Gibraltar Source Term Development

Prepared for

Gibraltar Mines Limited

Prepared by

SRK Consulting (Canada) Inc.
1CG021.011
May 2018

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List of Abbreviations

ABA	Acid Base Accounting
ARD	Acid Rock Drainage
AP	Acid Potential
CGM	Conceptual Geochemical Model
CNP	Carbonate Neutralization Potential
ML	Metal Leaching
Mt	Mega tonne
NP	Neutralization Potential
PAG	Potentially Acid Generating
PLS	Pregnant Leach Solution
SX/EW	Solvent Extraction/ Electrowinning

1 Introduction

The Gibraltar Mine is a copper-molybdenum mine operated by Gibraltar Mines Limited (Gibraltar). Gibraltar is located approximately 60 km to the north of Williams Lake, BC. It is accessed via a paved highway that joins Highway 97 near the northern side of McLeese Lake. The mine is located on the east slope of the Fraser River (elevation of 853 m to 1,371 m) and includes 211 mineral claims and 32 mining leases.

The mine first began operations in the 1970s. The mine went into care and maintenance in 1998, when copper prices were depressed, but restarted in 2004.

The mine consists of four open pits: the Gibraltar East Pit, the Gibraltar West Pit, the Pollyanna Pit, and the Granite Pit. Currently only Granite Pit is mined. The majority of waste rock is deposited in the Pollyanna Pit and the 7 South Waste Rock Dump (7 Dump).

Ore is mined using truck and shovel open pit mining methods. The nominal mill throughput is 85,000 short tonnes per day. The ore is concentrated using conventional crushing, grinding and flotation to produce copper and molybdenum concentrates. When economic, oxide copper had historically been extracted from oxide ore stockpiles using sulphuric acid and solvent extraction and electrowinning (SX/EW). The SX/EW operation was idled in September 2015 and several leach stockpiles remain. There is no plan to restart the SX/EW during the next five years based on current economic conditions. Process tailings are deposited in the tailings storage facility located to the north of the mining area.

1.1 Previous Work

Source terms have previously been developed for the Gibraltar water quality predictions model. Source terms developed for each of the previous versions of the model are described below.

1.1.1 Original Source Term Development

The source terms were first developed for the original water and load balance model (SRK 2014). Source terms were developed for the following sources:

- Background water quality: surface and groundwater background water quality were based on monitoring data from upstream Lewis Creek station LCU1 and groundwater monitoring station MW07-3A/B, respectively,
- Dump areas: dumps were grouped into north and south areas and a single source term was developed for each,
- Pit walls: water quality from ponded water in Gib E Pit was used to represent pit wall runoff quality from all pits.
- Tailings: supernatant pond water quality was applied to tailings beach runoff.
- Heap leach runoff: to represent both pregnant leach solution (PLS) and raffinate, 95th percentile values were developed from all data collected in PLS Ponds.

The original water quality model aimed to reflected site conditions at that time to better understand site water management. Through calibration the model was evaluated on how it was able to ‘predict’ existing conditions did therefore the consideration of an upper bound case was not needed. Average case source terms only were developed for the original model.

1.1.2 2015 Source Term Revision

Based on feedback on the original water quality prediction model, including feedback from the Ministry of Energy and Mines (MEM) on source term development, SRK revised the water quality prediction model in 2015 (SRK 2015). The work built on previous work completed and included the following refinements.

The revised model included a set of average source terms, based on the median of historical measured concentrations, and upper bound case source terms based on the 95th percentile of historical measured concentrations.

In addition, the waste rock source terms were refined. Two waste rock terms, for acidic and basic waste rock, were used in the model. The acidic waste rock source term was applied to runoff and infiltration from all waste rock dumps and to infiltration from the leach stockpiles after active leaching. The basic waste rock source term was applied to pit walls. However, onset of acidification of pit walls was not considered.

Separate source terms were applied in the model for PLS and raffinate. These terms were developed from monitoring data. The PLS source term was applied to runoff and infiltration from the leach stockpiles during operations. The raffinate source term was applied to raffinate bleed to Gib E pit.

1.2 Purpose of the Current Source Terms Revision

In 2016, Gibraltar applied to the Chief Inspectors Office for an extension of the permitted 7 Dump boundary as part of their proposed G6 Pushback modified mine plan. Following review of the application, the Ministry of Energy and Mines (MEM) requested for Gibraltar to submit a report

1. Detailing the development of updated geochemical source terms for all key site waste facilities (Mine Act Permit Amendment M-40, Section C-5a), and
2. Evaluating the long-term potential for the onset of acidic conditions of tailings and associated surface discharge and tailings seepage water quality (Mine Act Permit Amendment M-40, Section C-5b).

This report has been prepared as a response to this request.

2 Background

2.1 Climate

The Gibraltar Mine area has warm, wet summers and cool, wet winters. The mean annual precipitation is 525 mm, of which approximately half falls as snow during the winter months. Snowmelt typically occurs in April, resulting in in-stream peak flows. Mean annual evaporation is 590 mm, with peak evaporation rates occurring in June and July.

2.2 Geological Setting

The Gibraltar Deposit is classified as a porphyry copper deposit of the calc-alkalic suite (Schroeter 1995) due to the style of mineralization, associated porphyry-type hydrothermal alteration and metal zonation. Similar deposits in BC are Highland Valley Copper, Island Copper, Huckleberry, Bell and Kemess.

Gibraltar is distinctive because hydrothermal mineralization occurred concurrently with regional deformation and metamorphism (Bysouth et al. 1995). The mineralization is associated with a single geological unit referred to as the Mine Phase Tonalite which is a phase of the regional Granite Mountain Batholith. As such, host rock lithology does not vary across the property. Also hydrothermal alteration is not distinctively zoned but is dominated by quartz-sericite-chlorite. Pyrite is present throughout and carbonate minerals occur at low percent concentrations. Potassium feldspar and biotite are not recognized as alteration minerals at Gibraltar.

Metal zoning is an important feature of the deposit which is hypothesized to correlate with decreasing mineralization temperature (Figure 2-1). It is also consistent with the zoning model of porphyries. Pollyanna and Granite pits are in the high temperature copper-molybdenum zone in which the non-pyrite suphide minerals are chalcopyrite and molybdenite with bornite. Gibraltar East Pit to the west has chalcopyrite and molybdenite but no bornite. Moving further west, molybdenite disappears, sphalerite is present and silver becomes enriched, and finally chalcopyrite diminishes in the undeveloped Gibraltar North zone.

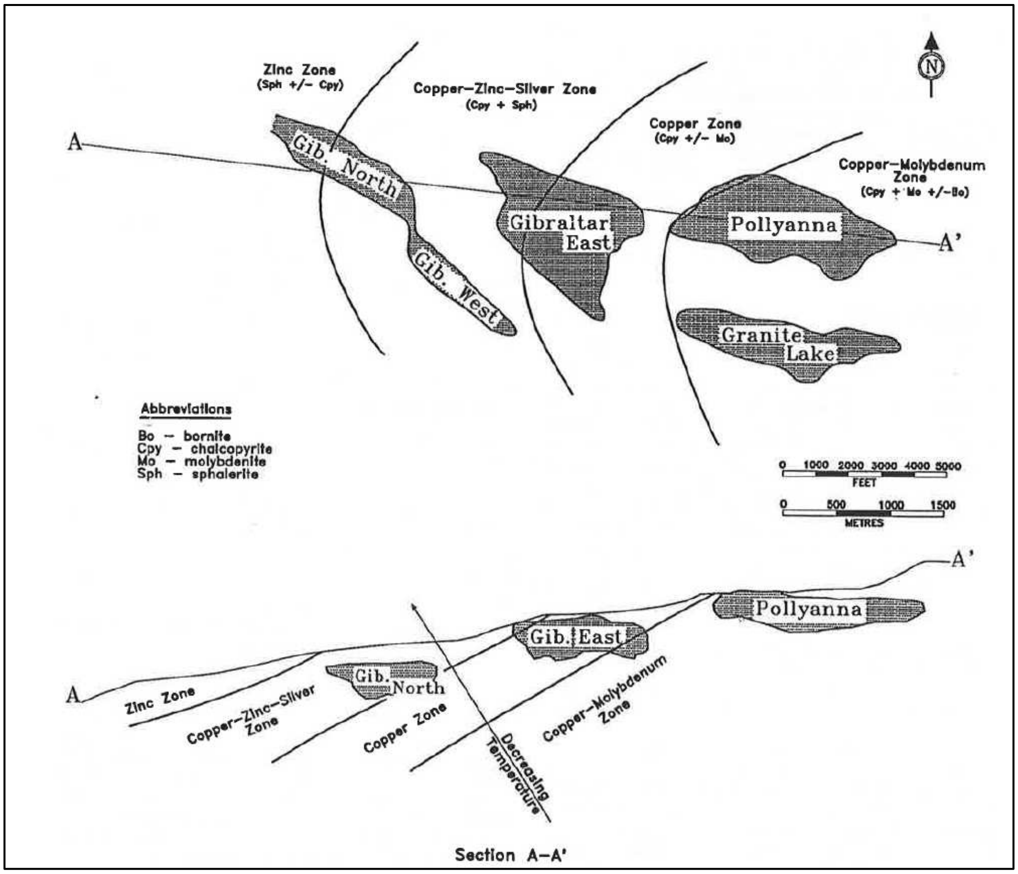

Figure 2-1: Metal Zoning at Gibraltar (Bysouth et al, 1995).

GML's geologists have determined that within the currently mined Granite Pit, there are no distinctive geological features that are relevant to the characterization of metal leaching and acid rock drainage potential (Taseko 2016). The host rock is the Mine Phase Tonalite. Hydrothermal alteration is dominated by chlorite and sericite with chalcopyrite and pyrite as the dominant sulphide minerals.

2.3 Mining

As part of this update, a thorough historical review of the progress of mining and waste rock disposal was completed. Mining records were used to determine which pits were mined since operations started and where waste rock was directed from each pit. The purpose of the review was to determine if the characteristics of the waste rock dumps could be linked to individual pits to allow refinement of the source terms for each dump. The result of the review is provided in Appendix A.

Mining occurred in two phases: from 1971 to 1998, and 2005 to current.

In the first phase, the dominant source of ore was Gibraltar East Pit which resulted in 164 Mt of waste rock which was disposed in Dumps 1 and 4. Waste rock placement occurred from 1971 to 1974, 1979 to 1985, and 1991 to 1998. Pollyanna Pit was the second source of ore resulting in 128 Mt of waste rock which was sent to Dump 3 from 1977 to 1993. 5 Mt of waste rock was sent to Dump 10 in 1989 and 1990. Waste rock from Granite Pit (1974 to 1977, and 1986 to 1990) was sent to Dumps 5 (40 Mt) and Dump 6 (31 Mt). The total quantity of waste rock produced in the first phase was 364 Mt.

Mining in the second phase has occurred in Pollyanna and Granite Pits (30 Mt and 485 Mt of waste rock, respectively for a total of 605 Mt). Pollyanna Pit waste rock continued to be placed in Dump 3. Granite Pit waste rock continued initially in Dumps 5 and 6 (189 Mt) and then transitioned to Dump 7 in 2013 (296 Mt).

