2.74 g/cm³

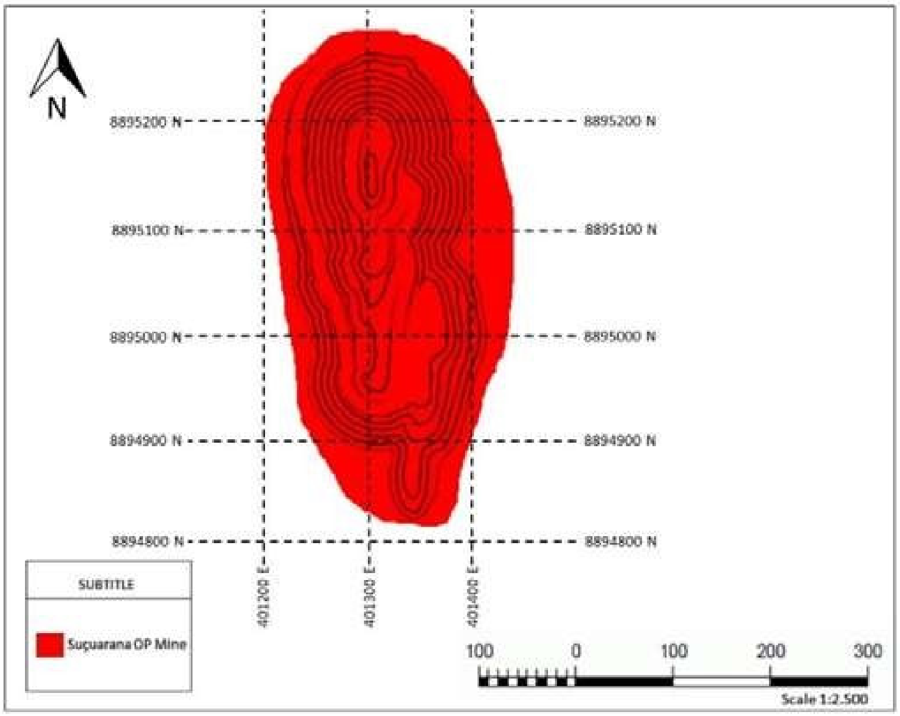


Figure 15-7: Final Pit Chosen Suçuarana South (MCSA, 2020)

15.2.2 Detailed Pit Design

The next step in the mineral reserve estimate process was to design an operational pit that incorporates catch berms and haulage ramps and applies inter-ramp angles based on geotechnical analyses. The operation of the pit followed geotechnical criteria and parameters defined by the MCSA geotechnical team based upon available geotechnical data and operational experience. Existing pit criteria were observed for re-starting operations, such as defining limits between the available ore and the existing main ramp, where applicable. The geotechnical parameters for each sector within the mine were incorporated into the detailed pit design. Additional practical constraints were incorporated into the design primarily pertaining to existing infrastructure, timing of the mining sequence for these mines, personnel requirements, ore transport as well as ore-sorting in the case of the Vermelhos District. The detailed design of the open pit mines was performed based upon the extensive operational experience within the open pit operations throughout the Curaçá Valley and application of geotechnical constraints.

15.2.3 Modifying Factors, Open Pit Mining

The modifying factors applied to the mineral reserve estimates for the open pit reserves of the Curaçá Valley, including the N8/N9 & Siriema OP Mines, Surubim OP and Suçuarana South OP Mine are operational dilution and metallurgical recovery.

Dilution is the waste material mined with the ore throughout the mining sequence and is sent to the processing plant with the ore mined. Dilution is defined as the ratio of waste mined and sent for processing over the combined ore and waste tonnage processed. An average was applied to each project based on prior operational experience, geological model considerations as well as equipment selection and expected selectivity.

Metallurgical recovery curves as a function of grade were used to estimate recoveries, consistent with the approach in prior mineral reserve estimates undertaken by the Company. Additional information regarding metallurgical testing and recoveries can be found in Chapter 13 of this Report.

The table below shows the modifying factors used in all open pit projects. The authors of this Report note that the forecast increase in metallurgical recoveries applied in the LOM production plan as a result of the recently commissioned HIG Mill were not considered when estimating the current mineral reserves.

Table 15-7: Modifying Factors for Open Pit projects

Project	Dilution	Metallurgical Recovery
N8/N9 & Siriema	10%	89%
Surubim	17%	85%
Suçuarana South	10%	89%

15.3 MINERAL RESERVE ESTIMATION METHODOLOGY, UNDERGROUND

There are three underground mines within the Curaçá Valley mineral reserve estimate, which includes the Pilar UG Mine (inclusive of the Deepening Extension Project), the Vermelhos UG Mine and the small C12 UG Mine. Current mining operations occur within the Pilar UG Mine and Vermelhos UG Mine. Current operational rates for the Pilar UG Mine and the Vermelhos UG/Mine are approximately 4,000 tonnes per day and 2,200 tonnes per day, respectively. Production volumes from underground mining operations of the Pilar Mine are expected to increase after the completion of a new 4.5m external shaft from surface.

15.3.1 Pilar UG Mine

Mineral reserves for the Pilar UG Mine were divided into two primary mine planning areas given the nature of the operations and development of the Deepening Extension Project as currently envisioned. The mineral reserves are based upon the Measured and Indicated mineral resources below level -965 (the Deepening Extension Project) and above level -965 in the Pilar UG Mine. The mineral reserve estimate is based on the following density parameters. Mineral reserve estimation parameters are described in Table 15-1.

Table 15-8: Density Parameters for Pilar UG Mine Optimization

Technical Parameters	Value
Ore Density	3.02 g/cm³
Waste Density in-situ	2.98 g/cm³
Swelled Waste Density	1.92 g/cm³

Considering the geological and geotechnical characteristics of the deposit, the recommended mining method for the Deepening Extension Project is open blast hole stoping, with delayed paste-fill. This mining method is applied either transverse or longitudinal to the deposit, based on the width of the mining zone, and is currently in use at the mine. The mine design incorporates geotechnical recommendations to define the production stopes, access to the production stopes as well as associated infrastructure and support requirements.

For the Deepening Extension Project stope dimensions for transverse stopes will be constrained to 15m wide, 26m high and the orebody width for length. In the case of longitudinal stopes the dimensions will be less than 15m wide, 26m high and 30m long. The Shape Optimizer ("SO") module included in the DESWIK design software was used to determine potential mining inventories and deposit continuity for the defined cutoff grade. The SO runs were done using Measured and Indicated resources only and include allowance for external dilution. No allowances are included for mining recovery. The Inferred resource grade was set to zero within SO.

Different paste-fill strengths were used depending on the specific purpose of the mix:

- 0.4 MPa was applied to paste intended for stope filling;
- 4.0 MPa was applied to paste where working underneath cured paste-fill is a requirement; and,
- 1.23 MPa was applied to paste where tunnels in cured paste-fill would be required.

The mine layout of the Pilar UG Mine considers that the primary ramp will continue from the current level -980 with development headings measuring 5.0m wide by 5.5m high and an arched back. These dimensions provide enough clearance for loaded 30 tonne capacity conventional haul trucks to move safely without rubbing or tearing the secondary ventilation used during the development phase. The ramp will be developed at a nominal gradient of -15%. The ramp is located along the mineralization moving slightly to the north and is designed, on average, approximately 50m offset from planned stopes.

The transport level development heading dimensions will be 5.0m wide by 5.5m high with an arched back. These are the same dimensions as the ramp and provide sufficient clearance for conventional trucks as well as secondary ventilation. Transport levels will be developed from the primary ramp and are designed on 26m vertical spacing, 30m apart from planned stopes.

Drilling and production drifts will be 4.5m wide by 4.8m high on heading following the hanging wall. Connection access between drilling and transport drifts will be 4.5m wide by 4.8m high.

In total over the LOM plan, the mine will contain 16 production sub-levels starting at level -965 to level -1381. Levels are developed to access the extent of the strike length of the deposit and connect the development to the return air raise ("RAR") in the north and south and fresh air raise ("FAR") along the middle of the development to establish flow-through ventilation.

Table 15-9: Technical Parameters for Pilar UG Reserves

Geometric Parameters - Mine Development	Description
Section - Horizontal Development	Arch-squared
	5.0m x 5.5m 4.5m x 4.80m
Section - Vertical Development	Circular
	3.10m / 4.5m
	Square

	5.0m x 5.0m
Slope (grid)	+1% (horizontal) +/- 15% (maximum)
Min. radius of curvature. Ramp	25m
Geometric Parameters - Mining UG	
Min. Stope Width	5m
Max. Stope Width	30m
Access Distance to Production Galleries	25-35m
Stope Height	26 – 50m

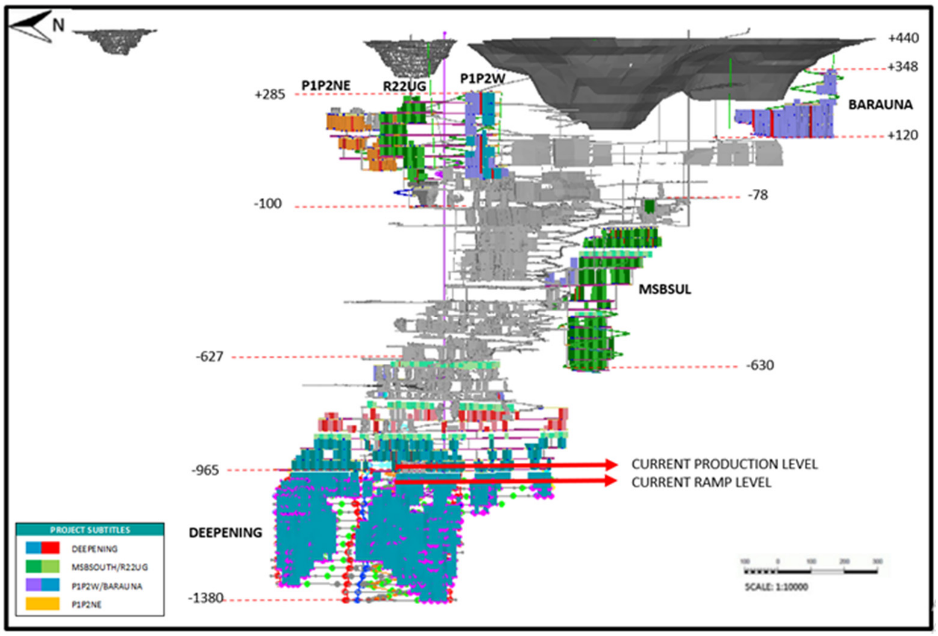


Figure 15-8: Overall of Pilar UG Mine & Deepening Extension Project Mineral Reserves (MCSA, 2020)

15.3.2 Vermelhos UG Mine

Mineral reserves for the Vermelhos UG Mine were divided into two primary mine planning areas given the nature of the operations and development of the East Zone as currently envisioned. The mineral reserves are based upon the Measured and Indicated mineral resources and the following density parameters. Mineral reserve estimation parameters are described in Table 15-1.

Table 15-10: Density Parameters for Vermelhos UG Mine

Technical Parameters	Value
Ore Density	2.98 g/cm³
Waste Density in-situ	2.89 g/cm³
Swelled Waste Density	1.86 g/cm³

The reserve was estimated considering the technical and economic parameters needed to define the stopes. The definition of the economic and geotechnical parameters, were based on the projects currently being executed by MCSA and are described in the table below:

Table 15-11: Technical Parameters for Vermelhos UG Reserves

Geometric Parameters - Mine Development	Description
Section - Horizontal Development	Arch-squared
	5.0m x 5.5m 4.5m x 5.0m
Section - Vertical Development	Circular
	3.10m / 4.5m
	Square
	5.0m x 5.0m
Slope (grid)	+1% (horizontal) +/- 15% (maximum)
Min. radius of curvature. Ramp	25m
Geometric Parameters - Mining UG	
Min. Stope Width	5m
Max. Stope Width	30m
Access Distance to Production Galleries	25-35m
Stope Height	26 – 50m

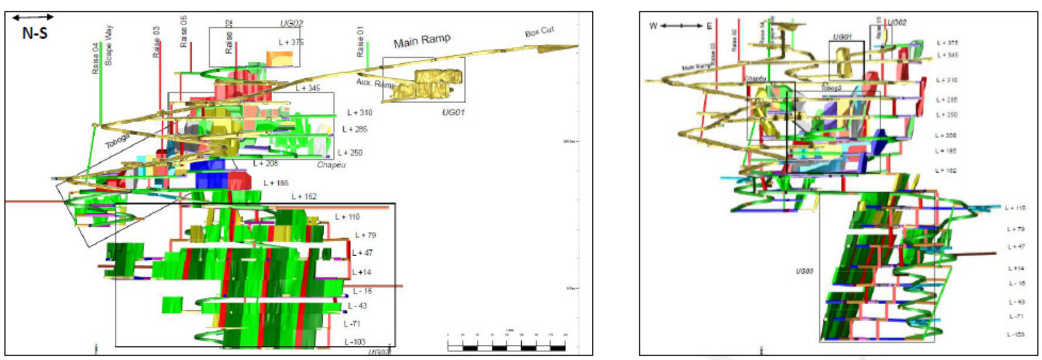


Figure 15-9: Long-Section of the Vermelhos UG Mine Mineral Reserve (colors reflect operational zones) (MCSA, 2020)

15.3.3 C12 UG MINE

Mineral reserves for the C12 UG Mine are based upon a single decline extending from the bottom of the C12 OP Mine after completion of open pit mining activities. The mineral reserves are based upon the Indicated mineral resources and the following density parameters. Mineral reserve estimation parameters are described in Table 15-1.

Table 15-12: Density Parameters for C12 UG Mine

Technical Parameters	Value
Ore Density	3.02 g/cm³
Waste Density in-situ	2.98 g/cm³
Swelled Waste Density	1.92 g/cm³

Table 15-13: Technical Parameters for C12 UG Reserves

Geometric Parameters - Mine Development	Description
Section - Horizontal Development	Arch-squared
	5.0m x 5.5m 4.5m x 4.80m
Section - Vertical Development	Circular
	3.10m / 4.5m
	Square
	5.0m x 5.0m
Slope (grid)	+1% (horizontal) +/- 15% (maximum)
Min. radius of curvature. Ramp	25m
Geometric Parameters - Mining UG	
Min. Stope Width	5m
Max. Stope Width	30m
Access Distance to Production Galleries	25-35m
Stope Height	26 – 50m

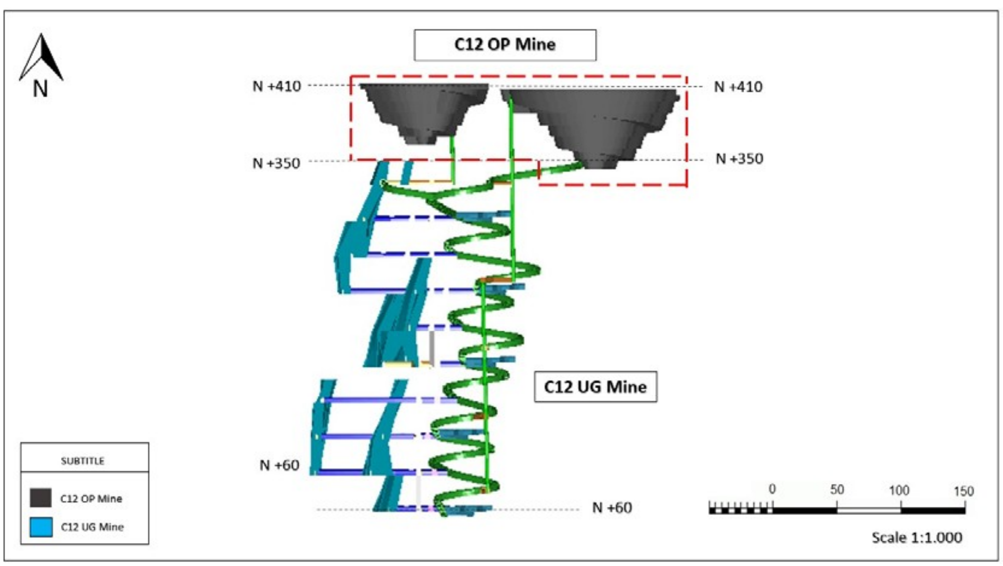


Figure 15-10: Overall cross-section of C12 UG Mine, looking north (MCSA, 2019)

15.3.4 Modifying Factors, UG Mineral Reserves

The modifying factors considered for the mineral reserve estimation of the Pilar UG Mine, including the Deepening Extension Project, the Vermelhos UG Mine and the C12 UG Mine include operational dilution, mining recovery and metallurgical recovery.

For Pilar UG Mine (and Deepening Extension Project) modeled stope dilution from a geotechnical viewpoint was estimated using the equivalent linear over-break slough ("ELOS") method (after Clark and Pakalnis, 1997) based on design stope dimensions. The ELOS is influenced by the rock mass condition of an unconfined stope wall, induced stresses, joint orientation and stope orientation for a given volume. The ELOS estimation results indicate that, for average and above rock mass conditions such as is commonly found in the Curaçá Valley, the anticipated ELOS of a gneiss Hanging Wall ("Hw") dipping from 70° to 90° will be less than 0.5m.

A similar approach, introduced by Papaioanou and Suorineni, has been applied as an alternative to the ELOS stability graph. The alternative approach was selected as the original stability graph is applicable to wide orebodies while the ELOS stability graph applies to narrow-vein orebodies and does not provide explicit quantitative dilution values. Data was statistically analyzed using Logistic regression and the Bayesian likelihood discrimination method to produce quantitative dilution-based stability graphs. The graphs provide the flexibility to design open stope sizes based on what dilution amounts are acceptable to a given operation or to estimate the amount of dilution it can be expect for a given stope dimension. The estimation results using this method indicate that, for average and above rock mass conditions, the anticipated dilution of a Gneiss Hw, dipping from 70° to 90° should be less than 5%. If dilution from the Foot Wall ("Fw") is added, total dilution should be less than 10%.

Despite these calculations, actual measured overbreak within the operations during 2019 and 2020 within the Pilar UG Mine indicated a significant amount of dilution in the four stopes evaluated (within Panel 21) by Ingeroc for calibration purposes. This dilution was most likely related to excessive overbreak and associated with sub-optimal operational practices, related to drilling and blasting procedures. Ingeroc is independent of the Company as such term is defined under NI 43-101.

For Vermelhos UG Mine and C12 UG Mine, Sublevel Open Stoping method ("SOS") is the mining method currently in use at Vermelhos and planned for the C12 UG Mine. Application of the method is based upon considerations of dip, plunge and thickness of the orebodies, RQD and overall competence of the host rock. Variations of this method are in use within the central high-grade area of the Vermelhos UG Mine for the maximum possible recovery via introduction of cemented rockfill matrix filling ("CRF") which enables the recovery of secondary stopes.

Overbreak occurs during the drilling and blasting stages through the mine operation. This factor can be influenced by geotechnical structures (failures, fractures in the rock mass), drilling deviations, explosive action during blasting or imperfections in the execution in the drill and blast design. Within the overbreak volume there is mass of waste and mass of mineralized material. The portion of waste material included within the overbreak is called the operational dilution. In 2020, a dilution model utilizing a marginal cut-off grade, was developed and incorporated into the mine planning stage of the current mineral reserve estimate and LOM production plan.

Underbreak, also called ore loss, is caused when the blasting efficiency is low, drilling is not accurate (length and deviation) and/or imperfections exist within the drill and blast design. The inverse calculation of the underbreak is called mining recovery (100% - underbreak%). 5% underbreak (95% of mining recovery) was applied for the mineral reserve estimate for 2020 based on operational performance. The figure below shows an Example of overbreak and underbreak in Vermelhos UG Mine.

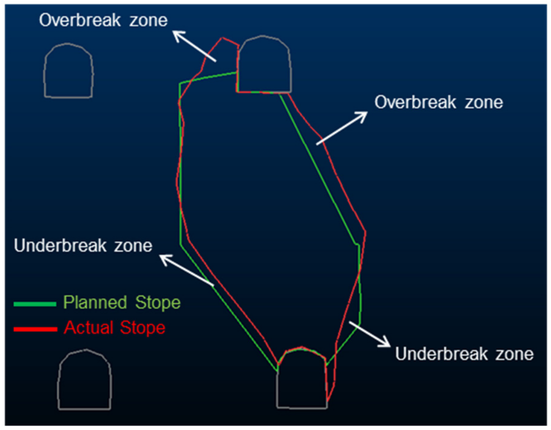


Figure 15-11: Example of overbreak and underbreak within the Vermelhos UG Mine (MCSA, 2020)

The table below shows the modifying factors used for Pilar UG Mine & Deepening Extension Project, the Vermelhos UG Mine and the C12 UG Mine. The authors of this Report note that the forecast increase in metallurgical recoveries applied in the LOM production plan as a result of the recently commissioned HIG Mill were not considered when estimating the current mineral reserves.

Table 15-14: Modifying Factors implemented MCSA UG Mines

Projects	Dilution	Mining recovery	Avg. Metallurgical Recovery
Pilar UG Mine & Deepening Project	12% (avg)	96%	90.39%
Vermelhos UG Mine	10%	95%	91.49%
C12 UG Mine	10%	95%	89.0%

Other modifying factors considered in the determination of the mineral reserve estimate include:

- Maximum underground stope dimensions based on geotechnical assessments from previous studies and past operating experience within each mining area, combined with evaluation of induced stresses and the RMR.
- VRM method with cemented paste fill was selected for the Pilar UG Mine, where the method is currently in use.
- Within designed stopes, all contained material was assumed to be mined with no selectivity. Inferred mineral resources, where unavoidably included within a defined mining shape have been included in the mineral reserves estimate at zero grade. Mining dilution resulting from Measured and Indicated blocks was assigned the grade of those blocks captured in the dilution envelope using the current mineral resource estimate.

15.4 QP COMMENTS

Dr. Beck Nader of BNA, the QP responsible for the mineral reserve estimate of the Curaçá Valley, is of the opinion that the mineral reserve estimation has been performed to industry best practices and conform to the requirements of the CIM Standards and CIM Guidelines.

Dr. Beck Nader has checked the data used to construct the current mineral reserve models and considers the models to be suitable to support advanced mining studies and the current mining operations as currently envisioned.

Dr. Beck Nader has not identified any metallurgical, infrastructure, permitting, legal, political, environmental, title, taxation, socio-economic, marketing or other relevant factors that could materially affect the potential development of the stated mineral reserves.

The Qualified Person, Dr. Beck Nader of BNA notes the following recommendations related to mineral reserve estimation:

- Expand ongoing geometallurgical studies to encompass all deposits and blends therein to study mill feed interaction. Suggest including standardized laboratory tests as normal operating procedure. Additionally, it is recommended that the Company advance geometallurgical studies for inclusion in mineral reserve definition, in order to classify metallurgical recovery according to the different characteristics associated with each lithological domain rather than by deposit.

- Confirm the expected improvement in metallurgical recoveries following the addition of the HIG Mill to validate a recovery improvement in the definition of mineral reserves in the future.

- Install a sample tower to improve the mine to mill reconciliation process for the current operating mines. Such an installation will allow differentiation of ore source reconciliation within the processing plant.

- Improve systems for mineral reserve attribute database management to standardize fleet sizing, economic and consumable parameters, swell factors, dilution and mine call factors as well as store historic block model and design attributes including mathematical pit designs and supporting assumptions within a centralized validated database to improve the application of mineral reserve modifying factors in future studies.

- The authors recommend that a drill program for the Deepening Inferred Project be executed so as to promote the resource classification from Inferred to Measured or Indicated. Additional engineering work should continue alongside the exploration program to promote the confidence of the mine design and costing parameters of the Deepening Inferred Project. The authors note at the time of this Report, such programs were underway.

16 MINING METHODS

This chapter presents the mining methods for the Pilar UG Mine, Vermelhos UG Mine, C12 UG Mine and the open pit mines, including N8, N9, N5, Surubim and Suçuarana. The geotechnical considerations and parameters, as well as the regional hydrogeological considerations for these, are also presented.

Please refer to Chapter 15, Mineral Reserve Estimates, for dilution, mining recovery and other relevant modifying factors applied to each of the mining operations stated above and described in greater detail below.

16.1 PILAR UG MINE

Underground mining operation within the Pilar Mine have been active for approximately 34 years. The mine currently produces an average of 4,100 t/day and approximately 1,170m per month of development is expected starting in 2022 (average of 14k m/year) for the next 5 years.

The Pilar UG Mine is divided into six main zones: Deepening Extension Zone (or Deepening), Barauna, MSBS, P1P2NE, P1P2W and the West Limb which encompasses an area known as R22UG and P1P2W. Figure 16-1 shows a North-South longitudinal section of the Pilar UG Mine.

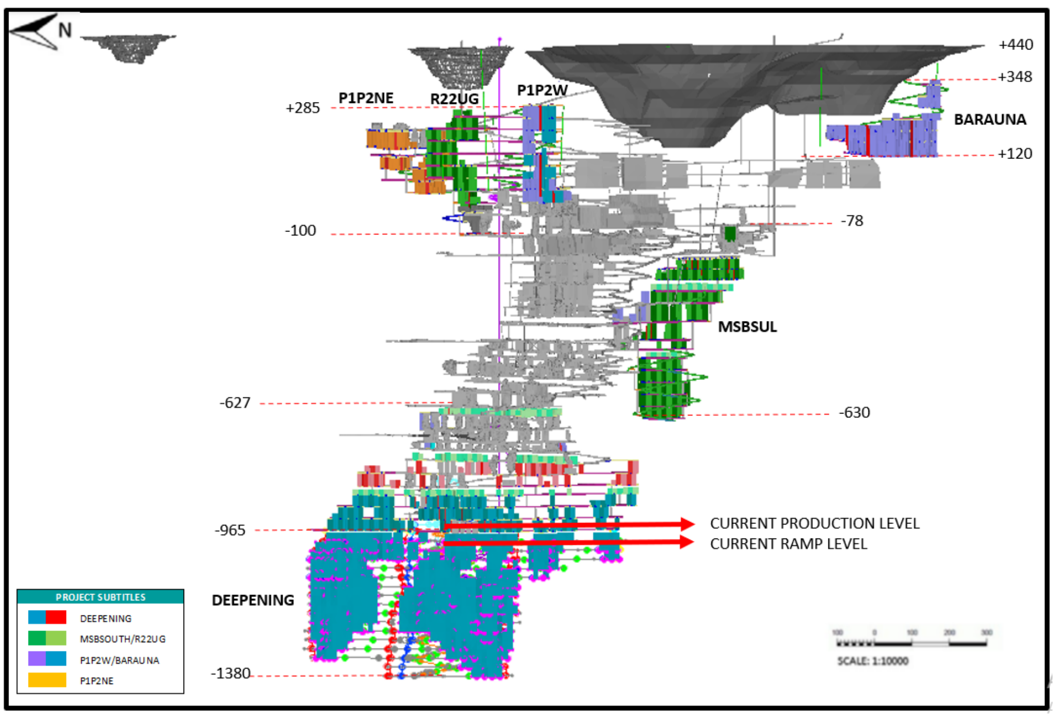


Figure 16-1: Pilar UG Mine long-section showing planned stopes (MCSA, 2020)

16.1.1 Mining Methods, Pilar UG Mine

The Pilar UG Mine has previously employed the following mining methods: Sublevel Stoping, VRM and Vertical Crater Retreat ("VCR"). VRM is the method currently employed, whereby ore is removed from the stope after it is blasted and cemented paste backfill is pumped into the mined stopes to ensure geotechnical stability prior to advancing to adjacent stopes.

The mining method selection is heavily influenced by the deposit type and rock mass characteristics. Other factors influencing the selection process are the proximity of the resource to the surface, the nature of the surface topography, the strength of the deposit and host rock, the configuration (i.e., shape, dimensions, and dip) of the deposit, the resource being mined, the required selectivity, productivity and overarching safety considerations.

To determine a safe and economically viable means of mining, several factors are taken into consideration. The factors considered for mining the deposit are listed below.

- Deposit shape, continuity, dimensions, and inclination;
- Depth below surface and mine access;
- Topographical features and constraints;
- Rock mass characteristics including groundwater hydrology;
- Mining methods and ground control;
- Production capacity and scheduling;
- Material handling and mechanization;
- Mine ventilation; and,
- Underground services and support infrastructure.

The current VRM method in currently in use varies in dimensions, with an average stope height of 35m. The majority of production drilling is performed using a Fandrill with 3½" diameter hole. The holes of the free-face are widened to approximately 8" in diameter as shown in the figure below.

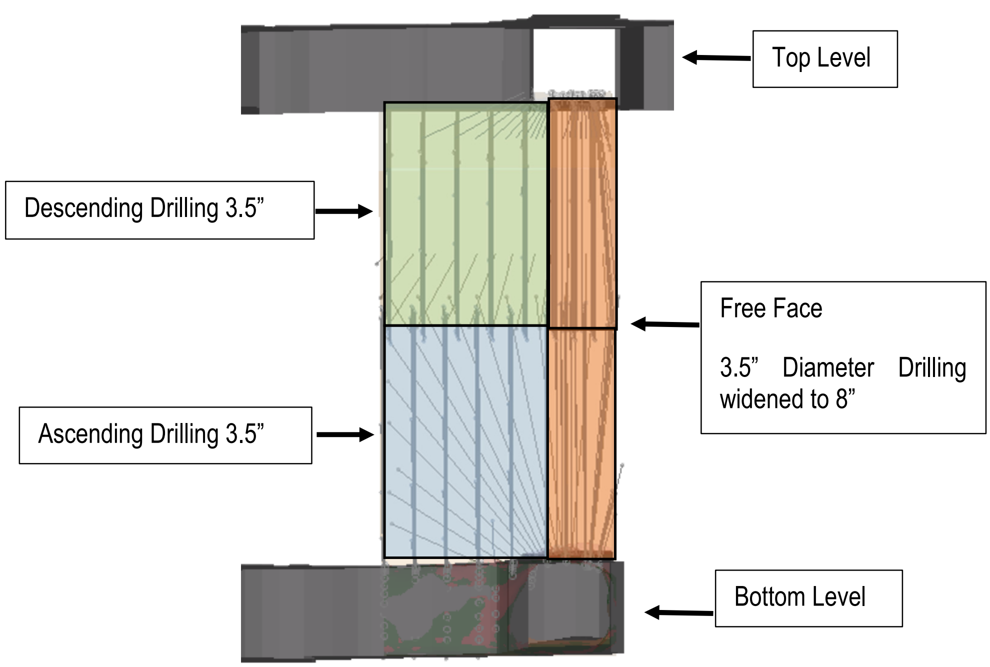


Figure 16-2: VRM variant method schematic (MCSA, 2020)

Design dimensions of each stope vary according to the modeled geotechnical conditions based upon calculated induced stresses and defined rock mass classifications within the areas of development. While locally variable, on average, stope parameters can be described as having the following dimensions:

- In non-faulted zones: 10m width x 20m length x 35m height; and
- In fault zones, the size of stopes is reduced to 10m width x 15m length x 35m height.

For the Deepening Extension Project the same mining method will be employed as the rest of the Pilar UG Mine. A panel height reduction from 35m to 26m will be applied to improve mining recovery and reduce dilution. The mining sequence will be divided based upon the presence of both narrow and thick stopes within the mine design. Longitudinal will be applied to narrow stopes (shown in blue below) and transverse will be applied to thick stopes (shown in red below). The planned modifications to the mining sequence and stope design for the Deepening Extension Project is expected to provide less overbreak and dilution, enhance the stability of the operation and improve mining recovery.

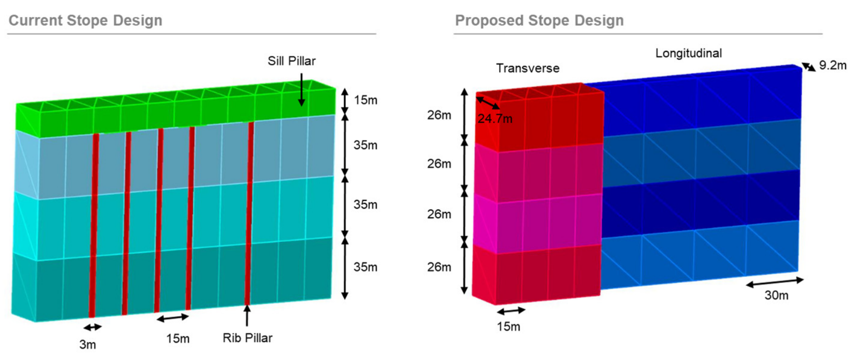


Figure 16-3: Proposed Mine Design for the Deepening Extension Project (MCSA, 2020)

The Pilar UG Mine ramp development utilizes a maximum design grade of 15% and 25m radius on center. Ramp design targets an average distance of 20m from the ramp to ore gallery access to limit access development requirements.

Gallery access design dimensions of 5.0m x 5.5m are employed due to the size of the equipment operated by MCSA and the infrastructure necessary for further development of the galleries (ventilation ducts and production equipment access). Production gallery design dimensions are 4.5m x 4.8m. Transport cross-cuts are located at an average distance of 35m from the orebody and are made parallel to the mineralized zone.

Currently, all ore extracted in the underground mine area (except ore from the near-surface mine zone of the West Limb, which is hauled to surface) is directed to the -78 level where it is discharged into an ore pass. After crushing in one of the two primary jaw crushers, the crushed material is transported by conveyor to an intermediate ore silo connected to the shaft hoisting system.

The material (ore and waste) produced from the Deepening Extension Project will be directed to a new external vertical shaft, that will connect the underground mine at the level -1,075 to the surface. The new transportation shaft will be commissioned in early 2025. Please refer to Chapter 18 of this Report for additional details.

A center-out mining sequence and a pyramidal shape from bottom to top has been applied for the Pilar UG Mine. The sequence leaves no secondary stopes and avoids high stress concentrations, as shown in the figure below.

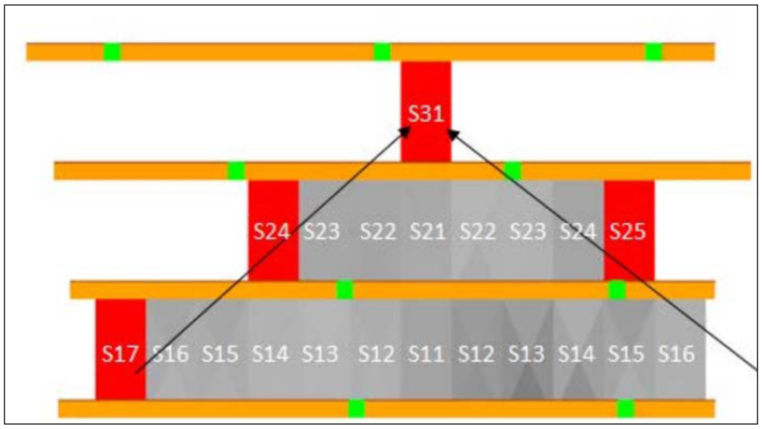


Figure 16-4: Center-out mining sequence (MCSA, 2020)

All stope excavations are backfilled with cemented paste or rockfill. With the exception of the planned stopes within P1P2NE that will use waste rock for backfill, all areas are designed to use cemented paste as the main backfill system.

Paste fill uses a combination of flotation tailings and cement, which is used to fill mined out stope volumes to provide additional support, reduce in-situ stresses and increase mine recoveries. Paste comprised of thickened tails and approximately 4% cement by weight is gravity fed from the paste fill plant to the underground workings as called for in the production sequence.

The waste rock used for backfilling, where required, is generated by the horizontal development from the Pilar UG mine.

16.1.2 Mine Development & Pastefill Schedule, Pilar UG Mine

To meet the production plan targets, the following development rates are planned from 2020 to 2031 for the Pilar UG Mine (table below). In total, the production plan calls for approximately 98,000m of development, including ramp and horizontal access development.

Table 16-1: Pilar horizontal development schedule

Year	Total Development (meters)
Q4/2020	2,490
2021	13,165
2022	14,216
2023	13,980
2024	13,526
2025	13,313
2026	12,380
2027	9,312
2028	3,624
2029	1,557
2030	32
2031	13

Q4 2020 development plan outlines schedule for the three months from the effective date of October 1, 2020 to December 31, 2020.

Vertical development is presented in the table below.

Table 16-2: Vertical Development

Description	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Exhaust Raises	33	274	181	110	150	241	155	229	122	1,808
Ore passes from Upper	0	0	0	0	392	27	0	0	0	418
Ventilation Raise Borer	17	423	136	81	114	100	52	199	140	1,504
Hosting Shaft	0	725	671	127	0	0	0	0	0	1,523
Poco Sul 2 Raise	294	0	0	0	0	0	0	0	0	294
TOTAL	**344**	**1,422**	**988**	**318**	**655**	**368**	**207**	**428**	**262**	5,547

The Pastefill production plan is presented in the table below.

Table 16-3: Pastefill Schedule

Year	Total Pastefill (tonnes)
Q4/2020	80,876
2021	416,690
2022	917,220
2023	1,215,691
2024	1,254,428
2025	1,409,168
2026	982,893
2027	953,713
2028	1,005,504
2029	744,867
2030	614,302
2031	196,232
2032	374,981
2033	393,673

16.1.3 Mine Fleet, Pilar UG Mine

The current mining fleet that will be used in support of planned mining activities at the Pilar UG Mine is listed below. Replacement of equipment at the end of each equipment's useful life and required increases to the existing fleet in support of the LOM production plan are captured in the capital expenditure forecast included in this Report.

Table 16-4: Pilar UG Mine Equipment

Equipment	PrimaryFunction	Qty
Jumbo	Horizontal Drilling	6
Cubex	Vertical drilling	4
Cabolt	Cable bolting	2
Fandrill	General drilling	2
Rockbolt	Rock support	6
Scaler	Scaling	5
Shotcrete carriers/mixers	Shotcrete transport	5
Concrete sprayers	Shotcrete application	3
Loaders	Loading material	12
Trucks	Transport material	24
Shift Trucks	Personnel transport	6
Platforms	Mesh installation and infrastructure	10
Support	Support Equipment	20
Total		**105**

All the development for the Deepening Extension Project will be performed utilizing MCSA's own equipment and personnel. Production activities will be performed using radial long-hole drills for blast holes. Loading (mucking) will be performed using long haul dump trucks ("LHDs") and 27 tonne conventional trucks will be used for ore haulage. Production crews will share emulsion loading vehicles for blasting of the stopes.

Loading and transportation will be done with 10 cubic yard LHDs between stopes in the production levels and stockpiles. From the stockpiles the material will be directly loaded to trucks with 10 cubic yard LHDs. Transportation to the underground crusher will be done using 27 tonne conventional t trucks.

The proposed mucking/haulage fleet was selected to accommodate excavations 5.0m wide by 5.5m high. For the purposes of this Report, the existing loader and truck combination fleet type was selected for operational synergies. For waste haulage, the same trucks will be used as currently in operation.

16.2 VERMELHOS UG MINE

The Vermelhos UG Mine is located approximately 80 km north of the Pilar UG Mine and the Caraíba Mill, and it has been in operation since 2018. Current Mineral Reserves at the mine are sufficient for production of approximately six years. The main Vermelhos UG Mine deposit remains open along strike and at depth, and Ero Copper is actively exploring extensions of the deposit to depth, and to the south of the main Vermelhos UG Mine in an area known as the Southern Vermelhos Corridor.

16.2.1 Mining Method, Vermelhos UG Mine

The SOS method was chosen as the mining method at Vermelhos UG Mine considering the dip, plunge and thickness of the orebodies as well as the rock quality designation and overall competence of the host rock. Variations of this method are planned for the central area for maximum possible recovery using the CRF technique.

The mine design, currently in practice, entails mining panels of 25m to 30m, on average, in the vertical dimension without the need for rib pillars to support the open excavations. In the central and western high-grade areas (the "Tobogã") mining occurs using sub-horizontal stopes. In these areas, the panel size has been reduced to 25m and is filled using CRF to maximize mining recoveries and limit in-situ stresses. Panel size and thickness has been constrained by the geotechnical design parameters as determined by 2D and 3D geotechnical modeling of the stresses induced by panel excavation. The geotechnical analysis was performed by MCSA's geotechnical engineering team and reviewed by the authors of this Report.

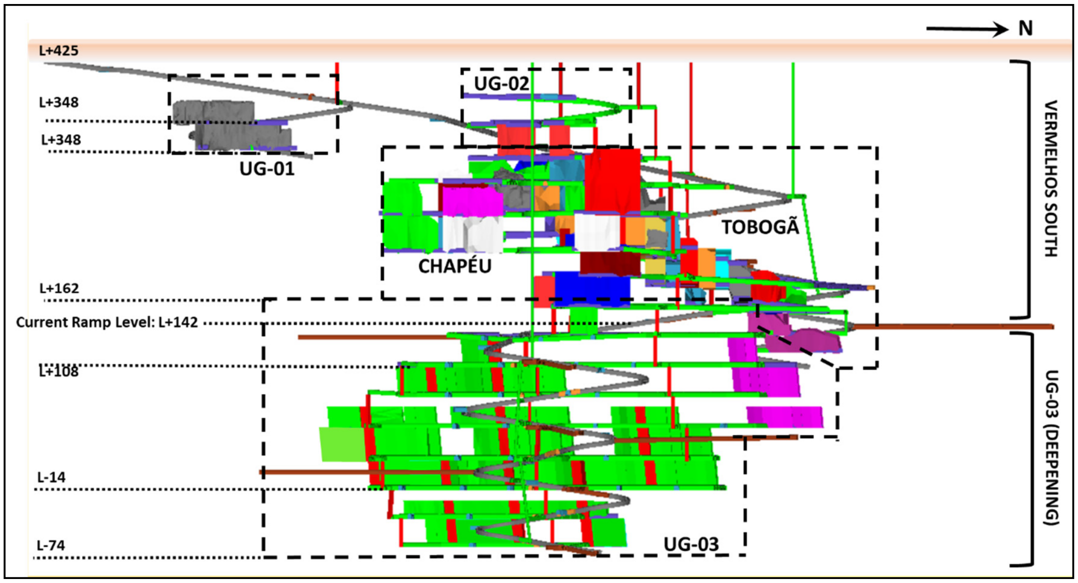


Figure 16-5: North-South schematic profile of the Vermelhos UG Mine (MCSA, 2020)

Within the Vermelhos UG Mine, the vertical sections of the deposit typically range from 2.5m to 8.0m wide, with strike dimensions of up to 80.0m. Within the sub-horizontal high-grade portion of the deposit (Tobogã, or "Toboggan") the dimensions are approximately 195m in length, 75m in thickness and 23m to 27m in height.

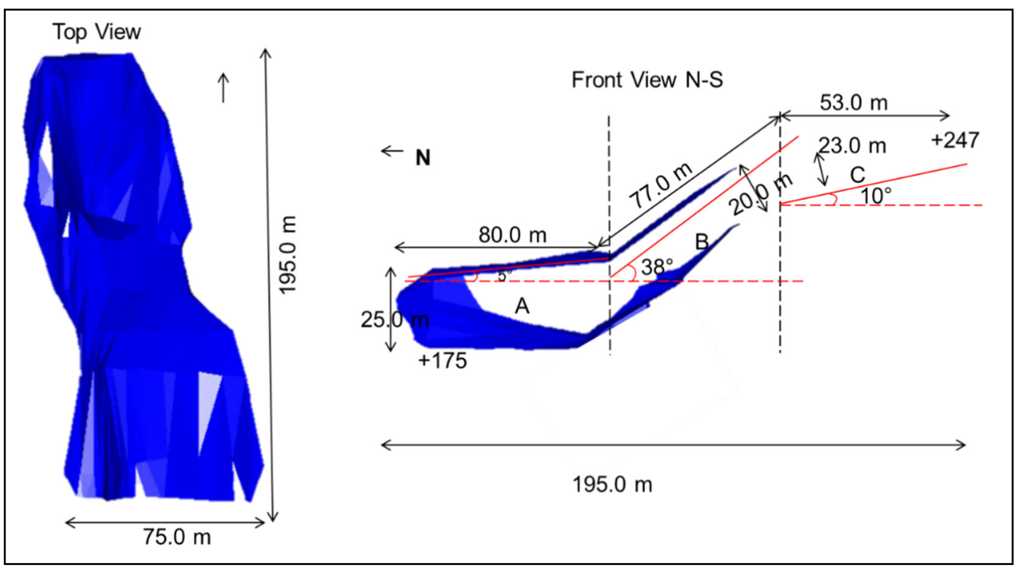


Figure 16-6: Tobogã orebody, Vermelhos UG Mine – Dimensions (MCSA, 2020)

The typical dimensions of stopes within the Tobogã central zone are 15m in width in average by 25m to 30m in height by maximum of 90m in length. Stopes of the east and west vertical areas have average dimensions of 10m in width by 30m in height by 50 m in length.

The top and bottom levels are drilled within each mining panel. Drilling will be performed ascending (from the base level) 15m and descending (from the top level) 15m, with a 3" diameter radial fan pattern within the sub-horizontal stopes of the Tobogã zone. The figure below shows drilling, development and proposed mining sequence for the vertical and sub-horizontal stopes.

To enable maximum recovery of the geological resource of the Vermelhos UG Mine, CRF technique is used, whereby after primary stopes are mined, secondary stopes are mined after the CRF filling of the primary stope has cured. An illustrative sequence is shown in the figure below.

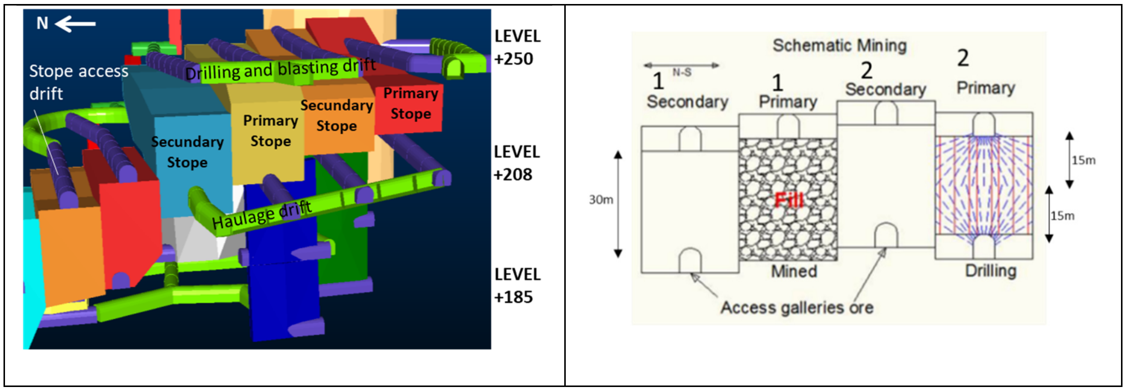


Figure 16-7: Tobogã orebody, Vermelhos South area – Dimensions (MCSA, 2020)

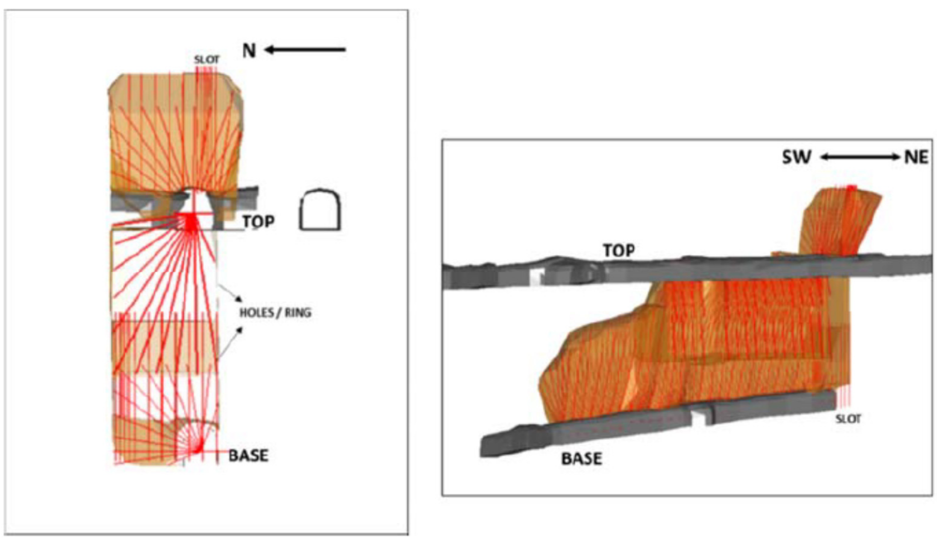


Figure 16-8: Vertical stopes - drilling design schematic in the Vermelhos UG Mine (MCSA, 2020)

Similar to Pilar UG mine, Vermelhos UG Mine ramp development utilizes a maximum design grade of 15% and 25m radius on center (same parameters as the Pilar UG Mine). Ramp design targets an average distance of 30m from the ramp to ore gallery access to limit access development meterage.

Gallery access design dimensions of 4.5m x 5.0m are employed due to the size of the equipment operated by MCSA and the infrastructure necessary for further development of the galleries (ventilation ducts and production equipment access). Production galleries design dimensions are 4.5m x 5.0m. Transport crosscuts are located at an average distance of 35m from the ore body and parallel to the mineralized zone.

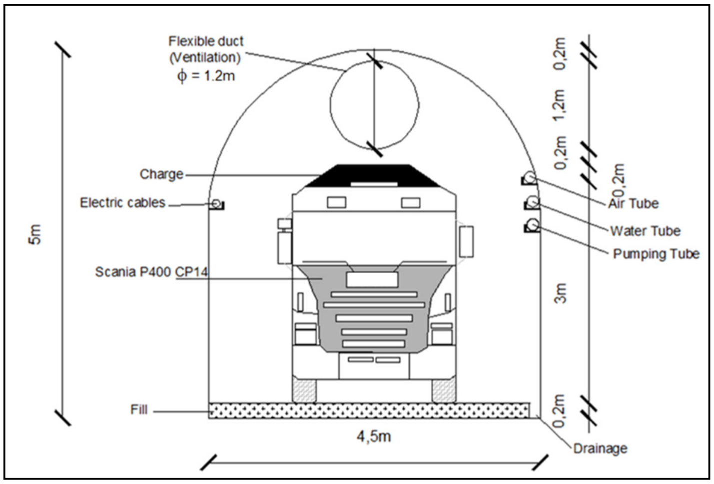


Figure 16-9: Vermelhos UG development size (MCSA, 2020)

The ore production of Vermelhos UG includes two handling phases: mine-to-pile and pile-to-plant handling.

- The mine-to-pile production is carried out via the primary ramp utilizing haulage equipment, over a current average haulage distance of 2.5 km to the stockpile area on surface. The average loaded tonnage of the articulated trucks that transport ore to the surface is 25 tonnes.
- For the pile-to-plant production, 50 tonne excavators and bi-train haul trucks contracted through a third-party materials handling company are used, with an average loaded tonnage of 72 tonnes per bi-train. The distance traveled from the pile to the plant is approximately 70 km.

Linked to the mining process, there is the cement rock fill activity of the exhausted stopes. The rock-fill is prepared on a surface plant by crushing and mixing the waste with water and cement, and then moved from the surface to the previously mined stopes via the primary ramp by 25 tonne trucks.

The waste generated during gallery development is transported by trucks via the primary ramp to surface and disposed in the waste piles. Most of the waste is used for the generation of gravel for the composition of the rock-fill used to fill previously mined stopes.

The stockpile is strategically located close to the main ramp entrance, to minimize the average haulage distance on the surface (figure below). There are protective windows and channels installed to control surface drainage with the design goal of eliminating external drainage from the stockpile.

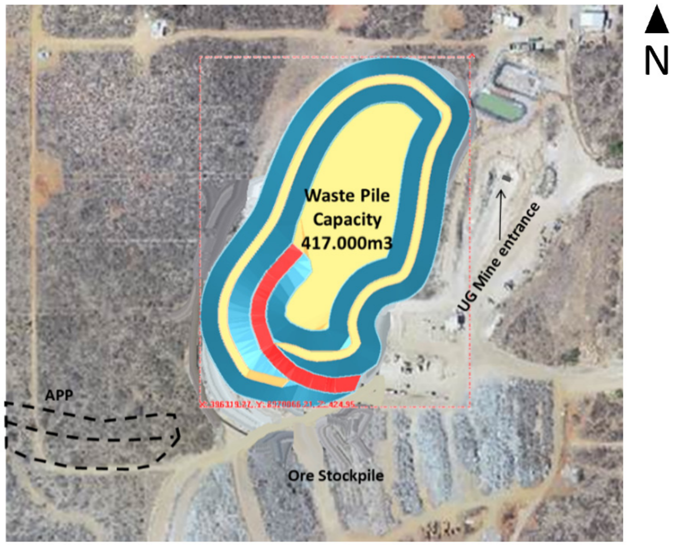


Figure 16-10: Vermelhos UG Mine Waste Pile (MCSA, 2020)

16.2.2 Mine Development and Backfill Schedules, Vermelhos UG Mine

To meet the production plan targets, the following development rates are planned from 2020 to 2025 for the Pilar UG Mine (table below). In total, the production plan calls for approximately 17,500m of development, including ramp and horizontal access development.

Table 16-5: Vermelhos UG Mine horizontal development schedule

Year	Total Development (m)
Q4/2020	929
2021	3,951
2022	3,838
2023	3,528
2024	3,059
2025	2,225

Vertical development is presented in the table below.

Table 16-6: Vermelhos UG Mine vertical development schedule

Description	2021	2022	2023	2024	2025	Total
Exhaust Raises	79	141	174	271	85	**750**
Ventilation Raise Borer	153	202	-	44	-	**400**
TOTAL	**232**	**343**	**174**	**315**	**85**	**1,150**

The CRF production plan is presented in the table below.

Table 16-7: Vermelhos CRF schedule

Year	Total CRF (t)
Q4/2020	77,587
2021	421,788
2022	395,432
2023	397,005
2024	397,580
2025	395,467
2026	300,963

16.2.3 Mine Fleet, Vermelhos UG Mine

The Vermelhos UG Mine equipment fleet has been determined based on actual operating experience since commissioning of the mine in 2018 as well as achieved availabilities and useful life of the equipment within the Pilar UG Mine (table below).

Table 16-8: Vermelhos Equipment Fleet

Equipment	Primary Function	Qty
Jumbo	Horizontal Drilling	3
Fandrill	Vertical drilling	1
LHD	Loading material	3
Trucks	Transport material from mine to stockpile	7
Haul Trucks	Transport stockpile ore to Mill	22
Scaler	Scaling	2
Scissor Lifter	Mesh installation and infrastructure	2
Backhoe loader	General support	1
Motor grader	Road grading	1
Shift Trucks	Personnel transport	1
Support	General support	3
Total		**46**

16.3 C12 UG MINE

16.3.1 Mining Method – C12 UG Mine

The SOS mining method was selected on consideration of the lenticular sub-vertical shape and the moderate thickness of the orebody as well as geotechnical parameters. Among the main advantages of the SOS method are safety and the implementation of simultaneous unit operations, resulting in high productivity.

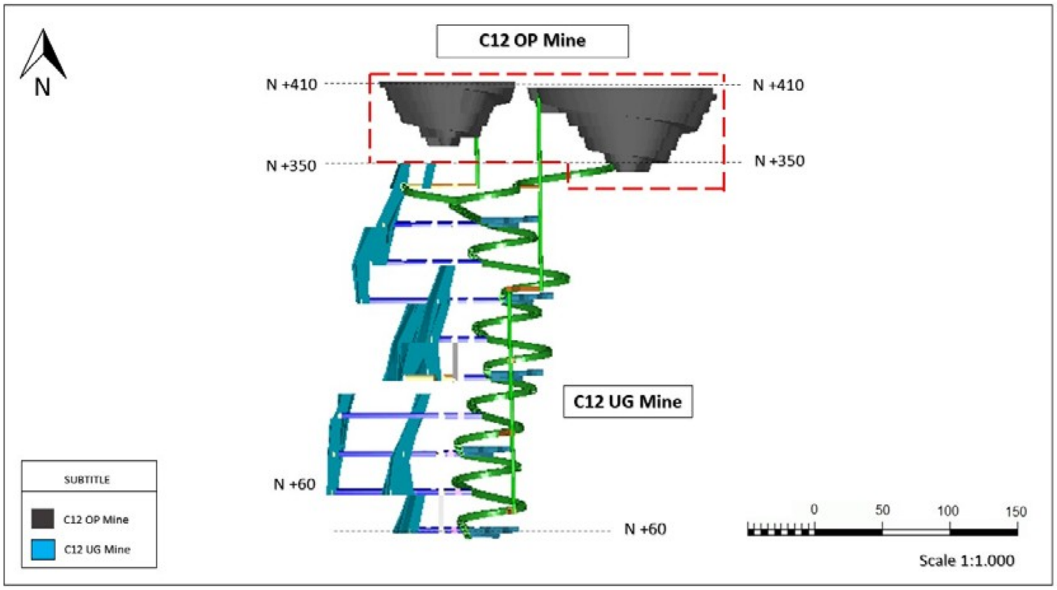


Figure 16-11: C12 UG Mine cross-section, looking north (MCSA, 2019)

The designed panels of the C12 UG Mine have a variable height that average approximately 35m. Roof support consisting of cable bolts will be used in order to limit dilution to 10% during mining operations.

The C12 UG Mine development utilizes the same geometrical parameters used in Pilar UG and Vermelhos UG Mine. Specifically, a maximum primary ramp design grade of 15% and 25m radius on center, with an average distance of 20m from the ramp to ore gallery access. Gallery access drift dimensions are designed to 5.0m x 5.5m and production gallery dimensions are designed to 4.5m x 4.8m. Transport cross-cuts will be located at an average distance of 35m from the ore body, parallel to the mineralized zones.

Within each mining panel, the top and bottom levels are drilled using a 3.5" diameter radial fan pattern with 10m to 20m length in ascending stopes and longer 20m to 30m length patterns in descending stopes.

Ore will be transported via the primary ramp to the coarse ore stockpile on surface using 6x4 trucks with a capacity of 30 tonnes each. From the stockpile, the ore will be transported to the Caraíba Mill for processing via dual-axle 70 tonne haul trucks, as is currently performed for the Vermelhos UG Mine.

16.3.2 Mine Equipment - C12 UG Mine

The required mining fleet to be used in support of planned mining activities will be transferred from Pilar UG Mine and Vermelhos UG Mine to the C12 UG Mine, given the synergy of these projects and timelines as envisioned in the Company's LOM production plan. The required fleet to meet the demands of the production plan is listed in the table below.

Table 16-9: C12 UG Equipment

Equipment	Primary Function	Qty.
Jumbo	Horizontal Drilling	2
Rockbolt	General drilling	2
Scaler	Scaling	1
Fandrill	Vertical drilling	2
Loader	Loading material	5
Excavator	Loading material	2
Truck	Transport material	8
B-double truck	Transport material	9
Support Truck	Support equipment	11
Shift truck	Personnel transport	1
Total		**43**

16.4 MCSA OPEN PIT MINES (N8, N9, N5, SURUBIM AND SUÇUARANA)

MCSA has six open pit projects in Curaçá Valley, N8/N9 and N5 OP Mines, within the Vermelhos District; the Suçuarana OP Mine, in Pilar District; and Surubim and C12 OP Mine in the Surubim District. In total, approximately 26% of the total copper metal produced in the LOM plan is expected to come from open pit operations within the Curaçá Valley.

16.4.1 Mining Methods, Open Pit

The open pit operations of Curaçá Valley utilize conventional open pit mining, implementing proven drilling, blasting and loading / haulage equipment and technologies used in prior open pit operations within the Curaçá Valley by the Company.

To prepare sulphide copper ore for mining, the waste material located in the upper portion of the deposits (mostly comprised of waste rock and oxidized mineralization) is stripped mechanically by a bulldozer. While variable, the weathered profile is, on average, 15m to 20m in thickness throughout the Curaçá Valley. Waste material generated during stripping is stacked outside of the pit area, following the technical and environmental recommendations for each open pit mine.

After pre-stripping, hard rock mining of both barren waste and ore comprising the mineral reserves will be carried out by blasting with explosives. Primary rock drilling will be performed using hydraulic drills rigs with 127mm diameter blast holes, and a 2.40m x 4.80m staged mesh. The explosives, blasting agents and blasting accessories will be supplied by a licensed explosive supplier, readily available in the Curaçá Valley as demonstrated by the Company's existing operations.

Ore and waste will be loaded by hydraulic backhoes with bucket capacities of 4.5 tonnes and transported from the open pit to the coarse ore stockpile using trucks with a capacity of 35 tonnes each.

Ore will be classified by grade in a near-mine stockpile then transported via dual-train haul trucks with a capacity of 70 tonne each to the Caraíba Mill for processing, as is currently performed at the Vermelhos UG Mine.

16.4.2 Mine Equipment

The current mining fleet to be used in support of planned mining activities at the peak of MCSA's open pit operations are listed in the table below. Given the synergy of Vermelhos District open pit mines (N8/N9 and Siriema), the total fleet shown represents the fleet requirements for the operation of all three open pit operations within the Vermelhos District.

As the main loading, haul, dump and blasting operations will be carried out by contractors, consistent with Company's prior open pit operations, the investment needed for equipment is limited to drill machines and operational support fleet.

Table 16-10: MCSA Open Pit Fleet

Equipment	Primary Function	Vermelhos District	Surubim/ C12	Suçuarana
Drill Machine	Primary Drilling	8	4	3
Backhoes	Loading	10	6	4
35-t Trucks	Transportation	35	20	15
70-t Trucks	Transportation	15	8	6
Bulldozer	Operational support	1	1	1
Water truck	Operational support	1	1	1
Fuel truck	Operational support	1	1	1
Total		**71**	**41**	**31**

16.5 GEOTECHNICAL CONSIDERATIONS

The geotechnical characterization of the MCSA Mining Complex continues to be based on the RMR classification system developed by Bieniawski (1989), which allows classifying the rock mass based on geotechnical quality. Main parameters of RMR include intact rock strength ("IS"), RQD, fracture spacing, fracture condition (persistence, roughness, filling and modification) and ground water.

Geotechnical conditions at Caraíba are divided into six geotechnical domains that correspond to six litho-domains; they are: Basalt, Gabbro, Gneiss, Granite, HDR, veins and faults (see table below). Based on geotechnical logging and lab tests results, most of the domains are classified under this system as 'good to very good' rocks, Fault zones, where locally encountered, are characterized as being 'poor.' In summary, the quality of the host rock at Caraíba is 'good to very good'. Locally, poor ground conditions are expected in the vicinity of faults and intersections with shear zones, as can be observed in practice within the mining operations.

The rock mass of the MCSA Mining Complex is classified as good geomechanical quality, composed of mostly competent rocks with a high resistance to uniaxial compression varying in average between 160 and 240 MPa. However, some extremely elastic characteristics of certain lithologies exhibit brittle failure, without deforming, breaking abruptly when reaching the limit of the resistance. The system of discontinuities provides the formation of blocks, wedges that must be properly identified and controlled with good practice during mining operations.

All the mineral deposits along Curaçá Valley have very similar geomechanical features containing more specific features as further described in this section. The table below presents the statistical analysis of values of Bieniawski´s basic RMR ("RMRB") and RQD distribution.

Table 16-11: RMRB Bieniawski values without adjustments

Lithology	Weighted parameters		Unweighted parameters		33% parameter value according to cumulative distribution	
	RMRB	RQD	RMRB	RQD	RMRB	RQD
Basalt	80.14	92.54	75.42	83.4	79	92.31
Gabbro	81.37	93.19	76.11	84.33	81	94.01
Gneiss	83.45	90.59	77.9	80.37	83	92.33
Granite	79.09	89.23	72.67	78.56	78	92.28
HDR	67.82	79.86	62.11	64.03	65	78.66
STR	68.07	84.04	67.6	82.06	67	75

16.5.1 Pilar District

PILAR UG MINE

Pilar District, located in the central part of the Curaçá Valley, is the best-known area from a geotechnical perspective as a result of accumulated data since mining activities commenced in the 1970s. The rock mass is predominantly classified as Class II and III, with some occurrence of Class IV in the mineralized areas. Five RMR groups identified in the rock mass have been mapped from the Pilar UG Mine separated by vertical structural planes – generally characterized by fault zones.

