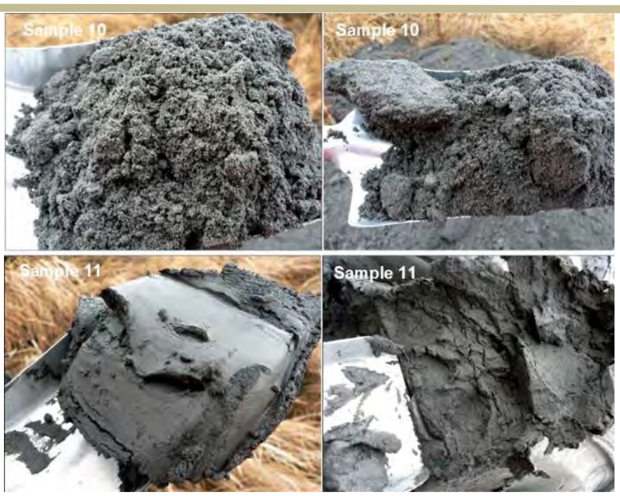
Public Reporting on Exploration Results and Mineral Resource Estimation for the Chvaletice Manganese Project Chvaletice, Czech Republic



PRESENTED TO
Mangan Chvaletice sro

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Public Reporting on Exploration Results and Mineral Resource Estimation for the Chvaletice Manganese Project Chvaletice, Czech Republic

Effective Date: April 27, 2018

Signed and dated this 21 day of June 2018, at Vancouver, British Columbia.

Prepared by: *original signed and sealed* Date: June 21, 2018

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
ABA	Acid-base accounting
Bpv	Baltic Vertical Datum
Ca	calcium
CCD	count-current decanter
CINF	CINF Engineering Co.
CMP	Chvaletice Manganese Project
CP	Competent Person
CRIMM	Changsha Research Institute of Mining and Metallurgy Co.
CRMs	certified reference materials
Code	Australian Code for Reporting Exploration Results, Mineral Resources and Ore Reserves
DEM	digital elevation model
EIA	environmental impact assessment
EMD	electrolytic manganese dioxide
EMM	electrolytic manganese metal
EMMP	Environmental Monitoring and Management Plan
ERT	electric resistivity tomography
Fe	iron
GPS	global positioning system
HIMS	high intensity magnetic separation
HPMSM	high purity manganese sulphate monohydrate
ICP	inductively coupled plasma
ICP-MS	inductively coupled plasma-mass spectrometry
ISO	International Organization for Standardization
JORC	Joint Ore Reserve Committee
masl	metres above sea level
Mg	magnesium
Mn	manganese
MW	megawatt
NPR	neutralization potential ratios
NSR	net smelter royalty
PRC	People’s Republic of China

Acronyms/Abbreviations	Definition
PSA	particle size analysis
QA	quality assurance
QC	quality control
SGS	SGS Mineral Services
sMn	soluble manganese
SWOT	strength-weakness-opportunities-threats
T	tesla
tMn	total manganese
UTM	Universal Transverse Mercator
WGS	World Geodetic System
XRD	x-ray diffraction
XRF	x-ray fluorescence

1.0 EXECUTIVE SUMMARY

The Chvaletice Manganese Project (CMP) is located in the western area of the Pardubice region of the Czech Republic, approximately 89 km by road east of Prague, on the southern shore of the Labe River (Figure 1-1). The CMP contemplates reprocessing of fine-grained tailings material for production of high purity, selenium-free, 99.9% electrolytic manganese metal (EMM) and/or high purity manganese sulphate monohydrate (HPMSM) at a hydrometallurgical refinery expected to be located near the tailings. The tailings were deposited into three separate tailings cells, referred to as Cell 1, Cell 2 and Cell 3 from historical mining and processing activities. The Chvaletice Property (the Property) is the subject of two exploration licences, numbered 631/550/14-Hd and MZP/2018/550/386-Hd (together the "Exploration Licences") and a Preliminary Mining Permit, numbered MZP/2018/550/387-HD, which is registered to include mineral rights over an area of 0.98 km^2 (98 ha, encompassing all three tailings cells) (Figure 1-2).

Mangan Chvaletice sro (Mangan) retained Tetra Tech Canada Inc. (Tetra Tech) to prepare a Public Report and to undertake a mineral resource estimate based on the data generated from work completed to date. This report and mineral resource estimate has been prepared for the CMP in accordance with the Australian Code for Reporting Exploration Results, Mineral Resources and Ore Reserves (Code) published by the Joint Ore Reserve Committee (the JORC Code) guidelines and following CIM Best Practices. The document is structured according to requirements under Form 1 of the Canadian National Instrument 43-101 Standards of Disclosure for Mineral Projects (NI 43-101). The effective date for this report is April 27, 2018. In accordance with the JORC Code guidelines, the Competent Persons for this report are Mr. James Barr, P.Geo., Senior Geologist, and Mr. Jianhui Huang, Ph.D., P.Eng, Senior Metallurgical Engineer, both with Tetra Tech.

The Exploration Licences and the Preliminary Mining Permit are held by Mangan (a private company established in the Czech Republic as a partnership between GET s.r.o. (GET), Geomin s.r.o. (Geomin), and Orex Consultants s.r.o. (Orex). Euro Manganese Inc. (EMI) owns 100% of Mangan. Terms of the purchase agreement dated May 2016 included transfer of an exploration licence, number 631/550/14-Hd, from GET to Mangan and purchase of 100% of Mangan by EMI. On May 4, 2018, the Czech Ministry of Environment issued Mangan an additional exploration licence, MZP/2018/550/386-Hd, allowing it to drill the slopes on the perimeter of the tailings piles. The additional exploration license became effective May 23, 2018, and is valid until May 31, 2023. Further, in April 2018, Mangan was issued a Preliminary Mining Permit, valid until April 30, 2023, and covering the areas included in the Exploration Licences. The Preliminary Mining Permit is a precursor to applying for a Mining Permit and grants EMI the right to conduct an Environmental Impact Assessment. A net smelter royalty (NSR) agreement with a total aggregate amount of 1.2% is held by the original shareholders of Mangan, which was granted as part of the purchase transaction by EMI for 100% ownership of Mangan.

At present, Mangan does not hold surface rights to the CMP area, which are considered as those lands of original ground elevation surrounding, and those parcels of original ground underlying and immediately surrounding, Cells 1, 2, and 3. The area of interest for the CMP overlies 18 privately owned land parcels with surface rights. Mangan received the consent to conduct exploration activities and to access the site from the land owners whose surface properties underlie the tailings

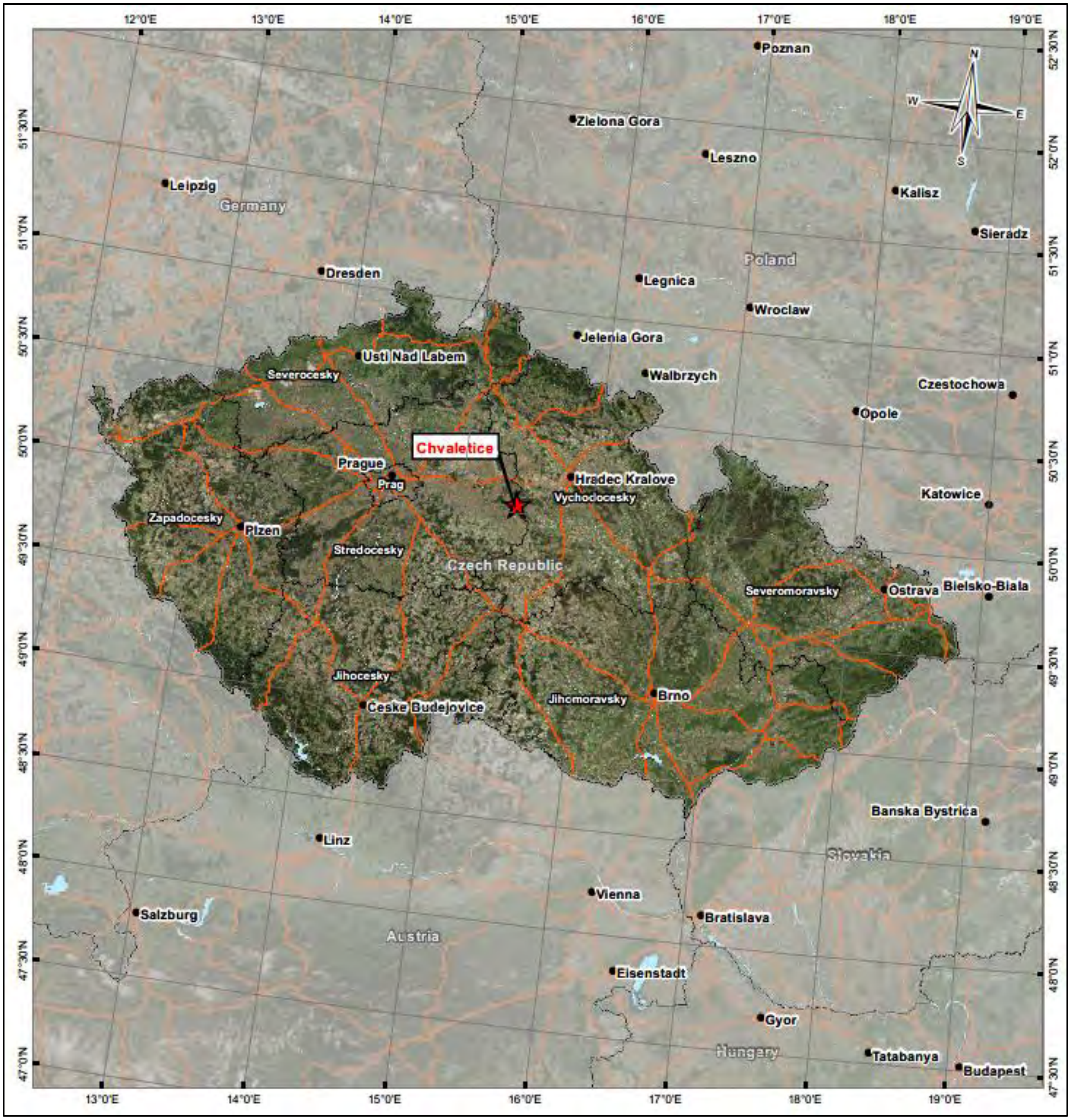
Infrastructure in the vicinity of, and accessible to, the CMP includes highways, a major rail corridor, water supply, a pre-cast concrete plant operated by Eurobeton, and an 800 MW lignite coal-fired power station operated by Severní Energetická a.s.

A significant skilled and trainable labour workforce is accessible in the nearby communities, including the villages of Chvaletice (population of 3200) and Trnavka (population 250) and the nearby towns and cities of Kutna Hora (population 21,000), Kolin (population 31,000), Pardubice (population 89,000), Hradec Kralove (population 93,000), and Prague (population 1,200,000).

Mining supplies, services and technical expertise can be found mainly in Prague and Pardubice.

Environmental baseline and hydrogeological studies have been initiated and are ongoing for the project. The work includes monitoring of groundwater conditions underlying the tailings which have been identified to have been impacted by the history of industrial activity in the area.

Figure 1-1: Location of the Chvaletice Manganese Project



1.1 History

Historical mining in the region dates back to approximately 677 AD through to medieval times according to records of iron (Fe) production from local mines. Intermittent mining for iron in the region continued through until the mid-19th Century, when iron and manganese (Mn) minerals near Chvaletice were discovered. Systematic underground mining within the Chvaletice Mine produced manganese between the years 1915 and 1945. Thereafter, from 1951 to 1975, milling operations occurred for the recovery of pyrite as basic raw material for the production of sulphuric acid, which produced the three adjacent tailings deposits. Conversion from underground to bulk tonnage open pit mining occurred during this period, during which time an estimated 32 Mt of material was mined for pyrite, with approximately 20 Mm^3 of waste rock deposited on the spoil heaps, and over 17 Mm^3 of flotation waste was placed into the unlined tailing ponds. These tailings ponds are the target of the CMP and are referred to as Cells 1, 2, and 3. Mining and production of tailings material was terminated in 1975.

An extensive evaluation of the tailings material was conducted between April 1986 and July 1988 by Bateria Slany, the former Czechoslovakian, State-owned manufacturer of batteries, for the potential manufacture of electrolytic manganese dioxide (EMD). The results from their investigation included a “reserve calculation”, currently registered as the “Řečany – Tailings Pond 3” and “Chvaletice – Tailings Ponds 1, 2” as a “State Reserve” with the Czech Republic Government. This historical calculation comprised 27,557,441 tonnes of “reserves”, containing 25,496,299 tonnes at a grade of 5.15% leachable Mn (7.06% total Mn) at a “C2” category, and 2,061,143 tonnes of material average grade of 4.97% of leachable Mn (7.39% total Mn) at a “C1” category. The definition of C2 and C1 categories references a system developed in the Czech Republic for classification of minerals “resources” and “reserves”, where resources classified as C1 are supported in greater detail than those that are classified as C2. The Czech system differs significantly from the classification system defined under the CIM Terms and Definitions as referenced by the JORC Code and cannot be misconstrued to imply a similar level of confidence. This historical calculation cannot be relied upon as being accurate.

1.2 Geology and Mineralization

The cells are estimated to contain approximately 19.5 Mm^3 of material, with approximately 17.5 Mm^3 comprised of silt and clay sized particulate tailings material. The remaining estimated 2 Mm^3 is native soils that were used for dam construction and reclamation topsoil. Cell 1 averages approximately 25 m thick, with a surface area of approximately 326,400 m^2, and has a volume of approximately 6,908,700 m^3. Cell 2 averages approximately 26 m thick, with a surface area of approximately 393,200 m^2, and has a volume of approximately 8,198,500 m^3. Cell 3 averages approximately 11 m thick, with a surface area of approximately 313,200 m^2, and has a volume of approximately 3,219,300 m^3.

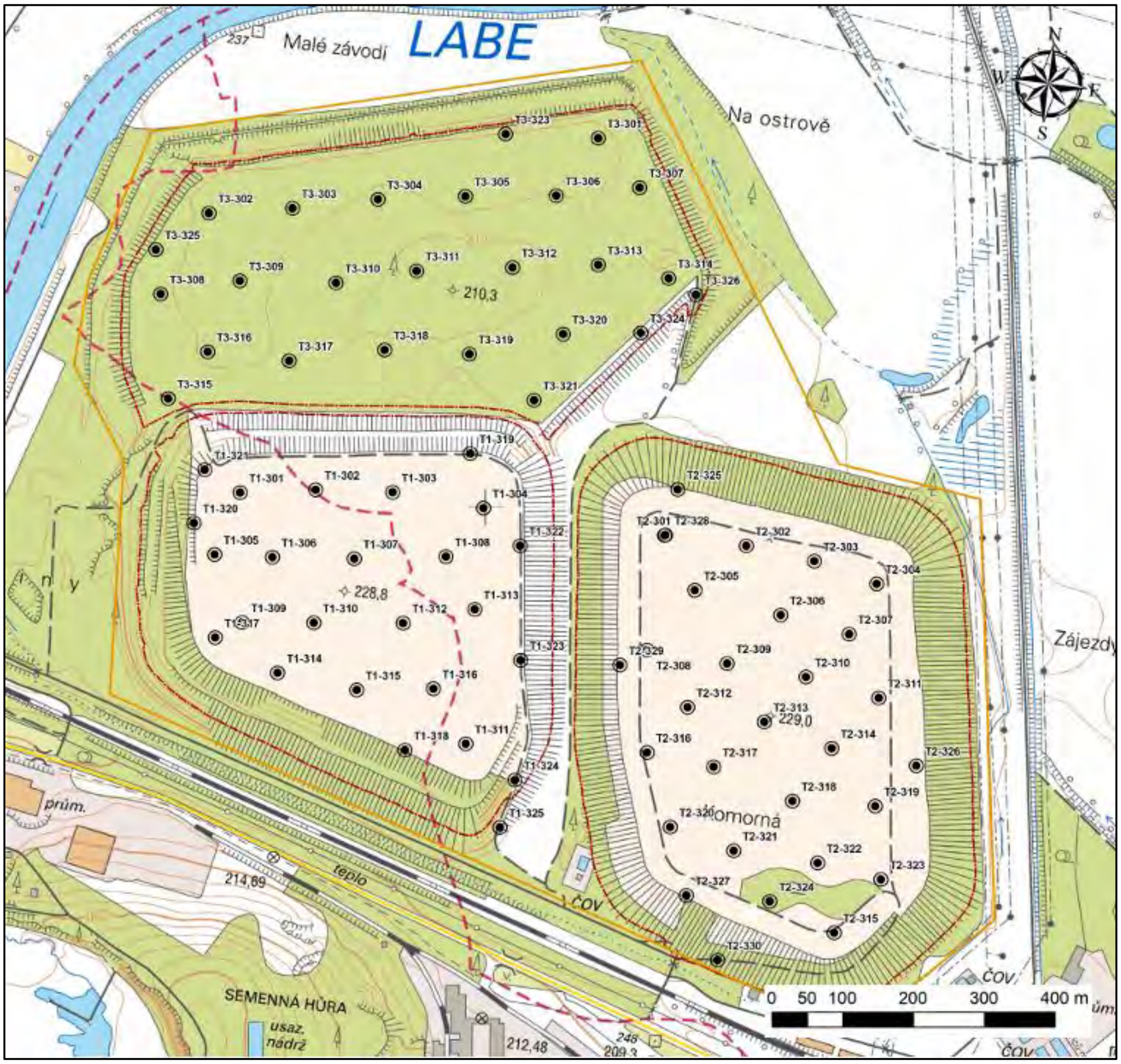
EMI began recent exploration activity on the Property in 2014, when a series of near surface samples were collected from auger holes and test pits for preliminary materials characterization. In June 2017, EMI initiated an 80-hole Sonic drilling campaign totaling 1,679.3 m within Cells 1, 2, and 3 to evaluate the mineral resource potential both horizontally and vertically through the full tailings profile, referred to as the 2017 Drilling Program. Drill hole spacing was approximately 100 m throughout each cell. The perimeter embankments of each cell were not safely accessible to the sonic drill rig and was not drilled. To verify the composition of the embankments, four additional drill holes were collared on access ramps. Each hole intersected a layer of topsoil with average thickness of approximately 1m, manganese bearing tailings material, and terminated in native basal soils at elevations consistent with other drill holes. Additionally, a resistivity and seismic survey was conducted over six survey lines across the tailings and the adjacent land. Information collected during the investigation will be used for the purposes of mineralogy; Mineral Resource estimation; and hydrological, geotechnical, metallurgical, environmental and process engineering.

Samples were collected on intervals ranging from 0.9 m to 2.9 m with the average length representative of the 2 m core runs. Each sample was logged for lithology, moisture, particle size, wet mass, and recovery in the field. A total of 755 samples were split in the field. A 25% sub-sample split of each sample was shipped to SGS Mineral Services (SGS) laboratories in Bor, Serbia, for analysis and test work, and a 75% sub-sample was shipped to Changsha Research Institute of Mining and Metallurgy Co. Ltd. (CRIMM) in China, for bulk sample metallurgical and processing test work, respectively. A rigorous quality assurance (QA) and quality control (QC) program was implemented by EMI, which included use of field duplicates, lab duplicates, insertion of three certified reference materials (CRMs), and insertion of two certified blank materials. Quality control methods were reviewed by Tetra Tech CP James Barr, P.Geo., during a two-day site visit to the property, and following receipt of analytical results Tetra Tech undertook compilation of the geological database, the verification of laboratory data and the QA/QC program for data validation. The Competent Person (CP) is satisfied that the sampling method and analytical integrity has been preserved throughout sample handling, preparation, and the analytical process.

Analysis and testwork conducted on the samples, included:

- Multi-element assay using aqua regia and four acid digestions as proxy for soluble (smn) and total manganese (tmn) concentrations
- Whole rock analysis using fusion-x-ray fluorescence (XRF)
- Particle-size analysis using laser diffraction and sieve/hydrometer methods
- Mass measurements
- Moisture measurements
- Specific gravity by pycnometer.

Figure 1-2: Tailings Cells and 2017 Drill Hole Layout



A preliminary in situ dry bulk density investigation was conducted by EMI in advance of the 2017 drilling program using a cylinder test method from near surface samples. This work was followed by in-depth calculation of in situ dry bulk density using core recovery volumes and dry mass using SGS laboratory measurements. Calculated in situ dry bulk density values for individual samples range between 0.74 t/m^3 and 2.85 t/m^3, with a mean value of 1.55 t/m^3.

Manganese is primarily hosted in carbonate minerals with lesser amounts as silicate and oxide minerals, as identified by x-ray diffraction (XRD) analyses completed by EMI in 2015 and reported by AMEC in their initial investigation in 2016 (AMEC 2016). The analysis identified three manganese bearing minerals from tailings samples including rhodochrosite ($MnCO_3$); moderate proportions of spessartine (a nesosilicate, manganese aluminum garnet ($Mn_3Al_2(SiO_4)_3$); and ankerite/dolomite (manganese-substitution in a calcium (Ca)/magnesium (Mg) carbonate ($Ca(Fe, Mg, Mn)(CO_3)_2$). Subsequent Scanning Electron Microscope investigations work identified a rare and locally named mineral kutnohorite ($Ca(Mn^{2+}, Mg, Fe^{2+})(CO_3)_2$), which forms a series with dolomite and ankerite. Additional manganese minerals which were identified in trace quantities include silicates such as sursassite (a manganese bearing sorosilicate), pyrolusite (a manganese dioxide (MnO_2), and kurchatovite (calcium-magnesium-manganese-iron borate ($Ca(Mg,Mn,Fe^{2+})B_2O_5$).

Total sulphur concentration in the tailings averages approximately 3.1% which is sourced form sulphide, sulphate and organic sulphur origin. Total carbon concentrations averages approximately 3.4%, which includes contributions from graphite, organic carbon and carbonate origins. Photos of core recovered from drill hole T1-312, near the core of Cell 1, are shown on Photo 1–1.

Photo 1-1: Core Photos from Drill Hole T1-312, from Depths 3-4 m, 9-10 m and 23-25 m

1.3 Mineral Resource Estimate

A three-dimensional model was constructed for Cells 1, 2 and 3 using a digital topographic model (DTM) compiled by GET using data from the 5th generation digital elevation model (DEM) 5G developed by the Land Survey Office in Prague from LiDAR data in the System Jednotne Trigonometricke Site Katastralni (S-JTSK) (Krovak East North) coordinate system and the Baltic Vertical Datum (Bpv). The topography has been used to constrain volume estimates for each cell.

Lithology logs were used to construct an upper contacting surface between tailings and topsoil, then used to construct a lower contact surface between tailings and native subsoil. The intervening volume defined the volume of tailings material in each cell and was used to constrain all laboratory analysis and test work data that was subsequently used to model various physical and chemical attributes of the tailings material.

Data analysis and modelling was undertaken using Aranz Leapfrog® Geo, Phinar x10 Geo, and Geovia GEMS™ software. All sample data was composited to 2 m, and each cell was modelled separately. No capping was applied to any variable following inspection of the composited data.

Volume models were developed for physical parameters including grain size, in situ dry bulk density, and moisture content. Grain size was represented using D_{50}, D_{80}, D_{90}, which are the average diameter of the particles at the 50th, 80th and 90th percentiles, respectively, and using P_{75} which is the percentage of the sample that passes a standard 200 mesh, equivalent to a 75 µm nominal mesh. The model results show that particle size is gradational coarse to fine inwards in each cell and that a higher moisture content is contained within the finest particles mass at the center of each deposit. Average P_{75} for each cell ranged from 69.44% to 74.78%, indicating that the bulk of the material is silt size or smaller. In situ dry bulk density varies throughout each cell and is a function of the composite mineral densities in addition to the degree of compaction in the soils. Modelled in situ dry bulk density values ranged from 1.10 to 2.15 t/m^3, with an overall average of 1.52 t/m^3.

Total and soluble manganese concentrations were interpolated using a spherical interpolation method into a sub-block model with 50 m by 50 m by 4 m parent blocks, and 25 m by 25 m by 4 m sub-blocks. The dry in situ bulk density model was applied to the sub-block model to calculate block tonnages. The block model was classified and validated by Tetra Tech CP James Barr, P.Geo., using guidelines set forth by the JORC Code resulting in Inferred and Indicated Mineral Resource estimates for each of the cells. The estimates are listed in Table 1-1 with an effective date of April 27, 2018.

Table 1-1: Mineral Resource Estimate for the Chvaletice Manganese Project, Effective April 27, 2018

Cell	Class	Volume (m^3, ‘000s)	Tonnes (kt)	Bulk Density (t/m^3)	Total Mn (%)	Soluble Mn (%)
T1	Indicated	5,684	8,832	1.55	8.08	6.46
	Inferred	1,004	1,497	1.49	8.60	6.87
T2	Indicated	6,773	10,567	1.56	6.86	5.48
	Inferred	996	1,648	1.65	7.90	6.05
T3	Indicated	2,772	3,973	1.43	7.34	5.78
	Inferred	250	363	1.46	7.84	6.14
Total	**Indicated**	**15,229**	**23,372**	**1.53**	**7.40**	**5.90**
Total	**Inferred**	**2,250**	**3,508**	**1.56**	**8.21**	**6.43**

Notes:

- Mineral Resources do not have demonstrated economic viability but have reasonable prospects for eventual economic extraction. Inferred Resources have lower confidence than Indicated Resources. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, sociopolitical, marketing, or other relevant issues.
- A cut-off grade has not been applied. No capping has been applied.
- Numbers may not add exactly due to rounding.

1.4 Mineral Processing and Metallurgical Testing

Several preliminary metallurgical test programs have been carried out to investigate the mineralogical characteristics and assess the metallurgical responses of the tailings materials. The metallurgical test programs include the latest testing undertaken by EMI from 2015 through 2017 to investigate pre-concentration and acid leaching responses of various samples while the early testing by Bateria Slany, a Czechoslovak state battery producer, studied the production of EMD.

The preliminary mineralogical studies indicate that manganese is mainly present as rhodocrosite and as kutnohorite, with lesser amounts as sursassite, pyrolusite and kurchatovite (grouped as manganese-silicate minerals). The grain size of manganese-carbonates varies significantly with significant amounts occurring as liberated and middling grains, lesser amounts are present as sub-middling and locked grains. The manganese-carbonates are mainly in complex associations with other carbonates, quartz and feldspars, or manganese-silicate minerals. On average approximately 80 to 85% of the manganese is present as acid soluble manganese. Residual pyrite is also identified by the preliminary mineralogical studies.

The test results show that the mineralization responds well to high intensity magnetic separation, compared to the other pre-concentration treatments, such as flotation and gravity concentration. The investigation shows that when the magnetic field intensity is approximately 1.8 T, approximately 88% of the total manganese, or 87% for acid soluble manganese, reports to an 11% total manganese (tMn) concentrate. The ongoing test work on the overall composite sample generated from the 2017 drilling program shows that approximately 84% of the manganese was recovered into a 15% tMn concentrate at a magnetic field intensity of 1.8 T.

The preliminary acid leaching tests were conducted to investigate the metallurgical responses of the manganese minerals to sulphuric acid leaching. The results produced by SGS showed that at 50°C, 58 to 79% of the manganese was extracted from the Sample 10 and Sample 11 blended head sample depending on acid addition dosage. Up to 77% of the manganese in the magnetic concentrate sample was extracted with adding 500 kg/t sulphuric acid. The magnetic separation tailings showed much better metallurgical response.

Preliminary process development studies have conducted by AMEC and CINF Engineering Co., Ltd. (CINF). The proposed flowsheet includes the following main process circuits:

- Whole tailings material acid leaching.
- Iron and phosphorous precipitations.
- Leaching residue solid and liquid separation.
- Residue washing with manganese and ammonia recovery.
- Leaching pregnant solution purification, including heavy metal precipitation.
- Manganese electrowinning, manganese metal passivation, stripping from cathode plates.
- Magnesium removal from spent anolyte.

CINF and Tetra Tech are carrying out further process flowsheet development and optimization, including evaluation of magnetic separation treatment to pre-concentrate the leaching feed.

1.5 Recommendations

Further geological investigation is recommended to increase confidence in the short-range behavior of grade and material characteristics with the aim of classifying mineral resources as Measured, to confirm the contents and composition of the tailings perimeter embankments and perimeter foundations, and to confirm in situ dry bulk density estimates. Detailed analysis and interpretation is recommended of the lithogeochemical data collected from drilling with the aim to identify mineralogical distribution and presence of oxidized layers within the deposits. A static and kinetic test work program is recommended to characterize reaction dynamics for potential acid generation and metal leaching of the tailings materials.

A proposed Phase 1 geological investigation totaling approximately US$1,0M is recommended to fill-in gaps within the 2017 drilling campaign and to collect data from the perimeter areas of each cell in order to improve confidence in the modelled parameters. The estimated Phase 1 program budget is inclusive of drilling, analyses, and professional services.

Further metallurgical testing is recommended in continuity with the 2017 drilling investigation to measure metallurgical performances, optimize processing conditions and assess preliminary process design assumptions. A comprehensive beneficiation and metallurgical test work program, including pilot plant tests, is underway using drill core samples from the 2017 drilling program at the laboratories of CRIMM in Changsha, Hunan Province, People’s Republic of China (PRC). A total of approximately 11 t (dry) from 743 drill intervals is planned to be used for the testing program, including bench scale process condition development and optimization tests, large scale batch tests, and three pilot runs on different composite samples.

A total of US$1.2M has been estimated for the comprehensive testing program, excluding sample generation and shipment costs. This testwork is underway as of the Released Date of this report.

Details of the recommended work programs and cost breakdowns are included in Section 17 of the report.

2.0 INTRODUCTION

Mangan Chvaletice sro (Mangan) retained Tetra Tech Canada Inc. (Tetra Tech) to prepare this Public Report in for the Chvaletice Manganese Project (CMP), located in the Pardubice region of the Czech Republic, in accordance with the Australian Code for Reporting Exploration Results, Mineral Resources and Ore Reserves (Code) published by the Joint Ore Reserve Committee (JORC). Mineral tenure for the Property is held by Mangan, a 100% owned subsidiary of Euro Manganese Inc. (EMI), based in Prague, Czech Republic. The effective date for this report is April 27, 2018. The document is structured according to requirements under Form 1 of the Canadian National Instrument 43-101 Standards of Disclosure for Mineral Projects (NI 43-101).

The CMP name is derived from the local Chvaletice community, which was the site of historical open pit mining operations and processing of pyrite from 1951 to 1975, which produced nationally owned sulphuric acid from the pyritic shales. No additional mining or metal production is known to have been conducted on the Property since 1975. The mineral deposit being evaluated for the CMP comprises three tailings material stockpiles placed as a by-product of this historical production. These deposits are referred to as Cell 1, Cell 2, and Cell 3. EMI is evaluating the potential of reprocessing this tailings material for potential production of high purity, selenium-free, 99.9% electrolytic manganese metal (EMM) and/or high purity manganese sulphate monohydrate (HPMSM) at a hydrometallurgical refinery.

Since 2014, EMI has conducted various exploration, mineralogical, and materials testing campaigns as part of their preliminary site investigation efforts to characterize the deposits and potential recovery methods. Work to date has confirmed manganiferous mineralization is contained throughout the tailings deposits in carbonate form contained within dry to fully saturated compacted soils of predominantly silt sized particles.

The following terms of reference for the CMP are included throughout this report:

- The CMP, tailings materials, tailings deposit, and Cells 1 to 3, all refer to the manmade tailings deposits located near the community of Chvaletice, which comprises the mineralized material that is the subject of this report.
- The Chvaletice Bedrock Deposit refers to the original bedrock material that was mined historically for pyrite and production of sulphuric acid.

References used for this document include publicly available government documents, existing project test work, internal company reports, and verbal communication with EMI personnel. Current work being conducted by EMI aims to verify technical information and conclusions previously reported by Bateria Slany (1989). This work is one of a few historical technical references that exists for the Project, and includes a detailed description of technical investigations that were completed by EMI.

A Checklist of Assessment and Reporting Criteria, as per JORC Code is included in Appendix B.

2.1 Site Visits

In accordance with the JORC Code guidelines, the CPs for this report are Mr. James Barr, P.Geo., Senior Geologist, and Mr. Jianhui Huang, Ph.D., P.Eng, Senior Metallurgical Engineer, both with Tetra Tech.

Mr. James Barr, P.Geo., completed a site visit to the Property from July 1 to 3, 2017. During the site visit, Mr. Barr reviewed the Property layout, drill operations, sample collection methods, QA protocols, and collected independent verification samples. Conversations with on-site EMI technical personnel including Chris Baldys (geologist); Jaromir Tvrdý (Senior Geologist) and Tomas Pechar Jr. (Mining Engineer and Project Implementation Manager) of GET; Joseph Simek (geologist), and Petr Dolezal (hydrogeologist) with Geomin, covered topics relating to drilling recoveries, moisture content, soil class interpretation, surface property ownership, mineral tenure, and other project considerations. Mr. Barr is responsible as CP for the preparation of Sections 1 through 12, 14, 15, 16.1 and 17.1.

Mr. Jianhui Huang, Ph.D., P.Eng, visited the Property on February 5, 2018, and visited the CRIMM laboratory from January 20 to 22, 2017 and from September 27 to October 3, 2017. Mr. Huang also visited the SGS laboratory on June 29, 2017. Mr. Huang is responsible as CP for the preparation of Sections 13, 16.2 and 17.2.

2.2 Project Assumptions for Reporting

The coordinates system used for the CMP is the S-JTSK (Krovak East North) coordinate system and the Bpv, a system designed for the Czech Republic, as described further in Section 5.5. The accuracy of the topography and surveyed drill holes collar locations as provided is assumed to be reliable. Tetra Tech has approximately verified drill collar surveys in the field using handheld GPS.

Manganese grades are reported as percent elemental manganese (Mn%). Where necessary, they have been converted from manganese (II) oxide (MnO%) using as factor of 0.774. Manganese grades may not have a direct linear correlation to the amount of manganese product that could be produced. Metallurgical and process engineering is ongoing to evaluate material recovery effectiveness. The assay methods were selected to measure total elemental concentration in addition to measuring partial digestion concentrations of manganese as a proxy for "soluble manganese". Total manganese refers to the results of the four acid digestion methods, and soluble manganese refers to the results of the aqua regia digestion.

Observation of sample collection and handling was observed by the geology CP over two days during the site visit. It is assumed that the methods and protocols observed during this time, and as described in this report, were consistent with those used for the duration of the drilling project.

2.3 Effective Date

All information supporting the drilling program and mineral resource estimate described in Section 14 was received and validated by April 27, 2018. The mineral resource estimate was stated on November 22, 2017.

All information supporting the metallurgical work described in Section 13 was received and validated by April 27, 2018.

An effective date of April 27, 2018, has been applied to this report. Metallurgical testwork has been initiated and is ongoing at the effective date of this report. The CPs are not aware of any new information that is available for this Public Report as of the effective date.

3.0 RELIANCE ON OTHER EXPERTS

EMI provided Tetra Tech with information regarding mineral tenure and ownership of surface rights described in Section 4.0, based on a title opinion provided by PRK Partners s.r.o. in the Czech Republic in a letter dated June 20, 2018. The letter confirms that EMI is the sole shareholder of Mangan, Mangan is registered and in good standing under the laws of the Czech Republic, and that Mangan holds valid exploration licences and a Preliminary Mining Permit for the CMP. Tetra Tech has not sought legal verification of the information, but believes the information to be true.

The Czech Ministry of Environment approved Mangan’s application for a preliminary mining licence in a document dated April 17, 2018, and with reference to MZP/2018/550/387-Hd, ZN/MZP/2018/54. Details of this authorization are included in Section 4.1.

4.0 PROPERTY LOCATION AND DESCRIPTION

The Property is located in the western area of the Pardubice region of the Czech Republic at approximate latitude-longitude coordinates 15.444279°E and 50.038069°N. Communities within the immediate vicinity of the Project include *Trnávka*, *Chvaletice* and *Řečany nad Labem*. Prague is located approximately 75 km due west (Figure 4-1).

The tailings are deposited in three separate facilities, referred to as cells, which were built upon and are elevated with respect to the natural ground elevation in the region. Cell 1, the oldest deposit, covers a total surface area of 657,100 m^2, and has an average thickness of approximately 25 m. Cell 2 covers a total surface area of 787,600 m^2 and has an average thickness of approximately 26 m. Cell 3 covers a total surface area of 615,400 m^2 and has an average thickness of approximately 11 m. A plan map of the Property is shown in Figure 4-2.

4.1 Mineral Tenure

Governing authorities that regulate Mineral Resources and mining activities in the Czech Republic include the Czech Mining Authority, District Mining Authorities, the Ministry of the Industry and Trade, and the Ministry of Environment of the Czech Republic. The CMP lies within the Hradec Králové and Pardubice Region District Mining Authority. These authorities administer the Mining Act (44/1988), Mineral tenure is regulated under the Geological Act (62/1988) and administered by the Ministry of Environment in consultation with the Ministry of the Industry and Trade and with the Czech Mining Authority.