The historical review showed that individual dumps do not contain mixtures of waste rock from different pits. A summary is provided in Table 2-1.

Table 2-1: Summary of Dump Construction and Seepage Chemistry Record

Dump	Total (Mt)	Waste Distribution (%)		Source Pit and Phase	Seeps		History of Seeps
		1971-1998	2005-2017		1993 to 1998	2009-2017	
1	103	100	0	Gib E 1, 2, 3	None	1P-1D, S3-1D	pH<3
3	243	51	49	Pollyanna 1, 2, 3,4	None	S1-3D, S3-3D	S1-3D 2<pH<3 S3-3D 4<pH<5
4	61	100	0	Gib E 2, 3, Gib W	4D-1 (early), various 1 time seeps	4D-1 Several others	In 1998 pH>8 2010s 2<pH<7
5	99	41	59	Granite 2, Granite 3, 4	None	P2-5D, S1-5D	2<pH<3
6	162	14	86	Granite 3, 4	Numerous	Limited	2<pH<8 in 1990s and early 2000s
7	296	0	100	Granite 5	-	Limited	2<pH<8 (mainly 6<pH<8) in 2015 and 2017.
10	5	100	0	Pollyanna 4	None	None	None

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2.4 Geochemical Characteristics

2.4.1 Rock

Database

The static geochemical database has been accumulated through drilling of existing waste rock dumps, diamond drilling of in situ bedrock ahead of mining, and analysis of chips from production blast hole sampling. The current database (as of the end of 2016) consists of 4,673 samples distributed as shown in Table 2-2. Using a copper cut-off of 0.15% to represent ore, about 960 samples represent ore-type rock.

Drill core sampling has been extensive in the Granite and Pollyanna Pits but there is a lack of in situ analyses for the earlier-mined Gibraltar East Pit. A drilling program in 1997 evaluated the geochemical characteristics of the existing waste dumps (1, 3 to 6, and 10) which resulted in waste rock that could be assigned to Gibraltar East Pit (Dumps 1 and 4, pre-1998: 164.5 Mt), Pollyanna Pit (Dumps 3 and 10, pre-1998: 127.8 Mt) and Granite Pit (Dumps 5, and 6, pre-1998: 71.8 Mt). No metals analysis was conducted for these samples and, as a result, metal concentrations for Gibraltar East Pit waste rock are not available.

Table 2-2: Summary of Programs

Pit	Program Description	Date	Type	Analyses	Number of Samples
Gibraltar East	Waste Dump Drilling	1997	Waste rock chips	ABA	90
Pollyanna	Waste Dump Drilling	1997	Waste rock chips	ABA	32
	GM Claims	1995	Diamond drill core	ABA, trace elements	232
	Stage IV	1998	Diamond drill core	ABA	621
	Not specified	2016	Diamond drill core	Trace elements, including sulphur	1623
Granite	Waste Dump Drilling	1997	Waste rock chips	ABA	51
	Phase V and VI	2016	Diamond drill core	Trace elements, including sulphur	1895
	Not specified	Later than 2007	Diamond drill core	ABA, trace elements	30
	Operational	2014 to 2016	Production blast hole	ABA, trace elements	56

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Acid-base accounting typically included total sulphur, sulphur as sulphate (hydrochloric acid method), paste pH, neutralization potential (NP, Sobek et al 1978 method) and total inorganic carbon. Trace elements scans have been performed using ICP following aqua regia digestions. Scans done in the 1990s did not included sulphur analyses but were paired with acid-base accounting data. Later scans (2000s and 2010s) included sulphur and supplemented understanding of sulphur distribution. Selenium analyses were also added after the 1990s.

In the 1990s, analytical work was performed by the Placer Dome Research Centre in Vancouver. Later analysis is done by ALS Laboratories in Vancouver.

The rock geochemical database includes both waste and rock samples. The database does not include kinetic test results.

Waste Rock Characteristics

Waste rock characteristics are summarized as cumulative histograms for five categories: Gibraltar East, Pollyanna and Granite Waste Rock Dumps, and Pollyanna and Granite pre-mining drilling.

To optimize use of the full database to evaluate acid rock drainage potential, the following assumptions were made:

- Acid potential was calculated from total sulphur determined either by Leco furnace or ICP following aqua regia digestion.
- Neutralization potential used was the lowest of three estimates (Sobek et al. 1978 method, carbonate content converted to calcium carbonate equivalents, and calcium expressed as calcium carbonate equivalents). The presence of low levels of iron carbonates supports the use of carbonate (e.g. SRK 2017), and calcium correlates strongly with carbonate content. The regression for the latter was calculated using samples containing no detectable sulphate to eliminate the effect of gypsum.

  The regression equation in Figure 2-2 is

  $$\text{Log } CO_3 \text{ (kg CaCO3/t)} = 1.4\log \text{Ca}(\%) + 1.2 \text{ (r=0.9)}$$

  The regression is based on 792 samples and is highly statistically significant. As shown in Figure 2-2, there is a scattering of samples with relatively low carbonate compared to calcium. These samples are not clearly associated with elevated sulphate concentrations and therefore may represent analytical error. The scatter applies to about 5% of samples shown in Figure 2-2 which therefore represents the error in applying this method to calculate NP.

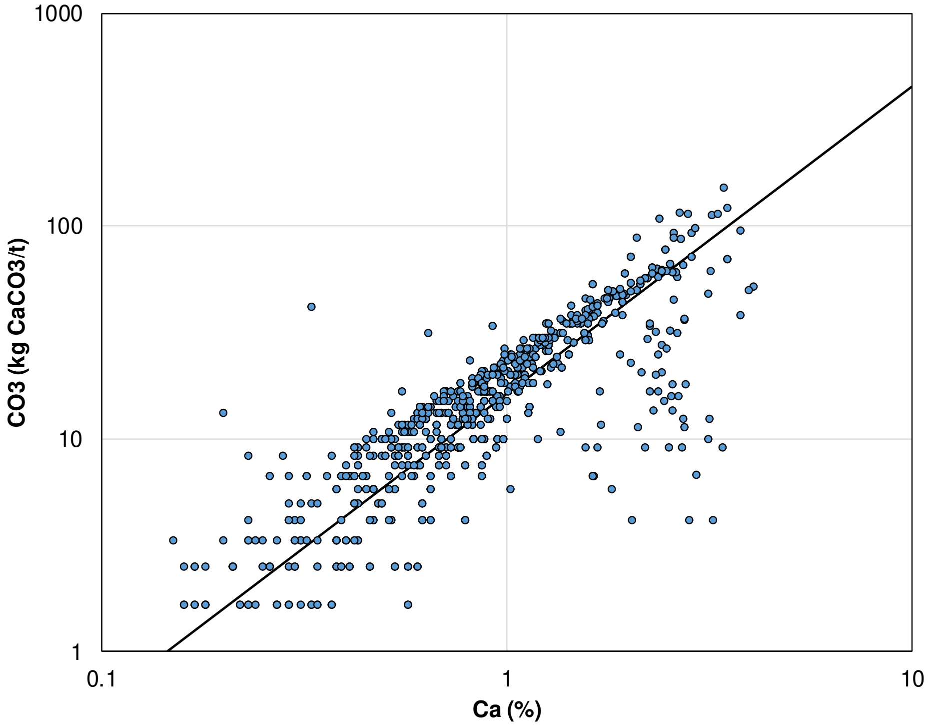

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Figure 2-2: Relationship between Ca and Carbonate Content

Cumulative histograms for AP, NP, NP/AP, Cu, Mo and Zn are shown in Figure 2-3.

For sulphur, the drill core distributions show a wider range of values than dump drilling samples. This is expected due to the narrower sampling intervals in core compared to the averaging effects that occurs in actual placed rock.

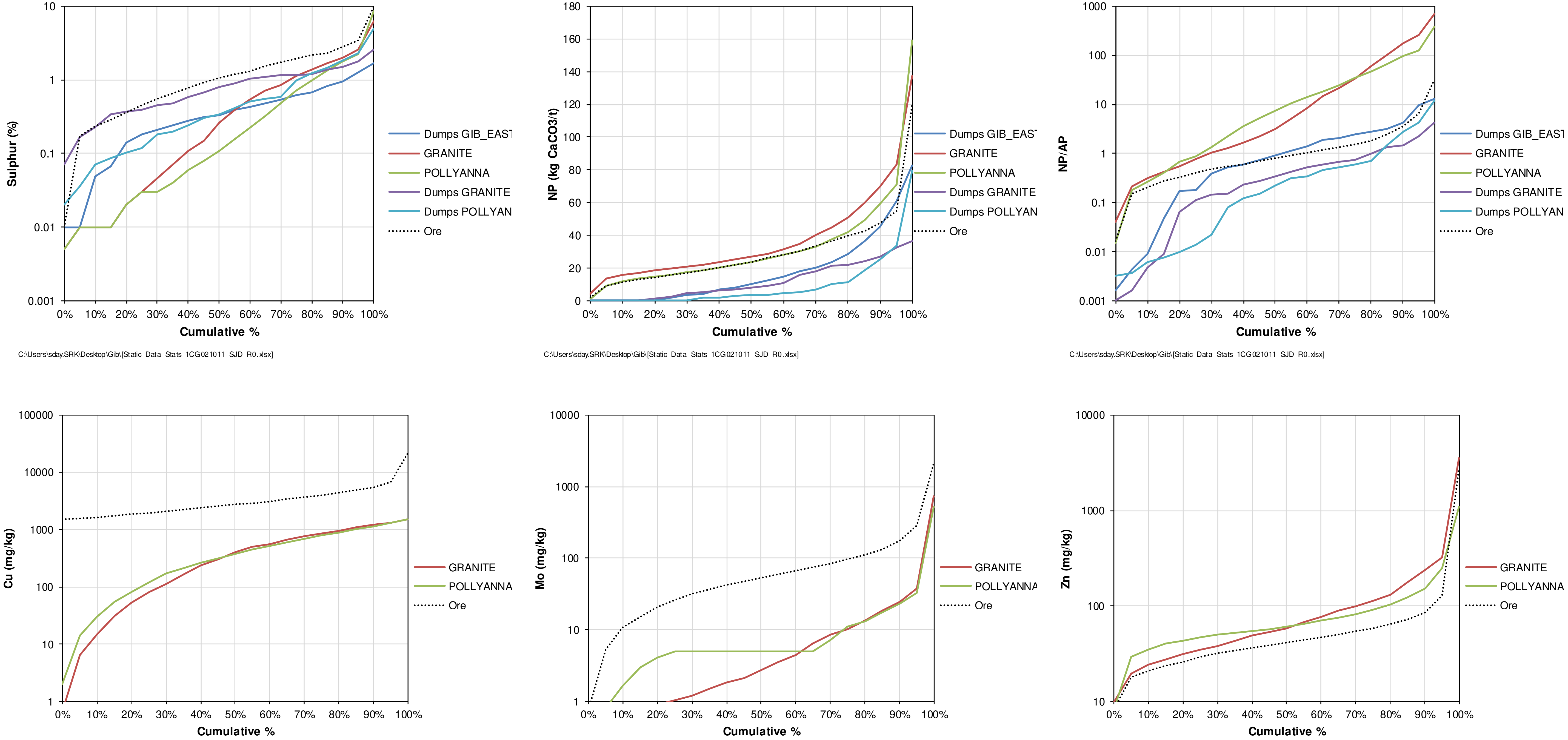

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Figure 2-3: Cumulative Histograms for ARD Potential Parameters and Selected Metals in Waste Rock and Ore.