A fault zone previously identified in the geotechnical model (2016) continues to propagate to the Deepening Extension Zone area, as can be evidenced in the inspection of drill core. This propagation below level N-400 shows two different behaviors: a highly fractured fault on the west side and a slightly fractured fault on the east side (figure below). The east fault lies within hanging wall about 60 m away from the mineralized zone, which is different from the upper levels. Within the Deepening Extension Project, all planned mine development is within the footwall of the orebody, such that there is no anticipated intersection with the known extent of the east structure.

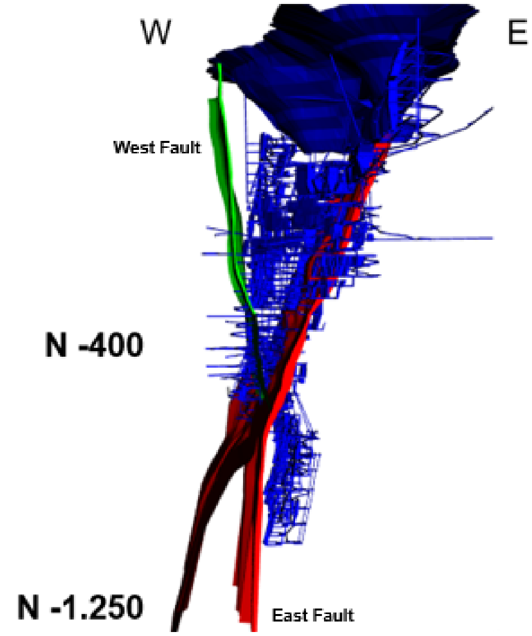


Figure 16-12: Pilar Mine 3D project showing the main faults (MCSA, 2020)

In support of the geotechnical design and geomechanical monitoring, MCSA incorporates a Micro-Seismic Monitoring System ("MMS") to map micro-seismic events within the Pilar UG Mine. MMS has been shown to accurately determine the location of natural and/or induced seismic events, their magnitude and as a tool to predict potential interference with mine operations (figure below). Induced seismic events occur during production blasting. The system consists of sensors installed throughout the mine which send signals to a database real-time. The geomechanical behavior of the rock mass is monitored by MCSA personnel in real-time using the installed MMS sensors.

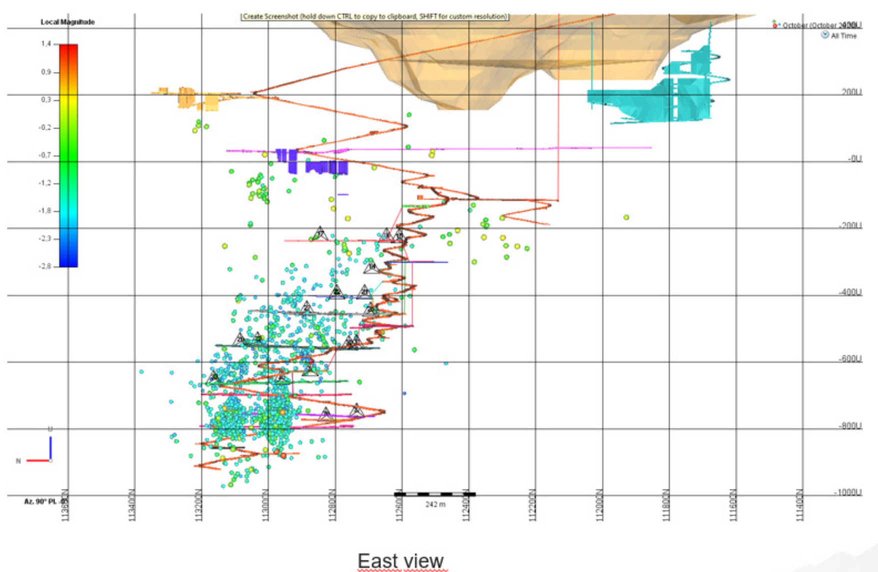


Figure 16-13: Seismic Monitoring System MCSA (MCSA, 2020)

Using existing geotechnical logging information, assessment of open stope stability was undertaken using the empirical method based on the Mining Rock Mass Rating ("MRMR"), (after Laubscher[2], 1990) and the Empirical Modified Stability Graph method (after Potvin et al., 1988). Several scenarios have been analyzed to evaluate the likely stability of hangingwall and stope backs in respect to stope inclination (65° to 90º), orebody thickness (5m to 30m), heights of stopes and rock mass classification for the proposed stope dimensions. Back dimensions were estimated using the MRMR system, and Potvin method was used to evaluate hangingwall and footwall stability.

The table below summarizes stope dimensions for each mining method. These dimensions are proposed for stopes in all sectors of the Pilar UG Mine.

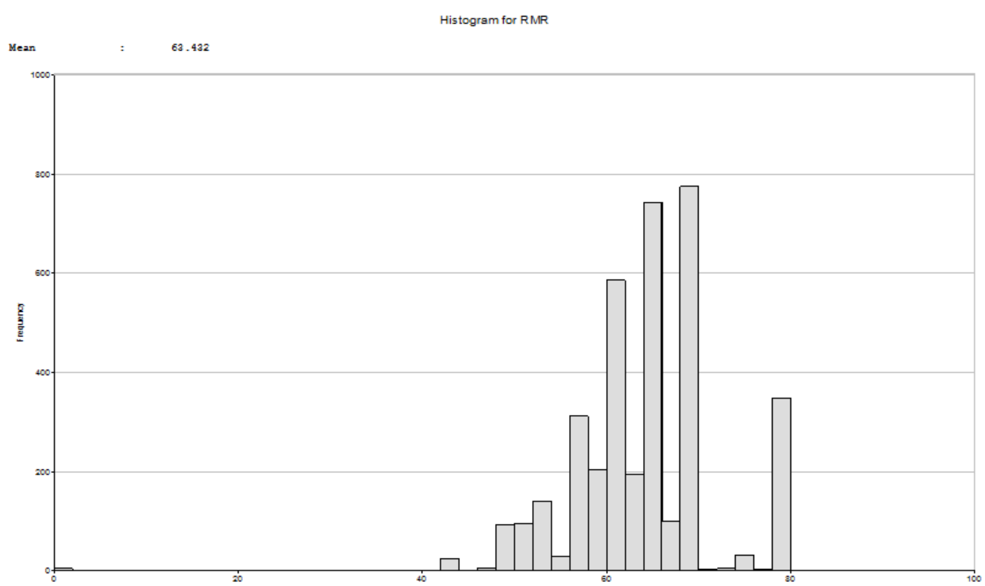
Table 16-12: Stope dimensions

Mining Method	Stope Width (m)	Stope Height (m)	Stope Length (m)
Transverse Stope	15	26	Orebody Width
Longitudinal Stope	<15	26	30

2 Laubscher, D.H., 1990, A Geomechanics classification system for the rating of rock mass in mine design.
3 Distance from bench to fill.

SUÇUARANA OP MINE

The rock mass of the Suçuarana OP Mine is mainly composed of Class II rocks, as shown in the RMR histogram and modeled evaluation of the safety factor observed in the historic open pit (figure below).



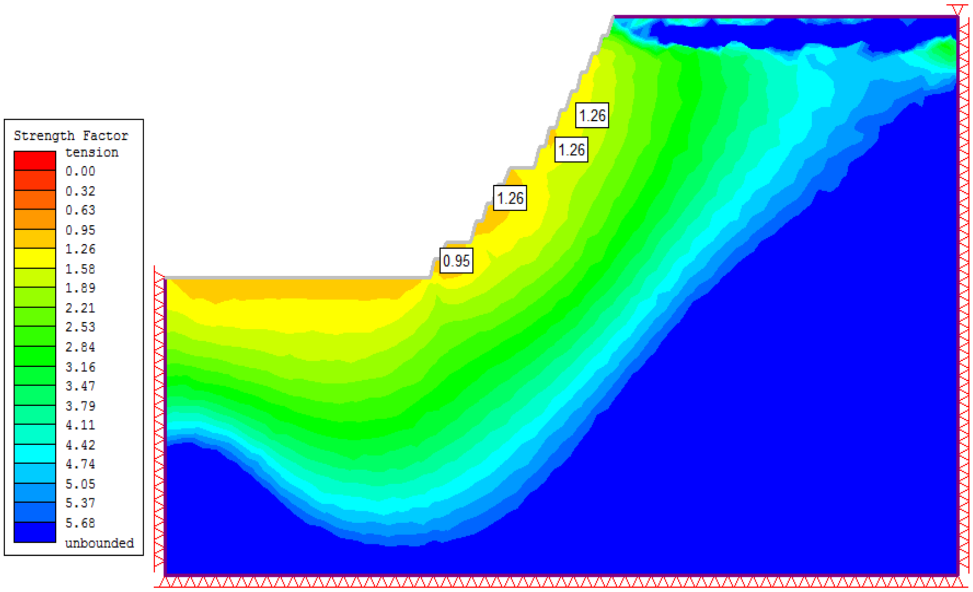


Figure 16-14: Histogram and safety factor for the Suçuarana OP Mine (MCSA, 2019)

Within the Suçuarana OP Mine, structural control occurs with discontinuities oriented preferentially N-S, however, there is a large family of discontinuities with a NW-SE orientation (figure below). The predominate fault and rock fabric orientations, identified in field mapping, were analyzed against design pit orientations to calculate planar and wedge failure possibilities for each expanded sector of the pit, the results of which were factored into the final open pit design for the current mineral reserve.

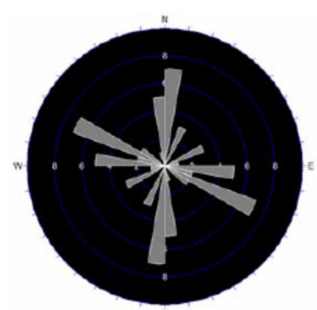


Figure 16-15: Discontinuities in Suçuarana OP Mine (MCSA, 2019)

16.5.2 Surubim District

<u>SURUBIM OP MINE</u>

With the resumption of operations at the Surubim OP Mine, the geotechnical engineering team at MCSA carried out further investigations (geotechnical inspections and structural mapping). These new surveys provided important information in terms of slope stability. The discontinuity families identified during field mapping were analyzed together with the slope guidelines and failure possibilities for each pit sector were developed for detailed mine design. Three main fault zones are located in the eastern and southern portion of the mine.

The quality of the rock mass of the Surubim OP Mine is considered, generally, medium to good, although areas of prior planer failures inside the pit are evident. The main structures found during field mapping indicate discontinuities from smooth to subvertical angles, a combination that provides instability in some sectors of the mine. The overall angle in the southern portion of the Surubim Mine expansion project, was established below 50º, due to the discontinuities in the sector, with benches of 4m and a bench angle reaching 65º. The design was based upon analysis of the quality of the mass, in the field mapping, operational experience, stereographic interpretations and analysis of numerical models.

The general safety factor of the slope in the original design was considered acceptable for mining, according to computational models, which assess breaks controlled by the mass's resistance. However, following additional analysis considering the influences of mapped discontinuity orientation, a conclusion was reached that the designed pit angles should intersect the main discontinuities obliquely to (ideally) perpendicular. A rotation in the design orientation of the benches approximately 30°, clockwise, was made so that the pit wall angle would intersect the primary fault planes obliquely, reducing the geotechnical risk of wall failure.

The pit was classified in three sectors for the definition of the geotechnical parameters, in order to ensure the stability of the mine according to the geotechnical studies carried out and prior mining activity.

- Sector 1 - west side;
- Sector 2 - east side; and,
- Sector 3 - above level 380 north and south.

In Sectors 1 and 2 - it is known that the west side is structurally more stable than the east side, which has a greater number of faults and fractures. This was observed in the quality of blasts carried out on the west side, during the most recent expansion of the pit.

In Sector 3 – above level 380, there is a predominance of friable material, including mud and soil, so the angles have been specified to ensure the stability of this friable material within this sector.

Below is an image of the pit detailing the design sectors.

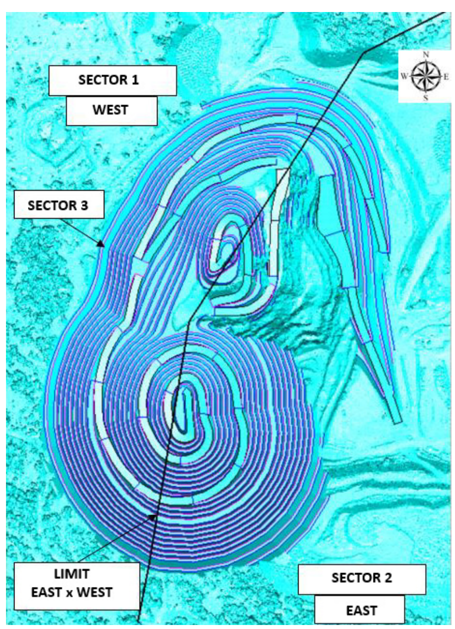


Figure 16-16: Geotechnical sectors of the Surubim OP (MCSA, 2020)

Below is the table with the geotechnical parameters of the pit design.

Table 16-13: Geotechnical parameters of the Surubim OP Mine design

Sector	Description	Overall Slope Angle (°)	Bench Face Angle (°)	Bench Height (m)	Berm Width (m)
1	West	55.0	70.0	10.0	3.4
2	East	52.5	70.0	10.0	4.0
3	Above 380 North & South	35.5	45.0	10.0	4.0

C12 OP MINE

The C12 OP Mine is located close to Surubim OP Mine and both lie within the same regional geological context. Due to their proximity, similar lithological types and geotechnical qualities (deformation styles and geological structures such as fault and foliations) were considered. Additional mapping on the surface of C12 highlights an intense fracturing pattern with predominant NE-SW and NW-SE directions as well as preferential NE-SW faults as shown in the figure below. The predominate fault and rock fabric orientations, identified in field mapping, were analyzed against design pit orientations to calculate planar and wedge failure possibilities for each expanded sector of the pit. The results of this analysis were captured in the final pit design of the current mineral reserve estimate.

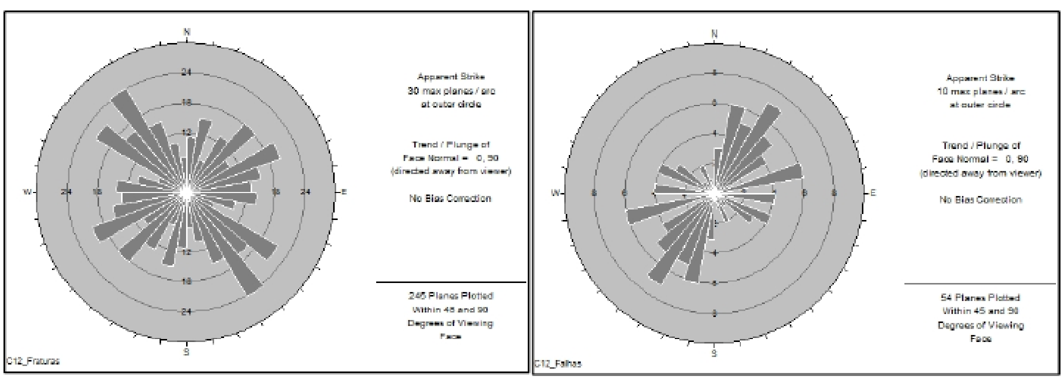


Figure 16-17: Fracture pattern with predominant NE-SW and NW-SE directions and faults preferably NE-SW (MCSA, 2020)

The structural complexity at C12 and Surubim OP Mine areas is notable, requiring special attention to each geotechnical parameter and ongoing studies to improve their geotechnical models. In light of preliminary analysis and based on experience with Surubim Mine and taking into account specific geotechnical parameters some considerations and recommendations for future pit designs, listed below, were incorporated into the final geotechnical design parameters, further detailed in the table below.

- As for the general angle, it is recommended, in order to avoid the mode of planar failure, reduce a maximum of 50°, on the eastern zones of the pit wall, due to a system of sub-vertical discontinuities with higher concentrations of poles in the NE, SE and NW orientations;
- Regarding the bench angle, it is recommended that the first two benches have a reduced slope, in both Surubim & C12 OP Mine, due to the presence of weathered rocks. On the west sector, an

overall slope angle of 55° should be used. On the east sector, due to the slope dipping in accordance with the weakness planes of the foliations, which dip predominantly to the west, an overall slope angle of 50° should be used;

- 10 m high benches;
- Berms width of 4m and 12m for the ramp. The parameters of the proposed project will be kept until the next studies and field monitoring indicate a different scenario, in which the teams should discuss suitable changes and improvements;
- Ramp slope of 13% ramp. The proposal to increase the 13% slope for 15%, in the last section of the ramp, in both pits, and the decrease in the width of 12m to 10m will be discussed after obtaining new information from future studies and follow-up;
- And finally, it is advisable to set the ramp entrances on the west side of the open pits, preferably in the NW quadrant, in order to avoid the greatest risks of instability.

Table 16-14: C12 OP Revised Geotechnical Parameters After Geotechnical Studies

C12 OP Mine Geotechnical Parameters		
Overall Slope Angle W	(°)	55.00
Overall Slope Angle E	(°)	50.00
Bench Face Angle W (2 initial benches)	(°)	55.00
Bench Face Angle E (2 initial benches)	(°)	50.00
Bench Face Angle (following 2 initial benches)	(°)	75.00
Bench Height	(m)	10.00
Berm E	(m)	4.00
Ramp Width	(m)	12.00
Ramp Slope	(%)	13.00

C12 UG MINE

Similar to the Surubim Mine, the C12 UG Mine design assumes the same rock mass behavior as the lower benches of Surubim, which can generally be characterized as having good quality rock mass. Additional design considerations were incorporated based on the dominant orientation of mapped joint-sets on surface at C12, and the design of the pit for the current mineral reserves considered the possibility of joint-sets creating planer or wedge failures. For the design of the stopes the same parameters used in Pilar UG Mine were adopted. Specifically: height of the stopes was assumed to be 35m, minimum distance between permanent developments and mining excavations of 30m and development sections were assumed to be similar to the Pilar UG and Vermelhos UG Mines.

16.5.3 **Vermelhos District**

VERMELHOS UG MINE

The quality of the rock mass was determined based on geotechnical drill logging and the resulting RMR geomechanical classification system by Bieniawski (1989). At Vermelhos, RMR values are typically above 60, indicating a rock mass of good quality that can be classified as Type II. Development and production activities to date, have confirmed the quality of the rock mass in underground mapping and production stopes.

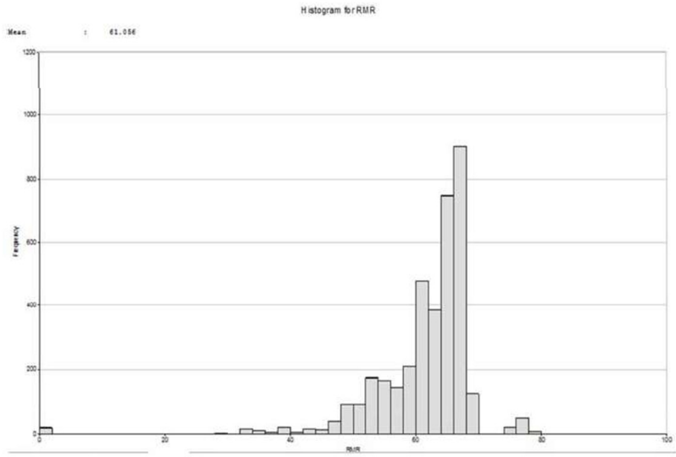


Figure 16-18: Vermelhos RMR histogram (MCSA, 2019)

Throughout the mine, geotechnical mapping is carried out to determine the main structural considerations of the mine. Structural control in Vermelhos indicates a dominant N-S orientation of major discontinuities related to lithology contacts of the mineralized zone and NE-SW fractures and faults. (Figure 16-19 and Figure 16-20).

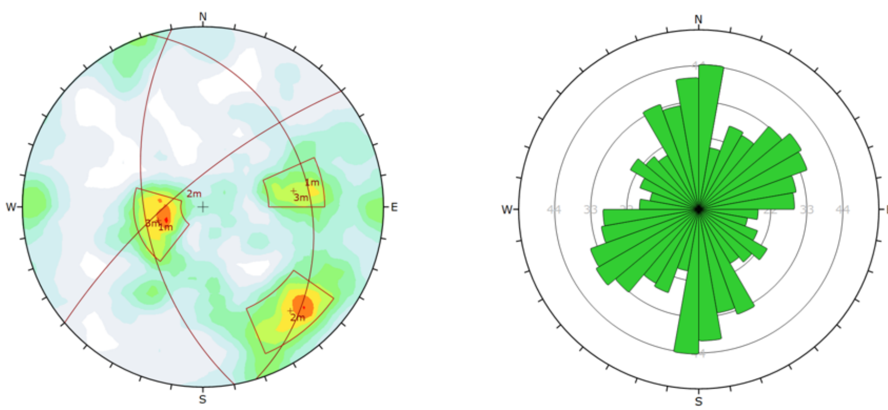


Figure 16-19: Main structures from Vermelhos Mapping (MCSA, 2019)

Figure 16-20: Structural mapping of Vermelhos Mine (red showing mapped discontinuities and green completed development) (MCSA, 2020)

In addition to underground mapping and ongoing geotechnical evaluation, the size of open stopes at Vermelhos relative to other mines of the Curaçá Valley, required additional evaluation using an empirical method for unsupported open stopes as proposed by Mawdesley (2004). The factors consider the classification of the rock mass value (Q'), observed state of fractures, structural orientation of predominant rock fabrics and the hydraulic radius of the openings. The study demonstrates a maximum stable hydraulic radius for stopes of 20.6m.

This work concluded that all excavations of temporary galleries, ramps and main permanent infrastructure must be positioned outside the area of influence of other excavations. This recommendation has been incorporated into the design of the current mineral reserves. Illustrative examples of these parameters are highlighted below:

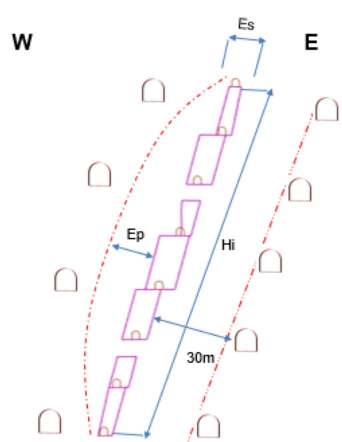


Figure 16-21: Interaction mines/permanent gallery UG3 (MCSA, 2020)

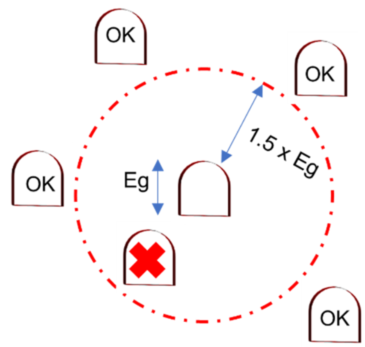


Figure 16-22: Gallery/permanent gallery interaction (MCSA, 2020)

The long-term geotechnical design parameters for the Vermelhos UG Mine are detailed below:

Table 16-15: Geotechnical Parameters for mining and development, Vermelhos UG Mine

Long-Term Geotechnical Parameters		
Vertical height between levels (m)	**UG 3**	**Vermelhos South**
	25	30
Maximum opening dimension (m)	**UG 3**	**Vermelhos South**
	60	90
Vertical height of Sill Pillar (m)	10	
Width of Rib Pillar (m)	**UG 3**	**Vermelhos South**
	15	10
Minimum distance between two parallel mines (m)	7	
Minimum distance between ramp and stope (m)	**HW**	**FW**
	35	30
Ramp Pilar - Raise (m)	15	
Pilar GT - Raise (m)	10	

N8/N9 OP & SIRIEMA OP MINES

The proximity of the N8/N9 and Siriema OP Mines to the Vermelhos UG Mine, and the observed similarities of the geomechanical parameters based on drill core logging, has demonstrated that the same parameters can be applied with a reasonable degree of confidence. The predominate fault and rock fabric orientations, identified in field mapping, were analyzed against design pit orientations to calculate planar and wedge failure possibilities for each expanded sector of the pit. The results of this analysis have been captured in the final design used for the current mineral reserve estimate.

Table 16-16: Geotechnical and technical parameters of the pit design N8/N9 OP & Siriema OP Mines

Geotechnical and Technical Parameters	Value
Overall Slope Angle	62°
Bench Face Angle	75°
Bench Height	15m
Berm Width	4m
Ramp Slope	13%
Ramp Width	12m

16.6 REGIONAL HYDROGEOLOGICAL CONSIDERATIONS

Annual rainfall within the Curaçá Valley is erratic and has a range of 100mm to 900mm. On average, total annual rainfall is less than 700mm. Most precipitation occurs during the rainy season, from December to March, in isolated high rainfall events associated with thunderstorm activity. The low rainfall, together with limited thickness of residual soils, indicates limited consideration for water pressures within the primary rock mass is required. This is supported by operational experience of the underground mining operations within the Curaçá Valley.

The Curaçá River which sits to the west of the municipality of Curaçá bordering Juazeiro, flows in the north direction. The drainage network of the Curaçá River is composed of rivers and streams that are all intermittent, with their flows oriented mainly to the north and northeast.

In the region there are two aquifers, a porous aquifer, represented by the deposits formed by the weathering of the rocks and / or alluvial deposits; and a fractured aquifer (deep), characterized by the presence of water in the discontinuities (faults and fractures), predominately within the compact gneiss rocks. The porous aquifer has primary (or granular) porosity, whereas the fractured aquifer is characterized by secondary porosity (or fracture) in which water circulates via rock faults or fractures.

Throughout the Curaçá Valley, where the weathering profile can be up to 25m in thickness, observed groundwater to date is present only in the fractured aquifer of the rock mass. The porous aquifer hosted locally within the shallow soils and alluvium has little relevance in understanding the local aquifer environment and is not relevant for mine design parameters.

According to studies and regional surveys in the Brazilian semi-arid region, there is a theory called "Riacho-Fenda", which, through analysis of well data, indicates that fractures filled with water do not exceed 170m of depth. The recharge of the fractured (and to a lesser extent porous) aquifers occurs during peak rain events, concentrated between the months of December to March. Recharge occurs within the alluvial cover and preferentially through fractures within the rock mass.

16.7 INTEGRATED PRODUCTION PLAN

The Vale do Curaçá's integrated LOM production plan is summarized in the Table 16-17. Additional notes associated with the LOM production plan include:

- Q4 2020 production outlines the mineral reserve schedule for the three months from the Effective Date to December 31, 2020;
- The difference between total tonnes processed in Table 16-17 and the current mineral reserve estimate as presented in Table 15-2 is due to:
  - Losses due to ore sorting operations (approximately 11.1 million tonnes grading 0.07% copper); and
  - The addition of stockpiled marginal material in 2031 to benefit from the spare capacity on the ore sorter and in the processing plant (1.98 million tonnes grading 0.22% copper). The

blend of this material with the N9 open pit material (1.19 million tonnes grading 0.60% copper) results in 3,18 million tonnes grading 0.36% copper for the year 2031.

- All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add up due to rounding.
- A 3.0% increase in forecast metallurgical recoveries has been applied in the LOM production plan commencing 2021, as a result of the recently commissioned HIG Mill.
- LOM plan operating and capital costs totals are based on mineral reserves and do not include the Deepening Inferred Project. Please see Chapter 24 for additional details.

Table 16-17: LOM production plan

	Q4 2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Underground Operations														
Pilar UG Mine, Ex-Deepening														
Tonnes Mined (000s)	233	945	1,146	1,232	1,010	644	749	1,100	778	851	875	-	-	-
Grade Mined (% Cu)	1.24%	1.09%	1.12%	1.26%	1.14%	1.06%	1.09%	0.94%	1.05%	0.97%	0.98%	-	-	-
Pilar UG Mine, Deepening (below -965)														
Tonnes Mined (000s)	-	-	6	184	650	979	1,007	939	946	555	244	397	664	757
Grade Mined (% Cu)	-	-	0.61%	0.98%	1.46%	1.29%	1.54%	1.47%	1.75%	2.11%	1.48%	1.85%	1.98%	2.42%
Pilar UG Mine, Deepening (above -965)														
Tonnes Mined (000s)	131	556	540	680	564	693	575	9	194	55	-	-	-	-
Grade Mined (% Cu)	2.17%	2.03%	2.17%	1.27%	1.75%	1.53%	1.07%	0.93%	0.83%	0.74%	-	-	-	-
Vermelhos UG Mine														
Tonnes Mined (000s)	184	839	851	882	813	876	700	-	-	-	-	-	-	-
Grade Mined (% Cu)	2.42%	2.48%	2.17%	1.88%	1.38%	1.35%	1.03%	-	-	-	-	-	-	-
Surubim UG Mine														
Tonnes Mined (000s)	-	-	-	-	-	-	-	8	184	206	630	-	-	-
Grade Mined (% Cu)	-	-	-	-	-	-	-	0.83%	0.98%	0.99%	0.95%	-	-	-
Open Pit Operations														
Vermelhos District, Open Pit (ex-Ore Sorting)														
Tonnes Mined (000s)	-	-	390	-	-	-	-	-	-	-	-	-	-	-
Grade Mined (% Cu)	-	-	0.54%	-	-	-	-	-	-	-	-	-	-	-
Surubim District, Open Pit														
Tonnes Mined (000s)	-	240	353	522	627	428	418	314	-	-	-	-	-	-
Grade Mined (% Cu)	-	0.63%	0.64%	0.65%	0.75%	0.89%	1.19%	0.89%	-	-	-	-	-	-
Ore Sorting Operations														
Vermelhos District, Open Pit														
Tonnes Crushed & Sorted (000s)	-	-	-	635	840	1,140	1,755	2,681	4,046	3,777	1,920	3,175	-	-
Grade Crushed & Sorted (% Cu)	-	-	-	0.62%	0.74%	0.55%	0.66%	0.74%	0.59%	0.52%	0.52%	0.36%	-	-
Sort Product, Vermelhos District														
Sorted Tonnes to Mill (000s)	-	-	-	302	399	542	834	1,273	1,922	1,794	912	914	-	-
Sorted Grade to Mill (% Cu)	-	-	-	1.23%	1.47%	1.09%	1.31%	1.47%	1.17%	1.02%	1.03%	1.03%	-	-
Production Plan														
Tonnes Mined & Processed (000s)	482	2,722	3,196	3,686	4,162	4,129	4,007	3,940	3,959	3,555	2,808	1,311	664	757
Grade Mined & Processed (% Cu)	2.07%	1.70%	1.46%	1.34%	1.29%	1.23%	1.26%	1.22%	1.27%	1.17%	1.04%	1.28%	1.98%	2.42%
Recoveries (%)	92.5%	92.8%	92.0%	91.5%	91.3%	91.1%	91.2%	91.0%	91.2%	90.8%	90.2%	91.3%	93.5%	94.5%
Copper in Concentrate (000 tonnes)	**9.2**	**43.0**	**42.9**	**45.1**	**48.9**	**46.3**	**46.2**	**43.9**	**46.0**	**37.8**	**26.3**	**15.3**	**12.3**	**17.3**

*Q4 2020 outlines the mineral reserve schedule for the three months from the Effective Date to December 31, 2020. All figures have been rounded to reflect the accuracy of the estimates. Summed amounts may not add due to rounding. LOM plan totals are based on mineral reserves and do not include the Deepening Inferred project. Please refer to Chapter 24 for additional details.

17 RECOVERY METHODS

17.1 CARAÍBA MILL FLOWSHEET AND PROCESS DESCRIPTION

The Caraíba Mill was designed and built by Milder Kaiser, a Canadian engineering, design and construction company. Processing operations commenced in 1979 and the plant has since had the benefit of decades of process optimization work performed by the Caraíba's process engineering team with the support of third-party consultants as needed. The concentrator is operated 24 hours per day, seven days per week with monthly scheduled downtime to perform routine maintenance. In its current configuration, the plant has capacity to treat a nominal 3.2 million tonnes of copper bearing ore per annum, assuming 91% total availability.

The Caraíba concentrator plant is composed of a three-stage crushing, two-stage milling and flotation design. Three-stage crushing is used to prepare a nominal 12.5mm top size crushed feed for the ball milling circuit that also feeds the regrind mill circuit prior to being sent to flotation for the recovery of copper-bearing minerals. Final flotation concentrate is filtered to a design target of 7.5% moisture and is transported via highway for smelting and refining either (i) locally at Paranapanema company, located in Dias D'Ávila, or (ii) sold via international export markets from Salvador's port, both approximately 475km from the Caraíba Mill.

Installed equipment of the Caraíba Mill are detailed in Table 17-3. A process flowsheet showing major unit operations is further detailed in Appendix C to the Report.

17.2 CRUSHING

There are two primary crushing operations. Ore from other mining sites is delivered to the surface primary gyro crusher, featuring a nominal capacity of 1,600t/h. Ore from underground mining is crushed underground by one of two primary jaw crushers with a nominal capacity of 400t/h each. Feed enters the primary crushing operations with maximum size of 48" and is discharged with maximum size of 10".

The blended product of the primary crushing operations is transported via conveyors to a feeder stockpile with a capacity of 12,000 tonnes. The stockpile feeds two primary double deck screens, configured with 100mm aperture on the top and 40mm aperture on the bottom decks. The material over 40mm feeds one of two secondary cone crushers (seven-feet ("ft.") standard Symons; 1,400t/h of capacity each) set to 28mm aperture. Screen undersize and secondary crushers products discharge onto one conveyor in an open circuit configuration.

Secondary cone crusher discharge and primary screen fines are blended with tertiary crusher discharge and are conveyed to the seven secondary double screen decks, configured with 25mm aperture on the top and 16mm aperture on the bottom decks. Tertiary crushing is performed with four standard CH660 Sandvik cone crushers (capacity of 350t/h each) set to 20mm aperture. Oversize material passes to the tertiary crushers operating in a closed-circuit configuration. Final product from the combined crushing and screening operations is 88% passing 1/2".

17.3 ORE BLENDING

Crushed ore is conveyed to the stacker-reclaimer system to further homogenize the ore for feeding the plant. The stacker-reclaimer system is comprised of a two-armed stacker and a 16 bucket-wheel reclaimer with capacities of 1,600t/h and 1,200t/h, respectively. Crushed ore capacity of the stacker-reclaim system is currently 140,000 tonnes.

17.4 GRINDING

The grinding circuit consists of two identical lines operating with a primary ball mill operating in closed circuit with a dedicated battery of 26" hydro-cyclones. Each ball mill is 5.0 m by 7.6 m, charged with 90 mm in diameter high chrome cast steel balls. The nominal grinding capacity of each mill is 200 t/h each. Typical ball consumption is 340 g/t.

Blended ore from the stacker reclaimer is withdrawn through belt feeders below one of the 3,000 tonne ore silos that are interconnected. Ore is delivered to the ball mill over a belt weightometer to control and measure the mass of ore sent to each mill for metallurgical accounting purposes.

The coarse fraction from the cyclone underflow recycles to the ball mill feed chute for further grinding. Overflow from both grinding lines combines as feed to the high frequency screeners and regrinding circuit.

17.5 HIGH FREQUENCY SCREENS AND REGRINDING CIRCUIT

The cyclone oversize is pumped to high frequency screening operations comprised of eight screens with five decks each of 105+ micron aperture. The high frequency screening coarse fraction is gravity fed to the vertical mill (STM HIG Mill HIG2300/23000) for regrinding, operating in an open circuit. The HIG Mill was commission in September 2020. The screening operation fines combine with the regrind mill product and are pumped to the flotation.

17.6 FLOTATION AND DEWATERING

The flotation circuit at Caraíba consists of a conventional rougher-cleaner-scavenger flotation process. The rougher circuit consists of three rougher banks divided into two stages of flotation with four cells in each unit operation. The first four cells of each bank produce a rougher concentrate that passes to the four cleaner cells. In practice, the concentrate of second rougher stage is returned to the head of the circuit to increase total rougher mass pull and retention time. Rougher concentrate is fed to the cleaner circuit and rougher tails are fed to the rougher scavenger circuit.

Rougher concentrate, combined with recleaner circuit tails and cleaner-scavenger concentrate, is sent to the cleaning circuit which consists of four cell banks. Each bank contains one recleaner cell, three cleaner cells and four cleaner-scavenger cells. Operated in a continuous process, the recleaner cell concentrate becomes the final product grading approximately 35% copper with minimal impurity elements. Notably, in 2019, all concentrate assays fell below detection limits of 100 ppm for Arsenic. By-product gold and silver averaged 2.3 g/t and 28.8 g/t, respectively. An assay of copper concentrate, performed on concentrate shipment from 2019 resulted in the following composition:

Table 17-1: Recent Copper Concentrate Assay (MCSA, 2020)

Cu	S	Fe	SiO_2	MgO	Al_2O_3	CaO	TiO_2	K_2O	Ni	Cr_2O_3	Zn	MnO	P_2O_5	V_2O_5	CoO	Others
35.09	22.97	20.08	11.36	3.92	2.08	0.87	0.03	0.15	0.36	0.09	0.03	0.01	0.02	0.004	0.02	2.92

Note: All elements determined using ICP-MS, except Cu (Volumetric technique). Recent assay results provided are illustrative for reference only and not intended to be representative of total concentrate production.

The startup of the Vermelhos mine has slightly changed the tenors of the concentrate. The composition of the Company's concentrate can be characterized in the table below:

Table 17-2: Concentrate Production Blend with Vermelhos Mine, 2019

Oxides / Elements	Tenor
Cu	35.09%
MgO	3.92%
SiO_2	11.36%
Al_2O_3	2.08%
CaO	0.87%
Fe	20.08%
S	22.97%
Ni	0.36%
Na	0.23%
Au	2.68g/t
Ag	48.92g/t
Cr	857ppm
Co	180ppm
Pb	60ppm
Zn	287ppm
Cd	<10ppm
Bi	33ppm
Sb	<30ppm
Mo	<20ppm
As	<30ppm
Se	270ppm
Te	191ppm
Cl	46ppm
V	41ppm

Note: All elements determined using ICP-MS, except Cu (Volumetric technique). Recent assay results provided are illustrative for reference only and not intended to be representative of total concentrate production

The scavenger concentrate from the cleaner-scavenger cells is recycled back to the cleaner circuit. Tailings from the cleaner-scavenger cells are recycled to the rougher circuit.

Throughout the flotation circuit samples of new feed, final concentrate, rougher tailings and final tailings are sampled by an automatic sampling devices. A fraction of the slurry is sent to an online XRF analyzer to determine the copper grades. The balance of each sample is accumulated during the duration of each operating shift for further laboratory assay and analysis performed by MCSA's laboratory and process engineering teams.

The final copper flotation concentrate is sent to one of two thickeners for dewatering prior to the filter press. Both concentrate thickeners are 24m in diameter and configured such that one is operating and one is on standby or undergoing routine maintenance. Overflow from the concentrate thickeners is recycled for plant process water. The thickener underflow is transferred to holding tanks that feed the filter press.

The thickened concentrate is filtered by a Diemme (GHT1500) plate filter press configured with 49 plates, producing a final dry concentrate of 7% to 8% moisture. Dry concentrate is stored in the Caraíba concentrate shed until it is loaded, weighed and transported via highway to local or international markets.

Final tailings from flotation operations are pumped to one of two tailings thickeners for dewatering. Both thickeners are 90m in diameter and configured such that one is operating and the other is on standby or undergoing routine maintenance. Water from the thickeners is recycled for plant process water. The thickened tails are pumped to the waste stockpiles for co-disposal and a fraction of the tailings to the paste fill plant for backfilling operations.

Table 17-3: Installed Equipment of the Caraíba Mill

Equipment	Size / Model	Qty
Primary gyro crusher	1.4m by 1.9m	1
Primary Screen	2.4m by 6.1m	2
Secondary crusher	7 ft	2
Secondary Screen	2.4m by 6.1m	7, each with 2 decks
Tertiary crusher	CH660	4
Stacker	1,600t/h	1
Reclaimer	1,200t/h	1
Ore bin	3,000t	2
Belt Feeders	various	20
Weightometers	2,5t; 0,5t	1;3
Ball mill	5.0m by 7.6m	2
Cyclone battery	6x 26"	2
Regrind mill	HIG2300/23000	1
Rougher cells	14.2m^3	24
Rougher-Scavenger cells	14.2m^3	24
Cleaner cells	8.5m^3	12
Scavenger cleaner cells	8.5m^3	16
Recleaner cells	8.5m^3	4
High frequency screens	1.0m by 1.5m	8, each with 5 decks
Tailing thickener	90.0m	2
Concentrate thickener	24m	2
Press filter	186.0m^2	1
Flash Float Cell	18.0m^3	1

17.7 LOADING AND TRANSPORTATION OF CONCENTRATE FOR SALE

The Caraíba Mill's primary concentrate shed, located adjacent to the filter press, has storage capacity for approximately 8,000 tonnes of final concentrate. The building has a concrete floor, steel siding and dimensions of 50m in length, 36m in width and an average height of 11m (peak height of 13m). A secondary, uncovered cemented floor storage area adjacent to the primary shed has capacity for an additional 6,000 tonnes of final concentrate (covered with canvas tarps). The dimensions of the uncovered storage area are 60m by 36m.

Figure 17-1: Exterior and Interior of the Primary Concentrate Shed at the Caraíba Mill (MCSA, 2020)

MCSA ships final concentrate for sale to both the domestic market, via the Paranapanema Smelter located in Dias D'Ávila, Bahia State, and to international markets via Salvador´s port located in Salvador city, Bahia State. All concentrate is transported by road using standard highway trucks loaded with 32 tonnes of concentrate.

Trucks are loaded to specified weight using a loader configured with a scale-coupled bucket. After loading, the truck is directed to MCSA's 100 tonne truck scale (+/- 10 kg), which is calibrated annually and certified by National Institute for Metrology, Quality and Technology (Inmetro). After final weight is recorded, the trucks are sampled for final assay. The samples obtained are hermetically packaged for moisture determination and copper and nickel. Analyses of final concentrates are performed by MCSA's laboratory. The invoice is issued for transport of concentrate and shipped to Paranapanema or Salvador´s port.

17.7.1 Concentrate Shipment for Export Market

After site weight and sampling, concentrate trucks leave the MCSA Mining Complex via state highways number BA314, traveling 54km to BR407 that goes to the town of Capim Grosso, then follow on federal highway number BR324 to Salvador City and the city's port, the second largest in Brazil's northeast. The total route is approximately 472.7km from the concentrate shed. Caraíba also has the option of exporting the concentrate via the other Salvador's port (Aratu) or the Aracaju port (TMIB).

On delivery, the concentrate is discharged into a secure warehouse contracted. Containers are loaded with bobcats. During loading, samples are taken from each loaded bucket for moisture and metal assay. Assay results are composited to determine final metal and moisture content.

Figure 17-2: Salvador's Port, where Caraíba Concentrate Departs for International Markets (MCSA, 2017)

17.7.2 Delivery of Concentrate for Domestic Market

After site weight and sampling, concentrate trucks leave the MCSA Mining Complex via state highway BA314, traveling 54km to BR407 that goes to the town of Capim Grosso, then federal highways BR324 and BA512 to Dias D'Ávila town and the Paranapanema Smelter. The total route is approximately 475.2km from the concentrate shed.

The copper concentrate delivered at Paranapanema is weighed to determine the final weight, unloaded and then transported via conveyor to the smelting facilities. Conveyor samples are taken during unloading for moisture and metal assay. Assay results are composited to determine final metal and moisture content.

17.8 CARAÍBA MILL PERFORMANCE

Through the end of 2019, the Caraíba Mill has produced a total of 3,231 million tonnes of concentrate containing 1,095 million tonnes of copper.

Summarized processing results of concentrate flotation operations between 1998 and 2019 are provided in Table 17-4.

Table 17-4: Caraíba Mill Processing Results, 1998 to 2018

	Caraíba Mill Feed		Copper Production	
Year	**Tonnes**	**Grade (% Cu)**	**Tonnes**	**Recovery (%)**
1998	2,665,700	1.49	34,325	89.6
1999	1,248,720	2.88	31,371	90.9
2000	1,173,452	3.11	31,786	89.0
2001	1,185,834	2.92	30,111	89.4
2002	1,195,136	2.97	30,642	88.7
2003	1,109,396	2.87	27,237	88.0
2004	1,557,261	1.93	25,748	88.1
2005	2,553,803	1.11	23,991	86.9
2006	3,093,042	0.99	22,720	82.0
2007	2,882,542	1.00	25,191	81.3
2008	3,340,765	0.80	22,911	85.3
2009	2,932,262	0.97	25,873	85.4
2010	2,044,002	1.32	23,313	86.4
2011	2,749,812	1.09	25,096	83.7
2012	2,717,980	1.07	24,827	85.4
2013	2,940,566	0.91	22,494	84.3
2014	3,014,269	1.01	25,717	84.7
2015	2,836,528	1.11	27,046	86.0
2016	826,759	0.71	4,895	83.5
2017	1,771,209	1.31	20,133	86.8
2018	2,257,917	1.56	30,426	86.3
2019	2,424,592	1.93	42,318	90.5

Table 17-5: January 2019 to September 2020 Processing Results

	Caraíba Mill Feed		Copper Production	
Year	**Tonnes**	**Grade (%Cu)**	**Tonnes**	**Recovery (%)**
2020 (Jan-Sep)	1,788,178	2.03	32,796	90.2

The reagent scheme utilized by the Caraíba Mill is determined by MCSA's process engineering team for each source of ore and verified through daily metallurgical composite bench testing as well as online process monitoring via an online XRF unit. The typical dosage of reagents for the copper circuit flotation is provided below in the table below.

Table 17-6: Typical Caraíba Mill Process Reagent Dosages

Reagent	Collector	Frother	Depressor	Lime	Flocculent
(g/t processed)	55.32	22.0	50.0	390	1.00

Power for the Caraíba Mill is supplied from CHESF. Average power consumption, for total Caraíba Mill operations is currently 29kWh/t to 31 kWh/t of ore processed. Water usage averages approximately 3.0 m3 per tonne of ore processed, of which 70% (approximately 2.1m3/t) is obtained from recycled process water. When including all water sources, including surface run-off water collection, recycled water represents approximately 90% of water usage.

Total forecast power and water usage (including recycled process water) are 31kWh and 3.0m3 per tonne of ore processed, respectively. These projections are in line with current and prior plant performance.

17.9 CARAÍBA MILL OPTIMIZATION & 4.2MTPA EXPANSION

A multi-phased and discretionary plan has been set forth to increase the mill capacity to 4.2Mtpa from current levels in support of the LOM plan. The authors of this report have not identified any metallurgical, infrastructure, permitting, legal, political, environmental, title, taxation, socio-economic, marketing or other relevant factors that could materially affect the potential development of the stated Mineral Reserves.

17.9.1 Current Operations (3.2Mtpa)

Depending on availability of mill feed, the Caraíba Mill operates at a maximum rated tonnage of approximately 9,600 tonnes per day, or approximately 3.2Mtpa. A number of optimization projects are ongoing related to both improving metallurgical recoveries and providing the foundation for continued mill expansion. Those projects are:

- Installation of a single, variable speed drive, HIG Mill (23000F/2300) scheduled to finish last commissioning phase by the first quarter of 2021 in order to improve copper recoveries through increased particle liberation (see Section 13.2 for additional information). Recovery increase already can be verified in the actual commissioning phase but will only became stable on the last phase.

- Installation of an expanded Carboxymethylcellulose ("CMC") circuit to increase the actual dosage from 200 g/t to 500 g/t dosage capability scheduled to be completed and commissioned during the first quarter of 2021 in order to suppress hydrophobic materials in the mill feed (primarily talc).

An apparent ancillary benefit of the selected HIG Mill configuration is that, based on HIG Mill grinding testwork, the installed power exceeds the required power to achieve the target grind size. Simulated plant models (JKSimMet software) post-installation of the selected HIG Mill show that there is sufficient power to achieve a maximum throughput rate of approximately 3.7Mtpa without sacrificing target grind. A simplified existing flowsheet, including the HIG Mill installation, is shown in the figure below.

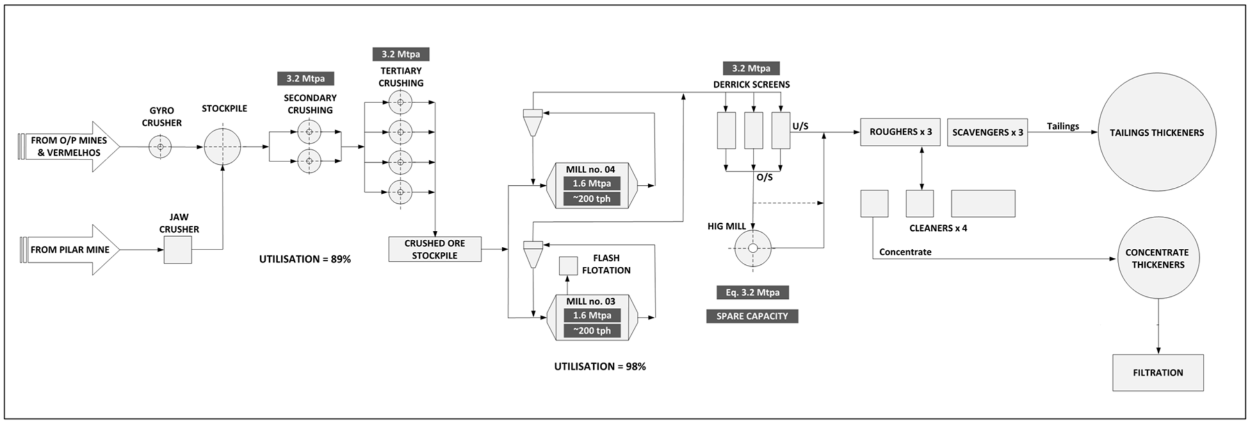


Figure 17-3: Simplified Process Flow-Sheet (MCSA, 2020)

17.9.2 HIG Mill Expansion (3.7Mtpa)

The commissioning of the HIG Mill, currently underway and expected to finish by the first quarter of 2021, provides increased milling throughput capability of up to 3.7Mtpa based on simulated plant performance. As a result of increased mill feed rates, hydrocylone overflow from the ball-milling circuit would coarsen necessitating an upgrade of the high-frequency screens currently in place with possible necessity of added units (Currently being studied). A simplified process flowsheet highlighting new equipment and upgrade requirements is shown in the figure below.

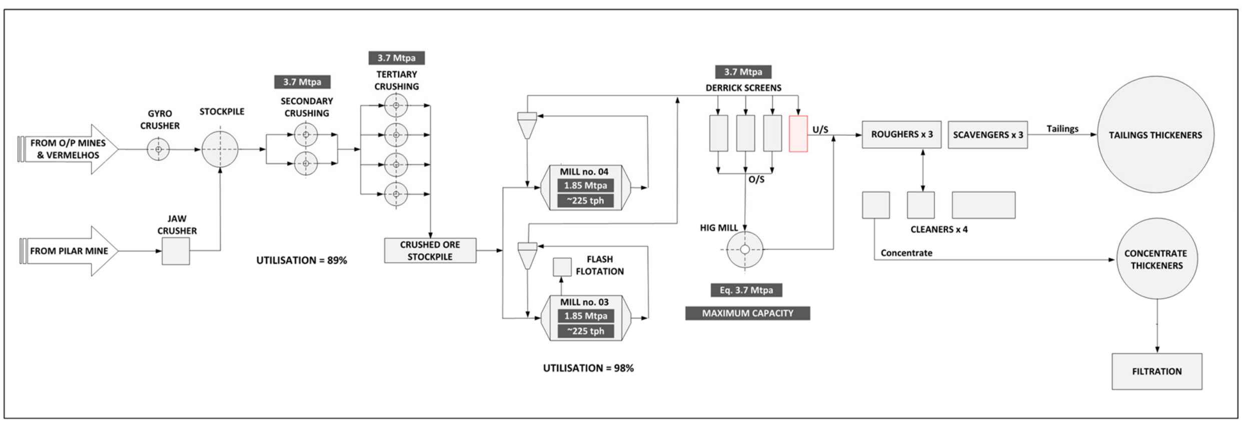


Figure 17-4: Simplified Process Flowsheet, 3.7Mtpa (MCSA, 2020)

17.9.3 High Pressure Grinding Roll Installation (4.2Mtpa)

The expansion to increase capacity to 4.2Mtpa of annual mill throughput requires the installation of quaternary crushing, additional increase in screening capacity, upgrades to the flotation circuit to ensure residence time is not impacted, and an increase in concentrate filtration capacity. While there are a number of options available for quaternary crushing, the characteristics of the Caraíba ore make it amenable to High Pressure Grinding Roll ("HPGR") crushing. Additional laboratory testwork is planned to confirm the HPGR sizing and design route and has been included in the capital cost estimates. A simplified process flowsheet highlighting new equipment and upgrade requirements is shown in the figure below.

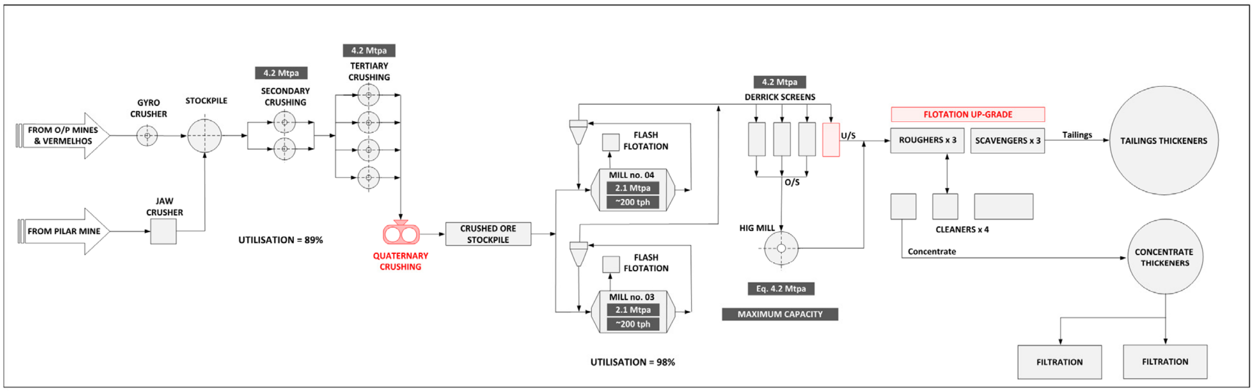


Figure 17-5: Simplified Process Flowsheet, 4.2Mtpa (MCSA, 2019)

Table 17-7: Modeled Plant Phase Input Data

Circuit Input Data	units	3.2 Mtpa	3.7 Mtpa	4.2 Mtpa
Throughput - Primary crusher	t/h	781	781	781
Throughput – Grinding	t/h	401	464	527
Circuit Configuration	-	3CB	3CB	3C-HPGRB
Cyclone overflow P80	micron	8	8	18
Specific Energy				
Secondary Crush Specific Energy	kWh/t	0.5	0.5	0.5
Tertiary Crushing Specific Energy	kWh/t	0.9	0.9	0.3
HPGR Specific Energy	kWh/t	-	-	1.5
Ball Mill Specific Energy	kWh/t	14.9	13	11.4
Total Primary Circuit Specific Energy	kWh/t	16.3	14.4	13.7
Tertiary Crushing Design				
New Feed	t/h	781	781	781
Product size P80	Mm	8	8	18
Number of Tertiary crushers		4	4	4
Tertiary crusher type		CH660	CH660	CH660
HPGR Design				
% recycle	%	-	-	100
Specific energy (total feed)	kWh/t	-	-	1.50
Roll Diameter	m	-	-	2.0
Roll Width	m	-	-	1.50
Total HPGR circuit feed rate	t/h	-	-	1,193
Nominal pinion power draw	kW	-	-	1,789
HPGR Unit Selected Power	MW	-	-	2.3
Grinding Circuit Design				
Grinding circuit throughput	t/h	401	464	527
Feed Size	F80 mm	8	8	3.7
Product Size	P80 µm	175	230	185
Ball Mills				
Number of ball mills		2	2	2
Mill motor installed size	kW	3,000	3,000	3,000
Fine Grinding Mill				
Mill Feed	t/h	127	253	184
Number of mills		1	1	1
Mill type		HIG Mill	HIG Mill	HIG Mill
Mill motor installed size	kW	2,300	2,300	2,300
Required pinion power	kW	945	2,266	1,412
Required Specific Energy	kWh/t	7.5	8.42	7.7
Target Grind Size (P_{80})	micron	74	74	74
Milling Specific Energy				
HIG Mill	kWh/t	2.4	4.9	2.7
Milling Operations	kWh/t	18.7	19.3	16.4

17.10 SX/EW PLANT

The SX/EW operations at the Caraíba Mine operated from 2007 until 2014, processing a total of approximately 5.9 million tonnes of oxide ore from open pit operations throughout the Curaçá Valley. Processing operations consisted of crushing, agglomeration / pre-treatment, heap leaching, solvent extraction ("SX") and electrowinning ("EW") producing a copper cathode. The EW unit operation has a maximum installed capacity of 430t of copper cathode per month.

In practice, crushed oxide ore was pre-treated with 98% sulphuric acid and water to agglomerate the material prior to placement on one of 22 heaps used for leaching. Each heap had approximate dimensions of 130m by 12m. Design heap height was initially 4m, but later reduced to 2m in practice. Leaching was performed over a period of 45 to 60 days, producing a pregnant leach solution ("PLS") of 5-7 grams per liter ("g/l") of copper in solution prior to SX/EW unit operations. Recovery of copper from PLS averaged 96%, with global metallurgical recoveries of 70.5%. Historic operating data from the SXEW operations is shown in the table below.

At the time of the Effective Date, there is no copper cathode production included in the production plan, economic projections, nor have oxide Mineral Resources been defined in sufficient quantities to incorporate economic projections.

Table 17-8: Historic SX/EW Plant Performance

	Oxide Ore Treated		Cu Cathode Production		Acid Consumption	
Year	**Tonnes**	**Grade (% Cu)**	**Tonnes**	**Recovery (%)**	**(kg / tonne Ore)**	**(kg / kg Cu)**
2007	117,533	0.72	913.0	60.0	28.0	3.6
2008	758,456	0.77	3,807.8	68.6	38.0	7.6
2009	891,934	0.73	4,398.0	74.9	35.7	7.2
2010	895,145	0.66	4,496.8	75.6	34.4	6.9
2011	943,580	0.68	4,549.8	77.4	30.6	6.3
2012	982,055	0.62	4,374.3	76.9	34.2	7.7
2013	1,077,577	0.57	3,999.2	71.2	36.3	9.8
2014	214,946	0.41	685.3	62.4	35.9	11.3
Total	**5,881,231**	**0.66**	**27,224.2**	**70.5**	**34.7**	**7.5**

18 PROJECT INFRASTRUCTURE

18.1 GENERAL INFRASTRUCTURE

The MCSA Mining Complex consists of fully-integrated mining, processing facilities and supporting infrastructure. The complex has been in near-continuous operation since 1979. In recent years, and in particular following the acquisition of MCSA, several improvement and modernization campaigns have occurred. An overview of the processing facilities and supporting infrastructure is shown in the figure below. Infrastructure maps of the Curaçá Valley, Caraíba Mine, Vermelhos UG Mine, the Surubim Mine, The C12 Mine, the N8/N9 OP Mine and the Siriema OP Mine are further detailed in Appendix D to the Report.

Figure 18-1: Primary Caraíba Mine Infrastructure and Site Layout (MCSA, 2017)

18.2 PROCESS AND MINE WATER SUPPLY

Water is supplied to the mine via an 86 km permanent steel pipeline (measuring 80 cm in diameter) from the São Francisco River. The primary pumping and water intake system is located 6.5 km upstream of Juazeiro city, in Bahia State. Flow rates of the river are controlled by the Sobradinho Hydroelectric Power Dam, located upstream of the primary pumping and water intake system. The available capacity of MCSA's water source has assured the constant delivery of fresh water for MCSA's mining and processing needs. The reservoir created by the Sobradinho Dam is reported to be the 12th largest man-made reservoir on earth.

Supported by three pumping stations, the maximum capacity of the freshwater intake system is 3,240 m^3/h, equivalent to approximately 2,000,000 $m^3/month$ at 21 hours of operation per day. Current pumped volume of water is approximately 2,287 m^3/h, equivalent to approximately 1,234,980 $m^3/month$ with only 17 hours of operation per day.

MCSA uses only 20% of the total pumped volume of the pipeline. As operator of the pipeline, MCSA provides water to the region's municipalities of Massaroca City, Abobora City and Umburnas City as well as local farmers located along the pipeline.

18.3 SITE POWER

Energy is supplied to the MCSA Mining Complex by CHESF via an overhead transmission line from the Sobradinho Hydroelectric Power Dam at 230kV. MCSA has a long-term contract with CHESF and the provision of power for the operations is not a relevant risk to the current or future development plans of the Company.

Power from CHESF is fed to the primary substation at Caraíba, which is comprised of two transformers configured with 60MVA/230kV/13.8kV that serve to distribute power to the Caraíba Mine, Caraíba Mill, processing support facilities and administration offices. The figure below shows the primary power substation on the property which was installed and commissioned in 1978.

Mine

Figure 18-2: Main Electrical Substation at the Caraíba Mill (MCSA, 2019)

Currently, MCSA uses less than 25% of its primary substation capacity. Further expansions of the Pilar UG Mine including cooling and ventilation requirements, as well as the increased milling capacity up to 4.2Mtpa currently envisioned, will result in less than 50% of the installed power of the primary substation capacity. No further investments of the power supply infrastructure are anticipated.The MCSA power supply infrastructure features a step-down substation (the "Main Electrical Substation") containing two 40/50/60 MVA ONAF power transformers (forced ventilation) and 230 / 13.8 kV transformation ratio in order to distribute power to the Pilar UG Mine, the Caraíba Mill, administrative and support offices located on site as well as the local town of Pilar. The distribution of power follows the schematic illustrated below.

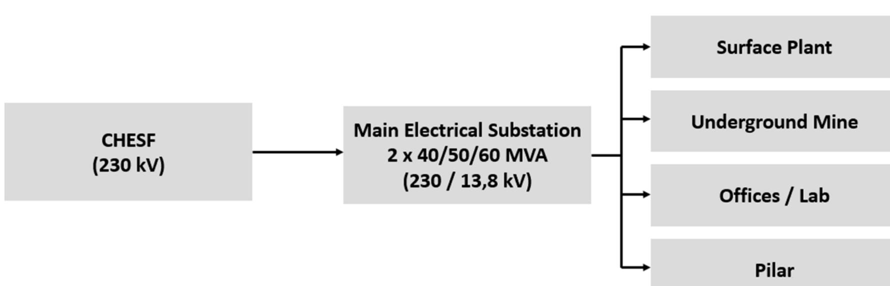


Figure 18-3: Simplified power distribution schematic (MCSA, 2020)

The Electrical reticulation is designed with a ring feed system so that there is 100% redundancy and only one circuit is in operation at any given time, with the second duplicate circuit on stand-by. The circuits are responsible for supplying two buses ("Bus A" and "Bus B"), from which 20 circuits are available for delivery of power with medium voltage cubicles ("QF"). The currently configured load of each QF is listed below, and the disposition of the main equipment in the Main Substation is illustrated in Figure 18-4the figure below.

