TECHNICAL MEMORANDUM

To:	**Nettie Ore, KGHM Ajax**	**Date: March 24, 2016**
From:	**Bruce Mattson & Timo Kirchner**	**Project #: J933-5**
Subject:	**Reponses to EA Information Requests**	

The following memo provides a response to a number of information requests (IRs) received from the BC Environmental Assessment Office regarding the geochemistry of the Ajax Project. At the request of KGHM Ajax, Lorax Environmental Services Ltd. has prepared the responses. The IR ID# is provided and the actual IR is reproduced prior to the response.

MEM 072

What geochemical parameters will be used to differentiate the low, medium and high-grade ores?

The ore static test samples were classified using the NSR cutoff values for each ore class which were provided by the KGHM mine planning group. The NSR value for each sample was derived through a relatively complex calculation that is based on Cu and Au grades as well as economic parameters.

MEM 073

The Sugar Loaf Diorite (SLD) has been divided into three sub-categories, weakly, moderately and strongly albitized, which is carried through the geochemical characterization of the waste rock. How are the three degrees of SLD albitization defined in the classification system

The degree of albitization used in the geochemical characterization was adopted from the KGHM drill core logging classification scheme. The degree of albitization was constrained visually during core logging for all SLD unit drill core.

MEM 074

Additional information is required on the historical waste rock located on the mine site. Please provide information on locations, volumes, available geochemistry information with a comparison to future mine waste geochemistry, as well as clarification of the re-handling and disposal plans as part of proposed future mining. This is required as a basis to understanding how historical waste has been considered in the water quality predictions.

Uneconomic mine rock that was produced during the historic Ajax operations (1980's and 90's) was backfilled into the East Pit and stockpiled in reclaimed facilities on the south side of

Uneconomic mine rock that was produced during the historic Ajax operations (1980's and 90's) was backfilled into the East Pit and stockpiled in reclaimed facilities on the south side of Peterson Creek. An estimated 4.5 Mt of material is currently stored in the East Pit and there is an additional mine rock area south of Peterson Creek. Site monitoring from water quality station WR-Seep (facility south of Peterson Creek) and monitoring wells MW12-01 and MW12-02 completed in the East Pit backfill were evaluated as constraints for water quality predictions. Since concentrations of most parameters were greater from the monitoring wells in the backfill, data from these locations were used as one analogue database to constrain the geochemical source terms (Appendix C-1 of Appendix C-2).

Several lines of evidence suggest that historic mine rock is geochemically representative of future material, albeit likely at different proportions. First, geologic and ML/ARD sample descriptions provided in reports associated with the historic Ajax operations suggest that most units to be disturbed in the future, have previously already been encountered during mining operations. The same conclusion was drawn from the evaluation of geologic cross-sections provided in Appendix F-2 of Appendix 3-A which illustrate that the existing pit voids intersect all of the major rock units. Second, analysis of field bin samples which were taken from the mentioned backfill facilities suggest that, with few exceptions, these materials are geochemically within the range of the static test database compiled for future operations. Third, a historical ARD study at the Ajax site (Robertson and Price, 1988) evaluated the results of 259 ABA samples selected to be representative of the ore and waste rock. The ABA results from this study are summarized below (Table MEM-74). The historic results are generally consistent with the ABA results presented in Appendix 3-A of the Application. The results indicate that sulphur content is lower in waste rock than ore and the vast majority of both waste rock, low grade or and ore samples are NPAG. One notable difference is that the average sulphur content in waste rock is 0.28%S from the West Pit and 0.38%S from the East Pit. This is likely due a higher ore/waste grade cutoff than is currently being used.

Table MEM-74a:
Average ABA values from Historic Ajax Rock

		Paste pH	Sulphur	Acid Potential	Neutralization Potential	NNP
			%	Tonnes $CaC0_3$/1000 Tonnes		
West Pit Waste Rock	Average	8.65	0.28	9	70	62
West Pit Low Grade	Average	8.55	0.42	13	81	68
West Pit Ore	Average	8.42	0.8	25	87	62
East Pit Waste Rock	Average	8.58	0.38	12	57	45
East Pit Low Grade	Average	8.39	0.74	23	58	35
East Pit Ore	Average	8.52	0.86	27	65	38

Table MEM-74b:
Minimum and Maximum ABA values from Historic Ajax Rock

		Paste pH	Sulphur	Acid Potential	Neutralization Potential	NNP
			%	Tonnes $CaC0_3$/1000 Tonnes		
West Pit Waste Rock	Maximum	9.64	1.51	47	205	202
West Pit Waste Rock	Minimum	8.01	0.01	0.4	25	-23
West Pit Low Grade	Maximum	9.83	1.51	47	143	134
West Pit Low Grade	Minimum	8.2	0.1	3	36	20
West Pit Ore	Maximum	8.85	2.02	63	152	143
West Pit Ore	Minimum	8.08	0.09	3	46	-17
East Pit Waste Rock	Maximum	9.26	1.45	45	105	100
East Pit Waste Rock	Minimum	8.02	0.02	1	32	-8
East Pit Low Grade	Maximum	8.76	1.72	54	123	101
East Pit Low Grade	Minimum	8.06	0.05	2	25	-16
East Pit Ore	Maximum	9.36	1.18	37	75	54
East Pit Ore	Minimum	8.27	0.43	14	48	15

MEM 076

The NP determination for operational management of waste rock and ore will be based on a calculation of CaNP from the total carbon content of a sample for the SLD, IMH and SLVH waste rock types. For the MAFV and PICR types, NP will be determined from CaNP and a correction factor based on the 25th percentile non-carbonate NP value. Please provide MEM with an explanation of how the non-carbonate NP is calculated and how the fixed-NP value was derived for the MAFV and PICR waste rock types.

Non-carbonate NP is calculated as the difference between Modified NP and carbonate NP (CaNP). The fixed NP values proposed for use during operational monitoring of PICR and MAFV were derived using the following steps.

- The amount of non-carbonate NP was calculated for each mine rock sample that had both a Modified NP and CaNP measurement.
- A statistical distribution of non-carbonate NP for each major mine rock lithology was determined (*i.e.* minimum, 10th, 25th, 50th, 75th, 90th percentiles and maximum).

- The 25th percentile non-carbonate NP value for the PICR (17 $kgCaCO_3/t$) and MAFV (8 $kgCaCO_3/t$) were selected to be used as the fixed NP value.

During operations, the available NP for the PICR unit will be calculated by adjusting the CaNP determined from the total carbon content as follows:

$$MAFV \quad available\ NP = \%TC \times 83.33 + 8$$

$$PICR \quad available\ NP = \%TC \times 83.33 + 17$$

This approach of using the 25th percentile is considered conservative as it statistically underestimates the amount of non-carbonate NP that was measured in the samples.

MEM 077

The AP determination for the operation management of waste rock and ore will be based on the calculation of AP from the non-sulphate-sulphur content, which is calculated as the difference between total-sulphur and sulphate-sulphur. MEM agrees that the data supports deriving the waste rock and ore AP by this method.

Thank you for your comment.

MEM 078

The general setup for the unsaturated column experiments included 5kg of waste rock that is trickled leached weekly with 300-500mL of deionized water, which is then collected one day later. Please provide information on the rationale for employing unsaturated columns over HCTs, as well as the choice of modified column test procedures. Examples of the use of unsaturated columns in previous investigations should be provided.

While humidity cells provide a standardized method to calculate reaction rates from mine materials, the water/rock ratio and geochemical regime is not representative of that found in mine rock piles. The Ajax site is located in an arid environment and it was considered appropriate to alter the kinetic test procedure to better reflect the low water/rock ratios that will be encountered on site while still allowing sufficient flushing of the sample material to allow for the calculation of reaction rates. The frequency and volume of water added to several columns was adjusted from 300 ml weekly to 500 ml bi-weekly to attempt to more closely simulate conditions within a waste rock dump at the arid Ajax site, which would receive an influx of water during snow melt and infrequently during spring and summer months. Given the very constrained laboratory conditions and methodology, it is possible to calculate leaching rates from the unsaturated columns as input for the water quality model while gaining an understanding of solubility limits that may apply at very small scales (*e.g*. Fe, Al), which may not be captured in humidity cell testing.

The use of columns for prediction of long-term weathering rates has been recommended in two recent ML/ARD guidance documents. Both the GARD Guide (INAP, 2009) and the Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND Report 1.20.1, 2009) state that the use of columns is advantageous because the test design can be modified to match field conditions, which is the approach taken with the Ajax laboratory column tests.

MEM 079

An updated summary of the results for unsaturated columns 2 to 6, collected since August 2015, will be required at permitting along with a detailed discussion of any implications to the project.