Core samples from Granite and Pollyanna Pits also show lower median sulphur concentrations than any of the dumps. Pollyanna and Gibraltar East Dump drilling samples showed somewhat similar median sulphur concentrations whereas Granite Dumps had distinctively higher sulphur concentrations which also partly reflected in the higher sulphur content of the Granite core samples. In general, the dump drilling reflects the pre-Taseko mining period when mining targeted higher grades therefore leading to higher sulphide content in waste rock.

The NP distributions show that core samples have higher NP than the drill hole sample, and Pollyanna core has slightly lower median NP than Granite core. This difference could reflect differences in NP between historic and recent production areas, but more likely is due to depletion of NP by ongoing oxidation.

NP/AP differences reflect the combination of higher sulphide and lower NP in the dump drilling samples compared to the core samples. The dump drilling samples indicate a median NP/AP less than 1, and therefore a dominance of potentially ARD generating rock (PAG rock). The core data show medians above 3 and a higher median for Pollyanna compared to Granite (7.6 and 3.2, respectively). Both core datasets show about 30% of rock with NP/AP less than 1.

Distributions of copper and zinc in the core datasets are virtually identical. Median copper concentrations are 370 mg/kg. Median zinc concentrations are 60 mg/kg. Selenium is not shown but a similar pattern is apparent with median selenium concentrations of 0.3 mg/kg. The molybdenum distributions imply a higher median concentration in Pollyanna core but this reflects the use of a detection limit of 5 mg/kg for some samples. The similarity of distributions at greater than 5 mg/kg shows the lack of difference between Granite and Pollyanna.

Ore Characteristics

Figure 2-3 also shows calculated distribution of ore-type materials defined using copper greater than 1500 mg/kg in core samples. The actual distribution in ore feed would not be expected to show these distributions due to the blending effects caused by mining and crushing.

Ore shows higher sulphur content than waste rock but similar NP. As a result, median NP/AP for ore is less than 1, and ore is dominantly expected to be PAG. The use of the copper cut-off value also results in higher molybdenum content of ore compared to waste rock (medians of 53 and 3 mg/kg, respectively). Median selenium in ore (0.7 mg/kg) is also greater than waste rock (0.3 mg/kg). Zinc content of ore (median 41 mg/kg) is distinctively lower than waste rock (60 mg/kg) possibly reflecting the copper and zinc zoning in the deposit (Figure 2-1).

Waste Rock Seepage Chemistry

Waste rock seepage chemistry is described in the annual reports for the ML/ARD Characterization and Monitoring Program (most recently, SRK 2017). Monitoring began in 1993 mainly focussed on the permanently flowing 4D-1 (4 Dump) Seep. 6 Dump seepage was monitored in the 1990s and 2000s but on an infrequent non-continuous basis. Eight seeps have been monitored at various times since 2009 primarily focussed on four seeps. Observations from monitoring at each dump are provided in Table 2-1.

Current seepage from 1, 3 and 4 Dumps is acidic (median pH<4). 1 and 3 Dump seeps have median pHs between 2.5 and 2.8 whereas 4 Dump seepage has median pH of 3.7. Ion chemistry for the most acidic seeps is dominated by sulphate, iron and copper, followed by aluminum and calcium.

4D-1 provides a useful long-term record of the evolution of drainage chemistry for waste rock dump for which construction began in 1979, continued until 1985, restarted in 1991 then stopped in 1998. No waste rock has been placed in the current mining by Taseko. The pH trend, starting in 1998 shows slightly basic pH trend until 2000 followed by a rapid downward trend to below 6 in 2001. Lower pHs were accompanied by increases in metal concentrations. For example, copper increased from about 2 mg/L to 100 mg/L. In contrast, molybdenum decreased from 0.3 mg/L to 0.006 mg/L.

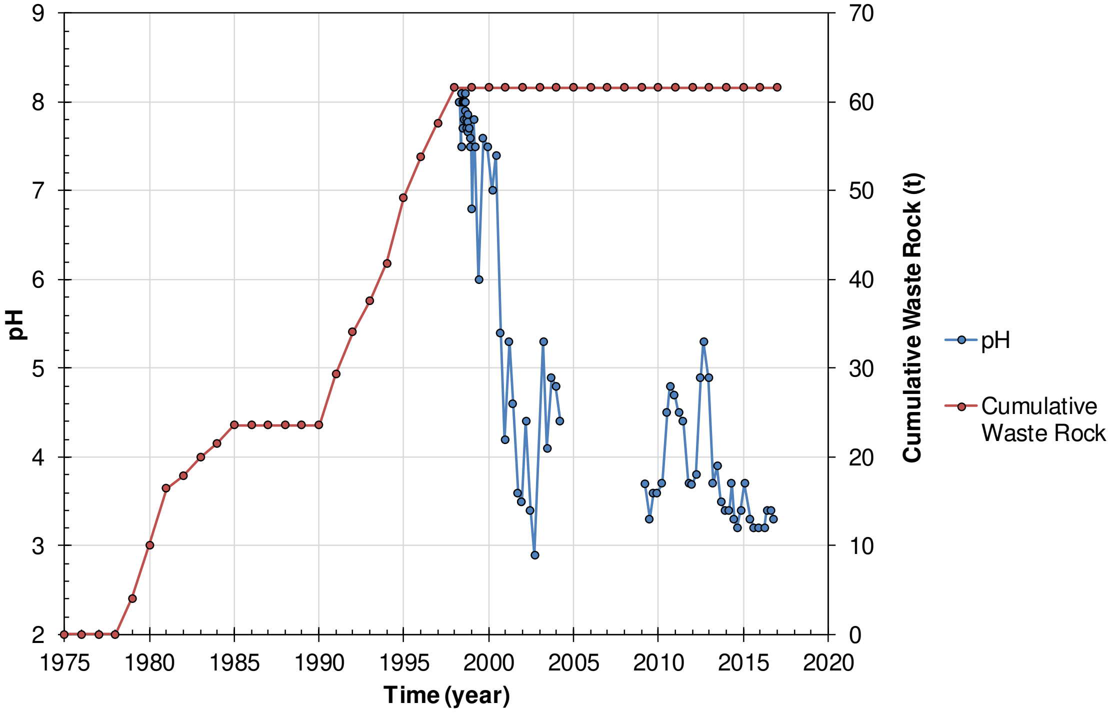

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Figure 2-4: Waste Rock Placement Record for 4 Dump and 4D-1 Seep pH Trend

2.4.2 Tailings

Database

Bulk tailings characteristics have been monitored since 2005. Separate monitoring of cyclone feed, underflow and overflow was initiated in 2015.

In addition, the core databases were used to estimate the characteristics on a pit scale by estimating residual sulphide content from the total sulphur and copper content, assuming copper is present as chalcopyrite and recovery of 95% is achieved.

Tailings Characteristics

Tailings geochemical characteristics as indicated by monitoring and calculation are shown as a function of time and as cumulative histograms, respectively in Figure 2-5. Tailings ARD potential in monitored tailings is classified according using CNP/AP=1.1 estimated from humidity cells (SRK 1998). For the cumulative histograms, NP was calculated using the same method as waste rock and therefore is assessed using NP/AP=2.

Bulk tailings monitoring data shows a lack of trending since 2005 with a median sulphide content of about 0.64% which is between the calculated values for Granite and Pollyanna Pits. The monitoring data shows CNP/AP fluctuating with occasional multi-month periods below above 1.1. In 2008, CNP/AP was below 1.1 for a year corresponding to sulphide content to higher sulphur concentrations near 1%. 2008 marked the transition from mining in Pollyanna Pit to exclusive extraction of ore from the Granite Pit, which is planned to continue. However, CNP/AP recovered in 2009. Median CNP/AP for the 2005 to 2016 is 1.1 which is similar to the median of the simulated NP/AP distributions. The simulated distributions imply that slightly lower CNP/AP can be expected from mining of Granite Pit.

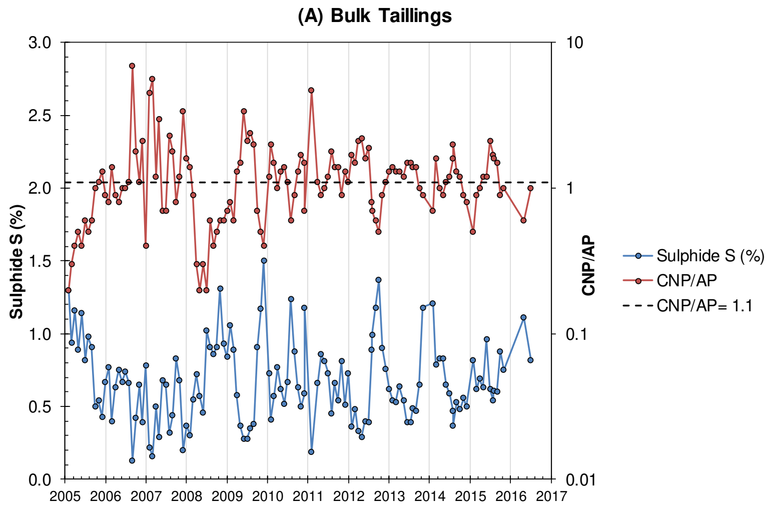
Monitoring of cyclone components over two years showed no apparent difference between the feed, underflow (sands) and overflow (fines) indicating that the ARD potential of cyclone sands can be expected to be comparable to bulk tailings (feed).

Tailings Seepage Chemistry

Tailings seepage and finger drain chemistry is described in the annual reports for the ML/ARD Characterization and Monitoring Program (most recently, SRK 2017). The database indicates stable pHs with medians near 7 and ion chemistry dominated by sulphate and calcium.

Tailings Pore Gas

Tailings pore O_2 and CO_2 concentrations are monitored at three locations in the cyclone sand dam (SRK 2017). Monitoring over three years shows similar profiles at each location. Oxygen concentrations show steep gradients decreasing to below 5% typically at about 15 m depth (Figure 2-6). Decrease in oxygen is accompanied by CO_2 concentrations increasing to typically about 5%.