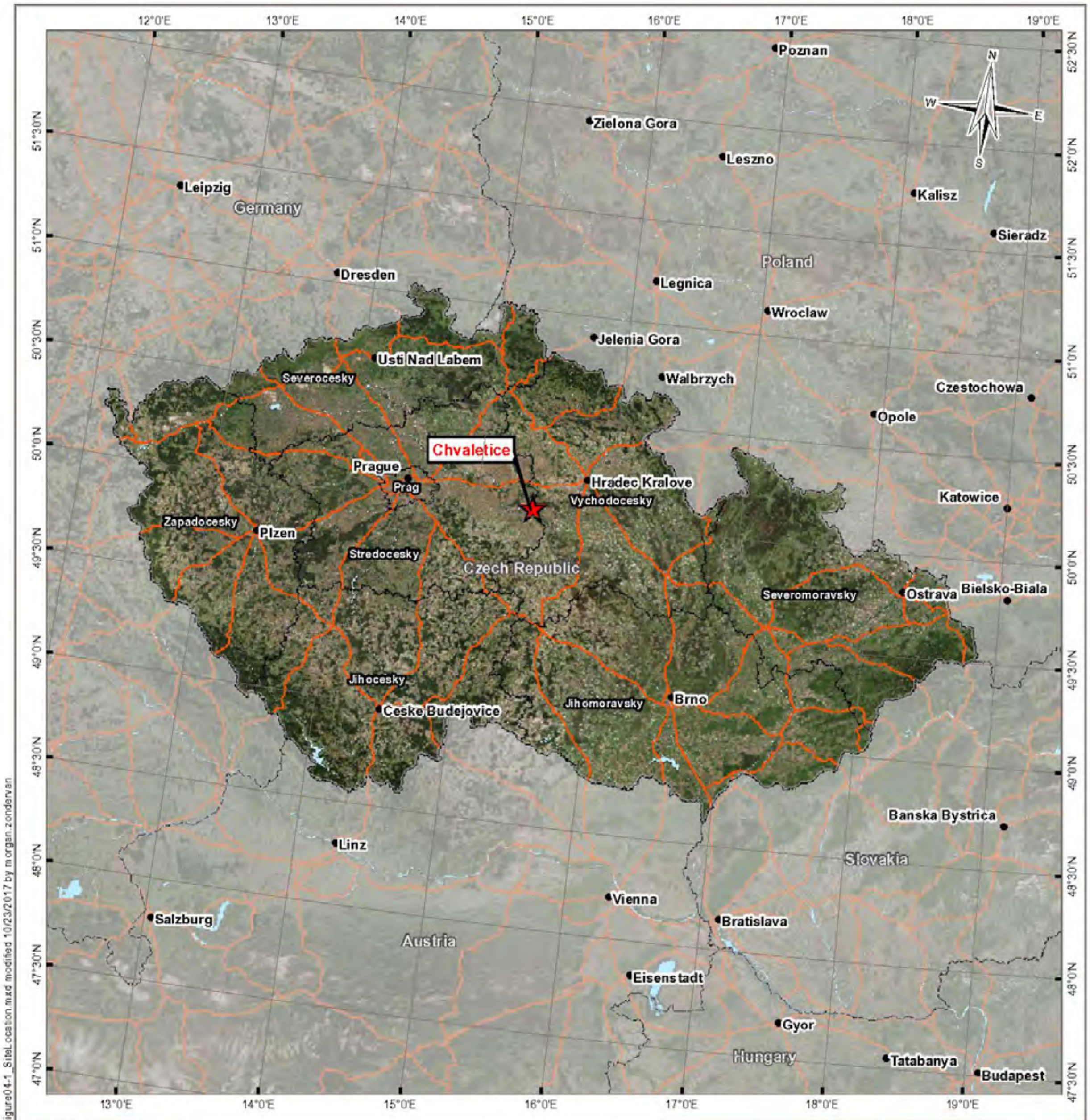
Application for the mineral tenure of the “Trnávka Exploration Area” was made by GET in April, 2014. The area of interest was considered to have been discovered by State Resource which allowed for competing bids. Following the Ministry of Environment’s review of competing bids, exploration license 631/550/14-Hd which encompasses the “Řečany - Tailings Pond 3” and “Chvaletice - Tailings Ponds 1, 2” was awarded to GET.

Mangan is a private company established in the Czech Republic in 1997. Mangan was used as the corporate vehicle for an incorporated partnership between GET (33%), Geomin (33%), and Orex (34%). On December 15, 2014, an Option Agreement was signed between EMI, Mangan, and its affiliates, granting EMI the right to earn an 80% equity interest in Mangan. In May 2016, the Option Agreement was amended and EMI purchased 100% ownership of Mangan from the Mangan shareholders, for an aggregate share value (EMI common shares) of CAD$1,500,000 and future prorated Net Smelter Return (NSR) payments of 1.2% to the original Mangan partners. Conditions precedent to the EMI-Mangan purchase agreement included transfer of the exploration licence number 631/550/14-Hd from GET to Mangan.

Exploration licence number 631/550/14-Hd is registered to include mineral rights on a total area of 0.98 km^2 (98 ha), of which 0.82 km^2 is located within the Municipality of Trnavka, and 0.16 km^2 is located within the Municipality of Chvaletice. Exploration Licence No. 631/550/14-Hd expires September 30, 2019. On May 4, 2018, the Czech Ministry of Environment issued Mangan an additional exploration Licence No. MZP/2018/550/386-Hd allowing it to drill the slopes on the perimeter of the tailings piles. Exploration Licence No. MZP/2018/550/386-Hd became effective May 23, 2018, and is valid until May 31, 2023. On April 17, 2018, with effect from April 28, 2018, Mangan was issued a Preliminary Mining Permit by the Ministry of Environment, Licence No. MZP/2018/550/387-HD and referred to by the Ministry of Environment as the prior consent with the establishment of the Mining Lease District (the "Preliminary Mining Permit"). The Preliminary Mining Permit, valid until April 30, 2023, covers the areas included in the Exploration Licences and secures Mangan’s rights for the entire deposit area.

The Preliminary Mining Permit forms one of the prerequisites for the application for the establishment of the Mining Lease District and represents one of the key steps towards final permitting for the project. Based on the Preliminary Mining Permit and other documents, including the Environmental Impact Assessment (which may commence after the Preliminary Mining Permit has been issued), Mangan has until April 30, 2023, to apply for the establishment of the Mining Lease District covering the areas included in the Exploration Licences. The establishment of the Mining Lease District, the application for the final Mining Permit, and applications for permits relating to the construction of infrastructure required for the project, are required prior to mining at the CMP. The Preliminary Mining Permit bounds are shown in Figure 4–3.

Figure 4-1: Chvaletice Manganese Project Location



LEGEND

★ Site Location
● Major City
— Major Road
Waterbody

NOTES
Base data source:
ESRI Data & Maps

STATUS
ISSUED FOR REVIEW

CHVALETICE MANGANESE PROJECT

Regional Map of Chvaletice in the Czech Republic

PROJECTION	DATUM	CLIENT
S-JTSK Krovak EastNorth	S JTSK	Euro Manganese Inc.

Scale: 1:3,000,000
50 25 0 50
Kilometres

FILE NO.
VMIN03117-02_Figure04-1_SiteLocation.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EM	0

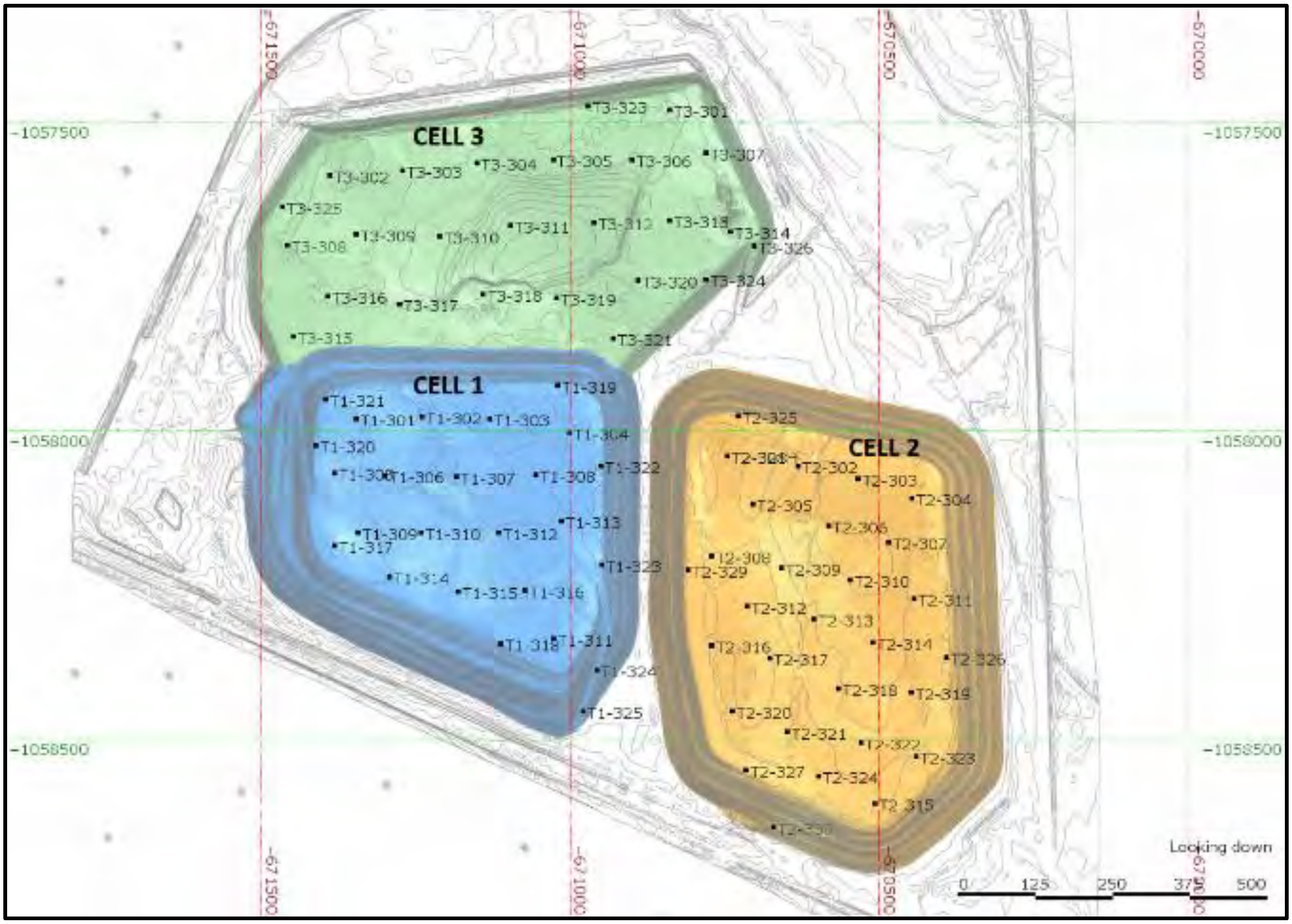
DATE	PROJECT NO.
October 23, 2017	MIN.VMIN03117-02

TETRA TECH

Figure 4-1

Q:\Vancouver\GIS\MINING\VMIN\VMIN03117-02\Maps\VMIN03117-02_Figure04-1_SiteLocation.mxd modified 10/23/2017 by morgan.zondervan

Figure 4-2: Plan Layout of the Project Tailings Deposits, Cells 1 to 3



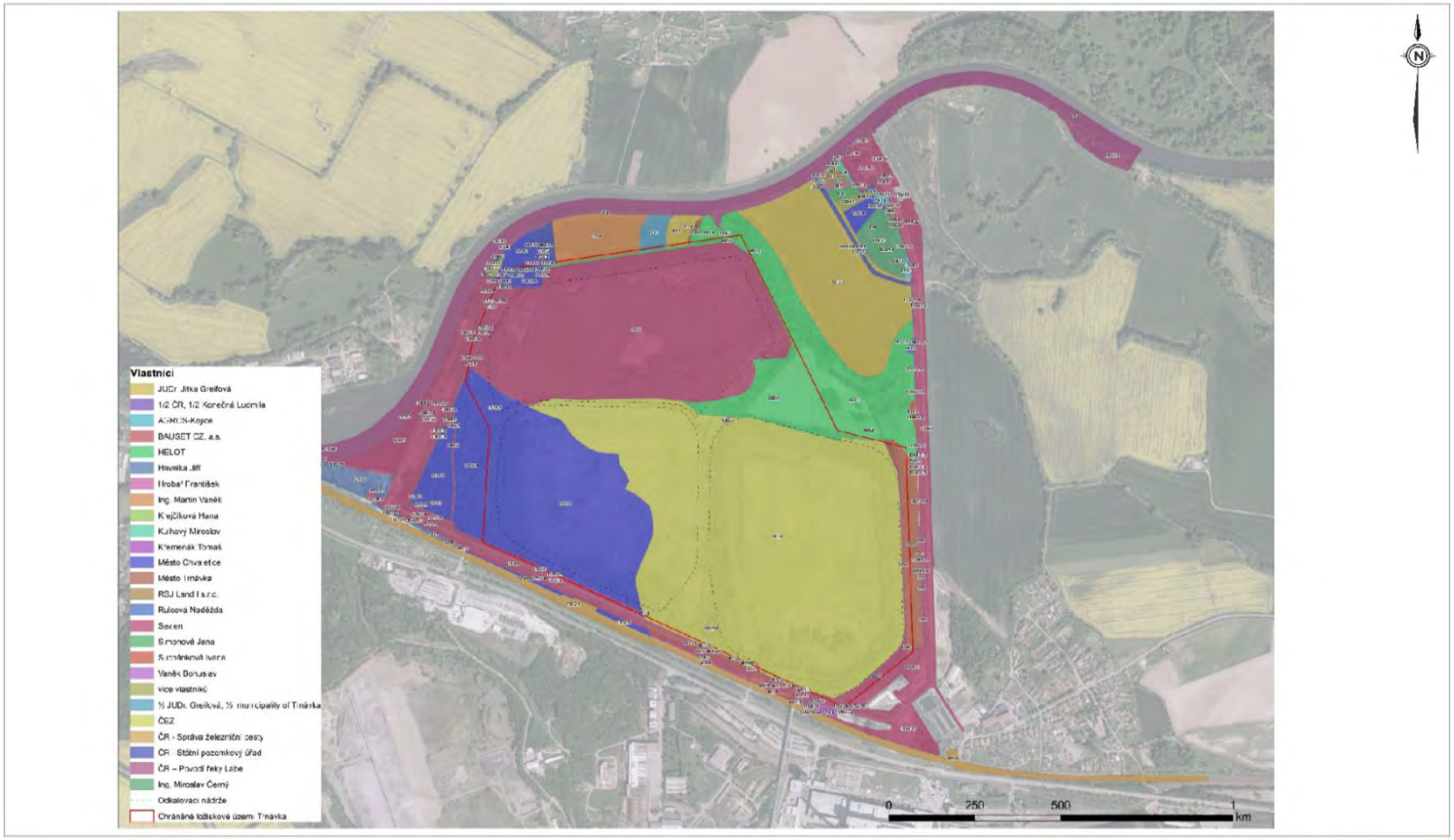
4.2 Surface Ownership and Land Access Agreements

At present, Mangan does not hold surface rights to the CMP area, which are considered as those lands of original ground elevation surrounding and immediately underlying the protected area that contains tailings Cells 1, 2, and 3. The area of interest for the CMP overlies and adjoins 18 privately owned land parcels with surface rights described as (Petru 2015), (Figure 4–3):

- the principal plots of land parcels 1170/1, 1170/4, 1170/7, 1217/1, and 1490/2 in the cadastral area of Chvaletice
- the principal plots of land parcels 349/2, 481/1, 613/1, 660/1, 661/1, 661/2, 662/1, 666/4, 1050, 1017/1, 1017/3, 1065, and 1180/30 in the cadastral area of Trnávka.

Land access agreements and permissions were obtained by Mangan from landowners as well as the Trnavka and Chvaletice Municipalities for sampling, surveys, studies, road-building and drilling that were conducted in 2016 and 2017.

Figure 4-3: Plan Map with Surface Ownership and Preliminary Mining Permit Boundaries



LEGEND

NOTES
Source:
EMI, 2017

STATUS
ISSUED FOR REVIEW

CLIENT
Euro Manganese Inc.

TETRA TECH

Chvaletice Manganese Project

Plan Map with
Surface Ownership and
Mineral Tenure Boundary

PROJECT NO.	DWN	CKD	APVD	REV	Figure 4-3
OFFICE TT-VANC	DATE October 2017				

Note: Preliminary Mining Permit MZP/2018/550/387-HD shown as an red line around the perimeter of the tailings deposits Cells 1, 2 and 3.

4.3 Royalties and Liens

An NSR agreement with total aggregate amount of 1.2% is held by the original shareholders of Mangan, which was granted as part of the purchase transaction by EMI for 100% ownership of Mangan. EMI has informed Tetra Tech that Mangan has not granted any other royalties or liens on the CMP.

Income taxes and fees imposed by the Government of Czech Republic on mineral resource projects is not a clearly defined one fit system. Discussions between Mangan/EMI and the Government of Czech Republic are ongoing to clarify the payment structure in regards to potential income taxes and fees as foreign investors for the project.

5.0 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 Climate

The climate in the western Pardubice region of central Czech Republic is seasonally variable and typical of European continental conditions with warm dry summers and cold winters. It is one of the driest and warmest regions in the Czech Republic. Annual average temperatures are around 8°, and total annual precipitation between 700 to 800 mm (Czech Hydrometeorological Institute). The area experiences a net negative precipitation, after factoring in evaporation. Monthly average temperatures vary from -3.1°C in January to 16.6°C in July.

5.2 Physiography

The physiography of Chvaletice region is described as flat lying with some rolling hills. The Property lies immediately south of the Labe River (German: Elbe) which is a regional hydrographic drainage merging with the Vltava River north or Prague. The property is within the Upper and Middle Elbe river Basin which is administered by the Elbe River Board under the Ministry of Agriculture.

Forests in the region are classified as boreal. Well-established vegetation growth on the tailings cells is comprised of grasses and small shrubs on the upper plateau, and juvenile to semi-mature birch trees along the side slopes.

The gentle landscape and moderate climate promotes a healthy agricultural industry, with arable lands that produce corn, barley, sugar beet, canola and other crops, which occupy the majority of the rural landscape.

5.3 Local Resources

The CMP deposit is located immediately adjacent to both an 820 MW lignite coal-fired power station operated by Severní Energetická a.s., and a pre-cast concrete plant operated by Eurobeton.

A rail line is located immediately to the south of the property which acts as main transportation line from Prague to communities of Eastern Czech Republic. Spur lines are used to transport and unload coal to the power station, and to service an adjacent industrial park which is the site of the former processing facilities that produced the deposits.

5.3.1 Water

Groundwater supplies the agriculture, urban and industrial water requirements in the region. Water resources in the Czech Republic are jointly managed at the national level by the Ministry of Agriculture (policies and regulates services), the Ministry of Environment (regulates wastewater discharge), National Institute of Public Health (controls drinking water quality) and the Ministry of Finance (regulates tariffs), all in conjunction with local municipalities.

Currently, exploration on the Property has minimal to no water demand.

5.3.2 Power

Local electrical power is generated by the Chvaletice power station, a key node in the Czech electrical grid, and which provides the regional power supply to many local communities.

5.3.3 Infrastructure

No infrastructure exists on the Property.

5.3.4 Community Services

A significant labour workforce is accessible in the nearby communities, including the villages of Chvaletice (population 3200) and Trnavka (250), as well as the towns and cities of Kutna Hora (21,000), Kolin (31,000), Pardubice (89,000), Hradec Kralove (93,000), and Prague (1,200,000).

Mining supplies, services and technical expertise can be found mainly in Prague and Pardubice.

5.4 Property Access

The Property is located along paved Highway #322 which connects to Prague, approximately 89 km by road, via Kolin and Highway #12. The Property is accessed by a short gravel road and locked gate, which is maintained by Severní Energetická.

5.5 Topographic Reference

Spatial survey in Czech Republic is conducted using the S-JTSK (Krovak East North) coordinate system and the Bpv, a system designed for the Czech Republic. Czech transformation key has an average positional error of 0.2 m and height error 0.3 m. The CMP is located with midpoint at approximately -670,860 E, -1,057,920 N and 206 masl (S-JTSK), which would have a Universal Transverse Mercator (UTM) (World Geodetic System (WGS)84) equivalent coordinate of approximately 531,840 E, 5543000 N and 250 masl.

Topography for the CMP was provided by GET using the DEM 5G model developed by the Land Survey Office in Prague. A map was provided by GET in MicroStation software format (.dgn file type) using the S-JTSK Bpv coordinate system, which included topographic contours extracted from the DEM 5G model to represent the site. After adjustment, the surface generated from the survey has total standard error of 0.18 m of height in the bare terrain and 0.3 m in forested terrain.

Tetra Tech transformed the topographic contours (i.e., DEM) provided by GET from S-JTSK into UTM; however, this transformation did include a modification to the relative elevation. It was observed that the drill collars have a relative difference in elevation of 44.25 m when projected using the S-JTSK system compared to the UTM system. It was decided to maintain spatial reference in the S-JTSK (Bpv) system for this project and geological model due to consistency with local surveying.

5.6 Environmental Studies and Liabilities

The area covered by the Chvaletice tailings has been significantly impacted by past mining and other heavy industrial activities. Czech law exempts land owners and developers from impacts prior to 1989, when communism ended in then Czechoslovakia. Mining activity at Chvaletice predates 1975.

Environmental baseline studies have been in progress since the summer of 2016. These include hydrological sampling and monitoring, as well fauna and flora surveys.

In September 2017, GET (author: Ing. Mario Petru) produced a report resulting from an environmental baseline study titled ‘Chvaletice – Trnávka Tailing Pond Project’ for the client, MANGAN Chvaletice, sro (Petru 2017). The purpose of GET's study was to document the characteristics of the CMP's location according to land registrars and land use plans for the municipalities of both Chvaletice and Trnávka. Environmental interests that are significant are included in the report, such as landscape ecological stability, protected areas and trees, landscape elements, and areas or sites with historical, cultural, archaeological or geological significance. Climate, air, water, soil, geological and natural resources, fauna, flora and ecosystems, landscape and population of the area are environmental characteristics outlined in the report. The baseline study provides an overall assessment of the environment in the area of interest, Chvaletice and Trnávka.

On March, 23, 2017, Tebodin Czech Republic, s.r.o. (author: Martin Vavron), provided a report, "Localization Services for Scoping Study (Czech Republic)" (Vavron 2017) for Euro Manganese Inc. that identified local requirements and permits required for the project. The study reports on the local operating and construction costs, such as reagent and logistic costs, operation consumables, duties and taxes, bulk construction material rates, labour surveys and the supply of electrical energy (tariff structure and quality) for the CMP. Local regulatory requirements discuss the permitting process and Czech environmental regulations, standards and best practices for an Environmental Monitoring and Management Plan (EMMP), including waste water, waste and tailings storage, air, noise and other environmental regulations. A time schedule for the process of an environmental impact assessment (EIA), environmental permits and building permits was provided, which suggests that permitting could take approximately 16 months from the time an Environmental Impact Assessment report and permit application is filed.

EMI has initiated pro-active and regular consultation with community stakeholders, which are expected to intensify as the CMP evaluation and planning advances. Mangan plans to open a Project Information Center in November 2017 in the Town of Chvaletice's Municipal Culture House to provide local residents with opportunities to learn about the Project and to provide feedback and suggestions to Mangan.

Due to the location of the CMP on the shore of the Labe River, there is potential for environmental sensitivities related to run-off and potential impacts to local groundwater. Currently, EMI has knowledge of impacted groundwater due to the historical industrial activity in the area and is being monitored by groundwater wells. Adequate baseline environmental data collection and planning will be required to ensure the effects to the receiving environment of a disturbed project site would be minimized. This baseline work has been initiated, as discussed above, and is ongoing.

6.0 HISTORY

Historically, from 1915 to 1945, several small underground mining operations near Chvaletice produced manganese raw ore and concentrates that were principally shipped to German steel mills. Thereafter, from 1951 to 1975, open pit mining and milling operations occurred for the recovery of pyrite to produce sulphuric acid for the chemical plants in nearby Pardubice which produced the three adjacent tailings deposits.

The following recount was extracted from the Bateria Slany report compiled for the property in 1989. References to Mineral Resources, Reserves or “ore” in this section are historical, have not been directly verified by the CP and cannot be relied upon.

6.1 Mining of Iron Ores

The first mention of iron mining at Chvaletice dates to the year 677. The medieval production of iron in the surrounding area can be linked to the origin of the name of Železné hory (Iron Mountains), whose northwest tip includes the Chvaletice mining district. Mining took place intermittently until the early 17th century. Mining ceased after the Thirty Years' War (1618 to 1648) and resumed at the end of the 18th century.

In the mid-19th century the Česká Montánní Společnost (Böhmische Montangesellschaft) came into the region and was the leading manufacturer of pig iron, the owner of a foundry and rolling mill and the iron mines in the Czech Lands. Zones of iron and manganese deposits at Chvaletice were found to extend over a length of about 12 km, and were relatively well explored. In 1885, mining produced about 400 t of oxide from iron cap containing 20% each of iron and manganese.

6.2 Mining of Manganese Mineralization

Mining was managed by the Pražská železářská společnost (Prager Eisenindustrie-Gesellschaft), which in 1909 took over the mines. Systematic extraction of metal at Chvaletice began in 1915. After mining out the minor gossan occurrences, mining focused on the West side of Chvaletice, where the No. IX underground mine was built. The annual production of manganese ranged between 10,000 and 50,000 t. After World War II, the Pražská železářská společnost was nationalized, and on January 1, 1946, was incorporated into the state enterprise Středočeské uhelné a železnorudné doly (Central Bohemian Coal and Iron Ore Mines). Small-scale, intermittent surface mining of manganese mineralization continued in Chvaletice until 1952.

6.3 Mining of Pyrite 1951-1975

From 1951 onwards, pyrite mined by open pit methods at Chvaletice became the basic raw material for the production of sulphuric acid. Pyrite in Czechoslovakia had been imported mainly from Rio Tinto in Spain and Boliden in Sweden, and from Yugoslavia after the war. After the Communist putsch in February 1948, the shipments of pyrite iron raw material from Western European countries stopped. Since heavy chemical industry and other downstream industries would be jeopardized, alternative sources were then obtained from pyrite shales from the Chvaletice deposit. In 1949, the No. IX mine was re-organized into a separate national enterprise called Manganorudné a Kyzové Závody Chvaletice (Manganese and Pyrite Enterprise (MKZ)). In the following year, a new processing plant and housing for employees was built. Its operation was officially launched on the occasion of the anniversary of the so-called Victorious February on 25. 2. 1951. Exploration work showed that the processing plant was inappropriately located and obstructed the mining of part of the deposit. The concept of underground mining was abandoned and the mining method changed to open pit mining.

In the years 1958 to 1960 the Czechoslovak chemical industry began to phase-out Chvaletice pyrite for the production of sulphuric acid, preferring imported sulphur from Poland. The economic production of manganese ore could never be achieved, given the low grade of the open pit ore and the metallurgical challenges of producing a concentrate.

In 1975, the production of pyrite concentrate was terminated. The Manganorudné a kyzové závody changed its name to Energostroj and started manufacturing machinery and equipment for the power industry.

During the entire period 1951 to 1975 the open pit reached 2 km long, 700 m wide, and 150 m deep. Over 32 Mt of pyrite was mined and this produced 7,467,000 tonnes of concentrate containing 38.3% of sulphur.

The mining lease for Chvaletice was canceled in 1981. The primary deposit is still recorded as having 108,805 kt potentially economic "Reserves" (according to the current Czech classification) containing 12.86% of total manganese. The residual "Mineral Resource" of pyrite, estimated to be 39,573 kt, with an average of 12.99% sulphur, is not kept in the State's balance sheet.

Photo 6-1: Photo of Original Chvaletice Iron and Manganese Mine, circa 1978

Photo 6-2: Photo of Original Chvaletice Iron and Manganese Mine, circa 1974

6.4 Elektrárna Chvaletice (Power Station)

After the closure of the mine, the plant site was used for the construction of a power plant. The site was chosen so that the minimum of agricultural land was used and it was possible to store fly ash in the mined-out pit area. The construction of the power plant was carried out in the years 1973 to 1979. The power plant provided employment opportunities not only for the former employees of the MKZ, but also expanded the population and 172 housing units were built. The waste heat from the power plant continues to be supplied as steam to Chvaletice, Trnávka and the adjacent industrial areas.

To supply the power plant with thermal coal, the river Labe from Mělník was made navigable and the Chvaletice port was built. Regular shipping of approximately 3.5 million tonnes of coal from mines in northern Czech Republic took place from 1977 until 1996, when it was completely transferred to rail.

Chvaletice power station has four generating units with a total installed capacity of 820 MW. The power station stack reaches a height of 303 m, and its cooling towers are approximately 120 m high.

Photo 6-3: Current Power Plant

Note: The CMP tailings are to the left in the photo and the historical open pit mine is behind the plant (looking southeast).

6.5 Use of Tailings Ponds as a Source of Manganese

The flotation waste was deposited into Cell 1 until 1961, then between 1962 and 1970 into Cell 2, and from 1971 until 1975 into Cell 3. The cessation of the production of pyrite concentrate occurred in 1975.

The waste tailings slurry suspension was placed into the ponds so that the coarser tailings accumulated on the edge, the fine sludge accumulated in the central part of the pond, and water was pumped back into the process plant. The tailings pond has a volume of over 16 Mm^3 registered with the State as potentially economic “Reserves“ “Chvaletice – tailing ponds No. 1,2“ and “Řečany – tailing pond No. 3” with estimated Mineral Resources of 29,996 kt (note: current estimates by Tetra Tech, as documented in Section 14, indicate the volume of tailings exceeds 17 Mm^3).

A geological evaluation and technological investigation of the three tailings ponds took place in the years 1985 to 1989 to confirm that the raw materials were available for the manufacture of EMD. The client was the former state-owned manufacturer of batteries, Bateria Slany. An extensive evaluation of the tailings material conducted between April 1986 and July 1988 resulted from their investigation including a “reserve calculation”. Raw data has not been sourced by EMI; however, reporting has been recovered and translated into English for reference. The work was stopped due to the collapse of the communist regime in 1989.

In September 2014, the Ministry of the Environment issued an exploration license over the area, following a public tender, which entitles the holder to carry out further exploration and to possess the mineral rights. The rights to the territory called Trnávka was obtained by GET who then they transferred the rights to Mangan in 2015.

6.6 Construction of Tailings Facility

Construction of the tailings facilities is believed to have commenced in 1950. Cell 1 was the first facility to have been constructed. Historical documentation has indicated that the cell's foundation is built from local native soils, which were also excavated and compacted to form the original perimeter starter dam. The dimensions of the starter dam are reported to have a trapezoidal cross-section being approximately 20 m wide at the base, 5 m wide at the top surface, and with overall height of approximately 3 m. This approach is assumed to be the same for construction of Cells 2 and 3. It is also assumed that the dam raises were constructed in an upstream direction using dried and compacted tailings material. Four drillholes were completed by EMI in the summer of 2017 to test for these historical structures but were not successful in intersecting them.

Perforated decantation towers (approximately 30 m high), (Photo 6–4) were constructed to channel water into a pit at the tailing pond's edge following the sedimentation of the tailings. The tailings were put in place hydraulically. Pipes or gutters transported tailings along the tailing pond perimeter to fill one-half of the pond while the other half dried. Dam lifts were built by bulldozers that scraped dewatered material away from the center of the tailing cells to the edge, after a pond was filled to the brim with tailings.

Photo 6-4: Historical Decantation Tower Located on Cell 3, Near Drill Holes T3-310, 311 and-318

The elevation of the Labe River and the base of the tailing ponds are similar, around 202 masl (Bpv datum). The perimeter of Cell 1 (26.6 m depth by 500 m by 500 m) and Cell 2 (28.7 m depth by 700 m by 550 m) are irregularly shaped polygons and measurements are approximate. Waste crusher fines from a granite aggregate quarry located near Chvaletice was used to cap, stabilize and reclaim the surfaces of Cell 1 (averaging 1.32 m depth with topsoil) and Cell 2 (averaging 1.23 m depth with topsoil). Cells 1 and 2 are mostly vegetated with grasses, and their embankments were planted with trees and grasses.

Construction of Cell 3 did not reach full capacity and reclamation was not fully completed; however, stands of young birch and aspen trees are most prevalent on Cell 3. This cell abuts the northern toe of Cell 1 and is covered with approximately 0.2 m of overburden material. An exception is in the southern area of Cell 3 where there is some old municipal waste and partial backfills of tailings from iron and manganese mineral extraction in Chvaletice.

Confirmation and evaluation of the location and size of these historical starter dams are recommended for future drilling campaigns.

6.7 History in Dates

Table 6-1 sets a chronological order of events related to mineral resource extraction near the Chvaletice region.

Table 6-1: Chronology of Mineral Resource Extraction in the Chvaletice Region

Year	Activity
est. 677	▪ According to the legend in the Hájek Chronicle dated 1541, iron was discovered at Chvaletice in 677
1143	▪ The founding of the Sedlec Monastery, which includes the village of Telčice (a part of today's Chvaletice) in addition to other possessions
1393	▪ The first written mention of the fortress Chvaletice
1845	▪ Start of the railway Prague - Pardubice
1858	▪ The Mining Court in Kutná Hora vested to Count Kinsky a mine area at Chvaletice consisting of four mineral claims
1886	▪ Česká montánní společnost (Böhmische Montangesellschaft = Bohemian Mining Company) asks for the conferring of the mining areas Karel (Charles) and Nadeje (Hope)
1909	▪ Pražská železářská společnost (Prager Eisenindustrie-Gesellschaft = Prague Iron Company) takes over the mines in Chvaletice mining district
1915	▪ Ferro manganese mining by Pražská železářská společnost until 1945
1946	▪ Pražská železářská společnost was nationalized and incorporated into n. p. Středočeské uhelné a železnorudné doly (Central Bohemian Coal and Iron Ore Mines)
1949	▪ Founded n. p. Manganorudné a kyzové závody Chvaletice (MKZ, Manganese and Pyrite Enterprise)
1951	▪ The ceremonial opening of the secondary mining school – because underground mining actually never started, the school never served its purpose, and today is a secondary school of agriculture
1951	▪ The new MKZ pyrite mining and processing plant started
1952	▪ Manganese mining was discontinued
1973	▪ The new Power Plant Chvaletice construction began
1975	▪ Pyrite mining ended and the reorganization of the MKZ to Energostroj Chvaletice

Year	Activity
1977	▪ Start of transport of thermal coal on the Elbe water way
1977	▪ Start of trial operations at Chvaletice power plant
1979	▪ Full operations at Chvaletice power plant
1981	▪ Chvaletice obtained Town status
1981	▪ Chvaletice mining lease expired
1989	▪ The end of three years of studies by Bateria Slany
1996	▪ All transport of coal to the power plant was switched to rail
2013	▪ The state controlled power company CEZ sells Chvaletice power plant to Severní Energetická Společnost for 4.12 billion crowns
2014	▪ GET granted the exploration license Trnávka for the exploration survey of manganese deposit in the tailing ponds Nos. 1 to 3
2015	▪ License transferred to Mangan
2015	▪ EMI initiates preliminary studies of the CMP, whose goal is to recycle the Chvaletice tailings to produce EMM.
2016	▪ EMI acquires Mangan

7.0 GEOLOGICAL SETTING AND MINERALIZATION

The following discussion is included for context of the geological setting of the original bedrock material that was mined and processed to form the tailings material that is the subject of this report. Due to grinding and flotation processes, none of the original textures that would have characterized the in situ rocks will have been preserved in the tailings material.

Mineralogy, specific to the tailings material, is discussed in Section 7.2.

7.1 Regional Geology

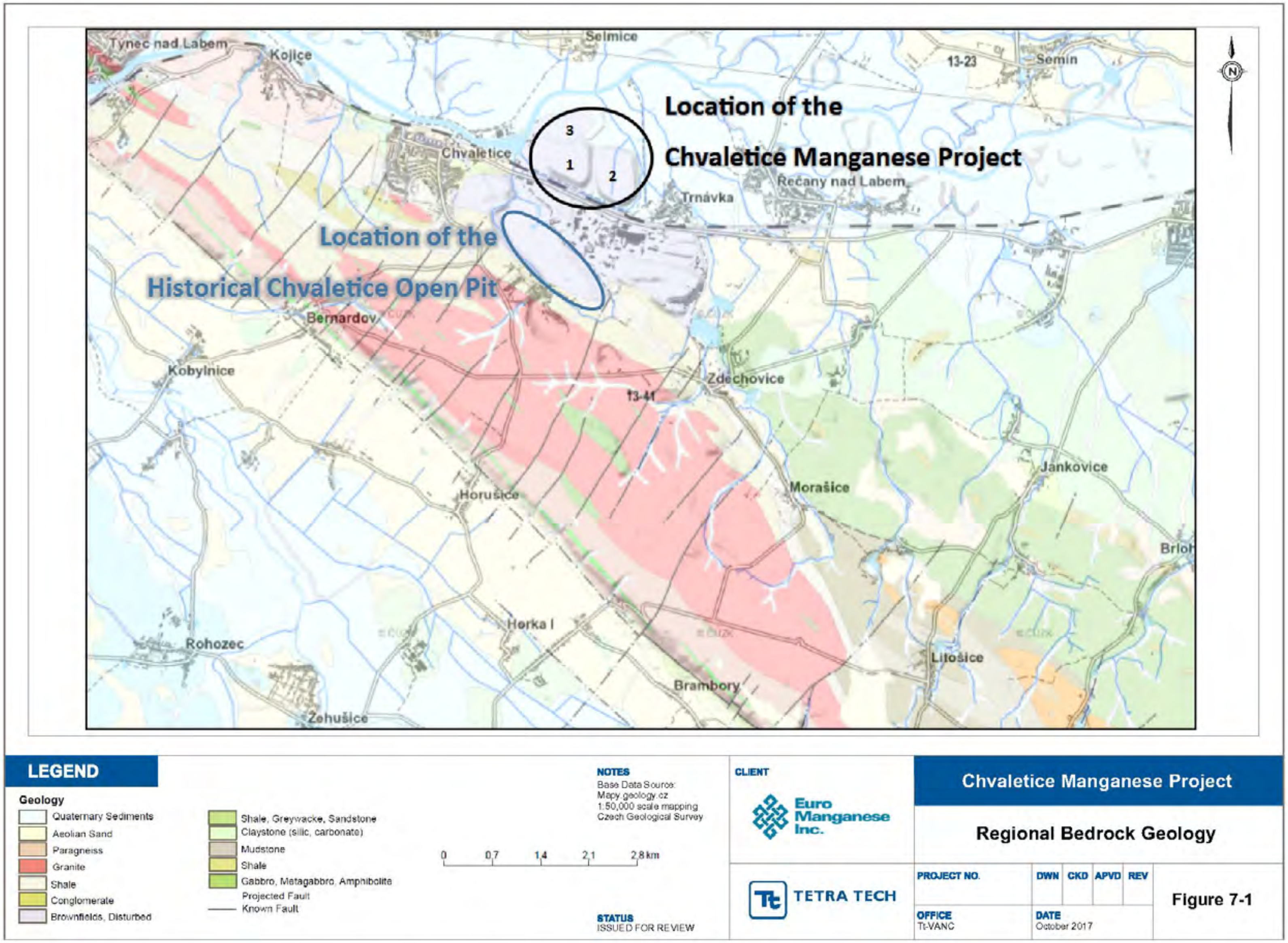
The original Chvaletice bedrock deposit is situated to the south of the CMP by approximately 1 km. Fly ash and other waste products have been used to backfill the original open pit which covers the majority of exposed bedrock. Here, the bedrock is Proterozoic in age and is comprised of deformed granitic crystalline and overlain meta-sedimentary rocks of the Bohemian Massif, in the marginal area of the Central Bohemian Region.

In the Proterozoic, basement rocks were overlain by the seafloor turbidite sequence off from the continent of Gondwana. Here, the thick layers of fine sediments were deposited in deeper areas of the sea, periodically redeposited by huge subaquatic slumps. At the same time, subaquatic volcanic activity was taking place, associated with extrusions of lavas and assent of hot geothermal fluids. These fluids enriched the host rocks with sulphur, iron and manganese.

At the end of the Proterozoic, rearrangement of lithospheric plates resulted from the Cadomian Orogeny, with related deformation and development of deep tectonic fracture zones. Magma and hydrothermal fluid ascent through fractures thermally affected the ambient rock domains forming weak to moderately metamorphosed phyllitic shales and greywackes. Intense folding and faulting of the sediments was developed during the orogeny as shown in the historical cross section schematic in Figure 7-1. The meta-sedimentary rocks were cut by dykes and sills which are preserved along the northeastern slopes of Zelezne Hory (Iron Mountains) between Týnec nad Labem Chvaletice and Zdechovice. Locally, a lens-shaped body locally called the Chvaletice Massif is composed of this Proterozoic granite and underlies the area south of Chvaletice and Zdechovice. The granite contains brittle deformation zones, altered to a variable degree. The rock is extracted in two quarries and is utilized as aggregate.