An updated set of kinetic test results will be provided with the Mine Permit Application.

MEM 080

A summary and discussion of the results for unsaturated columns 7 to 12 are required to provide MEM with a better understanding of the leaching characteristics of the PICR, MAFV and SVHYB waste rock. Additionally, these results should be carried through to determine the implications for the waste rock source terms and contribution to the site water quality model.

Short-term leaching behaviour of Col-7 through Col-12 was presented in Appendix 3-A of the EA application document, with the kinetic test data being used for operational (short-term) source term considerations in Appendix 3-B of the same document. The allocation of kinetic test leachate results for Geomet units in the context of source term development was given in Table 2-1 of Appendix 3-B. The table notes that only the predicted long-term mine rock drainage chemistry from Geomet units 4, 7, 8, and 12, would be affected by the additional data generated by Col-7 through Col-12. The original source terms have already incorporated the higher and more conservative rates from the short-term results into the operational source terms. Also, the ore sample in Col-9 was only used as input for the temporary (short-term) ore stockpile drainage chemistry model, thus, the longer-term leaching rates available from this test will not affect the original source terms.

A comparison of the long-term (post-closure) source term model input with and without the consideration of these more recently initiated kinetic test cells is discussed below. A full breakdown of updated loading rates by kinetic test cell and relevant geomet unit is provided in Table MEM 80 presents the original and revised loading rates calculated for each of the mentioned affected Geomet units. In this table, species whose updated input loading rates increase 3 times those from the original assessment used for the source term model are shaded in red.

Table MEM 80:

Date	Cycle	pH	Sulphate	Chloride	Fluoride	Bromide	Al	Sb	As	Ba	Be	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Hg	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	Tl	Sn	U	V	Zn
Mine Rock																																					
Col 2																																					
Operational	16-20	7.9	10	0.0059	0.016	0.0089	0.00095	0.000029	0.000051	0.0016	0.00000059	0.0021	0.00000080	3.8	0.000015	0.000019	0.00017	0.00030	0.0000017	0.00018	0.71	0.00045	0.0000006	0.0037	0.000059	0.00027	0.46	0.000041	0.39	0.00000030	0.30	0.044	0.00000059	0.000013	0.000080	0.00077	0.00017
Post-closure	last 5	8.2	0.45	0.0032	0.00096	0.0048	0.00016	0.0000064	0.000049	0.0057	0.00000032	0.00060	0.000000053	0.95	0.0000080	0.0000023	0.000096	0.000048	0.00000032	0.000077	0.26	0.000068	0.0000002	0.00095	0.000013	0.00014	0.23	0.000030	0.27	0.00000017	0.041	0.012	0.00000032	0.0000032	0.000022	0.00086	0.000032
Col 3																																					
Operational	16-20	7.6	92	0.060	0.010	0.0089	0.00026	0.00014	0.00017	0.0018	0.00000059	0.0043	0.0000077	35	0.000015	0.00023	0.00025	0.00024	0.0000018	0.00048	3.6	0.0027	0.0000003	0.025	0.0044	0.0025	3.9	0.00023	0.44	0.00000030	0.33	0.28	0.0000059	0.000013	0.00016	0.00030	0.00018
Post-closure	last 5	7.8	5.4	0.011	0.0011	0.0054	0.000095	0.000044	0.00013	0.0011	0.00000013	0.00088	0.0000030	2.4	0.0000024	0.0000047	0.000055	0.000083	0.00000027	0.000092	0.29	0.000065	0.0000002	0.012	0.000085	0.00011	0.86	0.00013	0.19	0.000000072	0.042	0.021	0.0000024	0.0000032	0.000011	0.00048	0.000027
Col 4																																					
Operational	16-20	8.0	0.24	0.012	0.0059	0.0090	0.0014	0.000019	0.00037	0.0043	0.00000060	0.0020	0.000000093	1.2	0.000015	0.0000050	0.000048	0.00036	0.0000018	0.00012	0.42	0.00015	0.0000003	0.00072	0.000036	0.00072	0.40	0.0000072	0.49	0.00000030	0.25	0.016	0.00000060	0.00010	0.000019	0.0022	0.00012
Post-closure	last 5	8.1	0.10	0.0030	0.00087	0.0044	0.00054	0.0000078	0.000097	0.0027	0.00000029	0.00065	0.000000078	0.67	0.0000073	0.0000015	0.000051	0.000050	0.0000011	0.00010	0.27	0.000068	0.0000001	0.00013	0.0000090	0.00013	0.20	0.0000057	0.25	0.00000015	0.040	0.0090	0.00000029	0.000026	0.0000067	0.00085	0.000034
Col 5																																					
Operational	16-20	8.0	1.1	0.18	0.018	0.0090	0.00052	0.00012	0.00041	0.0041	0.00000060	0.0035	0.000000090	1.6	0.000015	0.0000049	0.000096	0.00030	0.0000031	0.00018	0.47	0.000096	0.0000003	0.00027	0.000012	0.00027	0.77	0.0000090	0.52	0.00000030	0.38	0.021	0.00000060	0.000014	0.0000067	0.0032	0.00018
Post-closure	last 5	8.1	0.20	0.0031	0.0020	0.0046	0.00050	0.000040	0.00019	0.0076	0.00000031	0.00083	0.000000046	1.00	0.0000078	0.0000022	0.000062	0.000047	0.00000054	0.00022	0.47	0.000088	0.0000002	0.00014	0.000012	0.00014	0.77	0.000036	0.27	0.00000015	0.036	0.019	0.00000031	0.0000035	0.0000034	0.0015	0.000061
Col 6																																					
Operational	16-20	8.0	16	0.19	0.0054	0.0090	0.00016	0.00011	0.0020	0.0033	0.00000060	0.0094	0.0000040	4.0	0.000015	0.000050	0.00016	0.00030	0.000023	0.00024	2.2	0.0011	0.0000003	0.017	0.0045	0.0016	3.8	0.000029	0.68	0.00000030	0.40	0.065	0.0000079	0.0000047	0.000023	0.00026	0.00043
Post-closure	last 5	8.2	1.2	0.0032	0.0027	0.0041	0.00055	0.000045	0.0013	0.0041	0.00000028	0.0016	0.00000038	0.75	0.000020	0.0000061	0.000069	0.000047	0.00000053	0.00011	0.43	0.00011	0.0000001	0.0059	0.00046	0.00012	2.0	0.000056	0.29	0.00000014	0.035	0.011	0.0000029	0.0000012	0.0000038	0.00024	0.000051
Col 7																																					
Operational	16-20	8.0	0.41	0.0046	0.0051	0.0069	0.0019	0.00065	0.0033	0.0012	0.00000016	0.0041	0.0000001	0.77	0.0000018	0.00000055	0.000058	0.00016	0.000002	0.00010	0.12	0.000051	0.0000003	0.000033	0.0000023	0.000069	0.15	0.0000063	0.23	0.000000046	0.56	0.011	0.00000013	0.000103	0.0000065	0.0015	0.000042
Post-closure*	**last 5**	**8.1**	**0.16**	**0.029**	**0.0017**	**0.009**	**0.0021**	**0.00032**	**0.0016**	**0.0044**	**0.00000020**	**0.0016**	**0.00000017**	**1.1**	**0.0000009**	**0.00000040**	**0.000045**	**0.00020**	**0.0000028**	**0.000061**	**0.20**	**0.000086**	**0.0000003**	**0.000072**	**0.0000029**	**0.00009**	**0.10**	**0.0000080**	**0.16**	**0.00000006**	**0.078**	**0.016**	**0.00000014**	**0.000021**	**0.0000022**	**0.00064**	**0.000057**
Col 8																																					
Operational	16-20	8.1	0.55	0.0047	0.0042	0.0071	0.00068	0.000035	0.0027	0.00048	0.00000016	0.0052	0.000000075	0.36	0.0000085	0.00000071	0.000058	0.00016	0.0000028	0.00013	0.28	0.000026	0.00000024	0.000075	0.0000094	0.000071	0.23	0.000017	0.40	0.000000047	1.6	0.0067	0.00000012	0.000014	0.0000059	0.0028	0.000024
Post-closure*	**last 5**	**8.2**	**0.10**	**0.029**	**0.0017**	**0.009**	**0.00045**	**0.000017**	**0.00094**	**0.0012**	**0.00000020**	**0.0027**	**0.00000009**	**0.70**	**0.0000057**	**0.00000029**	**0.000036**	**0.00020**	**0.0000011**	**0.00011**	**0.55**	**0.0000074**	**0.0000003**	**0.000070**	**0.0000030**	**0.00009**	**0.33**	**0.000015**	**0.36**	**0.00000017**	**0.27**	**0.012**	**0.00000014**	**0.000049**	**0.0000044**	**0.0016**	**0.000030**
Col 10																																					
Operational	16-20	8.2	1.5	0.0096	0.0047	0.0071	0.00019	0.00025	0.024	0.0040	0.00000016	0.010	0.00000033	0.51	0.000012	0.0000024	0.000037	0.00016	0.0000028	0.00014	0.37	0.000043	0.00000024	0.00014	0.00018	0.000071	1.8	0.000040	0.41	0.000000047	0.60	0.011	0.00000092	0.0000085	0.00000099	0.00011	0.000047
Post-closure*	**last 5**	**8.1**	**0.31**	**0.030**	**0.0040**	**0.009**	**0.00024**	**0.000090**	**0.011**	**0.011**	**0.00000021**	**0.0033**	**0.00000009**	**0.66**	**0.000019**	**0.0000080**	**0.000042**	**0.00021**	**0.00000060**	**0.000096**	**0.30**	**0.0000078**	**0.0000003**	**0.00029**	**0.000081**	**0.00009**	**1.2**	**0.000021**	**0.30**	**0.00000017**	**0.16**	**0.0093**	**0.00000046**	**0.000013**	**0.00000038**	**0.000091**	**0.000032**
Col 11																																					
Operational	16-20	8.0	4.9	0.024	0.0014	0.0071	0.00013	0.000061	0.00051	0.0025	0.00000016	0.018	0.00000054	0.88	0.0000099	0.0000047	0.000032	0.00016	0.0000025	0.000063	0.82	0.00011	0.00000024	0.00042	0.00078	0.000071	1.8	0.00014	0.38	0.000000047	0.30	0.016	0.0000022	0.0000034	0.00000049	0.000031	0.000024
Post-closure*	**last 5**	**8.2**	**1.0**	**0.029**	**0.0017**	**0.009**	**0.00016**	**0.000023**	**0.00043**	**0.0069**	**0.00000020**	**0.0060**	**0.00000009**	**0.86**	**0.000030**	**0.0000019**	**0.000057**	**0.00020**	**0.0000016**	**0.000052**	**0.57**	**0.000018**	**0.0000003**	**0.00027**	**0.00022**	**0.00009**	**1.4**	**0.00010**	**0.38**	**0.00000011**	**0.054**	**0.011**	**0.0000012**	**0.0000046**	**0.00000041**	**0.000038**	**0.000030**
Col 12																																					
Operational	16-20	8.0	2.7	0.018	0.0077	0.0077	0.00055	0.00012	0.0015	0.0033	0.00000018	0.0066	0.0000013	1.1	0.000014	0.0000038	0.000074	0.00018	0.000031	0.00014	0.30	0.000018	0.00000026	0.0010	0.00049	0.000077	1.0	0.000040	0.49	0.000000051	0.67	0.020	0.0000014	0.0000035	0.000022	0.0015	0.00015
Post-closure*	**last 5**	**8.1**	**0.63**	**0.029**	**0.0017**	**0.009**	**0.00097**	**0.000046**	**0.00051**	**0.0064**	**0.00000020**	**0.0016**	**0.00000018**	**0.99**	**0.000012**	**0.0000021**	**0.000050**	**0.00020**	**0.0000023**	**0.000073**	**0.26**	**0.000012**	**0.0000003**	**0.00049**	**0.00015**	**0.00009**	**0.96**	**0.000019**	**0.35**	**0.00000017**	**0.080**	**0.014**	**0.00000085**	**0.0000079**	**0.000012**	**0.00086**	**0.000031**
** new long-term loading rates for Col-7 through Col-12*																																					
Geounit 4																																					
Post-closure		8.1	0.15	0.0031	0.0014	0.0045	0.00052	0.000024	0.00014	0.0052	0.00000030	0.00074	0.000000062	0.83	0.0000075	0.0000019	0.000057	0.000048	0.00000084	0.00016	0.37	0.000078	0.0000001	0.00014	0.000011	0.00013	0.49	0.000021	0.26	0.00000015	0.038	0.014	0.00000030	0.000015	0.0000050	0.0012	0.000047
Post-closure (updated)		8.1	0.14	0.016	0.0016	0.007	0.00090	0.000096	0.00070	0.0040	0.00000025	0.0014	0.00000010	0.85	0.0000054	0.0000011	0.000048	0.00012	0.0000014	0.00012	0.37	0.000062	0.0000002	0.00010	0.0000068	0.00011	0.35	0.000016	0.26	0.00000013	0.11	0.014	0.00000022	0.000025	0.0000042	0.0011	0.000045
Geounit 7																																					
Post-closure		8.2	1.2	0.0032	0.0027	0.0041	0.00055	0.000045	0.0013	0.0041	0.00000028	0.0016	0.00000038	0.75	0.000020	0.0000061	0.000069	0.000047	0.00000053	0.00011	0.43	0.00011	0.00000	0.0059	0.00046	0.00012	2.0	0.000056	0.29	0.00000014	0.035	0.011	0.0000029	0.0000012	0.0000038	0.00024	0.000051
Post-closure (updated)		8.2	0.44	0.030	0.0036	0.0089	0.00022	0.000078	0.0089	0.010	0.00000021	0.0038	0.000000092	0.70	0.000021	0.0000010	0.000045	0.00021	0.00000078	0.000088	0.35	0.0000098	0.00000031	0.00028	0.00011	0.000089	1.2	0.000036	0.31	0.00000016	0.14	0.0096	0.00000060	0.000012	0.00000038	0.000081	0.000031
Geounit 8																																					
Post-closure		8.2	1.2	0.0032	0.0027	0.0041	0.00055	0.000045	0.0013	0.0041	0.00000028	0.0016	0.00000038	0.75	0.000020	0.0000061	0.000069	0.000047	0.00000053	0.00011	0.43	0.00011	0.00000	0.0059	0.00046	0.00012	2.0	0.000056	0.29	0.00000014	0.035	0.011	0.0000029	0.0000012	0.0000038	0.00024	0.000051
Post-closure (updated)		8.1	0.63	0.029	0.0017	0.0086	0.00097	0.000046	0.00051	0.0064	0.00000020	0.0016	0.00000018	0.99	0.000012	0.0000021	0.000050	0.00020	0.0000023	0.000073	0.26	0.000012	0.00000029	0.00049	0.00015	0.000086	0.96	0.000019	0.35	0.00000017	0.080	0.014	0.00000085	0.0000079	0.000012	0.00086	0.000031
Geounit 12																																					
Post-closure		8.2	1.2	0.0032	0.0027	0.0041	0.00055	0.000045	0.0013	0.0041	0.00000028	0.0016	0.00000038	0.75	0.000020	0.0000061	0.000069	0.000047	0.00000053	0.00011	0.43	0.00011	0.00000	0.0059	0.00046	0.00012	2.0	0.000056	0.29	0.00000014	0.035	0.011	0.0000029	0.0000012	0.0000038	0.00024	0.000051
Post-closure (updated)		8.1	0.63	0.029	0.0017	0.0086	0.00097	0.000046	0.00051	0.0064	0.00000020	0.0016	0.00000018	0.99	0.000012	0.0000021	0.000050	0.00020	0.0000023	0.000073	0.26	0.000012	0.00000029	0.00049	0.00015	0.000086	0.96	0.000019	0.35	0.00000017	0.080	0.014	0.00000085	0.0000079	0.000012	0.00086	0.000031

Species that are significantly increased in loading rate considering the updated long-term loading rates include chloride (Geomet units 4, 7, 8, and 12) and As (Geomet unit 7). The long-term leachate concentrations of chloride are all below the detection limit and thus, the apparent increase in chloride loadings is the result of an increase in the detection limit (from 0.2 to 1.0 mg/L). The increase in As loading rate for Geomet unit 7 (PICR), on the other hand, caused by the high solid-phase As concentration in Col-10 (10 ppm) which, along with Col-11, was used to derive the new long-term PICR input loading rates. This solid-phase content is significantly higher than the median value (2.8 ppm) calculated for this population and thus, the revised loading rates can be considered highly conservative. Furthermore, it should be kept in mind that the As cap applied for MRSF and pit wall source terms would annul the effect of this increase in As loading rates for Geomet unit 7.

Overall, it can be said that the extended database considering the long-term leachate chemistry of Col-7 through Col-12 is representative of the previous assessment and would not lead to a significant increase predicted drainage concentrations. Rather, revised loading rates for several potentially problematic species such as Se, Cr and Mo, as well as As for the MAFV unit (Geomet units 8 and 12) are expected to be lower than previously calculated (Table 1) which deems the originally submitted source terms conservative.