- QF 2: Paste Fill, Ore Winch, Surface Ventilation;
- QF 4: Underground Mine;
- QF 5: Primary and Secondary Crushing;
- QF 6: Milling and Filtering;
- QF 7: Ball mills;
- QF 8: Dining hall and Offices;
- QF 9: Residential nucleus;
- QF 11: Capacitors bank;
- QF 12: Lab and Pipeline Station;
- QF 13: Ball mills;
- QF 14: Milling and Filtering;
- QF 15: Primary and Secondary Crushing;
- QF 16: Underground Mine;
- QF 18: Paste Fill, Ore Winch and Surface Ventilation.

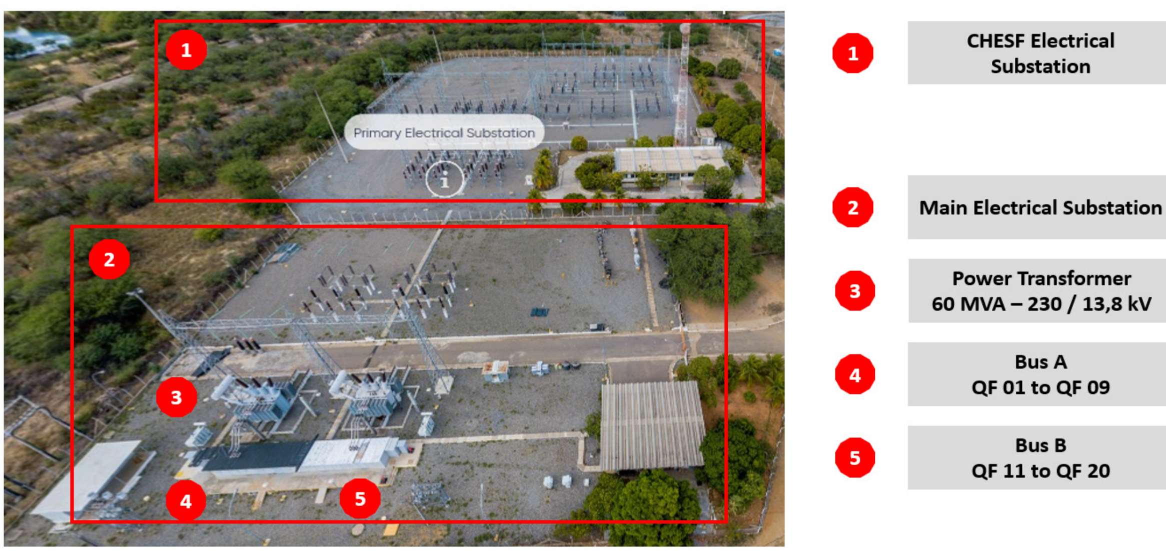


Figure 18-4: Location of equipment in Main Substation (MCSA, 2020)

In addition to the primary power distribution system, there is an installed emergency electrical generation system comprised of two diesel generator sets with individual nominal capacity of 1,200 kVA and supply of 800 kW each when in continuous operation. They operate in parallel and turn on automatically in the event of a main power failure. The emergency power system is designed to ensure power delivery to critical areas of the operation at all times, including: the tailings thickeners, surface lighting, management offices, IT servers, ventilation and key areas of the underground mine including lighting, communication and the personnel hoist of the main underground shaft to ensure availability of secondary escapeways at all times.

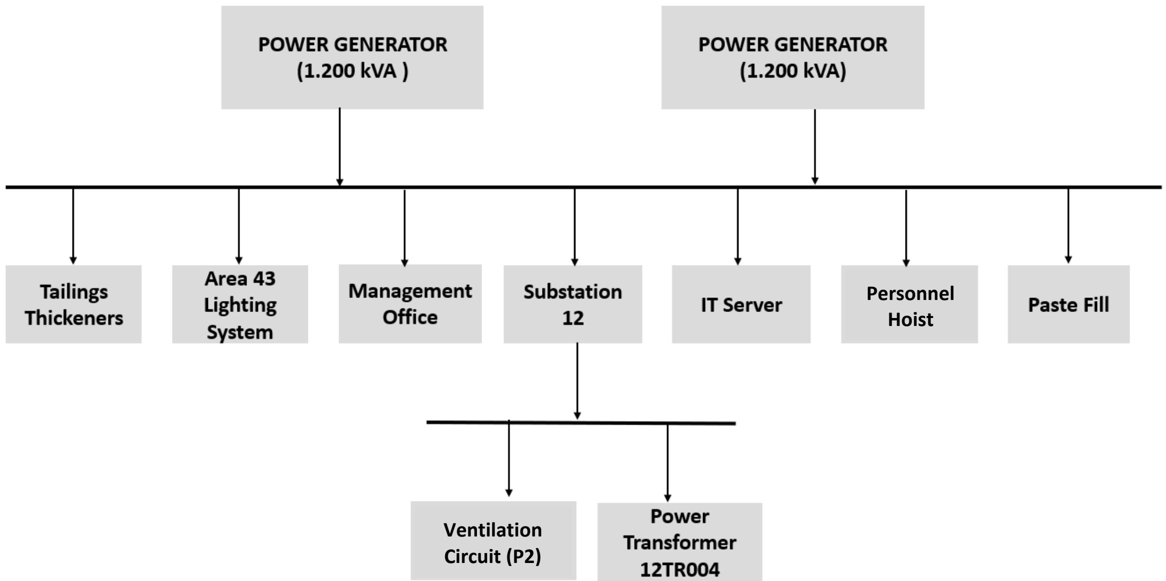


Figure 18-5: Loads served by the emergency generator system (MCSA, 2020)

18.4 CARAÍBA MILL

The fully integrated MCSA Mining Complex has been producing copper concentrate from the Caraíba Mill since commercial production was achieved in 1979. The individual components of the Caraíba Mill are described in greater detail in Chapter 17 – Recovery Methods and a process flowsheet is shown in Appendix C to the Report. The mill was initially constructed with four ball mills resulting in an installed nameplate design capacity of 800 t/h. In 1999, two of the four ball mills were sold, reducing the nominal capacity of the milling operations to 400 t/h using both mills. The balance of the Caraíba Mill operations, including secondary, tertiary crushing and blending operations remain configured for the original design capacity, which collectively currently serves as built-in redundancy for each process operations. A two-phased optimization and expansion program for increasing the mill capacity beyond its current level is currently planned in two stages. These stages will increase the milling capacity from 400 t/h to 464t/h with the HIG Mill installation (completed in 2020), and to 527 t/h with the installation of a HPGR circuit, currently scheduled for completion in 2023.

18.5 WASTE AND TAILINGS DISPOSAL, PILAR DISTRICT

The MCSA Mining Complex is a mature mining and processing operation with more than 40 years of operating history. Throughout the operating history, several methods have been used and continue to be used to dispose of flotation tailings as well as remediate coarse waste-rock stockpiles and historic open pit operations. There are three primary methods in which flotation tailings have been historically and are currently disposed of on site. These include: back-fill of open stopes within the Pilar UG Mine using cemented paste fill as part of production process, co-disposal of tailings into coarse waste rock stockpiles and the disposal of tailings in exhausted open pits. These methods and forecast total disposal volume by method for the current LOM plan are further detailed in Chapter 20.

Tailings management, reporting and monitoring are among the top priorities of the Company and its stakeholders. Following review of the operational practices in place, including various deposition methods, it is the opinion of the authors of this report that the tailings management system in place at the Company's operations aligns with industry best practices.

18.6 PILAR UG MINE INFRASTRUCTURE

The Pilar UG Mine complex is approximately 1.4 km deep and in total consists of approximately 124 km of gallery development. The underground mine consists of a large network of supporting infrastructure that has been expanded and modernized over the years.

18.6.1 Electrical Supply

The electrical supply for the Pilar UGUG Mine begins at QF 04 or QF 16 of the Main Electrical Substation, depending on which of the redundant circuits is active. Currently, QF circuit 16 (Main B, Busbar B) is responsible for the power supply.

On surface, there is a step-down electrical substation, SE 12, composed of 3 transformers (12TR001, 12TR002, 12TR003) that are collectively responsible for the energy supply of the entire underground mine.

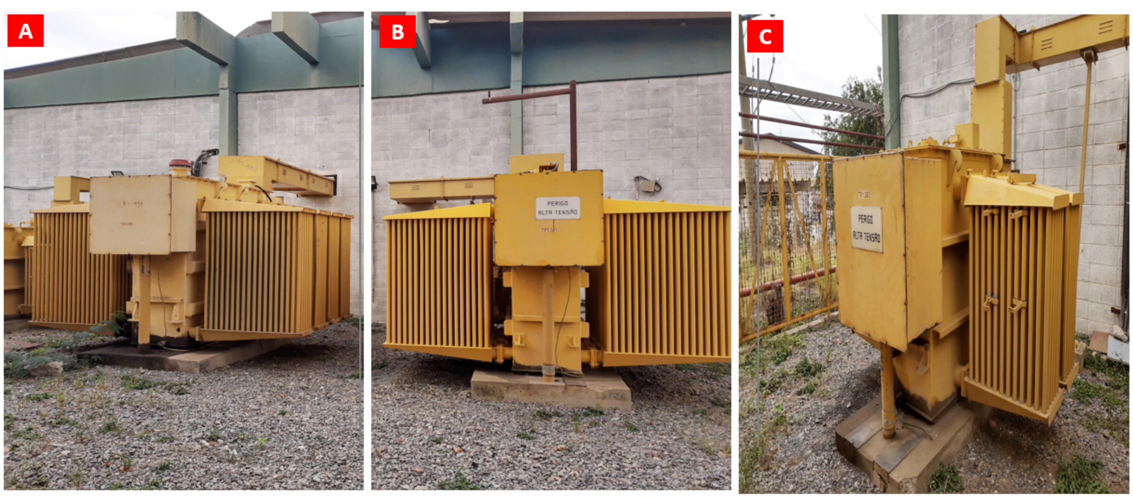


Figure 18-6: A: 12TR001; B: 12TR002; C: 12TR003 (MCSA, 2019)

The existing shaft, completed to approximately 700m below surface, provide the conduit for delivery of power to the underground mine. Three medium voltage cables are wired, originating from the 12TR001 transformer to the 21° bypass of the underground mine.

The cables are fixed to the shaft cabling structure and descend together to the bypass as shown in the figure below.

Figure 18-7: A: Existing Shaft; B: Cables running through Shaft (MCSA, 2019)

Within the mine, power cables are laid connecting o the mine's underground substations, where the voltage is lowered to 4.16kV and distributed throughout the mine.

The table below presents the installed capacity of each of the installed transformers relative to current demand. The Analysis considered daily demand from the 12 months prior to the Effective Date for transformers 12TR001, 12TR002 and 12TR003.

Table 18-1: Power capacity vs. demand of the Pilar UG mine

Transformer	Nominal Power (kVA)	Active demand (kW)	Reactive demand (kvar)	Apparent demand (kVA)	Power Factor	Current load*
12TR001 (21º Bypass)	5,000	2,899	1235	3151	0.92	63%
12TR002	5,000	1,660	707	1804	0.92	36%
12TR003	1,500	1,300	554	1413	0.92	94%

*Estimated future power needs for the Deepening Extension Project are detailed in Section 18.5.1 of this Report.

18.6.2 Water Management

The water management system of the Pilar UG Mine can be divided into 2 main components: water supply (inlet) and the pumping system (outlet).

The requirements for service water used in the mining operations is primarily related to equipment use (drilling equipment and concrete sprayers), as well as stationary facilities (workshops, offices and the underground shotcrete plant).

The average use of service water is currently approximately 50,000m³/month. Supply distribution is managed through an 8-inch HPDE circuit that starts from the main ramp (on surface) and passes through the levels via galleries or down vertical drill holes. The water flows by gravity and surge boxes (built of either steel or concrete) control the flow pressure and serve as buffers for varying water inflow levels throughout the mine.

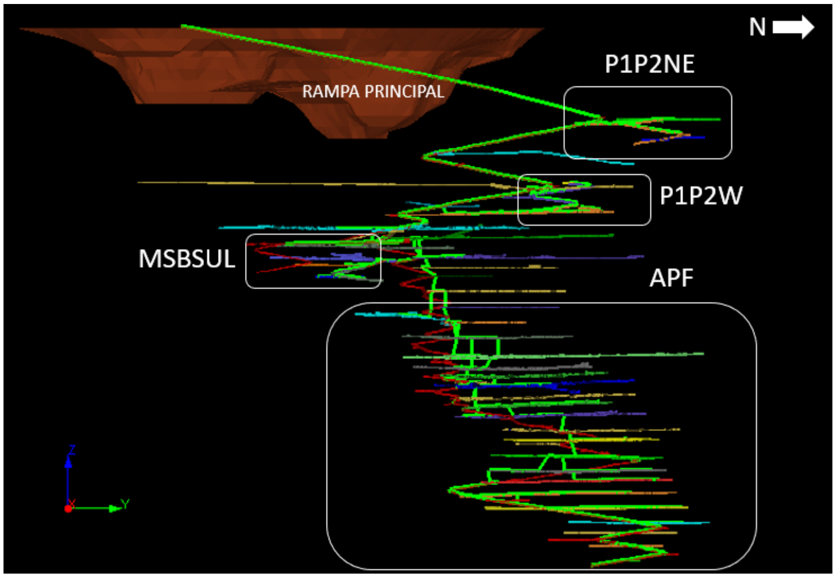


Figure 18-8: Service water schematic (green line) (MCSA, 2020)

After use, secondary water discharged through normal drilling and mining operations is directed for water capture by the main pumping system.

The main dewatering range has a diameter of 8 inches (225 mm). In total, the pumping system consist of approximately 1 km of carbon steel and approximately 5km of HDPE piping. Joints are coupled using both steel and HDPE fittings depending on the pipe installed and area of the mine. All piping for the pumping system is supported by a metallic structure fixed to the either the side of the galleries, or ceiling for permanent installations.

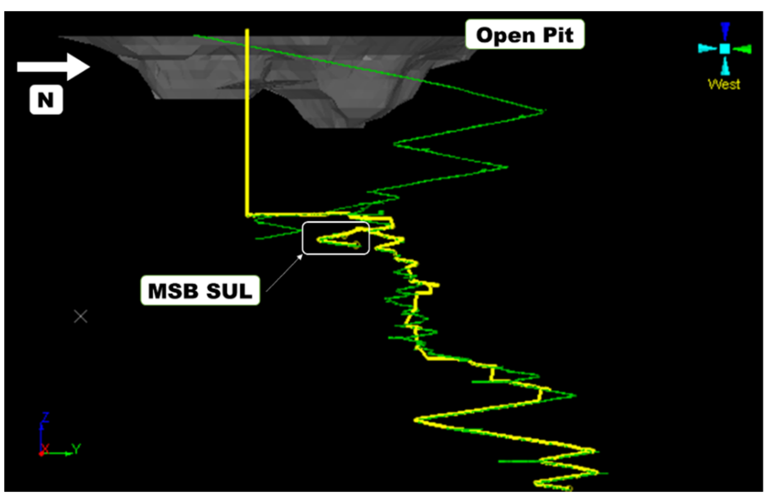


Figure 18-9: Pumping line schematic (MCSA, 2020)

The main stations are built of concrete containing two 4/3 E-HH pumps with a WEG 150 horsepower 4P motor. The decantation galleries contain settlement dams which provide storage and also allow the suspended solids to settle, which have the function of collecting water from the drainage system from the main ramp and retaining contained solids, which are filtered using a Geotextile Blanket before reporting to the suction inlet of the pump stations. The water enters the floodgates through pipes fixed to the gallery ceiling and positioned above the gates.

Currently, MCSA uses approximately 154m³/h of the pumping system, representing approximately 62% of the total installed capacity. While the existing circuit retains available capacity, the expansion the Deepening Extension Project, envisions the installation of a new pump range to reduce the number of intermediate stations. Construction of new pumping stations has been included in the Company's forecast capital expenditures for the current LOM plan.

Figure 18-10: Photo of a Main Pumping Station (MCSA, 2020)

18.6.3 Communication

The current communication, voice and video system installed in the Pilar UG Mine is a leaky feeder system featuring both transmitting and receiving devices. While the system has sufficient capacity for further expansion to meet the requirements of the Deepening Extension Project, at the time of authoring this Report, a technical study was being carried out by the MCSA mining and IT teams to evaluate modern alternatives to further advance the mine's communication system.

The existing leaky feeder infrastructure is divided into voice and video systems. The video system has a single exclusive channel for Pastefill monitoring and the voice system has 5 channels, as shown in the table below.

Table 18-2: Communication System Configuration

	Frequency		Description
	Uplink (MHz)	Downlink (MHz)	
Channel 1	172	157	Paste Fill operation
Channel 2	172	157	Maintenance
Channel 3	172	157	Shaft Operation
Channel 4	172	157	Traffic control at old ramp
Channel 5	173	158	Dispatch and operation communication

The components used to transmit the signals of this system include a series of cabinets, amplifiers, splitters and termination units designed to reach all working faces, fixed facilities (maintenance, etc.), and mobile equipment. The system is comprised of two main circuits. One is fixed permanently along the main ramp (Circuit 1) and another is wired through the existing shaft (Circuit 2).

Circuit 1 is responsible for the communication of the upper levels of the Pilar UG Mine, where the system enters through the main portal and connects to the levels below. Along its length there are amplifiers, power supplies, derivations, and terminations. Circuit 2, is directed via the existing shaft to the primary crushing area and the lower levels of the mine. Both circuits feature components to ensure quality distribution of the signal throughout the mine.

Figure 18-11: Leaky Feeder Circuit 1, Main Ramp (MCSA, 2020)

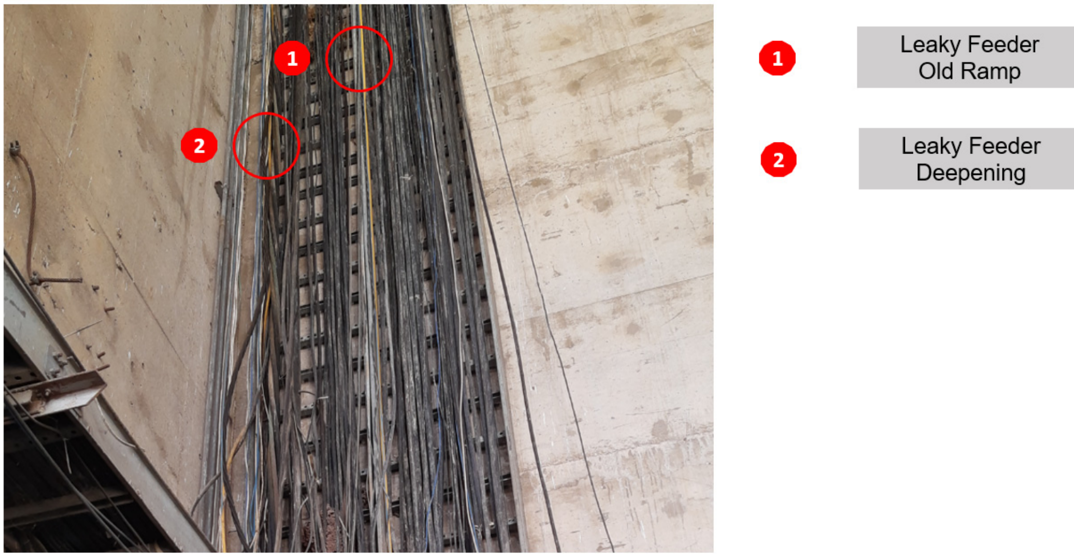


Figure 18-12: Leaky Feeder Circuit 2 via Shaft (MCSA, 2020)

18.6.4 Fleet Maintenance Facilities

Currently, there are four facilities for maintenance activities: a light vehicle workshop and central maintenance facility, both located on the surface; an LHD workshop located on level -137 of the underground mine and fuel supply and lubrication area located on level -732 of the underground mine. There is also a support location for performing truck tire changes on level -200 of the underground mine.

The central maintenance facility, located on the surface, consists of 7 large maintenance bays. One of the bays has been designed for the maintenance of platforms, two are reserved for preventive maintenance of drilling equipment, two for preventive maintenance of LHDs and support equipment and two other bays are designed for various maintenance and repair work. In addition to the maintenance bays, there is a subassembly maintenance area; meeting rooms for maintenance planning and control team, a central supplies warehouse as well as machining and welding areas. Most of the heavy maintenance performed for the operations of the Curaçá Valley is performed at the central maintenance facility.

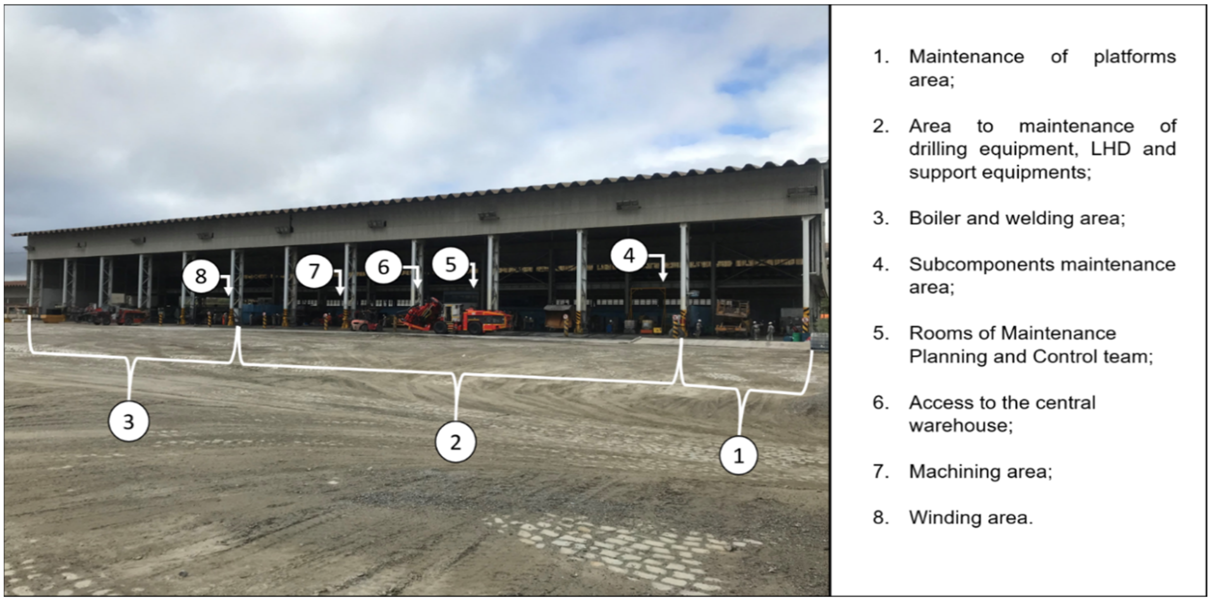


Figure 18-13: Central Maintenance Facility on Surface, Pilar Mine (MCSA, 2020)

The underground LHD workshop, located at L-137 in the underground mine serves as an area for preventive and corrective maintenance of the underground fleet. The workshop also serves as the staging area for the Company's underground ambulance. In addition, one bay is used as storage for spare parts and consumables used in the mining operation and maintenance processes.

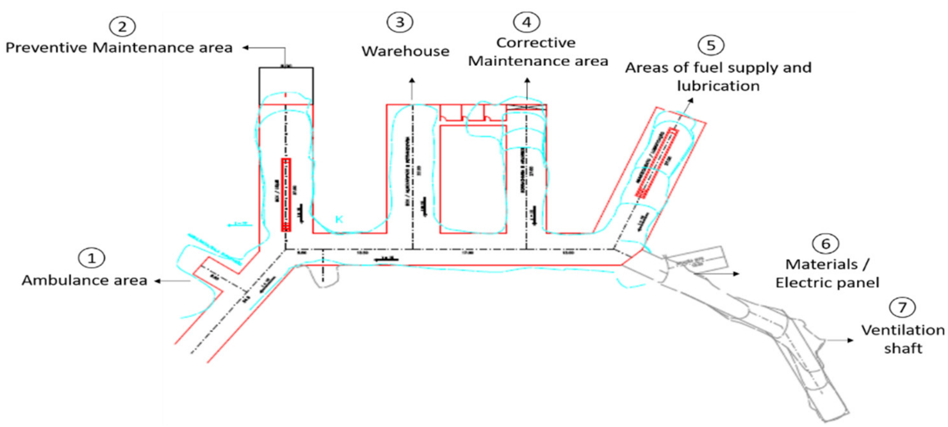


Figure 18-14: Schematic of the LHD Workshop at L-137 (MCSA, 2020)

In addition to the LHD workshop, there is a maintenance facility located at L-732 primarily used for fleet lubrication. The facility on L-137 is currently the deepest fixed facility in Pilar UG mine.

Figure 18-15: and Lubrification facility at L-732 (MCSA, 2020)

18.6.5 Compressed Air

To serve the underground mine, there is a central compressed air station located on the surface featuring six compressors working in parallel that are capable of generating a combined 8,852 m³/h of compressed air.

Compressed air leaving the compressors is stored in two 30m³ pressure vessels. These vessels store and deliver compressed air to the underground mine through compressed air piping and hoses passed through the shaft to meet the various working areas within the Pilar UG Mine.

Figure 18-16: Compressed air central station and pressure vessels at surface (MCSA, 2020)

Table 18-3: Pilar UG Mine compressor capacity

Compressor	Manufacturer	Model	Nominal Capacity (m³/h)	Working pressure (bar)
36CA001	Atlas Copco	GA160	1,677	7.40
36CA002	Atlas Copco	GA160	1,508	9.10
36CA003	Atlas Copco	GA110	1,128	9.10
36CA004	Atlas Copco	GA160	1,517	9.10

36CA005	Atlas Copco	GA160	1,511	9.10
36CA006	Atlas Copco	GA160	1,511	9.10
TOTAL			**8,852**	

Currently, approximately 8,000m³ of the total the air generated by the compressors is used by the primary drilling fleet (80% of total use), concrete production (10% of total use) and other fixed facilities (10% of total use). To ensure that the current installation can fulfill the air requirements of the LOM plan, the replacement of drill machines from air to electro-hydraulic has been implemented as the existing rigs are replaced at the end of their useful life along with improvements to the compressed air system.

18.6.6 Pastefill Plant

MCSA implemented the use of pastefill in mined out stopes beginning in 1998. There are three main objectives of the pastefill production and delivery system: (i) increase the structural integrity of mining operations, (ii) reduce the deposition of tailings in the waste piles, pits or tailings dam and (iii) maximize mineral extraction.

Paste is produced on surface in the Company's pastefill plant, where the tailings are conditioned and mixed with a binder (Portland cement) to form suitable paste according to specification for each application and then gravity fed into the stopes of the Pilar UG Mine. Currently, the pastefill plant has a batch capacity of 95m³/h. The capacity of the plant will be increased to 120m³/h with the expansion of the facility in support of the Deepening Extension Project.

The main components of the existing facility includes: 1 bulk storage tank, 2 disk filters, 1 pulp conditioner, 1 pulp mixer, 5 cement storage silos, conveyor belts, weighing machines and other associated mechanical equipment.

Figure 18-17: Pilar UG Mine Pastefill Plant (MCSA, 2020)

The paste produced by the pastefill plant is delivered underground by gravity, through 8-inch steel pipelines and directed to the top of the stopes being filled. Currently, the installed paste line, including all branches has a total length of approximately 3.5 km. A schematic of the paste fill plant lines are shown below for the upper levels of the mine.

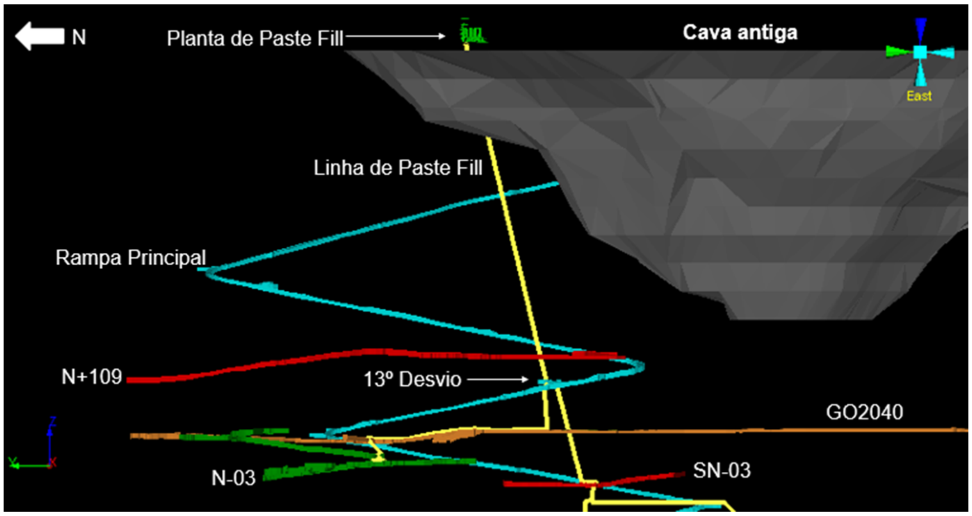


Figure 18-18: Pilar UG Mine Pastefill Pipeline Schematic (MCSA, 2020)

18.6.7 Ventilation

The ventilation system of the Pilar UG Mine is performed mechanically by a series of exhaust fans installed on surface and a series of ventilation raises that serve to both expel dust and gases from the various working fronts of the mine, as well as draw fresh-air into the mine. The current ventilation circuit is made of four ventilation raises, each primary raise is constructed with a 3.1 m diameter raise-bore connecting the interior of the mine to the surface exhaust fans. To ensure sufficient air flow at each of the working faces in the mine, mechanical auxiliary ventilation and flexible temporary ductwork is used.

In addition to the primary raises and boosters, secondary raises are also used to direct airflow according to the mines' needs. Ventilation design criteria is based on Brazilian standard NR 22.24.8 considering the highest required airflow for mining and development. The total required airflow of the mine is 540 m³/s according to this standard and the capacity of the current mine ventilation system is 630 m³/s.

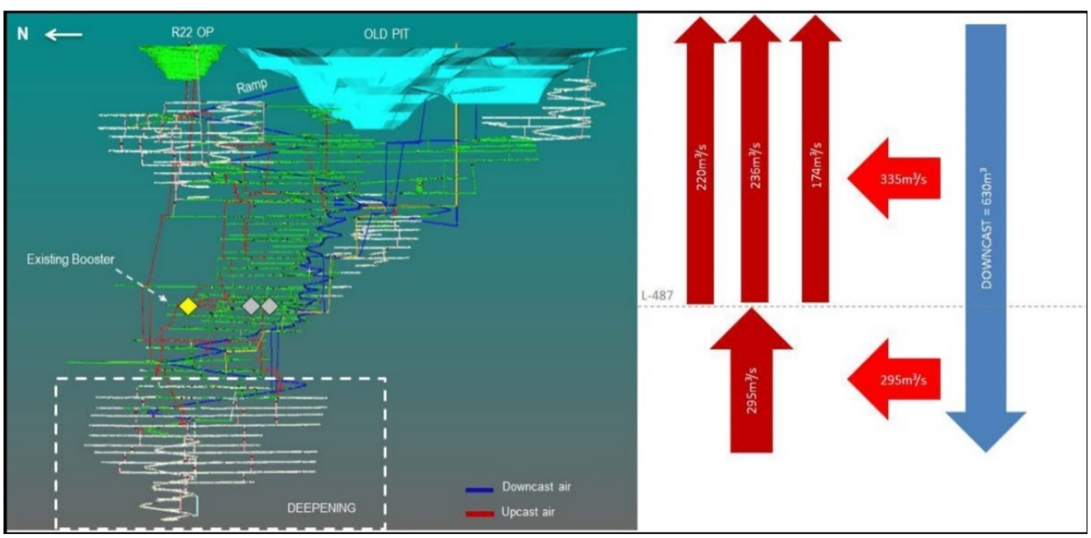


Figure 18-19: Schematic of MCSA's Main Ventilation System (MCSA, 2020)

To generate sufficient airflow, 5 surface exhaust fan systems, equipped with axial fans are placed at surface on top of three primary ventilation raises. The exhaust fans and raises include the P3, P1/P2 circuits and the exhaust fans installed in the historic open pit.

Figure 18-20: P3 exhaust fans – model SOMAX (MCSA, 2020)

Figure 18-21: P1/P2 exhaust fans – model SOMAX (MCSA, 2020)

Figure 18-22: Old pit exhaust fans – model TECSIS (MCSA, 2020)

18.7 VERMELHOS DISTRICT INFRASTRUCTURE

The installed infrastructure of the Vermelhos District is sufficient to continue providing support for the existing Vermelhos UG Mine as well as support the development and operations of the N8/N9 and Siriema OP mines, with minimum additional expansion required. Current installed infrastructure is comprised of the Vermelhos UG Mine and supporting infrastructure including offices, electrical supply, and mining infrastructure.

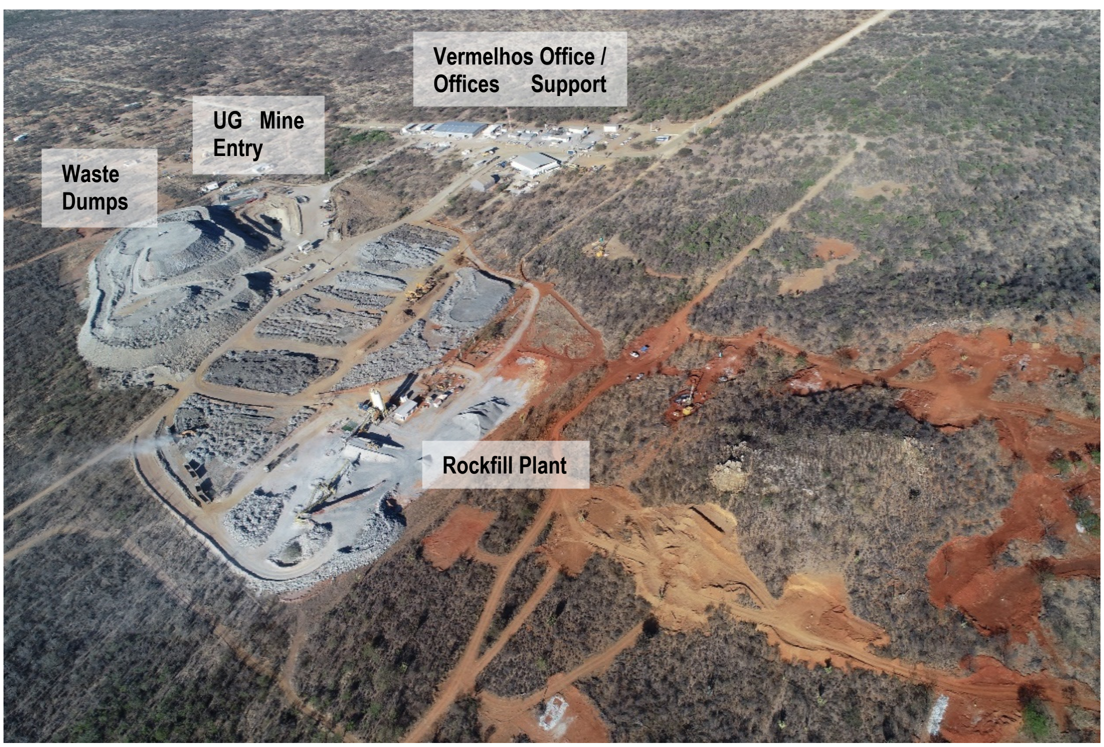


Figure 18-23: Vermelhos Industrial Area (MCSA, 2020)

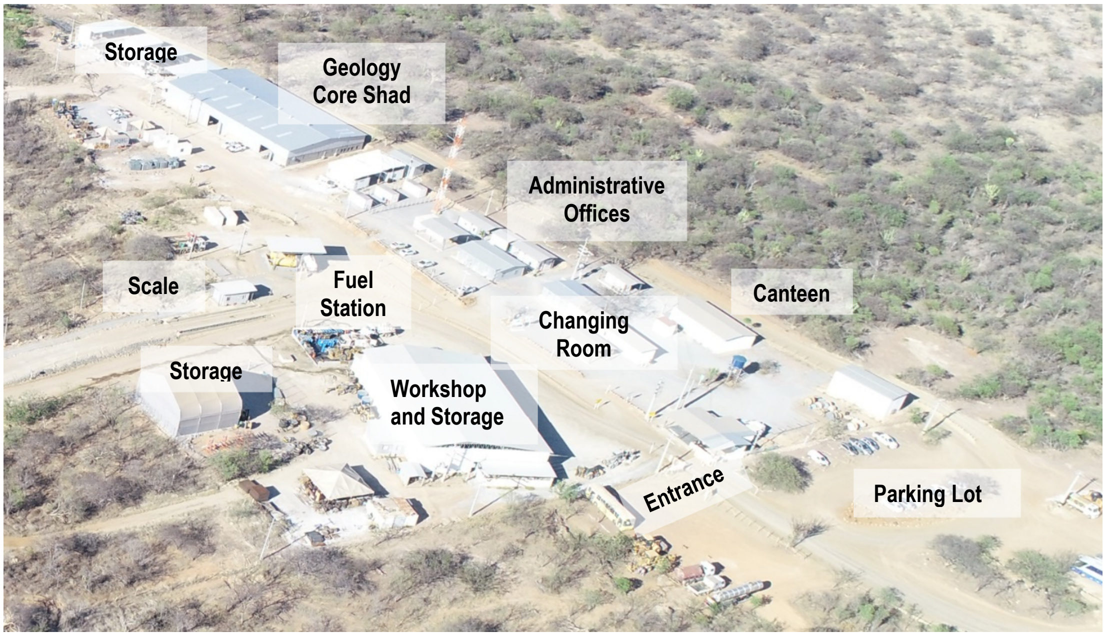


Figure 18-24: Vermelhos Office and Support Facilities (MCSA, 2020)

18.7.1 Electrical Supply

The Vermelhos UG Mine is supplied by the Bahian State power company, COELBA, initially at a voltage of 13.8 KV. A substation at the entrance of the mine provides step-down to 4.16KV, and is finally transformed to 440V by a substation located within the Vermelhos UG Mine. The figure below shows the transmission line (orange), comprised of approximately 30km of overhead electric lines from the "Barro Vermelho" community to the Vermelhos UG Mine.

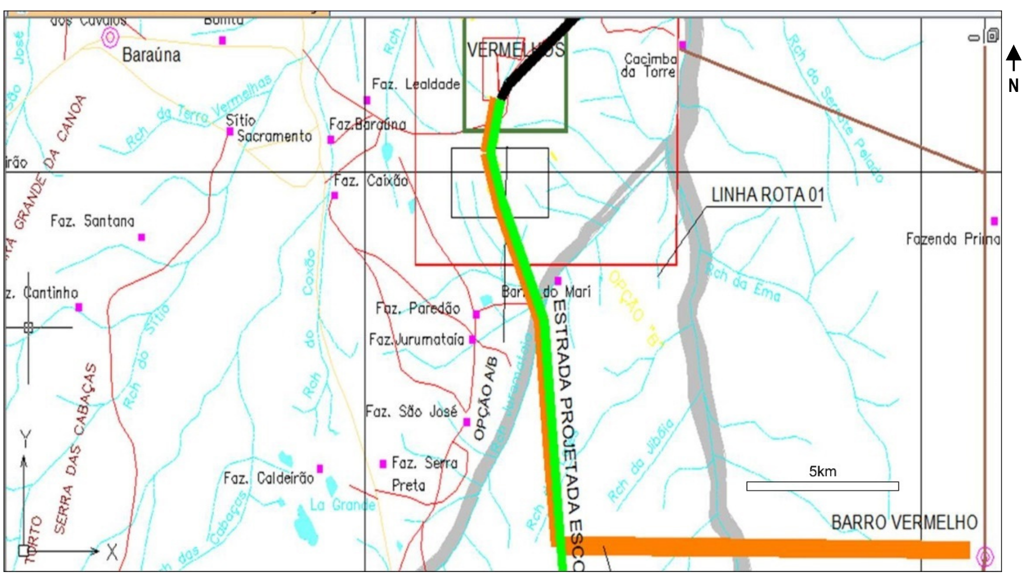


Figure 18-25: Vermelhos Infrastructure, Primary Electrical Supply (MCSA, 2020)

18.7.2 Water management

Water used at the Vermelhos UG Mine, including for production, offices and for the mine dry is pumped from several permitted artesian wells on the property. Fresh water is stored continuously in 4 storage tanks, each with a capacity of 10,000 liters (40,000 liters of total storage). The closed circuit system allows the Company to reuse more than 90% of the required water for the operations. A horizontal decanter with two 25,000 liter tanks and a reservoir is used as a contingency for water supply.

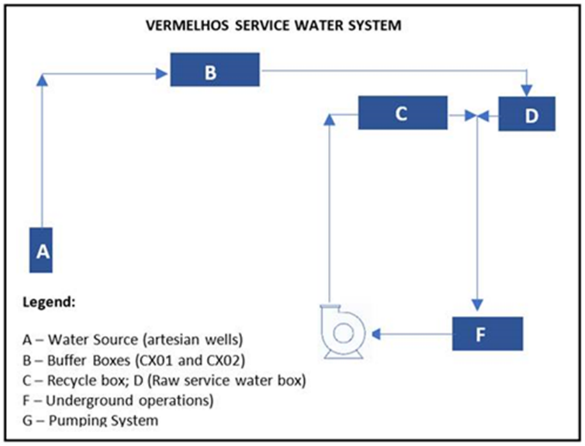


Figure 18-26: Industrial water circuit schematic (MCSA, 2020)

The Vermelhos UG Mine pumping system consists of 9 main pump stations with 130 m³/h capacity. Pump stations are located every 60 vertical meters along the ramp and connected to the closed circuit. Each main pumping station consists of two slurry pumps installed in parallel, whereby one is on standby at all times in case of operating pump failure. The pumping stations utilize a system of sluice gates to aid in the removal of fines prior to pumping.

Each level underground is developed with a 2% ascending grade to direct water back to the main ramp, where the water is collected in steel tanks linked to the main pumping stations. To complete the water balance, the entire industrial area is equipped with a surface water drainage system to collect and store surface run off for use. A water/oil separator is installed on surface to remove any oil and grease from the water.

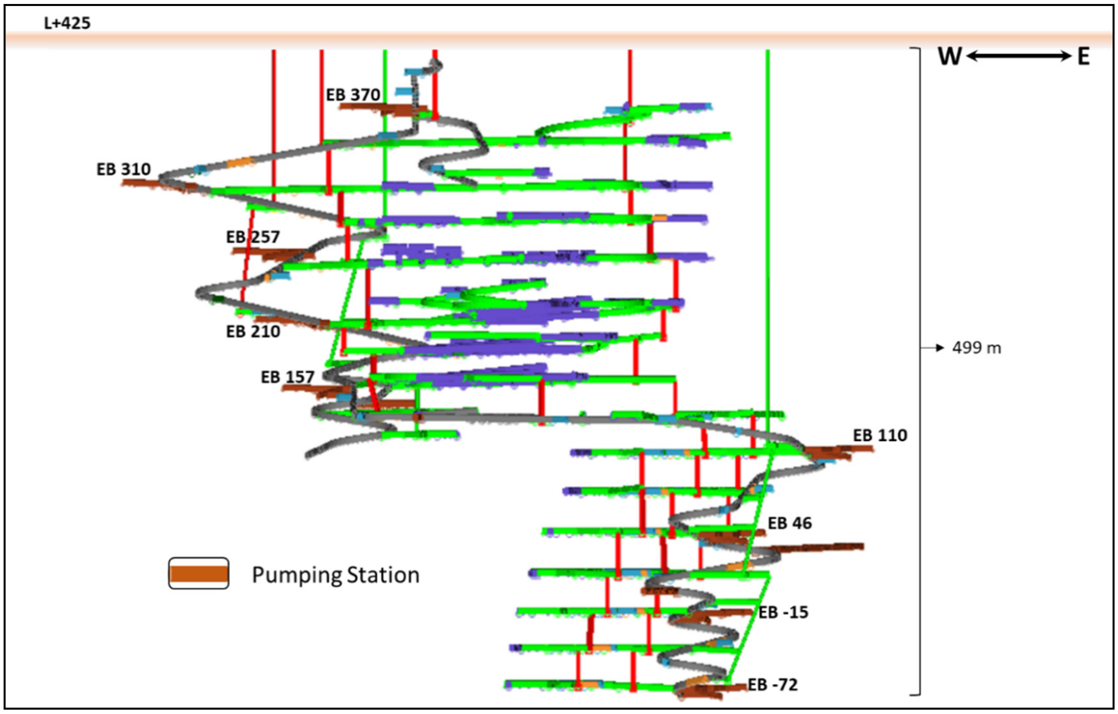


Figure 18-27: Vermelhos UG Mine pumping station locations (MCSA, 2020)

18.7.3 Ventilation Infrastructure

The Vermelhos UG Mine ventilation design is based on the published requirements of Brazil regulation NR 22.24 pertaining to underground mining activities and mandated air flow requirements. Model simulations performed by MCSA ensure adequate air flow is reached during the design phase using VENTSIM software. The ventilation system design of the mine entails the use of 4 fresh air intake points (ramp and raises), and two exhaust points (raises) located at surface. The ventilation raises have a design diameter of 3.0 m and are drilled using a raise-bore machine. Sub-vertical chimneys between levels are opened by blasting as required in the design.

Currently, there are 4 exhaust fans installed on surface (2 at vent raise-02 and 2 at vent raise-05), each with 60m³/s, static pressure of 150 millimetres water gauge, or millimetres column agua in Portuguese ("mmCA") (at the point of operation) and power of 200 CV. The fans provide a total flow of 240 m³/s. In 2021, the 5th exhaust fan will be installed, increasing the total installed airflow in the mine to 300m³/s. As at the time of this Report, the 5th exhaust fan had been delivered to site and preparation for installation was underway. Working faces are supplied with fresh air via mechanical auxiliary ventilation and flexible temporary ductwork as required. The ventilation system is shown schematically in figure below.

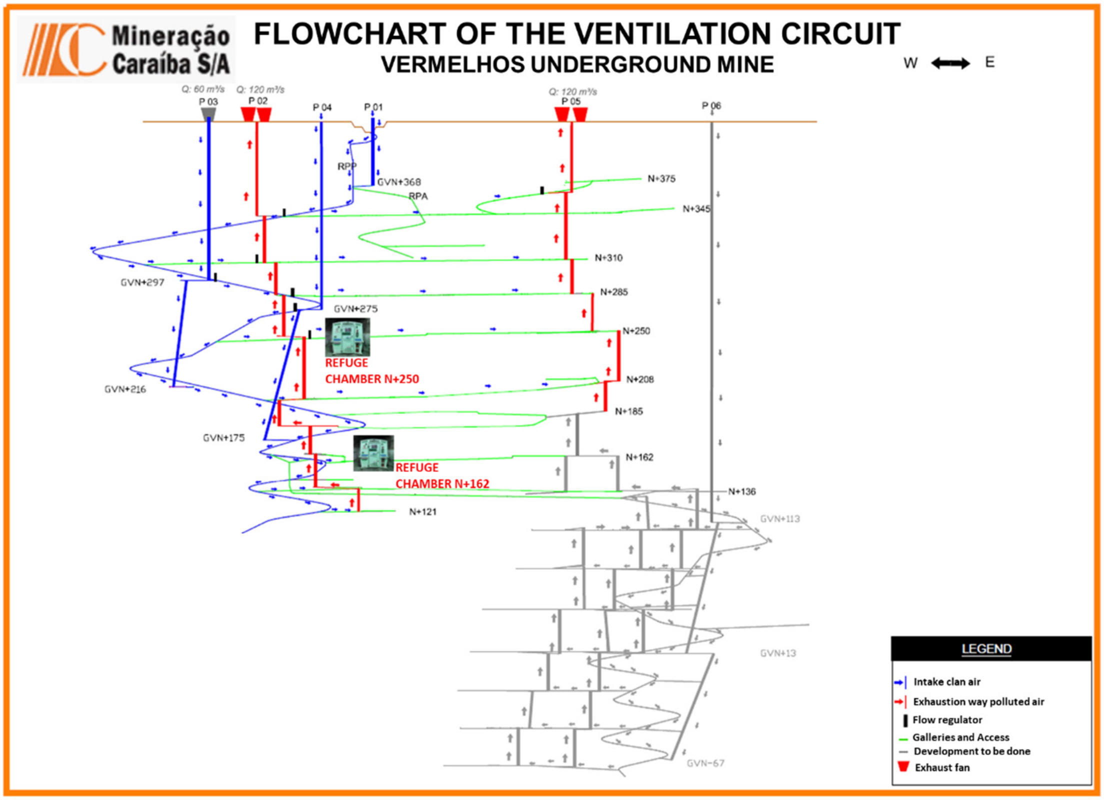


Figure 18-28: Vermelhos UG Mine main ventilation circuit schematic (MCSA, 2020)

18.7.4 Rockfill / CRF

To enable maximum recovery of the high-grade reserve of the Vermelhos UG Mine, CRF is used to fill the voids after primary stopes have been mined, thereby allowing adjacent secondary stopes to be mined after curing. Rock-fill is prepared on surface plant by crushing and mixing the waste with water and cement and transported from the surface to the stopes for filling via ramp by 25 tonne trucks.

In September 2020, an expansion of the rock-fill plant was completed, increasing the capacity from 23kt/month to 38kt/month. The expansion included an installation of a secondary crusher, breaker hammer and mixer.

In its current configuration, the plant consists of a primary jaw crusher (model Metso C80), a secondary cone crusher (Metso HP 100), a breaker hammer, interconnecting conveyor belts for the systems, 2 cement silos and a mixer. The waste pile used for CRF was generated during mine development and is located next to the rock-fill plant. Material from the pile is fed into the primary crusher using a CAT 966 wheel loader. After crushing, the gravel is mixed with cement and water at approximately 5% cement by weight. The material is discharged from the mixer directly into the truck, where it is transported to the primary stope being filled. A photograph of the CRF plant is shown below.

Figure 18-29: CRF Plant at Vermelhos UG Mine (MCSA, 2020)

18.7.5 Tailings and Waste Disposal

All ore mined from the Vermelhos District is transported for treatment at the Caraíba Mill. Waste rock stockpiles generated by the Vermelhos UG Mine are used for CRF and disposed of underground. Waste rock generated from open pit mining activities within the Vermelhos District will be stored for future use in end-of-life reclamation activities.

Please refer to Chapter 20 for additional detail on tailings disposal methods of the Caraíba Mill.

18.8 SURUBIM DISTRICT INFRASTRUCTURE

The mining operations of the Surubim District commenced operations in 2010. The district features a large installed infrastructure base that will support the re-start of the Surubim OP Mine and the delivery of the C12 Mine.

18.8.1 Electrical Supply

The Surubim OP Mine is supplied by the Bahia State power company, COELBA, initially at a voltage of 13.8 KV. The industrial area of the Surubim OP Mine has 3 transformers that reduce the voltage to 380/220V for supply to the main administrative and support facilities and 1 transformer to supply the operation inside the open pit mine with 440V.

18.8.2 Water Supply

The water used in the mining process, administrative and support areas is pumped to surface for storage from permitted ground wells. As at the Effective Date, Surubim had 3 productive wells, each with an average flow of 2-3m^3/s.

18.8.3 Fleet Maintenance

The Surubim OP Mine infrastructure includes 2 permanent metal canopies that provide workspace to support the maintenance and consumable materials storage to support the mining fleet.

Figure 18-30: Surubim maintenance facilities (MCSA, 2020)

18.8.4 Offices and other facilities

Adjacent to the Surubim OP Mine, additional infrastructure installed to support the operations of the Surubim District includes:

- Offices for operations and administrative support;
- Geology and core storage areas;
- Entrance and security gate;
- Telecommunication Infrastructure;
- Office for health and safety support;
- Cafeteria;
- Explosive storage

Figure 18-31: Surubim security gate and parking lot (MCSA, 2020)

Figure 18-32: Surubim geology core shack and telecom tower (MCSA, 2020)

Figure 18-33: Surubim cafeteria and support offices (MCSA, 2020)

18.8.5 Tailings and Waste Disposal

All ore mined from the Surubim District is transported for treatment at the Caraíba Mill. Waste rock generated from open pit mining activities within the Surubim District will be stored for future use in end-of-life reclamation activities.

Please refer to Chapter 20 for additional detail on tailings disposal methods of the Caraíba Mill.

18.9 PLANNED INFRASTRUCTURE MODIFICATIONS, DEEPENING EXTENSION PROJECT

The delivery of the Pilar UG Mine Deepening Extension Project, will require the following modifications and expansion of underground infrastructure as further described herein. These modifications are aligned with the project expansion needs and have been incorporated into the LOM capital cost profile. Please refer to Chapters 21 and 22 for capital cost details.

18.9.1 Electrical Supply

A complete review of the forecast power demands of the Pilar UG Mine, including the Deepening Extension Project cooling and ventilation systems was conducted. The table below shows the expected energy consumption for the different supply systems and production areas of the Pilar UG Mine.

Table 18-4: Estimated power requirements, by mine area (kWh)

Area	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Deepening Extension Project	1,627	1,401	2,421	1,945	2,096	2,000	3,000	4,000	4,000	4,000	4,000
P1P2 / R22UG	2,709	2,904	2,432	1,942	947	456	501	611	-	-	-
MSBSouth	1,144	1,188	1,415	984	836	693	-	-	-	-	-
Barauna	-	45	227	930	751	1,082	1,400	913	1,022	-	-
Total	**5,480**	**5,538**	**6,495**	**5,801**	**4,630**	**4,231**	**4,901**	**5,524**	**5,022**	**4,000**	**4,000**

Modifications to the electrical supply system for the Deepening Extension Project has been designed incorporating for upgrading of the existing substations as well as installation of a new substation. The design captured the expected electrical demands for various components of mine equipment and support infrastructure including drilling machines, fans and water pumps that are part of the operating plan for the Project. In addition, the design sought to maintain stable voltage throughout the mine, including in the upper levels of the mine.

A new underground electrical substation has been included to provide 13.8 kV power supply through the new external shaft to be built in support of the project. The new substation, to be located on L-1075 will provide a new 4.16 kV distribution network throughout the lower levels of the mine. Construction of the new external shaft is planned to commence during the third quarter of 2021. Please refer to the materials handling, Section 18.9.4, of this Chapter for additional details. The figure below provides a schematic of the primary electrical supply system of the Pilar UG Mine, including DF-1204.

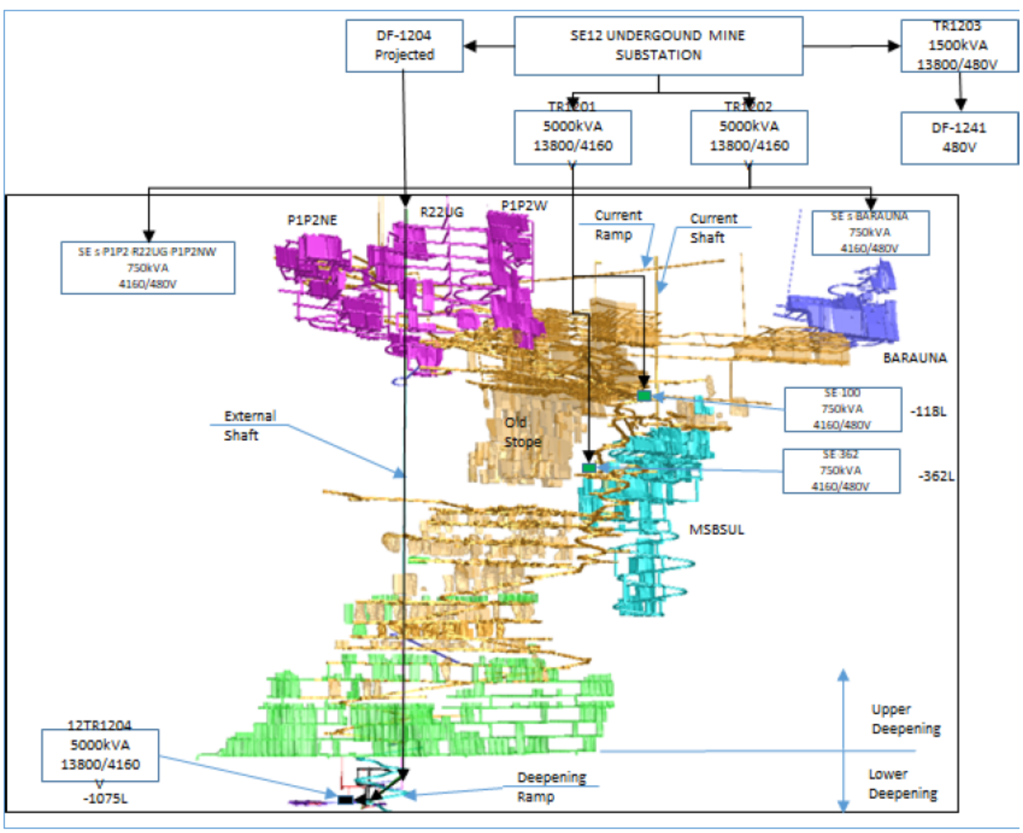


Figure 18-34: Pilar UG Mine Electrical Infrastructure (MCSA, 2020)

18.9.2 **Communication**

While the existing leaky feeder system installed in the mine (see Section 18.6.3 for additional details), at the time of this report, technical evaluations were underway to evaluate alternative technologies as compared to an extension of the existing communication system. Allowances have been made to upgrade the existing circuit. The incremental cost of modernizing the communication of the mine is not considered a material component of the Deepening Extension Project.

18.9.3 **Pastefill**

The installation and commissioning of the Company's new HIG Mill in late 2020 will result in an overall reduction in particle size of the flotation tailings. The impact of a finer grind size will result in increased binder consumption (higher requirements of cement) that can be attributed to change in particle surface area and increases in rheology.

All of the areas of the Pilar UG MIne, with the exception of P1P2NE, will use pastefill. Paste backfill will be delivered to MSBSouth and Deepening Extension Project via the existing surface borehole located adjacent the existing paste plant. Two new lines will be built for the P1P2W and Baraúna mining areas, as shown below.

As a result of increased demands for the quality and delivery of paste associated with the Deepening Extension Project, modifications of the existing Pastefill Plant have been designed to improve process control and ensure paste quality. These modifications have been divided into two Phases:

- Phase 1 – Instrumentation, automation and control system improvements; and,
- Phase 2 – Expansion of the filtering and mixing capacity. To achieve the filtration area required for the Deepening Extension Project, a new wing will be constructed adding one new filter, oriented at 90 degrees to the existing filters, to increase batch productivity to approximately 120m^3/h.

The new filter to be installed in Phase 2, will have its own tailings conveyor to transport the filter cake into the conditioning mixer, operating in parallel with the existing filters. The newly installed 3.2m x 10 disc filter has been designed to have a total filtration area of 142 m^2. When combined with the two existing filters currently in use, the expansion will result in a total filtration area of 350 m^2. A schematic of the plant upgrade is shown below.

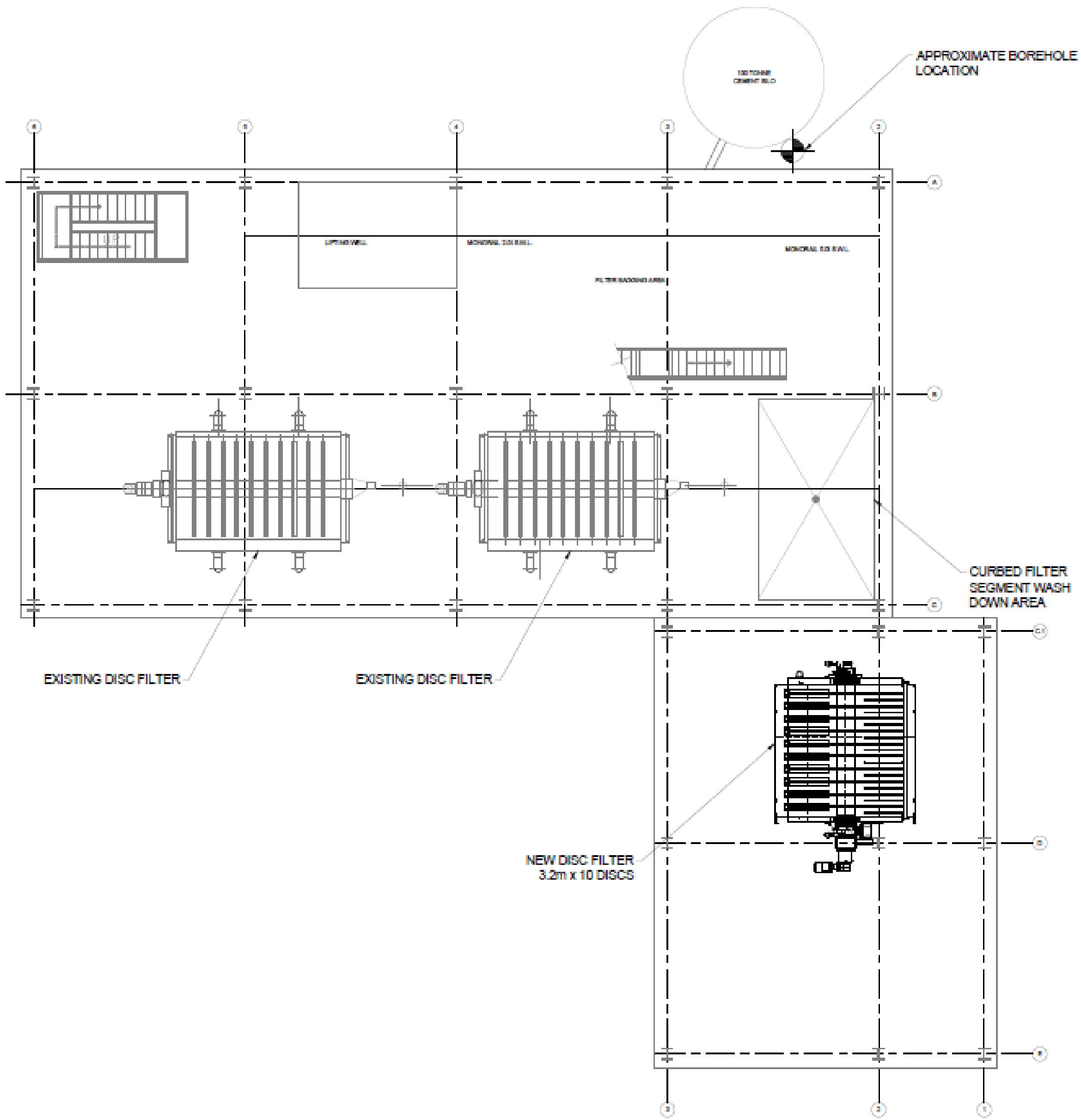


Figure 18-35: Paste Plant Upgrade (MCSA, 2020)

18.9.4 Materials Handling, Deepening Extension Project

In order to maximize the return on invested capital for the development of the updated mineral resources and mineral reserves within the Deepening Extension Zone of the Pilar UG Mine, a comprehensive trade-off study was undertaken by the Company. In addition to maximizing return, the analysis sought to evaluate and minimize interference with the existing operations of the mine and ensure the health and safety of the Company's employees operating underground.

The comprehensive evaluation considered an initial list of 33 solutions that were evaluated at a scoping level. These included a vertical shaft, conveyor belt, rail-veyor, vertical belt, pocket lift, and an extension of the current system. From these 33 initial scoping solutions studied, 9 materials handling solutions were selected for a detailed trade-off analysis using the modeled capital, operating costs and associated production profile of the Deepening Extension Project. An overview of the results of these trade-off studies, presented in relative NPV is shown below.