Other pyritic and manganiferous mineralized bodies are aligned along a trend that extends from the western edge of the municipality of Chvaletice to the nearby village of Sovolusky forming a 12 km long belt. In the western part, it creates a synclinorium, while towards the east it has developed into irregular zones that are intruded with porphyries. The maximum thickness of the pyritic schist in the western part is about 90 m, while the minimum is approximately 30 m, thereby with an overall average of thickness of some 60 m.

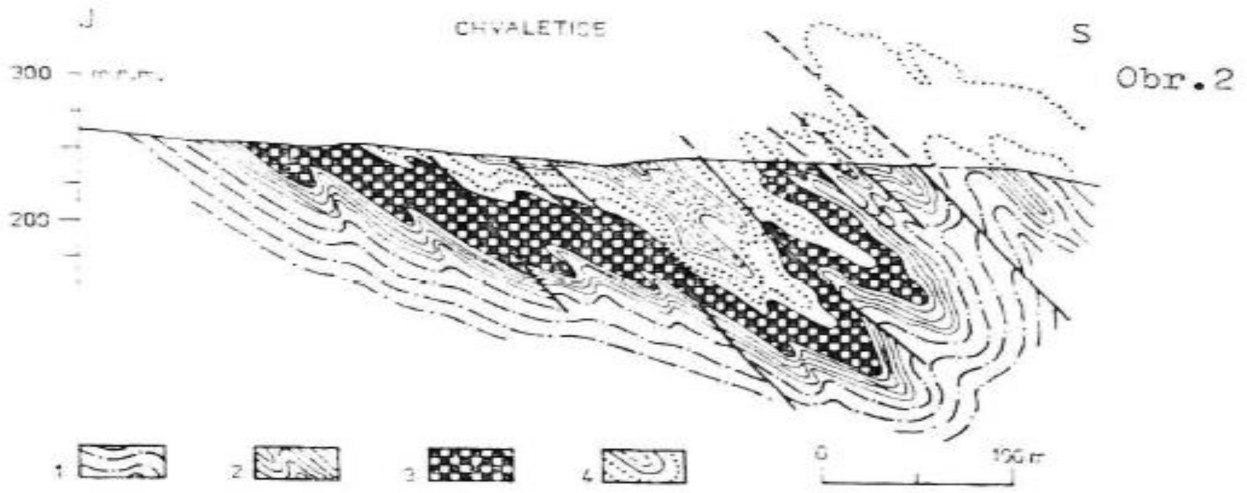
Figure 7-1: Regional Bedrock Geology



The syngenetic Chvaletice deposit of pyrite-manganese mineralization is hosted by the intensely southwesterly directed folded and moderately metamorphosed Neoproterozoic sediments located to the north of the southeasterly trending contact with granite. To the northeast, the sediments are overlain by younger Palaeozoic and Cretaceous strata.

Terrestrial fresh-water to marine claystones, siltstones, sandstones, and conglomerates of the Upper Cretaceous immediately underlie the CMP tailings deposits.

Figure 7-2: A Simplified Schematic of the Geological Section of Pyrite-Manganese Ores in Chvaletice



136. Schematický řez ložiskem pyrito-manganových rud Chvaletice (upraveno podle M. Mikuše 1960)
1 — podložní břidlice; 2 — podložní kyzové břidlice; 3 — pyrito-manganová ruda; 4 — nadložní kyzové břidlice a sericitické břidlice

Notes: The 1) underlying schist; 2) underlying pyrite schist; 3) pyrite-manganese "ore" (black hatch pattern); and 4) overlying pyrite schist and sericite schist.

Source: Mikuš (1960)

7.2 Local Geology

The Chvaletice bedrock deposits of iron and manganese mineralization constitutes one horizon in the meta-sedimentary stratigraphy with variable mineralogy laterally from west to east with variable proportions of carbonate and silicate minerals. Through mineral processing during historical mining operations, these minerals have been reduced in size and partially blended by grinding and flotation processes.

Through depositionary processes, these mineral particles were distributed throughout the tailings facilities by sedimentation from suspension in a tailings slurry. Thin beds of sediment will have been deposited laterally with a gradation from coarse to fine particles away from the point of deposition. It is then interpreted that grain size and moisture content may have more similarity with materials in a vertical sense and have more variability in a lateral sense. Whereas, mineral and grade distribution, being related more to the process rather than deposition, is interpreted to have more similarity with materials in a lateral sense and less direct similarity with materials in a vertical sense.

XRD and SEM-EDS analyses was completed by Met-Solve on behalf of EMI in 2016 using the samples collected from test pits in 2015. The analysis identified the main manganese bearing minerals were rhodochrosite ($MnCO_3$), and kutnohorite ($Ca(Mn^{2+}, Mg, Fe^{2+})(CO_3)_2$) which forms a series with dolomite and ankerite. These were classified as the principle Mn-carbonate minerals. Additionally, the presence of trace quantities of Mn-silicates such as sursassite (a manganese bearing sorosilicate), and oxides such as pyrolusite (a manganese dioxide (MnO2) and kurchatovite (calcium-magneseum-manganese-iron borate (Ca(Mg,Mn,Fe2+)B2O5) were identified. Pyrite was noted to be the primary form of sulphide mineral, with concentrations in the samples between 5-9%. Gangue mineralogy consists of primarily quartz with moderate amounts of plagioclase, feldspars, micas, and apatite. Low concentrations (less than 5%) of kaolinite clay mineral was identified

From recent whole rock lithogeochemical analysis conducted on the 2017 drilling samples, total sulphur concentration in the tailings averages approximately 3.1% which is sourced form sulphide, sulphate and organic origin. Total carbon concentrations averages approximately 3.4%, which includes contributions from graphite, organic and carbonate origins.

8.0 DEPOSIT TYPES

On the world scale, the most important manganese minerals are oxides, including pyrolusite, a manganese (IV) oxide (MnO_2). Other economically important manganese ores usually show a close relationship to the iron ores. Land-based resources are large but irregularly distributed. About 80% of the known world manganese resources are in South Africa, with other important manganese deposits found in Ukraine, Australia, India, China, Gabon and Brazil. Deposits in China are known to be numerous, with low manganese content, but generally are relatively small.

On a purely descriptive basis, manganese ores can be classed as sediment-hosted, volcanic-hosted, or karst-hosted. Chemical distinctions among these types include:

- much higher silicon dioxide (SiO_2) in volcanic rock-hosted deposits, which likely reflects a more oceanic setting with important contributions from pelagic radiolaria and diatoms
- higher phosphorus pentoxide (P_2O_5) in sediment-hosted deposits, which may be related to upwelling
- strong enrichment of barium (Ba) and lead in karstic deposits, enabled by the open tunnels in the structure of cryptomelane-group minerals.

The mineralization found in tailings at the CMP deposited by manmade processes following grinding and flotation processes of black pyritic shale and is therefore not characteristic of a traditional manganese deposit. The material can be physically characterized as a compacted soil, with varying degrees of particle sizes from clay to coarse sand.

There is sorting of the flotation waste by grain size and weight, resulting from the sedimentation from the edge to the center of the tailing pond (based on other tailing pond borehole sludge studies (Novotny et al. 1972). Subsequently, three zones of grain sizes in the tailing pond can result with:

- an outer zone of fine-grained sand and silty sand
- a central zone of alternating sandy laminae with the outer and inner zone types, and
- an inner zone comprised of silt to slightly clayey silt (finest material of all zones).

This typical zoning results from an aquatic environment in the inner zone, fluctuation of water level during sluicing operations within the central zone, and a gentle slope (1.5%) with no water during slicing at the outer zone (Bateria Slany, Chapter 2, 1989).

9.0 EXPLORATION

EMI has been conducting exploration and investigation on the Property since 2014, during which time multiple investigations have been conducted to sample and characterize the chemical and physical subsurface conditions of the tailings materials and surrounding ground. A summary of exploration work by year is included in the following subsections, and as shown in Figure 13-1.

9.1 Hand Auger Sampling, 2014

Four shallow (2.0 to 2.5 m) hand auger drillings were collected for assay and grain size test work from the periphery of the tailings deposits on November 7, 2014. The samples were identified as T1 to T4.

Results of the program indicated that total and soluble manganese assay results were comparable to those results reported historically by Bateria Slany (1989), but the sampling was considered to be indicative and not representative of the entire deposit with respect to grade and particle size distribution (AMEC, 2016).

9.2 Test Pit Sampling, 2015

In 2015, two test pitting programs were conducted using an excavator to collect samples at greater depth, and with more volume than the previous hand auger program. Four pits, identified as T5 to T8, were dug down between 1.8 and 3.1 m deep at the periphery of the cells on November 11, 2015, and three additional pits, identified as T9 to T11, were dug to between 2.5 and 3.8 m deep at the center of each of the cells on December 14, 2015.

Again, results of the program indicated that total and soluble manganese assay results were comparable to those results reported historically by Bateria Slany (1989). With deeper sampling, the small particle size of the tailings in the center of the tailings was identified to be a potential issue for dewatering and further work was recommend (AMEC 2016).

9.3 AMEC Foster Wheeler Scoping Study, 2016

With results from the 2014 and 2015 sampling programs, a process evaluation report was completed by AMEC in September 2016, which considered a potential flowsheet for processing of the tailings with production of high purity, selenium-free EMM. The results of the study were positive and were used to develop a strength-weakness-opportunities-threats (SWOT) analysis. A list of detailed recommendations were presented for further material characterization and metallurgical test work to de-risk and refine the processing flowsheet.

9.4 Seismic and Resistivity Geophysical Survey, 2017

In July of 2017, EMI commissioned a geophysical survey over the tailings. A total of 6.6 km lines of high-resolution electric resistivity tomography (ERT) and seismic refraction was conducted by GImpuls Praha spol. s.r.o.

The purpose of the survey was to enhance the geological knowledge of the area with response from sub-horizontal geological components underlying the surface and to evaluate structures down to a maximum depth of the first tens of metres.

Initial results from ERT measurements show mostly very low resistivity with a maximum of 10 Ωm. According to typical geological ERT results, this may indicate the presence of electrically conductive clay in the rocks (in this case, sandstones with conductive glauconite).

Alternatively, or additionally, the lower measured resistivity values can be attributed to a massive presence of groundwater in the rocks, which, combined with the presence of the chemical infusions from the tailings, could cause low resistivity values. This theory is supported by the results of the seismic refraction that detected bedrock at depths of roughly 5 to 10 m with velocities of approximately 2,000 to 3,000 m/s.

Figure 9-1: Plan Map of Geophysical Survey Lines and Measurement Stations

9.5 Bulk Sample, 2017

A highly-representative bulk sample weighing approximately fifteen tonnes was collected using a Sonic drill rig from tailings materials during the 2017 drilling investigation. The material was the 75% split of the core samples collected, as discussed in Section 11. The samples were packed individually in plastic sample bags and steel barrels, and shipped via rail to the CRIMM laboratory in China. Further description of the bulk sample analyses is discussed in Section 13.

10.0 DRILLING

The 2017 drilling and sampling program was carried out between June 12, 2017 and July 19, 2017 utilizing advanced sonic rig technology provided by Eijkelkamp SonicSampDrill B.V. and crews from Giesbeek, the Netherlands (Photo 10-1). The program was supervised in the field by Chris Baldys, P.Geo. (BC), a non-independent CP at the time of the investigation.

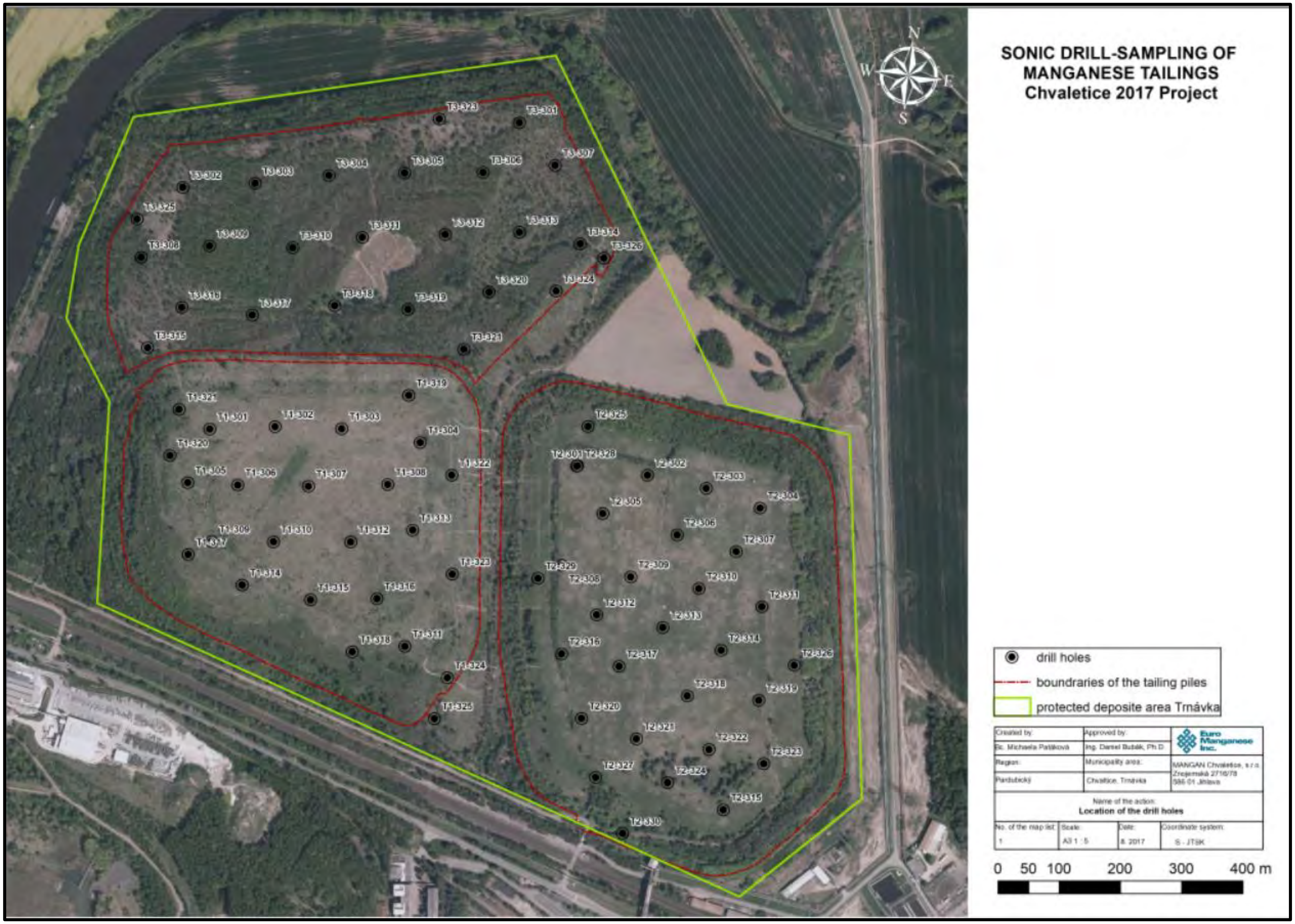
A total of 1,679.3 m was drilled in 80 holes, using 100 mm diameter size rods and sonic core barrel advance (Figure 10-1). Twenty-five holes totaling 629 m were completed on Cell 1, 30 holes totaling 755.3 m were completed on Cell 2 and 25 holes totaling 295 m was completed on Cell 3. All holes were drilled vertically; no downhole surveying was completed. Figure 10-1 shows the drill hole layout. Drill holes were spaced evenly at approximately 100 m centers throughout the upper bench of each cell, encompassing a combined area of 1.2 km x 1.2 km (Figure 10-1).

Coring progressed using 2 m core runs. No casing was installed and drill rods were pulled for each core run. Minor caving and pooling of water is assumed to have occurred on re-entry; however, this material accumulated in the hollow core rods above the core barrel and is believed to have had minimal effect on the integrity of the recovered sample. This material was dumped on surface adjacent the borehole and has been collected by Mangan for future evaluation if required.

Access to the embankment slopes around the perimeter of the tailings was limited due to safety and not included in this investigation. To verify the composition of the embankments, four additional drill holes (DrillholesT1-324, T1-325, T2-330 and T3-326) were collared on access ramps. Each hole intersected a layer of topsoil with average thickness of approximately 1 m, manganese bearing tailings material, and terminated in native basal soils at an elevation consistent with surrounding drillholes. Based on these drill results, the presence of manganiferous tailings material was confirmed within the perimeter embankment, and based on the elevation of the basal soil contact, the historical starter dyke was not identified at these locations.

Photo 10-1: Showing Eiikelamp SonicSampDrill B.V. and Drill Crew

Figure 10-1: Plan View of Drill Collar Layout, 80 Holes Totaling 1,679.3 m at Chvaletice Manganese Project



11.0 SAMPLE PREPARATION, ANALYSES AND SECURITY

The sample preparation and analysis program described in this section was developed by EMI for the 2017 drilling campaign, with input from Tetra Tech, and implemented in the field by technical personnel employed by EMI. The program was designed to evaluate chemical and physical characteristics of the tailings material for the purposes of mineralogy; Mineral Resource estimation; and hydrogeological, geotechnical, metallurgical, and process engineering.

Samples were analyzed and tested for manganese and elemental assay, lithogeo chemistry, particle size distribution, mass, moisture content, paste pH and EC and specific gravity. Wet and dry in situ bulk density was calculated based on core recovery measured in the field, along with the sample mass and moisture data measured at the lab.

The program is summarized in the following bullet points and details of the analysis are included in the subsequent sections.

- 755 core samples were recovered and recorded for analyses and material characterization.
- 108 control samples were generated internally by EMI to monitor commercial lab performances.
- 21 laboratory duplicates were generated by the primary lab (SGS) for review and analysis.
- Sample wet mass, recovery, moisture, magnetic susceptibility and geological data were logged at the drill sites by a qualified team of geologists.
- Photographs of each core sample were taken for additional reference.
- Shipment to analytical labs was done in accordance with chain of custody.
- Analysis for multi-element assay with aqua regia and four acid digestion (inductively coupled plasma (ICP) and AAS) and fusion-XRF.
- Particle size distribution test work with laser diffraction, and sieve/hydrometer.
- Wet and dry mass, and moisture measurements were collected in field and lab (used for bulk density calculation).
- Specific gravity by pycnometer measured in the laboratory.

The primary lab selected for sample analysis was SGS with facilities in Lakefield, Canada, and Bor, Serbia. The lab, formerly Société Générale de Surveillance, is a multinational company headquartered in Geneva, Switzerland which provides inspection, verification, testing and certification services.

Comparative particle size analysis by sieve and hydrometer methods was completed at GeoTest located in Brno, Czech Republic.

The analytical program is summarized in Figure 11-1, which shows the sample handling and analysis flowsheet. Photos 11-1 and 11-2 show core recovered from holes T1-318 and T-312 representing unsaturated materials near the edge of the deposits and saturated materials near the core of the tailings deposits, respectively.

Photo 11-1: Core Photos from Drill Hole T1-318, from Depths 1-2 m, 19-20 m and 24-25 m

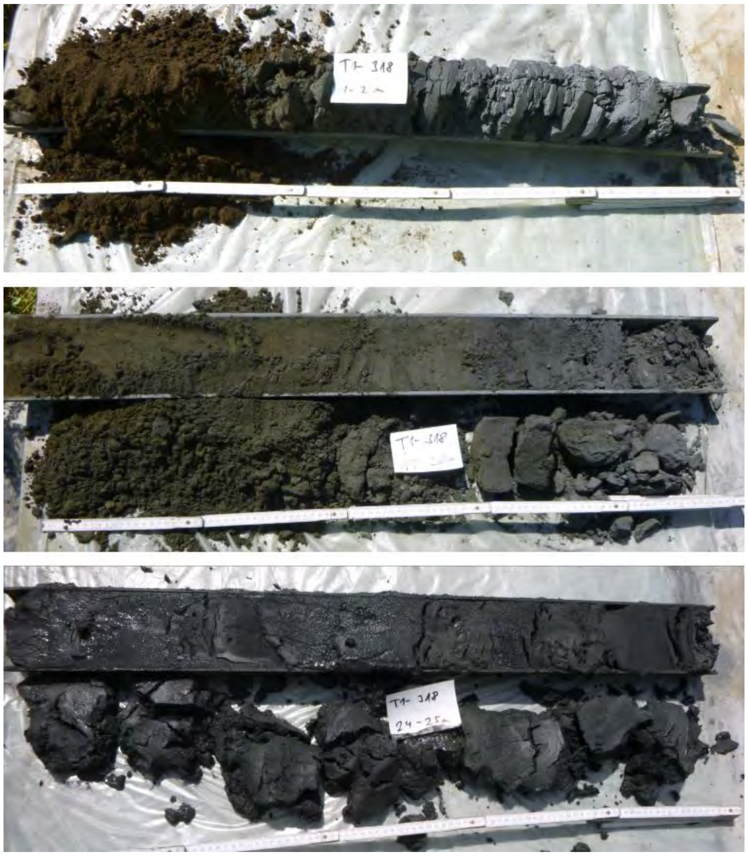


Photo 11-2: Core Photos from Drill Hole T1-312, from Depths 3-4 m, 9-10 m and 23-25 m

11.1 Sample Collection

Cores samples were collected continuously from the lower topsoil contact to the base of the tailings material at the subsoil contact. Sampling included only tailings material and excluded the upper topsoil and lower subsoil materials. A total of 755 samples with a combined wet weight of 23,521 kg were collected, representing 1,497.8 m of cross stratigraphy tailings material.

The drilling was advanced on 2 m core runs. The core was extracted from the core tube in 1 m intervals into half cylinder core trays. These sub-samples were logged geologically and field measurements were collected. Field measurements included sample wet mass, recovery, moisture and magnetic susceptibility. Core logs and field measurements were recorded on-site and later merged into a digital database.

Core recovery was measured on one metre sub-samples and ranged from 45 to 110%. Some loss of material was encountered during flushing of drill pipes and likewise some elongation of core resulted due to plasticity if the material at certain locations in the deposit.

Each one metre sub-sample was then quarter split (25:75) using a cutter along the length of the core axis (Photo 11-3) to preserve the in situ material distribution; the samples were not homogenized in the field. The 25% split was bagged and recombined with the corresponding quarter split from the other remaining one metre core run sub-sample. The 75% split was also bagged and recombined with the corresponding 75% core run sub-sample. Identification tags were included with each sample before the bags were sealed.

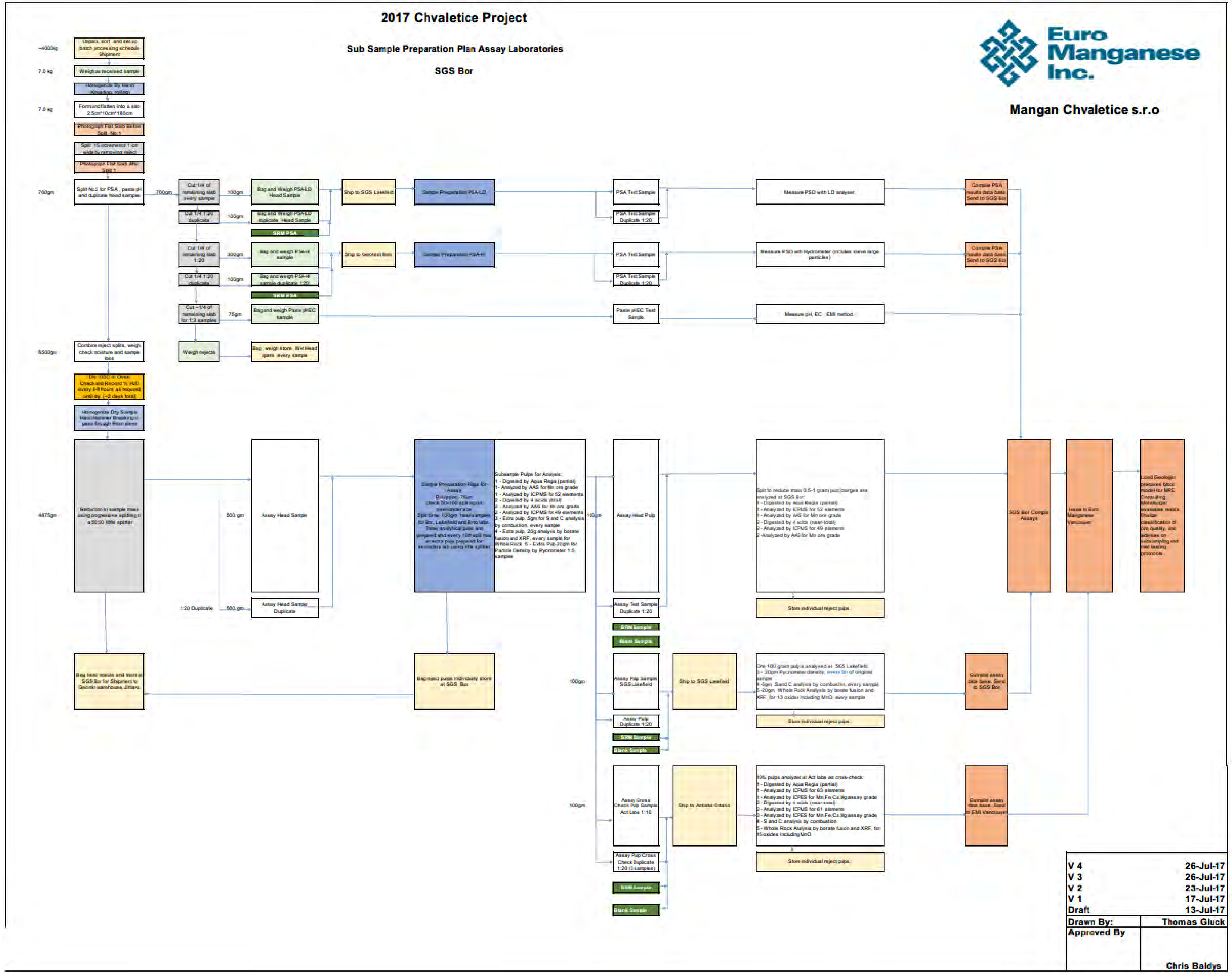
Photo 11-3: Sample Collection

Notes: a) 1 m core run sub-sample, b) and c) half and quarter splitting or core in field, d) sealed sample bags (bulk samples)

The 25% split samples were assembled for assay and particle size analysis ("assay samples"). The samples were delivered to SGS located in Bor, Serbia, in two shipments, then divided into 19 analytical batches at the lab (7 and 12 batches per shipment respectively). The samples remained in custody of EMI personnel until being delivered by a commercial logistic company to SGS.

The 75% split samples were collected for the purposes of a bulk sample and advanced metallurgical testwork ("metallurgical samples"). These samples were collected at a field warehouse which is managed by Geomin in Jihlava, inventoried, placed into 54 sealed steel drums strapped to pallets which loaded into a 40 ft. shipping container at the shipping warehouse in Hamburg.

Figure 11-1: Subsampling and Analysis Flowsheet Developed by EMI for 2017 Drill Investigation



11.2 Laboratory Preparation and Sample Splitting

Assay samples received at SGS Bor were weighed (wet) and homogenized by hand using the “Japanese slab cake method” of kneading and rolling the sample. The homogenized sample was rolled out into a slab approximately 10 cm by 180 cm and 2.5 cm thick, as shown in Photo 11-4.

Photo 11-4: Example of Sample Splitting by the Wet Japanese Slab Cake Homogenization Method

A first split was achieved by forming fifteen smaller slabs from the original sample volume by cutting and removing the reject from around the perimeter of the slabs.

A quarter of each of the small slabs was cut from one to make about 100 g of head sample. This split was not dried and was sent for laser diffraction particle size analysis (PSA-LD) at SGS in Lakefield, Canada. 1:20 duplicates were sent to Geotest Brno for comparative hydrometer particle-size analysis (PSA-H). Approximately 75 g of materials as extracted for pH and electrical conductivity (EC) measurement using a paste pH method.

The remaining slab material was dried at 105°C and homogenized using standard lab methods.

The wet cut method was selected to preserve the in situ state of the particles for PSA-LD. The total mass of material extracted from the PSA-LD, PSA-H, paste pH and electrical conductivity (EC) splits was approximately 500 g.

Duplicate splits which are master head assay duplicates were again taken 1:20 for heterogeneity/sampling error monitoring. These are identified as “lab duplicates” in the QA/QC assessment in Section 11.9.3.

All reject materials from the PSA splits were recombined, weighed and dried. Moisture content of the sample was determined from the moisture loss measured at this stage of preparation. The sample was again homogenized and approximately 1 kg of material was extracted for assaying. These samples were pulverized to -75 µm.

The remaining head rejects were bagged, inventoried and shipped for storage at the Geomin field warehouse in Jihlava.

11.3 Assay

A total of 863 assay samples, of approximately one kilogram each (except for 50g certified reference standards), were delivered to SGS in Bor, Serbia, for assay. The samples were submitted for the analyses listed in Table 11-1. The assay methods were selected to measure total elemental concentration in addition to measuring partial digestion concentrations of manganese as a proxy for “soluble manganese”. Total manganese refers to the results of the four acid digestion methods, and soluble manganese refers to the results of the aqua regia digestion.

A tailings material samples exceeding 10,000 ppm manganese, which is the upper detection limit of the inductively coupled plasma-mass spectrometry (ICP-MS) equipment and were submitted for ore grade analysis.

Table 11-1: Tabulated Description of Analytical Methods used for Assay of Tailings Sample

Digestion	Finish	SGS Method	Description
Aqua Regia	ICP-MS, AAS	IMS14B, AAS15Q	52 elements, analysis for “soluble” manganese
Four acid	ICP-MS, AAS	IMS40B, AAS42S	49 elements, analysis for “total” manganese
Borate fusion	XRF	GO_XRF76V	Total digestion lithogeochemistry
Combustion	LECO or SC632	GE_CSA06V	Inorganic carbon and sulphur assay

11.4 Particle Size Analysis

Particle size distribution throughout the deposit varies significantly due to the processed nature of tailings slurry material and the dynamics during deposition and particle settlement. Grain size may significantly influence the engineering process that is developed for the CMP. As regrinding of the tailings is not envisaged, understanding of particle size distribution is considered a critical variable for the deposit.

The primary method for particle size distribution analysis was by laser diffraction technology (PSA-LD) in a Malvern Mastersizer located at SGS in Lakefield, Canada (SGS method ME-LR-MIN-MET-SC-A03) using wet material. This equipment is able to analyze particle sizes from 0.02 to 2,000 µm, which is ideal for very fine materials such as silt and clays. A total of 830 PSA-LD results were received, which included 720 primary tailings samples. An additional 76 sample duplicates were submitted by EMI, 5 sample duplicates prepared internally by SGS, and 31 internal QC standards.

Particle size distribution analysis was also conducted through sieve and hydrometer methods, using the European standard International Organization for Standardization (ISO) TS 17892-4, at GeoTest located in Brno, Czech Republic. The method includes passing dried material through standard screens, with the smallest screen size at

0.063 mm. Fractions passing this screen are classified as silt and clay and subjected to hydrometer testing. A total of 93 samples were submitted for hydrometer tests.

Grain sizing used for the CMP incorporates both North American standard ASTM D-422 and the European standard ISO14688-1 / -2.

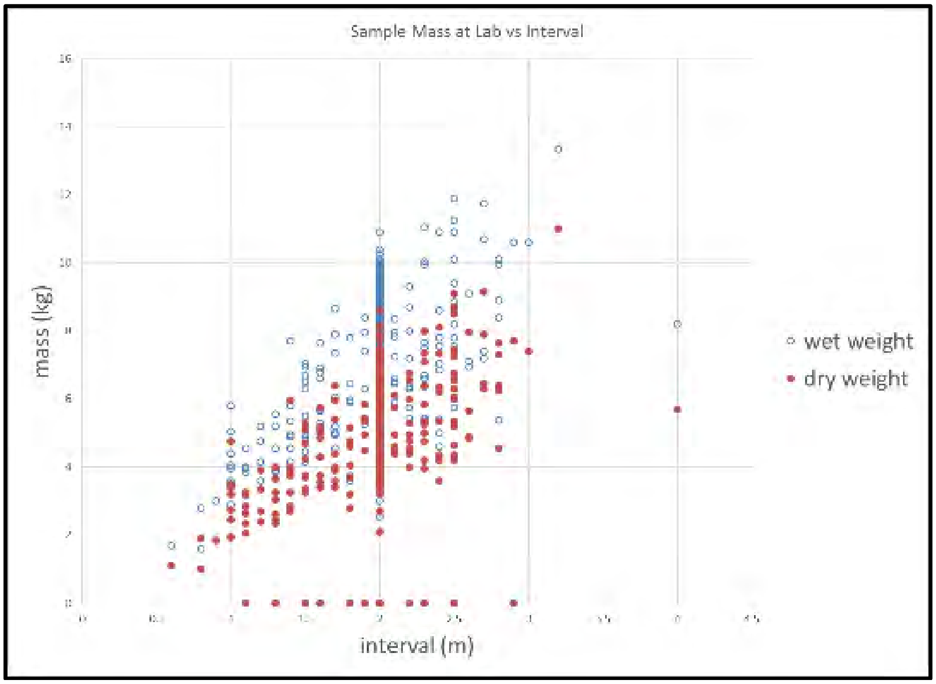
11.5 Lithogeochemistry

Lithogeochemistry was conducted at SGS in Lakefield Bor using lithium borate fusion with XRF detection of 12 major oxides. A total of 714 samples, excluding certified reference standards, were submitted for analysis.

11.6 Moisture and Mass

Mass was measured in the field as wet mass on one metre core run sub-samples, and also as wet and dry mass at the SGS laboratory in Bor in Serbia on the 25% split samples which represented the full 2 m core run sample size. Figure 11-2 depicts the relationship between wet and dry mass measured at SGS in Bor with the total represented sample interval length.

Figure 11-2: Wet and Dry Mass Measured at SGS Bor vs. Sample Interval



Approximate moisture content was measured in the field using a Delta-T MT3 soil moisture sensor (Photo 11-5), and at SGS in Bor from the assay samples that were received. The field moisture measurement approximated values ranged from 4% to 33%, with average value of 17.9%. Comparatively, laboratory moisture was calculated from the mass lost after wet samples were dried with values ranging from 5.6% to 27.4%, with average value of 17.4%.

Photo 11-5: Collection of Moisture and Magnetic Susceptibility Data in the Field

11.7 Specific Gravity

Specific gravity analysis was conducted at SGS Bor on splits from the assay sample using method ME-LR-MIN-MET-DS-A01. The pycnometer tests results are directly proportional to the individual densities of the mineral grains in the sample and are only weakly indicative of in situ bulk density. The pycnometer specific gravity results ranged from 2.90 to 3.28 with average value of 3.05.

11.8 Bulk Density

Calculation of in situ dry bulk density was based on core recovery estimated in the field and the dry mass weights measured at SGS Bor. Further description of in situ bulk density calculation is included in Section 14.3.6.

11.9 Quality Control of Laboratory Analysis

A systematic QA/QC program was designed in connection with the drill-sampling and analytical work. The program consists of the following:

- insertion of additional 15.7% control samples (CRMs, duplicates, and blanks) inserted into the analytical stream to monitor the performance of the labs
- access to internal QC data generated by the labs
- re-analysis or repeat of the test work on batches and samples that fail the QC criteria.

A total of 755 samples were shipped to SGS for elemental analysis. This included 695 assays, 3 CRMs (33 analyses), 35 blanks and 41 field duplicates. The laboratory included 21 additional lab duplicates. This resulted in a total of 884 assay results reported to EMI.

11.9.1 Certified Reference Materials

A total of three CRMs were inserted in sequence with the samples that were shipped to SGS in Bor. The name of the samples was recorded on the sample tag and was delivered to the lab as a blind sample with composition unknown to the lab. CRM insertions assess the accuracy of the analysis being performed and are intended to be present at a rate of at least one CRM per sample batch. Batch sizes at SGS included approximately 45 samples per batch, including field and laboratory QC sample insertions.

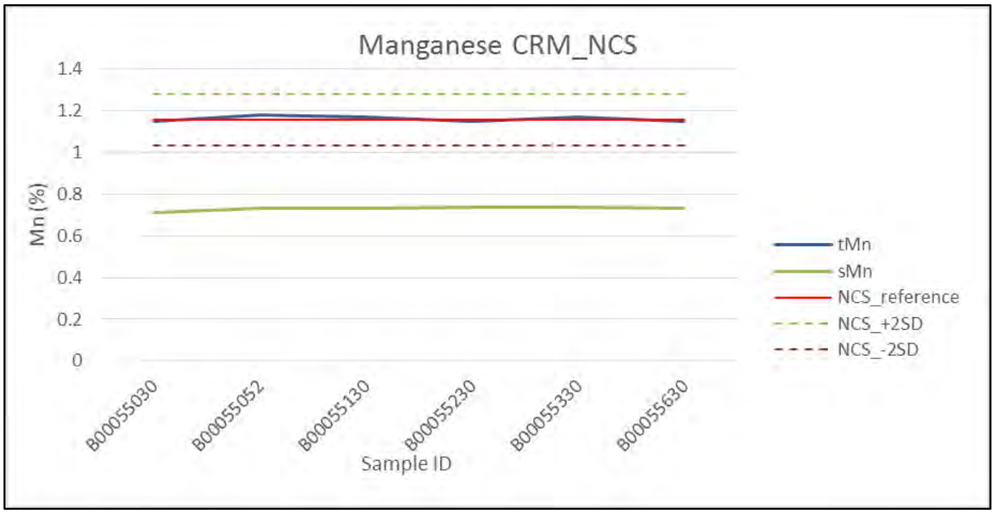
Three reference materials were selected by EMI at the onset of the program to be used as standards: as described in the following sections.

11.9.1.1 Certified Reference Material – NCS

The NCS reference was supplied by China National Analysis Center for Iron and Steel. The source material is not disclosed in the material datasheet. The expected mean manganese (II) oxide grade of 1.49% (1.154% manganese) and standard deviation of 0.08%.

This sample accounted for seven analyses. Figure 11-3 shows the performance of the standard, where total manganese grade falls within the confidence interval of ±2 standard deviations. Soluble manganese values falls below the confidence interval, as expected, with good correlation to the total manganese values.