MEM 081

An updated summary of the results for HC-1 to HC-6, collected since August 2015 will be required at permitting along with a detailed discussion of any implications to the project.

An updated set of kinetic test results will be provided with the Mine Permit Application.

MEM 082

A summary and discussion of the results for HC- 7 to HC-10 are required to provide MEM with a better understanding of the differences between normal and carbonate depleted leaching characteristics. Additionally, these results should be carried through to determine the implications for the waste rock source terms and contribution to the site water quality model.

Due to the relatively low sulphur content in the HC-7 through HC-10 HCTs the carbonate-deplete cells (HC9 and HC10) require an extended time to remove artefacts from pre-leaching and residual carbonate, which was a requirement also observed for HC3. A number of leachate signatures support that the pre-leached samples HC-9 and HC10 are not yet fully buffered by silicate phases.

- First, measurable alkalinity at levels of 2 to 5 mg $CaCO_3$/L are still being measured in leachate from HC9 and HC10. Although these are low levels, slightly lower alkalinity would be expected if the HCTs were only buffered by silicate mineral phases as documented by HC3 and HC4. Conversely, the humidity cell samples that were not pre-leached, HC7 and HC8 maintain alkalinity between 10 to 15 mg $CaCO_3$/L.

- Second, the molar ratios of Na and Mg molar concentrations indicate the relative influence of residiual NaOAc and mafic silicate mineral dissolution in buffering acidity produced by sulphide oxidation. Na is still the dominant cation being released from HC9 and HC10. However, for HC10 in particular, relative levels of Na appear to be decreasing and Mg increasing as illustrated in Figure MEM-82.

The implications of these results on the source terms are that leaching conditions buffered solely by non-carbonate sources will be rare to non-existent in a MRSF. The blend of NPAG will provide excess alkalinity to the restricted areas of the dump that has depleted carbonate content. Due to these conditions, the leaching rates in both carbonate buffered and non-carbonate buffered portions of the MRSFs are expected to leach at rates observed under alkaline conditions rather than those recorded from HCTs that are buffered solely by non-carbonate minerals. An updated set of kinetic test results and discussion is being prepared for the Mine Permit review.

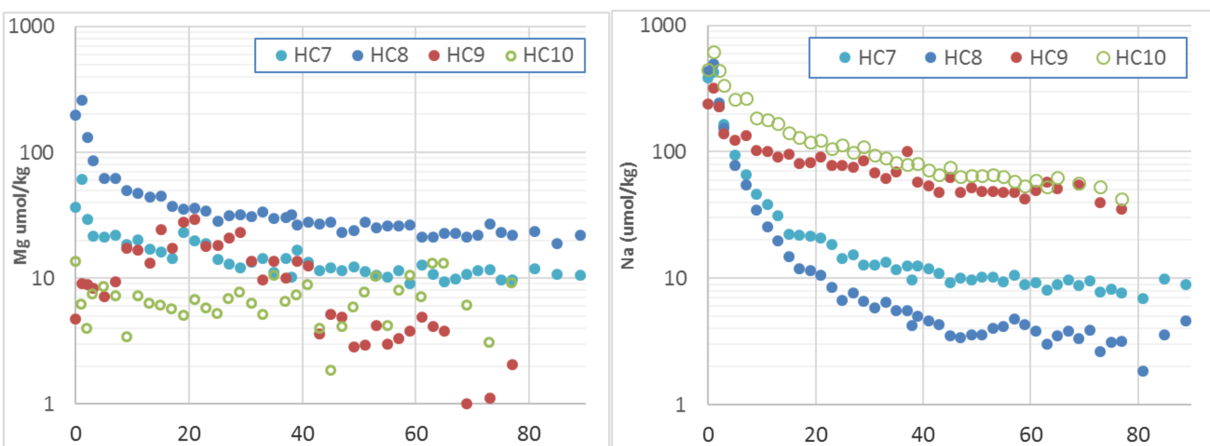


Figure MEM-82: Na and Mg molar loads for Picrite Humidity Cell Tests

MEM 083

The report focuses on the results of the HCT results from the normal and carbonate-depleted (sodium acetate treated) SLD waste rock samples; however, duplicate HCTs were conducted for SLD treated with HOAc and H_2SO_4. Please provide a rationale for excluding the results of the SLD waste rock that was carbonate-depleted with HOAc and H_2SO_4 from the HCT discussion.

The HOAc and H_2SO_4 treated HCTs were initiated when the effects of NaOAc were still apparent in the HC3 leachate after 12 months of operation. They were initiated to provide alternate approaches to removing carbonate on duplicate samples that may allow the sample to eliminate the artefacts of the pre-leaching treatment more rapidly than was being observed from HC3. The cells were discontinued because the HOAc treated cell had a very similar signature as HC3 and there were indications that the H_2SO_4 treatment had not effectively removed carbonate from the sample. Thus, the leaching results from HC3 and HC4 were considered to provide the best indication of carbonate-deplete conditions.

MEM 084

The leaching behaviour of metals in the SLD waste rock HCTs are discussed in 6.1.1.5 (page 6-33); however, only the results for Cu and V are included. The difference in metal leaching behaviour between waste rock controlled by CaNP and silicate-NP is important to understanding the long-term implications of site water quality of the proposed reliance on silicate-NP. In order to assist MEM in understanding the potential for metal leaching in a silicate-NP controlled system, please provide a comparison and discussion of the leaching of metals between normal and carbonate-depleted waste rock in the SLD (HC 1 to HC 6) and PICR (HC 7 to HC 10) HCT results.

A set of mine rock management measures are being implemented to ensure that the MRSFs remain pH-neutral. TSF Embankments and the East MRSF will only contain NPAG rock and the South and West MRSFs and in-pit backfill will be blended to ensure excess alkalinity is available. Under these conditions the MRSFs will leach at rates similar to those measured in carbonate buffered kinetic tests. Metal leaching rates approaching those measured in the kinetic tests that were buffered by non-carbonate minerals will only be observed from zones where blending of mine rock is not undertaken such as the pit walls. The geochemical source terms for pit walls have incorporated these higher metal leaching rates for the carbonate-deplete pit wall source terms.

Table MEM-84 provides the ratio of the carbonate-deplete humidity cells with the original samples and also provides ratios of the three cells that used HOAc (HC5) and H_2SO_4 (HC6) to deplete carbonate relative to the NaOAc leached cell (HC3). Parameters with leaching rates 3 times and by 1/3 are highlighted in red and green, respectively. The ratios were obtained from periods when data is available from all cells at approximately 100 cycles, although the timing varies slightly as the picrite cells (HC7 to HC10 have data available to 79 or 89 cycles and HC5 and HC6 were terminated after 112 cycles).

Table MEM 084

Cycle		SO_4	Cl	F	Br	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Hg	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	Tl	Sn	Ti	U	V	Zn	Zr
100-120	***HC3/HC1***	1.3	1.0	1.0	1.0	0.2	1.0	0.6	0.4	1.0	1.0	0.4	2.0	0.2	1.0	25	8	1.3	1.4	1.0	0.5	1.8	1.0	0.0	4.1	1.0	0.5	1.6	0.8	1.0	1.3	0.1	1.0	0.5	1.4	0.2	0.1	1.9	1.0
100-120	***HC4/HC2***	2.0	1.0	1.0	1.0	2.1	1.0	0.4	1.5	4.8	1.0	1.3	7.1	0.6	1.0	685	858	1.0	2.7	1.9	4.2	11.3	1.0	0.0	171	1.2	0.8	1.8	4.4	1.0	1.2	0.6	1.0	0.3	0.3	0.3	0.0	6.7	1.0
100-112/100-12(	***HC5/HC3***	1.2	1.0	1.0	1.0	2.5	1.0	0.8	1.6	1.0	1.0	2.2	0.5	2.1	1.0	0.1	0.3	3.5	0.5	1.0	1.0	0.3	1.0	3.5	0.3	1.0	1.3	1.4	1.9	1.0	1.0	2.3	1.0	0.6	2.6	0.1	2.4	0.3	1.5
100-112/100-12(	***HC6/HC3***	1.0	1.0	1.0	1.0	5.4	1.0	1.7	3.4	1.0	1.0	2.2	0.5	6.4	1.0	0.0	0.2	1.9	0.5	1.0	1.0	0.1	1.0	5.5	0.3	4.2	2.0	1.2	1.9	1.0	0.8	5.3	1.0	0.5	1.5	2.7	6.3	0.3	1.0
69-77/81-89	***HC9/HC7***	0.8	0.9	0.9	0.9	1.3	0.3	0.4	0.0	0.9	0.9	0.8	0.8	0.0	1.2	1.9	1.0	1.8	0.3	0.3	0.1	1.0	2.7	0.2	1.1	12.5	0.1	0.8	3.5	1.0	5.0	0.0	0.6	1.9	1.1	0.5	0.8	0.7	0.9
69-77/81-90	***HC10/HC8***	2.0	1.0	1.0	1.0	1.6	1.0	0.2	4.5	1.0	1.0	1.3	0.6	3.9	3.7	2.6	1.1	3.1	1.6	1.1	4.4	3.2	1.2	1.9	3.9	1.7	6.6	4.1	1.7	0.5	1.2	6.3	1.0	0.8	1.9	1.1	0.9	1.0	1.0