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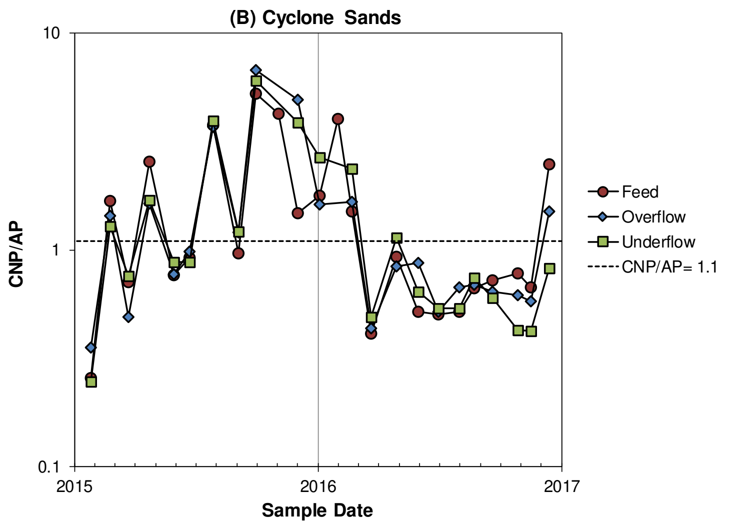

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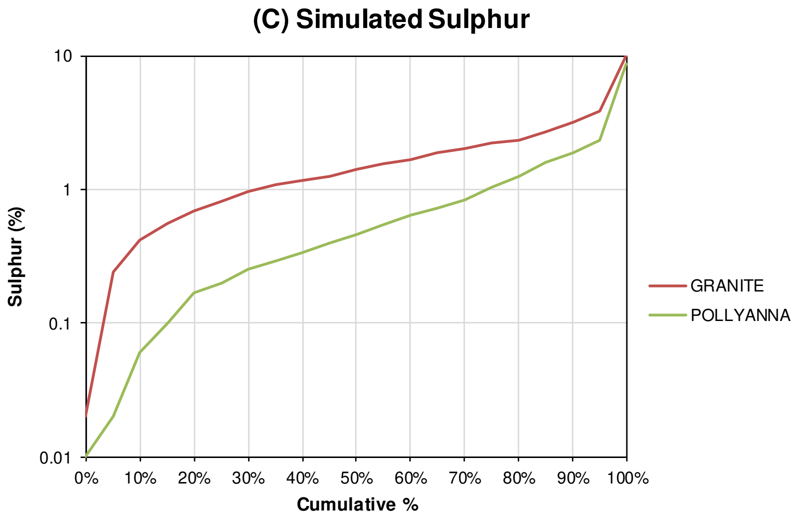

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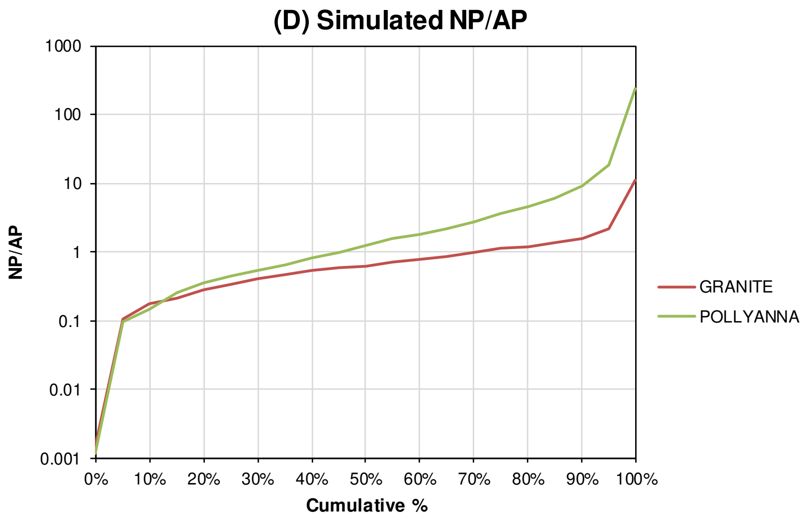

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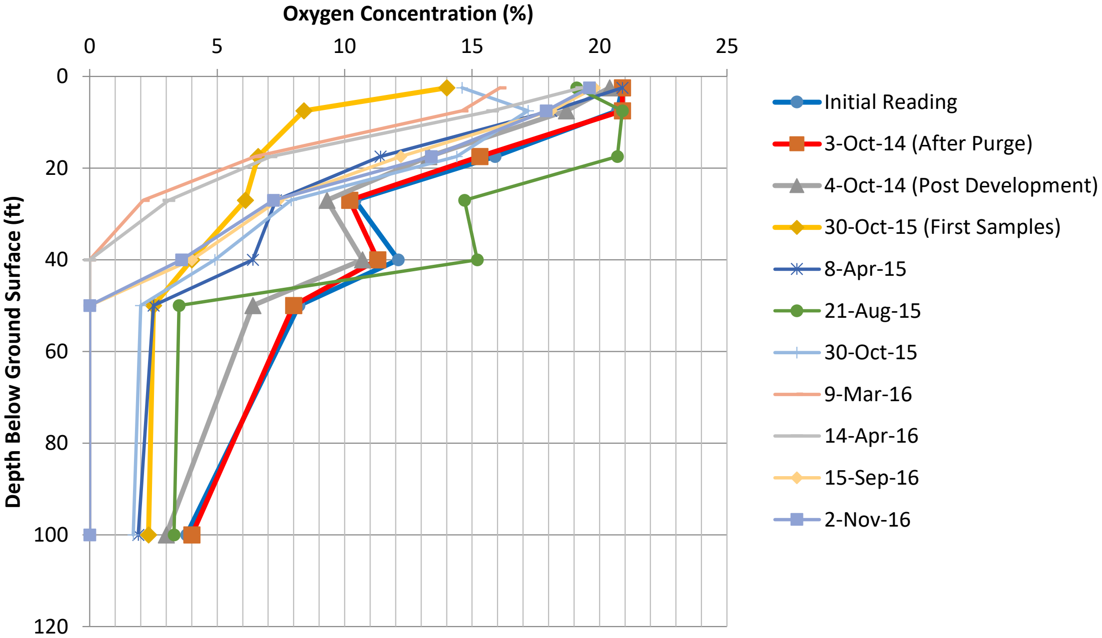
Figure 2-5: Tailings Characteristics



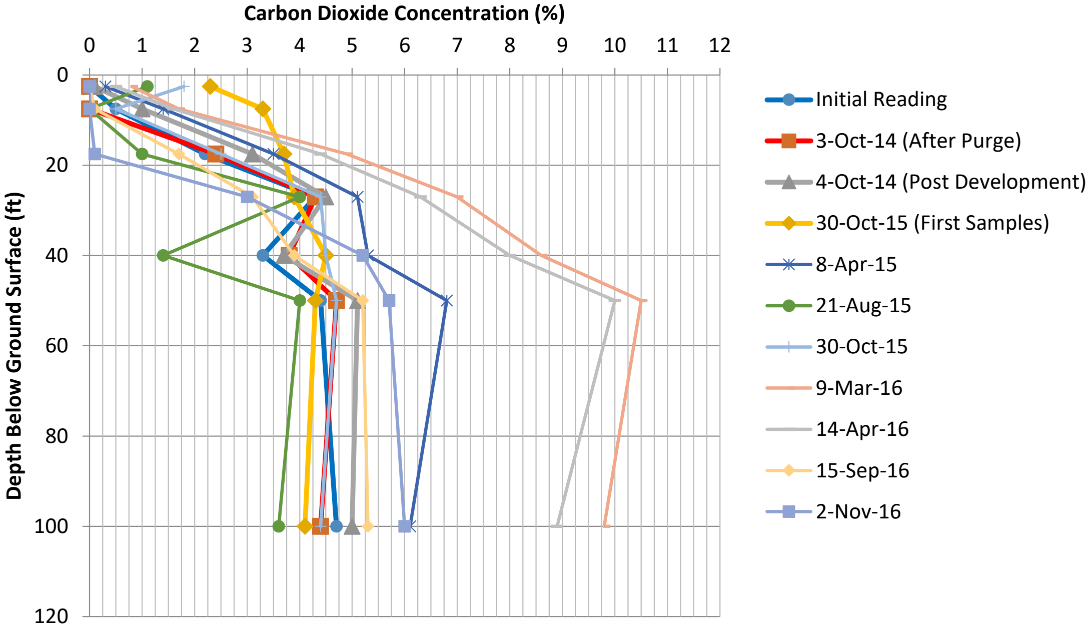


Figure 2-6: Examples of Gas Profiles (GM14-01, SRK 2017)

2.5 List of Source Terms

Table 2-3 summarizes the source terms, how each of these sources was addressed in the previous water quality prediction model, and discretization considered in this update.

Table 2-3: Updates to Source Terms Compared to Existing Water Quality Predictions Model

Permit Requirement	Previous Model	Updates Evaluated
Individual waste rock dumps and in-pit waste rock dumps	Single source term for acidic waste rock applied to all waste rock dumps	Separate distinctive source terms were developed for Dumps 1, 3, 4, 5, 6, 7 and 10. Average and upper bound case source terms were based on waste rock seepage data.
Heap-leach facilities	PLS source term applied to leach pad runoff. Raffinate source term applied to historical raffinate bleed from SX/EW to Gib E pit.	No update. SX/EW is closed and no additional data available or changes to configuration expected.
Individual open pits (including but not limited to highwalls and pit lakes)	Basic waste rock source term is used for pit wall runoff. Pit lakes quality are predicted as a mix of multiple sources.	Updated to provide proportion of basic and acidic wall area and associated source term during operations and closure phases. Approach to pit lakes continued.
Tailings storage facility	Beached tailings source term is currently implemented in the water quality prediction model. Tailings pond quality predicted as a mix of multiple sources.	Average and upper bound case source terms were revised for beached tailings contact water. In addition, average and upper bound source terms for tailings infiltration water were developed. Approach to tailings pond continued.
Water treatment facilities (influent and effluent)	Influent is predicted as a mix of multiple sources. Effluent quality will be based on performance criteria for the water treatment plant.	Water treatment plant performance criteria will be identified as part of the site mitigation report.
Processing plants (influent and effluent)	Influent is predicted as a mix of multiple sources. A source term for tailings slurry water has not been developed. Currently effluent quality is the same as influent quality.	Monitoring data indicate that the process water chemistry is evolving and the use of a fixed source term for this source may not be appropriate. Additional work has been initiated that aims to characterize mill effluent however, that work is ongoing and not presented within this report.

3 Conceptual Geochemical Models

Conceptual geochemical models (CGMs) describe the expected geochemical performance of each source using current understanding indicated by the background information. The CGMs inform numerical implementation to develop source terms. The following sections described update CGMs for which major updates to the source terms have been developed (waste rock and tailings).

3.1 Waste Rock

Waste rock at Gibraltar Mines has and will be generated by conventional drill and blast approaches yielded coarse material that is readily amendable to water and oxygen entry. The latter is expected to occur by both diffusion and advection. Oxygen availability may be limited internally due to oxygen-consuming processes but for the purpose of this CGM it is assumed O_2 is not a limiting reactant and that sulphide oxidation occurs sufficiently rapidly that the primary control on water chemistry is the solubility of oxidation products rather than the rate of the oxidation and neutralization reactions.