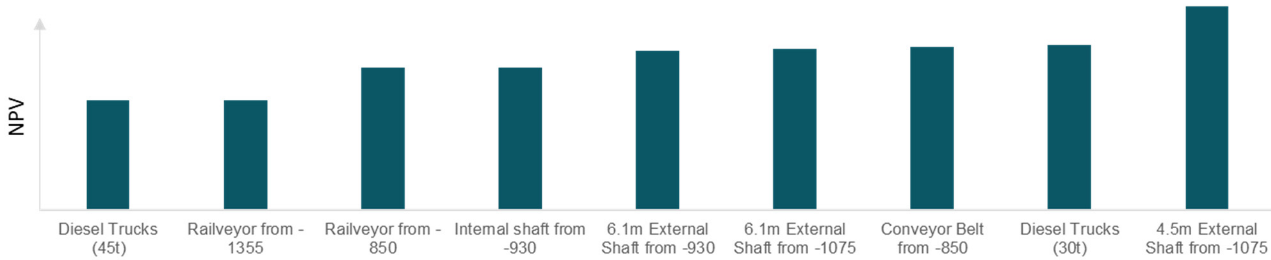


Figure 18-36: Trade-off Study Results, Materials Handling Solutions (MCSA, 2020)

As demonstrated in the trade-off analysis performed, installation of a new 4.5 m diameter external shaft from surface to level -1075 resulted in an approximate 20% improvement in NPV over the next best option, the 30 tonne diesel truck scenario. The external shaft features several advantages over other options evaluated including improved working time at the face, downcast ventilation and cooling, facilitation of service installations and overall improvements in health and safety of the mine and the ability to commence construction on the external shaft with minimal interference on the existing operations of the mine. A schematic of the external shaft and ventilation circuit is shown below.

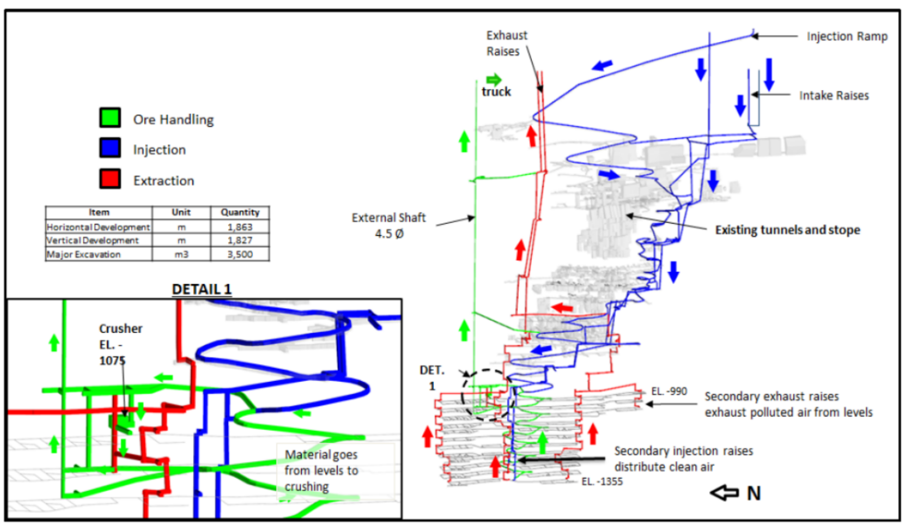


Figure 18-37: 4.5m Diameter External Shaft with a New Crusher at -1075L Schematic (MCSA, 2020)

In practice, crushed ore will be belt conveyed to a 2,200 tonne crushed ore silo. Waste will be discharged directly into the 1,500 tonne waste silo, after passing through a 400 x 400 waste grizzly with rock breakers.

For each of the ore and waste silos control chutes with installed vibrating feeders will feed a 42", 65 meter long, 40 horsepower, conveyor belt that will be used to transport broken rock from the silos to the shaft measuring flask. A conventional loading station with one distribution chute and two measuring flasks will be installed within a recess built into a shaft wall to feed the 13 tonne skips.

The following figures detail the installation design of the shaft, headframe, loading pocket and truck discharge station of the new external shaft. Total capital costs of the shaft installation including ancillary support infrastructure is further detailed in the Company's capital cost estimates for the LOM plan as outlined in Chapter 21 and 22 of this Report.

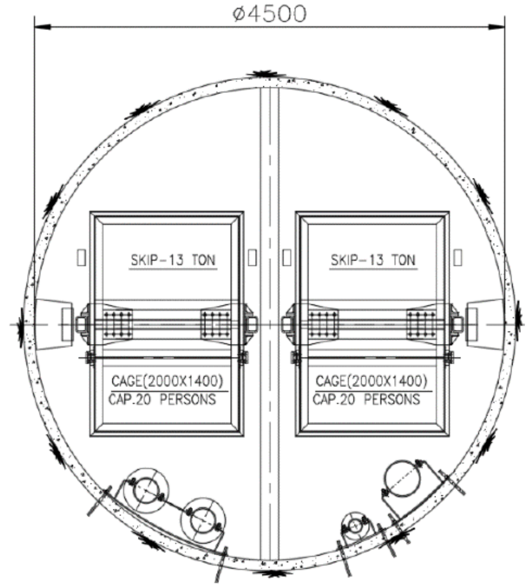


Figure 18-38: 4.5m Shaft Section – Combined Skip/Cage (MCSA, 2020)

The headframe installed to support the production hoist will be 40 meters high to accommodate both of the 13 tonne skips with required skip overrun space. Safety devices including wedge guides, spectacle plates and jack catches have been incorporated into the design at the higher levels of the headframe.

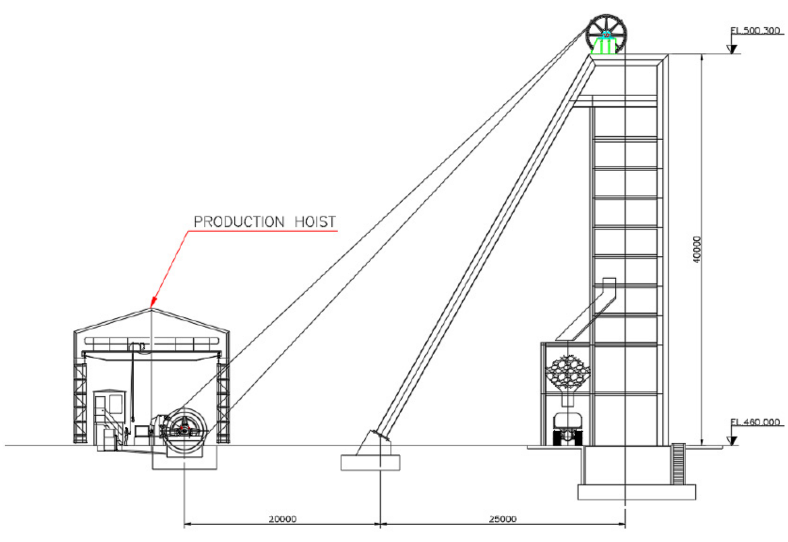


Figure 18-39: Shaft headframe (MCSA, 2020)

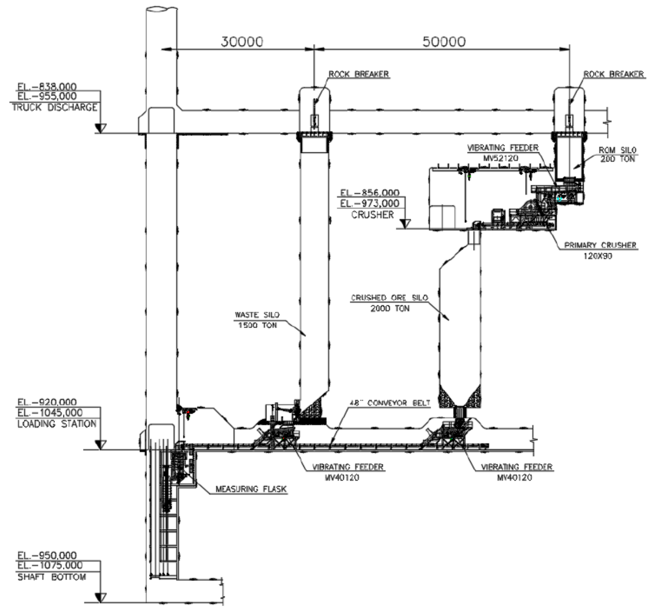


Figure 18-40: Skip Loading Station (MCSA, 2020)

The figure below shows the typical arrangement of truck discharge area.

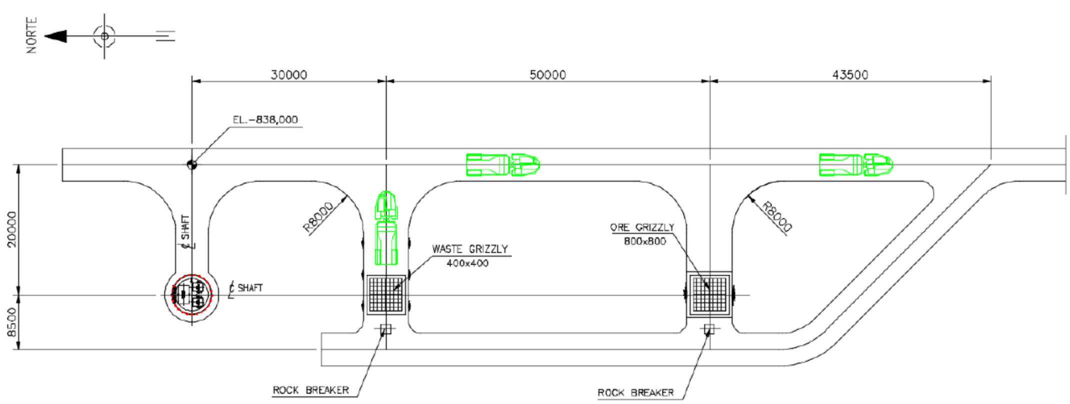


Figure 18-41: Truck Discharge Station Schematic (MCSA, 2020)

18.9.5 **Ventilation & Cooling**

To support the planned production rates as envisioned in the LOM plan from the Deepening Extension Project and ensure the safety and health of the underground mining staff, MCSA has designed an expansion of its ventilation system and will install cooling in the mine. Several options for ventilation and cooling solutions were studied in a comprehensive analysis, including different types of bulk air coolers both underground and at surface, and spot coolers.

To meet the cooling objectives for the Deepening Extension Project, 3 cooling plants are to be built over the next 3 years. The installation of the cooling system has been broken into three phases. Phase 1 and Phase 2 have been designed to meet the immediate development needs to further advance the main ramp of the mine, required for the completion of the new external shaft.

Phase 1 and 2 (short-term): consists of a cooling plant with an installed 6MWR capacity that is scheduled to be installed in 2021, utilizing the existing intake circuit of the "Poço South" ventilation raise, located in the upper portion of the historic Pilar open pit. A parallel ventilation raise with 4.5m diameter will be sunk commencing in 2021, and an additional 9MWR of cooling will be installed in early 2022, for a total of 15MWR of installed capacity in these phases.

Phase 3 (long-term): Completion of the cooling infrastructure will be completed with an additional 3MWR to be installed upon completion of the new 4.5m external shaft. Upon completion of the ventilation circuit, including Phase 3, the operating temperature of the underground mine has a design temperature of between 23-28 ºC wet bulb (for rejected air) at all working faces. Design and working face temperature modeling was performed in accordance with Brazilian Regulatory Standards.

The peak projected airflow required for the totality of the Pilar UG Mine, as currently envisioned is 1,067m^3/s. In order to increase the exhaust capacity, the following actions are being undertaken in 2020 and 2021.

- Duplication of the existing ventilation shafts of the P3 circuit, in order to decrease the resistance in the ventilation circuit;
- Develop a new independent circuit for the West Limb, equipped with 2 centrifugal fans; and,
- Install 2 booster fans at L-732 to reduce resistance and direct airflow to the Deepening Extension Project.

The ventilation and cooling requirements as outlined have been captured in the Company's capital and operating cost forecast for the LOM plan. Please refer to Chapters 21 and 22 for additional detail.

19 MARKET STUDIES AND CONTRACTS

19.1 MARKET STUDIES

The COVID-19 pandemic contributed to significant spot copper price volatility throughout 2020. Although the LME copper price increased approximately 27% during the year 2020, the volatility of the metal price resulted in a low of $4,617/t in late March 2020 before closing out the year at $7,804/t, nearly 70% above its yearly low. With that context, the investment community generally expects the copper market to remain tight for the next several years, with the copper price trading in excess of the cost curve. A comprehensive review of third-party market research is outside the scope of this Technical Report; however, a brief synopsis of the major market factors has been provided below.

In excess of 2 Mt of new supply is expected to put modest pressure on spot copper price in the short-term, however increased infrastructure spending and electrification are key drivers that are expected to be positive for copper demand and outpace supply in the medium to long term. More stringent environmental regulation for mines, smelters and refineries as well as within scrap industries may delay the availability of existing and new supply, thereby providing upside pressure to the copper price. Sustained copper price strength will be required to incentivize higher capital intensity, lower-grade copper projects to provide market balance.

Copper concentrate produced by MCSA grades 35% copper and contains low levels of penalty elements. Premium copper concentrates, such as those produced by MCSA, have shown to be attractive to both smelters and metal traders. In the current market environment, and considering the factors above, demand for MCSA's concentrate is expected to remain robust. Concentrate produced by MCSA is sold either to Paranapanema Smelter located in Dias D'Avila, near Salvador, or via international markets from the port in Salvador.

In considering the factors above, the authors of this Report view US$3.00 per lb. as a long-term copper price to be reasonable and in line with the broader industry view.

19.2 CONTRACTS

The following contracts are in place and are material to MCSA's operations:

- A copper concentrate sales agreement is in place with a Brazilian smelter, at terms within industry norms.
- Copper concentrate is transported by truck from the Caraíba Mill to Salvador by local transportation contractor(s). Contract terms are revisited periodically but are considered within industry norms.
- Most electric power has been, and will continue to be, provided by CHESF, a subsidiary of Eletrobras, under the terms of an existing contract valid through 2037. Contract pricing is consistent with the regional power costs and is subject to annual tariff increases based on customary inflationary adjustments. Any additional power is purchased under a 5-year contract with a company that specializes in purchasing power on the open market.
- Diesel and associated pumping and storage infrastructure has been and will continue to be provided by Petrobras under contract valid through 2020. Fuel is provided at a nominal discount to the prevailing market price of the region.
- An ore haulage agreement (equipment) related to the movement of ore from distal operations in the Curaçá Valley is currently in place. MCSA uses the haulage company for movement of ore from the Vermelhos UG Mine.

Existing contracts are renewed and/or re-negotiated from time-to-time commensurate with contracting under the normal course of business.

The authors of this Report relied on MCSA and Ero Copper for commodity price forecasts and the terms of the material contracts for use in the economic analysis contained in Chapter 22 – Economic Analysis. The QPs of this report are of the opinion that the information and studies provided by MCSA and Ero Copper Corp. support the assumptions in the Report. Pricing and contract terms relied upon are within generally acceptable industry norms and consistent with prior operating results.

20 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

This chapter presents a brief overview of the environmental and social aspects related to MCSA's operations in the Curaçá Valley, addressing:

- Permitting requirements and the status of key permits and pending permit applications;
- A brief summary of the results of the environmental studies and overview of environmental and social considerations, if any, that could materially impact the Company's ability to extract the current mineral reserves;
- Conditions (and plans) for waste and tailings disposal, including monitoring and waste water management;
- Overview of the social and community related requirements for the successful operation of the mine(s); and,
- Mine closure (remediation and reclamation) requirements and costs.

20.1 PERMITTING REQUIREMENTS

Environmental licensing requirements were introduced in Brazil by the National Environmental Policy ("PNMA") issued in 1981, and subsequently restated by the 1988 Federal Constitution. Currently, environmental licensing is regulated by a comprehensive framework of federal, state and municipal laws, notably by resolutions 01/1986 and 237/1997 issued by National Environmental Council ("CONAMA"). The Brazilian environmental and safety management system ("SISNAMA") is regulated by the Federal Decree 99.274, which defines the roles and authorities of all environmental agencies, at the federal, state and municipal levels, including CONAMA and the Institute of the Environment and Renewable Natural Resources ("IBAMA") that acts as the federal executive agency as well as numerous state (sectional) and municipal (local) agencies. IBAMA is in charge of licensing activities that may cause national or regional environmental impacts.

Brazil has a singular environmental licensing procedure, with licensing conducted in three stages, including the Preliminary Environmental License, Installation License and Operating License ("LO"). The LO is the most relevant phase for the operations of the MCSA Mining Complex, which is in production. In practice, the LO is granted, or renewed, after the project sponsor demonstrates compliance with all requirements and conditions set out in the prior licenses, including social issues, when applicable. The LO must be renewed on a regular basis under normal operating procedures, with the renewal period varying from two to ten years depending on the nature of the operations.

Each state and municipality has its own environmental agencies that are responsible for the application of their own supplementary environmental norms and standards within their respective jurisdictions, and are responsible for ensuring compliance with all related federal norms. The MCSA operations are licensed by the Bahia State environmental agency (Instituto do Meio Ambiente e Recursos Hídricos, "INEMA") in accordance with Bahia State environmental legislation, notably State Laws 10.431/ 2006 and 11.612/ 2009, and State Decree 15,682/2014 that regulates environmental permitting procedures in the state of Bahia.

The Caraíba Mine (within the Pilar District) feasibility studies were initiated in the late 60's and the mine started commercial operations in 1979, prior to the formation of the current environmental legislation in Brazil. As a result, the Pilar District environmental management plans, (including reclamation plan and closure plans), were developed in current form after the mine was commissioned, following the formation of environmental legislation in Brazil. More recent operations, including those within the Surubim District and the Vermelhos District, were subject to formal environmental permitting processes including environmental impact studies, as more fully described in the next section.

20.2 MCSA ENVIRONMENTAL STUDIES AND BACKGROUND INFORMATION

A list of relevant environmental and social impact studies for each of the primary mining Districts of Pilar, Surubim and Vermelhos are detailed below:

Main Environmental and Social Studies – Pilar District

- BRANDT MEIO AMBIENTE. 2006. Closure plan: Pilar district - Jaguarari, BA - MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2006.
- BRANDT MEIO AMBIENTE. 2007a. Degraded areas reclamation plan to the targets R-22 and R-75: Pilar district - Jaguarari, BA - MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2007.
- BRANDT MEIO AMBIENTE. 2007b. Environmental reclamation of Curaçá River, Sulapa Creek and Pedra de Fogo in the Mineração Caraíba S/A – Plan for desilting of river bed affected areas and revegetation of APP with native species of Caatinga biome: Distrito Pilar - Jaguarari, BA - MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2007.
- BRANDT MEIO AMBIENTE. 2008. Environmental resources agreement term attendance – open pit mines, waste piles and marginal ore: Jaguarari, BA - MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2008b.
- BRANDT MEIO AMBIENTE. 2008. Environmental resources agreement term attendance to the tailing dam: Jaguarari, BA - MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2008.
- BRANDT MEIO AMBIENTE. 2008. Environmental resources agreement term attendance. Item VIII – socioeconomic issues – Núcleo Habitacional de Pilar / Município de Jaguarari Bahia. Jaguarari, BA - MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2008.
- BRANDT MEIO AMBIENTE. 2013. Review of degraded areas reclamation plan – Pilar unit. Distrito Pilar - Jaguarari - BA. Nova Lima, MG, 2013.
- MINERAÇÃO CARAÍBA S/A. 2016. Characterization of the enterprise – Pilar unit. Jaguarari – BA, 2016.
- MINERAÇÃO CARAÍBA S/A. 2010. Attendance survey of the obligations included in the Environmental resources agreement term. Jaguarari – BA, 2010.
- MINERAÇÃO CARAÍBA S/A. 2015. Attendance report of the obligations included in the environmental resources agreement term. Jaguarari – BA, 2015.
- CAROSO, CARLOS Et al. 2013. Socioeconomics and cultural diagnosis. Audits of the sociocultural actuation in the influence area of Mineração Caraíba S/A. Jaguarari – BA, 2013.
- NUNES, JACINTO, 2016. Project of tailings disposal in waste piles of Caraíba Mines. April, 2016.
- BRANDT MEIO AMBIENTE. 2020. Review Closure plan: Pilar district - Jaguarari, BA - MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2020.

- MINERAÇÃO CARAÍBA S/A, 2020. Review Project of tailings disposal in waste piles of Caraíba Mines. December, 2020

Main Environmental and Social Studies – Surubim OP Mine

- COPA CONSULTORIA EM PROJETOS AMBIENTAIS. 2008. Environmental Impact Study - EIA. Copper Ore Mining. Surubim Project. Distrito de Poço de Fora Curaçá – BA. Salvador, BA, 2008.
- BRANDT MEIO AMBIENTE. 2008a. Environmental Impact Study (EIA) - Copper ore mining for extraction of 5.6 million tons in the Surubim Target: Distrito Poço de Fora - Curaçá, BA - MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2008a.
- BRANDT MEIO AMBIENTE. 2014. Closure Plan - Surubim Mine. Curaçá, BA. MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2014.
- BRANDT MEIO AMBIENTE. 2017. Review of degraded areas reclamation plan – Surubim mine. Distrito Pilar - Jaguarari - BA. Nova Lima, MG, 2017.
- MINERAÇÃO CARAÍBA S/A. 2017. Characterization of the enterprise – Surubim Mine. Jaguarari – BA, 2017.
- BRANDT MEIO AMBIENTE. 2020. Review Closure Plan - Surubim Mine. Curaçá, BA. MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2020.

Main Environmental and Social Studies – Vermelhos UG Mine

- MINERAÇÃO VALE DO CURAÇÁ. 2015. Medium Environmental Impact Study – EMI – Projeto Vermelhos. Juazeiro– BA, 2015.
- MINERAÇÃO VALE DO CURAÇÁ. 2015. Characterization of the Enterprise – Vermelhos Project. Juazeiro - BA, 2015.
- COPA CONSULTORIA EM PROJETOS AMBIENTAIS. 2015. Environmental Impact Study - EIA. Copper Ore Mining. Vermelhos Project. - Município de Juazeiro – BA. Salvador, BA, 2015.
- BRANDT MEIO AMBIENTE. 2018. Closure Plan - Vermelhos Mine. Juazeiro, BA. MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2018.
- XYZ Temas, Consultoria e Serviços ltda. 2018. Hydrological and Hydrogeological Study to Evaluate Potential Impacts in Relation to Aquiferos And Wells Existing in the Environment of the Vermelhos Project. Juazeiro, BA. Salvador, BA, 2018
- HIDROGEO, Engenharia e Gestão de Projetos. 2018. Technical Advice: "Technical Evaluation of the Potential of Generating Acid Effluent From Originating Oil Batteries or Another Mining Structure". Vermelhos Project. Juazeiro, BA, Brasil. Belo Horizonte, MG, 2018.
- BRANDT MEIO AMBIENTE. 2020. Review Closure Plan - Vermelhos Mine. Juazeiro, BA. MINERAÇÃO CARAÍBA S/A. Nova Lima, MG, 2020.

The mining and processing operations of the MCSA Mining Complex are located within the Curaça River basin, on the south-eastern margin of the São Francisco River Valley. The region has a semiarid climate, classified as BSh (semiarid - hot) in accordance to Köppen and Geiger. The average annual rainfall is less than 700 mm/year, concentrated to the summer rainy season. Temperatures range from a low of 20°C in the winter months to a high of 40°C in the summer months. Summer average temperatures are 29°C while winter averages are 23°C. Average annual rainfall totals have declined in the region over the last several decades, as illustrated in the following figure.

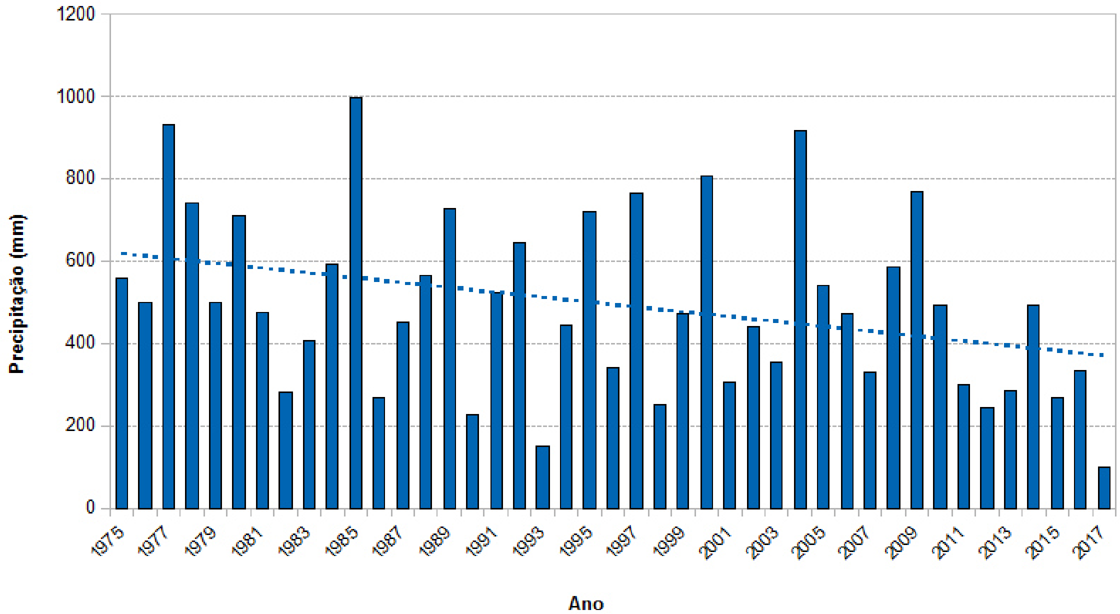


Figure 20-1: Annual Rainfall – Period from 1975 to 2017 (Mandacaru Station – Bahia State).

MCSA's operations are within the Caatinga Biome. The Caatinga consists of small trees, cacti, thick-stemmed plants, and arid grasses. The soils are poorly developed and rocky. The region has been developed since the 17th century and the native vegetation has been altered by extensive livestock grazing and locally, farming activities, with the latter primarily concentrated along the banks of the Sao Francisco River. Population centers in the region are also concentrated along the banks of the major rivers and water reservoirs, aside from villages that receive water vis water pipeline.

The environmental studies for the MCSA Mining Complex have determined that the potential impacts of MCSA's operations in the Curaçá Valley on water resources, local populations and native vegetation are limited. The mining operations are located distal to any natural bodies of water, within a sparsely occupied region and have a limited operational footprint.

Figure 20-2: Typical Caatinga Vegetation (MCSA, 2020)

20.3 STATUS OF MCSA ENVIRONMENTAL PERMITS & LICENSES

The Caraíba Mine, including the integrated processing operations, was granted its most recent renewed LO on April 5, 2017 – valid for three years, and the renewal process remains ongoing. The mining license was issued by Portaria No. 13,776, from INEMA, in support of both the underground operations of the Pilar UG Mine complex and the R22W Mine, with current estimated production rate of 1,440,000 tonnes/year under ANM 812.998/1973 (Portaria de Lavra nº 206/2008, R22W Mine, and 000737/1940 and Manifesto de Mina nº 417/1946). The LO supports the Caraíba Mill with a current estimated processing rate of 3,300,000 tonnes/year as well as administrative and operational support infrastructure, totaling approximately 2,400 ha of permitted area within the five mining concessions.

The first environmental license for the Caraíba Mine was issued in 2000, (CEPRAM Resolution no 1459/97, dated April 10, 2000). The mine's LO has been renewed on a regular basis since 2003, and the current LO was granted on April 6, 2017 – for a three year period, ending on April 6, 2020. The LO remains valid in accordance with State Decree 15,682/2014 that regulates environmental permitting in Bahia. More specifically, Article 159 of the State Decree specifies that environmental permits remain valid after the deadline if the operator of such license submits the renewal permit application within 120 days prior to expiry. MCSA submitted the application timely in accordance with Bahia State Regulation. As at the time of this Report, the permit renewal process has not been formally released from the agency due to the COVID-19 pandemic which resulted in INEMA suspending environmental site inspections, delaying the renewal of numerous environmental permits in Bahia including those of MCSA. In addition to the LO, the Pilar District has specific licenses for chemical products used in the processing and maintenance areas as well as a fuel station which are licensed by the local municipality.

The LO for the Surubim OP Mine was granted by INEMA (Ordinance No. 13.741 / 2010) on September 6, 2017, for a period of two years, expiring on September 6, 2019. The license remains valid, as MCSA applied for the permit renewal in accordance with the Bahia environmental legislation, analogous to the situation described above. The fuel station in Surubim has a specific environmental license issued by the local municipality.

The first Environmental License for the Vermelhos UG Mine was issued by INEMA in 2015 (Ordinance No. 10.559 / 2015) for a three year period. It was further renewed (INEMA Ordinance No. 17.064 dated of October 10, 2018) for a period of two years, ending on October 10, 2020. The license remains valid, in accordance with State Decree 15,682/2014, as MCSA applied in time for the permit renewal, similar to the aforementioned situation for the Caraíba Mine and Surubim OP Mine.

Table 20-1 below details the primary environmental licenses of the MCSA Mining Complex. While some of the licenses are under active renewal or alteration processes, the amendments and renewals are considered normal course of business and such licences remain valid as described above. The authors of this Report have reviewed the permitting requirements and environmental aspects related to the forecast LOM production plan and have not identified any issues that could materially impact MCSA's ability to extract the current mineral reserves of the Curaçá Valley.

Table 20-1: Permitting Chart of the MCSA Mining Complex

Mine/Project	License Scope	Project Phase	License Phase	Permit Period Start	Permit Period Expiry	Status
Caraíba Mine	Mining Operations	Operational	Renewal	April 6, 2017	April 6, 2020	Valid (1)
Caraíba Mine	Chemical Products	Operational	Renewal	October 23, 2020	October 22, 2021	Valid
Caraíba Mine	Fuel Station	Operational	Renewal	May 6, 2020	May 6, 2023	Valid
Surubim OP Mine	Mining Operations	Operational	New	September 6, 2017	September 6, 2019	Valid (1)
Surubim OP Mine	Fuel Station	Operational	Renewal	May 18, 2018	May 18, 2021	Valid
Vermelhos UG Mine	Mining Operations	Operational	New	October 10, 2018	October 10, 2020	Valid (1)
Vermelhos UG Mine	Fuel Station	Operational	New	May 14, 2018	May 14, 2021	Valid

The Operation Licenses for the Pilar, Surubim, and Vermelhos Mines are valid and in compliance with the applicable legislation, specifically the State Decree 15,682/2014 that regulates environmental permitting in the Bahia State.

In addition to the above primary permits, MCSA received an environmental authorization to complete a test open pit within the N8/N9 deposit, issued by INEMA Ordinance No. 20.519, dated April 2020. The authorization is valid for one year and allows MCSA to conduct vegetation removal within the defined pit area and specifies measures to relocate local fauna.

All environmental licenses issued by INEMA have a series of clauses detailing the environmental management procedures to be followed by MCSA, and in some cases, deadlines to present additional studies or to conclude reclamation actions, among others. The Caraíba Mine License has 24 clauses/conditions, the Surubim License has 23 clauses and the Vermelhos License 37 clauses. The MCSA environmental team presented an overview of the status of all clauses of the referred licenses, including conditions that could affect the renewal process. The MCSA environmental team confirmed that the Company complies with all terms of the licenses and it is the opinion of the authors of this Report that there are no identified issues that could adversely impact the renewal of the licenses.

20.3.1 Deepening Extension Project Environmental Permitting

The Deepening Extension Project is considered part of the existing Pilar UG Mine and does not require a material expansion of the existing infrastructure that would require additional permitting. This includes the processing plant, power and water supply systems. The Deepening Extension Project, as currently defined, is not expected to create additional environmental or additional social impacts. Therefore, there is no specific or additional permitting required for the Deepening Extension Project other than periodic renewal requirements obtained in the ordinary course of business.

20.3.2 Water Rights

MCSA has the water rights needed to conduct ongoing mining operations. The main water right was issued by the National Water Agency (Resolution nº18 dated of January 8, 2016), valid for 10 years, allowing the use of up to 1,690,000 m³/month from the São Francisco River via an 86 km water pipeline connecting the pumping station to the Pilar Mine. As noted in Chapter 18, Project Infrastructure, MCSA does not use all of the water pumped from the São Francisco River in its mining and processing operations and provides excess water to several communities located along the pipeline. MCSA also has water rights to exploit three wells in the Vermelhos UG Mine site, granted by INEMA Ordinance No. 10,554 / 2015 and INEMA Ordinance No. 19,285 / 2019, as summarized in the following table.

Table 20-2: Water Rights Status – MCSA Mining Complex

Mine/Project	Water Right	Granted Period		Status
		Start	End	
Caraíba Mine	Water Use Permit (São Francisco River)	January 8, 2016	January 8, 2026	Valid
Vermelhos UG Mine	Groundwater Use Permit (Wells # 1 and 2)	October 6, 2015	October 6, 2019	Valid (1)
Vermelhos UG Mine	Groundwater Use Permit (Well # 3)	October 5, 2019	October 5, 2023	Valid

(1) MCSA submitted the renewal application for the #1 and #2 groundwater wells on time and thus remain valid.

The authors of this Report have reviewed the permitting requirements and environmental aspects related to the LOM production plans proposed by MCSA, and has not identified an issues that could materially impact MCSA's ability to extract the current mineral reserves presented in this Report.

20.4 ENVIRONMENTAL MANAGEMENT – POLLUTION CONTROL

MCSA conducts several pollution control measures, including treatment and monitoring of effluent solutions, emissions reduction measures and air quality monitoring, among others, to ensure compliance within the Brazilian standards established by CONAMA as well as specific permitting terms defined by INEMA.

20.4.1 Liquid Effluents

The effluent discharge system of the Caraíba Mine consists of reclamation pumping, thickeners and treatment facilities to maintain site-wide water quality and reduce consumption of raw water through effluent recycle. Monthly sampling and analysis of effluent solutions is carried out in an effluent monitoring network, all performed in accordance with the Water Resources Quality Monitoring Plan approved under INEMA Ordinance No. 13.776 / 2017. Lubricating oils and hydraulic fluids are collected, stored and sent to third-parties for proper disposal or sold to recycling companies for re-use.

20.4.2 Solid Waste

MCSA operates a controlled landfill for non-hazardous and non-recyclable waste, a composting unit for organic waste and a warehouse for the temporary storage of recyclable waste, all licensed by INEMA through Ordinance 13.776 / 2017. Hazardous waste produced on site is removed from site and sent for proper disposal by licensed third-parties.

For human waste, distal operations such as the Surubim OP Mine and the Vermelhos UG Mine utilize a combination of chemical toilets and septic systems to collect and treat organic effluent as established by the Brazilian Association of Technical Standards, through standards NBR 7,229 and NBR 13,969.

20.4.3 Atmospheric Emissions

MCSA has an Air Quality Monitoring Plan to ensure that air quality standards are met on the site and surrounding areas. Monitoring points are distributed throughout all inhabited areas of the Curaçá Valley to measure total particulates and particulates in suspension that can be inhaled, as specified in the monitoring plan. The main sources of particulate emission in the mining activities of the Vermelhos UG Mine and the Surubim OP Mine are the fugitive emissions from ore haulage along unpaved routes within the area of the mining operations, and along the route to the Caraíba Mine. With ongoing mitigation measures such as haul road dust suppression and air quality monitoring, the environmental impacts in these areas have been deemed reversible and insignificant. Air quality monitoring is carried out in accordance with CONAMA Resolution 003/90.

20.5 DISPOSAL OF TAILINGS

MCSA used a conventional tailings dam until the year 2010. The conventional tailings dam has a capacity of 45 million m^3 and covers an area of approximately 653 ha^2. While inactive, the Company has maintained the dam in operating condition and has a valid environmental license in place for tailings deposition.

Commencing in 1998, MCSA began to integrate Approximately 11% of tailings generated in the Caraíba mill operations are mixed with cement and used in the Pilar UG Mine for paste-backfill operations to enhance mineable recoveries and ground stability. The balance, approximately 89% of the tailings, are disposed over waste rock piles or withing exhausted open pits in an effort to avoid the use of using a conventional tailings dam, improving site-wide water recovery, and reclaiming historically mined open pits. As a result of these ongoing initiatives, MCSA currently employs three different systems for tailings disposal, including:

- Back-fill open stopes within the Pilar UG Mine with cemented paste fill as part of production process;
- Co-disposal of tailings into waste rock stockpiles; and,
- Disposal of tailings in exhausted open pits;

20.5.1 Disposal of tailings – Back-fill Open Stopes

Since 1998, approximately 7.5 million tonnes of tailings have been used to back-fill open stopes at Pilar UG mine utilizing cemented paste backfill. The following figure illustrates the paste fill plant and the backfill operation using tailings.

Figure 20-3: Paste fill plant on surface and underground tailings disposal as cemented paste (MCSA, 2020)

20.5.2 Disposal of tailings, Co-disposal of Tailings

Since 2011, approximately 12.8 million tonnes of tailings, have been sent for co-disposal within the surface waste rock stockpiles. The co-disposal method entails utilizing the inherent void space within the waste rock stockpiles by allowing tailings to permeate the piles and, after fully filled, covering the final surface of the co-disposal pile with soils suitable for revegetation. The process is shown graphically in Figure 20-4 to Figure 20-6 and described in greater detail below. The method has produced excellent results, allowing increased water recovery, significantly reduced pumping costs, creating a substrate for revegetation of the waste rock stockpiles, and, since implementation, has eliminated the need for conventional tailings dam storage.

In practice, waste tailings, after thickening to approximately 65% solids, are pumped to the waste rock stockpiles for co-disposal. Small discrete compacted start rock berms are created along each stockpile to allow the material to be retained when first disposed on the pile. When the berm is completed, pumping maintains 1 m of freeboard along the berm. Operation then is stopped after an initial 21 days to allow time for percolation and drying of the material. After this first cycle, an excavator raises the dike on the top of the initial rock berm according to the design parameters. This lifting process is carried out continuously until the structure reaches the expected final dimensions, as shown in Figure 20-5. Multiple discrete ponds are prepared to allow operators to fill multiple sections according to natural drying sequence, accommodate various percolation rates, and enhance control of the co-disposal process. Revegetation with native plant species of Caatinga is conducted on the fully-completed piles.

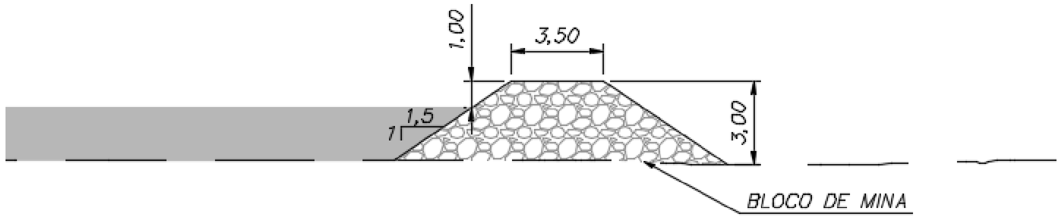


Figure 20-4: Initial dike dimensions prepared for co-disposal (MCSA, 2020)

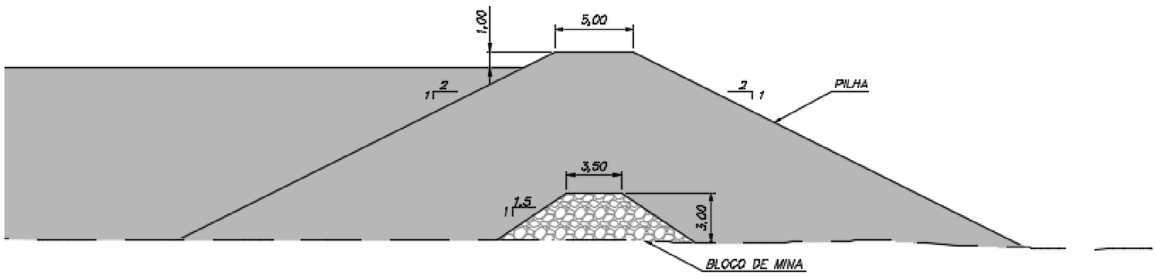


Figure 20-5: Illustrative scheme showing final dimensions of a typical co-disposal stockpile berm (MCSA, 2020)

Based on MCSA's operating history of co-disposal, the system has the following benefits:

- Eliminated the need to utilize the Company's conventional-tailings dam;
- Recover up to 90% of the water from the tailings produced, reducing the freshwater make-up requirements of the operations;
- Reduced pumping costs due to waste rock stockpiles' proximity to the Caraíba Mill; and
- Recontoured berms containing a mixture of coarse and fine particles create an enhanced substrate for revegetation efforts.

Figure 20-6: Photograph of Co-disposal Method on completion of Deposition (MCSA, 2019)

20.5.3 Disposal of tailings – Exhausted Pits

In total, approximately 7.3 million tonnes of tailings have been deposited in depleted open pits at the Caraíba Mine. This process allows topographic restoration and revegetation of previously mined pit areas, as well as promoting the reuse of the water during the disposal process. In practice, after pumping into the depleted pit, fine tailings settle to the bottom of the depleted pit, allowing a pumping and filtration system to deliver fresh water to the process plant for re-use. Upon completion of back-fill, revegetation using native Caatinga plant species can occur.

The sequence of photographs below provides an illustrative example of the evolution of back-filling operations for a previously mined open, known as R75 located in the Pilar District.

Figure 20-7: R75 open pit after its exhaustion in 2010 (MCSA, 2010)

Figure 20-8: R75 open pit during filling in 2011 (MCSA, 2011)

Figure 20-9: R75 open pit commencing revegetation in 2015 (MCSA, 2015)

Figure 20-10: R75 open pit revegetation in 2019 (MCSA, 2019)

20.5.4 Dry-stack Tailing Deposition, Technical Evaluation Work

At the time of this Report, MCSA is currently undertaking a technical study to further evaluate the use of dry-stack tailings disposal on surface in addition to, or as an alternative to, available in-pit and future co-disposal options. There is sufficient space available on surface for long-term disposal of tailings implementing this method. A trade-off study is being conducted to further evaluate disposal options at MCSA considering technical, environmental, and economic aspects. While this review remains ongoing, there are no current plans to integrate dry-stack tailings in the operations.

20.5.5 Tailings Disposal Forecast, LOM Plan

From 2020 to 2033, it is estimated that a total of approximately 10.9 Mt of tailings will be disposed as paste backfill and an additional 12.0 Mt co-disposed on waste stockpiles. The available open pit capacity for tailings disposal in the Pilar District is estimated to total approximately 60 million cubic meters, equivalent to approximately 100 Mt of storage capacity. Based on the updated LOM production plan, 17 Mt of tailings will be disposed into the historic open pit, and with the remaining storage capacity, approximately 83 Mt, sufficient for an additional 20 years of production at a mining and processing rate of 4.2 Mt per annum. In summary, while technical trade-off studies remain ongoing to determine the optimal long-term storage methods considering all current technical, environmental and economic parameters, the authors of this Report have concluded that MCSA has no tailings or waste disposal restrictions that could adversely impact the extraction of the current mineral reserves.

Table 20-3: Tailings disposal historic and forecast (2016 – 2033)

		Historic				Forecast														
	Unit	2016	2017	2018	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**TOTAL**
Ore to Mill	kt	827	1,771	2,258	2,425	2,270	2,722	3,196	3,686	4,162	4,129	4,007	3,940	3,959	3,555	2,808	964	664	1,104	41,166
Tailings Production	kt	812	1,714	2,170	2,303	2,146	2,598	3,071	3,555	4,020	3,995	3,874	3,813	3,826	3,445	2,731	927	629	1,047	39,677
Tailings Disposal Method																				
1 - Pastefill	**kt**		173	115	291	382	417	917	1,216	1,254	1,409	983	954	1,006	745	614	196	375	394	10,861
2 - Co-Deposition (waste piles)	**kt**	739	1,422	1,895	1,793	1,661	2,181	1,954	2,139	2,000	2,031									11,966
Pile 1	kt	386	702	974	850	727	317													1,044
Piles 05, 06 and 07	kt	354	721	921	943	934	1,500	329												2,763
Piles 08, 09, 10 and 11	kt						364	1,625	1,170											3,159
Pile West									969	2,000	2,031									5,000
3 - Within exhausted open pits	**kt**	11	207	157	218	45		200	200	766	555	2,891	2,859	2,826	2,700	2,117	731	254	653	16,797
TOTAL DISPOSAL		750	1,802	2,166	2,302	2,088	2,598	3,071	3,555	4,020	3,995	3,874	3,813	3,826	3,445	2,731	927	629	1,047	39,620

Note: Totals do not include historic amounts, which are shown for reference only.

20.6 RECLAMATION OF DEGRADED AREAS

MCSA has developed Reclamation of Degraded Areas Plans ("PRADs") for each mine currently in operation as well as the past producing mines within the Curaçá Valley. The plans are managed by MCSA personnel in consultation with the environmental agency. The PRADs are reviewed and updated on a regular basis, incorporating new techniques, and rehabilitation alternatives as well as periodic adjustments for depletion, new mining activities and the restart of previously mined areas.

20.7 MINE CLOSURE COST ESTIMATE

Brandt Meio Ambiente, a Brazilian environmental consulting firm, with the support from MCSA's environmental team prepared conceptual mine closure and reclamation plans for each mine currently in operation as well as the past producing mines in the region. The closure cost estimates and trade-off studies are periodically updated by external consultants. The total estimated reclamation costs for the MCSA Mining Complex in the Curaçá Valley is approximately R$89.3 million. The costs were estimated maintaining the synergy in the LOM operations, with the use of resources (labor and equipment) to maintain continuity of operations. These estimates have been reviewed by the authors of this Report, who find the amounts to be reasonable and in-line with expectations given the nature of the operations and operational history of previously performed and ongoing reclamation activities.

20.7.1 Caraíba Mine

The estimated reclamation costs for the Caraíba Mine, excluding operations elsewhere in the Curaçá Valley, totals approximately R$79.0 million. The estimate includes the removal of surface infrastructure, re-contouring, revegetation and reclamation of the SX/EW plant and associated infrastructure. Detail is shown in the table below.

Table 20-4: Summary of Mine Closure Costs for the Caraíba Mine

Caraíba Mine Structures	Estimated Reclamation Cost (R$)
Riparian forest	R$ 6,905,200
Borrow areas	R$ 484,741
Environmental programs elaboration	R$ 494,101
Environmental programs execution	R$ 2,470,508
Pilar Mine Open Pit (historic)	R$ 7,596,571
R-75 (MCA 7) and R-22 (MCA 2) Open Pits	R$ 1,466,707
Underground Mine	R$ 494,101
Historic Tailings Dam	R$ 25,940,494

Waste Stockpiles	R$ 1,873,392
Concentrator Decommissioning	R$ 4,941,019
Operational Support and Infrastructure	R$ 494,101
Total Caraíba Mine Structures	**R$ 53,160,934**
Oxide Leach Facilities	
Environmental programs elaboration	R$ 687,251
Environmental programs execution	R$ 2,290,837
Oxide Ore Stockpiles	R$ 763,612
SX/EW Plant	R$ 1,527,225
Oxidized Waste Piles	R$ 19,960,982
Heap Leach	R$ 610,890
Total Oxide Leach Facilities	**R$ 25,840,798**
Total, Caraíba Mine	R$ **79,001,734**

20.7.2 Surubim OP Mine

The estimated reclamation cost for the Surubim OP Mine totals approximately R$3.4 million. The estimate includes the removal of surface infrastructure, re-contouring, and revegetation. Detail is shown in the table below.

Table 20-5: Summary of Mine Closure Costs for the Surubim OP Mine

Structures	Estimated Reclamation Cost (R$)
Open Pit	R$ 270,000
Waste Stockpiles	R$ 2,176,788
Low-Grade Ore Stockpiles	R$ 260,000
Infrastructure & Operational Support	R$ 725,431
Total	**R$ 3,432,220**

20.7.3 Angicos Mine

The estimated reclamation cost for the Angicos Mine totals approximately R$1.5 million. The estimate includes the removal of surface infrastructure, re-contouring, and revegetation. Detail is shown in the table below.

Table 20-6: Summary of Mine Closure Costs for the Angicos Mine

Structures	Estimated Reclamation Cost (R$)
Open Pit	R$ 260,000
Waste Stockpiles	R$ 382,190
Low-Grade Ore Stockpiles	R$ 420,792
Infrastructure & Operational Support	R$ 488,710
Total	**R$ 1,551,693**

20.7.4 Suçuarana Mine

The estimated reclamation cost for the Suçuarana Mine totals approximately R$1.7 million. The estimate includes the removal of surface infrastructure, re-contouring, and revegetation. Detail is shown in the table below.

Table 20-7: Summary of Mine Closure Costs for the Suçuarana Mine

Structures	Estimated Reclamation Cost (R$)	
Open Pit	R$	164,051
Degraded Areas & Mine Rehabilitation	R$	549,266
Infrastructure & Operational Support	R$	1,022,099
Total	**R$**	**1,735,327**

20.7.5 Vermelhos UG Mine

The estimated reclamation cost for the Vermelhos Mine totals approximately R$3.7 million. The estimate includes the removal of surface infrastructure, re-contouring, and revegetation. Detail is shown in the table below.

Table 20-8: Summary of Mine Closure Costs for the Vermelhos Mine

Structures	Estimated Reclamation Cost (R$)	
Surface Stockpiles	R$	987,377
Degraded Areas & Mine Rehabilitation	R$	153,300
Infrastructure & Operational Support	R$	1,523,660
Total	**R$**	**3,664,338**

20.7.6 Social and Community Outreach

MCSA maintains an excellent relationship with the communities throughout the Curaçá Valley, having held regular meetings and consultation sessions with all stakeholders over the 40 year operating history of the operations. In support of this relationship, MCSA undertakes several key initiatives focused on sustainable community development.

The following table sets out the main programs, projects and social outreach activities carried out by MCSA in the influenced areas of its mining projects in the Curaçá Valley. The table is not intended to be an exhaustive list of all activities and programs supported by MCSA, which are extensive.

Table 20-9: Portfolio of Socio-Environmental Work

Portfolio of Socio-Environmental Work in the Curaçá Valley	
Program	**Project**
Rural Sustainability in the Semiarid	Sheep and Goat Production Chain Leather Workshop Entrepreneurship, a Matter of Attitude Women in Action Community Vegetable Garden Communitary Nursery
Education and Vocational Training	Young Entrepreneurship Firsts Steps (JEPP) - SEBRAE Young Apprentice - SENAI Support of the Pilar Student Association (AEP) Incentive to the Sport of Pilar (PIEP) and Surubim (FEET) - Pilar Club Association
Cultural Identity	Rescue and Valorization of Local Culture
Socio-Environmental Communication	Community Relationship and Participatory Management Plan

20.8 QP STATEMENT ON ENVIRONMENTAL PERMITTING

It is the opinion of the QP responsible for Chapter 20 that there are no identified environmental, social, or licensing concerns that could materially adversely impact the mineral reserve estimates presented in this Report. The QP reviewed and relied upon documentation provided by MCSA's environmental team to evaluate the permitting status and the environmental and social aspects relevant to the Company's production plans.

The authors of this Report have verified that MCSA has an experienced team of social and environmental specialists responsible for environmental and social management matters, who aim to ensure compliance with the applicable legislation and the specific terms of the environmental permits. The MCSA team was able to provide clarification on the status of the main environmental permits for the authors of this Report, which remain in good standing.

In summary, MCSA has adopted and has in place, environmental and social management practices that align with industry best practices, including advanced occupational health and safety programs and adherence to the United Nations' Sustainable Development Goals. The environmental studies prepared for the various mines and facilities were prepared by reputable environmental consultants in Brazil, which were reviewed by the authors of this Report. MCSA can improve its environmental and social management and reporting systems, through the formal adoption of international environmental and social standards, such as the International Finance Corporation, Environmental and Social Standards. The QP recommends the preparation of routine environmental and social audit reports, focused on legal and permitting compliance, as part of its regular reporting protocols.

21 CAPITAL AND OPERATING COSTS

21.1 INTRODUCTION

This chapter summarizes the capital and operating cost estimates for the MCSA Mining assets using historic equipment costing and consumption coefficients, which are applied to the specific demands of the production plan.

The Authors reviewed the capital and operating cost estimates prepared by MCSA and found them to be in accordance with industry best practices, and sufficient for use in support of the current Mineral Reserves estimate.

21.2 CAPITAL COST ESTIMATES

21.2.1 Capital Cost Summary

Total capital investment related to the LOM production plan for the period from October 2020 to December 2033 are estimated to be R$2,767M. Total capital investments include capitalized development as well as ongoing capital requirements. Capital cost projections were estimated based upon vendor quotes and management estimates incorporating historical operating data and previously supplied quotes for the current mine operations. Capital expenditures shown are inclusive of mines for which there are Mineral Reserves and are included in the stated LOM production plan. Specifically, these include: the Pilar UG Mine, Vermelhos UG Mine, Vermelhos District open pit mines (N8 / N9 & Siriema) the Surubim UG mine, and the Surubim District open pit mines (Surubim & C12).

Table 21-1: Total Capital Expenditure Summary

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Capital Costs (R$ 000s)														
Deepening below -965	2,314	108,418	171,209	204,433	206,038	78,018	89,588	49,945	25,767	15,786	53	-	-	-
Equipment	-	34,818	23,548	5,841	20,957	9,277	24,346	4,364	-	-	-	-	-	-
Ventilation and Cooling	-	29,248	49,566	19,708	2,754	4,954	6,603	3,377	3,998	5,901	-	-	-	-
Development	-	21,909	47,031	46,677	38,026	49,448	56,384	39,723	21,716	9,833	-	-	-	-
Shaft	-	13,245	42,573	124,399	135,778	63	-	-	-	-	-	-	-	-
Infrastructure/Other	2,314	9,198	8,492	7,808	8,524	14,275	2,256	2,481	53	53	53	-	-	-
Pilar District (ex-Deepening below -965)	96,974	229,703	166,004	161,739	104,204	79,010	59,365	44,903	15,003	14,171	16,418	6,647	-	-
Development	30,433	98,496	75,020	75,371	80,481	65,210	49,951	25,861	506	-	-	-	-	-
Equipment	1,909	7,872	12,079	7,626	2,748	-	-	-	-	-	-	-	-	-
Mill Improvements	-	-	-	50,000	-	-	-	-	-	-	-	-	-	-
Other (incl. Ventilation & Cooling)	64,632	123,335	78,905	28,742	20,975	13,800	9,415	19,042	14,497	14,171	16,418	6,647	-	-
Vermelhos Underground	9,185	44,315	50,288	39,876	40,720	14,038	395	595	495	495	495	395	-	-
Development	5,576	32,920	33,421	32,596	30,495	13,628	-	-	-	-	-	-	-	-
Equipment	300	1,521	2,346	700	-	-	-	-	-	-	-	-	-	-
Other	3,308	9,874	14,521	6,580	10,225	410	395	595	495	495	495	395	-	-
Vermelhos Open Pit	2,650	29,819	69,234	33,241	57,029	22,945	64,748	66,348	356	-	7,504	-	-	-
Pre-Stripping	2,650	-	9,295	886	35,059	1,345	398	66,348	356	-	32	-	-	-
Equipment	-	23,949	5,489	32,355	-	-	-	-	-	-	-	-	-	-
Ore Sorting	-	-	49,950	-	21,600	21,600	64,350	-	-	-	-	-	-	-
Other	-	5,870	4,500	-	370	-	-	-	-	-	7,472	-	-	-
Surubim Underground	-	-		-	-	-	-	8,180	13,180	12,120	3,290	-	-	-
Development	-	-	-	-	-	-	-	7,680	12,530	11,470	3,290	-	-	-
Equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	500	650	650	-	-	-	-
Surubim Open Pit	3,306	52,215	54,201	52,322	46,072	4,876	10,916	4,194	331	338	345	353	-	-
Pre-Stripping	3,049	47,418	52,165	50,998	44,933	3,920	2,330	3,280	-	-	-	-	-	-
Equipment	-	2,099	-	-	-	-	-	-	-	-	-	-	-	-
Other	257	2,698	2,035	1,324	1,139	955	8,586	914	331	338	345	353	-	-
Total Capital Costs (R$ 000s)	**114,429**	**464,470**	**510,935**	**491,611**	**454,062**	**198,886**	**225,012**	**174,166**	**55,132**	**42,910**	**28,105**	**7,395**	**-**	**-**

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

21.2.2 Capitalized Development

Capitalized development includes underground lateral development, infrastructure and vertical development required for the primary ramps of the Pilar UG Mine, the Vermelhos UG Mine, and the Surubim / C12 UG Mine. Total capitalized development is estimated to be R$1,016M over the LOM production plan.

Table 21-2: Capitalized Development

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Capitalized Development (R$ 000s)														
Deepening below -965	-	21,909	47,031	46,677	38,026	49,448	56,384	39,723	21,716	9,833	-	-	-	-
Pilar District (ex-Deepening below -965)	30,433	98,496	75,020	75,371	80,481	65,210	49,951	25,861	506	-	-	-	-	-
Vermelhos Underground	5,576	32,920	33,421	32,596	30,495	13,628	-	-	-	-	-	-	-	-
Surubim Underground	-	-	-	-	-	-	-	7,680	12,530	11,470	3,290	-	-	-
Total Capital Costs (R$ 000s)	**36,009**	**153,325**	**155,472**	**154,644**	**149,002**	**128,286**	**106,334**	**73,264**	**34,752**	**21,303**	**3,290**	**-**	**-**	**-**

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

21.2.3 Sustaining Capital

Total sustaining capital costs are estimated at R$195M. Sustaining capital consists primarily of equipment rebuilds, equipment replacements, and ongoing reclamation work.

Table 21-3: Sustaining Capital Expenditure

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Sustaining Capital (R$ 000s)														
Deepening below -965	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pilar District (ex-Deepening below -965)	31,800	61,833	49,589	21,101	14,116	1,594	1,531	1,505	200	207	200	200	-	-
Vermelhos Underground	1,539	5,776	459	361	340	300	300	300	300	300	300	300	-	-
Vermelhos Open Pit	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surubim Underground	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surubim Open Pit	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Sustaining Capital Costs (R$ 000s)	**33,339**	**67,609**	**50,048**	**21,462**	**14,456**	**1,894**	**1,831**	**1,805**	**500**	**507**	**500**	**500**	**-**	**-**

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

21.3 OPERATING COST ESTIMATES

21.3.1 Operating Cost Summary

An operating cost model was generated based on actual historic operating costs at MCSA, utilizing specific consumption coefficients based on operational performance, after application of adjustments for differences between ore sources in the stated LOM production plan. Cost estimates are built using first principles incorporating both fixed and variable components to account for production rate variations.

All costs are based on historical operating data. Costs were adjusted annually based on the changes to ore sources including rock support, transport, and infrastructure requirements.

Table 21-4: Operating Cost Summary

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Operating Cost Summary (R$/tonne)														
Pilar UG*	100.12	102.56	105.32	100.68	95.44	91.79	90.34	94.65	93.34	96.99	101.76	175.16	129.96	118.60
Vermelhos Underground*	162.39	151.59	145.58	146.94	152.70	148.69	147.75	-	-	-	-	-	-	-
Vermelhos Open Pit*	-	-	12.32	11.69	12.80	9.87	11.84	12.37	13.72	15.95	13.96	32.84	-	-
Surubim Underground*	-	-	-	-	-	-	-	284.58	113.67	108.40	70.27	-	-	-
Surubim Open Pit*	-	18.26	14.86	14.95	16.01	27.95	35.22	11.17	-	-	-	-	-	-
Plant**	46.85	35.92	33.65	32.02	30.57	31.05	31.09	31.32	30.85	32.39	34.86	47.01	83.52	85.19
Operational Support**	32.11	24.65	19.84	17.45	15.78	15.75	16.15	15.04	13.99	13.73	14.44	24.89	44.51	39.49
G&A**	50.78	34.02	28.98	25.12	22.25	22.43	23.11	23.50	23.39	26.05	32.98	47.09	69.74	65.49

* R$/tonne mined (ore + opex waste)
** R$/tonne processed

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

Table 21-5: C1 Cash Cost Summary

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Operating Costs (R$000s)														
Mining Costs (incl. transport and sorting)	67,830	299,064	369,784	413,498	448,932	543,247	493,964	404,625	415,249	330,385	254,303	158,982	86,495	89,983
Processing	22,558	97,774	107,541	117,623	127,424	126,737	124,240	122,857	123,246	114,924	99,558	68,765	55,454	57,370
Operational Support	15,459	67,107	63,409	64,238	65,731	64,728	64,672	59,096	55,699	48,760	40,896	33,565	29,505	28,952
less: Precious Metal Credits	(18,531)	(70,776)	(72,701)	(76,323)	(82,851)	(78,467)	(78,223)	(74,297)	(77,850)	(64,079)	(44,609)	(25,982)	(20,498)	(28,944)
plus: TC/RCs, Net of Tax	(6,223)	(6,834)	(41,893)	(48,268)	(50,641)	(48,164)	(48,992)	(44,973)	(49,791)	(39,351)	(28,557)	(18,049)	(13,511)	(17,723)
C1 Cash Costs Basis (R$ 000s)	**81,093**	**386,336**	**426,141**	**470,767**	**508,594**	**608,082**	**555,662**	**467,308**	**466,553**	**390,639**	**321,592**	**217,282**	**137,444**	**129,638**
C1 Cash Costs (US$/lb)	**$0.80**	**$0.81**	**$0.90**	**$0.95**	**$0.94**	**$1.19**	**$1.09**	**$0.97**	**$0.92**	**$0.94**	**$1.11**	**$1.28**	**$1.02**	**$0.68**

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

21.3.2 Underground Mine Operating Costs

Underground mining costs consist of the operational costs related to ore extraction at the Pilar UG Mine, Vermelhos UG Mine, and Surubim / C12 UG Mine. Direct mining costs include drilling, blasting, and mucking. Indirect costs include ore and waste transport, mine services, and mine supplies. The average mine operating cost for underground mining in the Pilar District for the period from October 2020 to December 2033 is estimated at R$99.85/t mined, the average mine operating cost for underground mining in the Vermelhos District is estimated at R$143.17/t mined, and the average underground mine operating cost for the Surubim District is R$88.67.

Table 21-6: Operating Costs, Pilar District Underground Mining

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Pilar District UG Costs														
Salaries	42.85	36.35	32.56	28.90	25.94	22.47	21.08	21.59	20.06	26.31	36.68	82.66	49.46	43.37
Operating Materials	23.04	26.33	31.49	31.39	30.59	30.84	30.94	32.68	32.88	30.96	27.17	35.33	33.16	31.30
Maintenance	22.14	26.72	28.22	27.92	27.08	27.08	27.08	28.56	28.62	27.37	24.80	34.27	30.55	28.64
Services & Contracts	5.83	4.58	3.99	3.54	3.20	2.81	2.67	2.80	2.76	3.66	5.13	11.56	6.92	6.07
Public Services	5.45	7.90	8.51	8.44	8.20	8.22	8.23	8.68	8.70	8.28	7.42	10.07	9.12	8.57
Others	0.80	0.68	0.55	0.48	0.43	0.37	0.35	0.35	0.31	0.40	0.56	1.26	0.76	0.66
Total	100.12	102.56	105.32	100.68	95.44	91.79	90.34	94.65	93.34	96.99	101.76	175.16	129.96	118.60

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

Table 21-7: Operating Costs, Vermelhos District Underground Mining

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Vermelhos District UG Costs														
Salaries	41.97	35.43	36.17	35.61	39.11	36.20	35.05	-	-	-	-	-	-	-
Operating Materials	27.03	23.85	17.50	17.83	18.12	18.01	18.08	-	-	-	-	-	-	-
Maintenance	20.64	16.14	13.89	14.15	14.40	14.29	14.33	-	-	-	-	-	-	-
Services & Contracts	54.91	67.21	69.50	70.68	72.19	71.43	71.52	-	-	-	-	-	-	-
Public Services	17.45	8.63	8.19	8.33	8.50	8.41	8.43	-	-	-	-	-	-	-
Others	0.38	0.33	0.34	0.34	0.37	0.34	0.33	-	-	-	-	-	-	-
Total	162.39	151.59	145.58	146.94	152.70	148.69	147.75	-	-	-	-	-	-	-

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

Table 21-8: Operating Costs, Surubim District Underground Mining

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Surubim District UG Costs														
Salaries	-	-	-	-	-	-	-	108.81	56.64	54.01	26.87	-	-	-
Operating Materials	-	-	-	-	-	-	-	27.73	14.44	13.77	6.85	-	-	-
Maintenance	-	-	-	-	-	-	-	14.34	7.46	7.12	3.54	-	-	-
Services & Contracts	-	-	-	-	-	-	-	107.38	21.44	20.45	26.51	-	-	-
Public Services	-	-	-	-	-	-	-	18.93	9.86	9.40	4.68	-	-	-
Others	-	-	-	-	-	-	-	7.39	3.84	3.67	1.82	-	-	-
Total	-	-	-	-	-	-	-	284.58	113.67	108.40	70.27	-	-	-

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

21.3.3 Open Pit Mine Operating Costs

Open pit mining costs consist of the operational costs related to ore extraction at the Surubim OP, C12 OP, N8 / N9 OP, and Siriema OP Mines including all transport from mines to processing plant as well as any costs associated with ore sorting. Direct mining costs include drilling, loading, and mucking. Indirect mining costs include ore and waste transport, mine services, and mine supplies. The average open pit mine operating cost for the Surubim District for the period from October 2020 to December 2033 is estimated at R$16.58/t moved and the average open pit mine operating cost for the Vermelhos District is estimated at R$13.28/t moved.