Notable observations include the following:

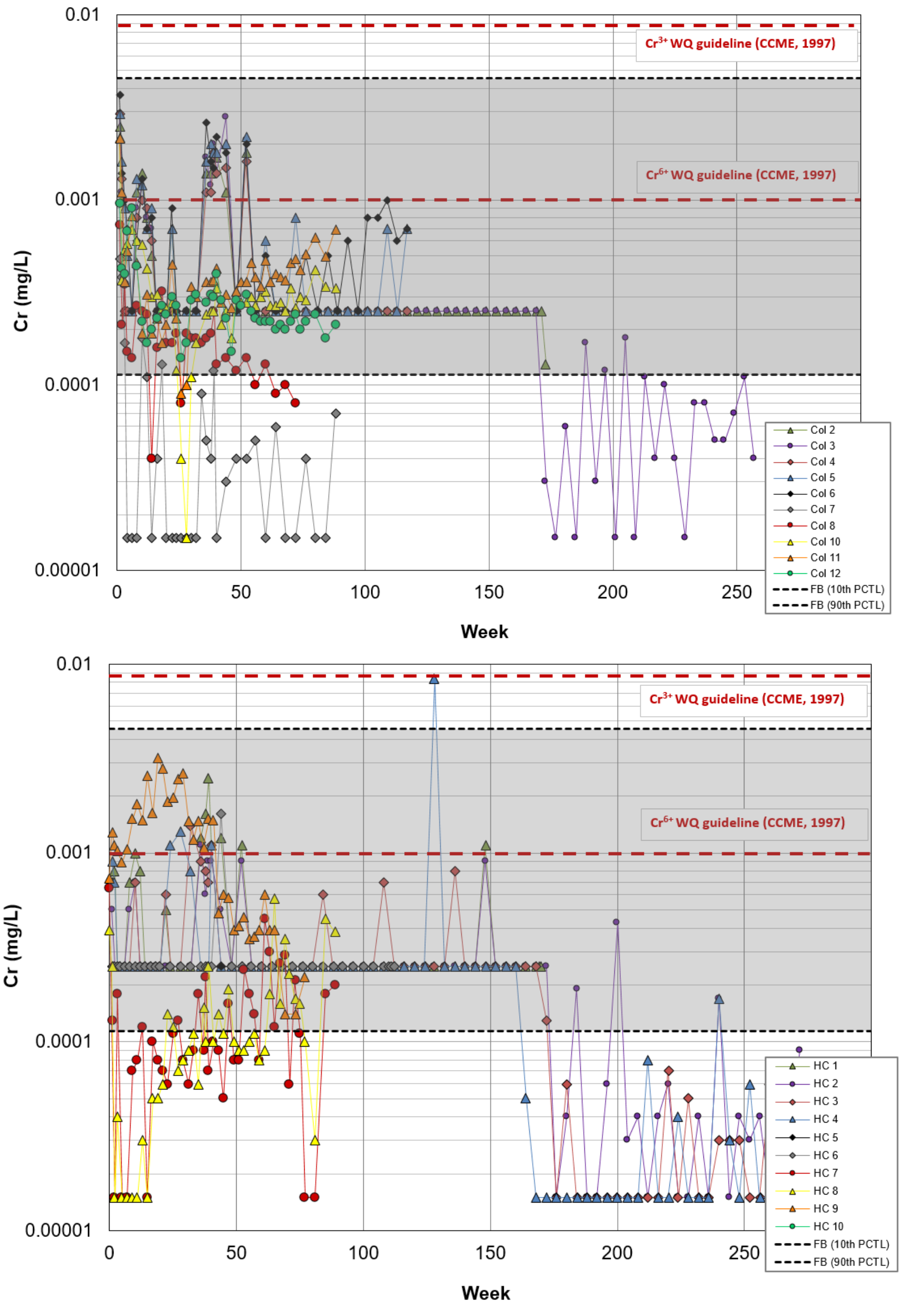
- Carbonate deplete SLD cells released higher rates of Co, Cu and Ni. The cell with higher sulphide oxidation rates (HC4) also had greater rates of Be, Cd, Mg, Mn, Si and Zn.
- The two duplicate SLD cells (HC5 and HC6) that were not used for developing source terms showed similar geochemical signature to HC3. However, the sample with the greatest amount of residual carbonate (HC6) had higher Ca and Sr release. HC6 also released Al, Ba, P, and V at greater rates. The higher leaching rates for these elements in HC6 are likely related to the sulphuric acid attacking other minerals not targeted by the carbonate removal pre-leach. Unlike HC3, greater amounts of Mo were released from both HC5 and HC6.
- The picrite cell that appears to be influenced the most by the NaOAc residue (HC9) has similar or lower metal release rates than its pH-neutral precursor. However, HC10 is releasing greater of the metlas Cr, Fe, Mn, Ni, which are elements are typically associated with mafic minerals and would be expected to be attenuated at the pH levels predicted for the net dump seepage. Major elements Ca, Mg, and Sr are also released at higher rates from HC10, which are expected to be limited by secondary carbonate mineral precipitation.

MEM 086

Field Bin weathering test results for the IMH, SLD, and PICR waste rock types indicate that BC WQG were exceeded for median dissolved Cr concentrations (Table 6-7); however, no discussion is provided on potential mechanisms or comparisons drawn with the unsaturated column and HCT results. Please provide this information.

Chromium is a transition series metal that is commonly compatible with mafic and ultramafic rocks and so, not surprisingly, was shown to be elevated in the PICR and, to a lesser extent, MAFV units (Table 5-6 of Appendix 3-A). As an aqueous species, Cr can be present as Cr^{3+} or Cr^{6+}. The latter is considered more toxic with a guideline of 0.001 mg/L for the protection of freshwater aquatic life (CCME), while the guideline for the former is set at 0.0089 mg/L. Chromium is a low mobility element, especially under moderately oxidising and reducing conditions and near-neutral pH values. Cr^{6+} adsorption decreases with increasing pH due to its affinity to Fe-hydroxide surfaces, while Cr^{3+} adsorption increases with increasing pH, as the former occurs as an oxy-anion with a negative surface charge. At Ajax, the MAFV and PICR units show the highest Cr contents with mafic minerals likely being the major hosts of Cr. In these minerals, Cr occurs in its less toxic, trivalent state. Therefore, given the geology and mineralogy of the Ajax deposit it is likely that Cr^{6+} comprises a relatively small proportion of total Cr in the mine rock. The slow oxidation kinetics of Cr^{3+} enable it to be involved in other faster reactions (sorption or precipitation) that will remove it from solution prior to transforming to Cr^{6+}.

Figure MEM-86 show the concentrations of Cr being leached out of mine rock in the unsaturated columns and humidity cells, respectively. A representative range of field bin concentrations (10^{th} to 90^{th} percentiles) and the mentioned water quality guidelines are plotted for comparison. It becomes apparent that Cr concentrations in leachates from unsaturated columns, humidity cells, and field bins, fall in the same range suggesting that the scale of the reactor has little effect on this parameter. In other words, Cr appears to be solubility controlled (likely through adsorption or co-precipitation) at concentrations below 0.01 mg/L, consistent with the attenuation mechanisms above. The Cr^{6+} water quality guideline is exceeded in several instances for both sets of kinetic tests, where carbonate-depleted cells release the highest concentrations within the humidity cell suite.



MEM-86: Cr concentrations in leachates from Ajax unsaturated columns and humidity cells in comparison with the range from field bin concentrations (shaded grey) and water quality guidelines

MEM 087

The Raw data for the static test analyses conducted on tailings samples produced in 2014 are missing from Appendix C-2.1 through C-2.4

These data are now provided in Table MEM 87.