Figure 11-3: CRM_NCS Performance Plot for Total and Soluble Manganese

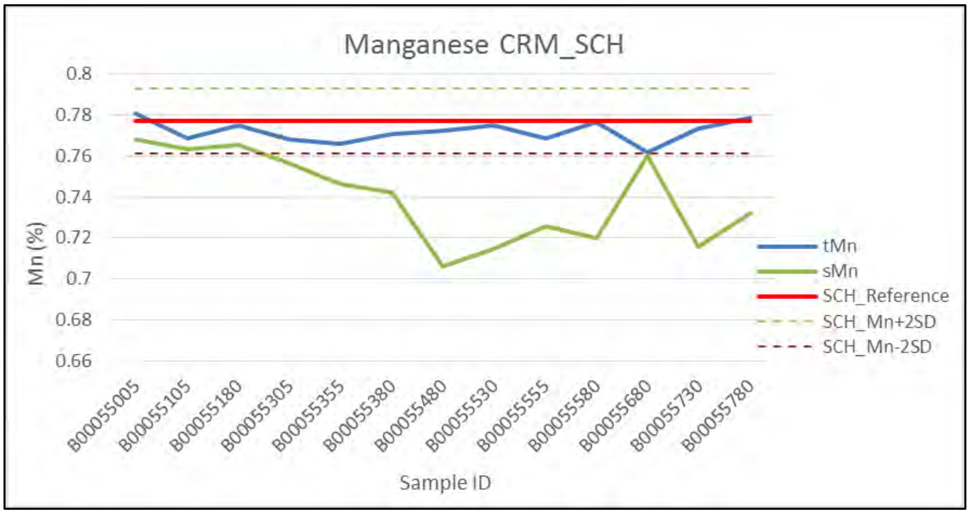


11.9.1.2 Certified Reference Material – SCH

The SCH-1 reference was supplied by the National Research Council of Canada CANMET and was prepared from iron ore as hematite with various hydrous oxides of iron from the Schefferville Mine in Quebec, Canada. The expected mean manganese grade is 0.777% with standard deviation of 0.008%.

This sample accounted for thirteen analyses. Figure 11-4: CRM_SCH-1 Performance Plot for Total and Soluble Manganese shows the performance of the standard, where total manganese grade falls within the confidence interval of ±2 standard deviations. Soluble manganese values falls below the confidence interval, as expected, with somewhat variable correlation to the total manganese values.

Figure 11-4: CRM_SCH-1 Performance Plot for Total and Soluble Manganese

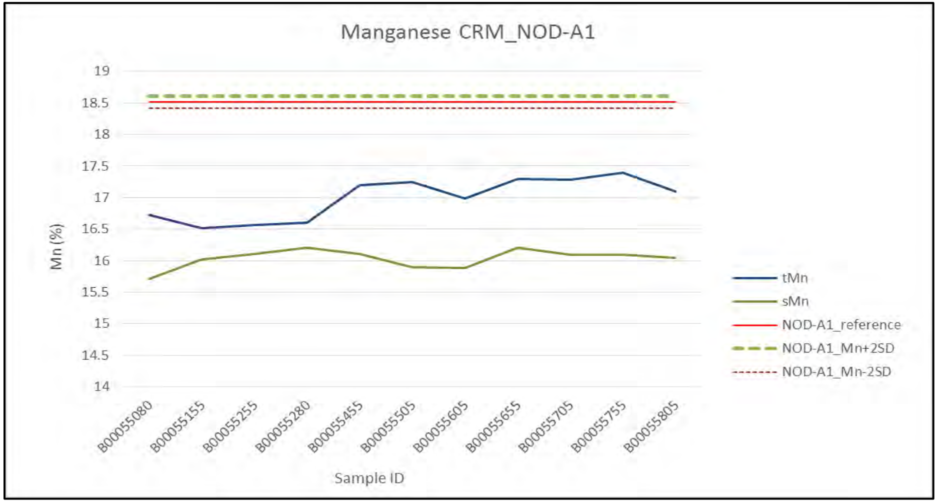


11.9.1.3 Certified Reference Material – NOD-A1

The NOD-A1 reference was supplied by the United States Geological Survey and was prepared from Atlantic Ocean seamount manganifeous nodules from the Blake Plateau. The expected mean manganese (II) oxide grade is 23.9% (18.51% manganese) with standard deviation of 0.065%.

This sample accounted for eleven analyses. Figure 11-5: CRM_NOD-A1 Performance Plot for Total and Soluble Manganese shows the performance of the standard, where total manganese grade falls below the confidence interval of standard deviations and soluble manganese values falls further below with good correlation to the total values. This performance failure has been identified by others (Cullen et al. 2013) whereby it was concluded that "the primary meta-borate fusion and ME-ICP06 analytical package did not provide sufficient extraction of manganese and iron to match reference material results that were based on XRF analysis". This CRM is not believed to be a suitable reference standard for control of exploration data as the results of this control measure are considered highly susceptible to analytical method. The materials do not assess, with validity, the digestion and equipment calibration used in this program's analysis.

Figure 11-5: CRM_NOD-A1 Performance Plot for Total and Soluble Manganese



11.9.2 Blank Analyses

11.9.2.1 Certified Blank – ST08

The ST-08 Certified Blank was supplied by Sklopísek Strelec, Czech Republic, as a high purity silica sand with low impurity concentration. The standard was manufactured for grain size distribution analysis and reports an expected manganese concentration; however, this is expected to be negligible.

This sample accounted for twenty-three analyses. Figure 11-6: Certified Blank – ST08 – Iron and Figure 11-7: Certified Blank – ST08 – Manganese show the performance of the standard for iron and manganese concentrations. One sample failure (B00055034) was observed for manganese with a concentration of 0.77%. The remaining concentrations were below 150 ppm. This ambient concentration may be due to residual manganese within the grinding equipment, but it was determined to be insignificant. Overall sample failure is less than 5% which is interpreted by the CP as acceptable.

Figure 11-6: Certified Blank – ST08 – Iron

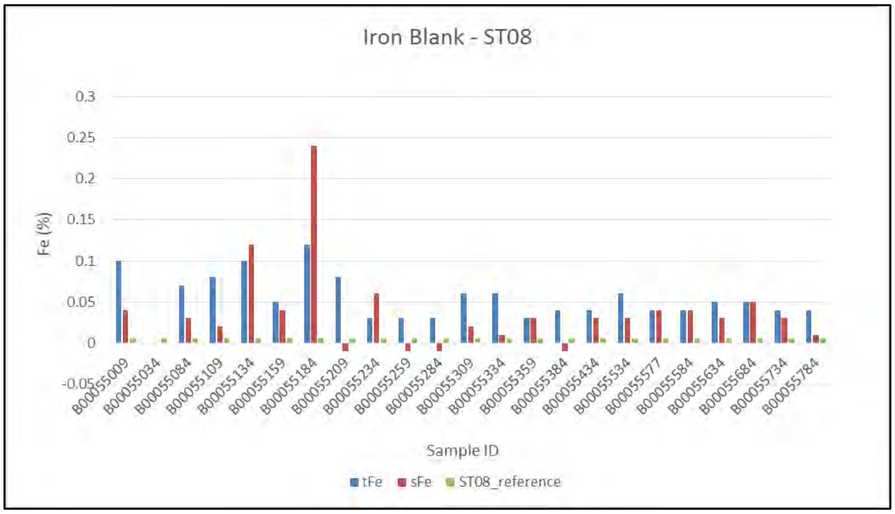
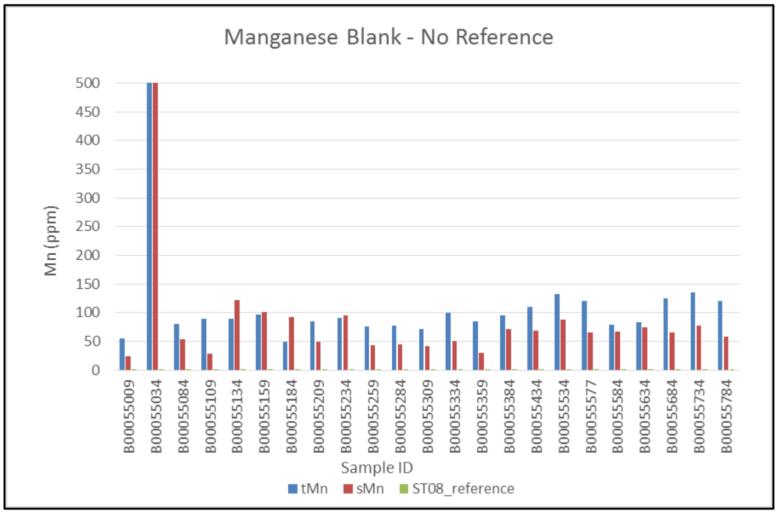


Figure 11-7: Certified Blank – ST08 – Manganese

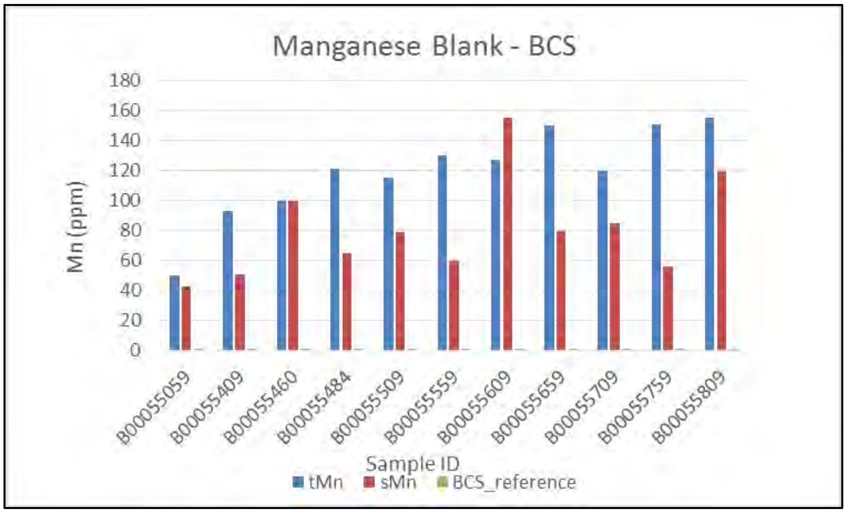


11.9.2.2 Certified Blank – BCS

The BCS certified blank was supplied by Bureau of Analysed Samples Ltd, based in England, prepared as low iron sand that passes a nominal 250 µm aperture. The standard has a “certified value” of 0.00014 MnO% with 95% confidence interval of 0.0003%.

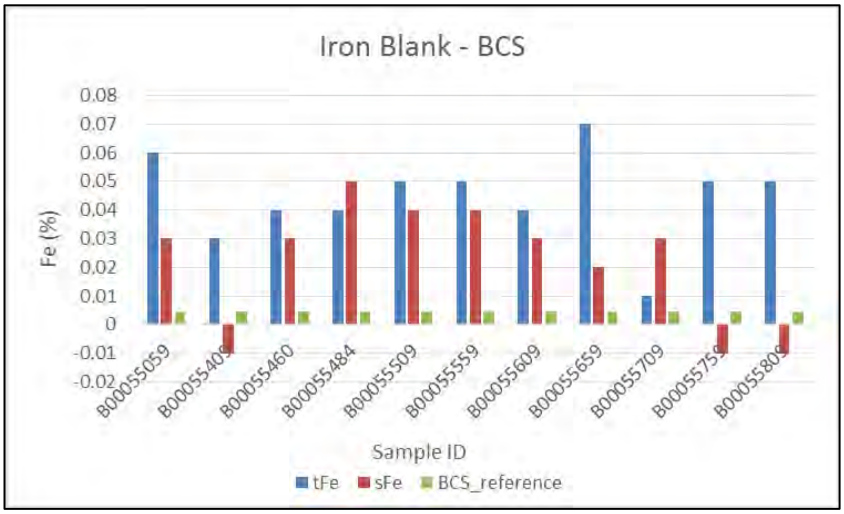
This sample accounted for eleven analyses. Figures 11–8 and 11-9 show the performance of the blank for manganese and iron concentrations. The manganese concentrations were below 150 ppm. This ambient concentration may be due to residual manganese within the grinding equipment, but it was determined to be insignificant.

Figure 11-8: Certified Blank – BCS – Manganese



The certified blank, BCS, (green) is consistently shown as having less Mn% than the total manganese, tMn, (blue) or soluble manganese, sMn, (red).

Figure 11-9: Certified Blank – BCS – Iron



11.9.3 Lab Duplicates

Lab duplicates represent those samples analyzed in duplicate internally by the lab as a blind duplicate. The results of the lab duplicate assays allow for pairwise assessment of analytical reproducibility, or precision.

A total of 20 pairs of lab duplicates were collected, with 16 result pairs for soluble manganese and 18 result pairs for total manganese. In the assay database, each pair was identified with the same sample number with one labelled with DUP as suffix and the second with no suffix. The duplicate sets were evaluated using simple linear regression and the Pearson's coefficient, and also for relative percent difference (RPD) as a measure of precision. An RPD of less than 10% within 90% confidence interval is considered to be a reasonable variation for evaluation of the quality of the data.

Figure 11-10 shows the duplicate regression for soluble manganese (sMn) and Figure 11-11 shows the regression for total manganese (tMn) against a 1:1 unity line in red. The soluble manganese regression indicated a slope of 1.0049 with Pearson's coefficient of 0.83, mainly due to one outlier. Total manganese indicated a slope of 0.9423 with Pearson's coefficient of 0.97.

Figure 11-10: Linear Regression of Soluble Manganese Assay Lab Duplicate Results

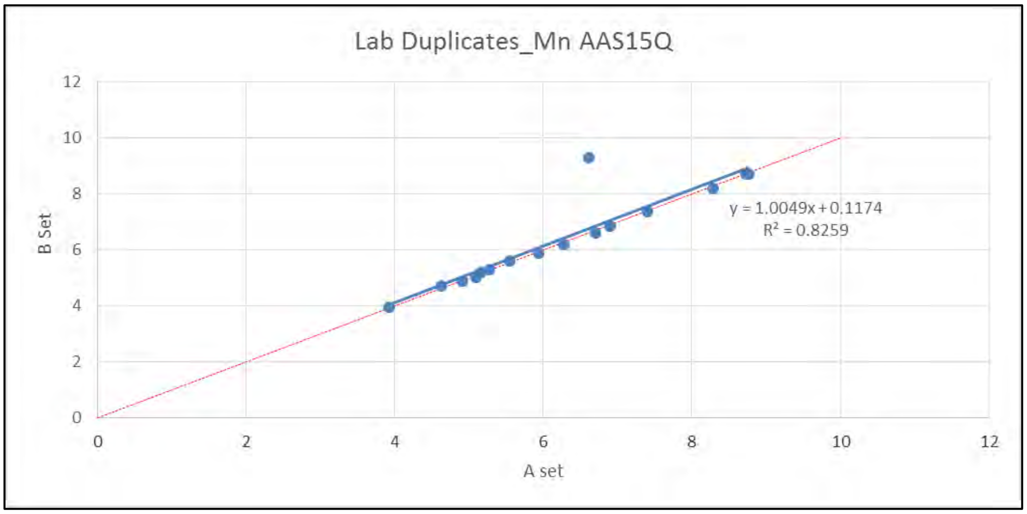
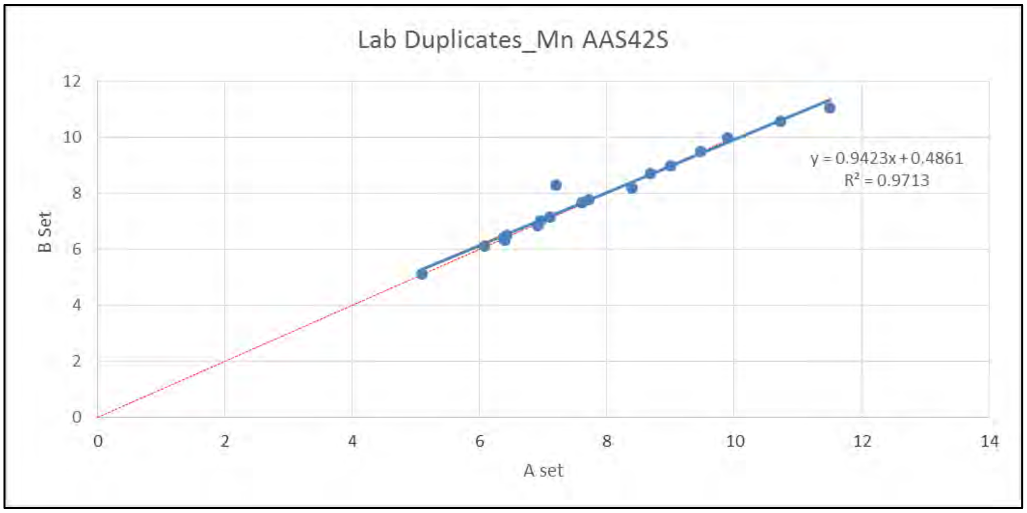


Figure 11-11: Linear Regression of Total Manganese Assay Lab Duplicate Results



RPD analysis of the field duplicates results for soluble manganese shows 15 of 16 pairs with a value of less than 1.72% and one sample pair with value of 33.82%. RPD analysis of the lab duplicates results for total manganese show 17 of 18 pairs with a value of less than 3.99% and one sample pair with value of 14.19%. A greater precision was observed for the total manganese assays.

11.9.4 Field Duplicates

Field duplicates represent those samples collected by EMI field staff at the drill and delivered to the lab as a blind duplicate. The results of the field duplicate assays allow for pairwise assessment of analytical reproducibility, or precision.

A total of 41 pairs of field duplicates were collected with reportable results. In the assay database, each pair was identified with the same sample number with one labelled with A as suffix and the second with B as the suffix. The A and B sets were evaluated using simple linear regression and the Pearson's coefficient, and also for RPD as a measure of precision. An RPD of less than 10% within 90% confidence interval is considered to be a reasonable variation for evaluation of the quality of the data.

Figure 11-12 shows the duplicate regression for soluble manganese (sMn) and Figure 11-13 shows the regression for total manganese (tMn) against a 1:1 unity line in red. The soluble manganese regression indicated a slope of 0.9174 with Pearson's coefficient of 0.94, and total manganese indicated a slope of 0.9977 with slope of 0.98.

Figure 11-12: Linear Regression of Soluble Manganese Assay Duplicate Results

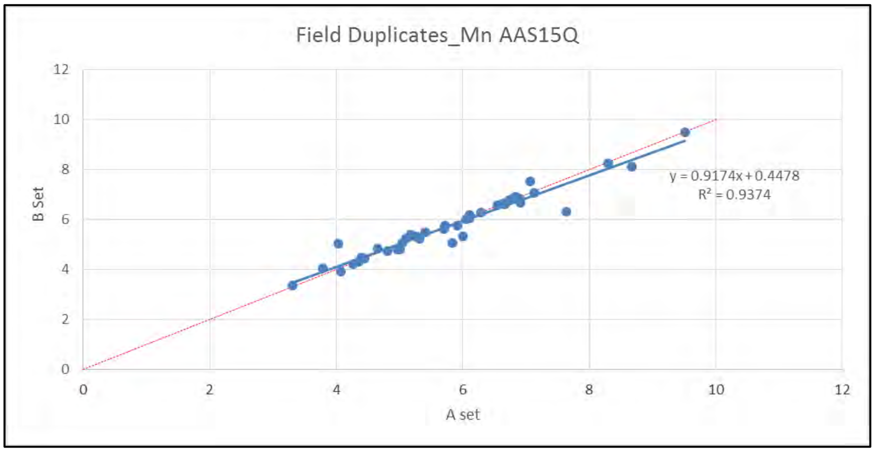
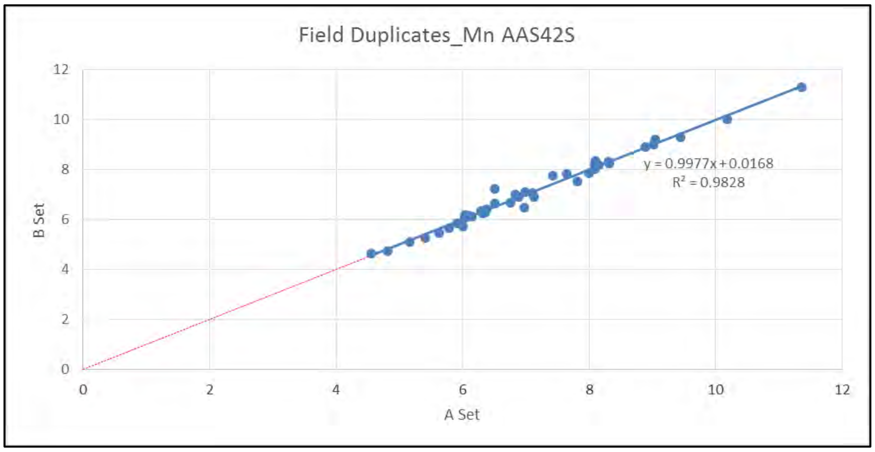


Figure 11-13: Linear Regression of Total Manganese Assay Duplicate Results



RPD analysis of the lab duplicates results for soluble manganese show 37 of 41 pairs with a value of less than 6.90% and four samples pair with values between 11.64% and 22.47%. RPD analysis of the lab duplicates results for total manganese show 40 of 41 pairs with a value of less than 7.43% and one sample pair with value of 10.48%. A greater precision was observed for the total manganese assays.

11.9.5 SGS Re-Analysis

Upon initial receipt of the laboratory data, instances were observed by EMI whereby concentrations of soluble manganese exceeded the reported concentrations of total manganese. As this is technically not possible, re-analysis of three batches was requested by EMI and completed by SGS. The re-runs were comprised of a split of the pulverized and homogenized sample.

Results of the re-analysis reduced the occurrence of soluble manganese exceeding total manganese to two samples, both of which were blank control samples at or below the detection limit.

11.9.6 External Laboratory Assay Verification

An external laboratory was selected by EMI to replicate the assay procedure for verification of assay splits that were prepared at SGS following initial receipt, drying, weighing and pulverizing of the sample. A total of 89 samples were shipped to Actlabs, located in Ancaster, Ontario, Canada. Comparison of total manganese grades from Actlabs with the SGS results are shown in Figure 11-14, and comparison of the soluble manganese grades are shown in Figure 11-15.

The results of the External Laboratory Verification indicate a reasonable comparison for both the total (4-acid) manganese and soluble (aqua regia) manganese data. Total manganese values show a slight scatter around a linear regression with Pearson's coefficient of 0.95, and slight bias to the Actlabs data with and slope of 0.98. A total of 14 total manganese grades, representing 16% of the data, showed RPD values of greater than 10%. Soluble manganese values show a slight scatter around a linear regression with Pearson's coefficient of 0.95, and slight bias to the Actlabs data with and slope of 0.96. A total of 46 soluble manganese grades, representing 51% of the data, showed RPD values of greater than 10%.

Figure 11-14: Linear Regression of Total Manganese Assay from Umpire Lab

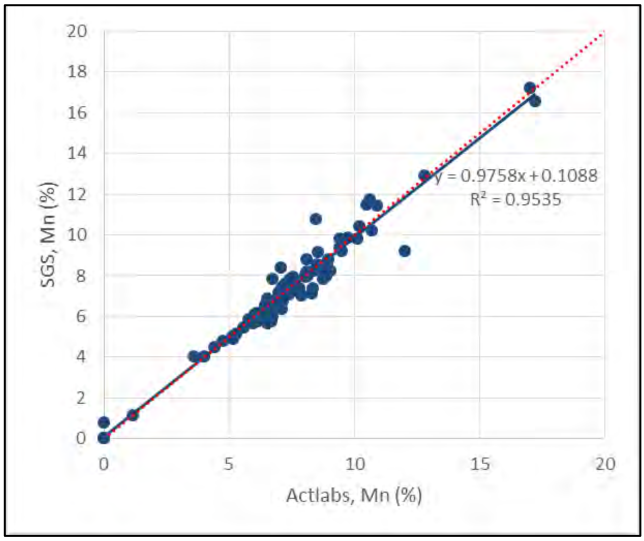


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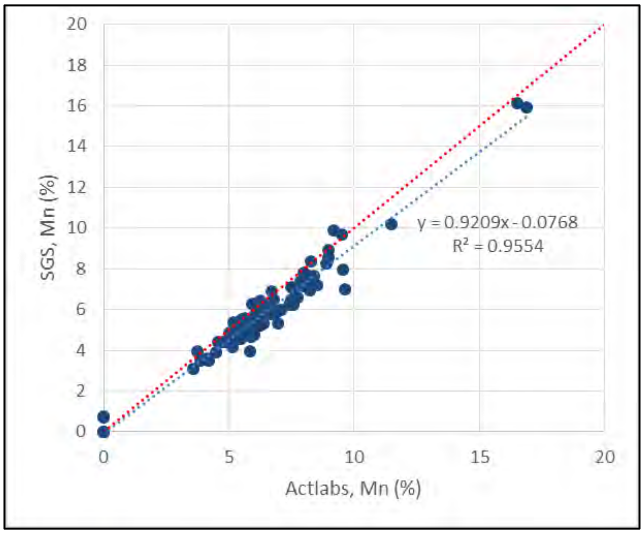
Figure 11-15: Linear Regression of Soluble Manganese Assay from Umpire Lab



Linear regression of the external laboratory assay verification supports the manganese grades reported from SGS analysis, however, RPD analysis suggests some variability exists between the laboratory analyses. This may be caused by heterogeneity in sampling in the field.

11.10 CP Opinion on Sample Collection, Preparation and Analyses

The methods implemented by EMI for sample collection, preparation and analysis were developed with great detail and with reference to applicable ISO and/or ASTM standards in advance of the drilling investigation. The procedures maximize use of sample volumes to measure physical and chemical parameters relevant to current and future project studies. The labs selected by EMI are recognized accredited laboratories which adhere to recognized ISO, ASTM or internally reproducible Standards. The CP feels the collection, analysis and security is reliable and adequate.

12.0 DATA VERIFICATION

12.1 Audit of the Drill Hole Database

12.1.1 Collar Survey and Topography

The Property topography was provided by GET as a MicroStation software format, dgn file, based on LiDAR imagery. The contours were extracted from these files and converted to a common .dxf file format. The original data was provided in Czech projection S-JTSK using the Bpv datum.

Surveying of drill hole collars was completed on-site by GET using a Trimble model R4 GNSS global positioning system (GPS) receiver equipment. The survey was reported in S-JTSK (Bpv), UTM (WGS84) and Lat-Lon (WGS84). It was observed that the average elevation difference between the Bpv and WGS84 datum equaled approximately 44.25 m. The elevation difference for drill hole T3-319 initially was reported as 46.36 m; however, this was later corrected to accurate Bpv equivalent elevation. The project references the S-JTSK (Bpv) coordinate system

A comparison between the corrected collar elevation surveys with the local topographic digital elevation model was undertaken. Of the 80 drill holes completed on the Property a mean deviation in elevation of 0.049 m was calculated between the collars and the DEM, with values ranging from -0.348 to +0.580 m. The site survey correlates well with the drill collar survey and is considered of high quality for spatial modelling.

12.1.2 Downhole Logs and Measurements

A drill hole database was compiled by GET using the field logs and measurements collected on-site. This database was inspected using digital validation tools within Leapfrog Geo modelling software. The validation tools assess the data for common errors such as overlapping intervals, major data gaps, drill hole depths versus sample depths, etc. These errors must be corrected prior to modelling to ensure the data is accurately represented.

Errors that were initially identified in the database were mainly due to the consolidated structure of the database that listed data measurements related to intervals for samples (2 m), core runs (1 m) and lithological intervals (variable lengths) on a single master spreadsheet. For modelling purposes, these various interval classes were parsed into three separate data sheets to represent data on 2 m sample intervals, 1 m field measurements, and the logged lithology sub-intervals.

These three subsets were again inspected in Leapfrog for common errors. This resulted in fewer errors which were corrected in the final database.

12.1.3 Geological Database Compilation

Tetra Tech received the raw data from laboratory testwork and analysis. The data was verified for completeness and was then compiled, processed and assessed for use in mineral resource estimation. The analytical data is saved in digital format as a geological database.

12.1.4 Cross Verification of Certificate of Analysis and Digital Data

Tetra Tech undertook verification of the data transfer and compilation process at SGS through visual comparison of the issued certificates of analysis with the digital assay records. This assessment was approached by first comparing the upper 25th percentile of assays reported for total manganese (n = 175), followed by a random spot check of an additional 10% of the remaining data (n = 55). No significant reporting errors were identified.

12.1.5 Independent Check Assay

Two samples were collected by the Tetra Tech CP geologist during the site visit. The samples were extracted as splits from recovered drill core weighing approximately 3 kg, placed in separate plastic bags, labelled with a generic sample identification and zip tied. One sample was extracted from hole T1-312 between depths of 22 and 23 m (EMI sample B00055404, and the second sample was extracted from hole T1-313 between depths of 22 and 23 m (EMI sample B00055416). Each sample weighed approximately 2 kg.

The samples were then transported by the CP to Prague and delivered to the GET office where shipping via DHL was arranged. Upon receipt of the samples in Canada, the packaging, polyethylene bags, zip ties and labelling was inspected. Evidence of tampering was not observed.

The samples were submitted to ALS Laboratories in North Vancouver, Canada, for a selective leach check analysis. The selective leach analysis progressively dissolved the sample in stages using stronger solvents for digestion. Table 12-1: Tabulated Description of Selective Leach Analytical Methods used for Independent Check Assay list the digestion solvent in successive order. Table 12-2: Cumulative Leaching Results from Selective Leach Analysis shows the cumulative percent of the manganese that is dissolved at each stage along with the total manganese grade for the sample. The samples reported 80% and 74% leaching of the total manganese in the first three stages of the selective leach, with the majority of this being dissolved at the aqua regia digestion stage.

Table 12-3: Independent Check Assay Comparison with EMI Results compares the total and soluble manganese concentrations between the Tetra Tech sampling and the EMI reported results. RPD analysis shows some variability in the assay comparisons with values of between 3% and 16% for soluble, and 1% to 13% for total. The check assay does repeat the general magnitude of the manganese assay value within the SGS results.

Table 12-1: Tabulated Description of Selective Leach Analytical Methods used for Independent Check Assay

Digestion	Finish	SGS Method	Mn Detection Limits
Aluminum Acetate	ICP-MS	ME-MS04	0.05-5,000 ppm
Cold Hydroxylamine-Hydrochloride	ICP-MS	MS05	0.05-5,000 ppm
Aqua Regia	ICP-MS, ICP-AES	MS42	5-50,000ppm
4-Acid	ICP-MS, ICP-AES	MS62	5-50,000ppm

Table 12-2: Cumulative Leaching Results from Selective Leach Analysis

Sample ID	ME-MS04 (cum_Mn%) (%)	ME-MS05 (cum_Mn%) (%)	MS42 (cum_Mn%) (%)	MS62 (cum_Mn%) (%)	Total Mn% (%)
CT1312 (T1-312, 22-23)	6	9	80	100	10.35
CT1313 (T1-313, 18-19m)	7	11	74	100	6.44

Table 12-3: Independent Check Assay Comparison with EMI Results

	CT1312 (B00055404)	CT1313 (B00055416)
Tetra Tech tMn(%)	10.35	6.44
EMI tMn(%)	10.42	7.36
RPD (%)	**1**	**13**
Tetra Tech sMn (%)	9.54	5.16
EMI sMn (%)	8.14	5.30
RPD (%)	**16**	**3**

12.1.5.1 Acid-base Accounting

Acid-base accounting (ABA) tests were also performed to measure total sulphide sulphur concentration using LECO furnace and net neutralization potential ratios of the sample. Total sulphide sulphur values for samples CT1312 and CT1313 were measured at 2.48% and 2.45%, respectively, and NPR values were reported as 3.11 and 1.94 (using Sobek method). In accordance with standard methodologies and as per guidelines set forth in MEND 1.20.1, Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (Price 2009), NPR values greater than 2 indicate the material is not potentially acid generating, materials with NPR between 1 and 2 have uncertain potential for net acid generation and materials with NPR less than 1 indicate they have potential for net acid generation. Based on these results, sample CT1312 does not have potential for acid generation, and sample CT1312 has uncertain potential for acid generation.

Summary of previous ARD-ML test work is discussed in Section 13.7. The results of the analysis of two samples identified neutralization potential ratios (NPR) of 0.94 and 0.4 indicating that the material has potential for acid generation.

The tailings materials, and their processed by-product, should be fully characterized for acid generating potential.

12.2 CP Opinion on Data Verification

The CP has audited the field data and drilling logs, compared digital analytical data to laboratory certificates, compiled the geological database and conducted independent sample verification following a site visit. The CP is satisfied that the geological database accurately reflects field observations and laboratory analysis and is adequate to support mineral resource estimation.

13.0 MINERAL PROCESSING AND METALLURGICAL TESTING

The CMP plans to recover manganese by reprocessing three adjacent tailings dumps that originated from pyrite mining conducted from 1951 to 1975. The potential recovery methods include:

- Pre-concentration of manganese minerals.
- Acid dissolution and related solid-liquid separation.
- Pregnant solution purification.
- Selenium and chromium -free electrowinning to produce high purity, electrolytic manganese metal (emm).
- Production of high purity manganese sulphate.

Several metallurgical test programs have been carried out to assess the metallurgical responses of the tailings materials. From 1986 to 1989, Bateria Slany, a Czechoslovak state battery producer, undertook extensive metallurgical studies and process design work, focused on the production of electrolytic manganese dioxide (EMD). The latest test programs were undertaken by EMI from 2015 through 2017. The recent metallurgical testing programs are listed in Table 13-1: Metallurgical Test Work Programs and the test results are summarized in the sections that follow.

Table 13-1: Metallurgical Test Work Programs

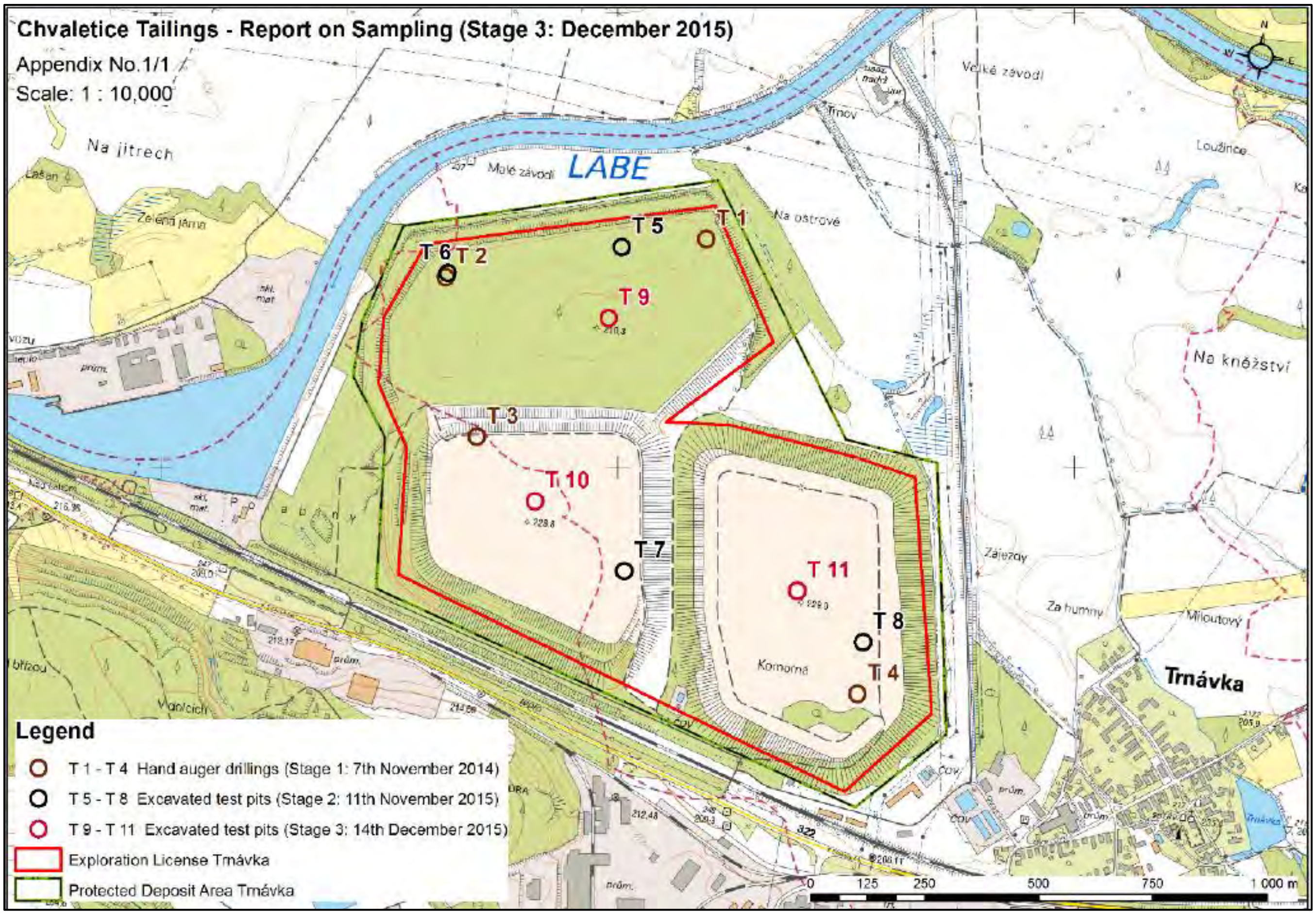
Year	Program ID	Laboratory	Mineralogy	Pre-concentration	Leaching	Others
2015	-	UBC	√			
2016	100301	Kemetco			√	
2016	Eu Mn J0201	Kemetco				√
2016	-	Kemetco		√		
2016	1656	Met-Solve	√	√		√
2017	-	CRIMM		√	√	
2017	16204-001	SGS			√	

Notes: Global ARD = Global ARD Testing Services Inc.
Kemetco = Kemetco Research Inc.
Met-Solve = Met-Solve Laboratories Inc.
PMC = Process Mineralogical Consulting Ltd.
UBC = University of British Columbia

13.1 Metallurgical Test Samples

Four phases of sampling have been conducted from the Chvaletice deposit by EMI. A sample collection location map is provided in Figure 13 1: Metallurgical Test Sample Collection Location.