Static geochemical characteristics of waste rock indicate that different geochemical behaviour can be expected for waste rock mined earlier in the operation than later. Dump drilling in 1998 showed that earlier waste rock had higher median sulphide content, lower NP and lower NP/AP though the comparison is inexact due to sampling different materials. The difference may reflect a transition in the overall mining approach at Gibraltar resulting in older waste rock containing higher sulphide content.

These differences imply that ARD onset for the older rock would be more rapid and drainage chemistry more severe than for recent waste rock. Placement of waste rock in 1 Dump and 4 Dump ended in 1998. 1 Dump had acidic seeps when monitored in 2005 indicating a delay to onset of acidic conditions of as early as 1 year. 4 Dump indicated that acidic conditions developed in about 2000, indicating a delay to onset of up to 21 years (i.e. assuming that rock placed in 1979 was responsible for pH depression) or as short as 2 years (if latest placed rock was responsible for pH depression).

Waste rock from Pollyanna and Granite Pits appears to have lower ARD potential, with Pollyanna lower than Granite, and possibly non-PAG on balance; however, both datasets indicate 20% of rock with sulphur content exceeding 1% and NP/AP below 1. Since waste is not specifically placed to result in mixing, and some waste components of the newer waste rock resembles the older waste rock, it is expected that waste rock placed after 2005 will generate ARD despite the lower ARD potential. Delay to onset of ARD may be longer for the newer waste rock. Construction of 7 Dump began in 2013 and one of five seeps monitored in 2015 and 2017 yielded one pH of 2.8, this dump appears to be dominantly non-acidic. 4 Dump is the logical analog for this dump with onset lagging placement by an average of 10 years.

Overall pH trends for waste rock are expected to show initial pHs near 7 followed by eventual pHs between 2 and 3. Once pHs reach these levels, recovery is not expected to occur even if over-dumping with fresh waste rock occurs because neutralization by leached alkalinity and neutralization along flow paths is expected to be ineffective. In the long term, pHs will remain acidic but may be expected to increase from between 2 and 3 to between 3 and 4 in response to depletion of rapidly oxidizing pyrite and buffering by precipitated ferric oxyhydroxides. In parallel, sulphate, acidity and metal concentrations can be expected to decrease; however, it is not possible to quantify these effects in the current model due to uncertainty about the inventory of available oxidizable sulphide.

3.2 Pit Walls

Pit walls can be conceptualized as thin waste rock dumps potentially showing similar geochemical behavior to waste rock dumps but at a smaller scale and independently of the surrounding rock. During operations, pit walls can be expected to relatively active and may not become acidic, except locally where sulphide contents are elevated. Based on the static geochemical data, Table 3-1 provides estimates the proportions of pit walls that may be acidic during operations and closure for the purpose of water quality modeling.

The percentages for Pollyanna and Granite are based on the distributions shown in Figure 2-3. The percentage acidic during operation reflects the presence of rock with several percent sulphide sulphur whereas the closure percentage assumes that all rock with NP/AP below about 2 could generate acid. The main assumption is that distributions in the sample datasets are reflected in the pit walls.

Table 3-1: Conceptualization of Pit Wall Performance

Pit	Acidic Wall During Operation	Acidic Wall at Closure
Gibraltar East	100%	100%
Pollyanna	10%	40%
Granite	10%	50%

3.3 Tailings

The two main weathering environments for tailings (Figure 3-1) will be:

- The exposed surfaces of the cyclone sand dam and impounded tailings beaches which will contribute loading to runoff from these surfaces; and
- Unsaturated sub-surface cyclone sands and tailing beaches which will contribute loading to infiltrating waters.

The former will contribute relatively small loadings due to the limited contact between runoff and weathering tailings. The actual depth contacted by waters is expected to be of the order of millimetres.

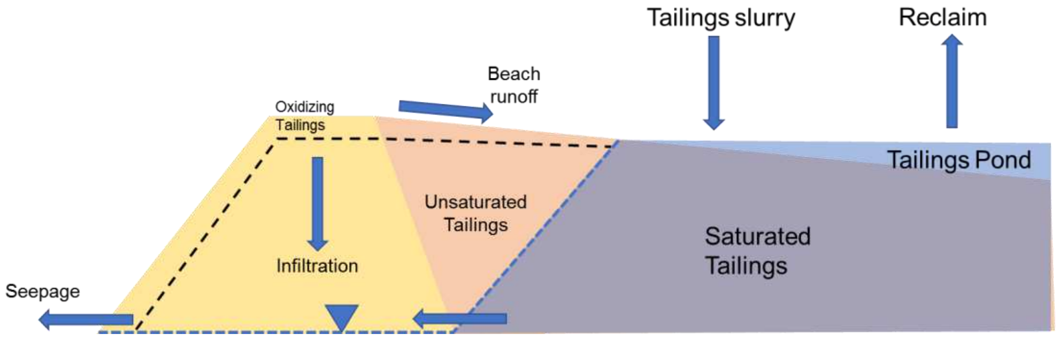


Figure 3-1: Tailing Source Terms Conceptual Model

For sub-surface tailings, the unsaturated mass is potentially available for weathering and leaching. However, unlike waste rock, gas entry into the impounded tailings and cyclone sands dams is by diffusion not advection as demonstrated by the conventional gas profiles in the tailings (SRK 2017). The form of the oxygen profiles (steep then flatter, Figure 2-6) shows that O_2 is being consumed in the profile by pyrite oxidation rather than reflecting simply diffusion along a gradient from 20% at surface to lower at depth. Acid is generated by oxidation reactions resulting in accumulation of CO_2 within the profile which then diffuses out of the tailings to much lower concentrations. None of the profiles were acidic at the time the monitoring arrays were installed in 2014.

Over time, these profiles are expected to continually evolve above the water table. Monitoring data indicate that some tailings may be marginally PAG. Where tailings are consistently PAG, acidification may occur first at surface as NP is depleted. If PAG tailings persist to depth, this acidic zone would progress downwards leaving a sulphide and NP depleted zone at surface, and non-acidic tailings at depth where oxidation rates are lower. The front between the acidic and non-acidic tailings would also progress over time. The progression of the zones and related fronts slows down with depth. Theoretically, the endpoint of these processes is a full oxidized profile above the water table containing negligible sulphide or carbonate. Near and below the water table, profile development is expected to stall due to the lower rate of diffusion of oxygen.

In practice, this theoretical evolution of the profile is not likely to occur at Gibraltar because the tailings to date are not consistently PAG and more likely consist of finely interlayered PAG and non-PAG tailings. Static geochemical characteristics indicate average characteristics lie very close to the threshold defining PAG and non-PAG. The likely result of evolution of the oxidation profile is locally acidic layers but overall pH neutral leaching conditions due to carbonate minerals in non-oxidizing PAG and non-PAG tailings at depth. Pore water chemistry is expected to be controlled by primary carbonate and secondary gypsum solubility.

4 Source Term Development

4.1 General Approach

The general approach to source term development was to use the current monitoring data rather than attempting to develop source terms from first principles. There is sufficient characterization of the sources that source terms can be developed by identifying analogs within the site.

4.2 Waste Rock

A database containing water quality data, including seepage data and other data collected through regular monitoring, was received from Gibraltar. The water quality data based included approximately 13,900 seepage samples, collected between April 1998 and January 2018. Data provided by Gibraltar was assumed to be of good quality, and no further QA/QC was performed.

A set of R code was developed to generate chemistry statistics for current waste rock dumps. The water quality database was imported into RStudio and filters were applied to extract data that meet the defined criteria, which includes pH ranges and selected periods of time. Table 4-1 summarizes the selection criteria for analog seeps to represent each current dump. For data under detection limit, the detection limit was used in the calculations, which provides conservative results with high chemical concentrations. The mean and 95th percentile concentrations for each element were calculated in R for each dump and exported as source terms in Table 5-1.

Table 4-1: Summary of Dump Construction and Seepage Chemistry Record

Dump	Source	Seeps		Expected Behaviour	Data Compiled to Develop Source Terms
		1993 to 1998	2009-2017		
1	Gibraltar East	None	1P-1D, S3-1D	Remain acidic	Current 1 Dump and 4 Dump Seeps: • 1P-1D (post-2004 data, pH<3), • S3-1D (post-2004 data, pH<3), • 4D-1 (post-2010 data, pH<4)
3	Pollyanna	None	S1-3D, S3-3D	Remain acidic	Current 3 Dump Seeps: • S1-3D (post-2004 data, pH<3), • S3-3D (post-2004 data, pH<5)
4	Gibraltar East	4D-1 (early), various 1-time seeps	4D-1 Several others	Remain acidic	Current 1 Dump and 4 Dump Seeps: • 1P-1D (post-2004 data, pH<3), • S3-1D (post-2004 data, pH<3), • 4D-1 (post-2010 data, pH<4)
5	Granite	None	P2-5D, S1-5D	Remain acidic	Current 5 Dump seeps • P2-5D (4 samples), • S1-5D (4 samples)
6	Granite	Numerous	Limited	Remain acidic	Current 5 Dump seeps • P2-5D (4 samples), • S1-5D (4 samples) Plus various 6 dump seeps with 2<pH<3.
7	Granite	-	Limited	Non-acidic evolving to acidic	For first 10 years: use 4 Dump seep: • 4D-1 samples with pH>6, 1998-2000 and 7 Dump seeps as data become available. Subsequently: Dump 5 Seeps: • P2-5D (4 samples), • S1-5D (4 samples)
10	Pollyanna	None	None	Remain acidic	Current 3 Dump Seeps: • S1-3D (post-2004 data, pH<3), • S3-3D (post-2004 data, pH<5)

Source: C:\Users\sday.SRK\Desktop\Gib\[Production_report_1CG021011_SJD_REV02.xlsx]

4.3 Pit Walls

Because pit walls are conceptualized as thin waste rock dumps potentially showing similar geochemical behaviour, source terms for pit walls will be based on waste rock source terms described in Section 4.2. However, the thickness of broken rock exposed in pit walls is much smaller than waste rock dumps and so a scaling factor of 0.1 (i.e., 10%) will be applied to waste rock source terms when used to estimate loadings from pit walls. This scaling factor will be evaluated through calibration and sensitivity analysis in the Site-wide Load Balance Model revision.

Source terms for dumps comprised of waste from a given pit will be applied to that pit's wall as per sources identified in Table 4-1. For example, waste from Gibraltar East and West Pits was placed in Dumps 1 and 4. Gibraltar East and West pit walls will receive the source term developed for Dumps 1 and 4.

For non-acidic conditions in Pollyanna and Granite pits, the non-acidic source term developed for the first 10 years for waste rock placed in 7 Dump will be applied.

Table 4-2 summarizes the application of waste rock source terms to pit walls.