Table MEM 87:

Sample ID	Paste pH	TIC	CaNP	Total S	SO_4 S	Sulphide S	Insol. S	Mod. NP	Fizz Test
		%	kg CaCO3/t	%	%	%	%	kg CaCO3/t	
MF6-10 Tailings	7.87	0.69	57.5	0.193	0.14	0.02	0.03	61.9	Moderate
MF11-21 Tailings	7.96	0.66	55.0	0.226	0.17	0.02	0.04	58.8	Moderate

Solid-Phase Composition

Sample ID	Ag	Al	B	Ba	Ca	Cr	Cu	Fe	K	Li	Mg	Mn	Na
	ppm	*%*	*ppm*	*ppm*	*%*	*ppm*	*ppm*	*%*	*%*	*ppm*	*%*	*ppm*	*%*
MF6-10 Tailings	0.1	1.73	20	98	3.24	450	414	2.46	0.15	9	1.79	269	0.04
MF11-21 Tailings	0.09	1.62	20	92	3.09	403	407	2.36	0.15	8	1.84	252	0.04

Sample ID	Ni	P	S	Sr	Ti	V	Zn	Zr	As	Be	Bi	Cd	Ce
	ppm	*ppm*	*%*	*ppm*	*%*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*
MF6-10 Tailings	195	0.118	0.22	80.9	0.14	127	14	3.8	7	0.3	<0.02	0.04	7.4
MF11-21 Tailings	178	0.11	0.26	77	0.12	120	10	3.3	6	0.3	<0.02	0.05	6.96

Sample ID	Co	Cs	Ga	Ge	Hf	Hg	In	La	Lu	Mo	Nb	Pb	Rb
	ppm	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*
MF6-10 Tailings	14.2	0.5	6.2	0.1	0.14	0.19	0.04	3.2	0.09	5.89	0.38	1.2	5.3
MF11-21 Tailings	14.7	0.5	6	0.1	0.13	0.21	0.03	3.1	0.08	6.49	0.26	0.9	5.8

Sample ID	Sb	Sc	Se	Sn	Ta	Tb	Te	Th	Tl	U	W	Y	Yb
	ppm	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*
MF6-10 Tailings	0.41	8.2	<1	0.5	<0.05	0.2	<0.05	0.4	<0.02	0.41	0.5	6.62	0.7
MF11-21 Tailings	0.32	8.3	<1	0.3	<0.05	0.18	0.15	0.4	<0.02	0.39	0.4	6.15	0.6

Particle Size

MF 6-10 Tailings	Aperture	Weight Retained		
				Cumulative
Sieve	(mm)	(g)	(%)	(%)
+ 60	0.250	25.40	25.4%	25.4%
-60 + 100	0.150	22.70	22.7%	48.1%
-100 + 140	0.106	11.90	11.9%	60.0%
-140 + 200	0.075	8.80	8.8%	68.8%
-200 + 270	0.053	10.00	10.0%	78.8%
-270 + 325	0.045	7.80	7.8%	86.6%
-325	-0.045	13.40	13.4%	100.0%
TOTAL		100.00	100.0%	

MF 11-21 Tailings	Aperture	Weight Retained		
				Cumulative
Sieve	(mm)	(g)	(%)	(%)
+ 60	0.250	21.30	21.3%	21.3%
-60 + 100	0.150	24.60	24.6%	45.9%
-100 + 140	0.106	13.60	13.6%	59.5%
-140 + 200	0.075	9.80	9.8%	69.3%
-200 + 270	0.053	9.00	9.0%	78.3%
-270 + 325	0.045	5.50	5.5%	83.8%
-325	-0.045	16.20	16.2%	100.0%
TOTAL		100.00	100.0%	

MEM 088

The 2014 tailings samples are indicated to be the most representative of tailings material composition that will be produced in years 6-10 and 11-21 (Page 3-25 and 5-51), but the application notes that as the metallurgical testwork is refined over time that the generated tailings are expected to become more representative of the final tailings material (pg 3-19, Appendix 3-A). Please provide additional information of the anticipated differences between the tailings used in this report and the final tailings and the implications of the evolution of the tailings geochemistry over the life of mine as it relates to the site water quality model.

As stated in Appendix 3-A, between 2009 and 2014 Lorax has received and analyzed several rounds of tailings materials generated during various metallurgical test programs. Over this time period, the metallurgical test program became more sophisticated in that different types of ore feed materials corresponding to the ore production schedule were collected and processed to produce tailings representative of certain production periods in the mine life. In addition, metallurgical testing was conducted to optimize the metallurgical extraction which in turn has led to an evolution of the tailings geochemistry. The most recently produced (2014) tailings batch is considered most representative of the latest mine plan and knowledge regarding ore feed proportions for years 6-10 and 11-21. Both the solid-phase geochemical data as well as kinetic testing suggests that the two types of 2014 materials produced (MF 6-10 and 11-21) are virtually identical. Therefore, a significant change in geochemical characteristics is not expected and was not modelled for TSF source terms over the life of mine. However, metallurgists at operating mines continually attempt to improve copper recovery so it is anticipated that the copper content of the tailings produced during operation will decrease over the life of mine.

MEM 089

Further to the previous comment, please provide any relevant information and a discussion of the differences between the tailings expected to be produced in years 1-5 and those produced in years 6-21. Additionally, please provide an explanation for why the 2014 samples can be used to represent these two tailings groups in the geochemical assessment

The ore feed used to produce the November 2013 tailings was selected to represent ore that will be mined during years 1-5 of the mine life. Similar to the 2014 tailings samples (T6 and T7), the November 2013 sample (T5) is NPAG and has a sulphide S $< 0.1\%$, which is in contrast to S $\geq 0.2\%$ in the 2009 tailings (T1) and January 2013 tailings (T3) samples (Appendix 3-A; Table 5-16). The tailings geochemical source terms were developed using leaching rates from T1, T3 and T5, providing a conservative estimate of loading since they were developed including tailings samples that have a higher sulphide content.

MEM 090

It is unclear why loading rates for As, Cu, Cr, Mo, Ni, Se, V and Zn for tailings samples T1 to T4 are substantially higher in the HCT compared to the unsaturated column results. Please provide a more thorough discussion of these results and provide a rationale for why the unsaturated dataset is appropriate for use as source terms in the water quality model.

The discrepancy in loading rates between HCT (T1, T3) and duplicate material columns (T2, T4) is especially evident for As, Cu, Cr, V, and Zn. Relatively constant loading rates are observed for Se in all tailings cells, while Mo loading rates are higher in the column leachates versus HCT (Appendix D-1.4 of Appendix 3-A). The reduction in loading rates for As, Cu, Cr, V, and Zn in column leachates can be explained geochemically by a solubility control. As described in Appendix 3-A, loading rates are calculated as a function of eluent volume and the mass of the rock sample. If the concentration of a species is saturated due to solubility limits at the scale of the HCT, a similar concentration will drain from the saturated column, such that the load on a per mass basis will be lower. Conversely, Se and Mo do not appear to be solubility-limited under the given geochemical conditions and hence, these species are being leached at proportionally (or over-proportionally) higher rates from columns versus humidity cells.

Loading rates from unsaturated tailings columns (T2 and T4) were not used as source term model input, rather after thorough assessment, the 95th percentile of unsaturated tailings column leachates were included as one of three potential analogue databases for assigning caps to the final source terms. This approach is warranted as comparison with tailings field bin and Afton TSF seepage chemistry suggested that a quasi-equilibrium is reached under the column experimental conditions for most species.

MEM 091

Please provide an updated summary of the results for the seven tailings HCTs collected since August 2015. This summary should focus on T-6 and T-7 and provide detailed discussion of the implications of the results on the conclusions drawn for the tailings in the EA.

Updated and new (T6 and T7) results are provided in Table MEM 91. The table also lists the loading rates from T1, T3 and T5 used in the EA to develop source terms. In the upper portion of this table, new data from HC T6 and T7 are presented from the period of the test that is directly related to the source term loading input calculations (median values from cycles 0-20 and 5-20). New overall loading rates considering these two reaction cells are presented (median of all cells) for active and inactive beach source terms (-rev.) and compared to the original source term model input. New loading values that exceed three times the input used for the EA application are highlighted in red and it is apparent that only Zr is considerably increased according to this criterion. However, this is due to an increased detection limit rather than an actual geochemical trend and therefore the integration of the new kinetic test cells T6 and T7 into source term model would not lead to a significant deviation from the original model.

While not directly applicable to the source term model, the lower portion of Table MEM 91 provides an update on the long-term leaching rates for all cells for which leachate data was discussed in the EA application. Note that HC T1 is not presented as this cell had already been terminated at the time of the EA submission and no new data became available. For the remaining cells (T2 through T5) the percent difference calculated for each species gives an overview of the overall change in leachate chemistry as these cells underwent continued operation. Most significant increases or decreases (>50%) in loading rates are observed for T5 which is not surprising as this cell was initiated relatively recently and leaching rates had not yet stabilized at the time of previous reporting.