Figure 13-1: Metallurgical Test Sample Collection Location

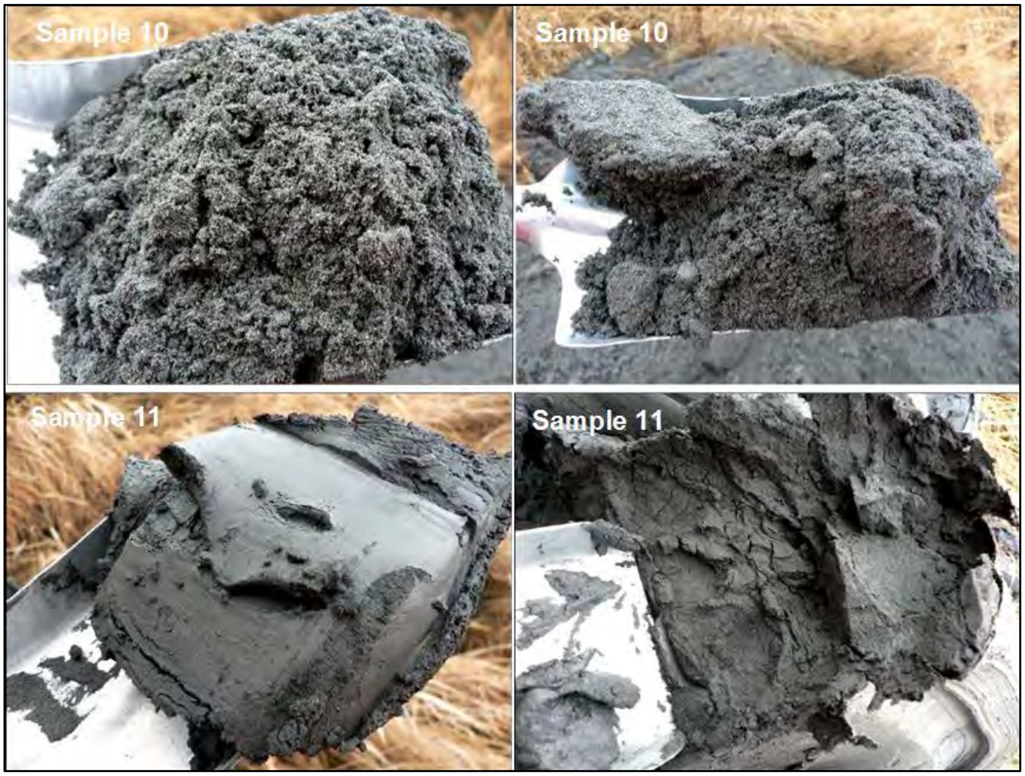


- Samples T1 to T4 (Phase 1) were taken in November 2014 from locations at the periphery of the dumps by hand auger drillings from depths of 2 to 2.5 m.
- Samples T5 to T8 (Phase 2) were taken in November 2015 from locations at the periphery of the dumps and from excavated test pits at depths of 1.8 to 3.1 m.
- Samples T9 to T11 (Phase 3) were taken in December 2015 from locations at the center of the dumps and from excavated test pits at depths of 2.5 to 3.8 m.
- Samples T7a to T10a (Phase 4) were taken in February 2017 from the locations where were labelled as T7 and T10 by the previous sampling program.

All depths reported are inclusive of overburden, typically ranging from 0.3 to 2.0 m in depth.

Figure 13-2: Physical Appearance of Sample 10 and Sample 11 shows physical appearances of the most recent samples recovered from the test pits labelled as Sample 10a and Sample 7a.

Figure 13-2: Physical Appearance of Sample 10 and Sample 11



13.2 Head Assay and Mineralogy

13.2.1 Phase 1 Samples

The samples collected for the Phase I sampling program were submitted for whole rock assay and multi-element assay. The chemical analysis results are shown in Table 13-2: Head Assay Phase I Samples.

Table 13-2: Head Assay Phase I Samples

Sample ID	Assays (%)					
	tMn	sMn	S	SiO_2	Ca	Fe
T1	9.60	7.69	4.38	41.3	3.81	6.5
T2	7.33	6.14	6.64	44.1	3.48	7.54
T3	10.4	8.71	4.92	38.8	3.49	8.21
T4	5.44	3.59	3.58	47.5	3.34	6.08

Notes: tMn = total manganese; sMn = sulphuric acid soluble manganese

Two tailings samples identified as Sample 3 and Sample 4 were preliminarily analyzed by quantitative phase XRD at UBC. The minerals identified and their contents are presented in Table 13-3 Quantitative Mineral Analysis.

Table 13-3: Quantitative Mineral Analysis

Mineral	Ideal Formula	Sample 3 (%)	Sample 4 (%)
Quartz	SiO_2	30.3	33.6
Clinochlore	$(Mg,Fe^{2+})_5Al(Si_3Al)O_{10}(OH)_8$	1.4	2.4
Kaolinite	$Al2Si_2O_5(OH)_4$	2.7	3.8
Muscovite	$KAl_2AlSi_3O_{10}(OH)_2$	4.2	9.8
Plagioclase	$NaAlSi_3O_8 – CaAlSi_2O_8$	6.0	14.4
K-feldspar	$KAlSi_3O_8$	1.4	1.8
Gypsum	$CaSO_4·2H_2O$	0.9	2.4
Anhydrite	$CaSO_4$	0.5	0.8
Rhodochrosite	$Mn^{2+}CO_3$	29.3	10.2
Spessartine	$Mn_3{}^{2+}Al_2(SiO4)_3$	7.2	7.8
Siderite	$Fe^{2+}CO_3$	-	1.1
Ankerite-Dolomite	$Ca(Fe^{2+},Mg,Mn)(CO_3)_2/CaMg(CO_3)_2$	0.7	1.4
Hydroxylapatite	$Ca_5(PO4)_3(OH)$	7.0	4.3
Pyrite	FeS_2	8.4	5.5
Marcasite	FeS_2	-	0.6
Total	**-**	**100.0**	**100.0**

The analysis shows that rhodochrosite is main manganese bearing mineral; some of the manganese occurs in silicate minerals. The main gangue mineral is quartz. Pyrite is the main sulphide mineral, accounting for approximately 5 to 9% of the total minerals.

13.2.2 Samples Tested at Met-Solve

In late 2015, three manganese bearing tailings samples were received by Met-Solve. The samples were assayed and the main elements are shown in Table 13-4: Head Assay Phase II and II Samples.

Table 13-4: Head Assay Phase II and II Samples

Sample ID	Assays (%)						Particle Size 80% Passing (µm)
	tMn	sMn	S	SiO_2	Ca	Fe	
CH*	7.83	-	4.70	43.17	3.81	6.95	147
T5-T8 Composite	6.68	5.88	4.47	47.20	4.15	6.48	151
T9-T11 Composite	7.01	5.88	2.13	45.07	3.77	5.21	47
T9	6.30	5.72	2.04	43.58	3.73	4.88	-
T10	7.20	5.87	1.64	46.93	3.26	5.07	-
T11	7.53	6.04	2.71	44.70	4.32	5.67	-

Note: *CH = Phase I sample

The head assay shows that the manganese contents range from 6.3 to 7.8%, with approximately 86% of the total manganese as acid soluble form. There is a significant difference in particle size distribution between Composite T5-T8 and Composite T9-T11. Composite T5-T8 with a particle size of 80% passing 151 µm is much coarser than Composite T9-T11 with a particle size of 80% passing 47 µm.

Composites T5-8 and T9-11 were separately submitted to PMC for chemical analysis and mineralogical analysis using the Tescan Integrated Mineral Analyser system, equipped on the Tescan Vega 3 Scanning Electron Microscope with Energy Dispersive X-ray detectors (SEM-EDS). The composites were sized into three size fractions (+38 µm, -38 to +20 µm, and -20 µm). The determination results are shown in the following subsections.

13.2.2.1 Composite T5-T8

The chemical analysis results by size fractions are shown in Table 13-5: Head Assay by Size Fraction Sample T5-T8. Although the finer than 20 µm fraction shows slightly higher manganese content and slightly lower calcium and iron contents, there is no significant variation in metal concentrations among the size fractions.

Table 13-5: Head Assay by Size Fraction Sample T5-T8

Fraction	Mass (%)	Content (%)			Distribution (%)		
		Ca	Fe	tMn	Ca	Fe	tMn
+38 µm	75.0	3.56	6.86	6.70	76.7	77.4	73.5
-38 µm to +20 µm	8.2	3.38	6.79	6.77	8.00	8.41	8.15
-20 µm	16.8	3.17	5.60	7.49	15.3	14.2	18.4
Head (Calc)	**100.0**	**3.48**	**6.64**	**6.84**	**100.0**	**100.0**	**100.0**
Head (Assay)	**-**	**3.17**	**5.60**	**6.65**	**-**	**-**	**-**

Mineralogical determination results are shown in Table 13-6: Mineral Abundance (Weight Percent) by Size Fraction Sample T5-T8 and summarized below:

- Manganese is mainly present as rhodocrosite ($MnCO_3$) and as kutnohorite $Ca(Mn,Mg,Fe^{2+})[CO_3]_2$ (Mn-carbonates) with lesser amounts as sursassite ($(Mn,Ca)_4(Al,Mg,Mn^{3+}Fe^{3+})_6(Si,Al)_6(O,OH)_{22}(OH)_6$), pyrolusite ($MnO_2$) and kurchatovite ($Ca(Mg,Mn,Fe^{2+})B_2O_5$) (grouped as Mn-silicate minerals).

- Manganese-carbonates have a grain size of 80% passing approximately 80 µm with significant amounts occurring as liberated and middling grains (approximately 70%), lesser amounts are present as sub-middling and locked grains. The manganese-carbonate liberation data are shown in Table 13–7

- The manganese-carbonates are mainly in complex associations with three or more minerals in a particle. These often include other carbonates, quartz and feldspars, or manganese-silicate minerals.

- Pyrite is the primary sulphide mineral present in the sample and is mainly present as grains having a particle size of 80% passing 70 µm and distributed in liberation across all categories.

Table 13-6: Mineral Abundance (Weight Percent) by Size Fraction Sample T5-T8

Minerals	Size Fraction			
	+38 µm	+20 µm	-20 µm	Total
Quartz	35.2	36.6	28.3	34.2
Plagioclase	12.3	11.9	17	13.0
Kutnohorite	10.6	10	6.44	9.87
Pyrite	9.54	7.84	4.7	8.58
K-Feldspar	6.60	4.31	6.41	6.38
Apatite	4.19	4.51	6.25	4.56
Muscovite	3.75	2.83	8.34	4.45
Rhodocrosite	4.16	4.12	3.32	4.02
Sursassite	2.93	6.63	2.94	3.23
Other Silicates	1.48	1.29	2.19	1.58
Calcic Siderite	1.41	1.89	1.2	1.41
Clays	1.29	0.63	2.14	1.38
Chlorite-Mg	0.58	0.95	3.17	1.05
Dolomite	1.02	1.25	0.88	1.01
Pyroxene	0.65	0.61	1.3	0.76
Amphibole	0.69	0.46	0.95	0.71
Biotite	0.58	0.59	0.76	0.61
Other Sulphides	0.40	0.86	0.86	0.51
Ankerite	0.42	0.31	0.37	0.40
Ilmenite	0.32	0.48	0.67	0.39
Calcite	0.34	0.57	0.33	0.35
Gypsum	0.45	0.06	0.04	0.35
Garnet	0.20	0.12	0.42	0.23
Pyrolusite	0.20	0.3	0.27	0.22
Magnetite	0.19	0.37	0.29	0.22
Other minerals	0.22	0.2	0.15	0.21
Kurchatovite	0.18	0.18	0.33	0.20
Bustamite	0.11	0.11	0.05	0.10
Total	**100**	**100**	**100**	**100**

Table 13-7: Mn-Carbonate Liberation by Grouped Categories – T5-T8

Minerals	Size Fraction			
	+38 µm	+20 µm	-20 µm	Total
Locked	8.6	3.8	1.7	7.4
Sub-Middling	25.1	13.4	8.3	22.1
Middling	37.9	26.4	16.4	34.4
Liberated	28.4	56.4	73.6	36.1
Total	**100.0**	**100.0**	**100.0**	**100.0**

13.2.2.2 Composite T9-T11

The results of the analysis for Composite T9-T11 are shown in Table 13-8 and Table 13-9 and are summarized as follows:

- Similar manganese minerals were determined from Composite T9-T11, compared to Composite T5-T10.
- Manganese-carbonates (rhodocrosite and kutnohorite) have a grain size of 80% passing approximately 20 µm with significant amounts occurring as liberated and middling grains (approximately 86%), lesser amounts are present as sub-middling and locked grains. The sub-middling category remains substantial at this grind size and a finer grind will likely release more manganese-carbonate minerals improving liberation. The manganese-carbonate liberation data are shown in Table 13-10.
- Manganese-carbonate occurrence with the other minerals is similar to Composite T5-T8.
- At the manganese-carbonate grain size of 80% passing approximately 20 µm, pyrolusite appears much finer with a particle size of approximately 10 µm while manganese-silicates are slightly coarser with a particle size of approximately 30 µm.
- Pyrite is the primary sulphide mineral present in the sample and is mainly present as liberated grains having a particle size of 80% passing 25 µm.

Table 13-8: Head Assay Size Fraction Sample T9-T11

Fraction	Mass (%)	Assay (%)			Distribution (%)		
		Ca	Fe	Mn	Ca	Fe	Mn
+38 µm	26.4	3.45	5.42	5.54	25.8	24.6	23.7
-38 +20 µm	8.9	3.37	5.76	5.43	8.45	8.76	7.79
- 20 µm	64.7	3.59	6.00	6.54	65.8	66.7	68.5
Head (Calc)	**100.0**	**3.53**	**5.83**	**6.18**	**100.0**	**100.0**	**100.0**
Head (Assay)	**-**	**3.40**	**5.10**	**5.29**	**-**	**-**	**-**

Table 13-9: Mineral Abundance (Weight Percent) by Size Fraction Sample T9-T11

Minerals	Size Fraction			
	+38 µm	+20 µm	-20 µm	Total
Quartz	39.7	38.4	30.7	33.8
Plagioclase	14.8	11.3	15.1	14.7
Kutnohorite	9.84	11.6	9.36	9.69
K-Feldspar	5.68	3.93	6.78	6.24
Apatite	4.52	5.52	6.87	6.13
Muscovite	3.17	3.09	6.72	5.46
Rhodocrosite	4.95	6.42	3.65	4.24
Pyrite	4.87	5.3	3.38	3.95
Other Silicates	1.72	1.85	2.61	2.30
Sursassite	2.46	3.6	2.02	2.28
Chlorite-Mg	0.75	1.05	2.89	2.16
Clays	0.60	0.88	2.21	1.67
Amphibole	0.62	0.44	1.02	0.86
Dolomite	1.06	1.23	0.65	0.81
Pyroxene	0.63	0.51	0.88	0.78
Biotite	0.52	0.52	0.73	0.65
Calcite	0.78	0.82	0.54	0.63
Magnetite	0.25	0.27	0.75	0.57
Other Sulphides	0.24	0.33	0.49	0.41
Garnet	0.21	0.11	0.51	0.40
Calcic Siderite	0.63	0.96	0.21	0.39
Ilmenite	0.28	0.39	0.38	0.36
Kurchatovite	0.20	0.25	0.41	0.34
Pyrolusite	0.23	0.20	0.38	0.32
Siderite_CaMg	0.27	0.31	0.31	0.3
Ankerite	0.42	0.28	0.18	0.25
Other minerals	0.33	0.33	0.20	0.24
Bustamite	0.11	0.11	0.11	0.11
Gypsum	0.06	0.05	0.01	0.02
Total	**100.0**	**100.0**	**100.0**	**100.0**

Table 13-10: Mn-Carbonate Liberation by Grouped Categories – T9-T11

Minerals	Size Fraction			
	+38 µm	+20 µm	-20 µm	Total
Locked	7.4	3.1	1.2	3.1
Sub-Middling	20.6	12.4	5.9	10.8
Middling	29.4	26.6	11.4	18.2
Liberated	42.6	57.9	81.5	67.9
Total	**100.0**	**100.0**	**100.0**	**100.0**

13.2.3 Samples Tested at Kemetco

In 2016, Kemetco conducted preliminary acid leach tests on a composite prepared from four individual samples identified as Samples T1, T2, T3 and T4. The assay results of the composite, namely EM Composite, are shown in Table 13-11.

Table 13-11: Head Assay by Fraction

Sample ID	Grade (%)										
	tMn	Fe	S	SiO_2	Ca	Fe	Ba	Al	Mg	P	C
EM Composite	8.19	7.37	5.36	43.35	3.86	7.37	0.40	3.9	1.11	0.95	3.5

13.2.4 Samples Tested at CRIMM

In early 2017, two, 25 kg samples identified as Sample 10 and Sample 11 were used for a preliminary test program by CRIMM. The samples were collected from the locations of T7a and T10a as shown in Sample 10 is relatively coarse and contained low moisture, compared to Sample 11 which is much finer and contained a high moisture. A composite sample (Sample 10+11) was also prepared by blending the two individual samples for metallurgical testing. The wet sieved size and related metal distributions in the different size fractions are presented in Table 13-1: Particle Size and Metal Distribution Sample 10.

Table 13-12: Particle Size and Metal Distribution Sample 10

Size (mm)	Mass (%)	Grade (%)		Distribution (%)	
		tMn	sMn	tMn	sMn
+0.30	0.70	2.79	2.17	0.23	0.24
-0.30+0.15	12.01	4.60	3.81	6.39	7.14
-0.15+0.125	8.12	7.55	6.28	7.10	7.96
-0.125+0.10	12.10	8.82	7.43	12.34	14.02
-0.10+0.075	14.06	9.79	7.70	15.93	16.89
-0.075+0.053	8.03	10.29	7.38	9.57	9.25
-0.053+0.045	13.01	10.38	6.98	15.63	14.17
-0.045+0.038	4.80	10.30	6.42	5.72	4.81
-0.038+0.028	9.17	9.67	6.18	10.26	8.84
-0.028+0.019	5.02	9.37	6.00	5.44	4.70
-0.019	12.97	7.59	5.92	11.39	11.98
Calculated Head	**100.00**	**8.64**	**6.41**	**100.00**	**100.00**
Measured Head	**-**	**8.44**	**6.21**	**-**	**-**

Table 13-13: Particle Size and Metal Distribution Sample 11

Size (mm)	Mass	Grade (%)		Distribution (%)	
	%	tMn	sMn	tMn	sMn
+0.075	0.68	2.84	2.36	0.37	0.35
-0.075+0.030	5.70	4.76	4.03	5.15	5.05
-0.03+0. 028	3.90	5.02	4.05	3.71	3.47
-0.028+0.019	6.21	4.81	3.78	5.67	5.16
-0.019	83.51	5.37	4.68	85.10	85.96
Calculated Head	**100.00**	**5.27**	**4.55**	**100.00**	**100.00**
Measured Head	**-**	**5.31**	**4.43**	**-**	**-**

Table 13-14: Chemical Analysis and XRF Analysis Results Sample 10 + 11

Component	**tMn***	**sMn***	**tMn**	**Fe**	**Cu**	**Si**	**TiO_2**	**Al**	**Ca**
%	7.09	5.44	6.91	5.54	0.01	21.6	0.11	8.11	3.63
Component	**Mg**	**Ti**	**P**	**S**	**O**	**Cl**	**V**	**Cr**	**Ni**
%	1.45	0.41	1.31	1.80	43.5	0.029	0.032	0.021	0.003
Component	Na	K	Zn	Rb	Sr	Y	Zr	Ba	
%	0.78	1.07	0.008	0.003	0.030	0.010	0.009	0.60	

Note: *by wet chemical analysis

As shown in Figure 13-3: Particle Size Distribution - Sample 10 and Figure 13-4: Particle Size Distribution - Sample 11, the particle size distribution of Sample 10 is much coarser than Sample 11. Eighty-three point 5 percent (83.5%) of the mass of Sample 11 occurs in the finest fraction (finer than 19 µm). Both the samples show lower metal contents in the coarse fractions in comparison to the other size fractions. Sample 10 has the highest manganese contents in the middle size fractions while the highest metal content is observed in the finest fraction for Sample 11.

Figure 13-3: Particle Size Distribution - Sample 10

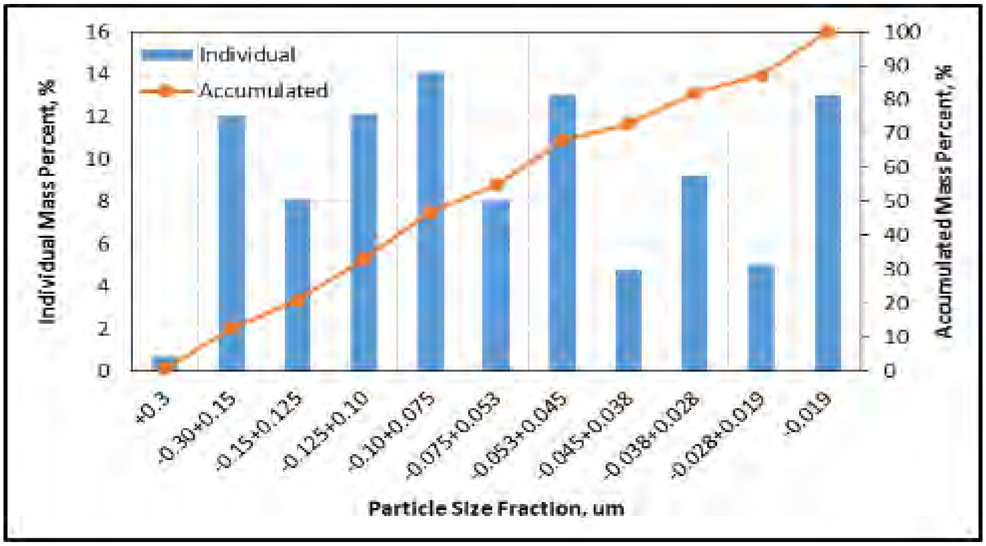
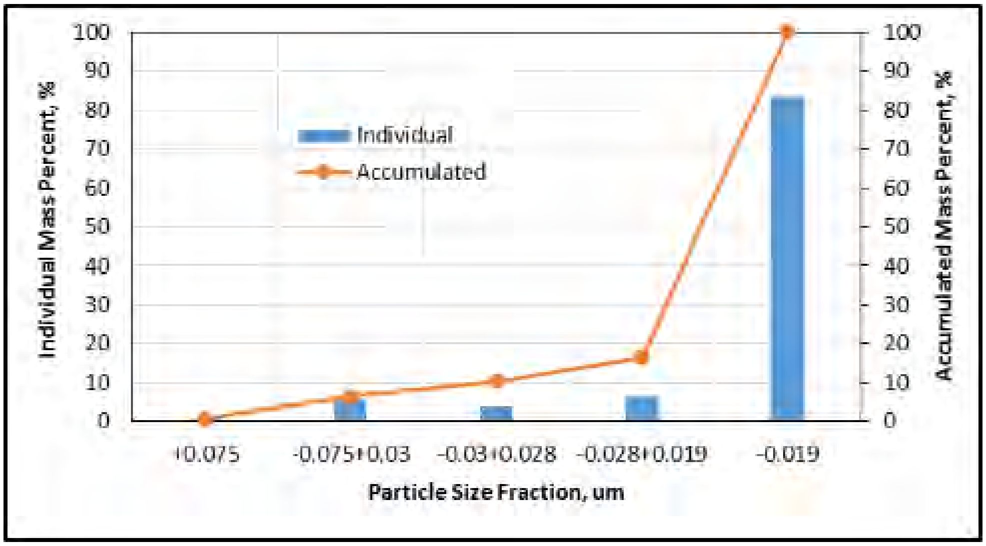


Figure 13-4: Particle Size Distribution - Sample 11



13.3 Pre-concentration

To reduce the mass amount fed to the downstream acid leach treatment, various pre-concentration tests were conducted in an effort to increase the manganese grade of the leach feed. The pre-concentration treatments tested included flotation, gravity concentration and magnetic separation.

13.3.1 Flotation

A series of scoping level flotations tests were conducted by Met-Solve on Sample T5-T8 using different reagent regimes. The reagents tested included:

- collectors: oleic acid and Cytec 801, 845, 827, and 727
- frother: methyl isobutyl carbinol (MIBC) and TF250
- modifier: soda ash or sodium hydroxide as pH modifier, sodium silicate to suppress silicates.

The most promising results were obtained with using Cytec 727 as collector and soda ash as pH modifier.

The test conditions and results are presented in Table 13-15 and Table 13-16.

Table 13-15: Flotation Test Reagent Dosage and Retention Time

Stage	Reagent Dosage (g/t)		Retention Time (min)		pH
	Soda Ash	727	Conditioning	Float	
Conditioning	9,306		3.0		9.2
Rougher Concentrate 1-1	4,595	862	7.5	7.5	8.7
Rougher Concentrate 1-2				7.5	8.6
Rougher Concentrate 2	862	862	7.5	7.0	10.0
Total	**16,199**	**1,723**	**18.0**	**22.0**	

Table 13-16: Flotation Test Results

Products	Grade (%)				Recovery (%)				
	tMn	sMn	Fe	SiO_2	Mass	tMn	sMn	Fe	SiO_2
Rougher Conc 1-1	12.49	8.45	6.89	33.10	28.5	51.2	42.7	30.3	19.6
Rougher Conc 1-2	7.87	7.28	8.13	37.42	9.1	10.2	11.7	11.3	7.0
Rougher Conc 2	8.22	8.07	8.71	38.05	28.1	33.1	40.1	37.7	22.2
Total Rougher Conc	10.03	8.13	7.84	35.81	65.7	94.5	94.6	79.2	48.9
Tailings	1.11	0.89	3.93	71.54	34.3	5.5	5.4	20.8	51.1
Calculated Head	**6.97**	**5.64**	**6.50**	**48.08**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Assayed Head	**6.68**	**5.88**	**6.48**	**47.20**	**-**	**-**	**-**	**-**	**-**

The test upgraded the total manganese content of the feed from 6.97% to 10.03% at a manganese recovery of approximately 94.5%. The mass rejection into the low grade tailings (1.11% tMn) was approximately 34%. However, the results were achieved under slow flotation kinetics, with a total laboratory residence time in an order of 22 minutes, and very high reagent consumptions (1,700 g/t Cytec 727, and 16,000 g/t soda ash).

It should be noted that a generic oleic acid could produce comparable metallurgical performances, compared to Cytec 727. Further test work should be conducted to optimize the reagent regime if pre-concentration by flotation is required.

Due to the appreciable quantity of pyrite present (approximately 5 to 9%), two preliminary tests were conducted to minimize the effect of pyrite on flotation of manganese minerals and potential acid generation issues, one using potassium amyl xanthate (PAX) as collector to float pyrite prior to manganese mineral flotation and the other using diethylene triamine (DETA) to suppress pyrite during manganese flotation. Both the tests did not produce encouraging results. Although pyrite flotation by PAX can reduce the tailings sulphur grade from 4.0% to 2.2%, the acid-based accounting (ABA) test results show that the flotation tailings may still be a potential acid generator due to the high sulphide sulphur content.

Further scoping flotation testing was conducted on Sample T9-T11 to investigate the flotation behavior of the material, which is much finer in particle size. The testing used Aero 727 as collector. Compared to Sample T5-T8, the fine particle size sample generated less selective metallurgical responses. The rougher concentrate grade was only 8.48% tMn at a manganese recovery of 88% for Sample T9-T11, compared to a concentrate grade of 10.03% tMn and a manganese recovery of 94.5% for Sample T5-T8. Similarly, the mass rejection decreased from 34% to 26%. The detrimental results may be resulting from the effect of the significantly high fines of the sample on the metallurgical performance.

To address the concerns of fine gangue entrainment, additional cleaner flotation test work was conducted to upgrade the rougher concentrate. The cleaner flotation test was conducted at a lower pulp density; approximately 10% w/w solids, with an agitator speed of 1,500 rpm in an effort to achieve a better cleaner efficiency. The floats were cleaned with spray water to reject entrained fine gangue minerals. Although the cleaner flotation was able to upgrade the cleaner concentrate grade to approximately 10.3% tMn, the manganese recovery reporting to the cleaner concentrate was only 63%, compared to higher than 90% for the T5-T8 sample. Again slow kinetics were observed with a total laboratory residence time of approximately 19 minutes.

Further flotation test work should be conducted to optimize reagent regimes and process conditions. It should be noted that potential impacts of the reagents used in the flotation on the downstream leaching and electrowinning processes should be investigated if this pre-concentration treatment method is planned.

13.3.2 Gravity Concentration

Preliminary gravity concentration tests were conducted on Sample CH (Phase 1) and Sample T5-T8 (Phase 2) using a centrifugal concentrator with two stages of passing. It appears that on average, only 11% of the manganese reported to the gravity concentrates with insignificant upgrading ratios.

No further investigations using the pre-concentration treatment were undertaken.

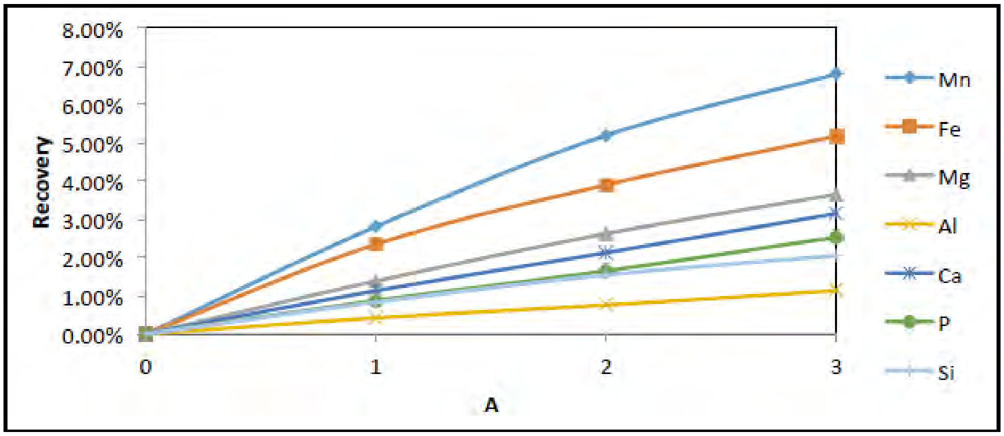
13.3.3 Magnetic Separation

Two preliminary magnetic separation test programs were conducted, one by Kemetco and the other by CRIMM.

13.3.3.1 Magnetic Separation Tests by Kemetco

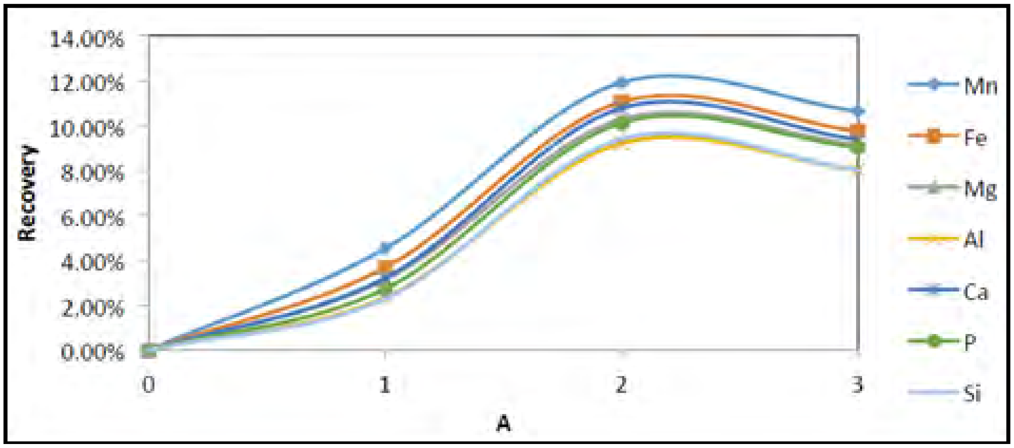
Kemetco conducted preliminary dry and wet magnetic separation tests on a sample from the Chvaletice tailings deposit. The wet magnetic separation test was conducted using a Carpo wet high intensity magnetic separator with a combination of ¾" and ½" steel balls as matrix. Three tests were run at three different magnetic field intensities. The electric current applied was 1, 2 and 3A. No applied magnetic field intensity was recorded for the related electric current. Although the magnetic separation was able to upgrade the magnetic concentrate grade from 8.4% manganese oxide in the feed to approximately 23% manganese oxide in the concentrate, the manganese recovery to the concentrate was low, ranging from approximately 3% to 7%. The metal recoveries vs the applied electric currents are shown in Figure 13-5.

Figure 13-5: Metal Recovery vs. Applied Electrical Current Wet Magnetic Separation



The dry magnetic separation was conducted using a Carpo dry high intensity magnetic separator. Three tests on the same sample tested by the wet magnetic separation were also run at three different magnetic field intensities with an applied electric current of 1, 2 and 3A. No applied magnetic field intensity was reported at the applied electric current. Compared to the wet magnetic separation, the dry magnetic separation produced lower upgrading ratio; the magnetic concentrate grades were only 13% at the 1A magnetic field and approximately 9.5 to 10% at the 2A and 3A magnetic fields. The manganese recovery to the concentrate was low, ranging from approximately 4% to 11%. The metal recoveries vs the applied electric current strengths are shown in Figure 13-6.

Figure 13-6: Metal Recovery vs. Applied Electrical Current Dry Magnetic Separation



13.3.3.2 Magnetic Separation Tests by CRIMM

In early 2017, CRIMM conducted an exploratory magnetic separation testing program on two, 25 kg samples identified as Sample 10 and Sample 11. The head sample characteristics are summarized in Section 13.2.

The test work investigated the effects of magnetic field intensity, magnetic separator type, and feed solid density on magnetic separation efficiency. Also the test work studied the effect of two different feed particle distributions on manganese recovery by the magnetic separation.

Several different high intensity magnetic separation (HIMS) equipment were used for the exploratory tests. The equipment specifications are summarized in Table 13-17 and the equipment are shown in Figure 13-7.

Table 13-17: Main Magnetic Separators Used for Testing

Name	Model	Diameter (mm)	MFI, T*	Capacity (t/h)
Drum Magnetic Separator	LILO-300	300	0.8	0.2 to 0.4
High Gradient Magnetic Separator	Slon-500 (Vertical Ring and Pulsating)	500	1.0	1 to 3
Combined High Intensity Magnetic Separator	SHP-560	560	1.8	1 to 3
High Gradient Magnetic Separator	Slon-100 (Vertical Ring and Pulsating)	100	1.8	Small

Note: *MFI = highest magnetic field intensity; T = Tesla

Figure 13-7: High Intensity Magnetic Separators

Slon-100 **Slon-500**

LILO-300 **SHP-560**

Sample 10 and Sample 11 were tested at a magnetic intensity of 1.2 and 1.8 Telsa (T) separately using a Slon-100 magnetic separator. The test results are shown in Table 13-18.

Table 13-18: Slon-100 Magnetic Separation Test Results Sample 10 and Sample 11

MFI/T	Product	Mass (%)	Grade (%)		Recovery (%)	
			tMn	sMn	tMn	sMn
Sample 10						
1.2	Concentrate	47.2	15.69	11.51	88.03	87.37
	Tailings	52.8	1.91	1.49	11.97	12.63
	Feed (Calc'd)	100.0	8.42	6.22	100.00	100.00
1.8	Concentrate	48.1	15.24	11.06	86.70	85.86
	Tailings	51.9	2.17	1.69	13.30	14.14
	Feed (Calc'd)	100.0	8.46	6.20	100.00	100.00
Sample 11						
1.2	Concentrate	19.2	16.44	13.66	61.17	59.38
	Tailings	80.8	2.48	2.22	38.83	40.62
	Feed (Calc'd)	100.0	5.16	4.42	100.00	100.00
1.8	Concentrate	22.7	14.49	12.29	64.47	63.16
	Tailings	77.3	2.35	2.11	35.53	36.84
	Feed (Calc'd)	100.0	5.11	4.43	100.00	100.00

The coarse particle size sample (Sample 10) produced much better magnetic separation performances, compared to the fine grain sample (Sample 11).

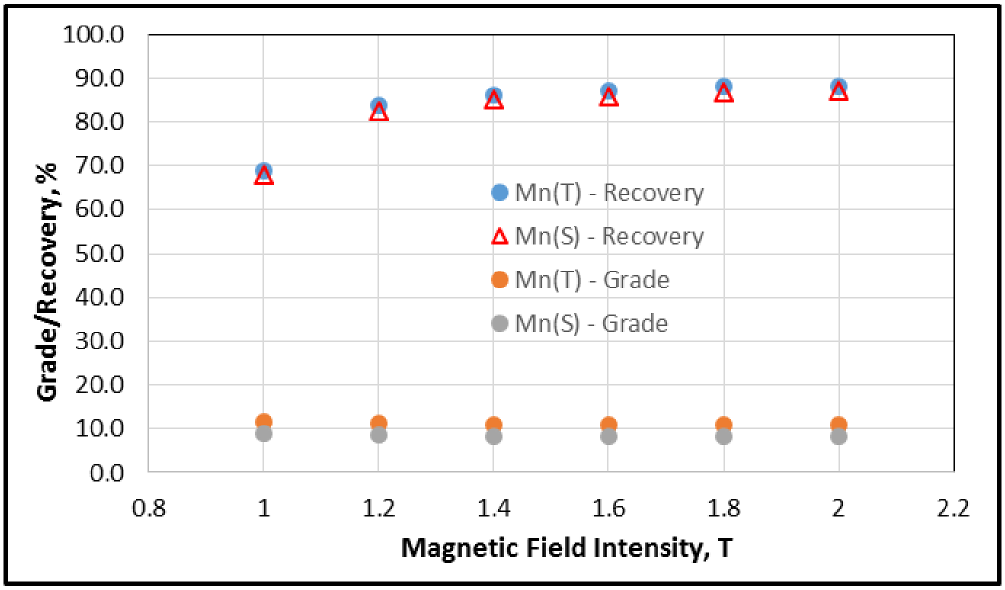
For Sample 10, on average, approximately 87% of the total manganese can be recovered into the concentrate containing approximately 15.5% tMn, or 11.3% sMn with a mass pull of 47.2 and 48.1%. The separation efficiency of the sample did not appear to improve with an increase of the magnetic intensity strength from 1.2 to 1.8 T.

Approximately 61% of the total manganese of Sample 11 was concentrated into a 16% tMn) magnetic concentrate at a magnetic field intensity of 1.2 T at a mass pull of 19.2%. The sample showed an improved metallurgical recovery by 3.3% when the magnetic field strength was increased to 1.8 T.

The effect of magnetic field intensity on the magnetic separation performance was further investigated on a blended composite, labelled as Sample 10+11, which was constructed by blending Sample 10 and Sample 11 at a blending ratio of 50:50. The tested magnetic field intensity ranged from 1 to 2 T using a SHP type magnetic separator equipped with pressured water washing. As shown in Figure 13-8, total manganese recovery improved with an increase in applied magnetic field intensity. When the magnetic field intensity is higher than 1.8 T, the total manganese reporting to an 11% tMn concentrate is approximately 88% for total manganese, or 87% for acid soluble manganese.

It appears that at a MFI of above 1.6T, the increased magnetic field intensity did not significantly impact on manganese grade of the concentrates produced from the tests.

Figure 13-8: Metallurgical Performance vs. Magnetic Field Intensity Sample 10 + 11



Note: *washing water pressure: 0.15 MPa

The effect of slurry solid density on magnetic separation performance of Sample 10+11 was tested. The test results show that in the tested slurry solid density ranging from 20% to 40% w/w, the total manganese grade of the concentrate decreased marginally 15.1% to 14.7%. The total manganese recovery was slightly increased from 85.9% to 86.7% at the highest slurry solid density. The concentrate and tailings produced at the solid density of 30% w/w were assayed for multi-elements and the results are shown in Table 13-19.