Table 4-2: Application of Waste Rock Source Terms to Pit Walls

Pit	During Operation		At Closure	
	Pit Wall Portion	Source Term Applied	Pit Wall Portion	Source Term Applied
Gibraltar East	Non-acidic (0%)	Not applicable	Non-acidic (0%)	Not applicable
	Acidic (100%)	Dump 1 and 4 Source Term x 10%	Acidic (100%)	Dump 1 and 4 Source Term x 10%
Gibraltar West	Non-acidic (0%)	Not applicable	Non-acidic (0%)	Not applicable
	Acidic (100%)	Dump 1 and 4 Source Term x 10%	Acidic (100%)	Dump 1 and 4 Source Term x 10%
Pollyanna	Non-acidic (90%)	Dump 7 (First 10 Years) Source Term x 10%	Non-acidic (60%)	Dump 7 (First 10 Years) Source Term x 10%
	Acidic (10%)	Dump 3 Source Term x 10%	Acidic (40%)	Dump 3 Source Term x 10%
Granite	Non-acidic (90%)	Dump 6 Source Term x 10%	Non-acidic (50%)	Dump 6 Source Term x 10%
	Acidic (10%)	Dump 7 (First 10 Years) Source Term x 10%	Acidic (50%)	Dump 7 (First 10 Years) Source Term x 10%

4.4 Tailings

4.4.1 Surface Runoff Source Term

The tailings surface runoff term is based on the loadings observed from three tailings humidity cell tests (SRK 1998) based on the assumption that the thickness of tailings exposed to leaching by runoff will be no greater than a few millimetres. The resulting source term is expressed as mg/m^2/year.

The source term was calculated as follows:

- Average release rates (mg/m^2/week) indicated for each cell were calculated from the leachate concentration (mg/L), the volume of leach recovered (L) and the area of the cell (0.035 m^2)
- The average release rates were scaled to allow for lower temperatures at the site (scaling factor of 0.3).
- The average and maximum of the three average release rates calculated as described above were used to calculate surface runoff loadings (Table 5-3).

4.4.2 Infiltration Source Term

Based on the conceptual model (Figure 3-1), water chemistry resulting from infiltrating meteoric water contacting the oxidizing profile in the tailings and cyclone sand dam is reflected in the current seepage chemistry, though the seepage chemistry also reflects mixing of this water with draining process water (Figure 3-1). In addition, the oxidation profile is not expected to change. Therefore, the seepage chemistry is an appropriate representation of current and future tailings infiltration water and seepage.

The source term for tailings infiltration was developed based on samples from 6 Seepage Pond, monitoring station 111 (Table 5-3). This assumption will be revisited as the overall water and load balance for the tailings storage facility is evaluated to consider changes in the load originating from ore processing and the effect on sulphate concentrations in process water (see Table 2-3).

5 Updated Source Term Summary

The updated average and upper bound case source terms for waste rock dumps are provided in Table 5-1 and Table 5-2, respectively. Tailings storage facility source terms, including tailings slurry water and beached tailings contact water, are provided in Table 5-3.

Table 5-1: Updated Source Terms for Waste Rock Dumps – Average Case

Parameter	Units	Dump 1	Dump 3	Dump 4	Dump 5	Dump 6	Dump 7		Dump 10
							First 10 Years	After 10 Years	
Acidity	mg/L	5000	3000	5000	2400	3700	13	2400	3000
Alkalinity	mg/L	-	1.2	-	-	-	150	-	1.2
Hardness	mg/L	2400	990	2400	1800	1700	1500	1800	990
Sulphate	mg/L	7500	3100	7500	3500	5600	1200	3500	3100
Chloride	mg/L	40	11	40	17	60	13	17	11
Fluoride	mg/L	16	5.3	16	9.2	9.2	-	9.2	5.3
NO_2+NO_3	mg/L	2.9	0.41	2.9	8.6	4.4	-	8.6	0.41
NH_3	mg/L	1.1	0.087	1.1	-	-	-	-	0.087
Ag	mg/L	-	-	-	-	0.027	0.011	-	-
Al	mg/L	490	150	490	330	430	0.24	330	150
As	mg/L	0.025	0.0079	0.025	0.0095	0.092	0.23	0.0095	0.0079
B	mg/L	1.2	0.17	1.2	0.44	0.9	0.11	0.44	0.17
Be	mg/L	-	-	-	-	0.015	0.0059	-	-
Ca	mg/L	430	280	430	390	380	430	390	280
Cd	mg/L	0.097	0.025	0.097	0.057	0.035	0.011	0.057	0.025
Co	mg/L	4.1	1	4.1	1.8	2.2	0.059	1.8	1
Cr	mg/L	0.039	0.028	0.039	0.038	0.082	0.012	0.038	0.028
Cu	mg/L	840	110	840	270	350	2.3	270	110
Fe	mg/L	260	320	260	63	660	0.04	63	320
Mg	mg/L	320	77	320	220	170	98	220	77
Mn	mg/L	110	24	110	57	46	2.1	57	24
Mo	mg/L	0.013	0.0011	0.013	0.0023	0.02	0.28	0.0023	0.0011
Na	mg/L	20	6.6	20	18	11	33	18	6.6
Ni	mg/L	0.85	0.24	0.85	0.65	0.69	0.059	0.65	0.24
Pb	mg/L	0.0058	0.00083	0.0058	0.0022	0.058	0.061	0.0022	0.00083
Sb	mg/L	0.012	0.0017	0.012	0.0044	0.089	0.23	0.0044	0.0017
Se	mg/L	0.0088	0.0011	0.0088	0.0037	0.082	0.23	0.0037	0.0011
Zn	mg/L	23	1.8	23	12	5.6	0.33	12	1.8

"-" indicates" that data were not available for this parameter.

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Table 5-2: Updated Source Terms for Waste Rock Dumps – Upper Bound Case

Parameter	Units	Dump 1	Dump 3	Dump 4	Dump 5	Dump 6	Dump 7		Dump 10
							First 10 Years	After 10 Years	
Acidity	mg/L	15000	6800	15000	4100	7400	17	4100	6800
Alkalinity	mg/L	-	2.2	-	-	-	180	-	2.2
Hardness	mg/L	4300	1800	4300	2200	2200	1700	2200	1800
Sulphate	mg/L	19000	8900	19000	5700	9600	1500	5700	8900
Chloride	mg/L	57	25	57	25	410	14	25	25
Fluoride	mg/L	44	16	44	17	17	-	17	16
NO_2+NO_3	mg/L	6.6	1.4	6.6	17	13	-	17	1.4
NH_3	mg/L	1.8	0.17	1.8	-	-	-	-	0.17
Ag	mg/L	-	-	-	-	0.047	0.01	-	-
Al	mg/L	1400	470	1400	490	770	0.34	490	470
As	mg/L	0.09	0.025	0.09	0.017	0.43	0.2	0.017	0.025
B	mg/L	5	0.5	5	0.5	2	0.1	0.5	0.5
Be	mg/L	-	-	-	-	0.028	0.005	-	-
Ca	mg/L	520	460	520	430	440	470	430	460
Cd	mg/L	0.27	0.076	0.27	0.11	0.06	0.01	0.11	0.076
Co	mg/L	12	2.9	12	2.6	3.3	0.16	2.6	2.9
Cr	mg/L	0.11	0.096	0.11	0.056	0.13	0.017	0.056	0.096
Cu	mg/L	2200	300	2200	370	630	3.9	370	300
Fe	mg/L	1100	1200	1100	170	1400	0.1	170	1200
Mg	mg/L	650	180	650	290	280	110	290	180
Mn	mg/L	330	67	330	82	69	5.2	82	67
Mo	mg/L	0.049	0.0027	0.049	0.0025	0.067	0.35	0.0025	0.0027
Na	mg/L	28	9.8	28	23	20	37	23	9.8
Ni	mg/L	2.2	0.59	2.2	1	1.1	0.05	1	0.59
Pb	mg/L	0.025	0.0025	0.025	0.0025	0.23	0.085	0.0025	0.0025
Sb	mg/L	0.05	0.005	0.05	0.005	0.43	0.2	0.005	0.005
Se	mg/L	0.025	0.0025	0.025	0.005	0.43	0.2	0.005	0.0025
Zn	mg/L	74	5.4	74	21	15	0.84	21	5.4

“-” indicates that data were not available for this parameter.

Source: P:\01_SITES\Gibraltar\1CG021.011_TOR_Implementation\300 Source Term Development\2.Data\Rock\Source Term Development\Gibraltar_SourceTermsStatistics_1CG021.011_AW_CAJ_v03.xlsx

Table 5-3: Updated Source Terms for the Tailings Storage Facility

Parameter	Beached Tailings Runoff			Seepage Water		
	Units	Average Case (P50)	Upper Bound Case (P95)	**Units**	Average Case (P50)	Upper Bound Case (P95)
Alkalinity	mg/m^2/week	2800	2990	mg/L	110	130
Hardness	mg/m^2/week	-	-	mg/L	920	1100
Sulphate	mg/m^2/week	5050	11000	mg/L	930	1300
Chloride	mg/m^2/week	-	-	mg/L	9.7	13
Fluoride	mg/m^2/week	-	-	mg/L	0.4	0.56
NO_2+NO_3	mg/m^2/week	-	-	mg/L	0.38	0.7
NH_3	mg/m^2/week	-	-	mg/L	0.38	0.68
Ag	mg/m^2/week	2.7	2.7	mg/L	0.00005	0.015
Al	mg/m^2/week	24	25	mg/L	0.0064	0.047
As	mg/m^2/week	0.020	0.024	mg/L	0.0005	0.001
B	mg/m^2/week	-	-	mg/L	0.02	0.1
Be	mg/m^2/week	0.91	0.91	mg/L	0.003	0.005
Ca	mg/m^2/week	2700	4700	mg/L	340	420
Cd	mg/m^2/week	1.8	1.8	mg/L	0.00025	0.005
Co	mg/m^2/week	2.7	2.7	mg/L	0.0011	0.0023
Cr	mg/m^2/week	2.7	2.7	mg/L	0.0025	0.005
Cu	mg/m^2/week	2.2	2.5	mg/L	0.006	0.07
Fe	mg/m^2/week	4.0	5.9	mg/L	0.02	0.082
Mg	mg/m^2/week	230	590	mg/L	16	21
Mn	mg/m^2/week	12	22	mg/L	0.75	1.2
Mo	mg/m^2/week	5.3	7.6	mg/L	0.34	0.62
Na	mg/m^2/week	370	370	mg/L	97	120
Ni	mg/m^2/week	3.7	3.7	mg/L	0.003	0.011
Pb	mg/m^2/week	9.1	9.1	mg/L	0.0001	0.05
Sb	mg/m^2/week	9.1	9.1	mg/L	0.0005	0.0017
Se	mg/m^2/week	24	24	mg/L	0.0005	0.001
Zn	mg/m^2/week	1.4	1.4	mg/L	0.01	0.03

“-” indicates that data were not available for this parameter.