MEM 092

A summary and discussion of the results for unsaturated columns 2, 13 and 14, are required to provide MEM with a better understanding of the leaching characteristics of the low, medium and high-grade ore. Additionally, these results should be carried through to determine the implications for the waste rock source terms and contribution to the site water quality model.

In the following, it is assumed that this comment refers to ore cells Col-1, Col-13 and Col-14 (not Col-2) and that the implications of additional data for the temporary ore stockpile source terms are to be assessed. Table MEM 92 presents a comparison of the median loading rates (last three cycles) from these columns at the time of the EA submission and to date. Overall, major dissolved ions (SO_4, Ca, Mn, K) are reduced in the revised loading assessment as the leachate solutions stabilize. Elements that are strongly increased (>100%) or reduced (<-50%) in comparison with the median data from the EA application database are generally the ones close to or below detection limit (*e.g.*, Fe, Hg) making them more sensitive to slight variations in leachate chemistry.

Since the ore stockpile is temporary and loading model inputs were derived only from a relatively early unsaturated column leaching stage (cycles 16-20), there would be no implications on the ore stockpile drainage prediction.

Table MEM 91:

Cycle	Sulphate	Chloride	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Hg	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	S	Tl	Sn	Ti	U	V	Zn	Zr
T1																																					
0-20	20	0.23	0.0074	0.00055	0.00079	0.030	0.0000047	0.0000024	0.0072	0.0000072	14	0.00044	0.000093	0.0011	0.00051	0.000028	0.00098	3.8	0.0025	0.0000024	0.012	0.00033	0.0045	3.0	0.0011	2.3	0.0000024	1.4	0.14	8.7	0.000047	0.00018	0.00016	0.00038	0.00093	0.00072	0.0000094
5-20	20	0.20	0.0078	0.00046	0.00065	0.031	0.0000047	0.0000024	0.0054	0.0000072	14	0.00037	0.000079	0.0011	0.00049	0.000044	0.00096	3.8	0.0028	0.0000024	0.0097	0.00033	0.0031	2.3	0.00095	2.2	0.0000024	1.0	0.13	8.3	0.000047	0.00015	0.00014	0.00034	0.00092	0.00096	0.0000050
T3																																					
0-20	38	0.090	0.010	0.00060	0.00086	0.018	0.0000045	0.0000023	0.0092	0.0000033	14	0.00011	0.000072	0.0011	0.00069	0.000010	0.0018	4.9	0.0058	0.0000023	0.011	0.00031	0.0020	4.2	0.00066	1.4	0.0000023	1.4	0.18	12	0.0000045	0.00055	0.000047	0.00013	0.00037	0.00047	0.0000023
5-20	29	0.088	0.011	0.00064	0.00078	0.019	0.0000045	0.0000023	0.0066	0.0000024	13	0.00011	0.000071	0.0011	0.00069	0.0000068	0.0014	4.7	0.0058	0.0000023	0.010	0.00029	0.0020	3.6	0.00067	1.4	0.0000023	1.0	0.15	10.0	0.0000045	0.00055	0.000066	0.00013	0.00039	0.00045	0.0000023
T5																																					
0-20	17	0.14	0.011	0.00074	0.0015	0.022	0.0000016	0.0000016	0.011	0.0000035	11	0.000023	0.000054	0.00059	0.0016	0.0000082	0.0014	2.9	0.0025	0.0000023	0.034	0.00016	0.0021	9.6	0.00059	2.0	0.00000046	1.7	0.12	7.8	0.0000056	0.00013	0.00014	0.000091	0.0011	0.00023	0.00045
5-20	15	0.11	0.012	0.00077	0.0015	0.037	0.0000016	0.0000016	0.0100	0.0000045	10	0.000018	0.000053	0.00059	0.0017	0.000018	0.0013	2.9	0.0022	0.0000023	0.034	0.00013	0.0019	9.0	0.00062	1.9	0.00000045	1.1	0.11	6.3	0.0000056	0.00012	0.00015	0.000070	0.0011	0.00023	0.00045
T6																																					
0-20	141	0.2	0.0092	0.0013	0.0025	0.0105	0.0000016	0.0000016	0.010	0.0000038	70	0.000030	0.00005	0.00033	0.0016	0.000018	0.0014	4	0.006	0.0000023	0.0042	0.00037	0.0007	5	0.00028	2.2	0.00000047	1.0	0.5	62	0.0000051	0.00007	0.000040	0.0005	0.0038	0.00023	0.00046
5-20	66	0.22	0.012	0.0013	0.0023	0.011	0.0000016	0.0000016	0.0079	0.0000030	32	0.000020	0.000031	0.00035	0.0016	0.000023	0.0010	2.6	0.0041	0.0000022	0.0033	0.00023	0.0007	4.2	0.00026	2.0	0.00000046	0.75	0.32	30	0.0000035	0.000051	0.000035	0.00021	0.0038	0.00023	0.00045
T7																																					
0-20	161	0.24	0.0071	0.0012	0.0022	0.012	0.0000016	0.0000016	0.010	0.0000038	76	0.000033	0.00005	0.00029	0.0016	0.0000070	0.0012	3	0.005	0.0000023	0.0030	0.0008	0.0007	5	0.00031	2.3	0.00000047	0.7	0.5	64	0.0000060	0.00008	0.000038	0.0004	0.0036	0.00024	0.00046
5-20	81	0.23	0.010	0.0011	0.0020	0.014	0.0000016	0.0000016	0.0089	0.0000029	34	0.000027	0.000033	0.00034	0.0016	0.0000045	0.0010	2.4	0.0040	0.0000023	0.0026	0.00042	0.0007	4.6	0.00031	2.1	0.00000047	0.64	0.34	34	0.0000049	0.000045	0.000037	0.00020	0.0036	0.00023	0.00046
Source Term Implications																																					
Beach runoff (active)	20	0.14	0.010	0.00060	0.00086	0.022	0.0000045	0.0000023	0.0092	0.0000035	14	0.00011	0.000072	0.0011	0.00069	0.000010	0.0014	3.8	0.0025	0.0000023	0.012	0.00031	0.0021	4.2	0.00066	2.0	0.0000023	1.4	0.14	8.7	0.0000056	0.00018	0.00014	0.00013	0.00093	0.00047	0.0000094
Beach runoff (active) - rev.	38	0.23	0.0092	0.00074	0.0015	0.018	0.0000016	0.0000016	0.0099	0.0000038	14	0.000033	0.000055	0.00059	0.0016	0.000010	0.0014	3.6	0.0050	0.0000023	0.011	0.00033	0.0020	5.2	0.00059	2.2	0.00000047	1.4	0.18	12	0.0000056	0.00013	0.000047	0.00037	0.0011	0.00024	0.00045
Beach runoff (inactive)	20	0.11	0.011	0.00064	0.00078	0.031	0.0000045	0.0000023	0.0066	0.0000045	13	0.00011	0.000071	0.0011	0.00069	0.000018	0.0013	3.8	0.0028	0.0000023	0.010	0.00029	0.0020	3.6	0.00067	1.9	0.0000023	1.0	0.13	8.3	0.0000056	0.00015	0.00014	0.00013	0.00092	0.00045	0.0000050
Beach runoff (inactive) - rev.	29	0.20	0.011	0.00077	0.0015	0.019	0.0000016	0.0000016	0.0079	0.0000030	14	0.000027	0.000053	0.00059	0.0016	0.000018	0.0010	2.9	0.0040	0.0000023	0.0097	0.00029	0.0019	4.2	0.00062	2.0	0.00000047	1.0	0.15	10.0	0.0000049	0.00012	0.000066	0.00020	0.0011	0.00023	0.00045
Notes: rev. = revised source term input loads considering cells T6 and T7, values shaded in red exceed three times the input value from the previous assessment.																																					
T2																																					
Last 3	2.2	0.0024	0.00010	0.000022	0.000036	0.00070	0.000000063	0.000000063	0.00058	0.000013	0.44	0.000019	0.00000039	0.000038	0.000055	0.0000018	0.00011	0.58	0.0000046	0.0000001	0.054	0.00000090	0.000027	0.14	0.00022	0.092	0.000000018	0.087	0.0058	0.81	0.000000060	0.00048	0.000026	0.000013	0.000039	0.000036	0.000018
Last 3 - rev.	2.0	0.0079	0.000089	0.000024	0.000038	0.00060	0.000000055	0.000000055	0.00053	0.000019	0.38	0.000026	0.00000048	0.000035	0.000055	0.00000079	0.00011	0.58	0.0000082	0.0000001	0.072	0.0000016	0.000024	0.11	0.00018	0.10	0.000000016	0.087	0.0045	0.70	0.000000040	0.00044	0.000028	0.000014	0.000044	0.000032	0.000016
% difference	-5%	228%	-15%	10%	6%	-14%	-12%	-12%	-9%	43%	-13%	35%	22%	-7%	0%	-56%	2%	-1%	78%	-34%	33%	77%	-12%	-19%	-21%	12%	-12%	0%	-22%	-13%	-34%	-9%	9%	5%	11%	-12%	-12%
T3																																					
Last 3	7.3	0.085	0.0091	0.00054	0.00063	0.053	0.0000016	0.0000016	0.0056	0.0000041	9.8	0.000018	0.000033	0.0012	0.0016	0.0000023	0.00045	3.0	0.0033	0.0000023	0.0063	0.000046	0.00069	1.9	0.00040	1.3	0.00000045	0.33	0.078	2.9	0.0000027	0.013	0.000072	0.000053	0.00049	0.00023	0.00045
Last 3 - rev.	7.7	0.22	0.0091	0.00049	0.00058	0.058	0.0000016	0.0000016	0.0031	0.0000036	9.7	0.000027	0.000019	0.00098	0.0016	0.000018	0.00039	2.5	0.0028	0.0000022	0.0075	0.000023	0.00067	1.5	0.00034	0.99	0.00000045	0.26	0.072	2.8	0.0000011	0.0047	0.000011	0.000057	0.00050	0.00045	0.00045
% difference	5%	162%	0%	-9%	-8%	10%	0%	-1%	-45%	-13%	-1%	47%	-43%	-17%	-2%	691%	-14%	-15%	-15%	-1%	18%	-51%	-2%	-19%	-14%	-23%	0%	-21%	-8%	-5%	-59%	-64%	-85%	8%	2%	98%	-1%
T4																																					
Last 3	6.2		0.00041	0.00017	0.00013	0.0024	0.00000025	0.00000025	0.0019	0.0000035	2.3	0.000025	0.0000067	0.00018	0.00025	0.0000014	0.00048	1.5	0.00023	0.0000004	0.011	0.000014	0.00011	1.2	0.00048	0.32	0.000000070	0.41	0.030	2.6	0.00000068	0.0000063	0.0000070	0.000024	0.000072	0.000035	0.000070
Last 3 - rev.	6.6		0.00048	0.00020	0.00015	0.0028	0.00000025	0.00000025	0.0016	0.0000033	1.8	0.000021	0.0000044	0.00018	0.00025	0.00000041	0.00040	1.6	0.00018	0.0000004	0.010	0.0000081	0.00011	1.3	0.00044	0.34	0.000000081	0.36	0.024	2.1	0.00000052	0.0000097	0.0000085	0.000018	0.00010	0.000065	0.000070
% difference	7%		18%	14%	21%	14%	0%	0%	-16%	-5%	-23%	-14%	-35%	0%	0%	-71%	-17%	5%	-24%	0%	-11%	-42%	0%	2%	-8%	6%	16%	-11%	-20%	-19%	-23%	54%	21%	-23%	41%	86%	0%
T5																																					
Last 3	8.5	0.18	0.011	0.00064	0.0015	0.045	0.0000016	0.0000016	0.0064	0.0000064	8.1	0.0000068	0.000019	0.00045	0.0016	0.0000023	0.00093	2.2	0.0017	0.0000022	0.024	0.000089	0.00067	6.8	0.00040	1.8	0.00000045	0.56	0.088	3.1	0.0000058	0.00014	0.00015	0.000037	0.0011	0.00022	0.00045
Last 3 - rev.	2.3	0.23	0.012	0.00019	0.00077	0.085	0.0000016	0.0000016	0.0018	0.0000098	7.9	0.000098	0.0000042	0.00046	0.0016	0.000036	0.00036	2.2	0.000058	0.0000023	0.040	0.000046	0.00068	3.3	0.00034	1.2	0.00000047	0.20	0.056	0.93	0.0000036	0.011	0.000053	0.000026	0.0010	0.00023	0.00046
% difference	-73%	25%	14%	-71%	-48%	86%	2%	2%	-72%	54%	-3%	1334%	-78%	1%	2%	1465%	-61%	-2%	-97%	2%	68%	-49%	2%	-51%	-17%	-34%	6%	-63%	-37%	-70%	-38%	7650%	-65%	-29%	-2%	2%	2%
Notes: rev. = revised median loading rates for last 3 cycles of updated cells; T1 was terminated before the EA submission and therefore no new data is available for this cell																																					