Table 21-9: Operating Costs, Vermelhos District Open Pit Mining

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Vermelhos District OP Costs														
Salaries	-	-	2.72	2.58	2.82	2.17	2.61	2.73	3.02	3.52	3.08	7.24	-	-
Operating Materials	-	-	1.59	1.51	1.65	1.27	1.52	1.59	1.77	2.05	1.80	4.23	-	-
Maintenance	-	-	1.22	1.16	1.27	0.98	1.17	1.23	1.36	1.58	1.38	3.25	-	-
Services & Contracts	-	-	5.96	5.66	6.20	4.78	5.73	5.99	6.64	7.72	6.76	15.90	-	-
Public Services	-	-	0.79	0.75	0.82	0.63	0.76	0.80	0.88	1.03	0.90	2.11	-	-
Others	-	-	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.05	0.04	0.10	-	-
Total	-	-	12.32	11.69	12.80	9.87	11.84	12.37	13.72	15.95	13.96	32.84	-	-

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

Table 21-10: Operating Costs, Surubim District Open Pit Mining

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Surubim District OP Costs														
Salaries	-	6.02	4.90	4.93	5.28	9.21	11.61	3.68	-	-	-	-	-	-
Operating Materials	-	4.37	3.56	3.58	3.84	6.70	8.44	2.67	-	-	-	-	-	-
Maintenance	-	0.23	0.19	0.19	0.20	0.36	0.45	0.14	-	-	-	-	-	-
Services & Contracts	-	7.51	6.11	6.15	6.59	11.50	14.49	4.59	-	-	-	-	-	-
Public Services	-	0.09	0.07	0.07	0.08	0.13	0.17	0.05	-	-	-	-	-	-
Others	-	0.04	0.03	0.03	0.03	0.06	0.07	0.02	-	-	-	-	-	-
Total	-	18.26	14.86	14.95	16.01	27.95	35.22	11.17	-	-	-	-	-	-

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

21.3.4 Processing Costs, Caraíba Mill

The Caraíba Mill is a conventional three-stage crush and flotation operation producing a high-grade copper concentrate. The plant operates 24 hours per day, seven days per week. The primary components of plant costs are salaries, operating materials, and power. These costs account for approximately 23%, 25%, and 31% of total plant costs, respectively. The average processing cost for the period October 2020 to December 2033 is estimated to be R$34.69/t processed.

Table 21-11: Processing Costs

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Plant Costs														
Salaries	18.23	11.16	9.80	8.50	7.53	7.59	7.82	7.95	7.91	8.81	11.16	23.89	47.18	41.37
Operating Materials	10.80	10.59	9.51	9.45	9.30	9.48	9.39	9.42	9.24	9.45	9.37	8.36	12.57	16.08
Maintenance	5.21	4.33	5.31	5.30	5.24	5.35	5.29	5.30	5.20	5.30	5.19	4.27	6.13	8.33
Services & Contracts	1.05	0.75	0.68	0.59	0.52	0.53	0.54	0.55	0.55	0.61	0.77	1.65	3.27	2.87
Public Services	11.00	8.85	8.16	8.01	7.82	7.96	7.91	7.94	7.80	8.04	8.15	8.35	13.42	15.70
Others	0.57	0.24	0.20	0.17	0.15	0.15	0.16	0.16	0.16	0.18	0.23	0.48	0.96	0.84
Total	46.85	35.92	33.65	32.02	30.57	31.05	31.09	31.32	30.85	32.39	34.86	47.01	83.52	85.19

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

21.3.5 G&A, Operational Support, and Selling Costs

General and administrative costs include sales expenses related to concentrate transport, assaying, insurance, other sales related expenditures and administrative expenses.

General and administrative ("G&A") costs include general support items, most notably site security, employee transport to site, mine site dining services, and unallocated maintenance activities.

Selling costs reflect the cost to transport concentrate from the concentrate shed to the place of sale.

Over the period October 2020 to December 2033, the total average G&A cost is estimated to be R$28.14/t processed and operational support and selling costs are estimated to be R$17.82/t processed.

Table 21-12: G&A Costs

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
G&A Costs														
Salaries	22.72	18.30	13.95	12.10	10.71	10.80	11.12	11.31	11.26	12.54	15.88	22.67	33.58	29.44
Operating Materials	0.37	0.26	0.30	0.26	0.23	0.23	0.24	0.24	0.24	0.27	0.34	0.49	0.73	0.64
Maintenance	0.24	0.03	0.11	0.09	0.08	0.08	0.09	0.09	0.09	0.10	0.12	0.18	0.26	0.23
Services & Contracts	23.60	12.40	12.44	10.79	9.55	9.63	9.92	10.09	10.04	11.19	14.16	20.22	29.94	26.26
Public Services	0.19	0.16	0.12	0.11	0.09	0.10	0.10	0.10	0.10	0.11	0.14	0.20	0.30	0.26
Others	3.66	2.88	2.05	1.78	1.58	1.59	1.64	1.67	1.66	1.85	2.34	3.34	4.94	8.67
Total	50.78	34.02	28.98	25.12	22.25	22.43	23.11	23.50	23.39	26.05	32.98	47.09	69.74	65.49

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

Table 21-13: Operational Support and Selling Costs

	Q4 2020 (1)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Operational Support Costs														
Salaries	11.26	7.26	6.75	5.85	5.18	5.23	5.38	4.93	4.41	4.43	5.04	9.72	17.27	13.63
Operating Materials	0.28	0.73	0.25	0.22	0.19	0.20	0.20	0.18	0.17	0.17	0.19	0.36	0.65	0.51
Maintenance	0.27	0.32	0.16	0.14	0.13	0.13	0.13	0.12	0.11	0.11	0.12	0.23	0.42	0.33
Services & Contracts	19.37	15.63	12.18	10.81	9.90	9.82	10.04	9.45	8.98	8.71	8.72	13.86	24.91	24.02
Public Services	0.38	0.15	0.13	0.11	0.10	0.10	0.10	0.09	0.08	0.08	0.09	0.18	0.32	0.26
Others	0.55	0.57	0.37	0.32	0.28	0.28	0.29	0.27	0.24	0.24	0.27	0.53	0.94	0.74
Total	32.11	24.65	19.84	17.45	15.78	15.75	16.15	15.04	13.99	13.73	14.44	24.89	44.51	39.49

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

22 ECONOMIC ANALYSIS

22.1 INTRODUCTION

The economic analysis of MCSA's Vale do Curaçá mineral assets is based solely on mineral reserves and does not include Measured and Indicated mineral resources which are not mineral reserves. The economic analysis presented captures all of the Company's Curaçá Valley assets.

The economic results consider that the date of first production and corresponding capital and operating costs will commence on the Effective Date. Reclamation costs have not been considered in the economic analysis provided below, please refer to Chapter 20.7 for estimated reclamation liabilities. A summary of the key criteria and assumptions are provided below. All amounts are shown in BRL unless otherwise noted.

GE21 and BNA have reviewed and verified the economic analysis prepared by MCSA in conjunction with the capital and operating estimates presented in this Report and confirms the outcome is a positive economic result in support of the statement of the mineral reserves.

22.2 REVENUES

- Total ore processed of 39.4 million tonnes at an average feed grade of 1.33% copper.
- Total sales of 480,802 tonnes of contained copper in concentrate.
- Payabililty, treatment and refining charges based on contracts currently in place.
- By-product revenue based on historic average gold and silver in concentrate of 2.1g/t and 41g/t, respectively.
- Copper price of US$3.00 per lb., gold and silver prices of US$1,750 and US$18.00 per ounce, respectively.
- USD:BRL exchange rate of 5.00 in years 2020 through 2033.
- Total undiscounted Net Revenue of R$15.8 billion including R$46.2 million in other revenues comprised of insurance recovery payments, scrap sales, and water pipeline operating cost recovery.

22.3 COSTS

- Total capital expenditures of R$2.8 billion million including capitalized development.
- Total operating expenditures of R$7.5 billion including G&A.

22.4 TAXATION & ROYALTIES

GE21 and BNA have relied upon MCSA for the calculations related to royalties and taxation including:

- CFEM royalty based on 2% of gross revenue.
- Incentivo Sudene adjusted income tax of 6.25%.
- Social contribution on profits based on 9% of taxable income base.
- Application of available tax credits for federal PIS/Confins tax credits and ICMS credits on export sales.

- Utilization of MCSA tax loss pools from the MCSA Mining Complex.

22.5 AFTER-TAX CASH FLOW & SENSITIVITY ANALYSIS

The Vale do Curaçá mineral assets comprising the MCSA Mining Complex produce an undiscounted after-tax cash flow of R$5.2 billion, or US$1.0 billion.

The after-tax NPV at an 8% discount rate is US$663.7 million.

The MCSA Mining Complex cash flow forecast is shown in Table 22-1. Sensitivity analyses were performed considering changes in copper price, foreign exchange rates, capital costs and operating costs. The MCSA Mining Complex cash flow is most sensitive to changes in metal price and foreign exchange. The results of the analyses are shown in

Table 22-2.

Average C1 cash costs over the production forecast period are estimated to be US$0.97 per lb of copper produced. A reconciliation of C1 cash costs is presented in Table 22-3. C1 cash costs per lb. of copper produced is a non-IFRS measure, refer to Chapter 22.6 for a description of non-IFRS measures.

Table 22-1: After-tax Cash Flow Summary – MCSA Mining Complex

Assumptions		2020 [1]	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Exchange Rate	R$/US$	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Copper Price	US$/tonne	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614
Copper Price	US$/lb	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Production															
Ore Processed	tonnes	481,500	2,722,259	3,195,865	3,685,914	4,162,318	4,128,927	4,007,498	3,940,287	3,959,190	3,554,640	2,807,691	1,310,943	663,931	757,090
Copper Grade Processed	%	2.07	1.70	1.46	1.34	1.29	1.23	1.26	1.22	1.27	1.17	1.04	1.28	1.98	2.42
Metallurgical Recovery	%	92.5	92.8	92.0	91.5	91.3	91.1	91.2	91.0	91.2	90.8	90.2	91.3	93.5	94.5
Copper Contained	**tonnes**	**9,234**	**43,032**	**42,940**	**45,080**	**48,936**	**46,346**	**46,202**	**43,883**	**45,982**	**37,848**	**26,348**	**15,346**	**12,283**	**17,343**
Copper Contained	**lbs**	**20,358,107**	**94,868,533**	**94,667,248**	**99,383,625**	**107,884,558**	**102,175,902**	**101,857,551**	**96,745,835**	**101,372,188**	**83,439,963**	**58,087,148**	**33,832,134**	**27,078,774**	**38,235,472**
Capex															
Total Capex	**000 R$**	**114,429**	**464,470**	**510,935**	**491,611**	**454,062**	**198,886**	**225,012**	**174,166**	**55,132**	**42,910**	**28,105**	**7,395**	**-**	**-**
Operating Costs															
Mining Costs (incl. transport and sorting)	000 R$	67,830	299,064	369,784	413,498	448,932	543,247	493,964	404,625	415,249	330,385	254,303	158,982	86,495	89,983
General & Administrative	000 R$	24,451	92,606	92,606	92,606	92,606	92,606	92,606	92,606	92,606	92,606	92,606	61,737	46,303	46,303
Operational Support	000 R$	15,459	67,107	63,409	64,238	65,731	64,728	64,672	59,096	55,699	48,760	40,896	33,565	29,505	28,952
Processing	000 R$	22,558	97,774	107,541	117,623	127,424	126,737	124,240	122,857	123,246	114,924	99,558	68,765	55,454	57,370
Sub Total	**000 R$**	**130,298**	**556,551**	**633,340**	**687,964**	**734,693**	**827,318**	**775,482**	**679,184**	**686,800**	**586,674**	**487,363**	**323,049**	**217,757**	**222,608**
Depreciation/Exhaustion	**000 R$**	**20,312**	**103,289**	**135,100**	**174,210**	**211,009**	**202,139**	**227,548**	**173,398**	**166,473**	**157,345**	**163,732**	**132,001**	**99,577**	**64,594**
Total Costs	**000 R$**	**150,610**	**659,840**	**768,440**	**862,174**	**945,702**	**1,029,457**	**1,003,030**	**852,582**	**853,273**	**744,020**	**651,095**	**455,050**	**317,334**	**287,203**
Revenue															
Copper Sales	tonnes	9,234	43,032	42,940	45,080	48,936	46,346	46,202	43,883	45,982	37,848	26,348	15,346	12,283	17,343
Gross Metal Revenue	000 R$	305,378	1,423,035	1,420,016	1,490,762	1,618,277	1,532,647	1,527,871	1,451,195	1,520,591	1,251,606	871,312	507,485	406,184	573,535
Total Net Metal Revenue	000 R$	317,825	1,393,131	1,405,441	1,479,757	1,604,549	1,519,813	1,516,204	1,440,293	1,508,256	1,243,658	868,006	506,617	402,016	568,294
Other Revenue [2]	000 R$	981	3,924	3,444	3,444	3,444	3,444	3,444	3,444	3,444	3,444	3,444	3,444	3,444	3,444
Total Net Revenue	**000 R$**	**318,806**	**1,397,055**	**1,408,885**	**1,483,201**	**1,607,993**	**1,523,257**	**1,519,648**	**1,443,737**	**1,511,700**	**1,247,102**	**871,450**	**510,061**	**405,460**	**571,738**
Revenue Invoiced with Taxes Added Back	*000 R$*	*352,974*	*1,520,801*	*1,587,114*	*1,666,185*	*1,808,704*	*1,712,998*	*1,707,661*	*1,621,962*	*1,699,523*	*1,398,886*	*973,842*	*567,202*	*454,123*	*641,225*
Cash Flow															
Revenue Invoiced with Taxes Added Back	000 R$	352,974	1,520,801	1,587,114	1,666,185	1,808,704	1,712,998	1,707,661	1,621,962	1,699,523	1,398,886	973,842	567,202	454,123	641,225
Opex (ex-Depreciation & Exhaustion)	000 R$	(130,298)	(556,551)	(633,340)	(687,964)	(734,693)	(827,318)	(775,482)	(679,184)	(686,800)	(586,674)	(487,363)	(323,049)	(217,757)	(222,608)
Less Capitalized Development [3]	000 R$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Income & Social Contribution Taxes	000 R$	(30,933)	(145,288)	(146,982)	(157,834)	(173,416)	(153,818)	(161,588)	(163,141)	(186,304)	(157,278)	(101,334)	(55,120)	(39,547)	(74,284)
Other Taxes & Credits	000 R$	19,976	47,229	(6,932)	(5,644)	(1,883)	-	-	-	-	-	-	-	-	-
Employee Profit Sharing & Bonuses	000 R$	-	(23,927)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)	(35,820)
Operating Cash Flow	**000 R$**	**211,720**	**842,264**	**764,040**	**778,923**	**862,893**	**696,042**	**734,770**	**743,817**	**790,600**	**619,114**	**349,325**	**153,213**	**160,999**	**308,513**
CAPEX	000 R$	(114,429)	(464,470)	(510,935)	(491,611)	(454,062)	(198,886)	(225,012)	(174,166)	(55,132)	(42,910)	(28,105)	(7,395)	-	-
Free Cash Flow	**000 R$**	**97,291**	**377,795**	**253,105**	**287,312**	**408,830**	**497,156**	**509,758**	**569,651**	**735,468**	**576,204**	**321,220**	**145,818**	**160,999**	**308,513**
Accumulated Free Cash Flow	000 R$	97,291	475,086	728,190	1,015,502	1,424,333	1,921,488	2,431,246	3,000,898	3,736,366	4,312,570	4,633,790	4,779,607	4,940,606	5,249,119
Free Cash Flow	**000 US$**	**19,458**	**75,559**	**50,621**	**57,462**	**81,766**	**99,431**	**101,952**	**113,930**	**147,094**	**115,241**	**64,244**	**29,164**	**32,200**	**61,703**
Accumulated Free Cash Flow	000 US$	19,458	95,017	145,638	203,100	284,867	384,298	486,249	600,180	747,273	862,514	926,758	955,921	988,121	1,049,824
EBITDA	**000 R$**	**188,508**	**840,504**	**775,544**	**795,237**	**873,300**	**695,939**	**744,166**	**764,554**	**824,901**	**660,428**	**384,087**	**187,012**	**187,702**	**349,129**
EBITDA	**000 US$**	**37,702**	**168,101**	**155,109**	**159,047**	**174,660**	**139,188**	**148,833**	**152,911**	**164,980**	**132,086**	**76,817**	**37,402**	**37,540**	**69,826**

Discount Rate	%pa	8%
Results		
After-Tax NPV_8	000 US$	663,663
IRR	%pa	n/a
Simple Payback	years	n/a

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020
(2) Other Revenue includes recovery of water pipeline operating costs and scrap sales

Table 22-2: After-tax Sensitivity Analysis – MCSA Mining Complex

Parameters	Units	-20%	-15%	-10%	-5%	Base Case	+5%	+10%	+15%	+20%
Copper Price	LT US$/tonne Cu	5,291	5,622	5,953	6,283	6,614	6,945	7,275	7,606	7,937
	NPV - 000 US$ [1]	233,890	341,333	448,776	556,220	663,663	771,107	878,550	985,994	1,093,431
	IRR - %/year	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Foreign Exchange	LT R$/US$	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
	NPV - 000 US$ [1]	292,362	401,568	498,641	585,495	663,663	734,381	798,682	857,386	911,198
	IRR - %/year	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Capex	000 US$	442,738	470,410	498,081	525,752	553,423	581,094	608,765	636,436	664,108
	NPV - 000 US$ [1]	751,297	729,388	707,480	685,572	663,663	641,755	619,847	597,938	576,030
	IRR - %/year	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Opex	000 US$	1,433,498	1,523,092	1,612,686	1,702,279	1,791,873	1,881,467	1,971,060	2,060,654	2,150,248
	NPV - 000 US$ [1]	864,072	813,970	763,868	713,766	663,663	613,561	563,459	513,357	463,254
	IRR - %/year	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

(1) NPV shown assumes 8% discount rate

Table 22-3: Forecast C1 Cash Cost Summary – MCSA Mining Complex

		2020 [1]	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Exchange Rate	R$/US$	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Ore Processed	(tonnes)	481,500	2,722,259	3,195,865	3,685,914	4,162,318	4,128,927	4,007,498	3,940,287	3,959,190	3,554,640	2,807,691	1,310,943	663,931	757,090	39,378,052
Copper Contained	**(tonnes)**	**9,234**	**43,032**	**42,940**	**45,080**	**48,936**	**46,346**	**46,202**	**43,883**	**45,982**	**37,848**	**26,348**	**15,346**	**12,283**	**17,343**	**480,802**
Copper Contained	**(lbs)**	**20,358,107**	**94,868,533**	**94,667,248**	**99,383,625**	**107,884,558**	**102,175,902**	**101,857,551**	**96,745,835**	**101,372,188**	**83,439,963**	**58,087,148**	**33,832,134**	**27,078,774**	**38,235,472**	**1,059,987,038**
Mining Costs (incl. transport and sorting)	000 R$	67,830	299,064	369,784	413,498	448,932	543,247	493,964	404,625	415,249	330,385	254,303	158,982	86,495	89,983	4,376,343
Operational Support	000 R$	15,459	67,107	63,409	64,238	65,731	64,728	64,672	59,096	55,699	48,760	40,896	33,565	29,505	28,952	701,817
Processing	000 R$	22,558	97,774	107,541	117,623	127,424	126,737	124,240	122,857	123,246	114,924	99,558	68,765	55,454	57,370	1,366,071
Sub Total	**000 R$**	**105,847**	**463,945**	**540,735**	**595,359**	**642,087**	**734,712**	**682,876**	**586,578**	**594,194**	**494,069**	**394,757**	**261,312**	**171,454**	**176,305**	**6,444,231**
less: Precious Metal Credits	000 R$	(18,531)	(70,776)	(72,701)	(76,323)	(82,851)	(78,467)	(78,223)	(74,297)	(77,850)	(64,079)	(44,609)	(25,982)	(20,498)	(28,944)	(814,132)
plus: TC/RCs, Net of Tax	000 R$	(6,223)	(6,834)	(41,893)	(48,268)	(50,641)	(48,164)	(48,992)	(44,973)	(49,791)	(39,351)	(28,557)	(18,049)	(13,511)	(17,723)	(462,970)
Total	**000 R$**	**81,093**	**386,336**	**426,141**	**470,768**	**508,594**	**608,081**	**555,662**	**467,308**	**466,553**	**390,639**	**321,592**	**217,282**	**137,444**	**129,638**	**5,167,130**
C1 Cash Cost	**R$/lb**	**3.98**	**4.07**	**4.50**	**4.74**	**4.71**	**5.95**	**5.46**	**4.83**	**4.60**	**4.68**	**5.54**	**6.42**	**5.08**	**3.39**	**4.87**
C1 Cash Cost	**US$/lb**	**0.80**	**0.81**	**0.90**	**0.95**	**0.94**	**1.19**	**1.09**	**0.97**	**0.92**	**0.94**	**1.11**	**1.28**	**1.02**	**0.68**	**0.97**

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

22.6 NON-IFRS MEASURES

22.6.1 C1 cash cost of copper produced (per lb.)

C1 cash cost of copper produced (per lb) is the sum of production costs, net of capital expenditure development costs and by-product credits, divided by the copper pounds produced. C1 cash costs reported by the Company include treatment, refining charges, offsite costs, and certain tax credits relating to sales invoiced to the Company's Brazilian customer on sales. By-product credits are calculated based on precious metal sales (net of treatment costs) during the period divided by the total pounds of copper produced during the period. C1 cash cost of copper produced per pound is a non-IFRS measure used by the Company to manage and evaluate operating performance of the Company's operating mining unit, and is widely reported in the mining industry as benchmarks for performance, but does not have a standardized meaning.

22.6.2 Earnings before interest, taxes, depreciation and amortization (EBITDA)

EBITDA represents earnings before interest expense, income taxes, depreciation, and amortization. Adjusted EBITDA includes further adjustments for non-recurring items and items not indicative to the future operating performance of the Company. The Company believes EBITDA and adjusted EBITDA are appropriate supplemental measures of debt service capacity and performance of its operations.

23 ADJACENT PROPERTIES

The information contained in this Report is based solely on the MCSA Mining Complex and the mineral assets therein.

24 OTHER RELEVANT DATA AND INFORMATION

The results of an independent preliminary economic assessment developed for the extraction of the Inferred mineral resources defined within the Deepening Extension Zone of the Pilar UG Mine are considered relevant to the conclusions and recommendations of the 2020 LOM plan, since they describe the Company's work undertaken on the project and indicate future potential of this deposit as well as shared synergies between the Deepening Inferred Project, as described herein, and the envisioned Deepening Extension Project, as more fully described in Chapters 15, 16 and 18 of this Report.

24.1 INTRODUCTION TO DEEPENING INFERRED PROJECT

The Deepening Inferred Project is based upon an ongoing exploration campaign in the Pilar UG mine below level -965 which as at the Effective Date, had identified a significant portion of Inferred mineral resources within the Deepening Extension Zone. Given the intrinsic synergies associated with the Deepening Extension Project, MCSA commissioned NCL to undertake engineering and trade-off studies for the development of the Deepening Inferred Project.

The Deepening Inferred Project is preliminary in nature and based on the Inferred mineral resources of the Deepening Extension Zone which are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that the Deepening Inferred Project will be realized. Mineral resources that are not mineral reserves do not have a demonstrated economic viability. The Company has commenced a program to continue infill drilling of the Inferred resource to further upgrade this material; however, until this work is completed and the Inferred resources have been upgraded to reserves, there is no certainty this material will be converted into mineral reserves.

24.2 MINE DESIGN, DEEPENING INFERRED PROJECT

24.2.1 Inferred Mineral Resources and Modifying Factors, Deepening Extension Zone

Production from the mineral reserves of the Deepening Extension Project as outlined elsewhere in this Report will be supported by the construction of a new 4.5 m diameter external shaft, as further detailed in Chapter 15 and 18. In the Company's updated LOM plan, Inferred mineral resources, where unavoidably mined were reported at zero grade.

The primary objective of the Deepening Inferred Project is to evaluate the potential to utilize the planned infrastructure to mine and process the Inferred mineral resources within the in the Pilar UG Mine Deepening Extension Zone, as well as evaluate the potential for the integration of required development in support of the Deepening Inferred Project. Inferred mineral resources of the Pilar UG Mine, Deepening Extension Zone are detailed below. Mineral resources which are not mineral reserves do not have demonstrated economic viability. Please refer to Chapter 14 for additional details on the determination of Inferred mineral resources within the Deepening Extension Zone.

The Deepening Inferred Project envisions application of the same mining and recovery methods as the Deepening Extension Project as more fully described in Chapters 13, 15 and 16 of this Report. Accordingly, the same mining, recovery and dilution modifying factors have been applied to the Deepening Inferred Project. Specifically, these modifying factors include: mining recovery of 96% and dilution that varies with stope height. For planned stopes with a height above 35 m, dilution of 15% has been applied, while for planned stopes with a height of 26 m, dilution of 7% has been applied.

The assumed available material and contained copper based on these parameters, after application of stated mining factors, is shown in the table below. Modified Inferred mineral resources are not mineral reserves. Mineral resources that are not mineral reserves do not have a demonstrated economic viability.

Table 24-1: Modified Inferred Mineral Resources in the Pilar UG Mine Below Level -965

	Deepening Extension Zone, Inferred Resources	Deepening Inferred Project, Captured Inferred Resource
Tonnes (000s)	4,476	4,203
Grade (% Cu)	2.12	2.01
Contained Cu (000 tonnes)	**94.8**	**84.5**

Deepening Inferred Project Notes:

4. Mineral resource effective date of August 8, 2020. All figures have been rounded to the relative accuracy of the estimates. Summed amounts may not add due to rounding. Mineral resources which are not mineral reserves do not have demonstrated economic viability.
5. The Inferred mineral resources (undiluted) outlined in this table are further detailed in Chapter 14 – Mineral Resource Estimates, of this Report. Mineral resources of the Pilar Mine are based on copper prices of US$2.90 per pound, net smelter return of 94.53%, average metallurgical recoveries of 90.7%, processing costs of US$5.65 per tonne (run of mine) and mining costs of US$17.30 per tonne.
6. Mineral resources have been constrained within newly developed 3D lithology models applying a 0.45% and 0.20% copper grade envelope for high and marginal grade, respectively. Within these envelopes, mineral resources for underground deposits were constrained using varying stope dimensions of up to 20m by 10m by 35m applying a 0.51% copper cut-off grade, as well as a 0.32% copper marginal cut-off grade. Mineral resources have been estimated using ordinary kriging inside 5m by 5m by 5m block sizes. The mineral resource estimates were prepared in accordance with the CIM Standards, and the CIM Guidelines, using geostatistical and/or classical methods, plus economic and mining parameters appropriate to the deposit. Please refer to Chapter 14 – Mineral Resource Estimates of this Report for additional details.

24.2.2 Stope Optimization

To optimize the stope design of the Inferred mineral resource, a cut-off-grade of 0.70% copper was used and SO runs were performed with the inferred resources maintained at the mineral resource grade within the volume. SO was configured for the levels between -1531L and -991L. Mining operations were assumed to be the same as for the Deepening Inferred Project, using a combination of transverse stoping and longitudinal stoping mining method. Dilution was set to 1.0 m, comprised of 0.5 m for the hanging wall, 0.5m for the footwall and a maximum waste percentage of 75%. The optimization by SO was run along the X axis (east coordinate), with the other two axes fixed at 15 m (Y) and 26 m (Z).

The current geological model indicates that mineralization within the Deepening Extension Zone, as defined by drilling to date, tends to increase in copper grades at depth – future drilling campaigns should confirm this. Average stope grades are presented in the figure below.

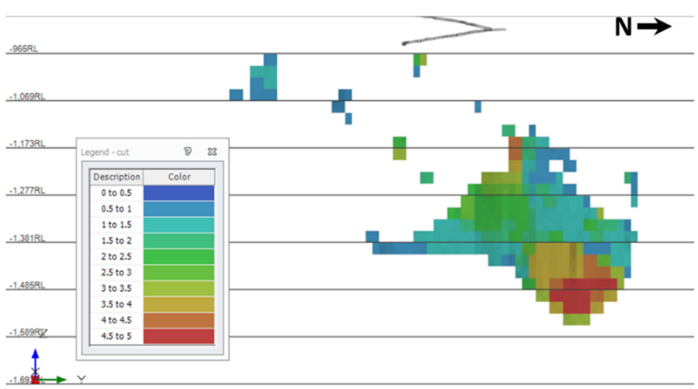


Figure 24-1: Copper Grade Distribution (%), Deepening Inferred Project (MCSA, 2020)

Extraction of mined material from the Deepening Inferred Project required the addition of two new panels below -1381L, as the production panels and supporting infrastructure to be built from level -1069 to -1381 are shared by the Deepening Extension Project. The distribution of panels by level for the Deepening Extension Zone is shown in Table 24-3 below.

Table 24-2: Distribution of Panels within the Pilar UG Mine, Deepening Extension Zone

Mining Method	Panel	Elevation of Reference
Longitudinal and Transverse Stoping (Shared with Deepening Extension Project)	1	Level -1069
	2	Level -1173
	3	Level -1277
	4	Level -1381
Longitudinal Stopes (Deepening Inferred Project only)	5	Level -1485
	6	Level -1563

The figure below illustrates these production panels across a vertical section. Based on information as at the Effective Date, the mineralization narrows to depth and only Longitudinal Stopes are planned below -1381L.

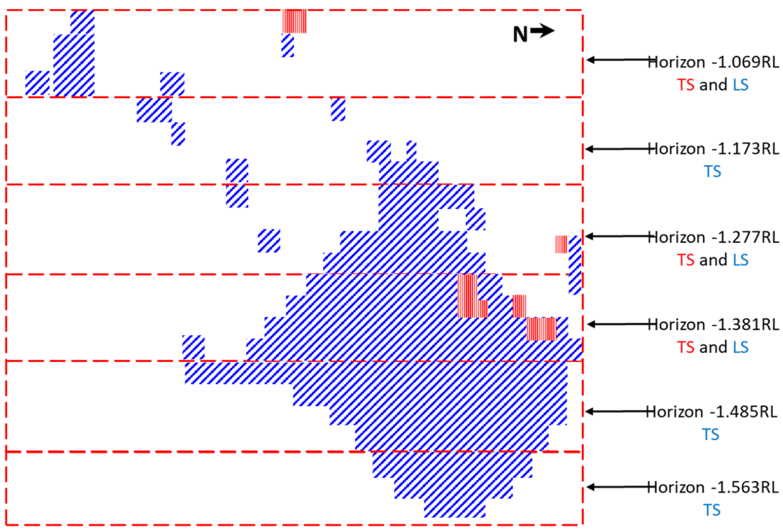


Figure 24-2: 2D Schematic of stope design by mining method (blue = longitudinal, red = transverse) (MCSA, 2020)

24.2.3 Mine Design

The primary ramp design for the Deepening Inferred Project is presented in the figure below. The primary ramp continues at depth beyond the Deepening Extension Project and is designed to follow the mineralization to the north, as more fully described in Chapter 16 and 18. The bottom of the new external hoisting shaft that will be built in support of the Deepening Extension Project will be completed to the -1075 Level. Two new panels with 4 production levels each are designed below -1381 Level in support of the Deepening Inferred Project.

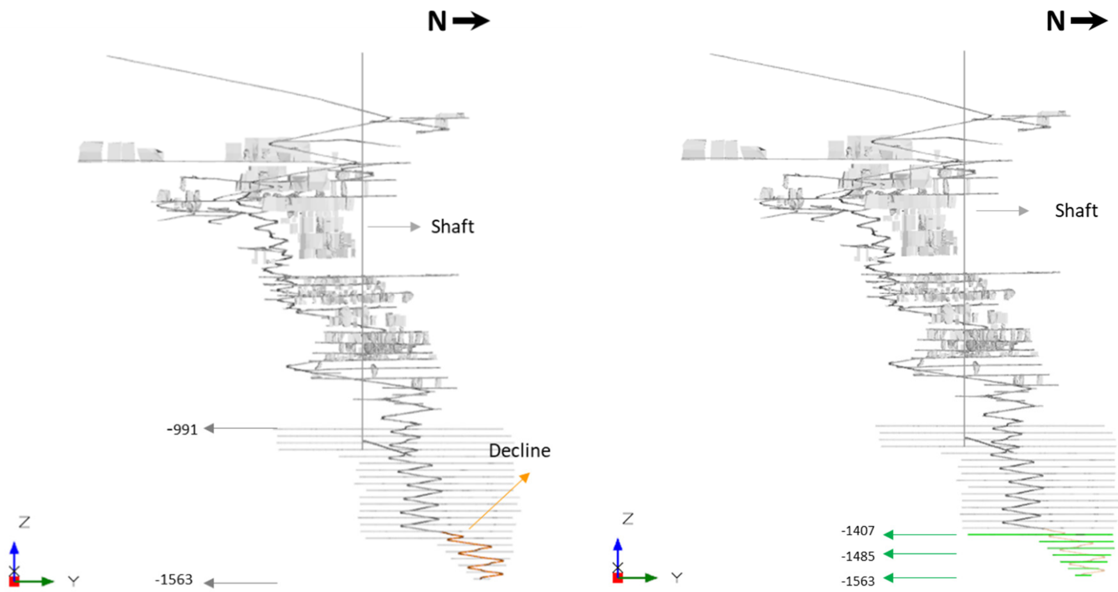


Figure 24-3: General Layout of Pilar UG Development, Deepening Extension Zone (MCSA, 2020)

The mine ventilation system for the deeper panels of the mine in support of the Deepening Inferred Project will utilize the existing mine ramp and internal ventilation raises connecting the production levels. This infrastructure, including cooling requirements, will be shared with the Deepening Extension Project, as more fully described in Chapter 18 of this Report.

24.2.4 Mine Development Schedules & Equipment Selection

The same assumptions for development rates and production schedules were incorporated into the mine design for the Deepening Inferred Project as were used for the mineral reserves incorporated into the Deepening Extension Project.

In support of the Deepening Inferred Project, an additional 15km of horizontal development is required when compared to the Deepening Extension Project. As much of the developed infrastructure, including development, will be shared by the Deepening Extension Project, the table below presents the development requirements for the Deepening Extension Project, as well as incremental development required for the Deepening Inferred Project.

Table 24-3: Horizontal Development Schedule for the Deepening Extension Zone, Pilar UG Mine

Description (meters)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
Dewatering	-	-	-	-	-	-	124	248	124	-	-	496
Level Accesses	-	-	-	-	-	-	61	83	57	-	-	201
Access Drifts	-	-	43	193	255	452	561	703	537	10	-	2,754
Production Drifts	-	-	60	126	423	613	1,267	1,867	2,482	421	15	7,274
Transport Drifts	-	-	50	25	-	-	44	1,046	625	-	-	1,790
Ventilation Drifts	-	-	-	-	-	-	39	131	231	-	-	401
Loading Points	-	-	-	-	-	-	60	205	145	-	-	410
Ramp	-	-	-	-	-	-	471	598	296	-	-	1,365
Substation	-	-	-	-	-	-	24	24	36	-	-	84
Deepening Inferred Project	**0**	**0**	**154**	**344**	**677**	**1,065**	**2,651**	**4,905**	**4,534**	**430**	**15**	**14,775**

In support of the Deepening Inferred Project, an additional 554 m of vertical development is required when compared to the Deepening Extension Project. As much of the developed infrastructure, including development, will be shared by the Deepening Extension Project, the table below presents the development requirements for the Deepening Extension Project, as well as incremental development required for the Deepening Inferred Project.

Table 24-4: Vertical Development Schedule for the Deepening Extension Zone, Pilar UG Mine (meters)

Description (meters)	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Exhaust Raises	-	-	-	-	-	-	-	48	264	312
------Ventilation Raise Borer	-	-	-	-	-	-	-	101	141	242
Deepening Inferred Project (incremental)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**149**	**405**	**554**

A summary of the additional fleet requirements estimated to deliver the forecast production rates from the Deepening Inferred Project is presented in the table below. As a result of the production sequence and synergies with the Deepening Extension Project, the equipment fleet presented below is expected to be fully augmented by equipment that will be shared jointly with the production requirements of the Deepening Extension Project.

Table 24-5: Mining Fleet Requirements for the Deepening Inferred Project

Fleet Requirement	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Jumbo	-	-	-	-	-	-	-	1	4	2	1	1	-	-
Rockbolt	-	-	-	-	-	-	-	2	4	2	1	1	-	-
Scaler	-	-	-	-	-	-	-	1	3	2	1	1	-	-
Shortcrete Mixer	-	-	-	-	-	-	-	-	3	2	1	1	-	-
Shotcrete Launcher	-	-	-	-	-	-	-	-	1	1	1	1	-	-
LHD	-	-	-	-	-	-	-	-	1	1	2	3	3	3
Haul Trucks	-	-	-	-	-	-	-	-	3	2	3	8	8	7
Cubex	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simba/Solo	-	-	-	-	-	-	-	-	-	-	1	3	3	2
Cabolt	-	-	-	-	-	-	-	-	-	-	-	2	2	1
Blindhole	-	-	-	-	-	-	-	-	-	-	-	1	1	1

24.3 PRODUCTION SCHEDULE, CAPITAL AND OPERATING COSTS, DEEPENING INFERRED PROJECT

The Deepening Inferred Project is expected to utilize the same infrastructure that will be built in support of the Deepening Extension Project, including a new external shaft as described in Chapter 18. Over the Deepening Inferred Project life, approximately 4.2 million tonnes grading 2.01% copper are expected to be mined, producing a total of approximately 78,900 tonnes of copper after average metallurgical recoveries of 93.2%. First development from the Deepening Inferred Project is expected in 2023 and first mined ore is expected after the completion of the new external shaft and associated development in support of the Deepening Extension Project of the Pilar Mine.

Table 24-6: Deepening Inferred Project Production Schedule

	Q4 2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Production Plan															
Ore Mined & Processed (kt)	-	-	-	19	40	71	193	260	254	645	956	803	536	426	4,203
Grade Mined & Processed (% Cu)	-	-	-	0.62%	0.77%	1.30%	1.20%	1.68%	1.66%	1.90%	2.59%	2.30%	1.61%	1.94%	2.01%
Recoveries (%)	-	-	-	85.6%	87.8%	91.3%	90.9%	92.4%	92.4%	92.9%	93.8%	93.9%	92.3%	93.3%	93.2%
Copper in Concentrate (kt)	**0.0**	**0.0**	**0.0**	**0.1**	**0.3**	**0.8**	**2.1**	**4.0**	**3.9**	**11.4**	**23.2**	**17.4**	**8.0**	**7.7**	**78.9**

The production detailed in the production schedule above contains only Inferred mineral resources. Inferred mineral resources are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that value from such Inferred mineral resources will be realized either in whole or in part. Mining of the Inferred mineral resource within the Pilar UG Mine's Deepening Extension Zone, as envisioned, reflects a continuation of mining of the Deepening Extension Project.

24.3.1 Operating and Capital Costs

As there is no certainty that the Deepening Inferred Project will be realized due to the nature of the preliminary economic assessment, fixed processing costs and most operational support costs, other than variable operational support costs associated with concentrate transport for the Deepening Inferred Project, have been allocated to the Company's LOM production plan as outlined elsewhere in this Report.

Mining costs for the Deepening Inferred Project were estimated using first principles and are based on the assumed costs of the Deepening Extension Project, which are further detailed in Chapter 21. Mining costs for the Deepening Inferred Project are shown below.

Table 24-7: Operating Costs for Deepening Inferred Project

	Q4 2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Operating Costs (R$ 000s)															
Mining Costs	-	-	-	650	3,226	6,709	15,602	24,456	27,593	62,295	66,358	52,316	34,314	25,890	319,409
Total Operating Costs (R$ 000s)	**-**	**-**	**-**	**650**	**3,226**	**6,709**	**15,602**	**24,456**	**27,593**	**62,295**	**66,358**	**52,316**	**34,314**	**25,890**	**319,409**

	Q4 2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Operating Costs (R$ 000s)															
Mining Costs	-	-	-	650	3,226	6,709	15,602	24,456	27,593	62,295	66,358	52,316	34,314	25,890	319,409
Processing	-	-	-	398	830	1,462	3,960	5,342	5,216	13,275	19,665	16,515	11,027	8,767	86,457
Operational Support	-	-	-	40	106	327	811	1,562	1,505	4,420	8,994	6,727	3,080	2,980	30,553
less: precious metal byproducts	-	-	-	(174)	(464)	(1,431)	(3,546)	(6,828)	(6,580)	(19,320)	(39,315)	(29,406)	(13,270)	(12,838)	(133,172)
plus: TC/RC, net of tax	-	-	-	(110)	(284)	(878)	(2,221)	(4,133)	(4,208)	(11,864)	(25,168)	(20,427)	(8,747)	(7,861)	(85,902)
C1 Cash Costs Basis (R$ 000s)	**-**	**-**	**-**	**805**	**3,414**	**6,189**	**14,606**	**20,399**	**23,526**	**48,806**	**30,534**	**25,726**	**26,403**	**16,937**	**217,345**

As a result of shared infrastructure and associated synergies with the Deepening Extension Project as reflected in the Company's LOM production plan, further detailed in Chapters 16, 17, 18 and 21, total capital costs for the Deepening Inferred Project, comprised of only equipment and development, are expected to total R$139.1 million over the production schedule, as detailed below.

Table 24-8: Capital Costs for Deepening Inferred Project

	Q4 2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Capital Costs (R$ 000s)															
Deepening below -965															
Equipment	-	-	-	-	-	-	-	18,678	13,392	-	20,146	-	-	-	52,216
Ventilation and Cooling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Development	-	-	-	1,010	5,486	4,571	5,761	14,960	32,820	22,165	105	-	-	-	86,878
Shaft	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Infrastructure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital Costs (R$ 000s)	**-**	**-**	**-**	**1,010**	**5,486**	**4,571**	**5,761**	**33,638**	**46,212**	**22,165**	**20,251**	**-**	**-**	**-**	**139,095**

24.4 ECONOMIC ANALYSIS, DEEPENING INFERRED PROJECT

The economic analysis for the Deepening Inferred Project has been prepared by Ero Copper and MCSA with inputs from NCL and under the supervision of BNA and GE21. MCSA provided the mining and processing cost estimates, and NCL provided capital cost estimates. The estimates were reviewed by the authors of this Report who have found the estimation procedures and outcomes to be in-line with industry best practice and well correlated to the performance of the existing operations.

24.4.1 Financial Analysis

Table 24-6: After-tax Cash Flow Summary – Deepening Inferred Project

Assumptions		2020 [1]	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Exchange Rate	R$/US$	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Copper Price	US$/tonne	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614	6,614
Copper Price	US$/lb	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Production															
Ore Processed	tonnes	-	-	-	19,363	40,351	71,075	192,504	259,715	253,578	645,362	955,989	802,886	536,069	426,184
Copper Grade Processed	%	-	-	-	0.62	0.77	1.30	1.20	1.68	1.66	1.90	2.59	2.30	1.61	1.94
Metallurgical Recovery	%	-	-	-	85.6	87.8	91.3	90.9	92.4	92.4	92.9	93.8	93.9	92.3	93.3
Copper Contained	**tonnes**	-	-	-	**103**	**274**	**845**	**2,095**	**4,033**	**3,886**	**11,411**	**23,221**	**17,368**	**7,952**	**7,693**
Copper Contained	**lbs**	-	-	-	**226,138**	**604,398**	**1,863,095**	**4,617,751**	**8,891,550**	**8,567,959**	**25,156,847**	**51,194,201**	**38,290,626**	**17,530,410**	**16,959,400**
Capex															
Total Capex	**000 R$**	-	-	-	**1,010**	**5,486**	**4,571**	**5,761**	**33,638**	**46,212**	**22,165**	**20,251**	-	-	-
Operating Costs															
Mining Costs (incl. transport and sorting)	000 R$	-	-	-	650	3,226	6,709	15,602	24,456	27,593	62,295	66,358	52,316	34,314	25,890
Operational Support	000 R$	-	-	-	40	106	327	811	1,562	1,505	4,420	8,994	6,727	3,080	2,980
Processing	000 R$	-	-	-	398	830	1,462	3,960	5,342	5,216	13,275	19,665	16,515	11,027	8,767
Sub Total	**000 R$**	-	-	-	**1,088**	**4,162**	**8,499**	**20,373**	**31,361**	**34,315**	**79,990**	**95,017**	**75,559**	**48,420**	**37,636**
Depreciation/Exhaustion	**000 R$**	-	-	-	**8,757**	**10,607**	**10,161**	**11,438**	**8,716**	**8,368**	**7,909**	**8,230**	**6,635**	**5,005**	**3,247**
Total Costs	**000 R$**	-	-	-	**9,845**	**14,769**	**18,659**	**31,812**	**40,077**	**42,683**	**87,899**	**103,247**	**82,194**	**53,426**	**40,883**
Revenue															
Copper Sales	tonnes	-	-	-	103	274	845	2,095	4,033	3,886	11,411	23,221	17,368	7,952	7,693
Gross Metal Revenue	000 R$	-	-	-	3,392	9,066	27,947	69,268	133,376	128,522	377,360	767,928	574,371	262,961	254,396
Total Net Metal Revenue	000 R$	-	-	-	3,367	8,989	27,713	68,739	132,374	127,479	374,964	765,015	573,389	260,263	252,071
Other Revenue [2]	000 R$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Net Revenue	**000 R$**	-	-	-	**3,367**	**8,989**	**27,713**	**68,739**	**132,374**	**127,479**	**374,964**	**765,015**	**573,389**	**260,263**	**252,071**
Revenue Invoiced with Taxes Added Back	*000 R$*	-	-	-	*3,791*	*10,133*	*31,236*	*77,419*	*149,071*	*143,646*	*421,765*	*858,293*	*641,959*	*293,997*	*284,421*
Cash Flow															
Revenue Invoiced with Taxes Added Back	000 R$	-	-	-	3,791	10,133	31,236	77,419	149,071	143,646	421,765	858,293	641,959	293,997	284,421
Opex (ex-Depreciation & Exhaustion)	000 R$	-	-	-	(1,088)	(4,162)	(8,499)	(20,373)	(31,361)	(34,315)	(79,990)	(95,017)	(75,559)	(48,420)	(37,636)
Less Capitalized Development [3]	000 R$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Effective Tax Rate	%	8.8	9.6	9.3	9.5	9.6	9.0	9.5	10.1	11.0	11.2	10.4	9.7	8.7	11.6
Income & Social Contribution Taxes	000 R$	-	-	-	(359)	(972)	(2,805)	(7,326)	(14,994)	(15,747)	(47,419)	(89,310)	(62,385)	(25,602)	(32,949)
Other Taxes & Credits	000 R$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Employee Profit Sharing & Bonuses	000 R$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Operating Cash Flow	**000 R$**	-	-	-	**2,344**	**4,999**	**19,932**	**49,719**	**102,716**	**93,584**	**294,356**	**673,966**	**504,015**	**219,974**	**213,835**
CAPEX	000 R$	-	-	-	(1,010)	(5,486)	(4,571)	(5,761)	(33,638)	(46,212)	(22,165)	(20,251)	-	-	-
Free Cash Flow	**000 R$**	-	-	-	**1,334**	**(487)**	**15,361**	**43,958**	**69,078**	**47,373**	**272,191**	**653,715**	**504,015**	**219,974**	**213,835**
Accumulated Free Cash Flow	000 R$	-	-	-	1,334	847	16,208	60,166	129,244	176,616	448,808	1,102,522	1,606,537	1,826,511	2,040,346
Free Cash Flow	**000 US$**	-	-	-	**267**	**(97)**	**3,072**	**8,792**	**13,816**	**9,475**	**54,438**	**130,743**	**100,803**	**43,995**	**42,767**
Accumulated Free Cash Flow	000 US$	-	-	-	267	169	3,242	12,033	25,849	35,323	89,762	220,504	321,307	365,302	408,069
EBITDA	**000 R$**	-	-	-	**2,279**	**4,827**	**19,214**	**48,365**	**101,013**	**93,165**	**294,974**	**669,998**	**497,831**	**211,843**	**214,435**
EBITDA	**000 US$**	-	-	-	**456**	**965**	**3,843**	**9,673**	**20,203**	**18,633**	**58,995**	**134,000**	**99,566**	**42,369**	**42,887**

Discount Rate	%pa	8%
Results		
After-Tax NPV_8	000 US$	188,661
IRR	%pa	n/a
Simple Payback	years	n/a

(3) 2020 based on the 3 months from the Effective Date to December 31, 2020
(4) Other Revenue includes recovery of water pipeline operating costs and scrap sales

Table 24-7: After-tax Sensitivity Analysis – Deepening Inferred Project

Parameters	Units	-20%	-15%	-10%	-5%	Base Case	+5%	+10%	+15%	+20%
Copper Price	LT US$/tonne Cu	5,291	5,622	5,953	6,283	6,614	6,945	7,275	7,606	7,937
	NPV - 000 US$ [1]	139,292	151,634	163,977	176,319	188,661	201,004	213,346	225,688	238,030
	IRR - %/year	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Foreign Exchange	LT R$/US$	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
	NPV - 000 US$ [1]	174,115	178,393	182,196	185,599	188,661	191,432	193,951	196,251	198,359
	IRR - %/year	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Capex	000 US$	442,738	470,410	498,081	525,752	553,423	581,094	608,765	636,436	664,108
	NPV - 000 US$ [1]	191,785	191,004	190,223	189,442	188,661	187,880	187,099	186,318	185,537
	IRR - %/year	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Opex	000 US$	1,433,498	1,523,092	1,612,686	1,702,279	1,791,873	1,881,467	1,971,060	2,060,654	2,150,248
	NPV - 000 US$ [1]	197,174	195,046	192,918	190,789	188,661	186,533	184,405	182,276	180,148
	IRR - %/year	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

(1) NPV shown assumes 8% discount rate

Table 24-8: Forecast C1 Cash Cost Summary – Deepening Inferred Project

		2020 [1]	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Exchange Rate	R$/US$	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Ore Processed	(tonnes)	-	-	-	19,363	40,351	71,075	192,504	259,715	253,578	645,362	955,989	802,886	536,069	426,184
Copper Contained	**(tonnes)**	**-**	**-**	**-**	**103**	**274**	**845**	**2,095**	**4,033**	**3,886**	**11,411**	**23,221**	**17,368**	**7,952**	**7,693**
Copper Contained	**(lbs)**	**-**	**-**	**-**	**226,138**	**604,398**	**1,863,095**	**4,617,751**	**8,891,550**	**8,567,959**	**25,156,847**	**51,194,201**	**38,290,626**	**17,530,410**	**16,959,400**
Mining Costs (incl. transport and sorting)	000 R$	-	-	-	650	3,226	6,709	15,602	24,456	27,593	62,295	66,358	52,316	34,314	25,890
Operational Support	000 R$	-	-	-	40	106	327	811	1,562	1,505	4,420	8,994	6,727	3,080	2,980
Processing	000 R$	-	-	-	398	830	1,462	3,960	5,342	5,216	13,275	19,665	16,515	11,027	8,767
Sub Total	**000 R$**	**-**	**-**	**-**	**1,088**	**4,162**	**8,499**	**20,373**	**31,361**	**34,315**	**79,990**	**95,017**	**75,559**	**48,420**	**37,636**
less: Precious Metal Credits	000 R$	-	-	-	(174)	(464)	(1,431)	(3,546)	(6,828)	(6,580)	(19,320)	(39,315)	(29,406)	(13,270)	(12,838)
plus: TC/RCs, Net of Tax	000 R$	-	-	-	(110)	(284)	(878)	(2,221)	(4,133)	(4,208)	(11,864)	(25,168)	(20,427)	(8,747)	(7,861)
Total	**000 R$**	**-**	**-**	**-**	**805**	**3,414**	**6,189**	**14,606**	**20,399**	**23,526**	**48,806**	**30,534**	**25,726**	**26,403**	**16,937**
C1 Cash Cost	**R$/lb**	**-**	**-**	**-**	**3.56**	**5.65**	**3.32**	**3.16**	**2.29**	**2.75**	**1.94**	**0.60**	**0.67**	**1.51**	**1.00**
C1 Cash Cost	**US$/lb**	**-**	**-**	**-**	**0.71**	**1.13**	**0.66**	**0.63**	**0.46**	**0.55**	**0.39**	**0.12**	**0.13**	**0.30**	**0.20**

(1) 2020 based on the 3 months from the Effective Date to December 31, 2020

24.4.2 QP Opinion, Deepening Inferred Project

The authors of this Report have reviewed the Deepening Inferred Project technical parameters and found them to be in-line with industry best-practices and consistent with the nature of a preliminary economic assessment.

The Deepening Inferred Project is preliminary in nature and based on the Inferred mineral resources of the Deepening Extension Zone which are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that the Deepening Inferred Project will be realized. Mineral resources that are not mineral reserves do not have a demonstrated economic viability. The Company has commenced a program to continue infill drilling of the Inferred resource to further upgrade this material; however, until this work is completed, and the Inferred resources have been upgraded to reserves, there is no certainty this material will be converted into mineral reserves.

The authors of this Report recommend that the planned drill program be executed to promote the resource classification from Inferred to Measured or Indicated. Additionally, engineering work should continue alongside the exploration program to promote the confidence of the mine design and costing parameters.

25 INTERPRETATION AND CONCLUSIONS

25.1 MINERAL EXPLORATION AND GEOLOGY

In general terms, the geological descriptions, sampling procedures and density tests that were evaluated were found to be of acceptable quality and in accordance with industry best practices.

It was noted that the data collection process was executed with the aim of maintaining data security. Data was stored in a standardized database, which was found to be secure and auditable.

The complexity of the mineralization controls and the quantity and phases of data in the Curaçá Valley merits the use of visualization and data integration tools that are more advanced than those which MCSA had at its disposal at the time of this Technical Report.

While GE21 believes that the current QA/QC program can guarantee the quality of the exploration data used in the resource estimates, GE21 suggests that a chain of custody program be implemented for good measure.

GE21 supervised the process through which density was determined and concluded that it was in conformity with industry best practices.

25.2 QA/QC

GE21 performed the evaluation of the data generated after the last validation and concludes that the QAQC procedures are being followed using the same standards. GE21 considered the standard QA/QC procedures to be in accordance with mining industry best practice and appropriate for use in the current mineral resource estimate.

It was observed throughout the 2020 GE21 review period, that the MCSA laboratory continues to display a tendency to systematically underestimate the copper assay values when using CRM ITAK 825; however, the results of the laboratory when using CRM ITAK 851, which features a similar copper grade range, demonstrate better reproducibility.

25.3 GEOLOGICAL MODEL

The procedure that was adopted to produce the 3D geological model (wireframes), consisting of generating triangulations between interpreted geological cross sections, was executed properly and in accordance with the opinions of GE21 staff. Due to the plunge of the mineralized zone at the Pilar UG Mine towards the north and the east-west geological cross sections, a pattern of sub-vertical discontinuous lenses was created locally within the regions of lower drill hole density. Despite these occurrences, verification of the mineralized zone interpretation was performed within regions of denser drill spacing.

GE21 noted that, with respect to the integration and interpretation of geological data, limited lithostructural mapping (mine, surface and subsurface) had been undertaken and no supporting petrographic data was used. GE21 also notes that the field interpretation and 3D interpretation were historically focused on interpreting only copper grade, therefore, few vertical and horizontal lithostructural geological sections were developed which may provide greater understanding and control of aspects relating to the geology and other potential metals of significance in the Curaçá Valley. In 2020, MCSA started to adopt 3D implicit modelling techniques based upon grouped lithologies and copper grade shells using Leapfrog software. This methodology was used by GE21 to create 3D validation models. GE21 believes this methodology of modelling helps to standardize the modelling of different targets by different teams.

25.4 GRADE ESTIMATION

The variograms that were used in the estimation method are satisfactory and consistent with respect to the grade estimation that was calculated via Ordinary Kriging, making use of search anisotropy determined in the variographic study.

The Kriging estimation strategy that was chosen made it possible to classify the resource in accordance with an empirically calculated search radius and the requisite data density for resource classification.

GE21 considers the resource classification model and the analysis of criteria for the classification of those Mineral Resources, to be satisfactory although some items could be improved. Such recommended improvements did not impose limitations on the classification of Measured and Indicated Resources.

25.5 MINERAL RESOURCES ESTIMATE

GE21 has not identified any mining, metallurgical, infrastructure, permitting, legal, political, environmental, technical, or other relevant factors that could materially affect the potential development of Mineral Resources.

25.6 MINERAL RESERVE ESTIMATE

GE21 and BNA carried out a detailed review of the current mineral reserves for Curaçá Valley, aimed at demonstrating its technical and profitable extraction for the production and sale of copper concentrate. The results for this review, demonstrated a good adherence using detailed verification procedures performed by the authors of this Report. In general resulting in differences of less than 1% in the total copper metal contained, which BNA considered acceptable.

The authors of this Report note the following related to the current mineral reserve:

- The metallurgical recovery value is expected to increase following commissioning and integration of the Company's HIG Mill. This improvement was not applied for the current mineral reserve estimation, which is the preferred approach, according to BNA's assessment given the limited operating history prior to the Effective Date, although the improvement was used in LOM planning;

- Within the Vermelhos District ore sorting will be integrated within the open pit operations to reduce transport and processing costs. However, these potential savings not yet been considered in current estimation of reserves for these operations, pending the completion of additional project assessments currently being conducted by the MCSA team;

- The operating mines of the Company (Pilar UG Mine and Vermelhos UG Mine) currently employ a joint reconciliation process in which it is difficult to accurately differentiate mine-to-mill reconciliation from one mine to another; and,

- As at the time of this Report, the ventilation and cooling infrastructure for the Pilar UG Mine, is being upgraded according to the plans developed by the MCSA team.

The mineral reserve estimation has been performed according to industry best practice and conform to the CIM Standards and CIM Guidelines.

BNA has not identified any mining, metallurgical, infrastructure, permitting, legal, political, environmental, technical, or other relevant factors that could materially affect the potential development of the current mineral reserves.

25.7 DEEPENING INFERRED PROJECT

NCL has carried out a mine schedule, production plan and capital cost estimates at a preliminary economic analysis level for the Deepening Inferred Project. Mining and processing operating costs were provided by MCSA. GE21 reviewed these plans and estimates and agrees with the potential economic value of the inferred mineral resource contained within the Deepening Extension Zone. GE21 is satisfied that the technical work adheres to industry best practices and that the favorable results of the potential economic assessment have been demonstrated, warranting further work.

The Company has commenced a program to continue infill drilling of the Inferred resource to further upgrade this material; however, until this work is completed and the Inferred resources have been upgraded to reserves, there is no certainty this material will be converted into mineral reserves.

26 RECOMMENDATIONS

Regarding the Mineral Resources and Mineral Reserves estimation, the authors recommend a work program to include the following, most of which can be completed at little or no cost. Estimated costs of the work program are shown in the table below.

i. Formalize the use of implicit modelling internally throughout the Company, emphasizing structural geology and variation in lithology for domain definition and exploration target integration.

ii. Implement additional empirical criteria for resource classification, based on the '15% Rule', as commonly attributed to Dr. Harry Parker and since expanded upon in multiple sources of geostatistical literature.

iii. Expand ongoing geometallurgical studies to encompass all deposits and blends therein to study mill feed interaction. Suggest including standardized laboratory tests as normal operating procedure. Additionally, it is recommended that the Company advance geometallurgical studies for inclusion in mineral reserve definition, in order to classify metallurgical recovery according to the different characteristics associated with each lithological domain rather than by deposit.

iv. Confirm the expected improvement in metallurgical recoveries following the addition of the HIG Mill to validate a recovery improvement in the definition of mineral reserves in the future.

v. Validate of the certified grade for CRM ITAK 825 due to the observed inconsistencies in assay values, in contrast with the consistent results obtained when utilizing CRM ITAK 851, which has a similar Cu grade range.

vi. Recommend standardizing QA/QC mass controls during assay sample crushing and grinding in order to evaluate the quality of the comminution procedures and ensure no sample loss during sample preparation.

vii. Install a sample tower to improve the mine to mill reconciliation process for the current operating mines. Such an installation will allow differentiation of ore source reconciliation within the processing plant.

viii. Improve systems for mineral reserve attribute database management to standardize fleet sizing, economic and consumable parameters, swell factors, dilution and mine call factors as well as store historic block model and design attributes including mathematical pit designs and supporting assumptions within a centralized validated database to improve the application of mineral reserve modifying factors in future studies.

ix. Advance geotechnical monitoring campaigns and 3D geotechnical lithological models to improve structural understanding of the current and future operations of the Curaçá Valley.

x. Execute the installation of ventilation and cooling within the operations of the Pilar UG Mine, both in the short term and in the long term as currently envisioned to ensure safe delivery of the Deepening Extension Project.

xi. The authors recommend that a drill program for the Deepening Inferred Project be executed in an effort to promote the resource classification from Inferred to Measured or Indicated. Additional engineering work should continue alongside the exploration program to promote the confidence of the mine design and costing parameters of the Deepening Inferred Project. The authors note at the time of this Report, such programs were underway.

Table 26-1: Proposed Budget for Recommended Work

Program	Budget (US$)
Advance geometallurgical studies	$200,000
Continued multi-element assays for the Vermelhos District (incl. check assays)	$50,000
Installation of sampling tower to enhance Mine-to-Mill reconciliation for multiple mining operations	$500,000
Improvement of reconciliation systems	$60,000
Advance geotechnical monitoring campaings and geotechnical-lithology model development	$100,000
Deepening Inferred Project drill program	$7,000,000
Total	**$7,910,000**

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Effective Date: October 1, 2020

Report Date: January 14, 2020

<signed & sealed in the original>

Porfírio Cabaleiro Rodriguez, MAIG

<signed & sealed in the original>

Fábio Valério Câmara Xavier, MAIG

<signed & sealed in the original>

Bernardo Horta de Cerqueira Viana, MAIG

<signed & sealed in the original>

Paulo Roberto Bergmann, FAusIMM

<signed & sealed in the original>

Dr. Beck (Alizeibek) Nader, FAIG

<signed & sealed in the original>

Dr. Augusto Ferreira Mendonça, RM SME

APPENDIX A

Technical Report QP Certificates

I, Porfirio Cabaleiro Rodriguez, MAIG, (#3708), as an author of the technical report titled "2020 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated January 14, 2021, with an effective date of October 1, 2020 (the "Technical Report"), prepared for Ero Copper Corp. (the "Issuer"), do hereby certify that:

1) I am a Mining Engineer and Director for GE21 Consultoria Mineral Ltda., which is located on Avenida Afonso Pena, 3130, 12th floor, Savassi, Belo Horizonte, MG, Brazil - CEP 30130-910.