Source beached tailings runoff: P:\01_SITES\Gibraltar\1CG021.011_TOR_Implementation\300 Source Term Development\2.Data\Tailings\TailingsRunoffTerm_1CG021011_SJD_R0.xlsx

Source tailings infiltration: P:\01_SITES\Gibraltar\1CG021.011_TOR_Implementation\300 Source Term Development\2.Data\Rock\Source Term Development\Gibraltar_SourceTermsStatistics_1CG021.011_AW_CAJ_v03.xlsx

6 Conclusions

The following can be concluded from this work:

- A historical review of the progress of mining and waste rock disposal showed that individual dumps do not contain mixtures of waste rock from different pits.
- Static geochemical characteristics of waste rock indicate that different geochemical behaviour can be expected for waste rock mined earlier in the operation than later. ARD onset for the older rock would be more rapid and drainage chemistry more severe than for recent waste rock.
- Dumps 1, 3, 4, 5, 6 and 10 are currently acidic and are expected to remain acidic.
- 7 Dump is currently dominantly non-acidic.
- Seepage data from 4D-1 provides a useful long-term record of the evolution of drainage chemistry for waste rock dump and is the logical analog for the evolution of 7 Dump with onset lagging placement by an average of 10 years.
- Separate distinctive source terms were developed for Dumps 1, 3, 4, 5, 6, 7 and 10. Average and upper Bound case source terms were based on waste rock seepage data.
- Because pit walls are conceptualized as thin waste rock dumps potentially showing similar geochemical behavior, source terms for pit walls will be based on waste rock source terms.
- No difference is apparent between the cyclone feed, underflow (sands) and overflow (fines) indicating that the ARD potential of cyclone sands can be expected to be comparable to bulk tailings.
- Oxidation profiles from within the tailings sands dams are not expected to change, and current seepage chemistry is an appropriate and conservative representation of combined beached tailings contact water.

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

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Appendix A: Historical Review of Gibraltar Mine Mining and Waste Rock Disposal

Production Year	Source	Tonnes Mined	Tonnes Milled	Cumulative Tonnes Mined	Cumulative Tonnes Milled	Strip ratio	Waste	Cumulative Waste
		tonnes/a	tonnes/a	tonnes	tonnes		tonnes/a	tonnes
1971	Gib E 1	7,900,000	0	7,900,000	0		7,900,000	7,900,000
1972	Gib E 1	21,000,000	10,900,000	28,900,000	10,900,000	0.9	10,100,000	18,000,000
1973	Gib E 1	29,300,000	15,100,000	58,200,000	26,000,000	0.9	14,200,000	32,200,000
1974	Gib E 1/Granite 1	31,400,000	13,400,000	89,600,000	39,400,000	1.3	18,000,000	50,200,000
1975	Granite 1	27,100,000	11,500,000	116,700,000	50,900,000	1.4	15,600,000	65,800,000
1976	Granite 1	15,300,000	8,500,000	132,000,000	59,400,000	0.8	6,800,000	72,600,000
1977	Granite 1/Pollyanna 1	32,100,000	14,100,000	164,100,000	73,500,000	1.3	18,000,000	90,600,000
1978	Pollyanna 1	17,700,000	5,700,000	181,800,000	79,200,000	2.1	12,000,000	102,600,000
1979	Pollyanna 1/Gib E 2	27,700,000	11,500,000	209,500,000	90,700,000	1.4	16,200,000	118,800,000
1980	Pollyanna 1/Gib E 2	38,100,000	13,900,000	247,600,000	104,600,000	1.7	24,200,000	143,000,000
1981	Gib E 2/Pollyanna 2	40,000,000	14,600,000	287,600,000	119,200,000	1.7	25,400,000	168,400,000
1982	Gib E 2/Pollyanna 2	20,200,000	14,500,000	307,800,000	133,700,000	0.4	5,700,000	174,100,000
1983	Gib E 2/Pollyanna 2/Gib W	23,300,000	14,900,000	331,100,000	148,600,000	0.6	8,400,000	182,500,000
1984	Gib E 2/Pollyanna 2/Gib W	20,800,000	14,500,000	351,900,000	163,100,000	0.4	6,300,000	188,800,000
1985	Gib E 2/Pollyanna 2/Gib W	22,900,000	14,800,000	374,800,000	177,900,000	0.5	8,100,000	196,900,000
1986	Pollyanna 2/Granite 2	24,700,000	13,400,000	399,500,000	191,300,000	0.8	11,300,000	208,200,000
1987	Pollyanna 2/Granite 2	28,100,000	13,900,000	427,600,000	205,200,000	1.0	14,200,000	222,400,000
1988	Pollyanna 2/Granite 2	12,100,000	6,000,000	439,700,000	211,200,000	1.0	6,100,000	228,500,000
1989	Granite 2/Pollyanna 3	26,000,000	13,200,000	465,700,000	224,400,000	1.0	12,800,000	241,300,000
1990	Granite 2/Pollyanna 3	31,400,000	12,900,000	497,100,000	237,300,000	1.4	18,500,000	259,800,000
1991	Pollyanna 3/Gib E 3	36,200,000	13,100,000	533,300,000	250,400,000	1.8	23,100,000	282,900,000
1992	Pollyanna 3/Gib E 3	33,000,000	14,000,000	566,300,000	264,400,000	1.4	19,000,000	301,900,000
1993	Pollyanna 3/Gib E 3	25,500,000	11,200,000	591,800,000	275,600,000	1.3	14,300,000	316,200,000
1994	Gib E 3	12,400,000	4,100,000	604,200,000	279,700,000	2.0	8,300,000	324,500,000
1995	Gib E 3	30,100,000	15,300,000	634,300,000	295,000,000	1.0	14,800,000	339,300,000
1996	Gib E 3	23,800,000	14,500,000	658,100,000	309,500,000	0.6	9,300,000	348,600,000
1997	Gib E 3	21,900,000	14,400,000	680,000,000	323,900,000	0.5	7,500,000	356,100,000
1998	Gib E 3	19,900,000	11,900,000	699,900,000	335,800,000	0.7	8,000,000	364,100,000
1999	#N/A	0	0	699,900,000	335,800,000	n/a	0	364,100,000
2000	#N/A	0	0	699,900,000	335,800,000	n/a	0	364,100,000
2001	#N/A	0	0	699,900,000	335,800,000	n/a	0	364,100,000
2002	#N/A	0	0	699,900,000	335,800,000	n/a	0	364,100,000
2003	#N/A	0	0	699,900,000	335,800,000	n/a	0	364,100,000
2004	#N/A	0	0	699,900,000	335,800,000	n/a	0	364,100,000
2005	Polyanna	40,000,000	11,500,000	739,900,000	347,300,000	2.5	28,500,000	392,600,000
2006	Polyanna	38,400,000	10,900,000	778,300,000	358,200,000	2.5	27,500,000	420,100,000
2007	Polyanna	35,400,000	9,700,000	813,700,000	367,900,000	2.6	25,700,000	445,800,000
2008	Polyanna, Granite	51,800,000	13,600,000	865,500,000	381,500,000	2.8	38,200,000	484,000,000
2009	Granite	34,900,000	13,000,000	900,400,000	394,500,000	1.7	21,900,000	505,900,000
2010	Granite	52,300,000	15,000,000	952,700,000	409,500,000	2.5	37,300,000	543,200,000
2011	Granite	57,500,000	15,200,000	1,010,200,000	424,700,000	2.8	42,300,000	585,500,000
2012	Granite	66,300,000	16,300,000	1,076,500,000	441,000,000	3.1	50,000,000	635,500,000
2013	Granite	89,500,000	24,500,000	1,166,000,000	465,500,000	2.7	65,000,000	700,500,000
2014	Granite	113,800,000	30,200,000	1,279,800,000	495,700,000	2.8	83,600,000	784,100,000
2015	Granite	93,700,000	30,500,000	1,373,500,000	526,200,000	2.1	63,200,000	847,300,000
2016	Granite	87,600,000	29,500,000	1,461,100,000	555,700,000	2.0	58,100,000	905,400,000
2017	Granite	93,135,000	29,824,000	1,554,235,000	585,524,000	2.1	63,311,000	968,711,000

	Waste Production From Each Pit						Waste Distribution by Dump From Each Pit							
	Pit Distribution Waste (assumed %)			Pit Distribution Waste			Waste Distribution from Gib East Pit (t/a)							
Production Year	**Gib East**	**Polyanna**	**Granite**	**Gib East**	**Polyanna**	**Granite**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**10**
				tonnes/a	**tonnes/a**	**tonnes/a**	**tonnes**		**tonnes**	**tonnes**	**tonnes**	**tonnes**	**tonnes**	**tonnes**
1971	100%	0%	0%	7,900,000	0	0	7,900,000	0	0	0	0	0	0	0
1972	100%	0%	0%	10,100,000	0	0	10,100,000	0	0	0	0	0	0	0
1973	100%	0%	0%	14,200,000	0	0	14,200,000	0	0	0	0	0	0	0
1974	50%	0%	50%	9,000,000	0	9,000,000	9,000,000	0	0	0	0	0	0	0
1975	0%	0%	100%	0	0	15,600,000	0	0	0	0	0	0	0	0
1976	0%	0%	100%	0	0	6,800,000	0	0	0	0	0	0	0	0
1977	0%	50%	50%	0	9,000,000	9,000,000	0	0	0	0	0	0	0	0
1978	0%	100%	0%	0	12,000,000	0	0	0	0	0	0	0	0	0
1979	50%	50%	0%	8,100,000	8,100,000	0	4,050,000	0	0	4,050,000	0	0	0	0
1980	50%	50%	0%	12,100,000	12,100,000	0	6,050,000	0	0	6,050,000	0	0	0	0
1981	50%	50%	0%	12,700,000	12,700,000	0	6,350,000	0	0	6,350,000	0	0	0	0
1982	50%	50%	0%	2,850,000	2,850,000	0	1,425,000	0	0	1,425,000	0	0	0	0
1983	50%	50%	0%	4,200,000	4,200,000	0	2,100,000	0	0	2,100,000	0	0	0	0
1984	50%	50%	0%	3,150,000	3,150,000	0	1,575,000	0	0	1,575,000	0	0	0	0
1985	50%	50%	0%	4,050,000	4,050,000	0	2,025,000	0	0	2,025,000	0	0	0	0
1986	0%	50%	50%	0	5,650,000	5,650,000	0	0	0	0	0	0	0	0
1987	0%	50%	50%	0	7,100,000	7,100,000	0	0	0	0	0	0	0	0
1988	0%	50%	50%	0	3,050,000	3,050,000	0	0	0	0	0	0	0	0
1989	0%	50%	50%	0	6,400,000	6,400,000	0	0	0	0	0	0	0	0
1990	0%	50%	50%	0	9,250,000	9,250,000	0	0	0	0	0	0	0	0
1991	50%	50%	0%	11,550,000	11,550,000	0	5,775,000	0	0	5,775,000	0	0	0	0
1992	50%	50%	0%	9,500,000	9,500,000	0	4,750,000	0	0	4,750,000	0	0	0	0
1993	50%	50%	0%	7,150,000	7,150,000	0	3,575,000	0	0	3,575,000	0	0	0	0
1994	100%	0%	0%	8,300,000	0	0	4,150,000	0	0	4,150,000	0	0	0	0
1995	100%	0%	0%	14,800,000	0	0	7,400,000	0	0	7,400,000	0	0	0	0
1996	100%	0%	0%	9,300,000	0	0	4,650,000	0	0	4,650,000	0	0	0	0
1997	100%	0%	0%	7,500,000	0	0	3,750,000	0	0	3,750,000	0	0	0	0
1998	100%	0%	0%	8,000,000	0	0	4,000,000	0	0	4,000,000	0	0	0	0
1999	0%	0%	0%	0	0	0	0	0	0	0	0	0	0	0
2000	0%	0%	0%	0	0	0	0	0	0	0	0	0	0	0
2001	0%	0%	0%	0	0	0	0	0	0	0	0	0	0	0
2002	0%	0%	0%	0	0	0	0	0	0	0	0	0	0	0
2003	0%	0%	0%	0	0	0	0	0	0	0	0	0	0	0
2004	0%	0%	0%	0	0	0	0	0	0	0	0	0	0	0
2005	0%	100%	0%	0	28,500,000	0	0	0	0	0	0	0	0	0
2006	0%	100%	0%	0	27,500,000	0	0	0	0	0	0	0	0	0
2007	0%	100%	0%	0	25,700,000	0	0	0	0	0	0	0	0	0
2008	0%	100%	0%	0	38,200,000	0	0	0	0	0	0	0	0	0
2009	0%	0%	100%	0	0	21,900,000	0	0	0	0	0	0	0	0
2010	0%	0%	100%	0	0	37,300,000	0	0	0	0	0	0	0	0
2011	0%	0%	100%	0	0	42,300,000	0	0	0	0	0	0	0	0
2012	0%	0%	100%	0	0	50,000,000	0	0	0	0	0	0	0	0
2013	0%	0%	100%	0	0	65,000,000	0	0	0	0	0	0	0	0
2014	0%	0%	100%	0	0	83,600,000	0	0	0	0	0	0	0	0
2015	0%	0%	100%	0	0	63,200,000	0	0	0	0	0	0	0	0
2016	0%	0%	100%	0	0	58,100,000	0	0	0	0	0	0	0	0
2017	0%	0%	100%	0	0	63,311,000	0	0	0	0	0	0	0	0