Table 13-19: Chemical Analysis Results Magnetic Separation Products

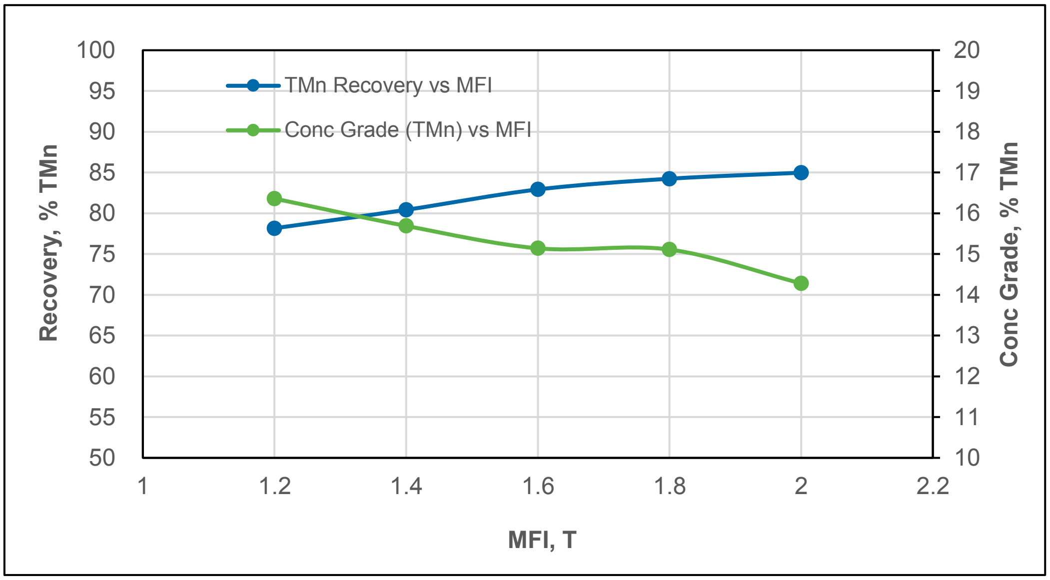
Product	Content (%)								
	tMn	sMn	Fe	CaO	MgO	SiO_2	Al_2O_3	S	C
Concentrate	15.05	11.60	10.17	6.92	3.20	23.99	5.43	3.28	3.28
Tailings	1.56	1.39	3.42	4.34	1.57	57.62	13.21	2.14	1.59
Feed (Calc'd)	6.84	5.42	6.07	5.35	2.21	44.41	10.15	2.59	2.25

As shown in Table 13-19, the iron, calcium oxide, magnesium oxide, sulphur and carbon components were concentrated into the magnetic concentrate while the silicon dioxide and aluminum oxide bearing minerals appeared to be enriched into the non-magnetic product. Compared to the manganese minerals, the test results show that the upgrading ratio of the impurities into the magnetic concentrate was lower, indicating selective removal of non-magnetic gangues to the tailings.

CRIMM also investigated the effect of the particle size on magnetic separation by classifying the blended composite into two fractions: coarse fraction and fine fraction at two different screen apertures of 0.1 mm and 0.15 mm. The coarse fractions showed better metallurgical responses, compared to the fine fractions. Also, two different magnetic field intensities were tested on the coarse fraction materials, the results indicate that a higher magnetic field intensity can improve manganese recovery to the magnetic concentrate.

The preliminary test results from the ongoing test program, which is being conducted at CRIMM using the overall composite sample generated from the 2017 drilling program, appear to show that on average the composite sample produced slightly better metallurgical performances.

Figure 13-9: Metallurgical Performance vs. Magnetic Field Intensity _ 2017 Overall Composite Sample



As shown in Figure 13-9, approximately 84% of the manganese was recovered into a 15% TMn concentrate at a magnetic field intensity of 1.8 T. A separate set of tests were conducted to investigate the effect of grinding size on magnetic separation performance. The results showed that magnetic concentrate grade was improved by approximately 1% to 16.4% TMn, however, the manganese recovery dropped by approximately 5%.

13.4 Acid Leaching

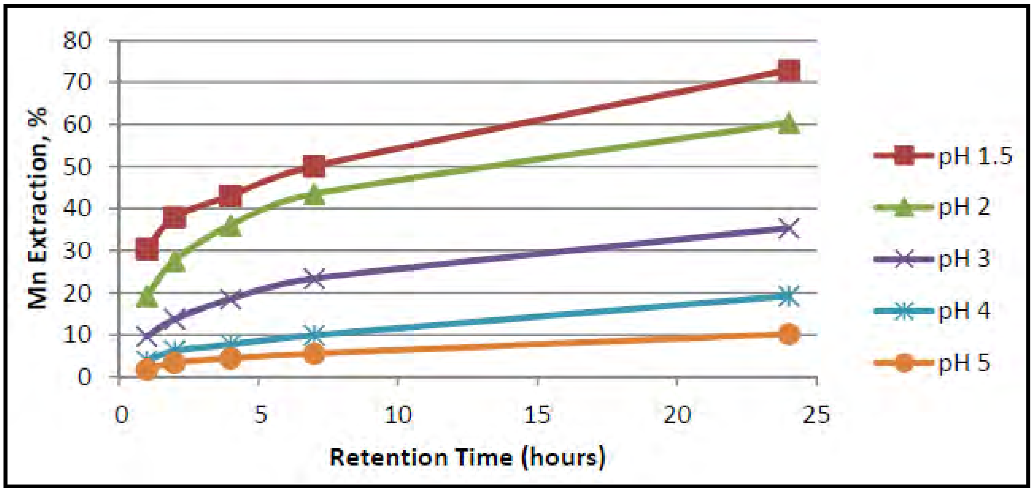
As discussed in Section 13.2, the primary manganese bearing minerals are carbonates, mainly rhodochrosite. The carbonates are expected to be readily leachable by sulphuric acid while the manganese-silicates should be refractory to the leach treatment. The ratio of the acid soluble manganese to the total manganese for the samples collected during 2015 and 2017 ranges from 66% to 91%, averaging 81%. As reported by AMEC Foster Wheeler, the Bateria Slany report indicates that the average sulphuric acid soluble manganese content of 968 samples was 70% of the total manganese content with only a minor difference in leachable fraction between the three tailings dumps.

Three preliminary sulphuric acid leaching tests were done on various samples, including head samples and magnetic separation concentrate and tailings samples.

13.4.1 Sulphuric Acid Leach by Kemetco

Kemetco conducted controlled pH preliminary sulphuric acid leach tests on the composite sample produced from the Phase 1 samples at ambient temperature. The leach pH was controlled at fixed levels ranged from 1.5 to 5 with adding sulphuric acid to maintain pH during the leaching. The leach retention time was 24 hours. Leach kinetics at varying pH are presented in Figure 13-10. The leach kinetics curves appear to show that the leaching had not been completed achieved the equilibrium state. 74% of the total manganese was extracted at pH 1.5 and 24 hours. It is likely that the manganese extraction may be improved by finding optimum leaching conditions using a different leaching test work procedure.

Figure 13-10: Leach Kinetics at Different Initial pH Levels



13.4.2 Sulphuric Acid Leach by CRIMM

CRIMM conducted four preliminary sulphuric acid leach tests, two on the blended head sample (Sample 10+11) and two on the magnetic concentrate at different temperatures. The tests used synthetic anolyte as leaching solution containing 15 g/L manganese and 120 g/L $(NH_4)_2SO_4$. Ratios of acid to solids in the feed were 0.184:1 (184 kg/tonne) for the head sample and 0.5:1 (500 kg/tonne) for the magnetic concentrate. Leach retention time was five hours. The test results are shown in Table 13-20.

Table 13-20: Preliminary Leach Test Results CRIMM

Sample	Feed Grade (% tMn)	Leaching Temperature (°C)	Residual Acid (g/L)	Mn Content in Pregnant Solution (g/L)	Mn Extraction (%)
Sample 10+11	7.09	60	1.96	30.9	49.7
Sample 10+11	7.09	90	0.98	32.5	52.4
Concentrate	14.5	60	2.0	25.4	57.0
Concentrate	14.5	90	0.98	28.0	64.1

The test results show that the manganese extractions were 49% for the head sample and 57% for the concentrate at the leaching temperature of 60°C. The extraction improved to 52% and 64% respectively when the leaching temperature was increased to 60°C.

The extractions are lower than the acid leachable manganese contents in the two head samples. As determined by CRIMM and SGS, on average, the acid soluble manganese contents are approximately 80% for the head sample and 78% for the magnetic separation concentrate. The lower manganese extractions may be due to the tests not being conducted at the optimum conditions.

13.4.3 Sulphuric Acid Leach by SGS

The head sample (Sample 10+11), magnetic concentrate sample (JKH-20-K) and magnetic tailings sample (JKH-20-X) produced by CRIMM were leached by sulphuric acid at a SGS lab, Canada. The tests were conducted at an initial pulp solid density of 27% w/w at a temperature of 50°C for 8 hours. The test results are summarized in Table 13-21.

Table 13-21: Preliminary Leach Test Results SGS

Sample	Feed Particle Size (P80%, µm)	pH	Sulphuric Acid		Calc'd Head (% tMn)	Cumulative Extraction (% tMn)
			Addition (kg/t)	Consumption (kg/t)		
Sample 10+11	88	1.7 - 2.4	166	163	6.74	58.0
Sample 10+11	88	1.1 - 1.9	200	195	6.57	67.2
Sample 10+11	88	1.1 - 1.5	300	265	6.53	78.6
JKH-20-K	143	0.5 - 1.2	500	479	14.3	76.2
JKH-20-K *	143	0.4 - 1.1	500	473	14.4	77.2
JKH-20-K	143	0.9 - 1.9	400	379	14.0	69.0
JKH-20-X	32	0.9 - 1.2	300	131	1.59	89.4
JKH-20-X	32	1.3 - 1.4	200	128	1.46	87.8

*Repeat test

The results indicated that manganese leach extraction improved with an increase in initial sulphuric acid dosage. The head sample and the magnetic concentrate sample produced similar manganese extraction rates, 78.6% for the head sample with adding 300 kg/t sulphuric acid and 76.7% for the concentrate sample with adding 500 kg/t sulphuric acid.

The non-magnetic tailings showed a much better metallurgical response. Approximately 87.8% of the manganese was extracted from the low-grade sample at an acid dosage of 200 kg/t. Chemical analysis shows that the acid leachable manganese content in the magnetic separation tailings is approximately 90.7%.

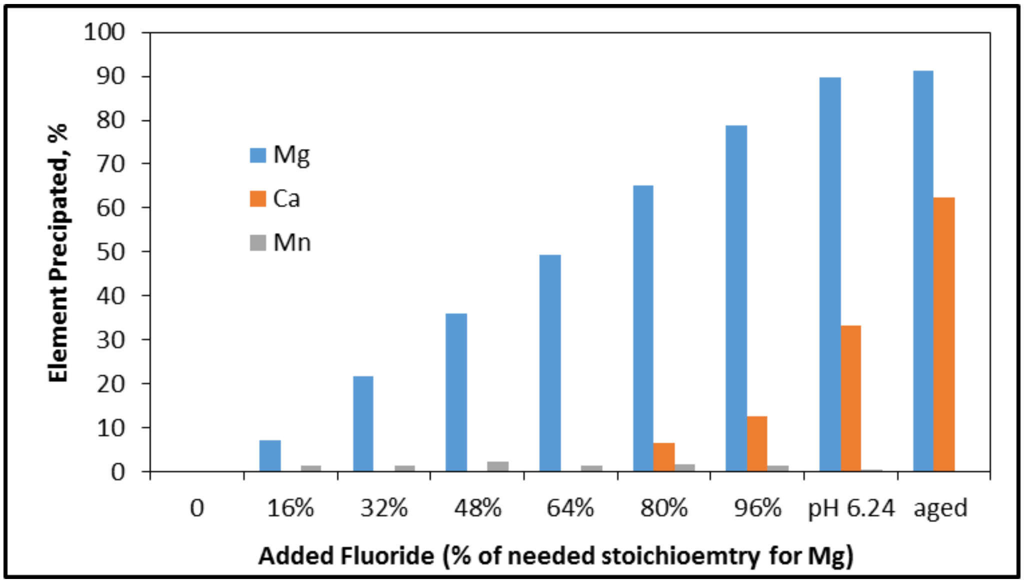
Further leach tests should be conducted to optimize the acid leach process conditions and investigate the metallurgical performances of various mineralization samples to the leaching treatment, including the materials upgraded by pre-concentration or without upgrading.

13.5 Magnesium Removal

As there is a high leachable magnesium content in the pyrite tailings material, preliminary magnesium removal tests were conducted to simulate whether magnesium concentration can be controlled in the electrowinning circuit to prevent from forming complex magnesium/manganese/ammonium sulphate salts. The salts would have a significant impact on tank house diaphragms and electrowinning cell performance.

The potential method for magnesium removal is to selectively precipitate the magnesium by ammonium fluoride. The tests were conducted by Kemetco using a synthetic electrolyte solution containing 40 g/L manganese, 6 g/L magnesium, 130 g/L $(NH_4)_2SO_4$. The synthetic solution was prepared from manganese sulphate, magnesium sulphate, ammonium sulphate and sodium sulphate laboratory reagents. The synthetic solution was then mixed with calcium hydroxide ($Ca(OH)_2$) and then with sulphuric acid to pH 2.5. The pulp pH increased after adding the fluoride. The final pH levels were adjusted to approximately pH 6 using aqueous ammonia. The magnesium removal test results are presented in Figure 13-11.

Figure 13-11: Metal Precipitation Extent in Fluoride Precipitation



The test results show that the magnesium can efficiently be removed with a very low level of manganese co-precipitation. The results also show significant co-precipitation of calcium.

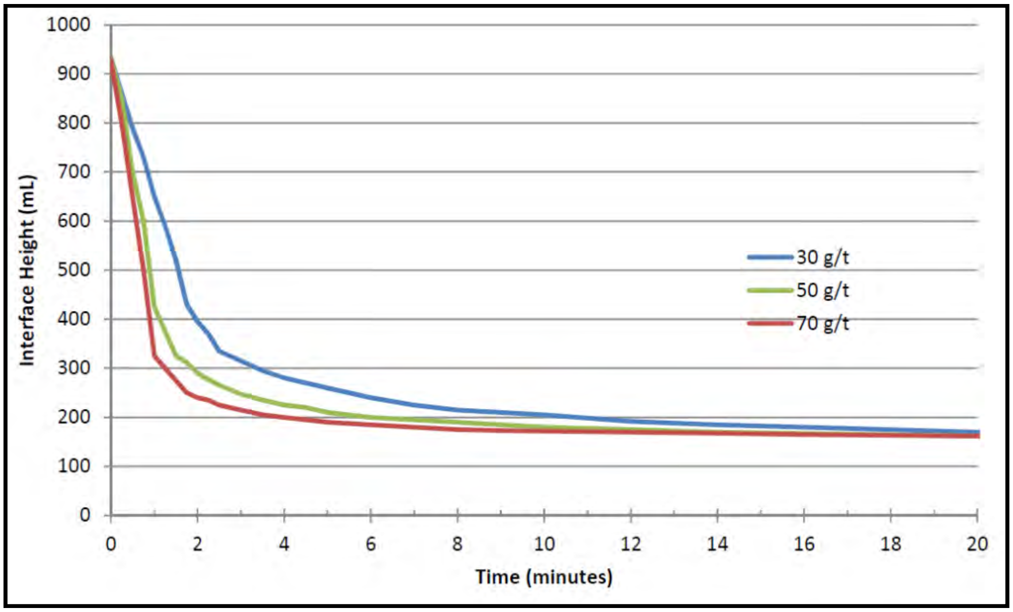
The precipitation of magnesium and calcium continued after fluoride addition was halted. This could be a result of residual fluoride and slow precipitation kinetics. Residual fluoride levels after acidic precipitation were in excess of 2,000 mg/L and dropped to 724 mg/L after pH adjustment to pH 6.2, and then further dropped to 410 mg/L after aging for approximately 48 hours.

13.6 Solid-Liquid Separation

13.6.1 Settling Test Work

Met-Solve conducted preliminary flocculant screening and batch settling test work on the flotation concentrates produced from Composite T9-T11. As shown in Figure 13–12, the material readily settles with adding the Cyfloc A-100 flocculant. At 50 g/t flocculant dosage and 10 % w/w feed solids density, a compressed solid density of 40% w/w was achieved in eight minutes.

Figure 13-12: Settling Curves at Different Flocculant Dosages



13.6.2 Filtration Test Work

Followed the settling tests, Met-Solve conducted preliminary pressure filtration tests using a 20 mm diameter bench scale filter on the samples used for the settling tests. The test Results are shown in Table 13-22.

Table 13-22: Filtration Test Results

Test ID	Pressure (psi)	Flocclant Dosage (g/t)	Time^1 (s)	Time^2 (s)	Cake Thickness (mm)	Dry Weight (g)	Moisture (%)
1	35	50	120	165	6.8	204.1	26.3
2	35	0	245	345	6.5	214.5	24.5
3	20	50	190	266	7.0	208.5	28.5
4	50	50	50	95	6.0	204.0	23.1
5	50	50	552	810	22.0	824.2	21.8

Note: Time^1: cake forming time, recorded before blowing air applied
Time^2: drying air blowing time

The cake moisture contents produced ranged from 21.8 to 28.5% depending on the filtration conditions, including pressure applied, cake forming retention time and air blowing time. Also it appears that addition of flocculant may slightly improve the filtration performance. A higher filtration pressure produced a lower cake moisture.

13.7 Acid-Base Accounting

Preliminary acid-base accounting of the Phase 2 composite samples were conducted by Global ARD Testing Services Inc. (Global ARD) to determine the acid generation potential of the material. The samples reported a neutralization potential ratio (NPR) of 0.94 indicating that the material is mildly acid generating.

An ABA test was conducted on the pyrite flotation tailings. The ABA determination results indicated that the flotation tailings would also be acid generating with a NPR value of 0.40.

13.8 Proposed Process Flowsheet by Process Evaluations

Preliminary process development studies have been conducted by AMEC Foster Wheeler (AMEC) and CINF Engineering Co., Ltd. (CINF). The proposed flowsheet includes following main process circuits:

- Whole tailings material acid leaching.
- Iron and phosphorous precipitations.
- Leaching residue solid and liquid separation with washing and recovery of manganese and ammonia.
- Leaching pregnant solution purification, including heavy metal precipitation.
- Manganese electrowinning, manganese metal passivation, stripping from cathode plates.
- Magnesium removal from spent anolyte and ammonia recovery from spent anolyte.

Further process flowsheet development and optimization are being carried out by CINF and Tetra Tech, including evaluation of magnetic separation treatment to pre-concentrate the leaching feed.

13.9 Test Work Recommendations

Further metallurgical testing is recommended to better understand metallurgical performances, optimize processing conditions and generate design related data. A comprehensive metallurgical testing program, including pilot plan tests is underway on the approximately 14.8 tonnes bulk sample that was shipped to CRIMM. The details are summarized in Section 17.0.

14.0 MINERAL RESOURCE ESTIMATES

14.1 Basis of Current Mineral Resource Estimate

The current mineral resource estimate has been based on 755 two metre samples taken from 80 drill holes collected by EMI in the summer of 2017. Samples were collected from three tailings cells within an above ground tailings facility. Tailings were generated from historical mining operations.

Data was analyzed in Phinar X10-Geo v.1.4.15.8 and Geovia GEMs v.6.2, and models constructed using Aranz Leapfrog Geo v.4.1,

A mineral resource estimate has been developed for total and soluble manganese concentrations and is effective April 27, 2018, to align with the day final analytical certificates or laboratory data were received. Additional variables have been included in the modelling process to help characterize and inform interpretation, these variables include in situ dry bulk density, total moisture and various grain size indicators.

14.2 Historical Mineral Resource Estimates

Two historical Mineral Resources Estimates reported by Bateria Slany are described below as they are considered relevant to the resource presented herein. The key assumptions, parameters and methods used to prepare the estimates is unknown and the results cannot be relied upon. Neither Tetra Tech nor EMI accepts these historical estimates as a current mineral resource or mineral reserves estimate.

Upon transfer of the Chvaletice mine from the Federal Government to the Chvaletice Energy Company in 1978, an estimation of “reserves” within the tailings facility, identified as “flotation sludge”, totaled 26,600,000 tonnes grading 7.09% Mn (total). The “reserve” was considered uneconomic, however, research into possible processing technologies was initiated.

From 1985 to 1989, Bateria Slany completed 956.3 metres of drilling to characterize the physical and chemical properties of the tailings sludge, in addition to over 200 m^3 of trenching. Extensive testing and analysis of the samples was undertaken by Bateria Slany, who in 1989, evaluated that the tailings deposits comprised 27,557,441 tonnes of “reserves”, containing 25,496,299 tonnes at a grade of 5.15% leachable Mn (7.06% total Mn) at a “C2” category, and 2,061,143 tonnes of material average grade of 4.97% of leachable Mn (7.39% total Mn) at a “C1” category. The definition of C2 and C1 categories references a system developed in the Czech Republic for classification of minerals “resources” and “reserves”, where resources classified as C1 are supported in greater detail than those classified as C2. The Czech system differs significantly from classification defined under the CIM Terms and Definitions as referenced by the JORC Code and cannot be misconstrued to imply a similar level of confidence.

14.3 Input Data and Analysis

14.3.1 Compositing

Samples were collected from drill core at 2 metre interval lengths equal to each drill run. The interval was increased or decreased at the top and bottom of the holes to accommodate tailings material logged in intervals that did not correspond with the start or finish of a 2 metre drill run. The raw assay data was composited to 2 metre sample lengths, with 1 metre minimum coverage required within the composite. This resulted in an increase from 755 raw samples to 759 composite samples (Table 14 1). A total of 42 composite sample lengths (5.5%) were less than 2 metres, ranging from 1 metre to 1.9 metres. The mean values and overall sample distribution was not significantly impacted by the compositing process (Table 14 1).

In Figure 14–1 below, the predominant sample length is 2 metres, with range from 0.6 metres to 4.0 metres with standard deviation of +/-0.3 metres.

Figure 14-1: Frequency Distribution of Sample Length

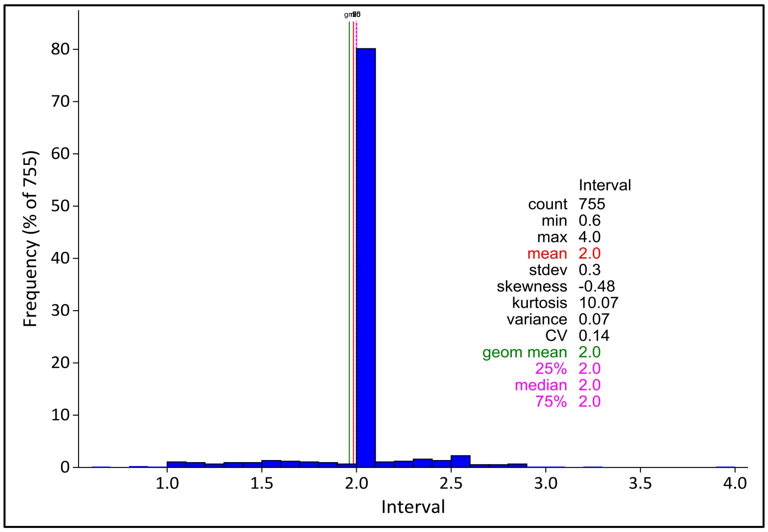
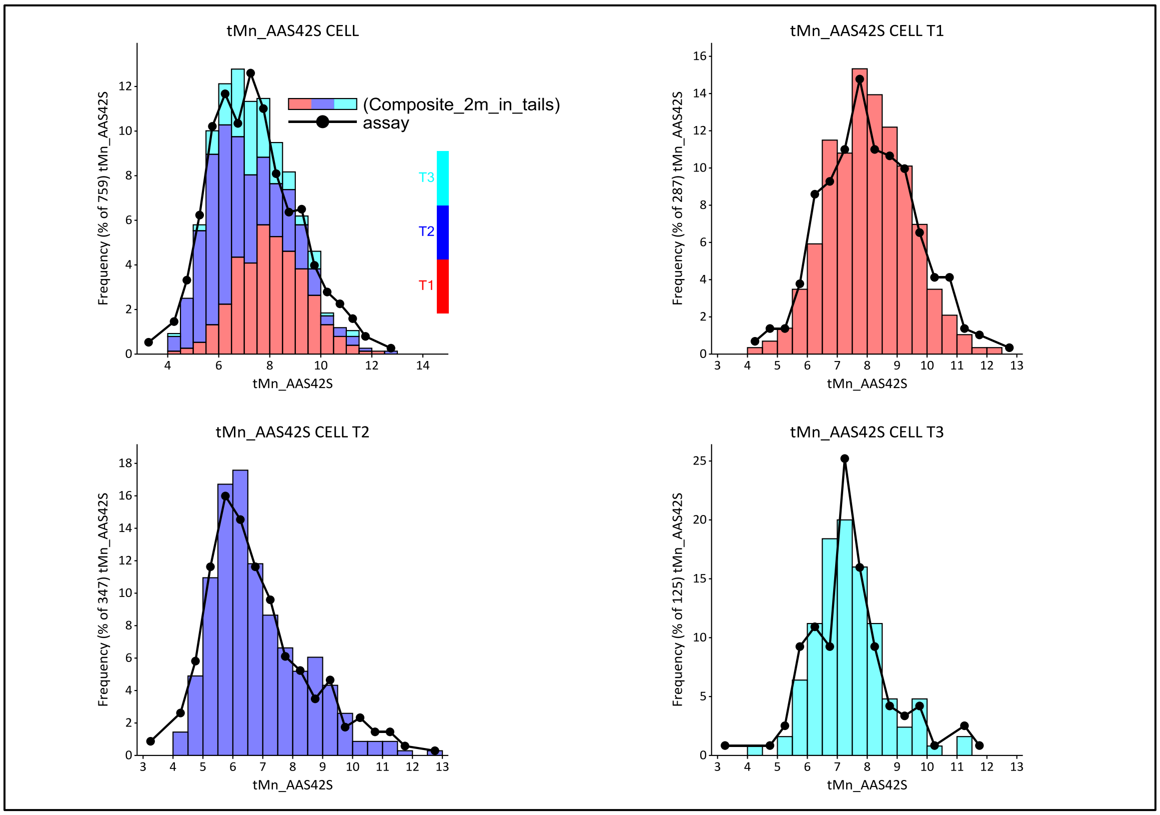


Table 14-1: Descriptive Statistical Comparison of Raw Data and 2 m Composite Data for Total Manganese

Dataset	Count	Mean	GeoMean	SD	Min	Max
Raw data	754	7.39	7.20	1.66	3.31	12.91
2 m composites	759	7.39	7.24	1.51	4.02	12.83

Figure 14-2: Frequency Distribution Comparison Between Raw Assay (Black Line) and 2 m Composites (Coloured Bars) for Total Manganese Concentrations by Cell



14.3.2 Capping Analysis

It was observed that outliers at both high and low ends of the grade distribution were located within lateral zones of similar grade trends. It was interpreted that these grades are representative of the natural variance within the deposit and no grade capping was applied.

14.3.3 Variogram Assessment

Downhole variogram analysis was undertaken on all 2 metre composite drill hole sample data using lag of 2 metres using Geovia GEMs Statistics v.6.7.4 to determine nugget (C_0) for manganese and iron data. An apparent nugget was modelled for total and soluble manganese, total iron, total magnesium and total calcium. These values are shown in Table 14-2.

Drill hole and corresponding assay data spacing within the model is approximately 100 metres. Experimental variogram analysis was conducted on the horizontal plane with lag distance at 50 m and 100 m to attempt to determine sill and range values for interpolation using all 2 metre composite data for each individual Cell. Insufficient short range data exists for to define ranges at less than 100 m based on the calculated sill for the data. It was concluded that some uncertainty exists in the variogram model due to shortage of short range data and that variography could not be completed for this dataset. This may be a function of the manmade nature of the tailings deposits.

14.3.4 Search Parameters

Interpolation searches were performed using the spheroid model in Leapfrog. This method is based on ordinary Kriging, however, lacks some fundamental control on the variogram model, kriging parameters, and composite input. A base range of 150 metres was used to represent 96% of the spheroid search distance. Anisotropy ratios in the search ellipse were 1:1 for the major and intermediate axis, and 1:20 for the minor axis relative to the major axis. All searches were performed with major and intermediate axes orientation on the horizontal plane. With these ratios, the resultant search dimensions were greater than the base range, as listed in Table 14-2, where the relationship is:

$$base\ range = \sqrt[3]{Max * Int * Min}$$

Table 14-2: Modelled Variables with Corresponding Search Parameters

Variable	Search Type	Nugget/Sill	Base Range	Major Range_X	Intermediate Range_Y	Minor Range_Z
“Total” Mn (tMn, %)	Spherical	0.2 / 2.5	150	400	400	20
“Soluble” Mn (sMn, %)	Spherical	0.1 / 2.0	150	400	400	20
“Total” Fe (tFe, %)	Spherical	0.1 / 2.0	150	400	400	20
“Total” Mg (tMg, %)	Spherical	0 / 0.09	150	400	400	20
“Total” Ca (tCa, %)	Spherical	0 / 0.3	150	400	400	20
Bulk Density (t/m^3)	Linear	n/a	150	250	250	50
Moisture (%)	Linear	n/a	150	250	250	50
Clay (%)	Linear	n/a	150	250	250	50
Silt (%)	Linear	n/a	150	250	250	50
Sand (%)	Linear	n/a	150	250	250	50
Gravel (%)	Linear	n/a	150	250	250	50
D_{10} (µm)	Linear	n/a	150	250	250	50
D_{50} (µm)	Linear	n/a	150	250	250	50
D_{80} (µm)	Linear	n/a	150	250	250	50
D_{90} (µm)	Linear	n/a	150	250	250	50
P_{75} (%)	Linear	n/a	150	250	250	50

14.3.5 Block Size Determination

A sub-block model was used to determine volumes of the Chvaletice tailings deposits allowing for higher resolution with smaller block sizes around the perimeter slopes of the model. Parent block size for the model was determined based on drill hole spacing and de-clustered mean analysis. Using the de-clustering cell size optimization utility in Geovia GEMS™, it was determined that 50 metre cell size were the optimal size (Figure 14-3). The model was established using a parent cell size of 50 metres by 50 metres by 4 metres, and minimum sub-cell size of 12.5 metres by 12.5 metres by 4 metres.

The de-clustered mean values for “total” and “soluble” manganese concentrations are listed in Table 14-3. The sub-block model was established with overall model dimension as listed in Table 14-4.

Figure 14-3: De-clustered Mean Versus Cell Size

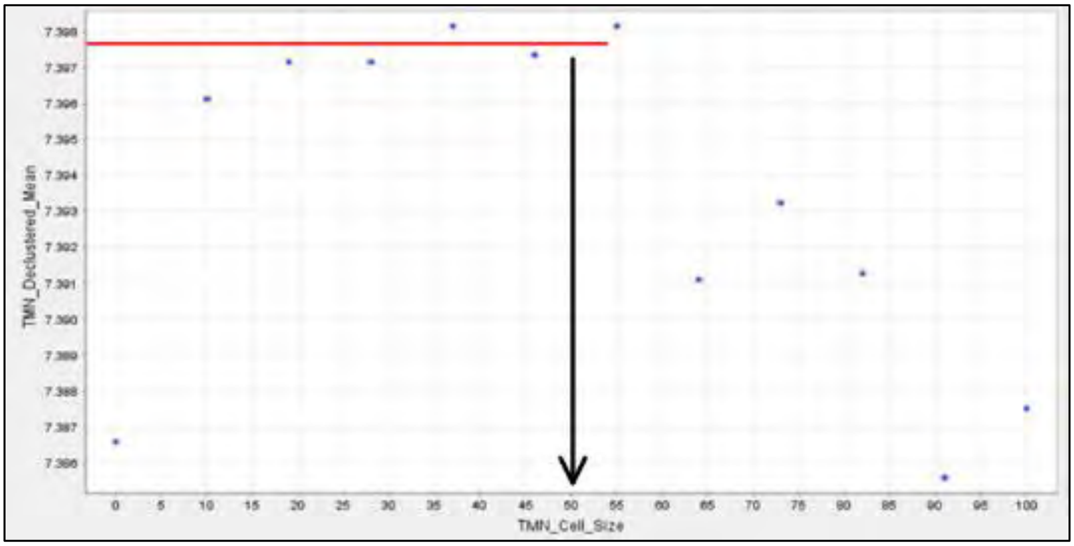


Table 14-3: Block Size Determination De-Clustered Manganese Concentrations

Dataset	Value	Count	Mean	De-clustered Mean
All	tMn	754	7.387	7.376
	sMn	-	5.902	5.893
T1	tMn	291	8.056	8.005
	sMn	-	6.441	6.398
T2	tMn	344	6.809	6.812
	sMn	-	5.468	5.473
T3	tMn	119	7.420	7.458
	sMn	-	5.835	5.873

Table 14-4: Block Model Dimensions (S-JTSK Coordinate System)

Model	Origin_X	Origin_Y	Origin_Z	Size_X	Size_Y	Size_Z	Blocks_X	Blocks_Y	Blocks_Z
Parent	-671,600	-1,058,750	240	50	50	4	27	28	23
Sub-block	-	-	-	12.5	12.5	4	-	-	-

14.3.6 Bulk Density Estimation

Deposition of processed material as a slurry into the tailings deposits has a significant influence on the final in situ dry bulk density of the tailings material. Water content, particle size gradations, mineral density composition and degree of compaction from overlying material all contribute to grain settlement and packing. Recovery of the tailings material from the sonic drill core tube was conducted to minimize the disturbance of in situ material conditions. In practice, controlled core recovery is nearly impossible for saturated tailings and very challenging in under saturated material. Slumping and plasticity of the material caused some variability in the estimated core recoveries.

Core recovery values were collected during field logging along with the moisture and mass measurements collected from laboratory sample processing were used as the basis for calculating in situ bulk density for the tailings material.

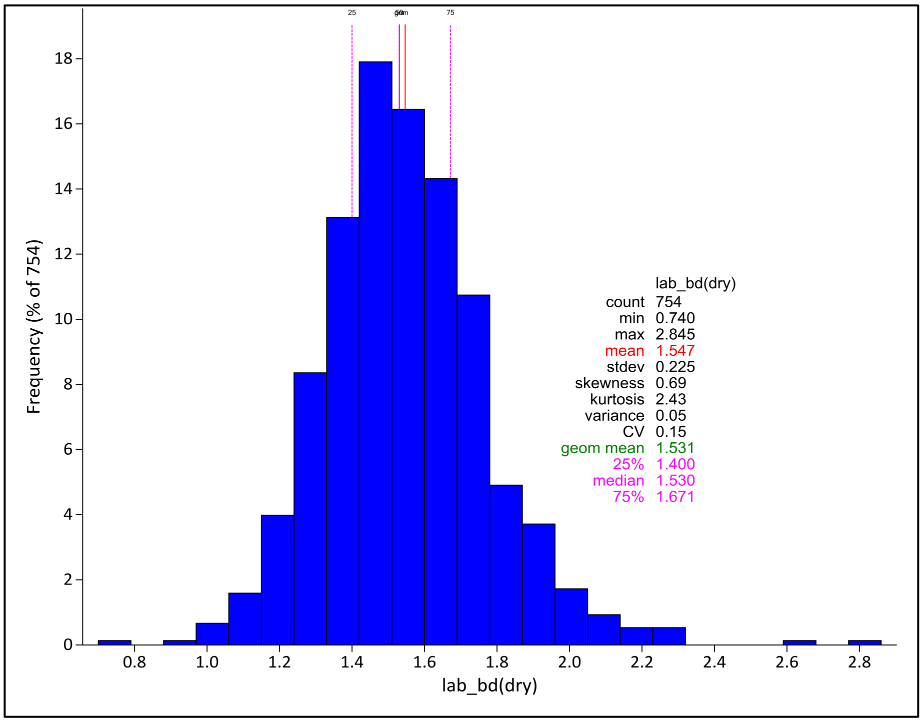
Idealized core volumes for the one metre sub-samples were factored for core volume recovery and then back calculated to the full two metre core run volume before being factored again by 0.25 to represent the volumes of 25% split assay samples that were sent to SGS.

All samples were weighed as wet samples on receipt at the lab, then again following split extraction for the PSA-LD samples. They were then dried at 105°C until no additional moisture loss was measured. In situ dry bulk density was calculated based on the wet mass of the assay sample received at SGS prior to extraction of the PSA-LD sample split, and then was factored to account for moisture loss during the PSA-LD sample preparation and from drying the final sample to estimate the dry mass of the assay sample as received. This dry mass was then factored over the sample volume estimated to have been received at the lab, using the following formula:

$$Insitu\ Dry\ bulk\ density = \frac{(Wet\ mass\ of\ sample\ as\ received) - (Mass\ of\ Total\ Moisture\ Content)}{Assay\ sample\ volume, measured\ in\ field}$$

In situ dry bulk density values for individual samples range between 0.74 t/m^3 and 2.85 t/m^3, with a mean value of 1.55 t/m^3, as depicted in the frequency distribution shown in Figure 14–4. The in situ dry bulk density values were composited and included as variables in the final model interpolation resulting in unique spatially unique values applied to the block model.

Figure 14-4: Frequency Distribution of Calculated In Situ Dry Bulk Density, Represented On Raw Sample Intervals



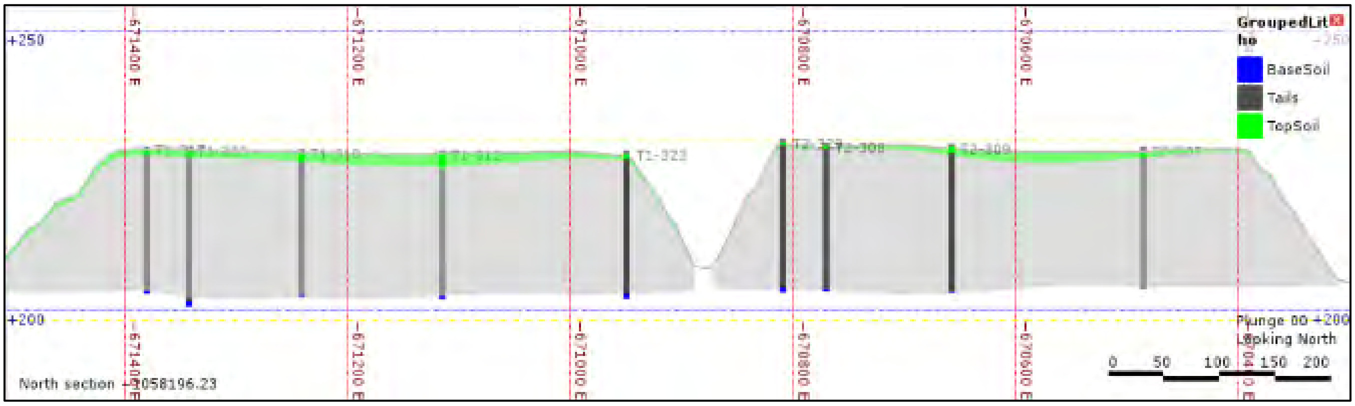
14.4 Volume Estimations

Volume estimates for the Cells were developed using the topographic DEM to constrain upper surfaces and deposit perimeters, and logged drill hole data were used to constrain the lower boundary of tailings with original ground soils. A simplified lithological model was developed for each cell to identify topsoil, tailings and subsoil. The volume of material defined as tailings was then used to confine all numerical models and estimates reported for each cell under the mineral resource estimates. Volumes estimates for tailings material contained in each cell are listed in Table 14–5 and Figure 14–5 shows a typical section through Cells 1 & 2 with the three simplified lithologies identified.