2) I am a graduate of the Federal University of Minas Gerais, located in Belo Horizonte, Brazil, and hold a Bachelor of Science Degree in Mining Engineering (1978). I have practised my profession continuously since 1979.

3) I am a Professional enrolled with the Australian Institute of Geoscientists ("AIG") - ("MAIG") #3708.

4) I am a professional Mining Engineer, with more than 40 years' relevant experience in Mineral Resource and Mineral Reserves estimation, which includes numerous mineral properties in Brazil, including copper properties.

5) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* ("NI 43-101") and certify that, by reason of my education, affiliation with a professional association as defined in NI 43-101, and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.

6) I have supervised the preparation of the Technical Report. I am responsible for Chapters 2, 3, 14, 19, 22, 23, and 27 and jointly responsible for Chapters 21 and 24. I am also responsible for the corresponding sections within Chapters 1, 25 and 26 that are related to the foregoing Chapters of this Technical Report.

7) I have maintained a close technical relationship with the property that is the subject of this Technical Report since 2006, while still working under the name of Geoexplore, and subsequently Coffey Mining. I was also hired as a consultant by companies interested in negotiating with Mineração Caraíba S.A. ("MCSA"). I was also an author of the independent technical report titled "2017 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated September 7, 2017, with an effective date of June 1, 2017; an author of the independent technical report titled "2018 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated October 17, 2018, with an effective date of August 1, 2018; and, an author of the independent technical report titled "2019 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley" dated November 25, 2019, with an effective date of September 18, 2019, each prepared for the Issuer. The relationship with the Issuer and its subsidiary, MCSA, was solely for professional works in exchange for fees based on rates set by commercial agreement. Payment of these fees is in no way dependent on the results of the Technical Report.

8) I personally inspected the property that is the subject of this Technical Report from the 17th to 19th of February, 2020 and in visits with three days' duration in June 2019, July 2018 and January 2017.

9) As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the sections of the Technical Report that I have authored and am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

10) I have no personal knowledge, as of the date of this certificate, of any material fact or material change which is not reflected in this Technical Report.

11) I am independent of the Issuer, applying all the tests in section 1.5 of NI 43-101.

12) I have read NI 43-101 and Form 43-101F1 – Technical Report, and the Technical Report has been prepared in compliance with such instrument and form.

Belo Horizonte, Brazil, January 14, 2021

<signed & sealed in the original>

Porfirio Cabaleiro Rodriguez, MAIG

I, Fábio Valério Câmara Xavier, MAIG, (#5179), as an author of the technical report titled "2020 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated January 14, 2021, with an effective date of October 1, 2020 (the "Technical Report"), prepared for Ero Copper Corp. (the "Issuer"), do hereby certify that:

1) I am a Geologist for GE21 Consultoria Mineral Ltda., which is located on Avenida Afonso Pena, 3130, 12th floor, Savassi, Belo Horizonte, MG, Brazil - CEP 30130-910.

2) I am a graduate of the Federal University of Rio Grande do Norte, located in Natal, Brazil, and hold a Bachelor of Science Degree in Geology (2003). I have practised my profession continuously since 2003.

3) I am a Professional enrolled with the Australian Institute of Geoscientists ("AIG") - ("MAIG") #5179.

4) I am a professional Geologist, with more than 17 years' relevant experience in resource estimation and geology exploration, which includes numerous mineral properties in Brazil, including copper properties.

5) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* ("NI 43-101") and certify that, by reason of my education, affiliation with a professional association as defined in NI 43-101, and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.

6) I am jointly responsible for Chapters 4, 5, 6, 7, 8, 9, 10, 11 and 12. I am also responsible for the corresponding sections within Chapters 1, 25 and 26 that are related to the foregoing Chapters of this Technical Report.

7) I have had prior involvement with the property that is the subject of this Technical Report as an author of the independent technical report titled "2017 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated September 7, 2017, with an effective date of June 1, 2017, and as an author of the independent technical report titled "2018 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated October 17, 2018, with an effective date of August 1, 2018, both prepared for the Issuer. The relationship with the Issuer and its subsidiary, MCSA, was solely for professional works in exchange for fees based on rates set by commercial agreement. Payment of these fees is in no way dependent on the results of the Technical Report.

8) I personally inspected the property that is the subject of this Technical Report in visits with five days' duration in July 2018, five days' duration in June 2018 and two days' duration in June 2017.

9) As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the sections of the Technical Report that I have authored and am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

10) I have no personal knowledge, as of the date of this certificate, of any material fact or material change which is not reflected in this Technical Report.

11) I am independent of the Issuer, applying all the tests in section 1.5 of NI 43-101.

12) I have read NI 43-101 and Form 43-101F1 – Technical Report, and the Technical Report has been prepared in compliance with such instrument and form.

Belo Horizonte, Brazil, January 14, 2021

<signed & sealed in the original>

Fábio Valério Câmara Xavier, MAIG

I, Bernardo Horta de Cerqueira Viana, MAIG, (#3709), as an author of the technical report titled "2020 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated January 14, 2021, with an effective date of October 1, 2020 (the "Technical Report"), prepared for Ero Copper Corp. (the "Issuer"), do hereby certify that:

1) I am a Geologist and Director for GE21 Consultoria Mineral Ltda., which is located on Avenida Afonso Pena, 3130, 12th floor, Savassi, Belo Horizonte, MG, Brazil - CEP 30130-910.

2) I am a graduate of the Federal University of Minas Gerais, located in Belo Horizonte, Brazil, and hold a Bachelor of Science Degree in Geology (2002). I have practiced my profession continuously since 2002.

3) I am a Professional enrolled with the Australian Institute of Geoscientists ("AIG") - ("MAIG") #3709.

4) I am a professional Geologist, with more than 18 years' relevant experience in ore resource estimation and geology exploration, which includes numerous mineral properties in Brazil, including copper properties.

5) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* ("NI 43-101") and certify that, by reason of my education, affiliation with a professional association as defined in NI 43-101, and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.

6) I am jointly responsible for Chapters 4, 5, 6, 7, 8, 9, 10, 11, 12 and 24. I am also responsible for the corresponding sections within Chapters 1, 25 and 26 that are related to the foregoing Chapters of this Technical Report.

7) I have maintained a close technical relationship with the property that is the subject of this Technical Report since 2006, while still working under the name of Geoexplore, and subsequently Coffey Mining. I was also hired as a consultant by companies interested in negotiating with Mineração Caraíba S.A. ("MCSA"). I was also an author of the independent technical report titled "2017 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated September 7, 2017, with an effective date of June 1, 2017; an author of the independent technical report titled "2018 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated October 17, 2018, with an effective date of August 1, 2018; and, an author of the independent technical report titled "2019 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley" dated November 25, 2019, with an effective date of September 18, 2019, each prepared for the Issuer. The relationship with the Issuer and its subsidiary, MCSA, was solely for professional works in exchange for fees based on rates set by commercial agreement. Payment of these fees is in no way dependent on the results of the Technical Report.

8) I personally inspected the property that is the subject of this Technical Report from the 17th to 19th of February, 2020 and in visits with three days' duration in June 2019, July 2018 and January 2017.

9) As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the sections of the Technical Report that I have authored and am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

10) I have no personal knowledge, as of the date of this certificate, of any material fact or material change which is not reflected in this Technical Report.

11) I am independent of the Issuer, applying all the tests in section 1.5 of NI 43-101.

12) I have read NI 43-101 and Form 43-101F1 – Technical Report, and the Technical Report has been prepared in compliance with such instrument and form.

Belo Horizonte, Brazil, January 14, 2021

<signed & sealed in the original>

Bernardo Horta de Cerqueira Viana, MAIG

I, Paulo Roberto Bergmann, FAusIMM (#333121), as an author of the technical report titled "2020 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated January 14, 2021, with an effective date of October 1, 2020 (the "Technical Report"), prepared for Ero Copper Corp. (the "Issuer"), do hereby certify that:

1) I am a Mining Engineer for GE21 Consultoria Mineral Ltda., which is located on Avenida Afonso Pena, 3130, 12th floor, Savassi, Belo Horizonte, MG, Brazil - CEP 30130-910.

2) I am a graduate of the Federal University of Minas Gerais, located in Belo Horizonte, Brazil, and hold a Bachelor of Science Degree in Mining Engineering (1983). I have practiced my profession continuously since 1983.

3) I am a Professional enrolled with the Australasian Institute of Mining and Metallurgy ("AusIMM") - ("FAusIMM" #333121).

4) I am a professional Mining Engineer, with more than 37 years' relevant experience in Mineral Processing and Mineral Reserves estimation, which includes numerous mineral properties in Brazil, including copper properties.

5) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* ("NI 43-101") and certify that, by reason of my education, affiliation with a professional association as defined in NI 43-101, and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.

6) I am responsible for Chapters 13 and 17 and jointly responsible for Chapter 21. I am also responsible for the corresponding sections within Chapters 1, 25 and 26 that are related to the foregoing Chapters of this Technical Report.

7) I have had no prior involvement with the property that is the subject of this Technical Report.

8) I personally inspected the property that is the subject of this Technical Report from the 18th to 20th of February, 2020.

9) As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the sections of the Technical Report that I have authored and am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

10) I have no personal knowledge, as of the date of this certificate, of any material fact or material change which is not reflected in this Technical Report.

11) I am independent of the Issuer, applying all the tests in section 1.5 of NI 43-101.

12) I have read NI 43-101 and Form 43-101F1 – Technical Report, and the Technical Report has been prepared in compliance with such instrument and form.

Belo Horizonte, Brazil, January 14, 2021

<signed & sealed in the original>

Paulo Roberto Bergmann, FAusIMM

I, Dr. Beck (Alizeibek) Nader, FAIG (#4472), as an author of the technical report titled "2020 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated January 14, 2021, with an effective date of October 1, 2020 (the "Technical Report"), prepared for Ero Copper Corp. (the "Issuer"), do hereby certify that:

1) I am a Mining Engineer for BNA Mining Solutions., which is located on Rua Desembargador Leão Starling, 200, Ouro Preto, Belo Horizonte, MG, Brazil - CEP 31310-370.

2) I am a graduate of the University of São Paulo - USP, located in São Paulo-SP, Brazil, and hold a Bachelor of Science Degree in Mining Engineering (1981). I hold a Master of Science Degree in Mineral Technology and a Doctoral of Science Degree in Mineral Engineering. I have practiced my profession continuously since 1982.

3) I am a Fellow enrolled with the Australian Institute of Geoscientists ("AIG") - ("FAIG" #4472).

4) I am a professional Mining Engineer, with more than 38 years' relevant experience in Mineral Resource and Mineral Reserves estimation, which includes numerous mineral properties in Brazil, including copper properties.

5) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* ("NI 43-101") and certify that, by reason of my education, affiliation with a professional association as defined in NI 43-101, and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.

6) I am responsible for Chapters 15, 16 and 18 and jointly responsible for Chapter 21. I am also responsible for the corresponding sections within Chapters 1, 25 and 26 that are related to the foregoing Chapters of this Technical Report.

7) I have had no prior involvement with the property that is the subject of this Technical Report.

8) I have not personally inspected the property that is the subject of this Technical Report.

9) As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the sections of the Technical Report that I have authored and am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

10) I have no personal knowledge, as of the date of this certificate, of any material fact or material change which is not reflected in this Technical Report.

11) I am independent of the Issuer, applying all the tests in section 1.5 of NI 43-101.

12) I have read NI 43-101 and Form 43-101F1 – Technical Report, and the Technical Report has been prepared in compliance with such instrument and form.

Belo Horizonte, Brazil, January 14, 2021

<signed & sealed in the original>

Dr. Beck (Alizeibek) Nader, FAIG

I, Dr. Augusto Ferreira Mendonça, RM SME (4053401RM), as an author of the technical report titled "2020 Updated Mineral Resources and Mineral Reserves Statements of Mineração Caraíba's Vale do Curaçá Mineral Assets, Curaçá Valley", dated January 14, 2021, with an effective date of October 1, 2020 (the "Technical Report"), prepared for Ero Copper Corp. (the "Issuer"), do hereby certify that:

1) I am engaged as a consultant with GE21 Consultoria Mineral Ltda., which is located on Avenida Afonso Pena, 3130, 12th floor, Savassi, Belo Horizonte, MG, Brazil - CEP 30130-910.

2) I graduated with a B.S. in Civil Engineering (1983), B.S. in Geology (1985) and M.S. in Economic Geology (1993) from the University of Brasília - UnB, located in the Federal District, Brazil, and a PhD in Mineral Economics (1998) from the Colorado School of Mines, Colorado, USA. I have practiced my profession continuously since 1985.

3) I am a Registered Member enrolled with The Society for Mining, Metallurgy and Exploration, Inc.- SME (RM-SME # 4053401RM).

4) I am a professional Geologist, with 35 years' relevant experience, including review and report as project manager of numerous environmental studies, including environmental impact assessments and environmental audits. Prior positions as Senior Environmental Consultant for the World Bank (Brazil, Africa and East Europe), and Expert in environmental engineering and science for MICI - InterAmerican Development Bank. Project head in numerous exploration campaigns and feasibility studies of mineral projects in Brazil, Africa, North America and Middle East, including metals and bulk minerals.

5) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* ("NI 43-101") and certify that, by reason of my education, affiliation with a professional association as defined in NI 43-101, and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.

6) I am responsible for Chapter 20. I am also responsible for the corresponding sections within Chapters 1, 25 and 26 that are related to the foregoing Chapter of this Technical Report.

7) I have had no prior involvement with the property that is the subject of this Technical Report.

8) I have not visited the property that is the subject of this Technical Report.

9) As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the sections of the Technical Report that I have authored and am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

10) I have no personal knowledge, as of the date of this certificate, of any material fact or material change which is not reflected in this Technical Report.

11) I am independent of the Issuer, applying all the tests in section 1.5 of NI 43-101.

12) I have read NI 43-101 and Form 43-101F1 – Technical Report, and the Technical Report has been prepared in compliance with such instrument and form.

Belo Horizonte, Brazil, January 14, 2021

<signed & sealed in the original>

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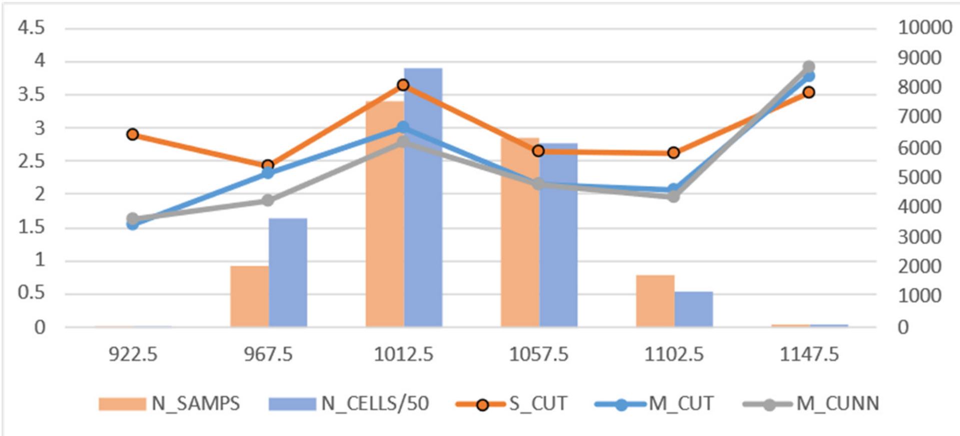
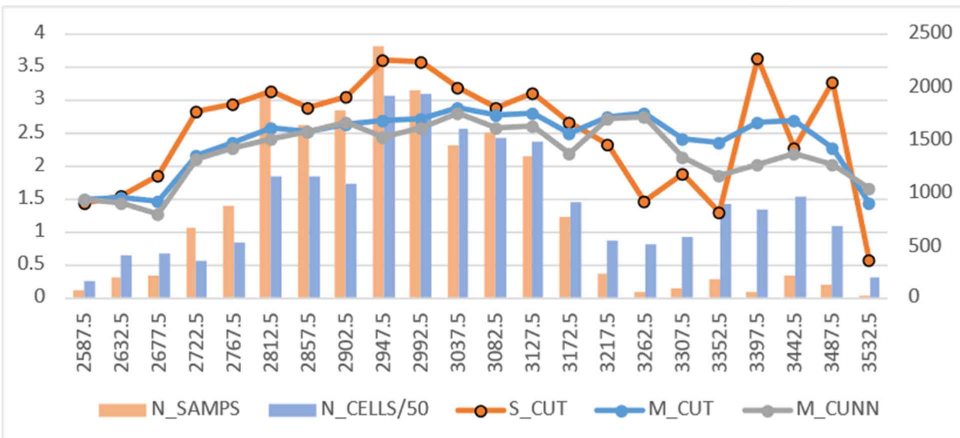
Dr. Augusto Ferreira Mendonça, RM-SME

APPENDIX B

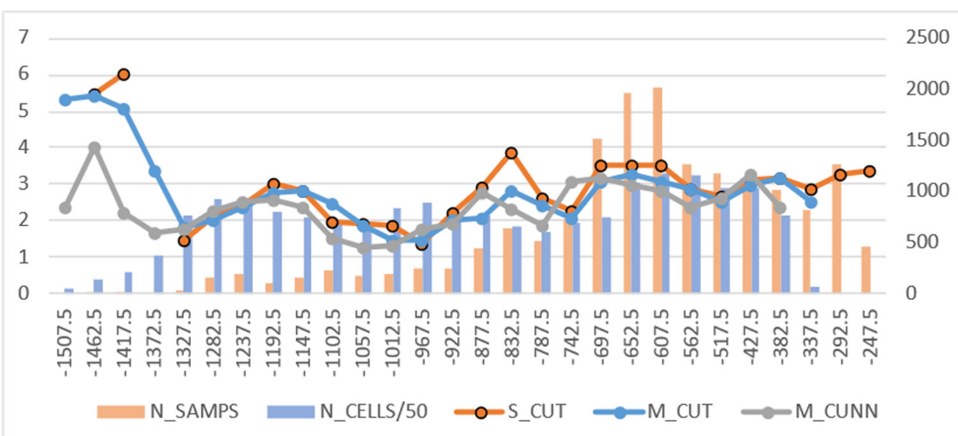
Swath Plots



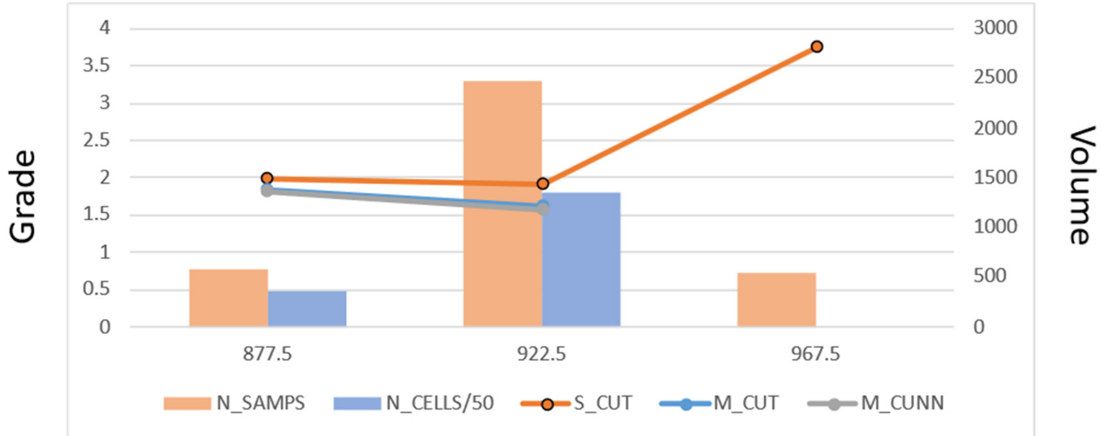
Swath Plot X axis – Deepening Domain, Rocktype 2004



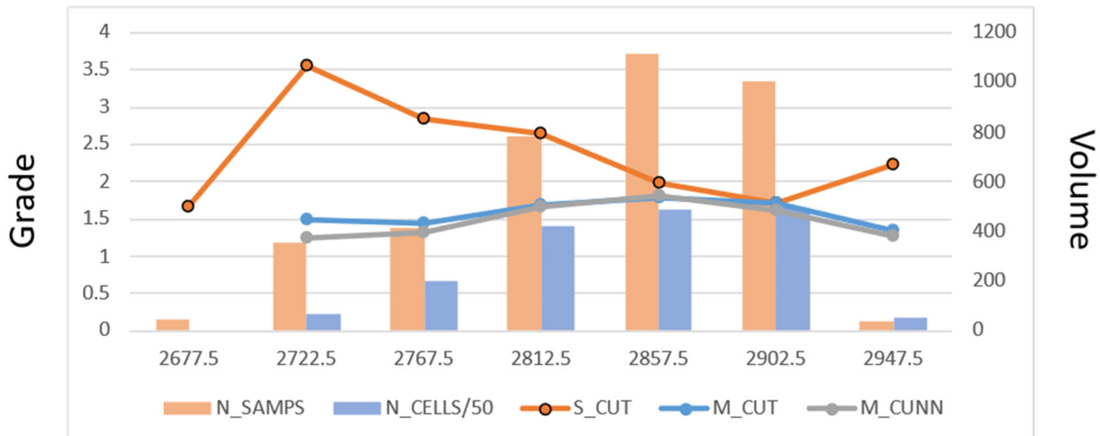
Swath Plot Y axis – Deepening Domain, Rocktype 2004



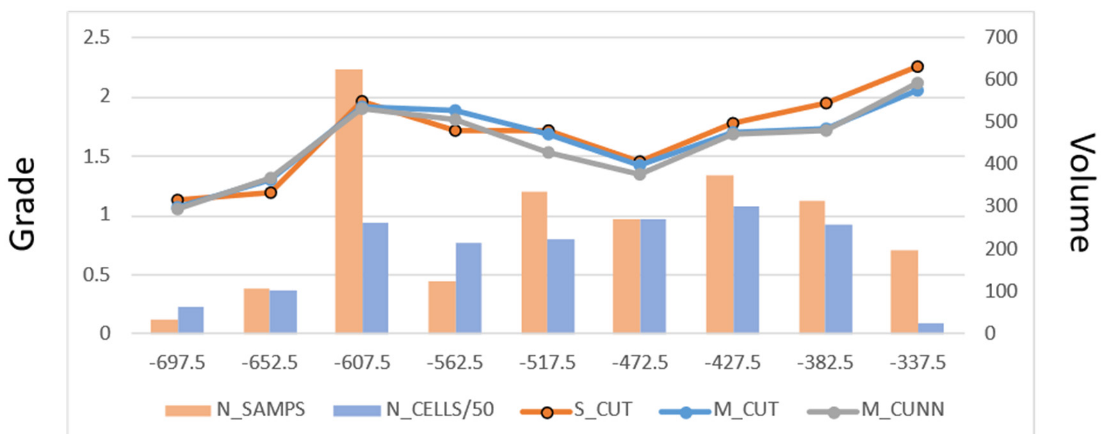
Swath Plot Z axis – Deepening Domain, Rocktype 2004



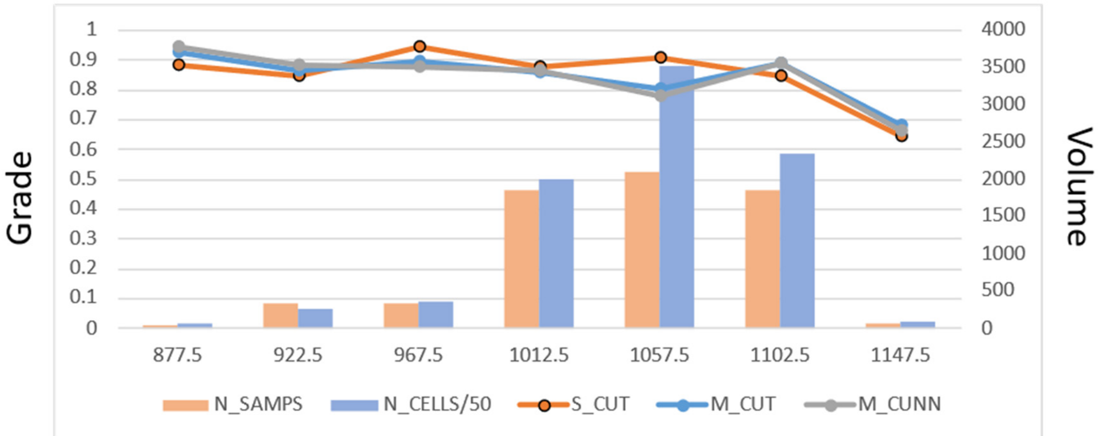
Swath Plot X axis – Deepening Domain, Rocktype 2005



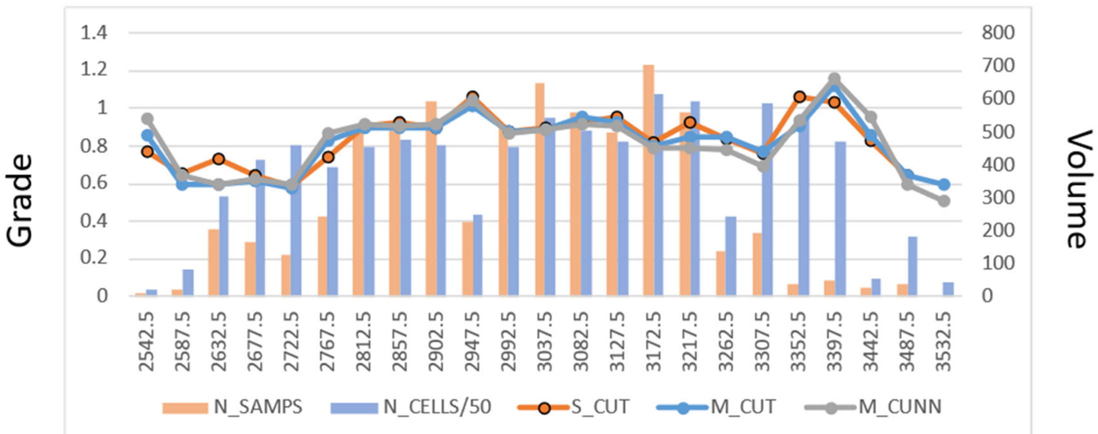
Swath Plot Y axis – Deepening Domain, Rocktype 2005



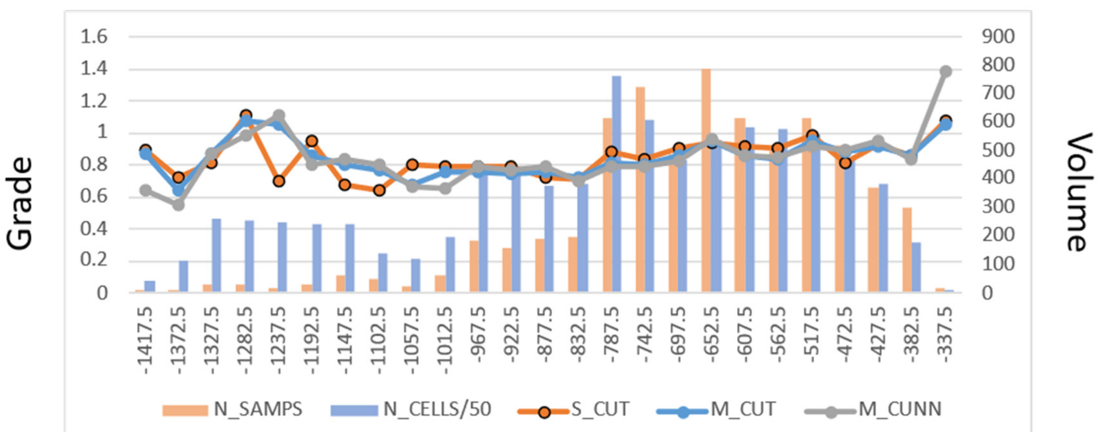
Swath Plot Z axis – Deepening Domain, Rocktype 2005



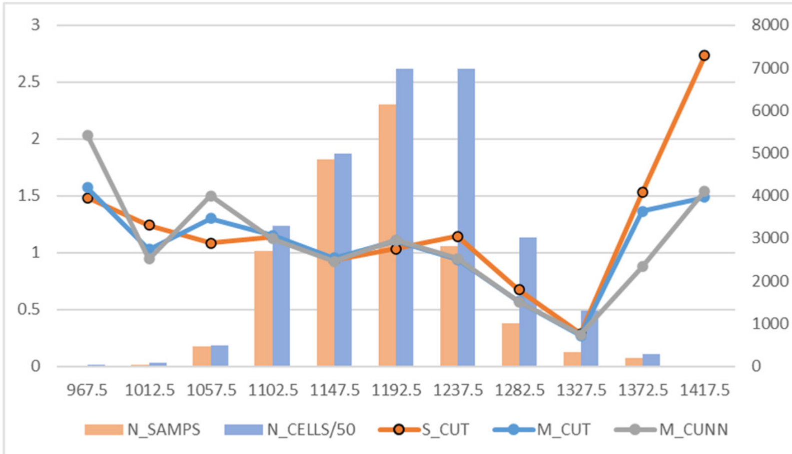
Swath Plot X axis – Deepening Domain, Rocktype 5005



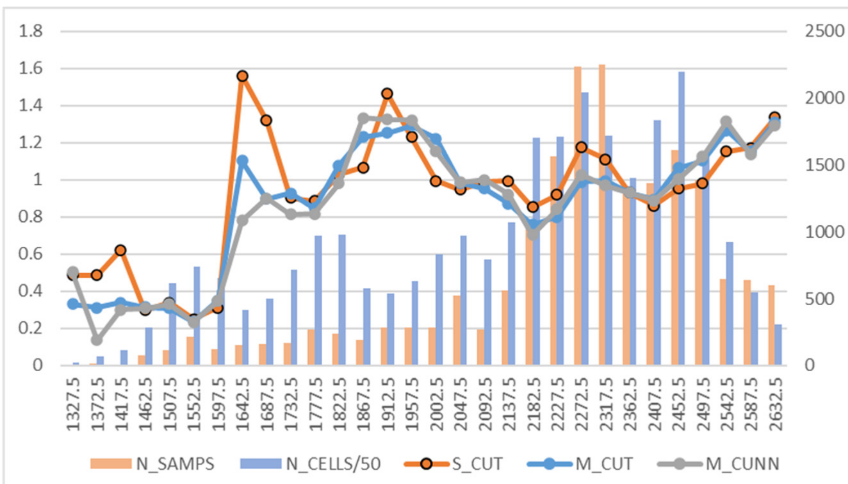
Swath Plot Y axis – Deepening Domain, Rocktype 5005



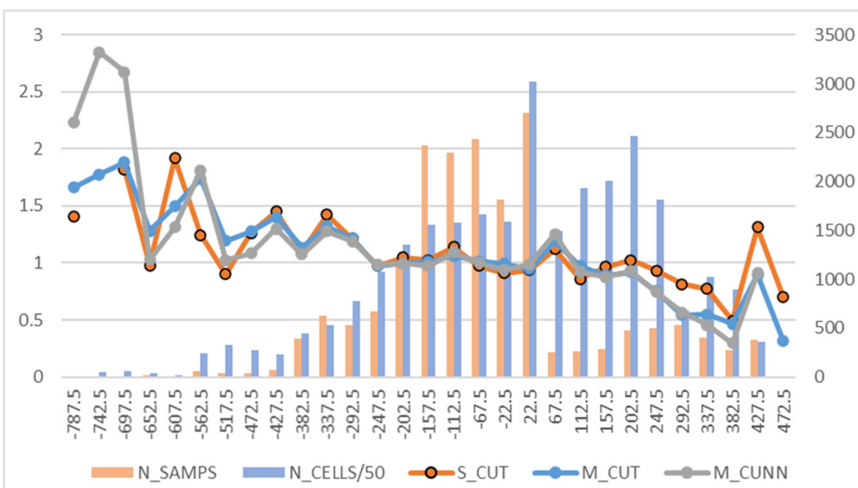
Swath Plot Z axis – Deepening Domain, Rocktype 5005



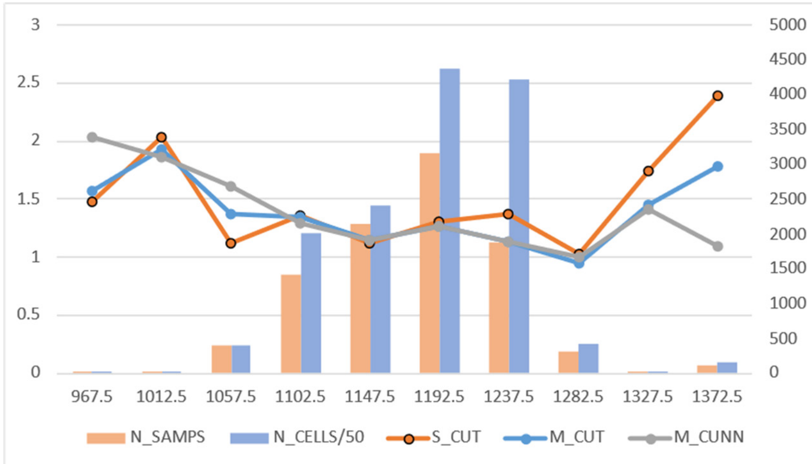
Swath Plot X axis – MSB Sul/ Barauna Domain



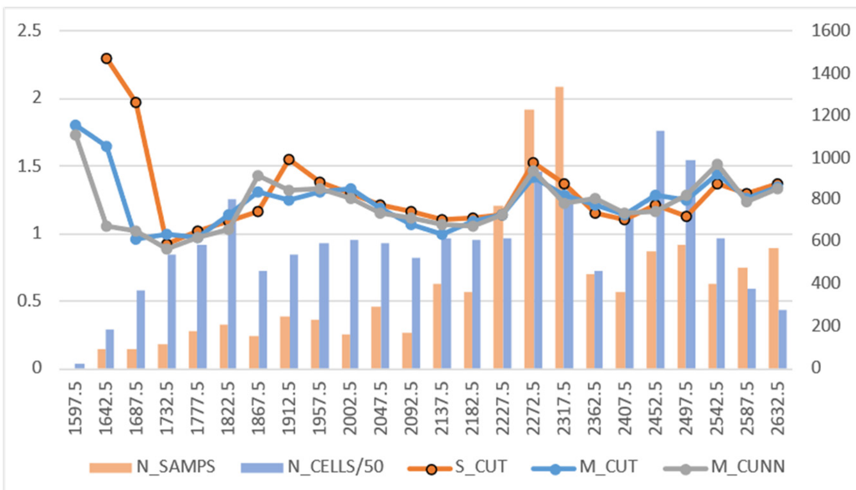
Swath Plot Y axis – MSB Sul/ Barauna Domain



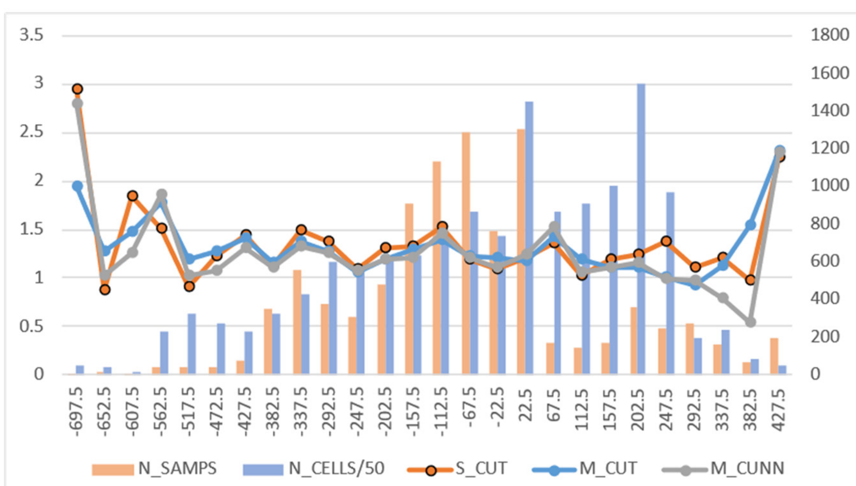
Swath Plot Z axis – MSB Sul/ Barauna Domain



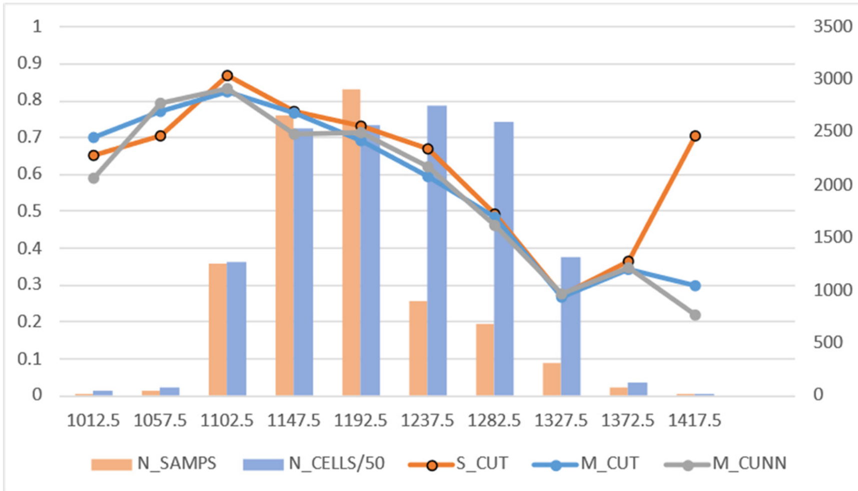
Swath Plot X axis – MSB Sul/ Barauna Domain, Rocktype 3001



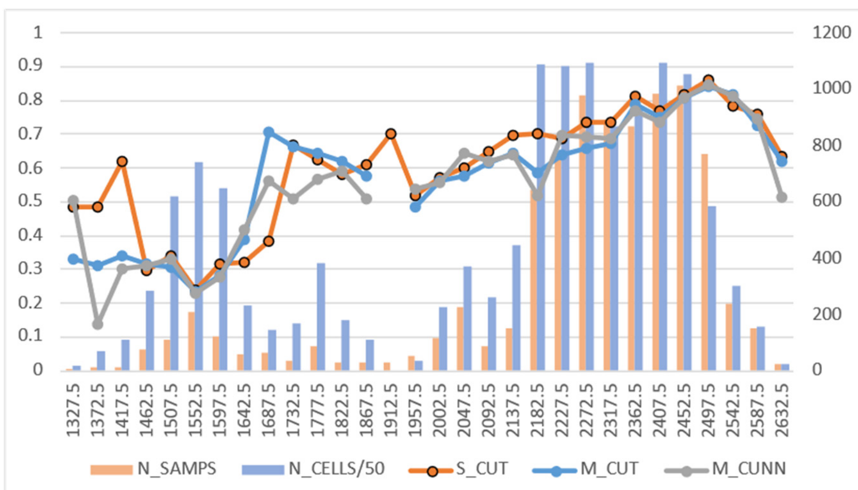
Swath Plot Y axis – MSB Sul/ Barauna Domain, Rocktype 3001



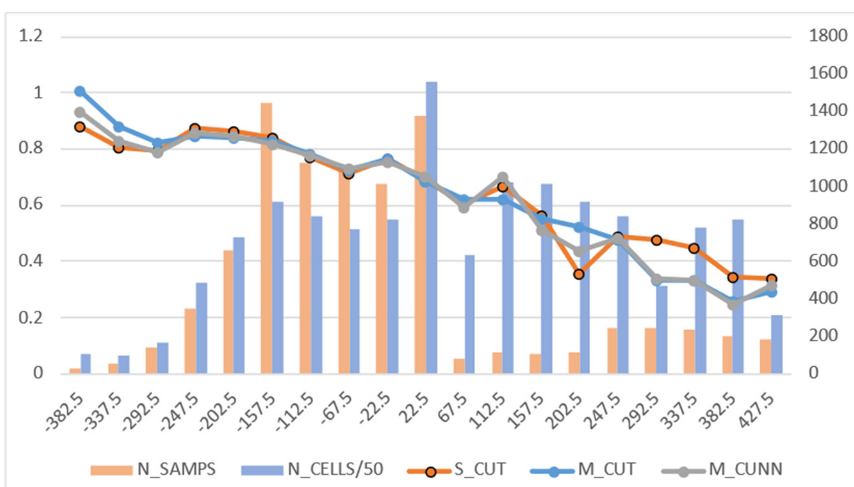
Swath Plot Z axis – MSB Sul/ Barauna Domain, Rocktype 3001



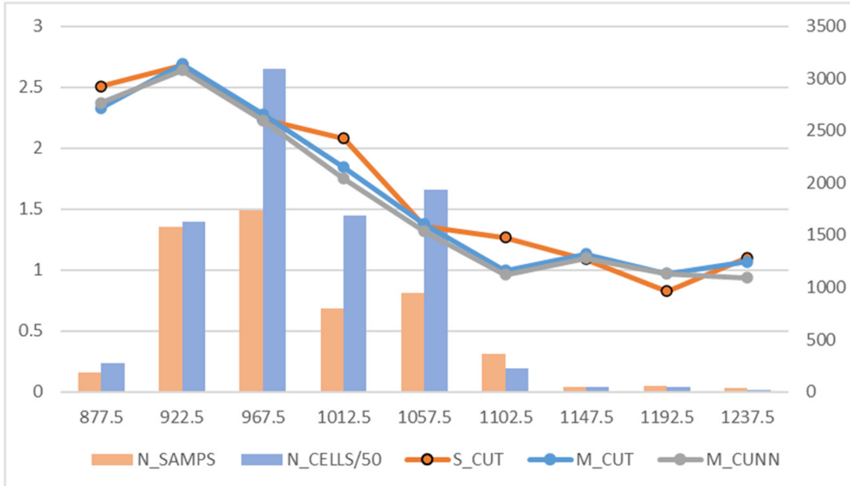
Swath Plot X axis – MSB Sul/ Barauna Domain, Rocktype 3002



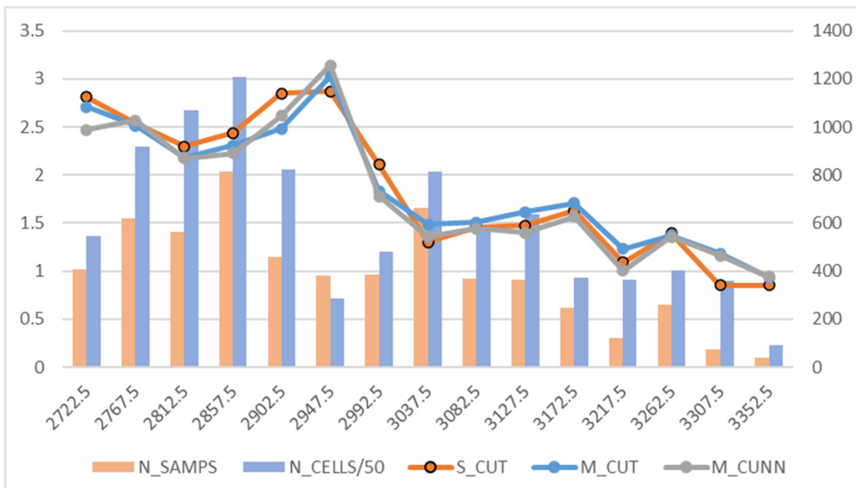
Swath Plot Y axis – MSB Sul/ Barauna Domain, Rocktype 3002



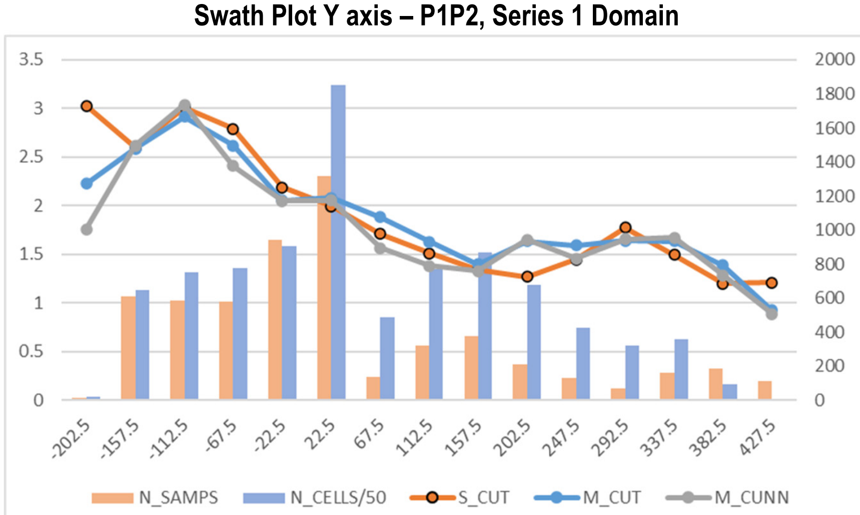
Swath Plot Z axis – MSB Sul/ Barauna Domain, Rocktype 3002



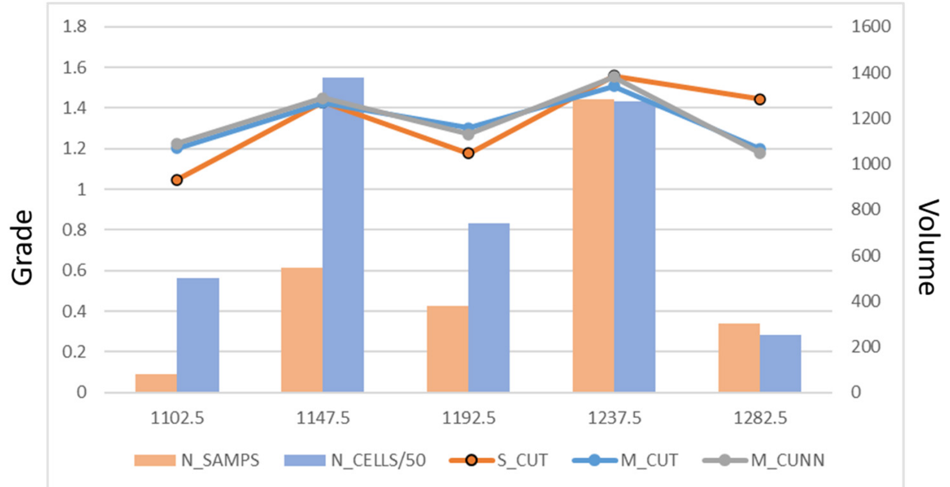
Swath Plot X axis – P1P2, Series 1 Domain



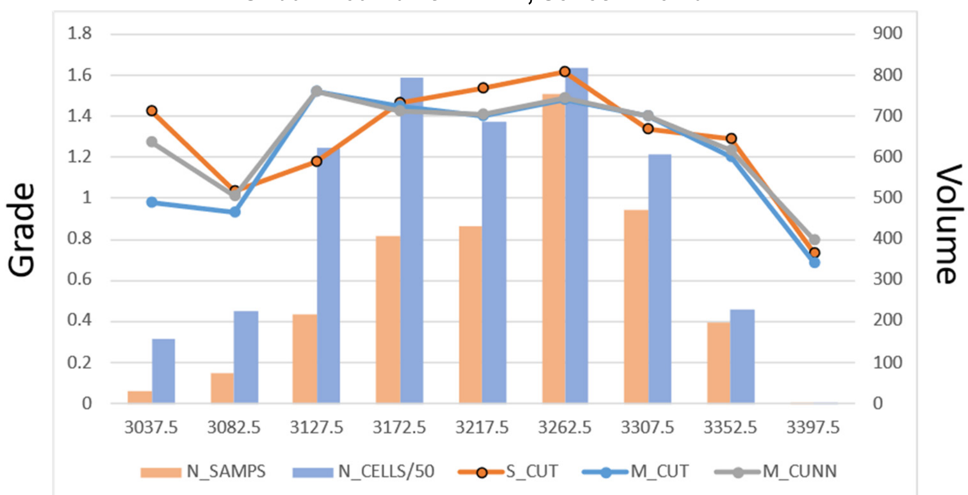
Swath Plot Y axis – P1P2, Series 1 Domain



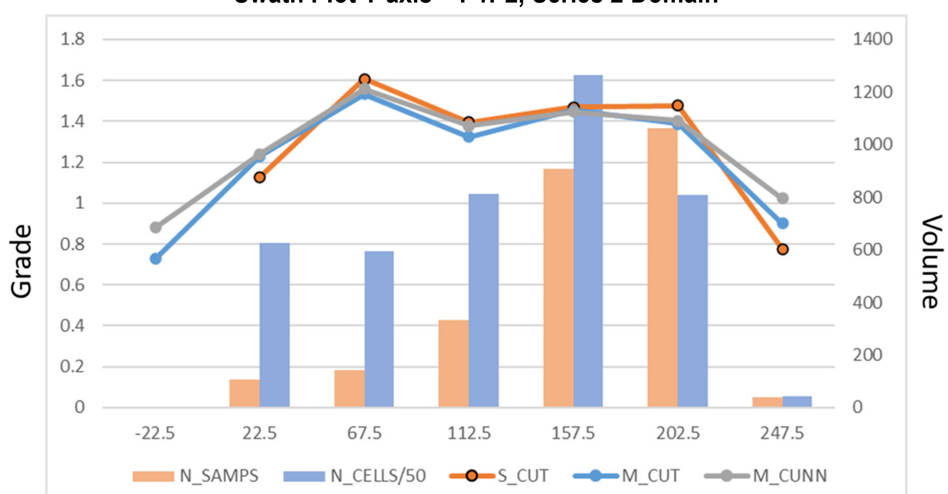
Swath Plot Z axis – P1P2, Series 1 Domain



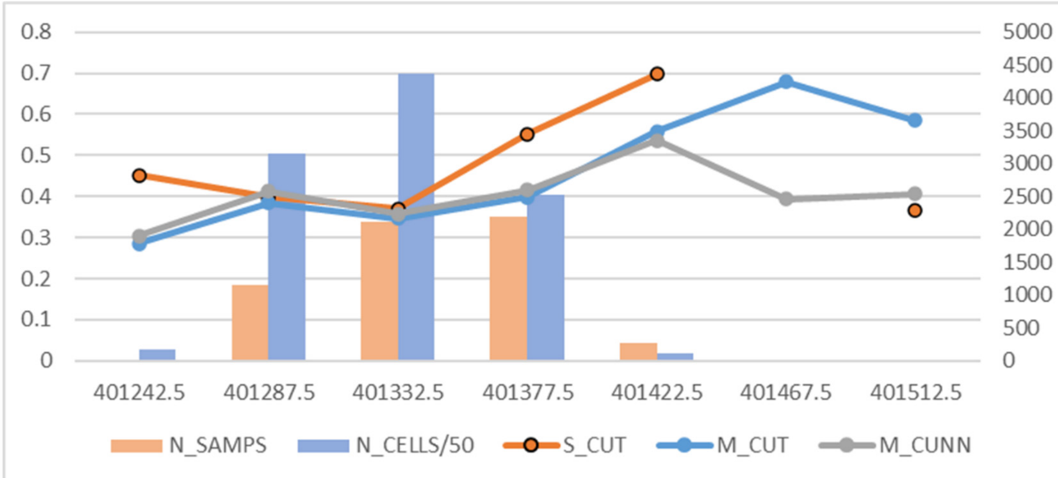
Swath Plot X axis – P1P2, Series 2 Domain



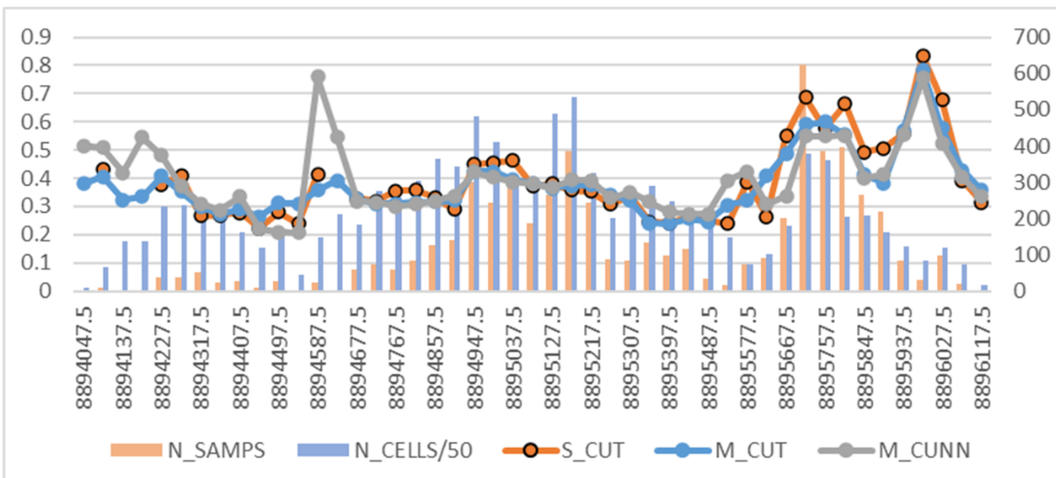
Swath Plot Y axis – P1P2, Series 2 Domain



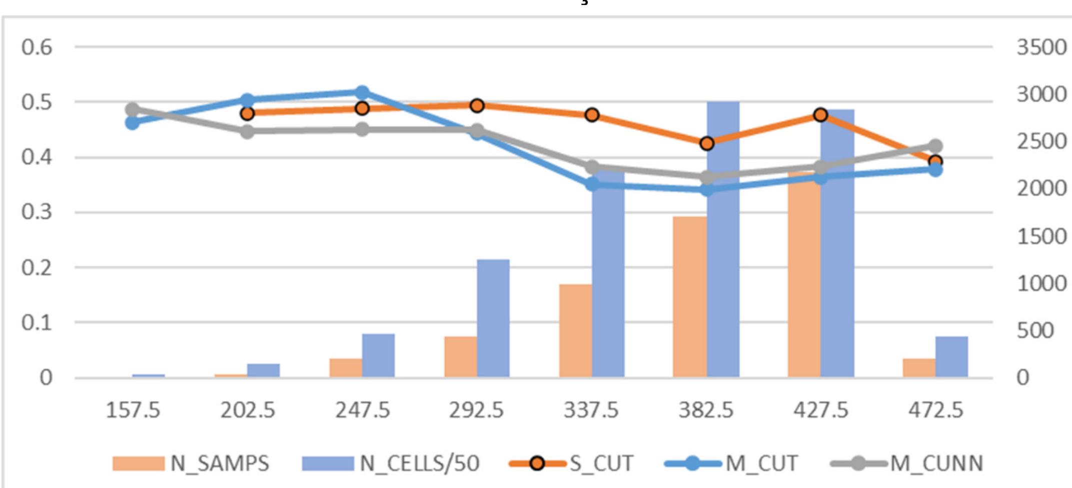
Swath Plot Z axis – P1P2, Series 2 Domain



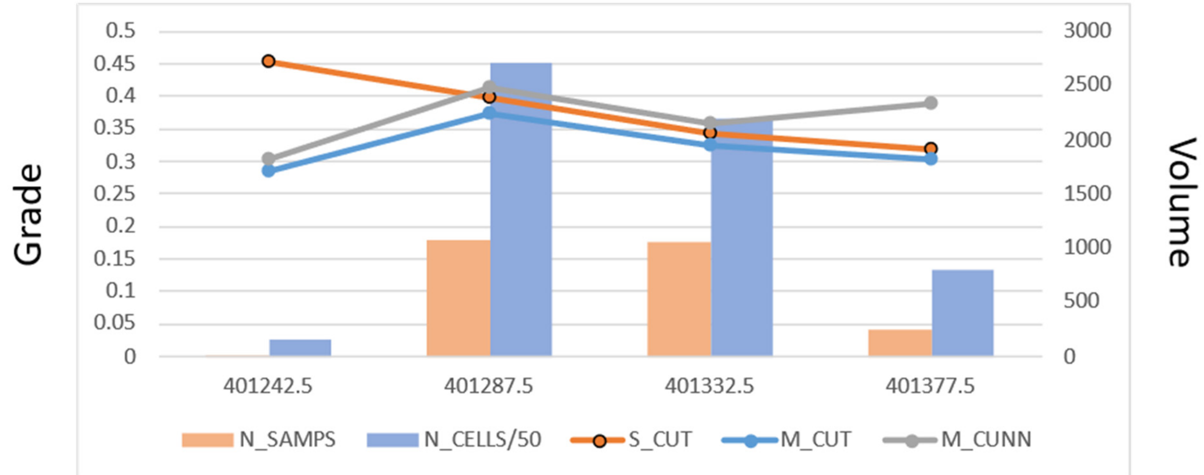
Swath Plot X axis – Suçuarana Domain



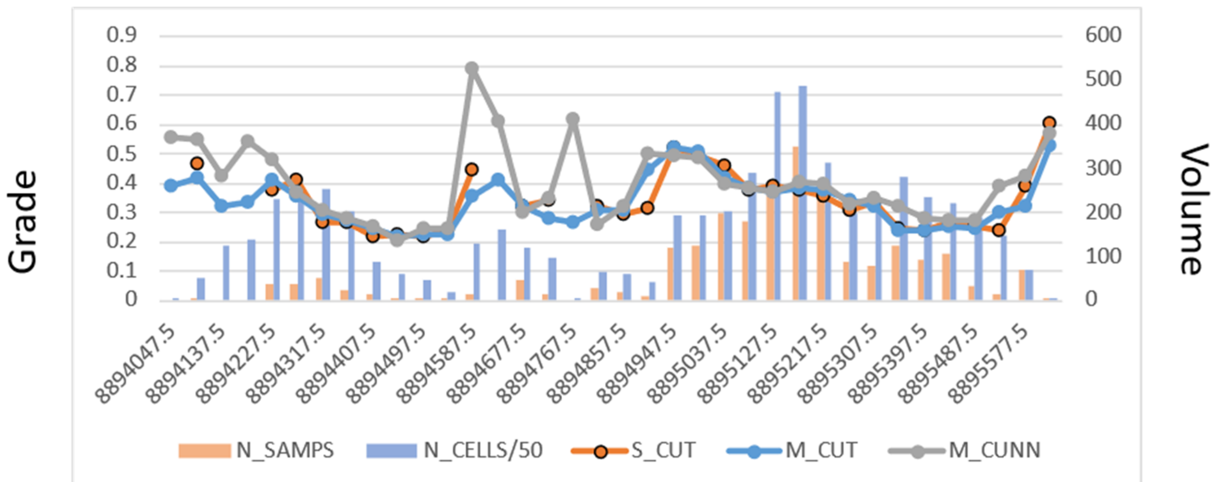
Swath Plot Y axis – Suçuarana Domain



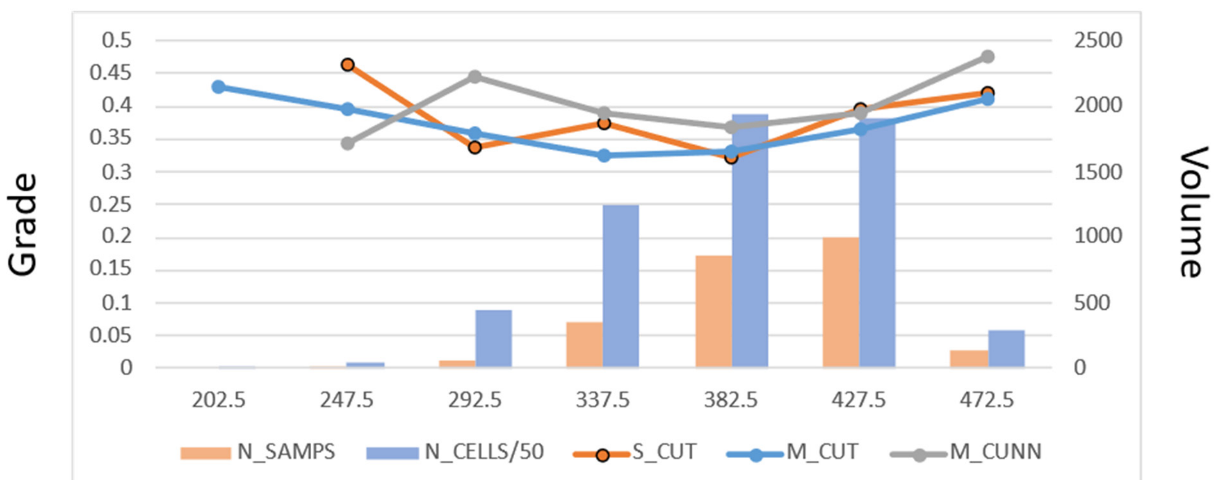
Swath Plot Z axis – Suçuarana Domain



Swath Plot X axis – Suçuarana Domain, Rocktype 560



Swath Plot Y axis – Suçuarana Domain, Rocktype 560



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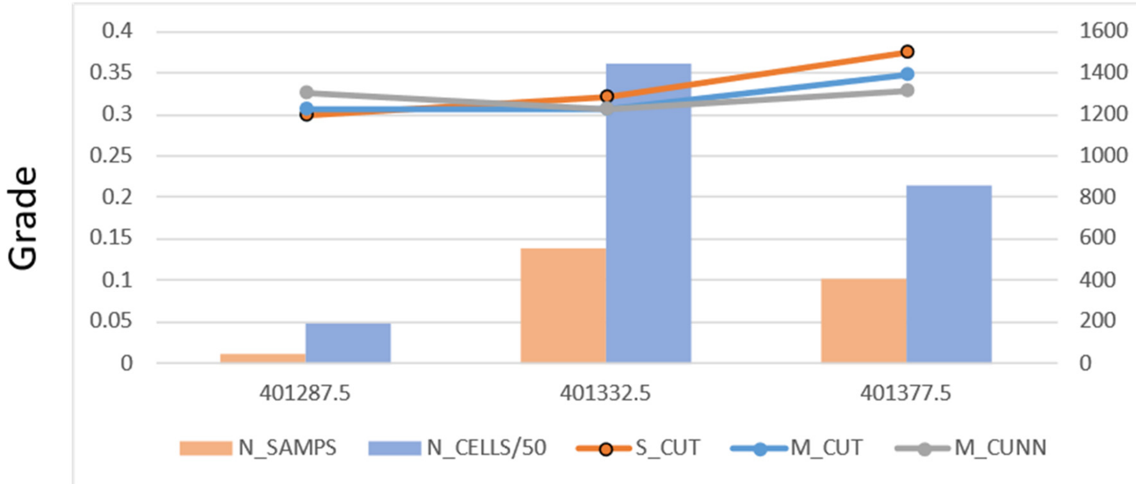