Waste Distribution by Dump From Each Pit

	Waste Distribution from Polyanna Pit (t/a)								Waste Distribution From Granite Pit (t/a)							
Production Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**10**
	tonnes		**tonnes**	**tonnes**	**tonnes**	**tonnes**	**tonnes**	**tonnes**	**tonnes**		**tonnes**	**tonnes**	**tonnes**	**tonnes**	**tonnes**	**tonnes**
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	9,000,000	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	15,600,000	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	6,800,000	0	0	0
1977	0	0	9,000,000	0	0	0	0	0	0	0	0	0	9,000,000	0	0	0
1978	0	0	12,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	8,100,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	12,100,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	12,700,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	2,850,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	4,200,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	3,150,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	4,050,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	5,650,000	0	0	0	0	0	0	0	0	0	0	5,650,000	0	0
1987	0	0	7,100,000	0	0	0	0	0	0	0	0	0	0	7,100,000	0	0
1988	0	0	3,050,000	0	0	0	0	0	0	0	0	0	0	3,050,000	0	0
1989	0	0	4,480,000	0	0	0	0	1,920,000	0	0	0	0	0	6,400,000	0	0
1990	0	0	6,475,000	0	0	0	0	2,775,000	0	0	0	0	0	9,250,000	0	0
1991	0	0	11,550,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	9,500,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	7,150,000	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	28,500,000	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	27,500,000	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	25,700,000	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	38,200,000	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	16,425,000	5,475,000	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	18,650,000	18,650,000	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	10,575,000	31,725,000	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0	12,500,000	37,500,000	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0	0	16,250,000	48,750,000	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	20,900,000	62,700,000	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63,200,000	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58,100,000	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63,311,000	0

	Total Waste Rock Volume for Each Dump (t/a)								Waste Rock Volume from Each Source for Each Dump					
									1			2		
Production Year	1	2	3	4	5	6	7	10	Gib	Pollyanna	Granite	Gib	Pollyanna	Granite
	tonnes		tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes/a	tonnes/a	tonnes/a	tonnes/a	tonnes/a	tonnes/a
1971	7,900,000	0	0	0	0	0	0	0	7,900,000	0	0	0	0	0
1972	10,100,000	0	0	0	0	0	0	0	10,100,000	0	0	0	0	0
1973	14,200,000	0	0	0	0	0	0	0	14,200,000	0	0	0	0	0
1974	9,000,000	0	0	0	9,000,000	0	0	0	9,000,000	0	0	0	0	0
1975	0	0	0	0	15,600,000	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	6,800,000	0	0	0	0	0	0	0	0	0
1977	0	0	9,000,000	0	9,000,000	0	0	0	0	0	0	0	0	0
1978	0	0	12,000,000	0	0	0	0	0	0	0	0	0	0	0
1979	4,050,000	0	8,100,000	4,050,000	0	0	0	0	4,050,000	0	0	0	0	0
1980	6,050,000	0	12,100,000	6,050,000	0	0	0	0	6,050,000	0	0	0	0	0
1981	6,350,000	0	12,700,000	6,350,000	0	0	0	0	6,350,000	0	0	0	0	0
1982	1,425,000	0	2,850,000	1,425,000	0	0	0	0	1,425,000	0	0	0	0	0
1983	2,100,000	0	4,200,000	2,100,000	0	0	0	0	2,100,000	0	0	0	0	0
1984	1,575,000	0	3,150,000	1,575,000	0	0	0	0	1,575,000	0	0	0	0	0
1985	2,025,000	0	4,050,000	2,025,000	0	0	0	0	2,025,000	0	0	0	0	0
1986	0	0	5,650,000	0	0	5,650,000	0	0	0	0	0	0	0	0
1987	0	0	7,100,000	0	0	7,100,000	0	0	0	0	0	0	0	0
1988	0	0	3,050,000	0	0	3,050,000	0	0	0	0	0	0	0	0
1989	0	0	4,480,000	0	0	6,400,000	0	1,920,000	0	0	0	0	0	0
1990	0	0	6,475,000	0	0	9,250,000	0	2,775,000	0	0	0	0	0	0
1991	5,775,000	0	11,550,000	5,775,000	0	0	0	0	5,775,000	0	0	0	0	0
1992	4,750,000	0	9,500,000	4,750,000	0	0	0	0	4,750,000	0	0	0	0	0
1993	3,575,000	0	7,150,000	3,575,000	0	0	0	0	3,575,000	0	0	0	0	0
1994	4,150,000	0	0	4,150,000	0	0	0	0	4,150,000	0	0	0	0	0
1995	7,400,000	0	0	7,400,000	0	0	0	0	7,400,000	0	0	0	0	0
1996	4,650,000	0	0	4,650,000	0	0	0	0	4,650,000	0	0	0	0	0
1997	3,750,000	0	0	3,750,000	0	0	0	0	3,750,000	0	0	0	0	0
1998	4,000,000	0	0	4,000,000	0	0	0	0	4,000,000	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	28,500,000	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	27,500,000	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	25,700,000	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	38,200,000	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	16,425,000	5,475,000	0	0	0	0	0	0	0	0
2010	0	0	0	0	18,650,000	18,650,000	0	0	0	0	0	0	0	0
2011	0	0	0	0	10,575,000	31,725,000	0	0	0	0	0	0	0	0
2012	0	0	0	0	12,500,000	37,500,000	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	16,250,000	48,750,000	0	0	0	0	0	0	0
2014	0	0	0	0	0	20,900,000	62,700,000	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	63,200,000	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	58,100,000	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	63,311,000	0	0	0	0	0	0	0

	Waste Rock Volume from Each Source for Each Dump								
	3			4			5		
Production Year	Gib	Pollyanna	Granite	Gib	Pollyanna	Granite	Gib	Pollyanna	Granite
	tonnes/a	tonnes/a	tonnes/a	tonnes/a	tonnes/a	tonnes/a	tonnes/a	tonnes/a	tonnes/a
1971	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	9,000,000
1975	0	0	0	0	0	0	0	0	15,600,000
1976	0	0	0	0	0	0	0	0	6,800,000
1977	0	9,000,000	0	0	0	0	0	0	9,000,000
1978	0	12,000,000	0	0	0	0	0	0	0
1979	0	8,100,000	0	4,050,000	0	0	0	0	0
1980	0	12,100,000	0	6,050,000	0	0	0	0	0
1981	0	12,700,000	0	6,350,000	0	0	0	0	0
1982	0	2,850,000	0	1,425,000	0	0	0	0	0
1983	0	4,200,000	0	2,100,000	0	0	0	0	0
1984	0	3,150,000	0	1,575,000	0	0	0	0	0
1985	0	4,050,000	0	2,025,000	0	0	0	0	0
1986	0	5,650,000	0	0	0	0	0	0	0
1987	0	7,100,000	0	0	0	0	0	0	0
1988	0	3,050,000	0	0	0	0	0	0	0
1989	0	4,480,000	0	0	0	0	0	0	0
1990	0	6,475,000	0	0	0	0	0	0	0
1991	0	11,550,000	0	5,775,000	0	0	0	0	0
1992	0	9,500,000	0	4,750,000	0	0	0	0	0
1993	0	7,150,000	0	3,575,000	0	0	0	0	0
1994	0	0	0	4,150,000	0	0	0	0	0
1995	0	0	0	7,400,000	0	0	0	0	0
1996	0	0	0	4,650,000	0	0	0	0	0
1997	0	0	0	3,750,000	0	0	0	0	0
1998	0	0	0	4,000,000	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0
2005	0	28,500,000	0	0	0	0	0	0	0
2006	0	27,500,000	0	0	0	0	0	0	0
2007	0	25,700,000	0	0	0	0	0	0	0
2008	0	38,200,000	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	16,425,000
2010	0	0	0	0	0	0	0	0	18,650,000
2011	0	0	0	0	0	0	0	0	10,575,000
2012	0	0	0	0	0	0	0	0	12,500,000
2013	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0

	Waste Rock Volume from Each Source for Each Dump								
	6			7			10		
Production Year	**Gib**	**Pollyanna**	**Granite**	**Gib**	**Pollyanna**	**Granite**	**Gib**	**Pollyanna**	**Granite**
	tonnes/a	**tonnes/a**	**tonnes/a**	**tonnes/a**	**tonnes/a**	**tonnes/a**	**tonnes/a**	**tonnes/a**	**tonnes/a**
1971	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0
1986	0	0	5,650,000	0	0	0	0	0	0
1987	0	0	7,100,000	0	0	0	0	0	0
1988	0	0	3,050,000	0	0	0	0	0	0
1989	0	0	6,400,000	0	0	0	0	1,920,000	0
1990	0	0	9,250,000	0	0	0	0	2,775,000	0
1991	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0
2009	0	0	5,475,000	0	0	0	0	0	0
2010	0	0	18,650,000	0	0	0	0	0	0
2011	0	0	31,725,000	0	0	0	0	0	0
2012	0	0	37,500,000	0	0	0	0	0	0
2013	0	0	16,250,000	0	0	48,750,000	0	0	0
2014	0	0	20,900,000	0	0	62,700,000	0	0	0
2015	0	0	0	0	0	63,200,000	0	0	0
2016	0	0	0	0	0	58,100,000	0	0	0
2017	0	0	0	0	0	63,311,000	0	0	0