Table 14-5: List of Estimated Volume of Tailings within Each Cell, Constrained by Topography

Cell	Surface Area	Topsoil Volume (m^3)	Tails Volume (m^3)
1	326,400	308,340	6,600,400
2	393,200	283,210	7,915,300
3	313,200	206,240	3,013,100
Total	**1,032,800**	**2,060,030**	**17,528,800**

Figure 14-5: Typical Section Looking North Through Cells 1 & 2 Showing the Simplified Lithology and Tailings Volume Used for Deposit Modelling (5x vertical exaggeration)



14.5 Geological Interpretation for Model

Deposition of tailings materials was episodic over the life of the historical mining operations. The material was deposited from processed materials with mixed particle sizes suspended in slurry. The deposits are characterized by the broad lateral (i.e., horizontal to sub-horizontal) extent of particle segregation as the slurry flooded the tailings facility. Thin beds of sediment would have been deposited laterally outwards with a particle gradation from coarse to fine away from the point of discharge. It is interpreted that grain size and moisture content may have more similarity with materials in a vertical sense and have more variability in a horizontal sense. Whereas, grade distribution, appears to be less dependant on particle size or moisture content and is interpreted to have more similarity with materials in a horizontal sense. All searches for block model interpolation were undertaken relative the horizontal plane.

Local beds, or lenses, of oxidized tailings material were observed in core logging to exist infrequently at depth within the deposit, with thicknesses typically ranging at less than 0.5 metres. These zones are due to oxidized pyrite and other sulphide minerals contained in under saturated tailings that were exposed to air for long durations, representing periods of hiatus or where local beaching occurred within the tailings at a distance to the point of deposition. These zones have not been modelled in detail, and are considered to be insignificant in the broader sense of the deposit. For the purpose of the mineral resource estimate, all tailings materials are considered to be primary, or unoxidized, materials.

A deposit model was developed using Aranz Leapfrog v.4.1 to represent the volume of tailings within each facility, and to further subdivide the tailings into domains representing ranges in elemental concentration, particle size and in situ dry bulk density.

Each Cell was first segmented into lithology volumes for topsoil, tailings and subsoil, based on descriptions in the field logs. The tailings unit for each Cell was applied as an external shell to constrain the grade, particle size, moisture and bulk density models.

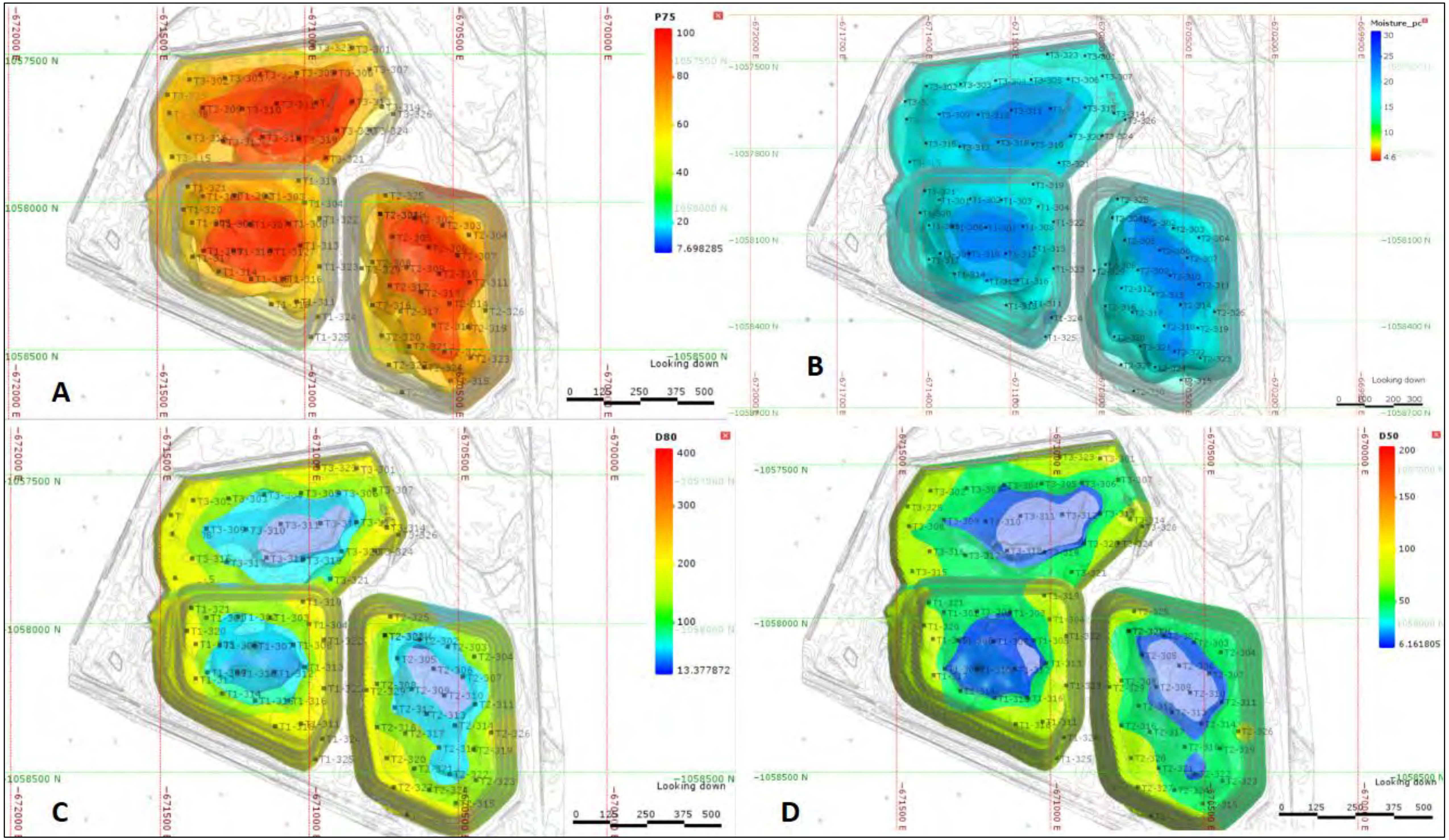
The particle size model was based on data from the laser diffraction particle size analysis. The grain size distribution was simplified to percentages of clay, silt, sand and gravel using both European and North American soil classification standards. Additionally, the data was simplified to single value indices to characterize the distribution. Particle diameters measured for each decile of the distribution characterizes how the particles are statistically distributed throughout the deposit, where D50 represents the particle size of the 50th percentile (or median value), and D80 represents the particle diameter at the 80th percentile. Alternatively, the distribution was also characterized by the percent of the sample which passes a defined screen mesh, such as P75 which describes the percentage of the sample which passes nominal screen size of 75 µm (i.e., 200 mesh). The average value for these indices as modelled are listed on Table 14-6, by Cell.

The moisture model was based on moisture data measured by SGS labs from mass measurements on receipt of the sample and after drying, after applying a correction for mass loss from the PSA-LD sample split. The average value for moisture content as modelled is listed on Table 14-6, by cell.

Table 14-6: List of Average Values for Modelled Variables Compared, Listed by Cell

Cell	Particle Size				Moisture
	D50 (µm)	D80 (µm)	D90 (µm)	P75 (%)	(%)
T1	55.74	134.77	197.20	69.44	18.58
T2	39.98	106.77	161.38	74.78	18.96
T3	45.12	120.16	187.50	74.04	18.18

Figure 14-6: Plan Views of Geological Model Volumes: a) P75 grain size indices, b) moisture, c) D80 grain size indices, and d) D50 grain size indices



14.6 Manganese Break-Even Grade

Studies are ongoing as the company evaluates the markets for production of high purity, selenium-free, 99.9% electrolytic manganese metal (EMM) and/or high purity manganese sulphate monohydrate (HPMSM) product.

Based on preliminary onsite and offsite operating cost estimates and metal recovery estimates, the break-even grade is estimated to be 3.85% tMn. All the costs and recoveries are based on preliminary estimates and may not be representative of the actual project costs and parameters. Assumptions for this grade calculation include:

- 99.7% EMM metal price of US$2.09/kg or US$0.95/lb (Infomine, April 2017). The commodity price is expected to be higher for 99.9% Mn EMM;
- Onsite and offsite operating cost estimates (US$5.22/t for onsite mining and magnetic pre-concentration treatment; US$173/t for manganese extraction and refining from 15% tMn concentrate, including off site and royalty cost);
- Approximately 68% metal recovery at the leaching and refining; 50% metal recovery at the magnetic concentration for lower than 4% tMn materials; and
- It is assumed that mining selectivity will not be applied due to inherent difficulty of grade control and selective mining for this deposit type.

The deposit is being considered as a bulk tonnage deposit and it is currently assumed that selective mining will not be applied. All tailings material will be sent to the process plant on a diluted basis, and no cut-off grade can reasonably be applied to the deposit (i.e., no mining waste will be generated). The case for economic extraction relies on the net value of resources being sent to the plant to be positive; the average feed grades must be greater than the break-even grade (cost equivalent) of 3.85% tMn.

14.7 Mineral Resource Estimate

The Mineral Resource Estimate was calculated using Aranz Leapfrog Geo using extrapolated volume models based on recent Phase 1 drilling results for the total and soluble manganese grades and bulk density values. The volume models were superimposed onto a sub-block model and reported on a block volume weighted basis.

The Mineral Resource Estimate for in situ tailings material at the Chvaletice Manganese Project are listed in Table 14-7. This estimate is effective as of April 27, 2018. This estimate adheres to guidelines set forth by the JORC Code.

Table 14-7: Mineral Resource Estimate for the Chvaletice Manganese Project, Effective April 27, 2018

Cell	Class	Volume (m^3, '000s)	Tonnes (kt)	Bulk Density (t/m^3)	Total Mn (%)	Soluble Mn (%)
T1	Indicated	5,684	8,832	1.55	8.08	6.46
	Inferred	1,004	1,497	1.49	8.60	6.87
T2	Indicated	6,773	10,567	1.56	6.86	5.48
	Inferred	996	1,648	1.65	7.90	6.05
T3	Indicated	2,772	3,973	1.43	7.34	5.78
	Inferred	250	363	1.46	7.84	6.14
Total	**Indicated**	**15,229**	**23,372**	**1.53**	**7.40**	**5.90**
Total	**Inferred**	**2,250**	**3,508**	**1.56**	**8.21**	**6.43**

Notes:

- Mineral Resources do not have demonstrated economic viability but have reasonable prospects for eventual economic extraction. Inferred Resources have lower confidence than Indicated Resources. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, sociopolitical, marketing, or other relevant issues.
- A cut-off grade has not been applied. No capping has been applied.
- Numbers may not add exactly due to rounding.

Figure 14–7 shows a plan view of the block model for Cells 1, 2 and 3 and definition of sections A-A' and B-B'. Vertical cross sections along these lines are shown in Figure 14-8 for soluble manganese block values and Figure 14-9 for P75 block values.

Figure 14-7: Plan View of Block Model Showing Section Lines and sMn Grade Distribution at Surface

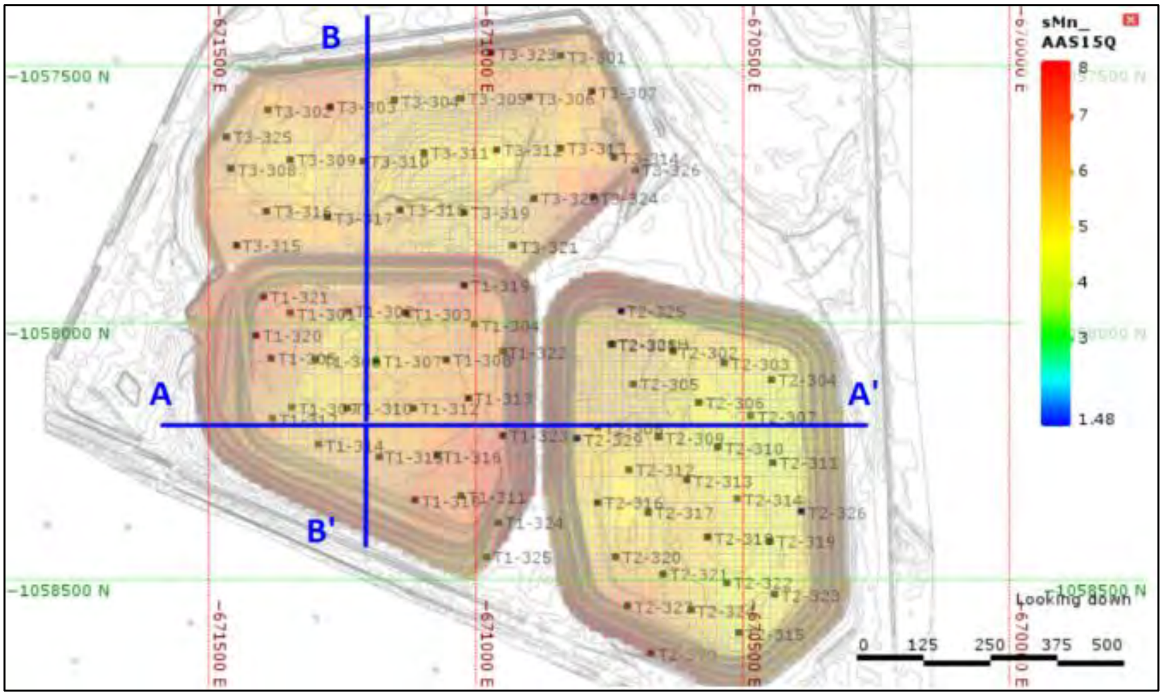


Figure 14-8: Vertical Cross-Section View Showing sMn Block Values along lines A-A’ and B-B’ (5x vertical exaggeration)

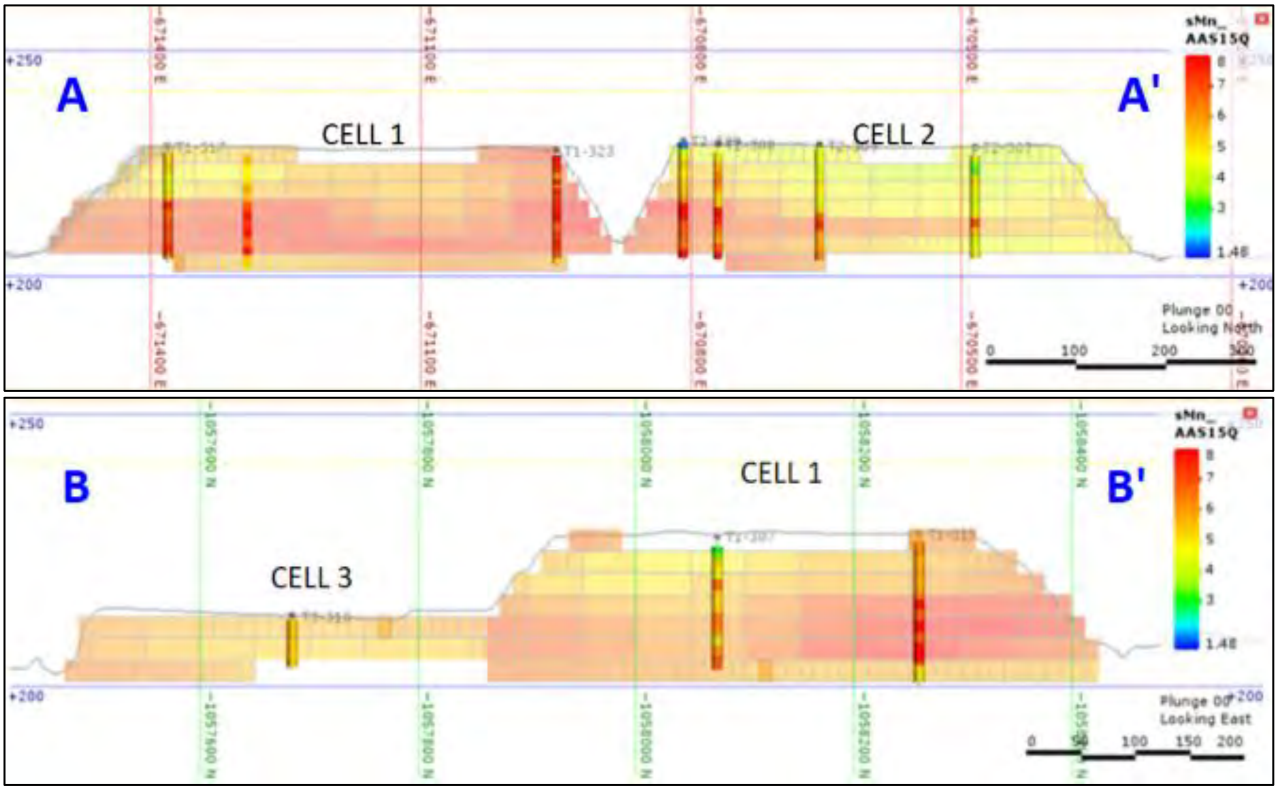
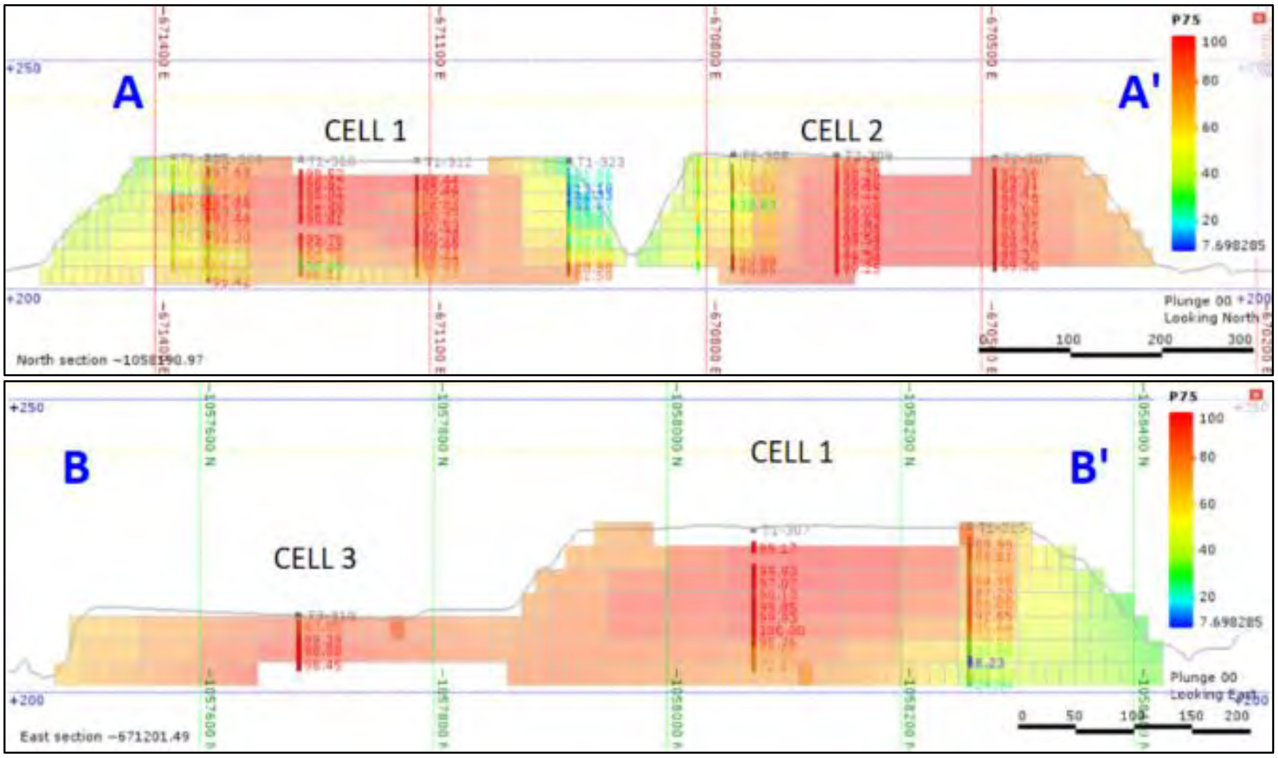


Figure 14-9: Vertical Cross-Section View Showing P75 Block Value along lines A-A’ and B-B’ (5x vertical exaggeration)



14.8 Classification

Mineral Resource Classification was performed in reference to the JORC Code. No set standard exists for classification of resources for tailings deposits.

The CP is of the opinion that the CMP is a reasonable prospect for eventual economic extraction on the basis of:

- The net average Inferred (8.21%) and Indicated (7.40%) tMn grades reported for the mineral resource estimate are greater than the break-even grade of 3.85% tMn (Section 14.6);
- The minimum composite tMn grade measured from drillhole sampling in the tailings deposit and used as input to the resource estimate is 4.02% tMn;
- The minimum tMn in the resource block model is 4.94% tMn. All material stated within the mineral resource estimate has tMn grade that is greater than the break-even grade, and therefore the net value of the deposit is estimated to be positive; and
- Further engineering and financial assessment will be conducted to validate the economic viability of the project.

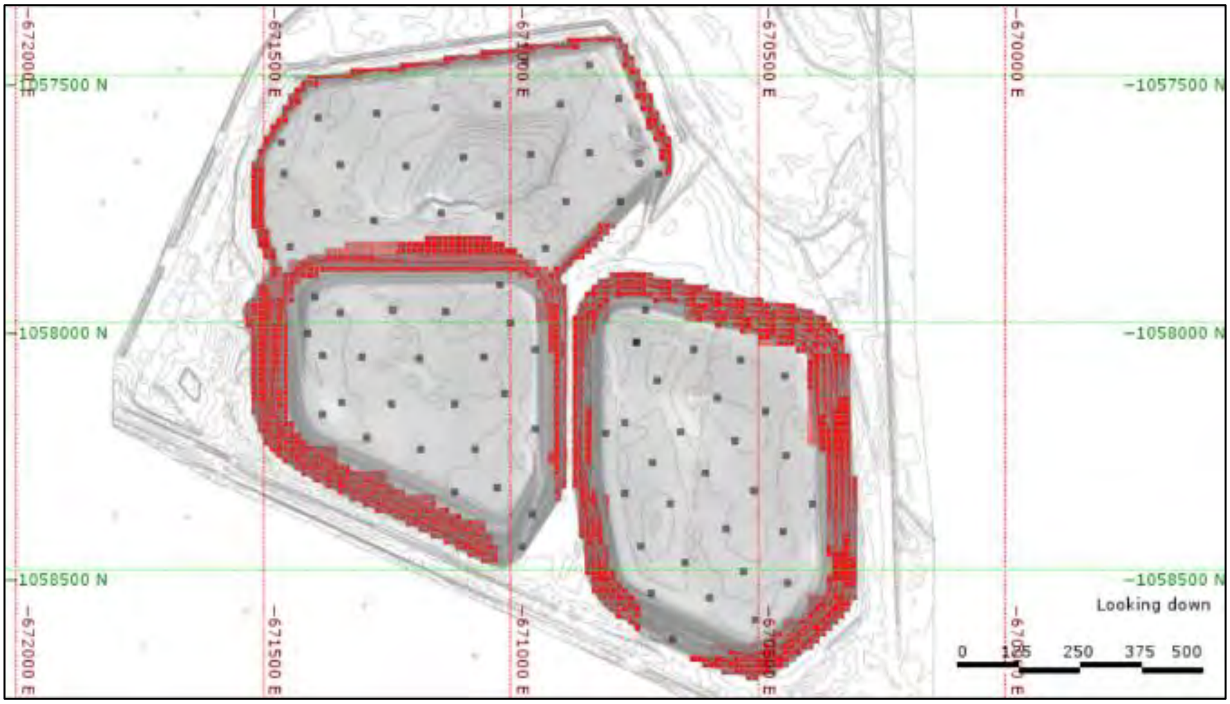
Inferred mineral resources are those materials where evidence is sufficient to imply but not verify geological and grade or quality continuity. Presence and continuity of manganese concentrations within the perimeter slopes of the cells has been demonstrated from few boreholes drilled on access ramps. Uncertainty in the actual concentration and distribution of manganese remains for the majority of the slopes, which will require additional drilling. Additionally, historical documentation reports that native soils were used to construct a perimeter starter berm for the tailings facility foundations. The lower contact of the tailings deposit is modelled based on the results of recent drilling, and has been extrapolated laterally where no data exists. The location and extent of this original native soil material has not been confirmed by drilling and some uncertainty exists to the volume of material, although the volume would not be considered significant to the overall resource volume. Due to these uncertainties around the perimeter slopes of the deposits, these materials have been classified as Inferred Mineral Resources. A vertical boundary has been defined near the upper bench perimeter of the deposits to define this outer zone of uncertainty.

Indicated mineral resources are those materials where evidence is derived from adequately detailed and reliable exploration, sampling and testing and is sufficient to assume geological and grade or quality continuity between points of observation. Distribution and concentration of manganese concentrations have been reasonably defined for the majority of the deposits by drilling spaced at approximately 100 metre spacing confirming trends with 3-dimensional continuity and allowing for modelling of grade distribution in conjunction with numerous other chemical and physical parameters. It is observed that the distribution of total and soluble manganese has a low standard deviation and coefficient of variation, suggesting that overall grade distribution is quite uniform. However, variogram analysis failed to demonstrate a functional relationship between grade and distance from known samples, which may have been related to the drill spacing interval or the nature of the manmade nature of these deposits. The data is considered to be high quality for this area of the deposits. These materials have been classified as Indicated Mineral Resources.

Figure 14-10 depicts the volumes of material which represent the core Indicated and perimeter Inferred resources.

Conversion of Indicated resources to Measured resources would require some short range and twin hole drilling to attempt to determine the short range variability in manganese grade for grade control and operational reconciliation purposes. Additionally, closer drilling would provide additional data to improve sample support of smaller blocks to better reflect standard mining units. Additionally, refinement to the modelled understanding in relationship and distribution of geochemical properties, such as zones with oxidized tailings and other factors which may influence the overall solubility or recovery of manganese.

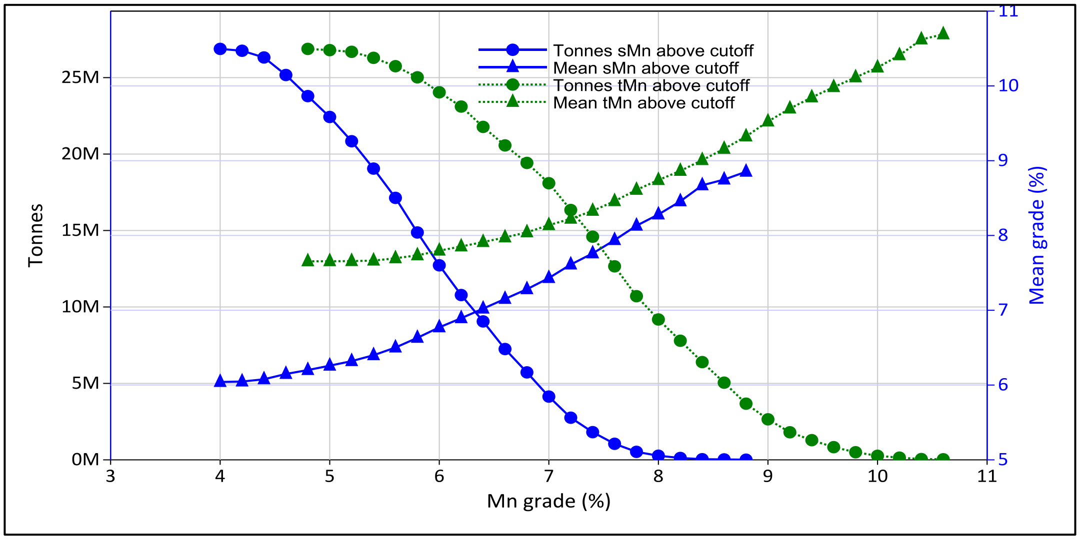
Figure 14-10: Plan View Showing Extent of Indicated (grey) and Inferred (red) Resource Volumes



14.9 Grade Tonnage Curves

As means of a reference to tonnage sensitivity and distribution of manganese grade, the following grade tonnage curve is presented. The grade tonnage tabulation includes all blocks contained within the model and has not been segmented based on mineral resource classification.

Figure 14-11: Grade Tonnage Curve for the Chvaletice Manganese Project



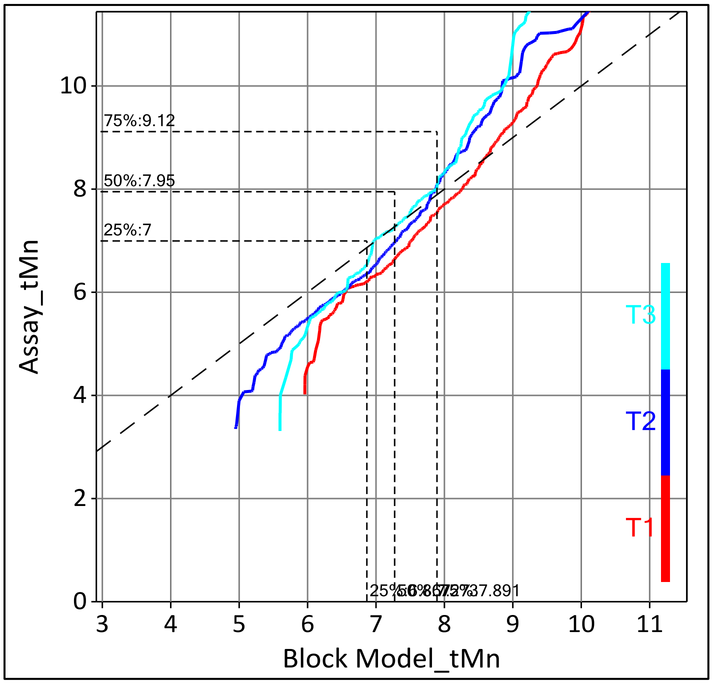
14.10 Model Validation

Model validation was conducted by visual inspection, and various geostatistical comparisons.

A visual inspection of the modelled variables along vertical cross sections comparing raw values, composite values and block values was conducted. No visual concerns were noted and the interpolated model fits the drill hole sample data well.

A quantile-quantile assessment is used as a visual check to compare shape of two dataset distributions. Figure 14-12 shows a QQ plot by Cell where quantiles of the composite tMn values are compared with the block tMn values. It is observed that median values are slightly higher in block values for Cells 1 and 2, and are equal for Cell 3. In general terms, the lower quantiles are elevated in block values and higher quantiles are elevated in composite values. This trend is expected and is a result of the de-clustering of higher grade values into the model blocks.

Figure 14-12: Quantile-Quantile Plot for 2m Composites and Block Model Values of tMn



A swath plot analysis was completed on the both the entire dataset and individual cell datasets. The analysis enables spatial verification for reasonable congruence of original assay data to the interpolated values along the three principal axes of the model. Figure 14-13 shows swath plots along the X-axis, Figure 14-14 along the Y-axis and Figure 14–5 along the Z axis. The analysis results indicate good correlation of the modelled blocks and no major bias has been introduced to the model during the interpolation process.

Figure 14-13: Swath Plots Along X Dimension, Total Mn Values Shown

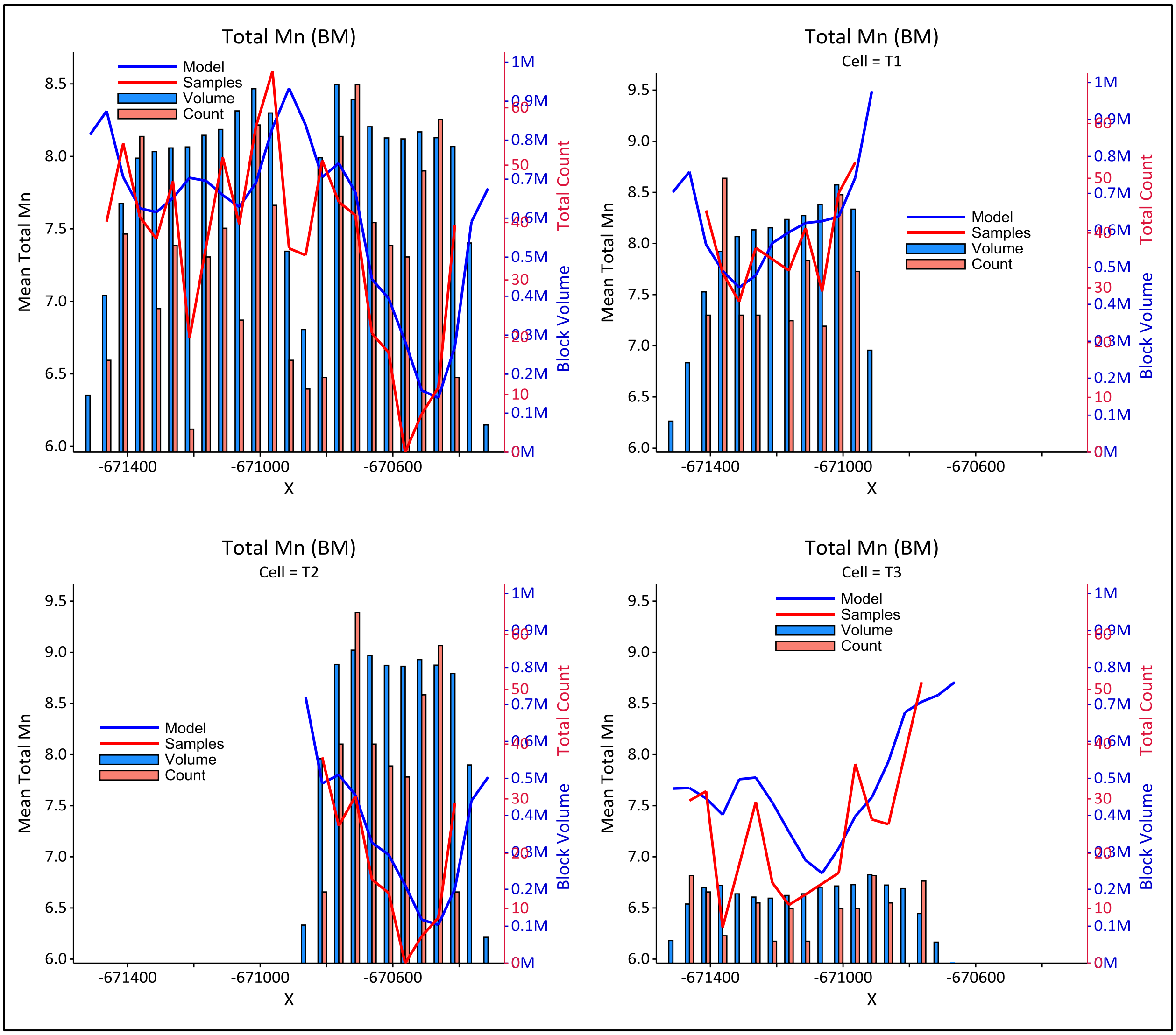


Figure 14-14: Swath Plots Along Y Dimension, Total Mn Values Shown

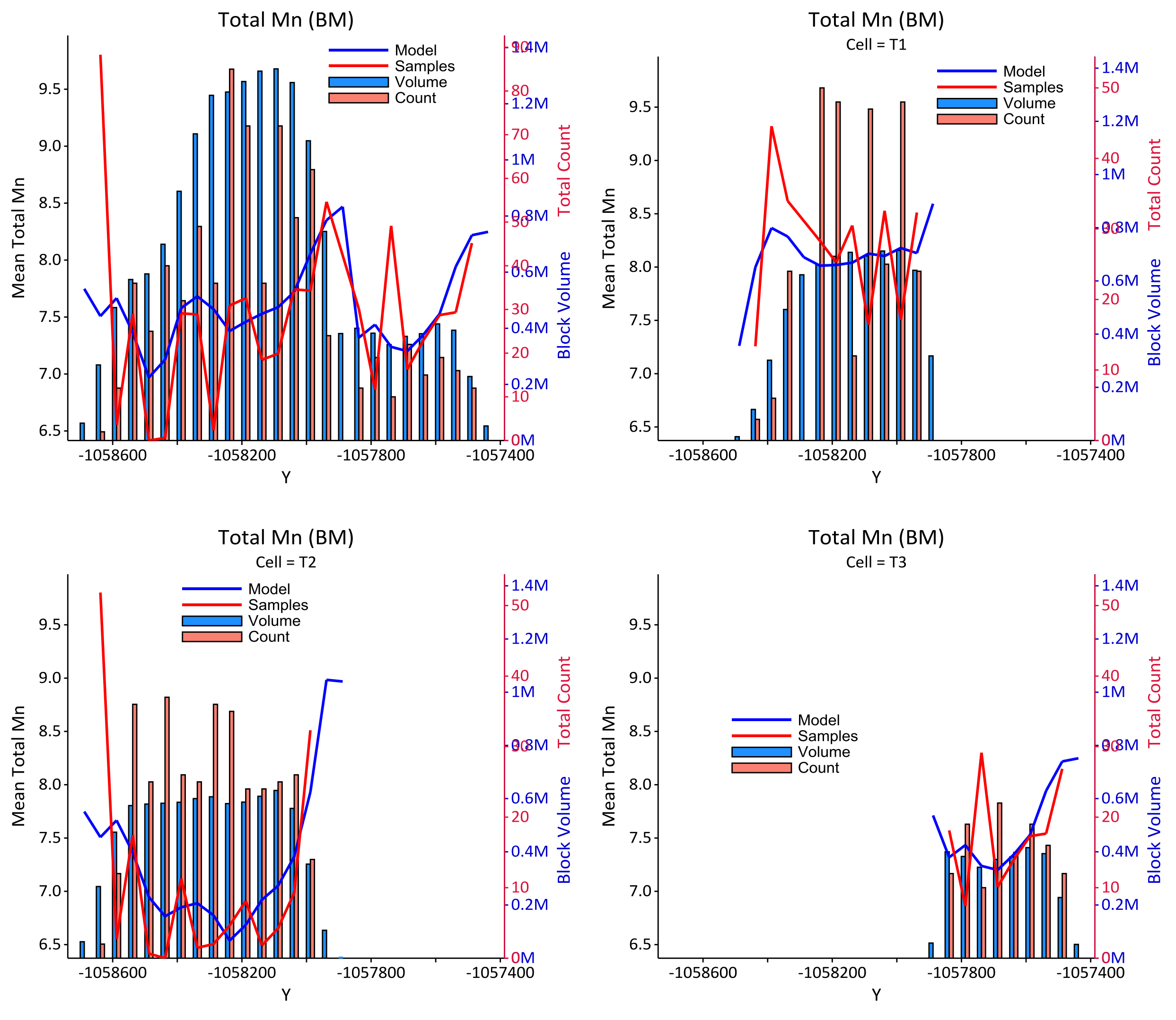
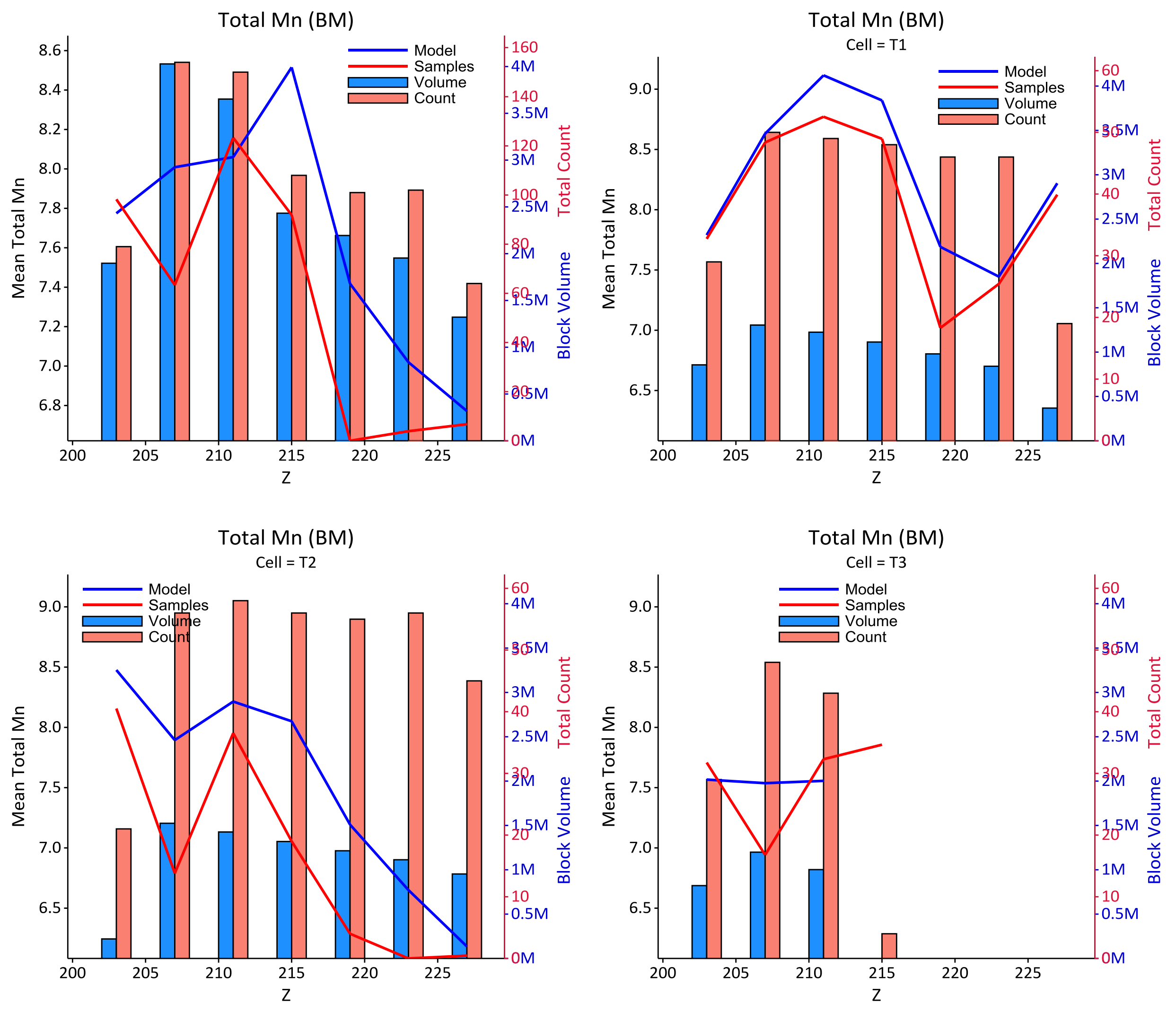


Figure 14-15: Swath Plots Along Z Dimension, Total Mn Values Shown



The author has conducted various forms of model validation and believes the model is a fair and reasonable representation of the sampling data collected from on-site investigations completed to date.