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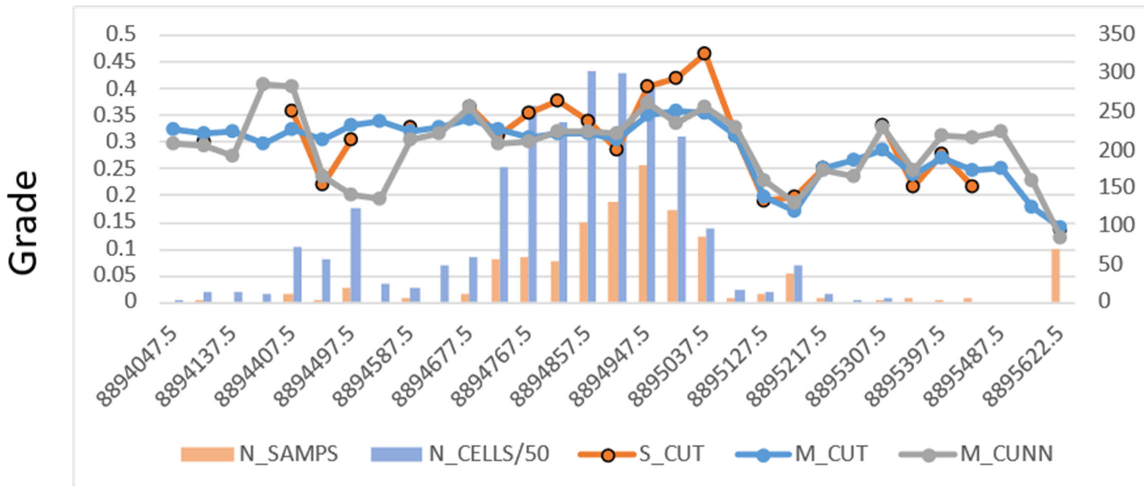
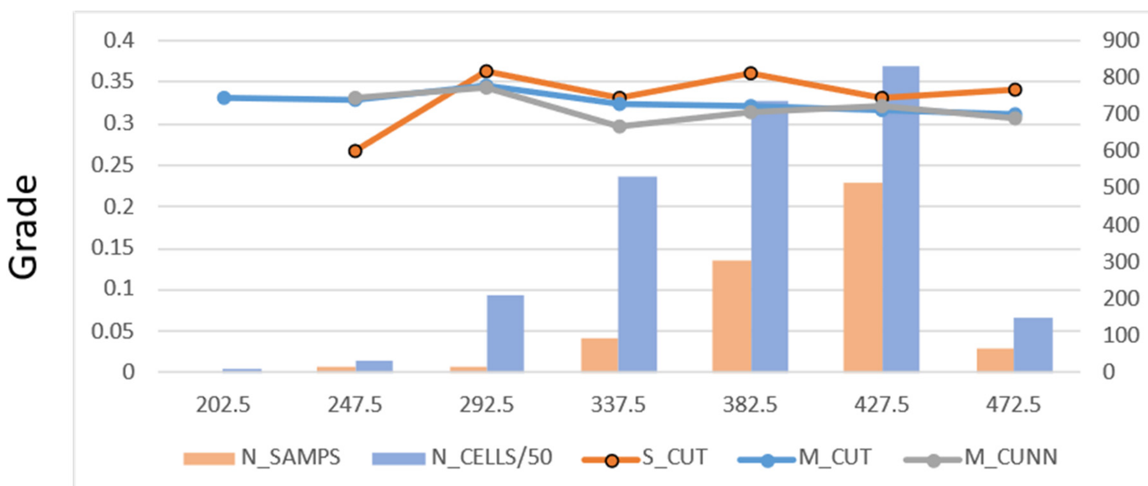


Swath Plot Y axis – Suçuarana Domain, Rocktype 570



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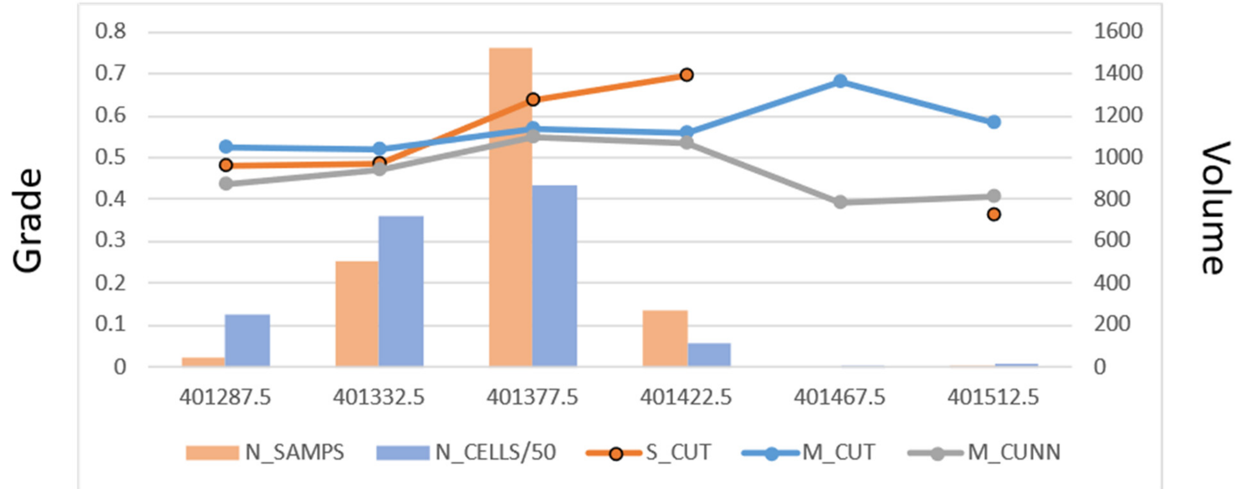
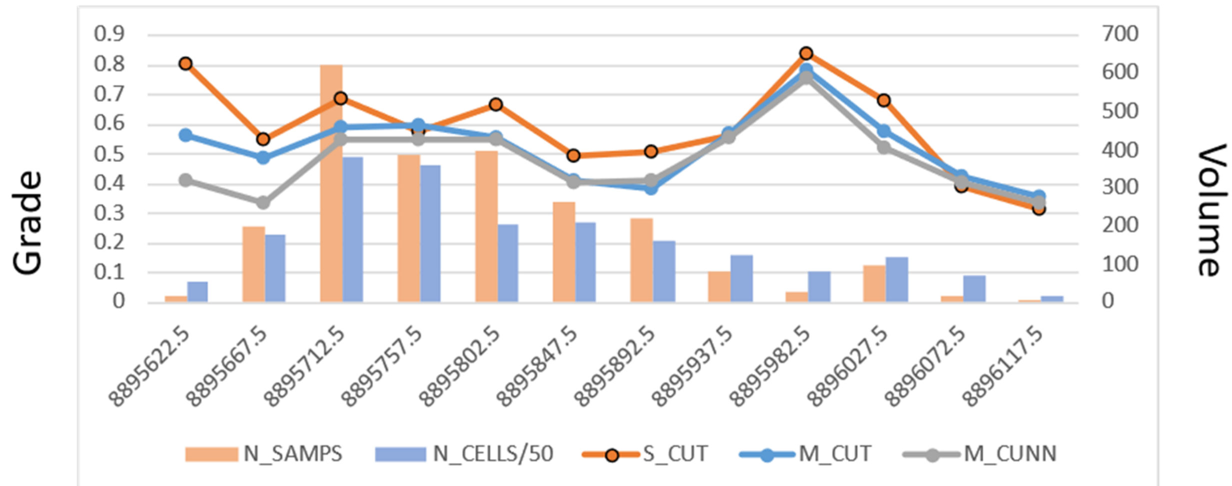
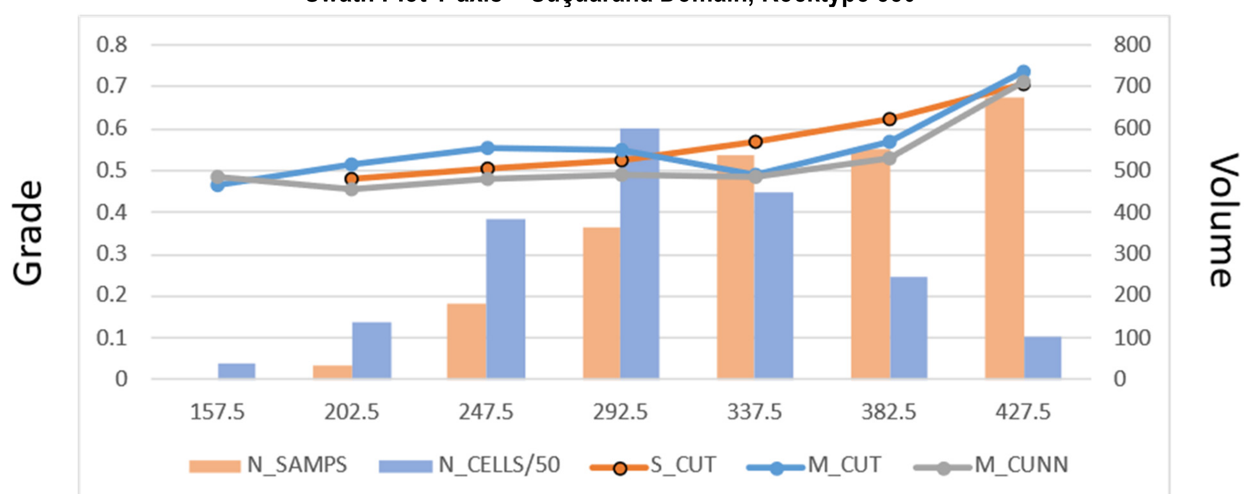


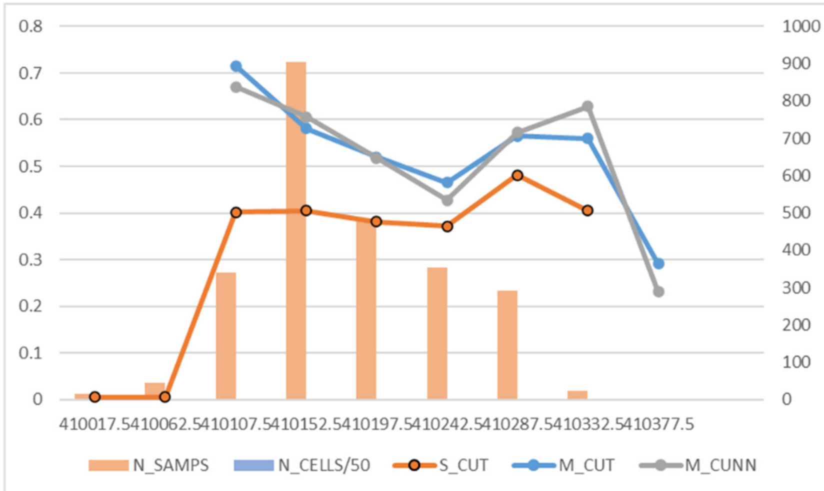
Swath Plot X axis – Suçuarana Domain, Rocktype 580



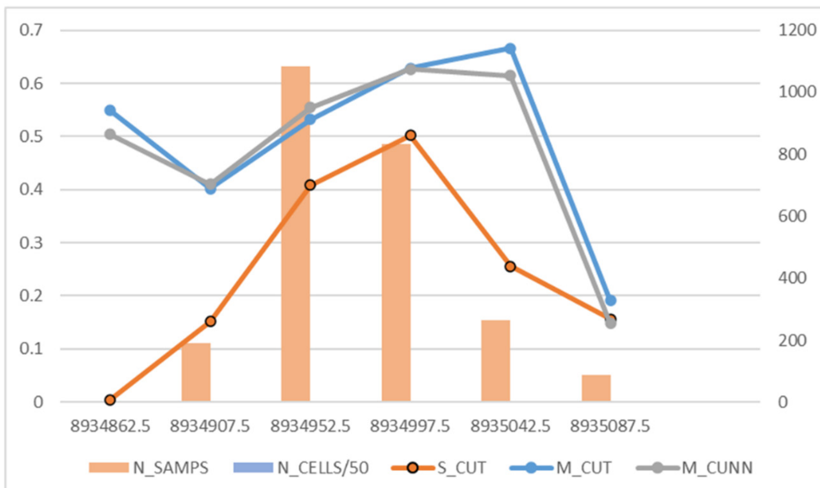
Swath Plot Y axis – Suçuarana Domain, Rocktype 580



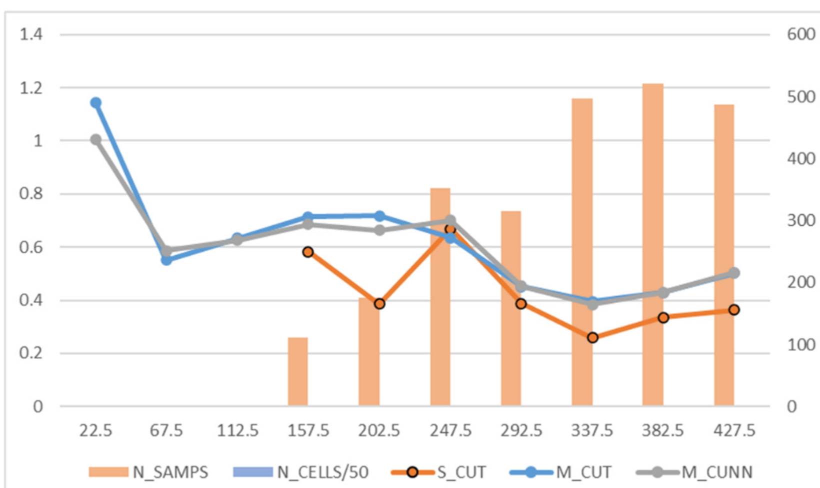
Swath Plot Z axis – Suçuarana Domain, Rocktype 580



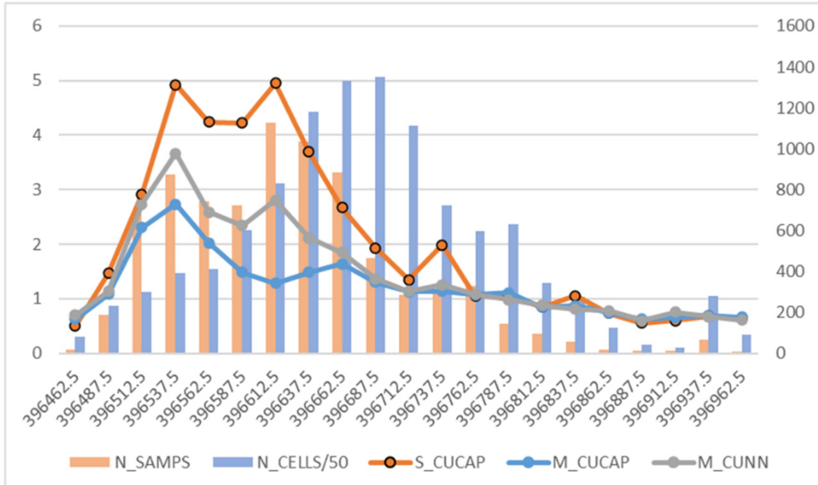
Swath Plot X axis – Terra do Sal Domain



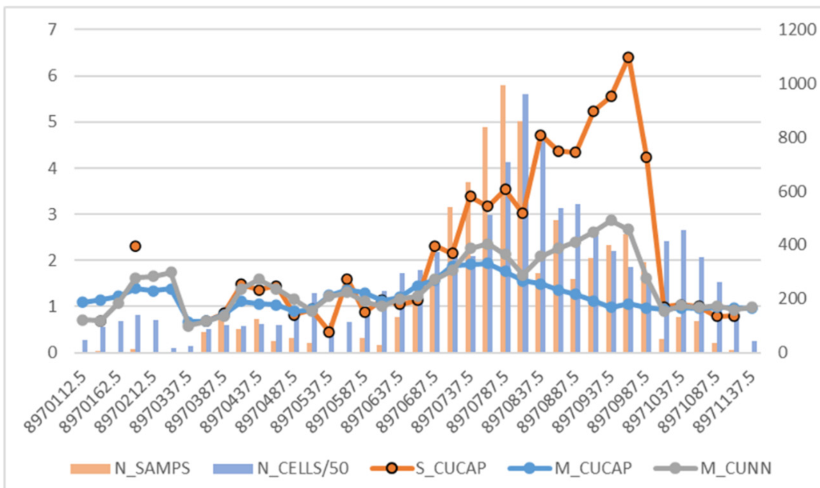
Swath Plot Y axis – Terra do Sal Domain



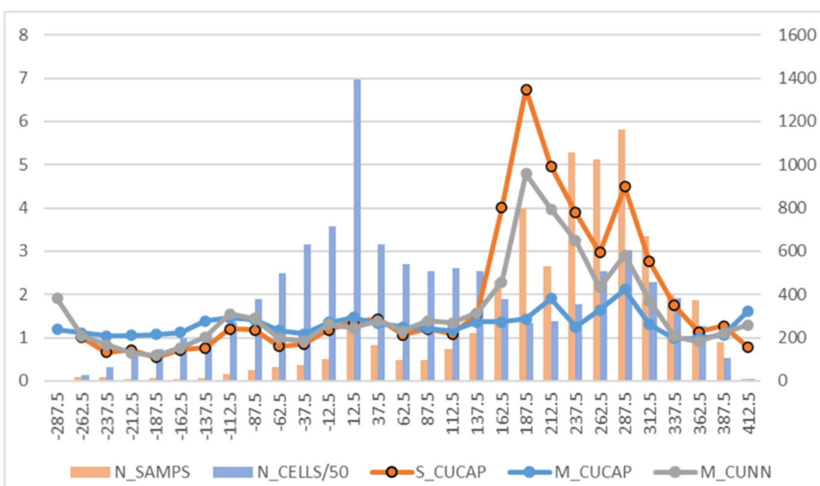
Swath Plot Z axis – Terra do Sal Domain



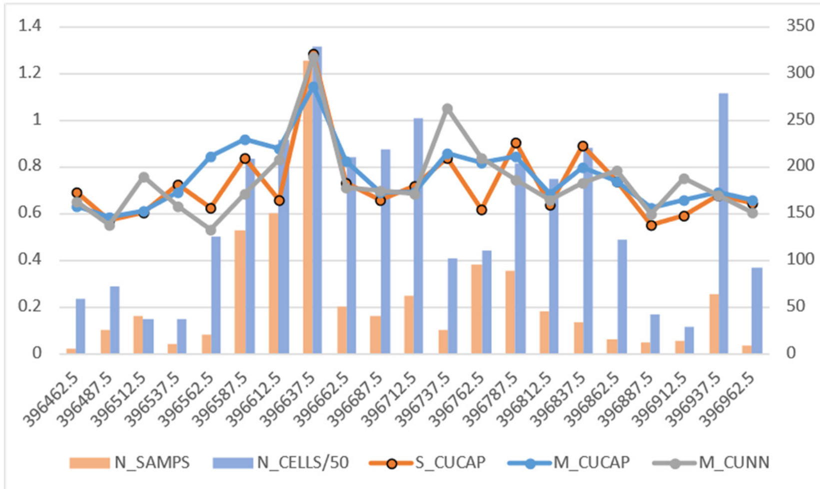
Swath Plot X axis – Vermelhos UG Mine Domain



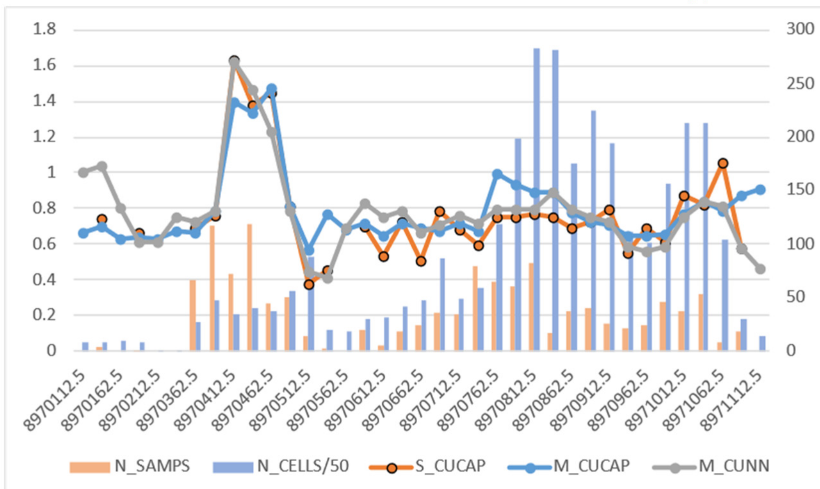
Swath Plot Y axis – Vermelhos UG Mine Domain



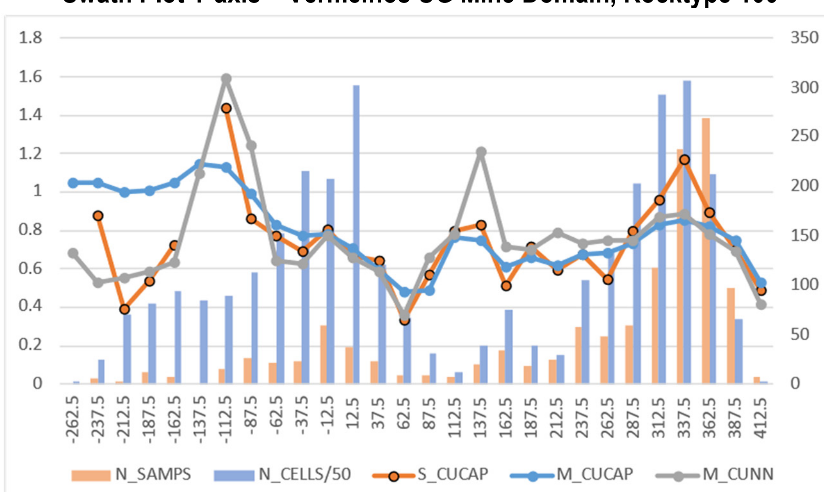
Swath Plot Z axis – Vermelhos UG Mine Domain



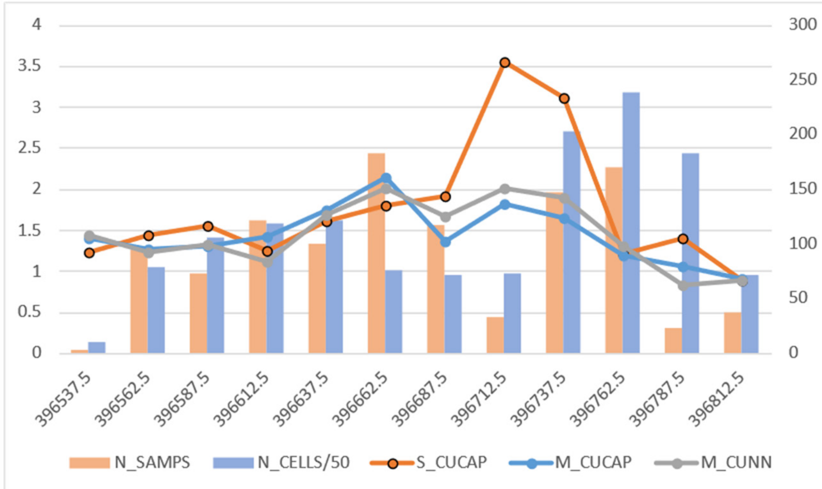
Swath Plot X axis – Vermelhos UG Mine Domain, Rocktype 100



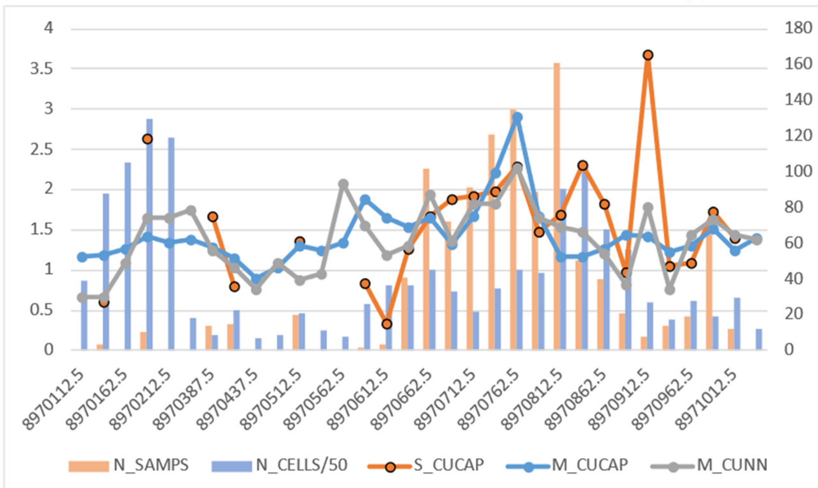
Swath Plot Y axis – Vermelhos UG Mine Domain, Rocktype 100



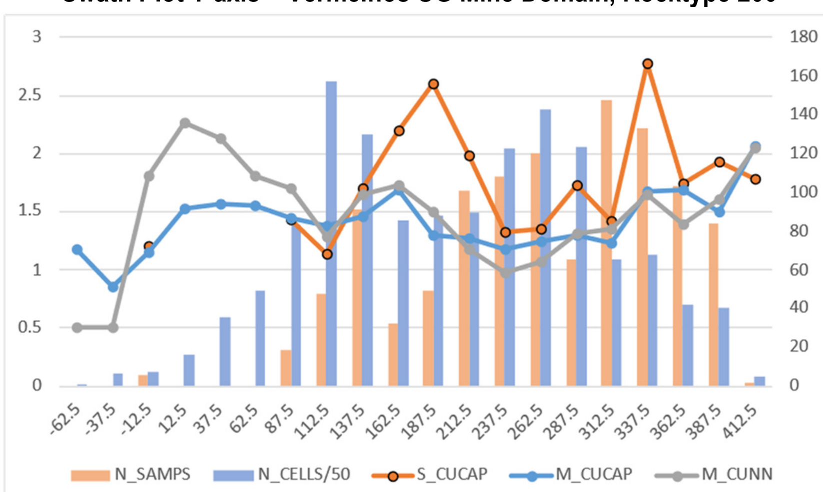
Swath Plot Z axis – Vermelhos UG Mine Domain, Rocktype 100



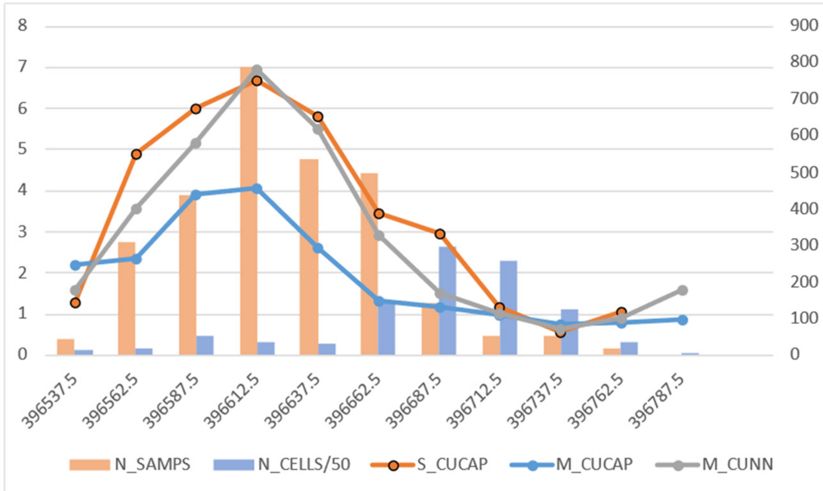
Swath Plot X axis – Vermelhos UG Mine Domain, Rocktype 200



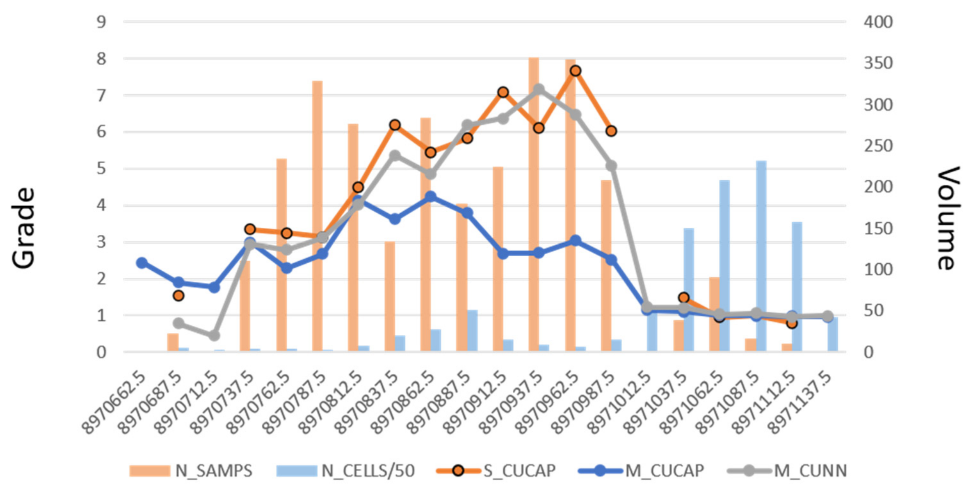
Swath Plot Y axis – Vermelhos UG Mine Domain, Rocktype 200



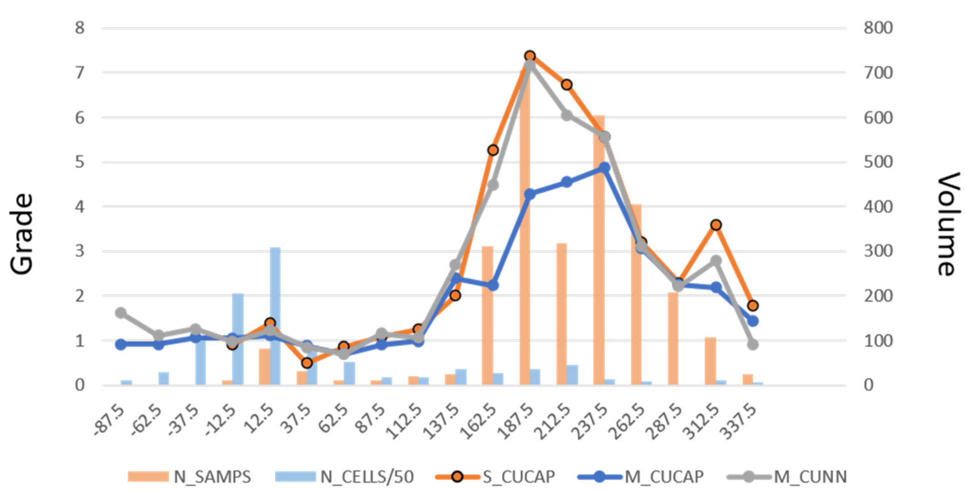
Swath Plot Z axis – Vermelhos UG Mine Domain, Rocktype 200



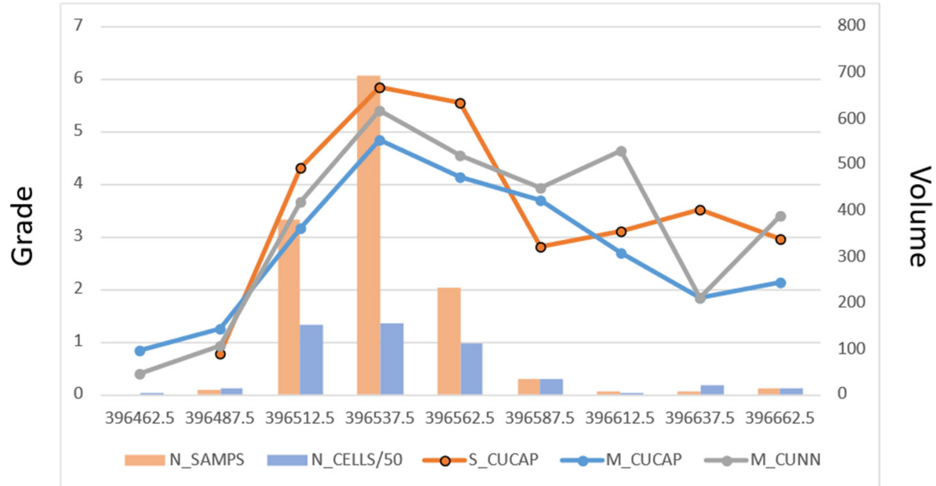
Swath Plot X axis – Vermelhos UG Mine Domain, Rocktype 300



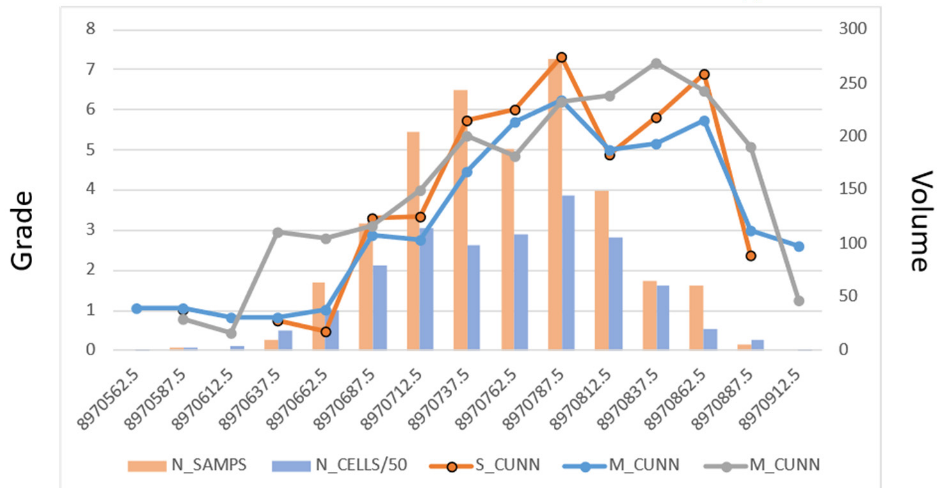
Swath Plot Y axis – Vermelhos UG Mine Domain, Rocktype 300



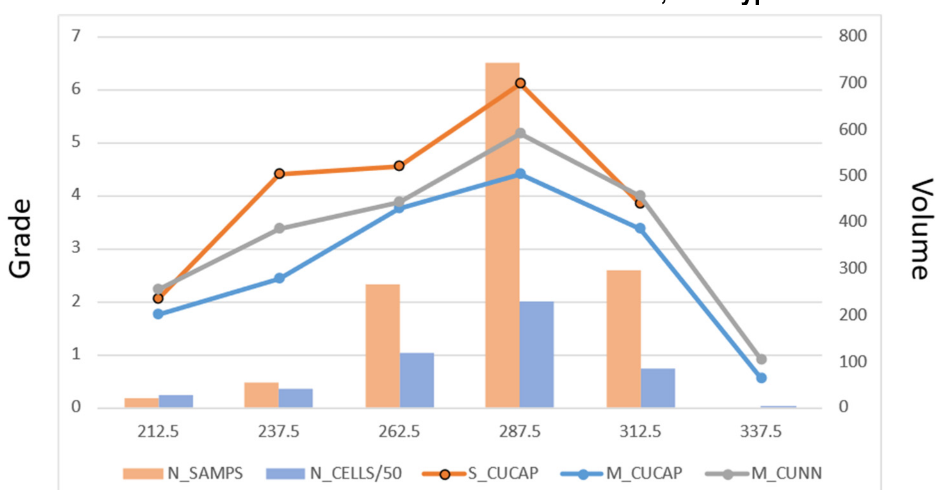
Swath Plot Z axis – Vermelhos UG Mine Domain, Rocktype 300



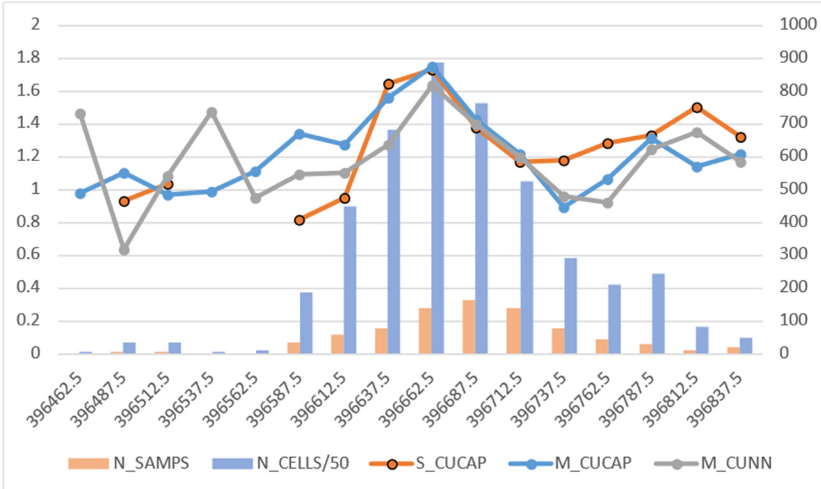
Swath Plot X axis – Vermelhos UG Mine Domain, Rocktype 400



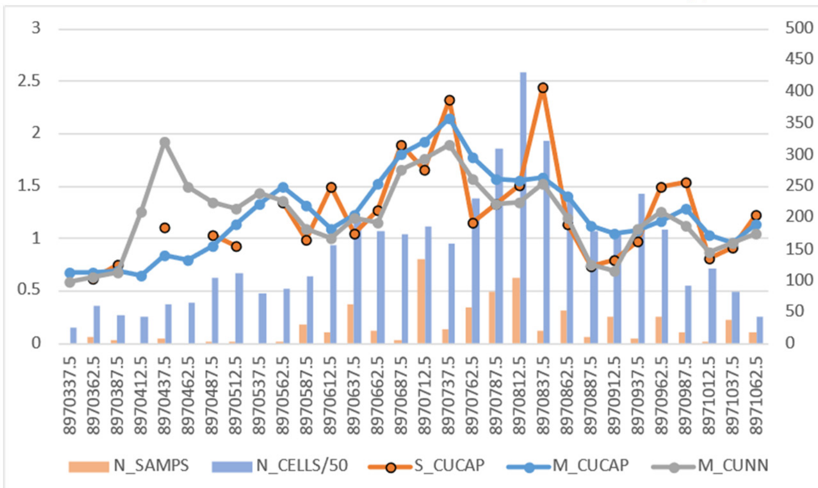
Swath Plot Y axis – Vermelhos UG Mine Domain, Rocktype 400



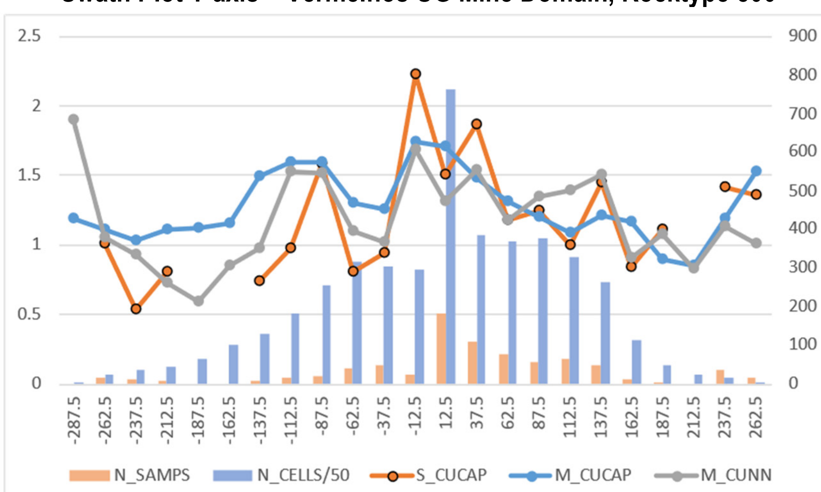
Swath Plot Z axis – Vermelhos UG Mine Domain, Rocktype 400



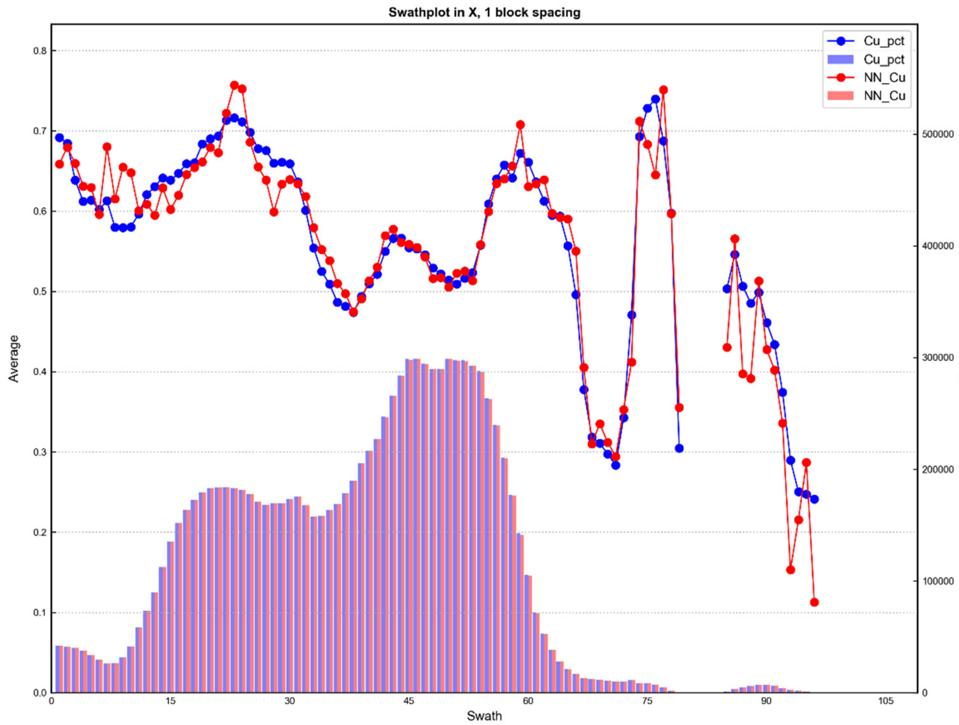
Swath Plot X axis – Vermelhos UG Mine Domain, Rocktype 500



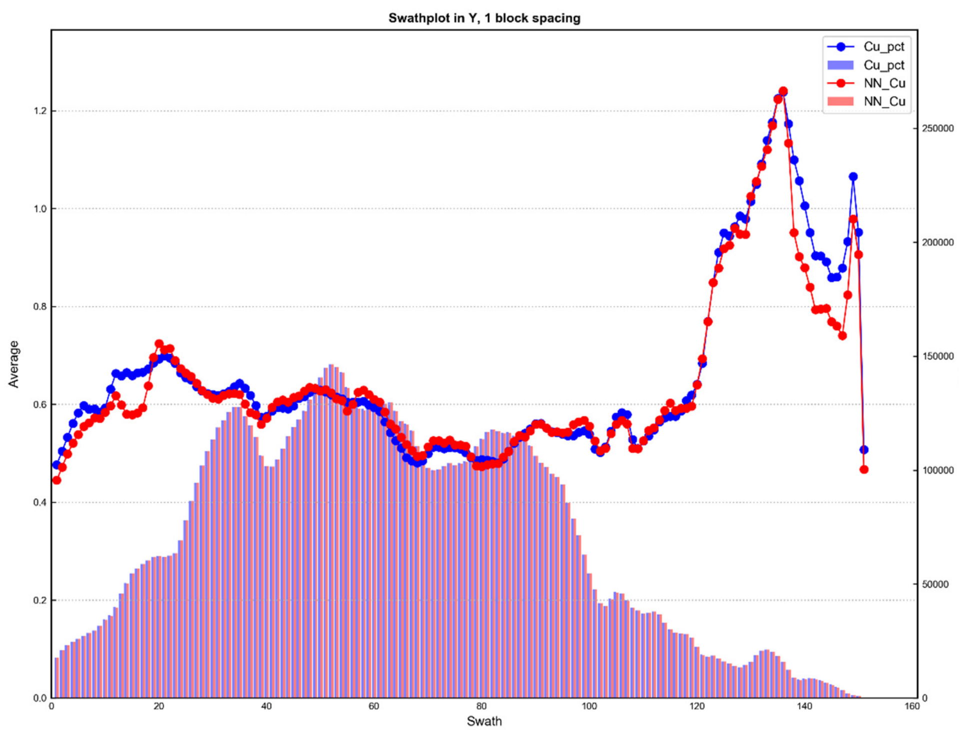
Swath Plot Y axis – Vermelhos UG Mine Domain, Rocktype 500



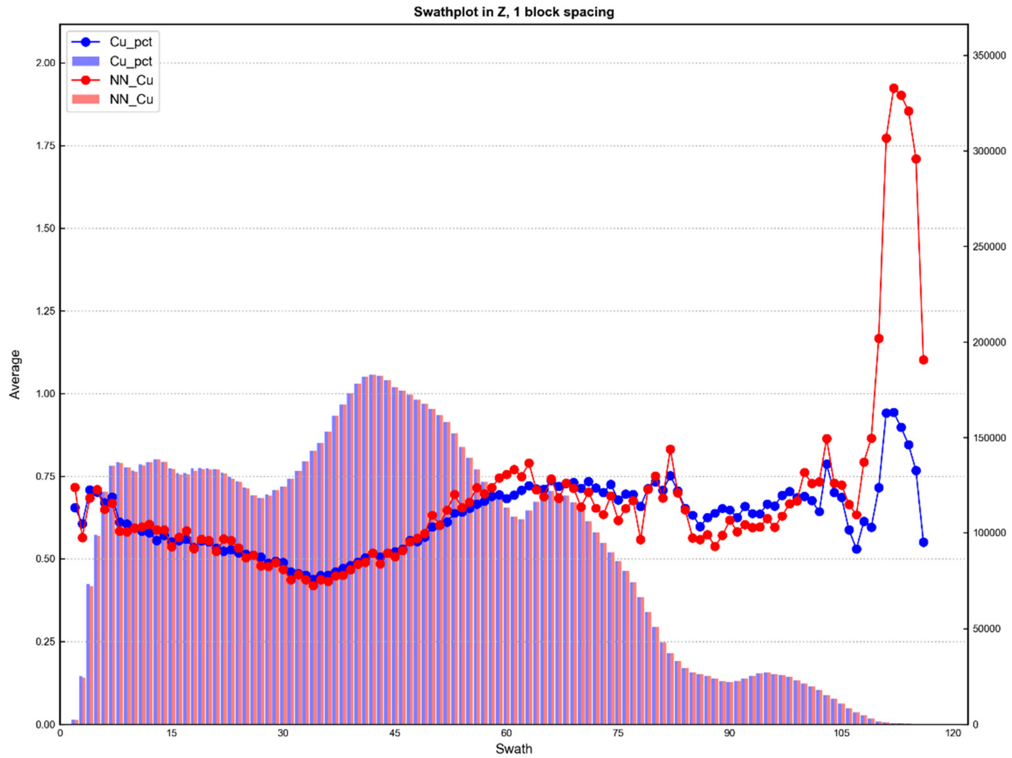
Swath Plot Z axis – Vermelhos UG Mine Domain, Rocktype 500



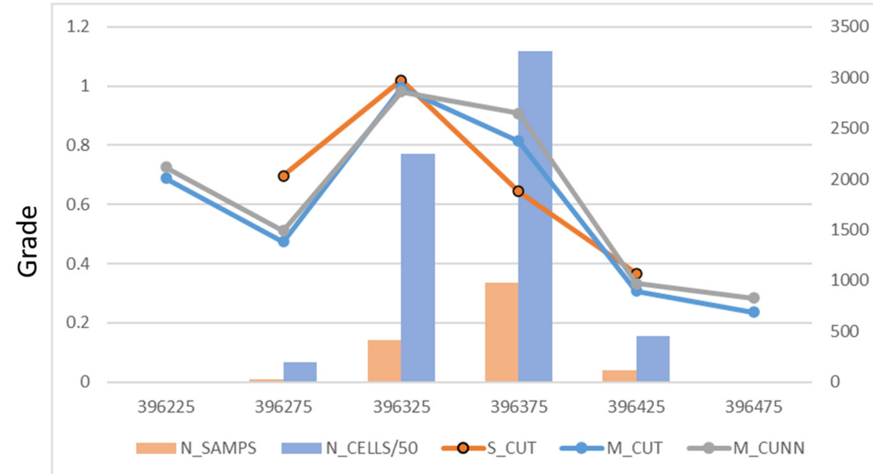
Swath Plot X axis – N8 Domain ("Cu_pct" value estimated by OK and "NN_Cu" value estimated by NN).



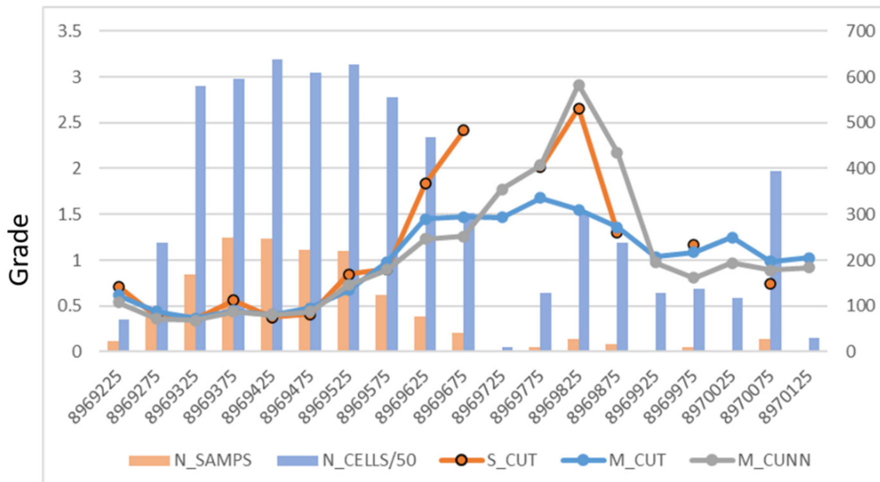
Swath Plot Y axis – N8 Domain ("Cu_pct" value estimated by OK and "NN_Cu" value estimated by NN)



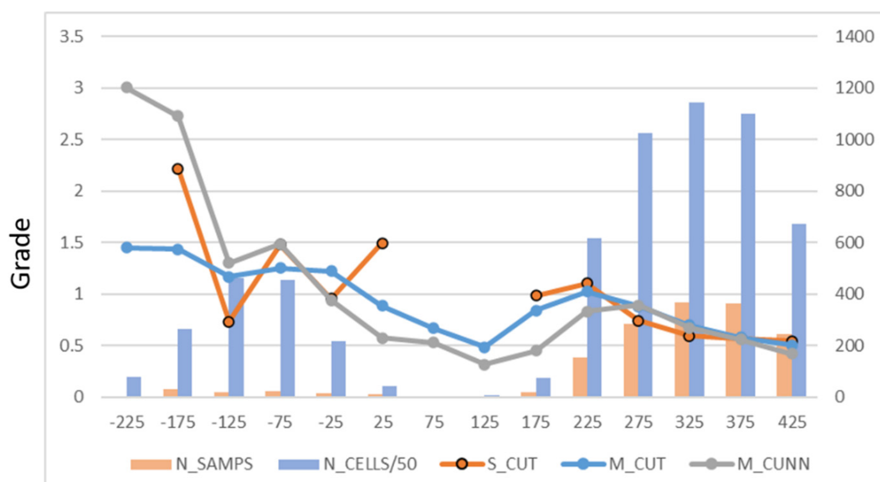
Swath Plot Z axis – N8 Domain ("Cu_pct" value estimated by OK and "NN_Cu" value estimated by NN)



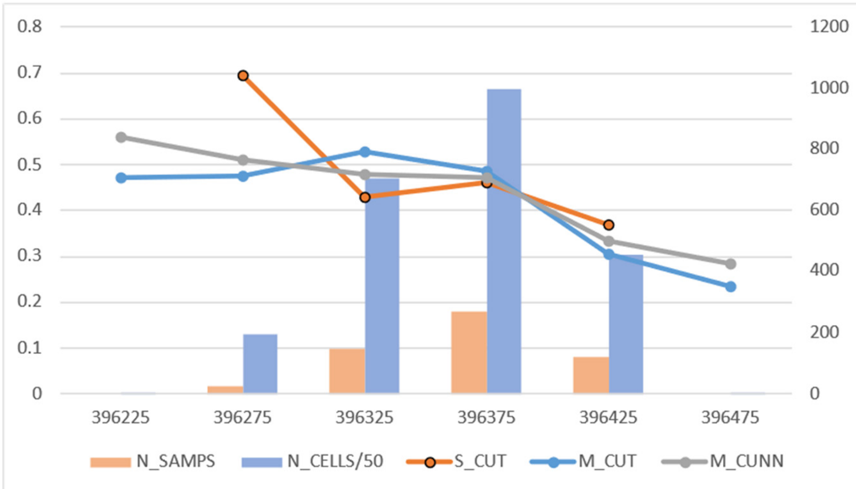
Swath Plot X axis – Siriema Domain



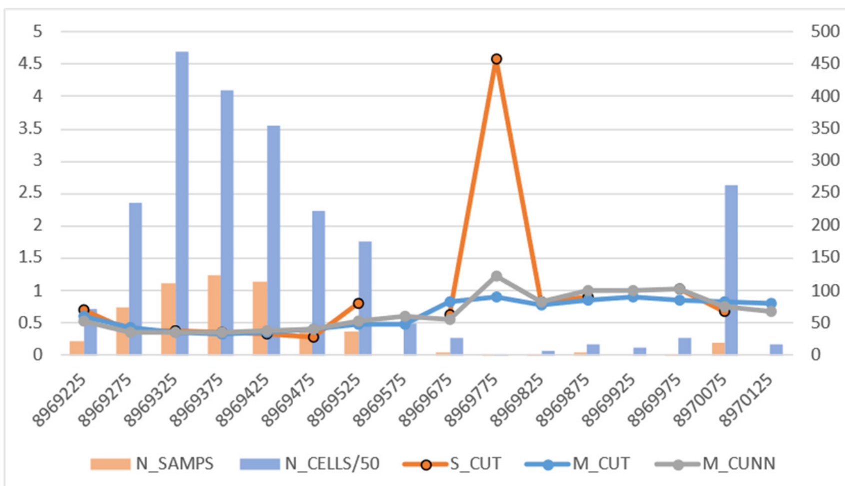
Swath Plot Y axis – Siriema Domain



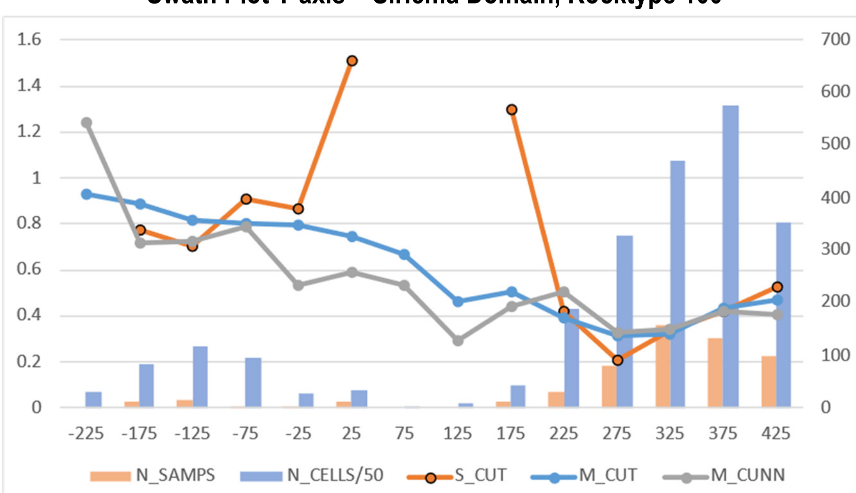
Swath Plot Z axis – N5 Domain



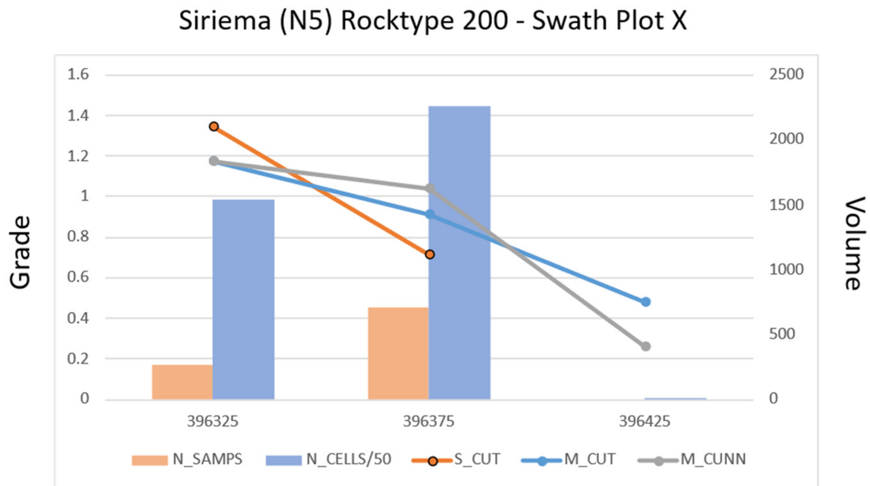
Swath Plot X axis – Siriema Domain, Rocktype 100



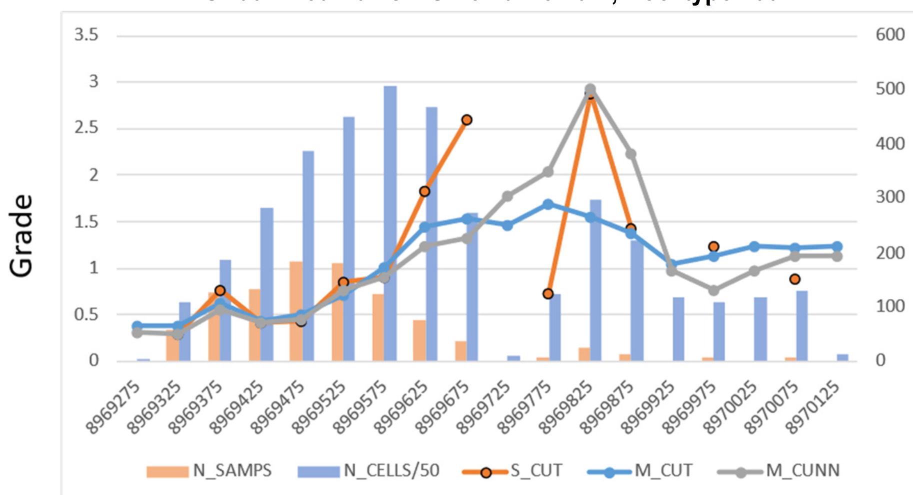
Swath Plot Y axis – Siriema Domain, Rocktype 100



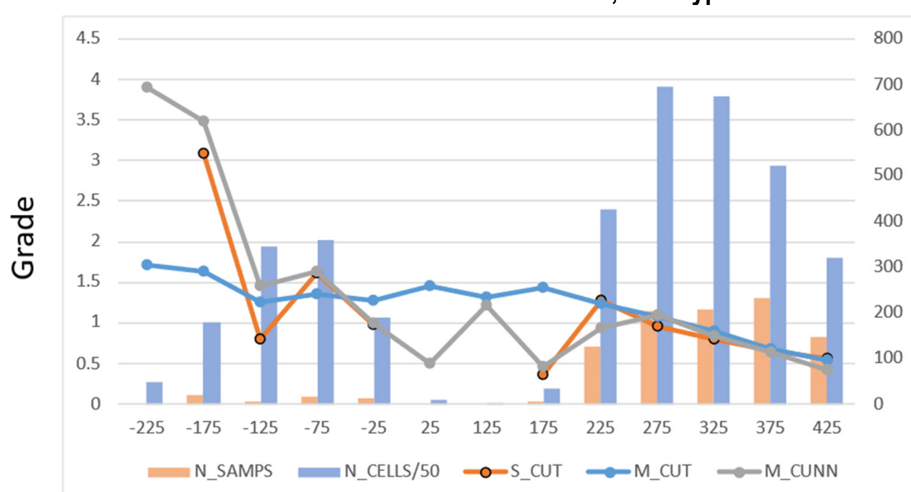
Swath Plot Z axis – Siriema Domain, Rocktype 100



Swath Plot X axis – Siriema Domain, Rocktype 200



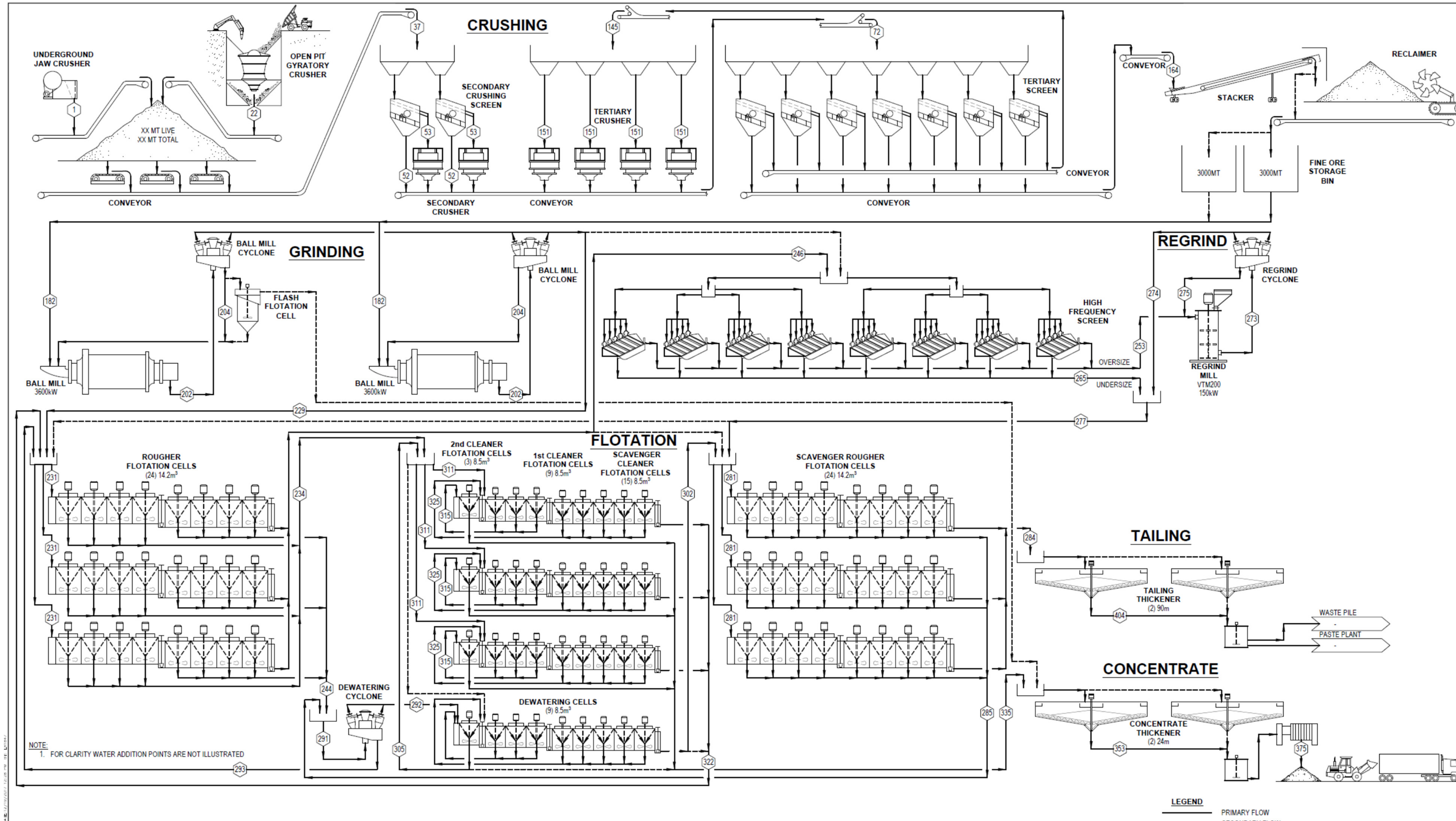
Swath Plot Y axis – Siriema Domain, Rocktype 200



Swath Plot Z axis – Siriema Domain, Rocktype 200

APPENDIX C

Process Flowsheets



Stream #	1	22	37	52	53	72	145	151	164	182	202	204	229
MTPH Solids	821.9	821.9	1,095.9	153.4	394.5	2,883.9	1,788.0	447.0	1,095.9	200.0	700.0	500.0	400.0
MTPH Aqueous	16.8	16.8	22.4	3.1	8.1	58.9	36.5	9.1	22.4	4.1	458.8	184.9	547.7
MTPH Total	838.7	838.7	1,118.3	156.6	402.6	2,942.8	1,824.5	456.1	1,118.3	204.1	1,158.8	684.9	947.7
% Solids (w/w)	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	60.4	73.0	42.2
S.G. Solids	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94
S.G. Aqueous	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S.G. Pulp	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	1.66	1.93	1.38
Cu, %	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
Au, gpt	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
m3/hr, Total	-	-	-	-	-	-	-	-	-	-	698	355	685
GPM, Total	-	-	-	-	-	-	-	-	-	-	3,071	1,564	3,014

Stream #	231	234	244	246	253	265	273	274	275	277	281	284	285
MTPH Solids	190.7	91.3	111.6	369.1	155.0	214.1	387.6	155.0	232.6	369.1	173.1	380.5	138.9
MTPH Aqueous	311.1	177.2	395.7	390.2	121.8	268.3	357.8	276.1	81.7	544.4	437.8	757.7	592.1
MTPH Total	501.8	268.5	507.3	759.3	276.9	482.4	745.4	431.1	314.3	913.6	610.9	1,138.2	731.0
% Solids (w/w)	38.0	34.0	22.0	48.6	56.0	44.4	52.0	36.0	74.0	40.4	28.3	33.4	19.0
S.G. Solids	2.91	2.58	2.89	3.01	3.01	3.01	3.01	3.01	3.01	3.01	2.99	3.03	2.89
S.G. Aqueous	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S.G. Pulp	1.33	1.26	1.17	1.48	1.59	1.42	1.53	1.31	1.97	1.37	1.23	1.29	1.14
Cu, %	2.66	10.00	3.00	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.99	0.27	2.95
Au, gpt	0.30	0.88	0.34	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.16	0.10	0.33
m3/hr, Total	377	213	435	514	174	340	487	328	159	668	496	885	641
GPM, Total	1,661	938	1,915	2,262	764	1,497	2,146	1,445	701	2,942	2,186	3,895	2,823

Stream #	291	292	293	302	305	311	315	322	325	335	353	375	404
MTPH Solids	250.5	200.4	50.1	150.3	50.1	75.0	17.5	121.9	16.9	19.5	19.5	19.5	380.5
MTPH Aqueous	987.8	969.2	18.5	768.9	200.4	190.4	37.1	366.5	39.5	39.5	9.2	1.7	204.9
MTPH Total	1,238.3	1,169.6	68.6	919.1	250.5	265.4	54.6	488.4	56.4	59.0	28.6	21.2	585.4
% Solids (w/w)	20.2	17.1	73.0	16.4	20.0	28.3	32.0	25.0	30.0	33.0	68.0	92.0	65.0
S.G. Solids	2.89	2.89	2.89	2.96	2.70	2.56	2.10	2.80	2.60	1.87	1.87	1.87	3.03
S.G. Aqueous	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S.G. Pulp	1.15	1.12	1.91	1.12	1.14	1.21	1.20	1.19	1.22	1.18	1.46	1.74	1.77
Cu, %	2.97	2.97	2.97	1.59	7.13	10.58	25.00	4.83	9.50	35.00	35.00	35.00	0.27
Au, gpt	0.33	0.33	0.33	0.20	0.73	0.96	1.86	0.64	0.82	2.00	2.00	2.00	0.10
m3/hr, Total	1,076	1,040	36	821	219	220	45	411	46	50	20	-	331
GPM, Total	4,738	4,580	158	3,615	966	969	200	1,808	203	220	86	-	1,457

DO NOT SCALE 11x17 DRAWINGS

LEGEND

- PRIMARY FLOW
- SECONDARY FLOW
- INTERMITTENT FLOW
- EQUIPMENT PACKAGE
- EXISTING EQUIPMENT
- FUTURE

PRELIMINARY
NOT FOR CONSTRUCTION

REFERENCES		REFERENCES		REVISIONS						REVISIONS					
DWG. NO.	TITLE	DWG. NO.	TITLE	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT

NO SCALE NONE	DATE
DESIGNED BY LMT	NOV 17
DRAWN BY LAR	NOV 17
CHECKED BY	
PROJECT MGR	
CLIENT APPR.	