15.0 ADJACENT PROPERTIES

Adjacent to the Chvaletice manganese deposit (tailings deposit) is a coal-fired power station and a pre-cast concrete plant, with an infrastructure of highways and railways running through the center of these properties.

Additionally, two small granite bedrock crush quarries are located to the south of the power plant.

16.0 INTERPRETATIONS AND CONCLUSIONS

16.1 Geology and Mineral Resources

The Chvaletice Manganese Project is located in the Pardubice region of the Czech Republic approximately 89 kilometres east of Prague by road. A long history of mining has occurred in the area, with continued industrial activity from the 820MW coal-fired power generation plant.

The tailings deposits are located with easy access to road, rail and river for transportation of goods, and a plentiful workforce exists in numerous local communities. The deposits were constructed above ground using dried and compacted manganiferous tailings as the perimeter dams to hold the slurries which were deposited from the historical flotation plants.

Recent delineation drilling completed by EMI has resulted in the completion of 80 drill holes, totaling 1,679.3 metres, spaced at approximately 100 metres throughout each of Cell 1, 2 and 3 which allowed for sampling through the full vertical profile of the tailings material. A resultant 755 samples were sent for analysis of geochemistry, particle size specific gravity and moisture.

Sample digestion using Aqua Regia has been used as a proxy for soluble manganese, however, actual solubility may vary relative to the solvents and processes determined from the metallurgical test work. Data analysis identifies concentrations of total and soluble manganese in every sample, where total concentrations range from 3.31% to 12.91% Mn, and soluble concentrations range from 3.08% to 9.64% Mn. The Mn concentrations were well-distributed throughout each Cell, however, a slight decrease in average grade is observed towards the center of each Cell. The upper portion of Cell 2 shows a consistently lower concentration of Mn compared to the lower portion of the Cell. A similar, but less pronounced, trend is observed for Cell 1. This may reflect changes to mining or processing methods, increased dilution or removal of materials with less manganese during the historical mining activities.

Preliminary inspection of the grain size distribution analysis indicates that the dominant particle size is silt. Overall approximately 7% of material is clay (<2µm), approximately 64% of the material is silt (>2µm, <63µm), 28% is sand (>63µm, <2mm) and approximately 1% is gravel based on the European ISO TS 17892-4 standard. A general trend in all three Cells is observed whereby particle size grade from coarse to fine towards the center of each Cell.

Moisture content measured from each sample ranges from approximately 5.6% to 27.4%, and averaging overall of 17.4%. As with particle size distributions, the center of each Cell is observed to be saturated with above average moisture contents. This is attributed to the retention capacity of the fine silt and clays towards the center of each Cell.

In situ dry bulk density has been estimated for each sample based on estimated core recovery volumes in the field and measured sample mass and moisture content in the laboratory. The in situ dry bulk density variable is considered critical for the accurate estimation of total tonnages with the deposit. The calculated values ranged from 0.740 t/3m to 2.845 t/m3, with an overall average of 1.547 t/m3. The values are quite variable throughout the deposit and do follow as obvious trend as particle size or moisture. The in situ dry bulk density is a function of the composite mineral densities in addition to the degree of compaction in the soils.

Quality assurance methods were reviewed by Tetra Tech CP James Barr, P.Geo., during a two-day site visit to the property and quality control was reviewed and verified following receipt of the laboratory data. The mineral resource estimate was prepared and validated by the CP using guidelines set forth by the JORC Code resulting in Inferred and Indicated mineral resource estimates for each of the Cells. The CP is satisfied that integrity of samples has been preserved during handling, preparation and analysis and believes the mineral resource estimate to be reasonably accurate.

16.2 Mineral Processing and Metallurgical Testing

The preliminary mineralogical studies indicate that manganese is mainly present as rhodocrosite and as kutnohorite with lesser amounts as sursassite, pyrolusite and kurchatovite (grouped as Mn-silicate minerals). The grain size of manganese-carbonates varies significantly with significant amounts occurring as liberated and middling grains, lesser amounts are present as sub-middling and locked grains.

The manganese Mn-carbonates are mainly in complex associations with other carbonates, quartz and feldspars, or manganese Mn-silicate minerals.

On average approximately 80% to 85% of the manganese is present as acid soluble manganese.

Pyrite is the primary sulphide mineral present in the samples tested.

Particle sizing of the mineralization varies substantially within the tailings storage piles. It appears that the particle size of the material located at the edge of the pyrite tailings storage pile is coarser than the material at the center of the pile.

The test results show that, so far, the mineralization responds well to magnetic separation, compared to the other pre-concentration treatments, such as flotation and gravity concentration. The investigation into the effect of magnetic field intensity on the magnetic separation performance of a blended composite from Sample 10 and Sample 11 shows that the total manganese recovery improved with an increase in applied magnetic field intensity. When the magnetic field intensity is approximately 1.8 T, the total manganese reporting to an 11% tMn concentrate is approximately 88% for total manganese, or 87% for acid soluble manganese.

Several preliminary acid leaching tests were conducted to investigate the metallurgical response of the manganese minerals to sulphuric acid leaching. The results produced by SGS showed that at 50°C, 58% to 79% of the manganese was extracted from the Sample 10 and Sample 11 blended head sample depending on acid addition dosage. Up to 77% of the manganese in the magnetic concentrate sample was extracted with adding 500 kg/t sulphuric acid. The magnetic separation tailings showed much better metallurgical response. Approximately 88% of the manganese was extracted from the low-grade sample at an initial acid dosage of 200 kg/t.

The test results by CRIMM show that the manganese extraction can be improved when leaching temperature is increased.

17.0 RECOMMENDATIONS

17.1 Geology and Mineral Resources

The first modern systematic drilling investigation to be conducted on the Chvaletice tailings deposit to assess both the vertical and lateral variation of physical and chemical characteristics was completed by EMI in the summer of 2017 and is the subject of this report. There has been no further drilling on the property since then.

In situ dry bulk density values have been calculated based on core volume recoveries that were estimated in the field, and sample mass and moisture volumes that were measured in the laboratory. A well-supported sample distribution has been modelled for in situ dry bulk density and developed for the project which can be used to estimate average values with error margins, or can be maintained as a variable model throughout the deposit. Sample volume is a critically sensitive variable to this calculation and care must be taken in the field to obtain accurate volume estimates for any future samples being evaluated for in situ bulk density.

Further assessment of the lithogeochemical database in conjunction with the drill logs and photos should be undertaken to identify zones of oxidized material which may influence the leaching characteristics of the materials. The results should be interpreted into the lithological model and superimposed into the block model.

The results of the seismic and geophysical survey in additional to subsurface logs from historical hydrogeology wells should be combined and interpreted for subsurface stratigraphy. The stratigraphy should be included into the existing tailings facility model for use in future hydrogeological, geotechnical and mine planning assessments.

The mineral resource estimate is classified with Inferred and Indicated grades, volumes and tonnages on the basis of drill spacing and grade variability. Inferred blocks are located around the perimeter of the Cells underlying the perimeter slope/embankments which were not safely accessible by the drill rig used during the recent Sonic drilling campaign. The current model uses extrapolated trends from areas where drilling was conducted to estimate parameters within the perimeter area that is classified as Inferred. Limited drilling was completed through portions of the slopes from access roads which confirmed the presence of manganiferous tailings. An investigation should be undertaken to target those areas within the perimeter embankments not previously drill tested to provide data to increase confidence in the modelled parameters and to reduce reliance on extrapolated trends.

Limited infill drilling is recommended within the areas currently classified as Indicated to evaluate if there is a predictable short-range variation to manganese grade and to improve the sample support for smaller block sizes for use in mine planning. A twin hole drilling program would be included in this infill program to assess the short-range variability.

Preliminary acid-base accounting conducted by EMI and Tetra Tech (this report) has indicated variable results of the potential of the tailings material to generate acid. It is recommended that a full characterization program is undertaken to fully evaluate the potential for net acid generation and the reaction dynamics of both the head (i.e., current tailings material) and tail (i.e., future tailings product) materials. The assessment should include metal leaching analysis of the existing tailings for interim excavation and the future tailings product for future reclamation planning.

A proposed Phase 1 geological investigation totaling approximately US$1,001,000, expected to be incurred in the summer of 2018, is recommended to fill-in gaps within the 2017 drilling campaign and to collect data from the perimeter areas of each cell in order to improve confidence in the modelled parameters. The estimated Phase 1 program budget is inclusive of drilling, analyses, and professional services and is segmented by task in Table 17-1 below:

Table 17-1: Recommended Phase 1 Geological and Mineral Resource Budget

Task	Unit rate* (US$)	Number of Units	Estimated Cost (US$)
Additional drilling to test the perimeter of Cells 1 to 3	$700/m	900m	$630,000
Additional infill drilling	$650/m	400m	$260,000
An ARD-ML program including initial static characterization and kinetic cells testing	$500 (static) $6,000 kinetic	24 samples 9 samples	$66,000
Technical services, consulting and revision to the mineral resource estimate.			$45,000
ESTIMATED TOTAL			**$1,001,000**

* Unit rates are considered to be inclusive of equipment, contractors, consumables, analysis, shipping, consulting, project management and travel expenses, and are estimated based on actual expenses previously incurred by EMI.

Based upon the results of the Phase 1 program and a preliminary economic assessment (PEA), EMI may elect to advance the project into a higher level of study such as a Feasibility Study. It is recommended that contingent upon the results of the Phase 1 program, a Phase 2 budget consider additional drilling, mineralogical and geochemical evaluation. The mineral resource estimate will be reviewed with mining, metallurgical and environmental disciplines to ensure the project is commensurate with potential conversion of mineral resources to mineral reserves. An estimated total contingent Phase 2 project budget of $785,000 is presented below in Table 17-2.

Table 17-2: Recommended Phase 2 Geological and Mineral Resource Budget, Contingent on the Results of Phase 1

Task	Unit rate*	Number of Units	Estimated Cost (US$)
Additional in-fill drilling within Cells 1 to 3	$650/m	800m	$520,000
Additional twin drilling program	$650/m	300m	$195,000
Geochemical characterization in conjunction with metallurgical and process testwork			$20,000
Revision of mineral resource and property geology model in conjunction with mining, metallurgical and environmental disciplines			$50,000
ESTIMATED TOTAL			**$785,000**

* Unit rates are considered inclusive of equipment, contractors, consumables, analysis, shipping, consulting, project management and travel expenses, and are estimated based on actual expenses previously incurred by EMI.

17.2 Mineral Processing and Metallurgical Testing

Further metallurgical testing is recommended to better understand metallurgical performances, optimize processing conditions and assess preliminary process design assumptions. Much of this work was already underway at the time of writing this report, and has continued through to the Released Date.

A suitable and very comprehensive beneficiation and metallurgical testing program, including pilot plant tests, is recommended and has already been initiated by EMI as of the effective date of this report. The samples used for the testing are from the 2017 drilling program and have been comprehensively assayed for determining physical, chemical, mineralogical and particle size distribution characteristics. The test samples have been shipped to the laboratories of CRIMM in Changsha, Hunan Province, China. A total of approximately 14.8 t (wet) from 743 drill intervals is planned to be used for the testing program. The composite samples that will be prepared for the comprehensive testing program include:

- A master composite which is representative of the overall mineralization of the deposit. This composite sample is being used for the process condition/flowsheet development and optimization. The sample will also be used for pilot scale testing, to investigate the beneficiation and to determine metallurgical performance of the sample in semi-continuous modes. Using the test results produced, the anticipated effects of the main recycling streams on the overall metallurgical performance will be simulated through Metsim, metallurgical process simulation modelling.

- Two composites that are representative of different mineralogical characteristics representing the high and low quality of potential mill feeds will be prepared and tested for their beneficiation and metallurgical responses to the process conditions developed from the master composite sample. The samples will also be used for pilot plant scale testing to investigate the metallurgical response of the samples in semi-continuous modes, especially the main recycling streams on the overall metallurgical performance.

- Three composites which are representative of three different particle size distribution classes (coarse, medium, fine) of the whole deposit will be tested at a larger than bench scale for their beneficiation and metallurgical performances to the process conditions developed from the master composite.

- Up to fifteen variability samples which are representative of different mineralogical characteristics and spatial locations will be tested at a bench scale for their beneficiation and metallurgical performances using the process conditions developed from the master composite.

The recommended test work should include:

- A detailed mineralogical study to further determine mineralization occurrences and compositions.

- Exploratory and pilot scale magnetic separation to pre-concentrate the manganese minerals, including various process condition optimization and equipment type selection tests.

- Solid and liquid separation tests on the magnetic separation tailings and concentrate. The testing should include thickening and filtration tests.

- Preliminary tests to further investigate the metallurgical performance of the mineralization to flotation pre-concentration treatments, including the flotation recovery of the carbonate manganese minerals from the magnetic separation tailings.

- Solid and liquid separation tests on the leach residue. The testing should include filtration tests and count-current decanter (CCD) washing on the filtered cakes.

- Detailed tests to investigate the mineral materials to conventional acid leaching, including the effect of acid consumption, leaching temperature, solid/liquid rate, particle size and other ore quality factors on manganese extraction. The testing should focus on the magnetic separation concentrates, however, preliminary testing on the head samples and magnetic tailings samples should also be conducted.

- Detailed tests to investigate purification treatments of the pregnant solution produced from the leaching treatment, including the removal of iron, phosphorus heavy metals and suspended solids which may affect downstream manganese electrowinning.

- Detailed electrowinning tests to optimize the manganese deposition by electrowinning and investigate the parameters for selenium and chromate-free manganese metal production.

- Preliminary tests to investigate the recovery of manganese and ammonia from the residue washing circuit.

- Test work to support an investigation into the opportunity of producing high purity manganese sulphate monohydrate.

The test work will include bench scale tests, large scale verification tests, bench scale variability tests and three pilot plant runs to simulate industrial operations.

The preliminary acid-base accounting (ABA) tests will also be conducted to assess the acid generating potential of the residue and tailings samples.

A total of US$1,200,000 has been estimated for the comprehensive testing program, excluding sample generation and shipment costs, as shown in Table 17-3. This testwork is underway as of the effective date of this report.

Table 17-3: Budget Estimate for Recommended Metallurgical and Process Engineering Work

Task	Detail	Estimated Cost (US$)
Metallurgical Testwork		
	Mineralogy	$ 16,000
	Bench Scale Beneficiation	$ 110,000
	Leaching Investigation	$ 74,000
	Solution Purification	$ 145,000
	EMM Electro-Winning	$ 89,000
	Product Processing (Passivation)	$ 13,000
	S/L Separation and Residue Washing	$ 35,000
	Mn Recovery from Washing Solution	$ 16,000
	Pilot-Scale Beneficiation Testing	$ 98,000
	Pilot-Scale Metallurgical Testing	$ 280,000
Testwork Management		$ 44,000
Process Engineering		$ 276,000
Estimated Total		$ 1,196,000

18.0 REFERENCES

ALS Canada Ltd, 30th Dec 2014, COA_VA14199511_116227-28883357

ALS Canada Ltd, 13th Jan 2015, COA_VA15005481_117190-28980198

AMEC Foster Wheeler (2016). Chvaletice EMM Project, Chvaletice, Czech Republic, Process Development Report. September 15th, 2016.

Bateria Slany – Various reports from 1986 to 1989, a Czech state battery producer's resource, metallurgical, environmental, engineering and economic studies of Chvaletice manganese tailings.

Changsha Research Institute of Mining and Metallurgy Co., Ltd., 27th May 2017, Exploratory Magnetic Separation Test Work Report

CINF Engineering Co., Ltd., Aug 2017, Scoping Study Report_Chvaletice EMM Project

Cullen, et al. (2013). Mineral Resource Estimate Technical Report for the Plymouth Mn-Fe Deposit Woodstock Property New Brunswick, Canada. Prepared for Buchans Minerals Corporation and Centrerock Mining Limited. May 6, 2013.

Czech Hydrometereological Institute, http://portal.chmi.cz/

Ministry of Environment of the Czech Republic, 2018, document reference number MZP/2018/550/387-Hd, ZN/MZP/2018/54, dated April 17, 2018.

Daniel Smutek, 2016; Chvaletice. Sulphur and Manganese Through Quarrying. Nature and Regional Protection Agency of Czech Republic (multi-stakeholder project for Iron Mountains Geopark with participation of European Union)

Dept. Earth and Ocean Sciences, UBC, 8th Jan 2015, Quantitative Phase Analysis of 2 Powder Samples Using the Rietveld Method and X-Ray Powder Diffraction Data

GET (2015), Legislative Aspects Related to The Granting of a Permit for the Mining and treatment of Manganese Ore, Chvaletice – Tailing Ponds 1, 2 (3104804), Řečany – Tailing Pond 3 (3243700), prepared for Navigator Management Ltd. April 2015,

Global ARD Testing Services Inc. 19th Dec 2015, Certificate of Analysis; Project # 1523

Global ARD Testing Services Inc. 25th Jan 2016, Certificate of Analysis; Project # 1523

Kemetco Research Inc., Jan 2015 to Feb 2015, Data Report KT1-5, Project #: I00301

Kemetco Research Inc., Feb 2016, Data Report – Mg Removal Using Fluoride, Project #: Eu Mn J0201

Kemetco Research Inc., Feb 2016, Data Report – Mg Removal Using Hydroxide, Project #: Eu Mn J0201

Met-Solve Laboratories Inc., 2nd Mar 2016, MS1656 Euro Manganese, Project #: MS1656

Met-Solve (2016), project MS1656 Euro Manganese prepared for Marco Romero, President and CEO, Euro Manganese Inc., March 2nd, 2016.

Novotny J. and Husak F. (1972). Borehold slude sedimentation grain size sorting (pg. 4/6 of Chvaletice P054730_en document)

Petru, M. (2015). The Environmental and Social Conditions in the Territory Conflicts of Interest in Regard to Environmental Protection Interim Report (translated from Czech). GET s.r.o. April 2015.

Petru, M. (2017). Chvaletice – Trnavka Tailing Pond, Environmental Baseline Study, for Mangan Chvaletice sro Published by GET September 2017.

Price, William, A, 2009. MEND Report 1.20.1. CANMET Mining and Mineral Sciences Laboratory, Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials.

PRK Partners, 2017, PRK Partners to Cannacord Genuity Corp,, confidential letter, subject: Legal Opinion on matters related to Euro Manganese Inc., dated April 27, 2018, Prague.

Process Mineralogical Consulting Ltd., 15th Dec 15 2015, Mineralogical Note

Process Mineralogical Consulting Ltd., 27th Jan 2016, Mineralogical Note

SGS Canada Inc., 6th Oct 2017; An Investigation into Acid Leaching and Mineralogical Characterization on Samples from the Chvaletice manganese deposit (draft report), Project 16204-001

Vavron, M. (2017). Localization Services for Scoping Study (Czech Republic). Prepared for Euro Manganese Inc. Published by Tebodin Czech Republic, s.r.o. March 23, 2017.

APPENDIX A

AUTHOR’S CERTIFICATES

Competent Person's Consent Form

Pursuant to the requirements of ASX Listing Rules 5.6, 5.22 and 5.24 and
Clause 9 of the JORC Code 2012 Edition (Written Consent Statement)

Report name

Public Reporting on Exploration Results and Mineral Resource Estimation for the Chvaletice Manganese Project Chvaletice, Czech Republic

(Insert name or heading of Report to be publicly released) ('Report')

Tetra Tech Canada Inc.

(Insert name of company releasing the Report)

Chvaletice Manganese Project

(Insert name of the deposit to which the Report refers)

If there is insufficient space, complete the following sheet and sign it in the same manner as this original sheet.

June 21, 2018

(Date of Report)

Statement

I/We,

Jianhui (John) Huang

(Insert full name(s))

confirm that I am the Competent Person for the Report and:

- I have read and understood the requirements of the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code, 2012 Edition).
- I am a Competent Person as defined by the JORC Code 2012 Edition, having five years' experience that is relevant to the style of mineralization and type of deposit described in the Report, and to the activity for which I am accepting responsibility.
- I am a Member or Fellow of The Australasian Institute of Mining and Metallurgy or the Australian Institute of Geoscientists or a 'Recognized Professional Organization' (RPO) included in a list promulgated by ASX from time to time.
- I have reviewed the Report to which this Consent Statement applies.

I/We am a full time employee of

Tetra Tech Canada Inc.

(Insert company name)

Or

I am a consultant working for

____

(Insert company name)

and have been engaged by

Mangan Chvaletice sro.

(Insert company name)

to prepare the documentation for

Mangan Chvaletice sro.

(Insert deposit name)

on which the Report is based, for the period ended

April 27, 2018

(Insert date of Resource/Reserve statement)

I have disclosed to the reporting company the full nature of the relationship between myself and the company, including any issue that could be perceived by investors as a conflict of interest.

I verify that the Report is based on and fairly and accurately reflects in the form and context in which it appears, the information in my supporting documentation relating to Exploration Targets, Exploration Results, Mineral Resources and/or Ore Reserves (*select as appropriate*).

Consent

I consent to the release of the Report and this Consent Statement by the directors of:

Mangan Chvaletic sro.

(Insert reporting company name)

	June 21, 2018
Signature of Competent Person	Date:
Engineers and Geoscientists of British Columbia	30898
Professional Membership: *(insert organization name)*	Membership Number:
	James Barr, Kelowna, BC
Signature of Witness:	Print Witness Name and Residence: (e.g. town/suburb)

Additional deposits covered by the Report for which the Competent Person signing this form is accepting responsibility:

None.

Additional Reports related to the deposit for which the Competent Person signing this form is accepting responsibility:

None.

June 21, 2018

Signature of Competent Person

Date

Original Signed and Sealed

Engineers and Geoscientists of British Columbia

Professional Membership:

(insert organization name)

30898

Membership Number:

Signature of Witness

James Barr, Kelowna, BC

Print Witness Name and Residence:

(eg. Town/suburb)

Competent Person's Consent Form

Pursuant to the requirements of ASX Listing Rules 5.6, 5.22 and 5.24 and
Clause 9 of the JORC Code 2012 Edition (Written Consent Statement)

Report name

Public Reporting on Exploration Results and Mineral Resource Estimation for the Chvaletice Manganese Project Chvaletice, Czech Republic

(Insert name or heading of Report to be publicly released) ('Report')

Tetra Tech Canada Inc.

(Insert name of company releasing the Report)

Chvaletice Manganese Project

(Insert name of the deposit to which the Report refers)

If there is insufficient space, complete the following sheet and sign it in the same manner as this original sheet.

June 21, 2018

(Date of Report)

Statement

I/We,

James Barr, P.Geo.

(Insert full name(s))

confirm that I am the Competent Person for the Report and:

- I have read and understood the requirements of the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code, 2012 Edition).
- I am a Competent Person as defined by the JORC Code 2012 Edition, having five years' experience that is relevant to the style of mineralization and type of deposit described in the Report, and to the activity for which I am accepting responsibility.
- I am a Member or Fellow of The Australasian Institute of Mining and Metallurgy or the Australian Institute of Geoscientists or a 'Recognized Professional Organization' (RPO) included in a list promulgated by ASX from time to time.
- I have reviewed the Report to which this Consent Statement applies.

I/We am a full time employee of

Tetra Tech Canada Inc.

(Insert company name)

Or

I am a consultant working for

(Insert company name)

and have been engaged by

Mangan Chvaletice sro.

(Insert company name)

to prepare the documentation for

Mangan Chvaletice sro.

(Insert deposit name)

on which the Report is based, for the period ended

April 27, 2018

(Insert date of Resource/Reserve statement)

I have disclosed to the reporting company the full nature of the relationship between myself and the company, including any issue that could be perceived by investors as a conflict of interest.

I verify that the Report is based on and fairly and accurately reflects in the form and context in which it appears, the information in my supporting documentation relating to Exploration Targets, Exploration Results, Mineral Resources and/or Ore Reserves (*select as appropriate*).

Consent

I consent to the release of the Report and this Consent Statement by the directors of:

Mangan Chvaletic sro.

(Insert reporting company name)

Original Signed and Sealed by James Barr	*June 21, 2018*
Signature of Competent Person	Date:
Engineers and Geoscientists of British Columbia	35150
Professional Membership: *(insert organization name)*	Membership Number:
Original signed by Jianhui (John) Huang	Jianhui (John) Huang, Vancouver, BC
Signature of Witness:	Print Witness Name and Residence: (e.g. town/suburb)

Additional deposits covered by the Report for which the Competent Person signing this form is accepting responsibility:

None.

Additional Reports related to the deposit for which the Competent Person signing this form is accepting responsibility:

None.

Original signed and sealed by James Barr	June 21, 2018
Signature of Competent Person	Date
Engineers and Geoscientists of British Columbia	35150
Professional Membership: *(insert organization name)*	Membership Number:
Original signed by Jianhui (John) Huang	Jianhui (John) Huang, Vancouver, BC
Signature of Witness	Print Witness Name and Residence: (eg. Town/suburb)

APPENDIX B

CHECKLIST OF ASSESSMENT AND REPORTING CRITERIA

SECTION 1. Sampling Techniques and Data

Criteria	Explanation
Sampling Techniques	▪ Sonic rig advanced at 2 m intervals, approx. 14 kg wet weight ▪ 755 core samples (2 m) were recovered ▪ Samples extracted from core tube at 1 m subsamples (approx. 7 kg wet weight) for logging and physical measurements ▪ A quarter split (approx. 3.5 kg wet weight) was extracted from the 1 m subsamples, recombined with the corresponding 1 m subsample, bagged and shipped to SGS for particle size analysis, lithogeochemistry, metals analysis and bulk density testing (approx. 7 kg for 2 m representative sample ▪ Remaining ¾ split recombined with respective 1 m subsample, bagged and send to CRIMM (China) for bulk sample and metallurgical testing (approx. 21 kg for 2 m representative sample)
Drilling Techniques	▪ A total of 1,679.3 m was drilled in 80 vertical holes, spaced approximately 100 m, using 100 mm diameter size rods and sonic core barrel advance provided by Eijkelkamp SonicSampDrill B.V. and crews from Giesbeek, the Netherlands
Drill Sample Recovery	▪ Recoveries estimated by field crew and recorded on geological logs ▪ No casing was installed and drill rods were pulled for each core run
Logging	▪ Logging was conducted in the field at drill side by GET sro, on hard copy paper and transcribed into digital drillhole database ▪ Records include lithological description, wet mass, field moisture, rinse pH, recovery, and magnetic susceptibility
Subsampling Techniques and Sample Preparation	▪ Sampling excludes overlying topsoil, and underlying native soil substrate ▪ Assay samples received at SGS Bor were weighed (wet) and homogenized by hand using the “Japanese slab cake method” of kneading and rolling the sample ▪ 100 g subsample sent to laser diffraction particle size analysis ▪ Remaining sample dried (105 degrees C) and homogenized ▪ 1 kg extracted for pulverization to -75µm and assaying
Quality of Assay Data and Laboratory Tests	▪ Samples were analyzed and tested for manganese and elemental assay, lithogeochemistry, particle size distribution, mass, moisture content, paste pH and EC and specific gravity ▪ Use of 4-acid and aqua regia for trace element and manganese concentrations (total and “soluble” portions) ▪ Lithogeochemistry to confirm complete digestion of manganese concentrations ▪ Particle size analysis by laser diffraction and sieve + hydrometer ▪ In situ bulk density (wet and dry) calculated using estimated recovery in field and laboratory estimated and mass and moisture measurements, and specific gravity by pycnometer
Verification of Sampling and Assaying	▪ Systematic QA/QC program was designed in connection with the drill-sampling and analytical work ▪ Insertion of additional 15.7% control samples (CRMs, duplicates, and blanks) ▪ Access to internal QC data generated by the labs ▪ Re-analysis or repeat of the test work on batches and samples that fail the QC criteria ▪ Field and pulp duplicates ▪ External laboratory analytical verification ▪ Independent CP sampling
Location of Data Points	▪ Property topography was provided by GET sro in Czech projection S-JTSK using the Bpv datum ▪ Surveying of drill hole collars was completed on-site by GET using a Trimble model R4 GNSS global positioning system (GPS) receiver equipment
Data Spacing and Distribution	▪ Holes spaced at approximately 100 m ▪ Downhole sampling continuous at 2 m intervals

SECTION 1. Sampling Techniques and Data

Criteria	Explanation
Orientation of Data in Relation to Geological Structure	▪ Drillholes were vertical through heterogeneous tailings mass
Sample Security	▪ Samples stored at a field warehouse managed by Geomin in Jihlava prior to shipping to laboratory for analyses
Audits or Reviews	▪ Independent site visit, sampling and data review completed by Tetra Tech Competent Person, James Barr, P.Geo., during the delineation drilling campaign

SECTION 2. Reporting of Exploration Results

Criteria	Explanation
Mineral Tenement and Land Tenure Status	▪ Mangan is a private company established in the Czech Republic in 1997, is 100% owned by Euro Manganese Incorporated, and holds 100% ownership of exploration licence number 631/550/14-Hd (valid until September 30, 2019) and exploration licence number MZP/2018/550/386-Hd (valid until May 31, 2023), ▪ Exploration licence number 631/550/14-Hd is registered to include mineral rights on a total area of 0.98 km² (98 ha) which cover the CMP, of which 0.82 km² is located within the Municipality of Trnavka, and 0.16 km² is located within the Municipality of Chvaletice ▪ Exploration licence MZP/2018/550/386-Hd allows the company to drill on the perimeter of the tailings piles ▪ On April 28, 2018, Mangan was issued a Preliminary Mining Permit by the Ministry of Environment, Licence No. MZP/2018/550/387-HD which covers the areas included in the Exploration Licences and secures Mangan's rights for the entire deposit area and is a prerequisite for the application for the establishment of the Mining Lease District. ▪ At present, Mangan does not hold surface rights to the CMP area, which are considered as those lands of original ground elevation surrounding and immediately underlying the protected area that contains tailings Cells 1, 2, and 3. The area of interest for the CMP overlies and adjoins 18 privately owned land parcels.
Exploration Done by Other Parties	▪ Hand auger sampling in 2014, four holes ranging from 2 to 2.5 m depth ▪ Testpit sampling in 2015, seven testpits ranging between 1.8 to 3.8 m depth
Geology	▪ The mineralization found in tailings at the CMP deposited by manmade processes following grinding and flotation processes of black pyritic shale and is therefore not characteristic of a traditional bedrock hosted manganese deposit ▪ The material can be physically characterized as a compacted soil, with varying degrees of particle sizes from clay to coarse sand.
Drill Hole Information	▪ Drillholes were collared on the surface of the tailings deposits and drilled vertically downwards to completion in the underlying native soil substrate, approximate average depth in Cell 1 = 26 m, Cell 2 = 27 m and Cell 3 = 11 m ▪ Detailed information of drillhole coordinates is not included here and can be seen in drillhole layouts in Figure 10-1 in the report
Data Aggregation Methods	▪ No data aggregation was performed on exploration results
Relationship Between Mineralization Widths and Intercept Points	▪ Downhole width is equivalent to true width
Diagrams	▪ Diagrams, maps and cross-sections are included in the report for reference
Balanced Reporting	▪ As a privately held company, no public disclosure was completed

SECTION 2. Reporting of Exploration Results

Criteria	Explanation
Other Substantive Exploration Data	▪ A total of 6.6 km lines of high-resolution electric resistivity tomography (ERT) and seismic refraction was conducted by GImpuls Praha spol. s.r.o. in 2017
Further Work	▪ Further work is recommended with a budget in the report to increase confidence in the perimeter of the tailings deposit and as infill drilling

SECTION 3 Estimation and Reporting of Mineral Resources

Criteria	Explanation
Database Integrity	▪ Tetra Tech undertook verification of the data transfer and compilation process at SGS through visual comparison of the issued certificates of analysis with the digital assay records ▪ The drillhole database was visually inspected by Tetra Tech, and corrections made prior to further inspection using digital validation tools within Leapfrog Geo modelling software
Site Visits	▪ A site visit was conducted by Tetra Tech CP, James Barr, P.Geo., from July 1 to 3, 2017 during the drilling campaign, and a site visit was conducted by Mr. Jianhui Huang, Ph.D., P.Eng on February 5, 2018.
Geological Interpretation	▪ A mineral resource estimate has been developed for total and soluble manganese concentrations ▪ Additionally, average moisture and grain size distribution indicators are reported for the deposit ▪ Geological interpretation assumes that deposition of tailings materials was episodic over the life of the historical mining operations, and the material was deposited from processed materials with mixed particle sizes suspended in slurry with thin lateral continuity with a particle gradation from coarse to fine away from the point of discharge
Dimensions	▪ Total surface area is approximately 1,032,800 m², approximate total volume (tailings) 17,528,800 m³, approximate total volume of topsoil is 2,060,030 m³ ▪ The resource is reported using a sub-block model with parent blocks 50x50x4 m and sub-blocks 25x25x4 m
Estimation and Modelling Techniques	▪ The Mineral Resource Estimate was calculated using Aranz Leapfrog Geo ▪ Interpolation searches were based on variography and were performed using the spheroid model in Leapfrog. This method is based on ordinary Kriging, however, lacks some fundamental control on the variogram model, kriging parameters, and composite input
Moisture	▪ The tonnage is reported on a dry material basis
Cut-off Parameters	▪ No cut-off parameters are applied
Mining Factors or Assumptions	▪ The deposit sits above ground and is candidate for traditional truck and shovel mining, or other possible surface extraction techniques following dewatering of tailings ▪ It is assumed that mining selectivity will not be applied due to inherent difficulty of grade control and selective mining for this deposit type ▪ Onsite and offsite operating cost estimates (US$5.22/t for onsite mining and magnetic pre-concentration treatment; US$173/t for manganese extraction and refining from 15% tMn concentrate, including off site and royalty cost)
Metallurgical Factors or Assumptions	▪ Process recovery of approximately 68% metal recovery at the leaching and refining; 50% metal recovery at the magnetic concentration for lower than 4% tMn materials ▪ 99.7% EMM metal price of US$2.09/kg or US$0.95/lb (Infomine, April 2017). The commodity price is expected to be higher for 99.9% Mn EMM; ▪ Metallurgical testwork is described in Section 13 of the report
Environmental Factors or Assumptions	▪ The area covered by the Chvaletice tailings has been significantly impacted by past mining and other heavy industrial activities ▪ Environmental baseline studies have been in progress since the summer of 2016. These include hydrological sampling and monitoring, as well fauna and flora surveys

SECTION 3 Estimation and Reporting of Mineral Resources

Criteria	Explanation
Bulk Density	▪ In situ dry bulk density is basis for tonnage estimate and was calculated from estimated core recovery along with laboratory measurements for mass and moisture ▪ Bulk density was a variable modelled into the block model based on the calculated in situ dry bulk density for each sample ▪ In situ dry bulk density values for individual samples range between 0.74 t/m^3 and 2.85 t/m^3, with a mean value of 1.55 t/m^3
Classification	▪ Classification is based on the JORC Code, and divides the mineral resource into Inferred and Indicated categories based primarily on drill spacing ▪ Inferred resources were classified around the perimeter of the deposit sue to uncertainty of composition of material used for the initial starter dykes and depth of topsoil cover on outer slopes
Audits and Reviews	▪ No external audits were performed ▪ Internal peer and senior review audits were performed as part of Tetra Tech's quality management system
Discussion of Relative Accuracy/Confidence	▪ The mineral resource estimate is reported as a weighted average grade and tonnage based on the search methodology and is not reported within error or confidence limits ▪ Inferred resources are considered lower confidence with higher margin of error than Indicated resources ▪ The modelling was validated using visual comparison, declustered mean comparison, and swath plots and is considered to be representative of the input data ▪ Bulk density relies on estimated recovery from the field which may introduce some error into the calculation ▪ Assumption of lateral continuity/gradation of particle size may introduce error