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Concentrator Assessment

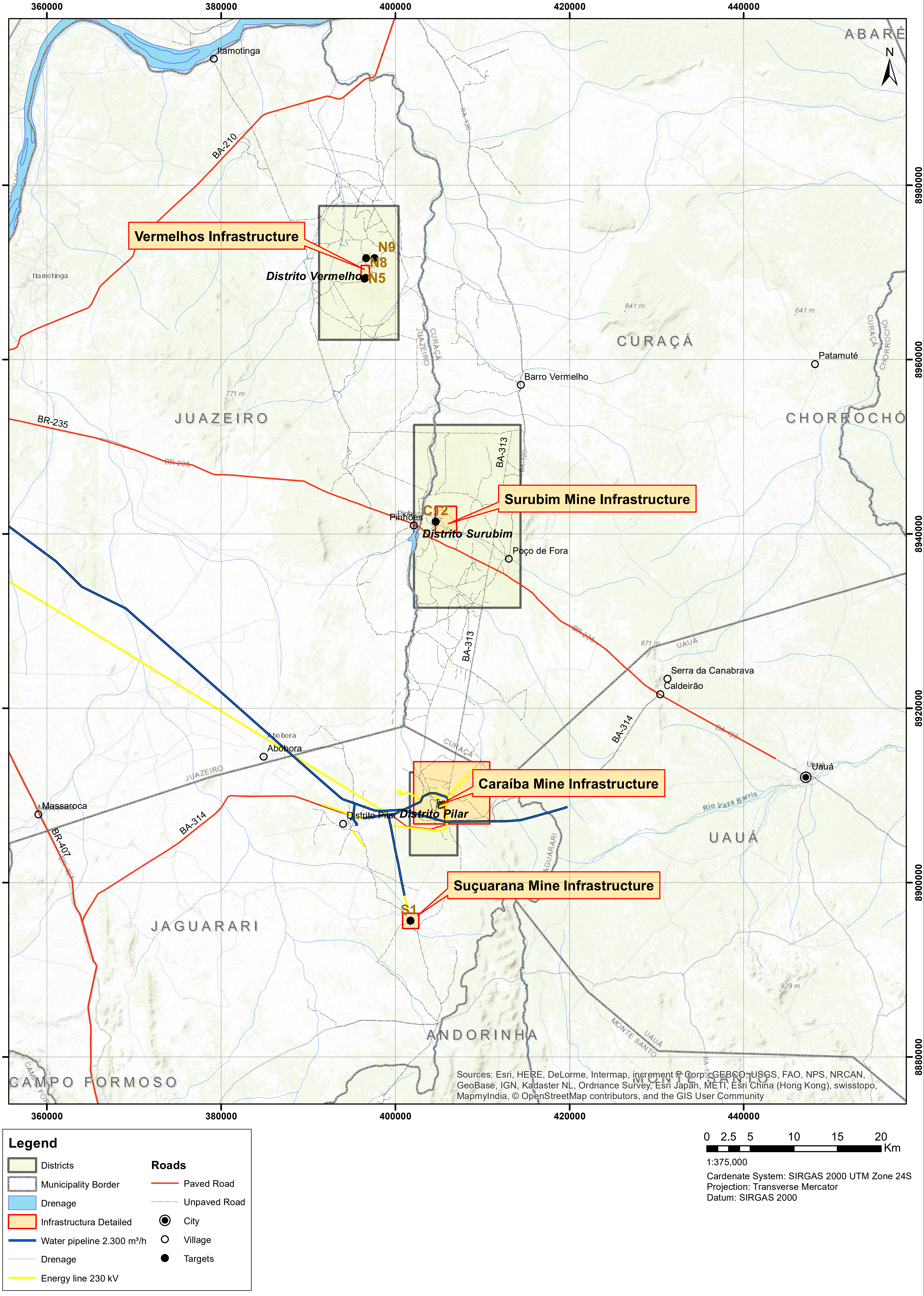
GENERAL FLOW SHEET OVERALL

PROJECT NO. M3-PN 170157
DWG NO. 000-FS-000
REV NO. P1
DATE 19 DEC 17

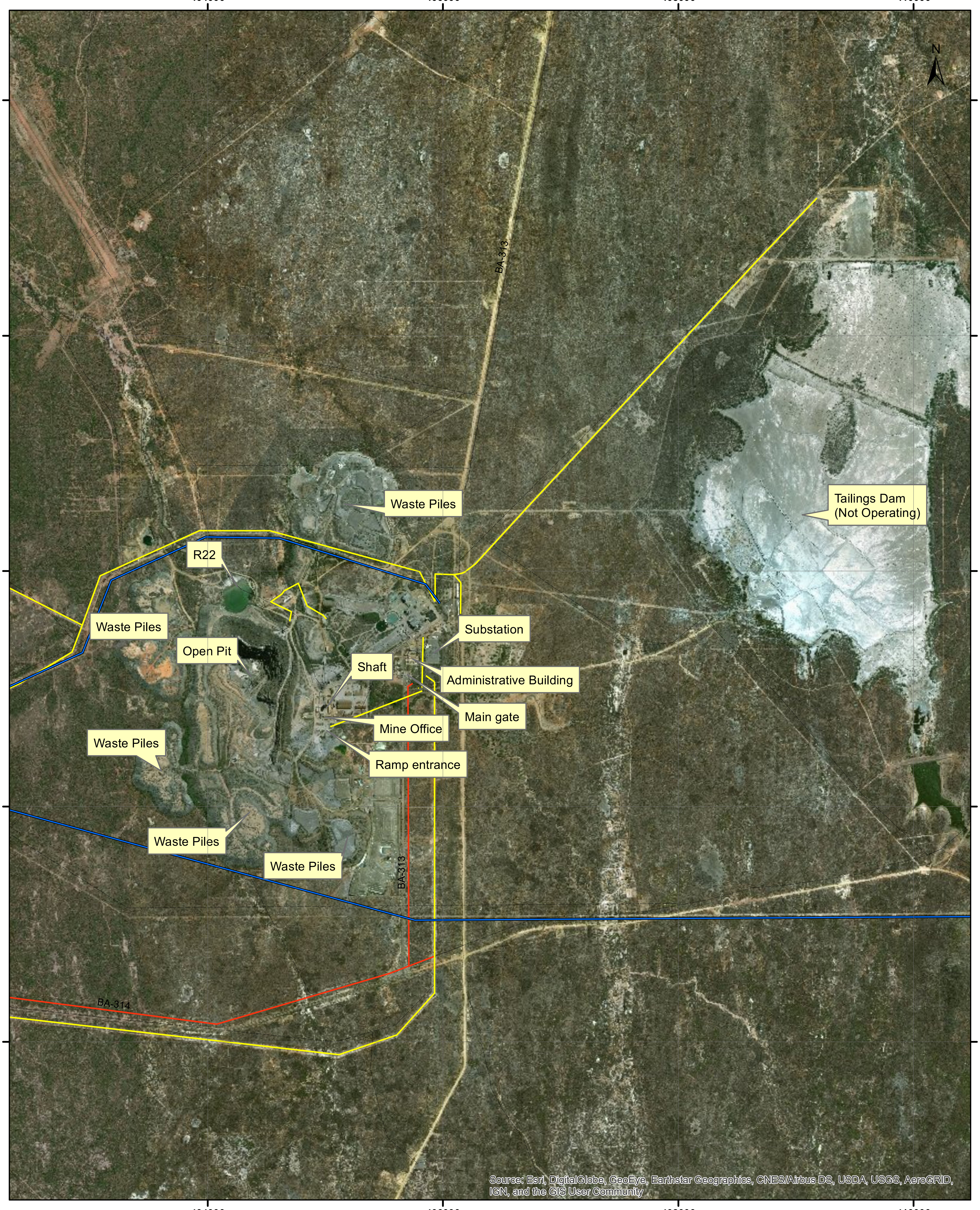
APPENDIX D

Infrastructure Maps of the Curaçá Valley

CURACA VALLEY INFRASTRUCTURE MAP



CARAIBA MINE INFRASTRUCTURE



Legend

Water pipeline

Energy line

Roads

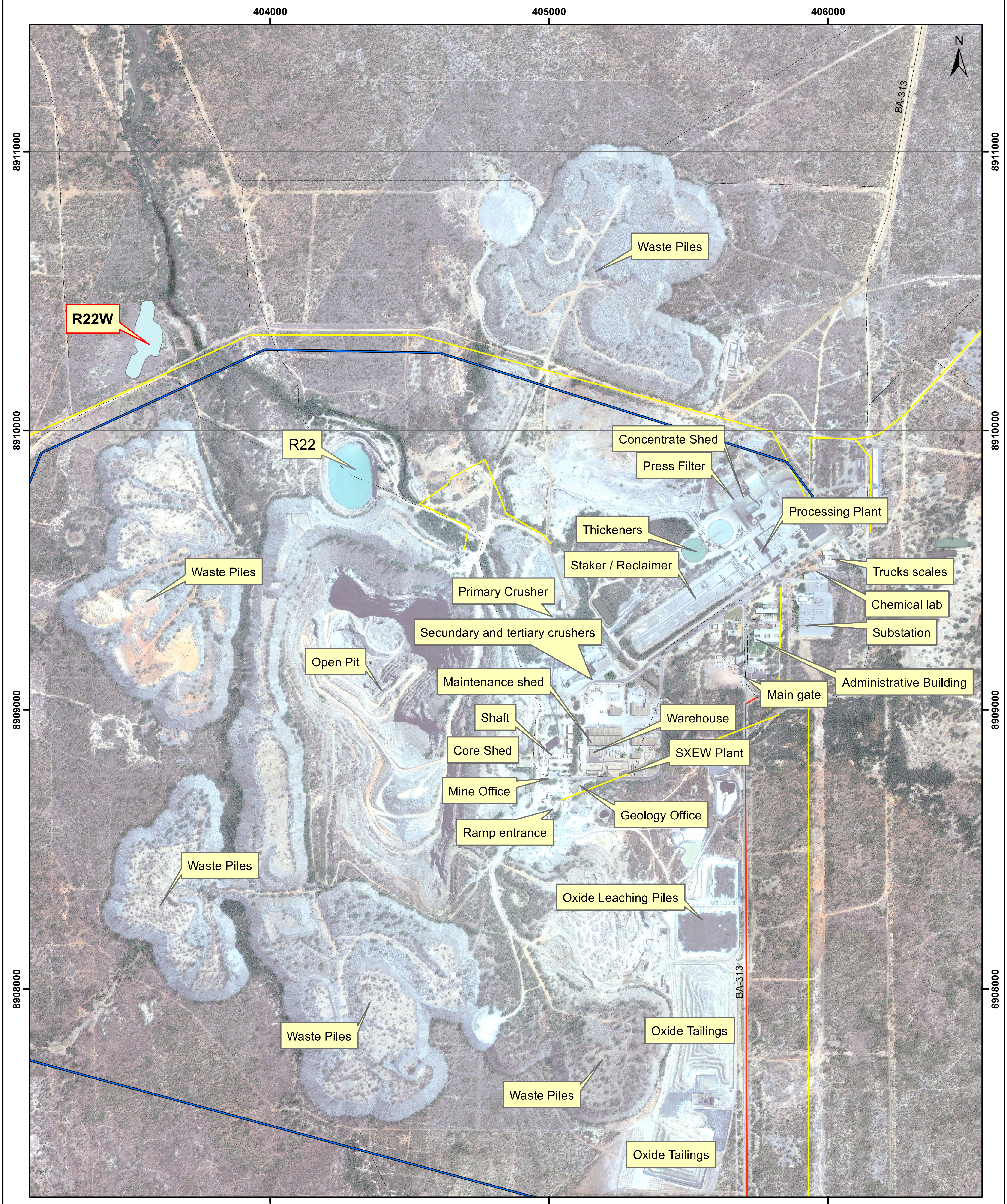
Paved Road

Unpaved Road

0 0.5 1 2 Km

Cardenate System: SIRGAS 2000 UTM Zone 24S
Projection: Transverse Mercator
Datum: SIRGAS 2000

CARAIBA MINE INFRASTRUCTURE



Legend

- Water pipeline
- Energy line

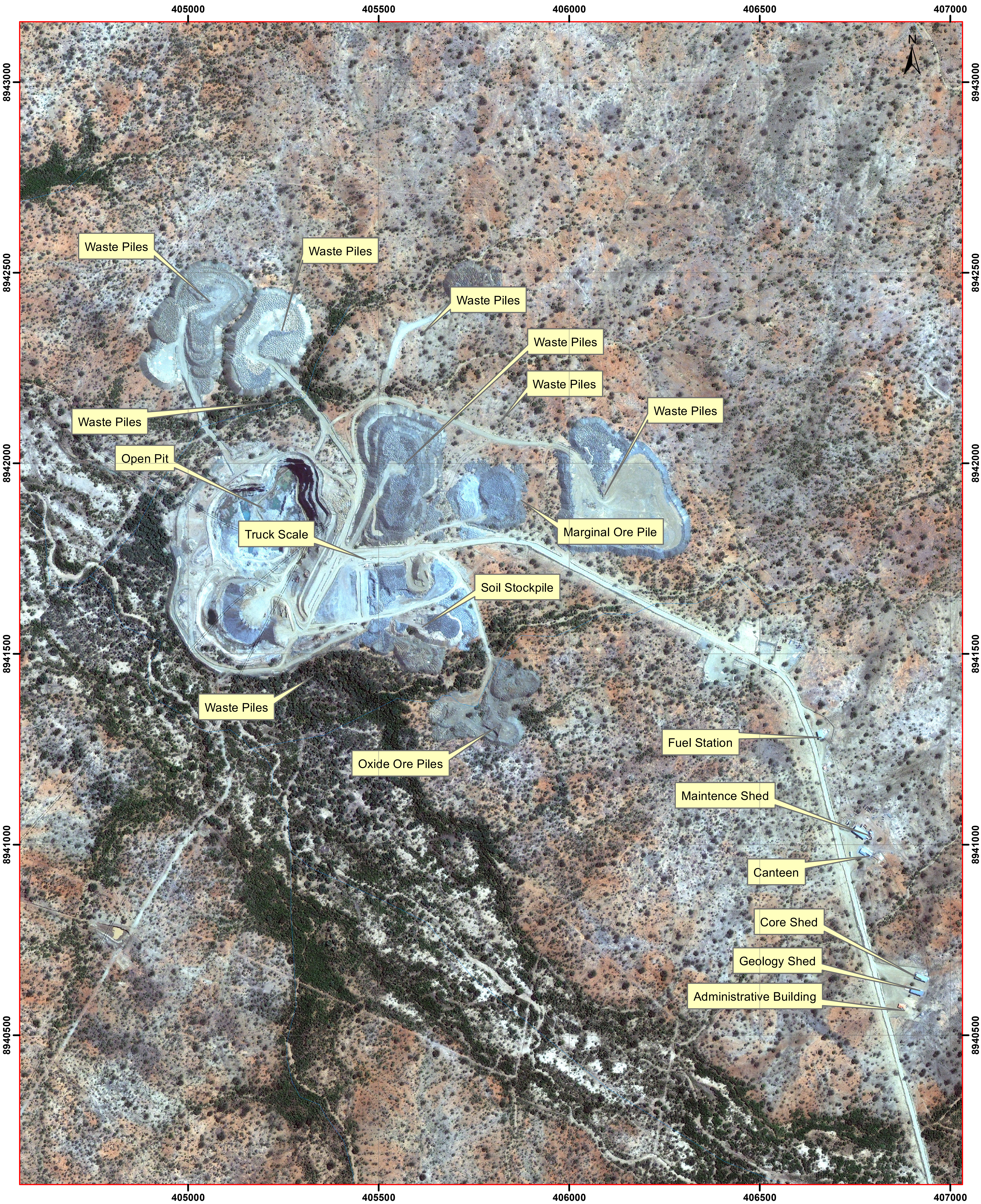
Roads

- Paved Road
- Unpaved Road

0 0.1 0.2 0.4 0.6 0.8 Km

Cardenate System: SIRGAS 2000 UTM Zone 24S
Projection: Transverse Mercator
Datum: SIRGAS 2000

SURUBIM MINE INFRASTRUCTURE



Legend

River

Roads

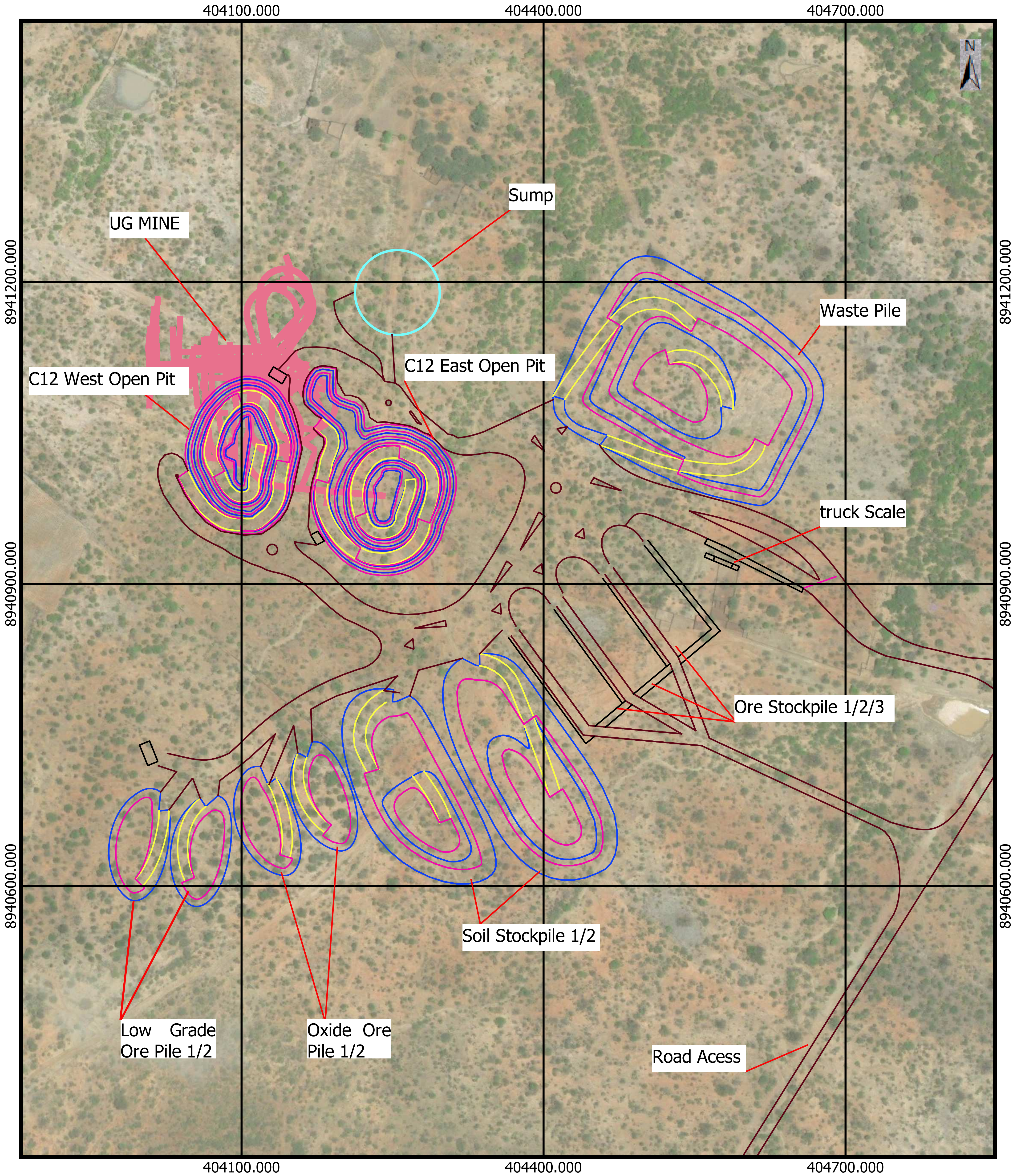
Unpaved Road

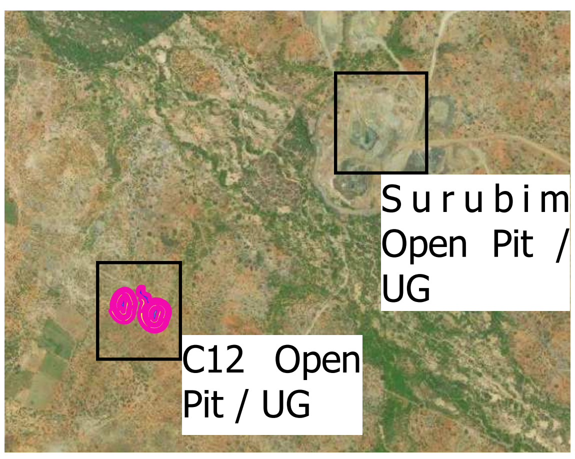
0 0.05 0.1 0.2 0.3 0.4 Km

1:9,000

Cardenate System: SIRGAS 2000 UTM Zone 24S
Projection: Transverse Mercator
Datum: SIRGAS 2000

C12 OPEN PIT AND UG MINE

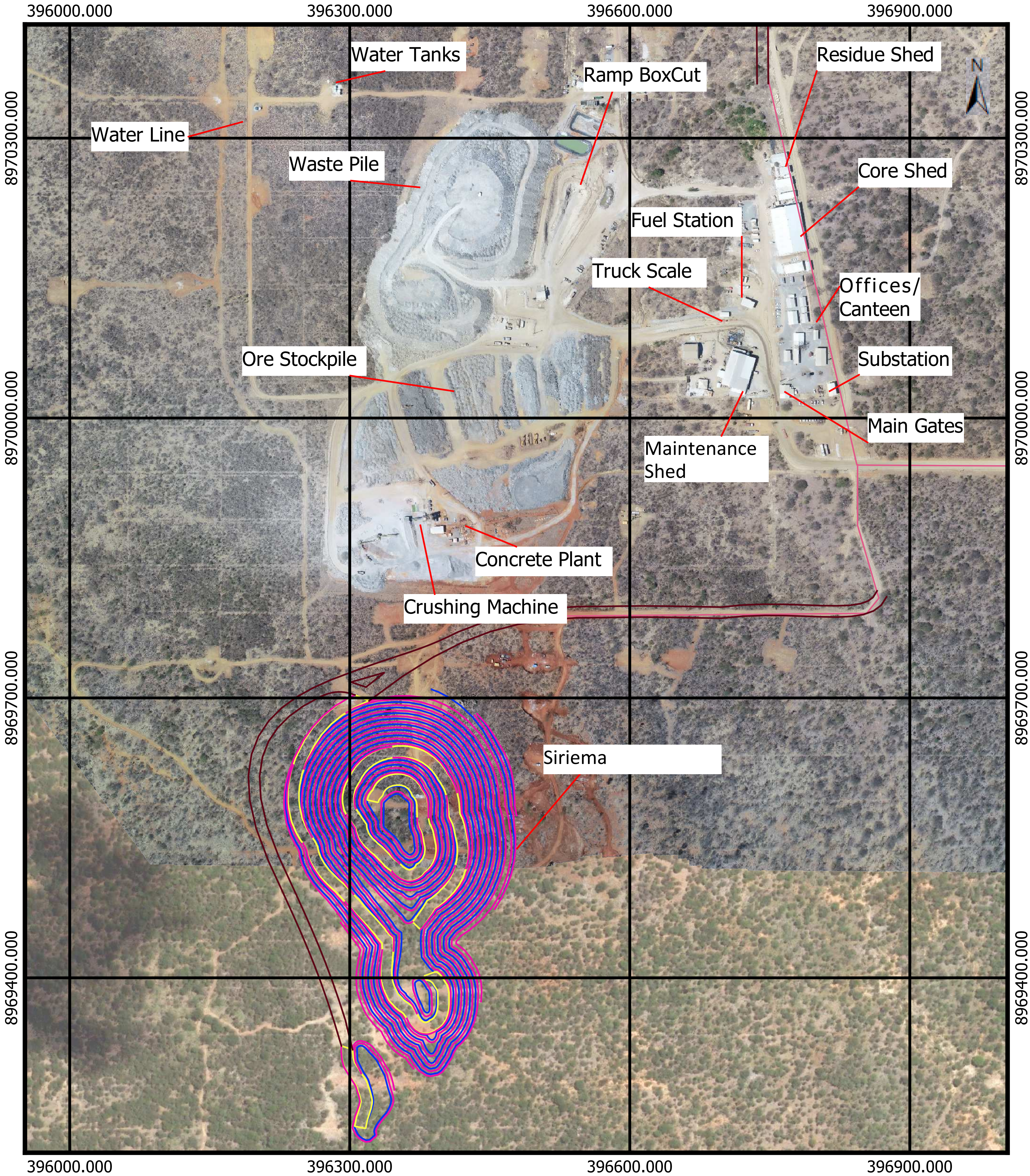


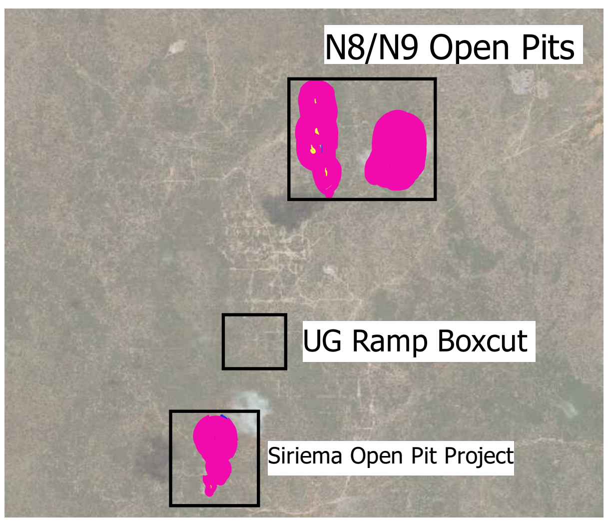


0 100 200 300 m

1: 5000
Cardenate System: Sirgas 2000 UTM Zone 24S
Projection: Transverse Mercator
DATUM: SIRGAS 2000

Vermelhos UG Mine & Siriema Surface Infrastructure

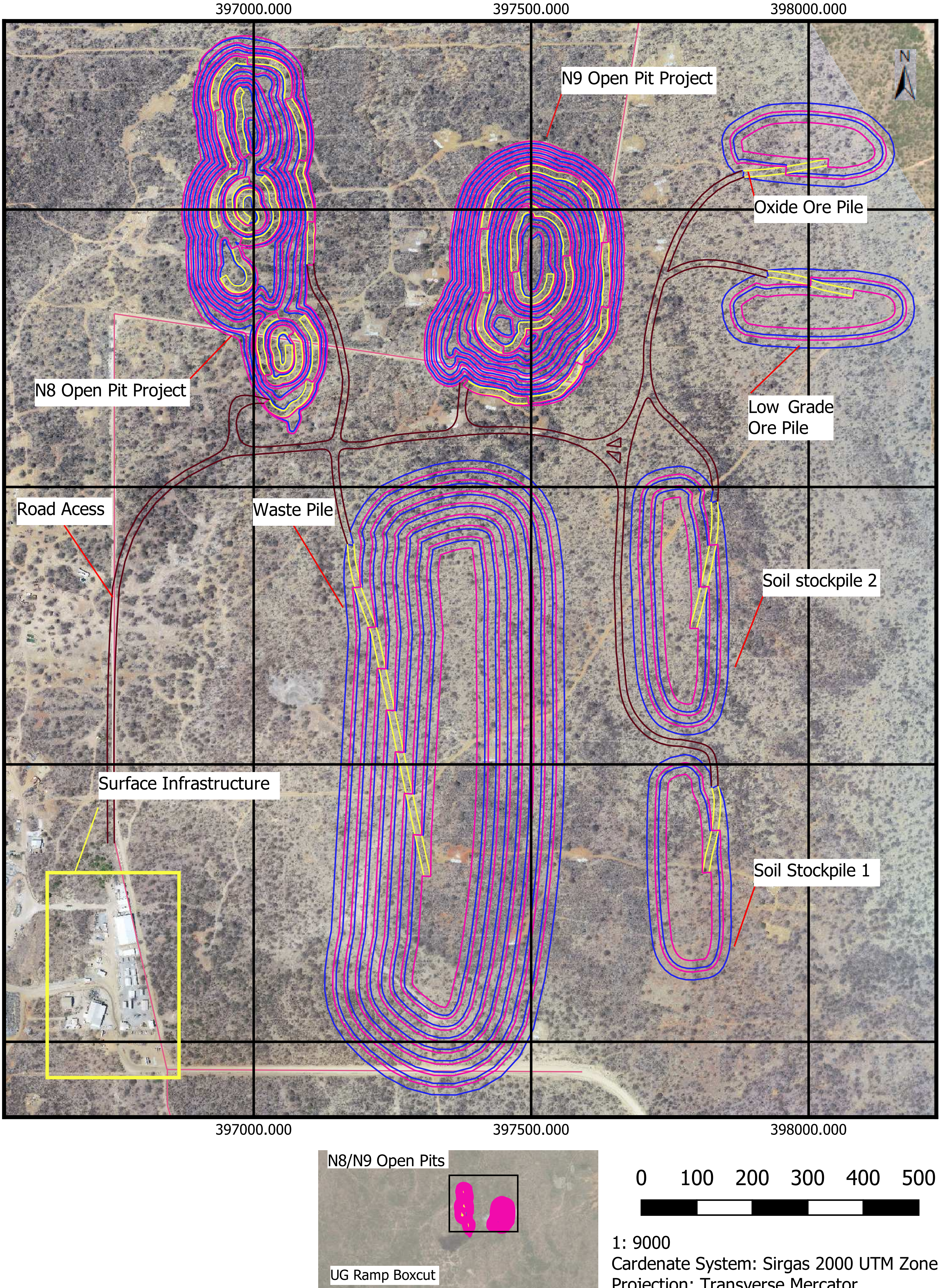




0 100 200 300 m

1: 6000
Cardenate System: Sirgas 2000 UTM Zone 24S
Projection: Transverse Mercator
DATUM: SIRGAS 2000

Vermelhos N8/N9 OP Mine



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Cardenate System: Sirgas 2000 UTM Zone 24S
Projection: Transverse Mercator
DATUM: SIRGAS 2000

APPENDIX E

Mineral Permits

ID NUMBER	PERMIT PHASE	AREA (ha)	PERMIT HOLDER	EXPIRY DATE
737/1940	Mining Permit	400.00	Mineração Caraíba S.A.	-
619/1964	Mining Permit	390.28	Mineração Caraíba S.A.	-
873648/2006	Mining Permit	343.62	Mineração Caraíba S.A.	-
812998/1973	Mining Permit	900.00	Mineração Caraíba S.A.	-
870347/1984	Mining Permit	923.50	Mineração Caraíba S.A.	-
871263/2011	Mining Permit	342.21	Mineração Caraíba S.A.	-
874450/2007	Mining Application	966.27	Mineração Caraíba S.A.	-
872124/2012	Right to request mining grant	1999.77	Mineração Caraíba S.A.	26-Mar-21
871033/2003	Exploration Permit	1500.40	Mineração Vale do Curaçá S.A.	28-Nov-10
873595/2009	Exploration Permit	1199.47	Mineração Caraíba S.A.	4-Sep-16
870086/2010	Exploration Permit	1973.13	Mineração Caraíba S.A.	4-Sep-16
870112/2010	Exploration Permit	999.73	Mineração Caraíba S.A.	4-Sep-16
870113/2010	Exploration Permit	1644.06	Mineração Caraíba S.A.	4-Sep-16
870114/2010	Exploration Permit	1249.98	Mineração Caraíba S.A.	4-Sep-16
870609/2010	Exploration Permit	151.16	Mineração Caraíba S.A.	4-Sep-16
870620/2010	Exploration Permit	944.59	Mineração Caraíba S.A.	4-Sep-16
870621/2010	Exploration Permit	1632.39	Mineração Caraíba S.A.	4-Sep-16
871305/2010	Exploration Permit	822.39	Mineração Caraíba S.A.	2-Jan-17
871808/2010	Exploration Permit	1883.03	Mineração Caraíba S.A.	25-Feb-17
871809/2010	Exploration Permit	1410.00	Mineração Caraíba S.A.	2-Jan-17
871812/2010	Exploration Permit	1928.23	Mineração Caraíba S.A.	2-Jan-17
871843/2010	Exploration Permit	385.52	Mineração Caraíba S.A.	18-Feb-17
871074/2011	Exploration Permit	1741.33	Mineração Caraíba S.A.	27-Aug-17
872008/2011	Exploration Permit	1999.42	Mineração Caraíba S.A.	27-Aug-17
872009/2011	Exploration Permit	1498.05	Mineração Caraíba S.A.	27-Aug-17
872010/2011	Exploration Permit	871.57	Mineração Caraíba S.A.	27-Aug-17
872015/2011	Exploration Permit	1996.17	Mineração Caraíba S.A.	27-Aug-17
872017/2011	Exploration Permit	997.29	Mineração Caraíba S.A.	27-Aug-17
872018/2011	Exploration Permit	1999.93	Mineração Caraíba S.A.	27-Aug-17
872019/2011	Exploration Permit	2000.00	Mineração Caraíba S.A.	27-Aug-17
873204/2011	Exploration Permit	1997.61	Mineração Caraíba S.A.	9-Sep-17
873469/2011	Exploration Permit	1497.52	Mineração Caraíba S.A.	9-Sep-17
873470/2011	Exploration Permit	1991.11	Mineração Caraíba S.A.	9-Sep-17
873471/2011	Exploration Permit	2000.00	Mineração Caraíba S.A.	12-Dec-17
873472/2011	Exploration Permit	1363.14	Mineração Caraíba S.A.	30-Sep-17
873473/2011	Exploration Permit	1500.01	Mineração Caraíba S.A.	9-Sep-17
873518/2011	Exploration Permit	1956.02	Mineração Caraíba S.A.	30-Sep-17
873659/2011	Exploration Permit	1503.42	Mineração Caraíba S.A.	24-Oct-17
873662/2011	Exploration Permit	842.28	Mineração Caraíba S.A.	24-Oct-17
873664/2011	Exploration Permit	615.98	Mineração Caraíba S.A.	24-Oct-17
873667/2011	Exploration Permit	1499.34	Mineração Caraíba S.A.	24-Oct-17
874666/2011	Exploration Permit	1951.63	Mineração Caraíba S.A.	14-Feb-21

ID NUMBER	PERMIT PHASE	AREA (ha)	PERMIT HOLDER	EXPIRY DATE
874667/2011	Exploration Permit	763.92	Mineração Caraíba S.A.	16-Oct-16
874668/2011	Exploration Permit	1779.62	Mineração Caraíba S.A.	16-Oct-16
874669/2011	Exploration Permit	419.71	Mineração Caraíba S.A.	16-Mar-20
874939/2011	Exploration Permit	1955.75	Mineração Caraíba S.A.	23-Feb-20
874940/2011	Exploration Permit	1445.09	Mineração Caraíba S.A.	3-Dec-22
874941/2011	Exploration Permit	1706.04	Mineração Caraíba S.A.	3-Dec-22
874942/2011	Exploration Permit	1990.80	Mineração Caraíba S.A.	19-Oct-20
874943/2011	Exploration Permit	1772.91	Mineração Caraíba S.A.	23-Feb-20
874944/2011	Exploration Permit	1973.69	Mineração Caraíba S.A.	19-Oct-20
874945/2011	Exploration Permit	1798.84	Mineração Caraíba S.A.	3-Dec-22
874946/2011	Exploration Permit	1052.00	Mineração Caraíba S.A.	3-Dec-22
874947/2011	Exploration Permit	730.71	Mineração Caraíba S.A.	19-Oct-20
874948/2011	Exploration Permit	1913.93	Mineração Caraíba S.A.	19-Oct-20
874949/2011	Exploration Permit	1989.80	Mineração Caraíba S.A.	19-Oct-20
874950/2011	Exploration Permit	1914.16	Mineração Caraíba S.A.	19-Oct-20
874951/2011	Exploration Permit	1985.89	Mineração Caraíba S.A.	19-Oct-20
874952/2011	Exploration Permit	1827.01	Mineração Caraíba S.A.	19-Oct-20
871290/2012	Exploration Permit	984.91	Mineração Caraíba S.A.	22-May-21
872123/2012	Exploration Permit	334.21	Mineração Caraíba S.A.	13-Jul-20
872286/2013	Exploration Permit	1637.55	Mineração Caraíba S.A.	4-Jan-21
870353/2014	Exploration Permit	998.73	Mineração Caraíba S.A.	24-Aug-20
871115/2014	Exploration Permit	1999.99	Mineração Caraíba S.A.	19-Oct-20
871116/2014	Exploration Permit	1365.25	Mineração Caraíba S.A.	19-Oct-20
871117/2014	Exploration Permit	1999.11	Mineração Caraíba S.A.	19-Oct-20
871118/2014	Exploration Permit	1997.99	Mineração Caraíba S.A.	19-Oct-20
871119/2014	Exploration Permit	1999.14	Mineração Caraíba S.A.	19-Oct-20
871120/2014	Exploration Permit	1493.53	Mineração Caraíba S.A.	19-Oct-20
871121/2014	Exploration Permit	1998.16	Mineração Caraíba S.A.	19-Oct-20
871122/2014	Exploration Permit	1371.02	Mineração Caraíba S.A.	19-Oct-20
871123/2014	Exploration Permit	1897.40	Mineração Caraíba S.A.	19-Oct-20
871124/2014	Exploration Permit	1999.23	Mineração Caraíba S.A.	19-Oct-20
871125/2014	Exploration Permit	1212.26	Mineração Caraíba S.A.	19-Oct-20
871431/2014	Exploration Permit	1998.26	Mineração Caraíba S.A.	4-Jan-21
871432/2014	Exploration Permit	1999.99	Mineração Caraíba S.A.	4-Jan-21
871525/2015	Exploration Permit	76.29	Mineração Caraíba S.A.	15-Dec-18
871531/2015	Exploration Permit	385.86	Mineração Caraíba S.A.	7-Mar-22
871497/2016	Exploration Permit	1800.01	Mineração Caraíba S.A.	6-Oct-19
871502/2016	Exploration Permit	878.14	Mineração Caraíba S.A.	6-Oct-19
871834/2016	Exploration Permit	1797.29	Mineração Caraíba S.A.	27-Mar-23
872555/2016	Exploration Permit	768.64	Mineração Caraíba S.A.	27-Mar-23
872816/2016	Exploration Permit	1792.04	Mineração Caraíba S.A.	27-Mar-23
872817/2016	Exploration Permit	1136.13	Mineração Caraíba S.A.	6-Apr-20

ID NUMBER	PERMIT PHASE	AREA (ha)	PERMIT HOLDER	EXPIRY DATE
871339/2017	Exploration Permit	1376.30	Mineração Caraíba S.A.	14-Nov-20
871340/2017	Exploration Permit	1997.38	Mineração Caraíba S.A.	14-Nov-20
871341/2017	Exploration Permit	999.37	Mineração Caraíba S.A.	14-Nov-20
870584/2018	Exploration Permit	1549.50	Mineração Caraíba S.A.	20-Jul-21
870585/2018	Exploration Permit	470.75	Mineração Caraíba S.A.	20-Jul-21
870586/2018	Exploration Permit	1351.69	Mineração Caraíba S.A.	20-Jul-21
870587/2018	Exploration Permit	1978.10	Mineração Caraíba S.A.	20-Jul-21
870588/2018	Exploration Permit	886.02	Mineração Caraíba S.A.	20-Jul-21
871733/2018	Exploration Permit	1464.68	Mineração Caraíba S.A.	27-May-22
871734/2018	Exploration Permit	1398.33	Mineração Caraíba S.A.	27-May-22
871735/2018	Exploration Permit	1414.34	Mineração Caraíba S.A.	27-May-22
871736/2018	Exploration Permit	1604.53	Mineração Caraíba S.A.	27-May-22
871737/2018	Exploration Permit	1453.10	Mineração Caraíba S.A.	27-May-22
871738/2018	Exploration Permit	1722.43	Mineração Caraíba S.A.	27-May-22
871739/2018	Exploration Permit	1454.58	Mineração Caraíba S.A.	27-May-22
871740/2018	Exploration Permit	1717.79	Mineração Caraíba S.A.	27-May-22
871741/2018	Exploration Permit	1936.45	Mineração Caraíba S.A.	20-May-22
871742/2018	Exploration Permit	1540.40	Mineração Caraíba S.A.	27-May-22
871743/2018	Exploration Permit	1913.60	Mineração Caraíba S.A.	27-May-22
871744/2018	Exploration Permit	1542.50	Mineração Caraíba S.A.	27-May-22
871745/2018	Exploration Permit	1352.78	Mineração Caraíba S.A.	27-May-22
871746/2018	Exploration Permit	1704.88	Mineração Caraíba S.A.	27-May-22
871915/2018	Exploration Permit	1843.03	Mineração Caraíba S.A.	29-Oct-22
870358/2019	Exploration Permit	315.96	Mineração Caraíba S.A.	17-Sep-22
870975/2019	Exploration Permit	1.86	Mineração Caraíba S.A.	13-Dec-22
871415/2020	Exploration Permit Application	21.13	Mineração Caraíba S.A.	-
874140/2011	Exploration Permit	1457.34	Zeus Mineração Ltda.	21-Mar-21
871234/2017	Exploration Permit	1991.37	RAFAEL HOISEL MALAGUTI	18-Oct-20
871427/2017	Exploration Permit	948.87	Zeus Mineração Ltda.	21-Dec-20
871428/2017	Exploration Permit	1999.71	Zeus Mineração Ltda.	21-Dec-20
871772/2017	Exploration Permit	1948.39	RAFAEL HOISEL MALAGUTI	11-Jan-21
871773/2017	Exploration Permit	694.64	RAFAEL HOISEL MALAGUTI	21-Dec-20
871774/2017	Exploration Permit	1573.34	RAFAEL HOISEL MALAGUTI	11-Jan-21

APPENDIX F

Standard Certificates

ITAK

Certificate of Analysis 0611

Date: 03-06-2018
Version: 02

CRM ITAK-814
Certified Reference Material
Copper Ore

Table 1 – ITAK-814 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a, f]	0.4507	0.0095	0.0053	0.0078	± 0.0029
Fe (%) [a, b, f]	10.14	0.20	0.10	0.17	± 0.072
S (%) [e]	0.434	0.051	0.015	0.049	± 0.020
Au (g/t) [c, d]	0.164	0.043	0.024	0.036	± 0.014
Ag (g/t) [a, f]	1.451	0.14	0.11	0.085	± 0.049

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.
[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).
[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.
[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.
[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.

Note: The letters in front of the elements are codes for Analytical Methods used.

Table 2 – ITAK-814 – Informative Values

Element/Unit	Reference Value [6]
Ni (%) [a, b, f]	0.025
C (%) [e]	0.517
F (g/t) [g]	492
Cl (g/t) [h, i]	942

[6] These values are informative. They were calculated according to ISO Guide 35 and ISO 5725-2 from fifteen to twenty results from a varying number of laboratories.

DESCRIPTION

ITAK-814 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Midwest of Brazil in 2017.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-814 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-814.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-814 was analyzed by twelve specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-055/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-814 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Fusion Method and determination by Atomic Emission Spectrometry (ICP).
- **c**: Fire Assay Method and determination by Atomic Absorption Spectrometry (AAS).
- **d**: Extraction and determination by Atomic Absorption Spectrometry (AAS).
- **e**: Infrared Analyzer (LECO).
- **f:** Acid digestion Method and determination by Atomic Emission Spectrometry (ICP).
- **g**: Fusion Method and determination by Ion Specific Electrode.
- **h:** Acid digestion Method and determination by Titration.
- **i**: Acid digestion Method and determination by Pontenciometry

PERIOD OF VALIDITY

This CRM certification is valid until: **March 06, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

Certificate of Analysis 0596

Date: 02-20-2018
Version: 02

CRM ITAK-821
Certified Reference Material
Copper Ore

Table 1 – ITAK-821 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a]	0.3622	0.0064	0.0037	0.0052	± 0.0019
Fe (%) [a, b, f]	6.24	0.54	0.11	0.53	± 0.19
S (%) [e]	2.526	0.097	0.071	0.066	± 0.030
C (%) [e]	0.213	0.083	0.0068	0.083	± 0.041
Au (g/t) [c, d]	0.318	0.032	0.021	0.024	± 0.011
Ni (%) [a]	0.0023	0.00068	0.00026	0.00063	± 0.00049

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.
[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).
[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.
[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.
[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.

Note: The letters in front of the elements are codes for Analytical Methods used.

Table 2 – ITAK-821 – Informative Values

Element/Unit	Reference Value [6]
Ag (g/t) [a]	1.962
F (g/t) [g]	1044

[6] These values are informative. They were calculated according to ISO Guide 35 and ISO 5725-2 from fifteen to twenty results from a varying number of laboratories.

DESCRIPTION

ITAK-821 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Midwest of Brazil in 2017.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-821 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-821.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-821 was analyzed by thirteen specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-040/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-821 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Fusion Method and determination by Atomic Emission Spectrometry (ICP).
- **c**: Fire Assay Method and determination by Atomic Absorption Spectrometry (AAS).
- **d**: Extraction and determination by Atomic Absorption Spectrometry (AAS).
- **e**: Infrared Analyzer (LECO).
- **f:** Acid digestion Method and determination by Titration.
- **g**: Fusion Method and determination by Ion specific electrode.

PERIOD OF VALIDITY

This CRM certification is valid until: **February 20, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

Certificate of Analysis 0578

Date: 02-06-2018
Version: 02

CRM ITAK-823
Certified Reference Material
Copper Ore

Table 1 – ITAK-823 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a, b]	0.874	0.025	0.010	0.023	± 0.011
S (%) [c]	0.682	0.016	0.0099	0.013	± 0.0059
Au (g/t) [d]	0.0877	0.017	0.017	0.0016	± 0.0037
Ag (g/t) [a, b]	3.455	0.37	0.36	0.090	± 0.092
Fe (%) [b]	9.59	0.44	0.072	0.43	± 0.22
Ni (g/t) [a, b]	537	21	10	18	± 8.2
F (%) [f]	0.077	0.025	0.0021	0.025	± 0.013
C (%) [c]	0.074	0.012	0.0043	0.012	± 0.0053

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.

[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).

[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.

[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.

[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.

Note: The letters in front of the elements are codes for Analytical Methods used.

Table 2 – ITAK-823 – Informative Values

Element/Unit	Reference Value [6]
Cl (%) e	0.0072

[6] These values are informative. They were calculated according to ISO Guide 35 and ISO 5725-2 from ten to fifteen results from a varying number of laboratories.

DESCRIPTION

ITAK-823 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2014.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-823 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-823.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-823 was analyzed by five specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-022/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-823 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Acid digestion Method and determination by Atomic Emission Spectrometry (ICP).
- **c**: Infrared Analyzer (LECO).
- **d**: Fire Assay Method and determination by Atomic Absorption Spectrometry (AAS).
- **e**: Acid digestion Method and determination by Titration.
- **f**: Fusion Method and determination by Ion specific electrode.

PERIOD OF VALIDITY

This CRM certification is valid until: **February 06, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

Certificate of Analysis 0577

Date: 02-05-2018
Version: 03

CRM ITAK-824
Certified Reference Material
Copper Ore

Table 1 – ITAK-824 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a, b]	2.678	0.067	0.046	0.049	± 0.024
S (%) [c]	2.122	0.050	0.029	0.041	± 0.019
Au (g/t) [d]	0.250	0.045	0.043	0.012	± 0.010
Ag (g/t) [a, b]	12.15	1.1	0.74	0.81	± 0.44
Ni (g/t) [a, b]	1268	82	25	78	± 35
F (%) [g]	0.055	0.017	0.0016	0.017	± 0.0086
C (%) [c]	0.092	0.013	0.0037	0.013	± 0.0057

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.
[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).
[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.
[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.
[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.
Note: The letters in front of the elements are codes for Analytical Methods used.

Table 2 – ITAK-824 – Informative Values

Element/Unit	Reference Value [6]
Fe (%) [a, b]	13.39
As (g/t) [b]	< 30
Cl (g/t) [e, f]	80
Th (g/t) [b]	< 20
U (g/t) [b]	< 30

[6] These values are informative. They were calculated according to ISO Guide 35 and ISO 5725-2 from ten to twenty results from a varying number of laboratories.

DESCRIPTION

ITAK-824 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2014.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-824 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-824.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-824 was analyzed by five specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-021/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-824 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Acid digestion Method and determination by Atomic Emission Spectrometry (ICP).
- **c**: Infrared Analyzer (LECO).
- **d**: Fire Assay Method and determination by Atomic Absorption Spectrometry (AAS).
- **e**: Acid digestion Method and determination by Titration.
- **f**: Neutron Activation Method.
- **g**: Acid digestion Method and determination by Ion specific electrode.

PERIOD OF VALIDITY

This CRM certification is valid until: **February 05, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

Certificate of Analysis 0581

Date: 02-06-2018
Version: 02

CRM ITAK-825
Certified Reference Material
Copper Ore

Table 1 – ITAK-825 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a, b, e]	5.76	0.11	0.041	0.10	± 0.032
S (%) [c, g]	3.96	0.16	0.042	0.15	± 0.044
Au (g/t) [d, h, i]	0.210	0.035	0.031	0.017	± 0.0069
Ag (g/t) [a, b]	6.98	0.43	0.25	0.35	± 0.14
Fe (%) [b, e, j]	13.36	0.30	0.15	0.25	± 0.092
Ni (%) [a, b]	0.1298	0.0088	0.0020	0.0085	± 0.0030
F (g/t) [f, k]	806	188	35	185	± 66
C (%) [c]	0.077	0.011	0.0025	0.010	± 0.0036
Cl (g/t) [e, k]	83	28	6	28	± 12

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.
[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).
[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.
[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.
[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.

Note: The letters in front of the elements are codes for Analytical Methods used.

Table 2 – ITAK-825 – Informative Values

Element/Unit	Reference Value [6]
As (g/t) [b]	< 30
Th (g/t) [b]	< 20
U (g/t) [b]	< 30

[6] These values are informative. They were calculated according to ISO Guide 35 and ISO 5725-2 from ten to fifteen results from a varying number of laboratories.

DESCRIPTION

ITAK-825 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2014.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-825 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-825.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-825 was analyzed by sixteen specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-025/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-825 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Acid digestion Method and determination by Atomic Emission Spectrometry (ICP).
- **c**: Infrared Analyzer (LECO).
- **d**: Fire Assay Method and determination by Atomic Absorption Spectrometry (AAS).
- **e**: Acid digestion Method and determination by Titration.
- **f**: Fusion Method and determination by Ion specific electrode.
- **g**: Acid digestion Method and determination by Gravimetry.
- **h**: Fire Assay Method and determination by Atomic Emission Spectrometry (ICP).
- **i**: Extraction and determination by Atomic Absorption Spectrometry (AAS).
- **j**: Fusion Method and determination by Atomic Emission Spectrometry (ICP).
- **k:** Acid digestion method and determination by Potentiometry.

PERIOD OF VALIDITY

This CRM certification is valid until: **February 06, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

Certificate of Analysis 0582

Date: 02-06-2018
Version: 01

CRM ITAK-833
Certified Reference Material
Copper Ore

Table 1 – ITAK-833 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a, b, e]	1.571	0.038	0.032	0.021	± 0.0085
S (%) [c, g]	18.86	0.65	0.24	0.60	± 0.27
Au (g/t) [d, h, i]	1.83	0.10	0.031	0.096	± 0.043
Ag (g/t) [a, b]	5.2	1.2	0.48	1.1	± 0.52
Fe (%) [a, b, e, j]	19.31	0.59	0.40	0.44	± 0.18
F (g/t) [f]	579	52	41	32	± 18
C (%) [c]	0.048	0.012	0.0032	0.011	± 0.0056

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.
[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).
[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.
[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.
[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.
Note: The letters in front of the elements are codes for Analytical Methods used.

Table 2 – ITAK-833 – Informative Values

Element/Unit	Reference Value [6]
Ni (g/t) [a, b]	48.3
SiO_2 (%) [g, j]	36.7

[6] These values are informative. They were calculated according to ISO Guide 35 and ISO 5725-2 from ten to fifteen results from a varying number of laboratories.

DESCRIPTION

ITAK-833 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2016.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-833 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-833.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-833 was analyzed by thirteen specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-026/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-833 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Acid digestion Method and determination by Atomic Emission Spectrometry (ICP).
- **c**: Infrared Analyzer (LECO).
- **d**: Fire Assay Method and determination by Atomic Absorption Spectrometry (AAS).
- **e**: Acid digestion Method and determination by Titration.
- **f**: Fusion Method and determination by Ion specific electrode.
- **g**: Acid digestion Method and determination by Gravimetry.
- **h**: Fire Assay Method and determination by Atomic Emission Spectrometry (ICP).
- **i**: Extraction and determination by Atomic Absorption Spectrometry (AAS).
- **j**: Fusion Method and determination by Atomic Emission Spectrometry (ICP).

PERIOD OF VALIDITY

This CRM certification is valid until: **February 06, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

ITAK

Certificate of Analysis 0683

Date: 06-04-2018

Version: 01

CRM ITAK-842
Certified Reference Material
Copper Ore

Table 1 – ITAK-842 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a]	1.562	0.028	0.018	0.021	± 0.0086
Ni (%) [a]	0.0458	0.0026	0.0021	0.0015	± 0.00067

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.

[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).

[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.

[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.

[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.

Note: The letters in front of the elements are codes for Analytical Methods used.

DESCRIPTION

ITAK-842 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2018.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-842 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-842.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-842 was analyzed by eight specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-127/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-842 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).

PERIOD OF VALIDITY

This CRM certification is valid until: **June 04, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

CRM ITAK-843
Certified Reference Material
Copper Ore

Table 1 – ITAK-843 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a]	0.796	0.019	0.010	0.016	± 0.0064
Ni (%) [a]	0.0770	0.0027	0.00084	0.0026	± 0.0010

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.

[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).

[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.

[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.

[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.

Note: The letters in front of the elements are codes for Analytical Methods used.

DESCRIPTION

ITAK-843 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2018.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-843 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-843.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-843 was analyzed by eight specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-128/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-843 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).

PERIOD OF VALIDITY

This CRM certification is valid until: **June 04, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

ITAK

Certificate of Analysis 0685

Date: 06-04-2018
Version: 01

CRM ITAK-844
Certified Reference Material
Copper Ore

Table 1 – ITAK-844 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a]	0.323	0.012	0.0032	0.012	± 0.0044
Ni (%) [a]	0.0393	0.0021	0.00054	0.0021	± 0.00079

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.

[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).

[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.

[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.

[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.

Note: The letters in front of the elements are codes for Analytical Methods used.

DESCRIPTION

ITAK-844 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2018.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-844 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-844.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-844 was analyzed by eight specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-129/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-844 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).

PERIOD OF VALIDITY

This CRM certification is valid until: **June 04, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

CRM ITAK-847
Certified Reference Material
Copper Ore

Table 1 – ITAK-847 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) a, b	0.4221	0.0074	0.0045	0.0059	± 0.0024
Ni (%) a, b	0.0486	0.0025	0.0013	0.0021	± 0.00090

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.
[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).
[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.
[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.
[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.
Note: The letters in front of the elements are codes for Analytical Methods used.

DESCRIPTION

ITAK-847 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2018.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-847 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-847.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-847 was analyzed by eight specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-166/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-847 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Acid digestion Method and determination by Atomic Emission Spectrometry (ICP).

PERIOD OF VALIDITY

This CRM certification is valid until: **October 10, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

ITAK

Certificate of Analysis 0724

Date: 10-10-2018
Version: 01

CRM ITAK-848
Certified Reference Material
Copper Ore

Table 1 – ITAK-848 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a, b]	0.6358	0.0077	0.0074	0.0020	± 0.0016
Ni (%) [a, b]	0.0626	0.0035	0.0011	0.0033	± 0.0015

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.
[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).
[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.
[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.
[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.

Note: The letters in front of the elements are codes for Analytical Methods used.

DESCRIPTION

ITAK-848 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2018.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-848 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-848.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-848 was analyzed by eight specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-167/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-848 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Acid digestion Method and determination by Atomic Emission Spectrometry (ICP).

PERIOD OF VALIDITY

This CRM certification is valid until: **October 10, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

CRM ITAK-849
Certified Reference Material
Copper Ore

Table 1 – ITAK-849 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a, b]	1.062	0.016	0.013	0.0088	± 0.0043
Ni (%) [a, b]	0.1072	0.0031	0.0015	0.0027	± 0.0013

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.
[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).
[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.
[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.
[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.

Note: The letters in front of the elements are codes for Analytical Methods used.

DESCRIPTION

ITAK-849 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2018.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-849 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-849.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-849 was analyzed by eight specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-168/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-849 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Acid digestion Method and determination by Atomic Emission Spectrometry (ICP).

PERIOD OF VALIDITY

This CRM certification is valid until: **October 10, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

Certificate of Analysis 0726

Date: 10-10-2018
Version: 01

CRM ITAK-850
Certified Reference Material
Copper Ore

Table 1 – ITAK-850 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a, b]	3.554	0.063	0.054	0.033	± 0.015
Ni (%) [a, b]	0.0720	0.0026	0.0012	0.0023	± 0.0010

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.
[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).
[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.
[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.
[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.

Note: The letters in front of the elements are codes for Analytical Methods used.

DESCRIPTION

ITAK-850 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2018.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-850 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-850.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-850 was analyzed by eight specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-169/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-850 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Acid digestion Method and determination by Atomic Emission Spectrometry (ICP).

PERIOD OF VALIDITY

This CRM certification is valid until: **October 10, 2028**.

CERTIFICATE REPRODUCTION

This certificate must not be modified and may only be reproduced in its entirety and without change.

Bráulio de Freitas Pessoa
Chemist – CRQ 02.202.008
Technical Director

CRM ITAK-851
Certified Reference Material
Copper Ore

Table 1 – ITAK-851 – Certified Values

Element/Unit	Certified Value [1]	s [2]	s_r [3]	s_L [4]	U [5]
Cu (%) [a, b]	6.98	0.29	0.12	0.26	± 0.094
Ni (%) [a, b]	0.1003	0.0050	0.0014	0.0048	± 0.0021

[1] The Certified Value was calculated according to ISO Guide 35 and ISO 5725-2.
[2] The standard deviation for proficiency assessment was calculated according to ISO 13528 and 5725-2. This standard deviation can be used for control charts for individual analysis (*n=1*).
[3] The within-laboratory standard deviation was calculated according to ISO 5725-2.
[4] The between-laboratory standard deviation was calculated according to ISO 5725-2.
[5] The extended standard uncertainty of the mean (α=5%) was calculated according to ISO Guide 35.
Note: The letters in front of the elements are codes for Analytical Methods used.

DESCRIPTION

ITAK-851 was prepared from a sample of Copper Ore donated by a Copper Mining Company from the Northeast of Brazil in 2018.

This Certified Reference Material (CRM) is presented as a fine powder.

INTENDED USE AND INSTRUCTIONS

ITAK-851 provides an important control in analytical data from exploration and can be used as a tool for grade control in routine mining and laboratory operations.

This Certified Reference Material can be used for calibration of analytical equipment, assess and develop new methods, validation of analytical methods, and arbitration – proficiency testing for example.

The bottles/sachets content should be thoroughly mixed before taking samples of ITAK-851.

The Certified Reference Material should be used without pre-treatment. ITAK is not responsible for any changes occurring after opening said bottles/sachets.

The Certified Reference Material should be stored in a dry place and without contact with excessive heat or moisture.

CERTIFICATION AND STATISTICAL EVALUATION OF ANALYTICAL DATA

ITAK-851 was analyzed by eight specialized laboratories. The statistical evaluation was carried out according to ISO GUIDE 35 and ISO 5725-2, using: identification and treatment of outliers, stragglers and technically invalid data, certified value calculation, standard deviation calculation, and extended standard uncertainty calculation.

The Technical Report: RT-170/18 STD contains full details of all phases of manufacturing, certifying results, participating laboratories, and the statistical evaluation.
Note: This report is available on the ITAK database for CRM users.

ANALYTICAL METHODS

The methods used on the certification of CRM ITAK-851 are mentioned as follows:

- **a**: Acid digestion Method and determination by Atomic Absorption Spectrometry (AAS).
- **b**: Acid digestion Method and determination by Atomic Emission Spectrometry (ICP).

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