Table MEM 92:

	Sulphate	Chloride	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Hg	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	S	Tl	Sn	Ti	U	V	Zn	Zr
Col-1																																					
Last 3	4.2	0.0038	0.00011	0.000010	0.000063	0.0011	0.00000012	0.00000012	0.00082	0.0000013	2.3	0.0000019	0.0000025	0.000096	0.000038	0.00000035	0.000071	0.18	0.000093	0.00000018	0.0082	0.0000070	0.00016	0.30	0.000100	0.21	0.000000069	0.036	0.013	1.7	0.00000084	0.00082	0.000011	0.0000093	0.00034	0.000019	0.000035
Last 3 - rev.	3.9	0.018	0.00012	0.000012	0.000081	0.0012	0.00000012	0.00000012	0.00080	0.0000011	2.3	0.0000020	0.0000016	0.000095	0.00012	0.00000020	0.000065	0.20	0.000055	0.00000018	0.0060	0.0000020	0.000053	0.22	0.00011	0.21	0.000000036	0.034	0.0099	1.7	0.00000081	0.00055	0.0000035	0.0000089	0.00038	0.000020	0.000036
% difference	-7%	367%	7%	17%	29%	4%	1%	1%	-4%	-15%	-1%	7%	-38%	-1%	227%	-41%	-10%	14%	-41%	1%	-27%	-71%	-66%	-27%	9%	2%	-49%	-5%	-25%	-3%	-3%	-33%	-69%	-5%	13%	7%	1%
Col-13																																					
Last 3	65	0.025	0.00012	0.000039	0.000099	0.00072	0.00000017	0.00000017	0.0021	0.00000066	27	0.0000028	0.000015	0.00015	0.00017	0.00000025	0.00012	0.90	0.00067	0.00000028	0.0013	0.000039	0.000074	0.17	0.000025	0.51	0.00000028	0.082	0.11	22	0.00000012	0.0000085	0.0000069	0.000032	0.00086	0.000098	0.000049
Last 3 - rev.	35	0.028	0.00017	0.000028	0.000066	0.00076	0.00000019	0.00000019	0.0013	0.00000033	16	0.0000023	0.0000056	0.00014	0.00019	0.00000029	0.000095	0.49	0.00042	0.00000055	0.00070	0.000017	0.000083	0.085	0.000017	0.46	0.00000011	0.040	0.060	12	0.00000014	0.0000083	0.0000029	0.000028	0.00074	0.000029	0.000055
% difference	-45%	12%	35%	-29%	-33%	6%	12%	12%	-37%	-50%	-41%	-17%	-62%	-5%	12%	16%	-21%	-46%	-37%	100%	-44%	-56%	12%	-50%	-34%	-10%	-60%	-51%	-45%	-45%	12%	-2%	-58%	-13%	-14%	-71%	12%
Col-14																																					
Last 3	12	0.027	0.00020	0.00037	0.00034	0.0011	0.00000019	0.00000019	0.0017	0.0000037	2.9	0.0000027	0.0000091	0.00046	0.00019	0.00000028	0.00045	1.4	0.00062	0.00000028	0.016	0.000027	0.000081	1.8	0.00044	0.35	0.00000022	0.20	0.036	4.1	0.0000012	0.00000027	0.000011	0.000022	0.00017	0.000047	0.000054
Last 3 - rev.	5.5	0.028	0.00031	0.00040	0.00042	0.0017	0.00000020	0.00000020	0.0010	0.0000024	1.9	0.0000034	0.0000060	0.00047	0.00020	0.00000056	0.00030	1.1	0.00041	0.00000056	0.010	0.000011	0.000084	1.3	0.00035	0.35	0.00000022	0.12	0.021	2.0	0.0000013	0.0000062	0.0000045	0.000012	0.00021	0.000028	0.000056
% difference	-52%	4%	54%	8%	22%	46%	4%	4%	-42%	-36%	-33%	27%	-34%	4%	4%	104%	-35%	-24%	-34%	104%	-37%	-58%	4%	-25%	-20%	0%	2%	-41%	-40%	-50%	8%	2181%	-59%	-44%	24%	-40%	4%

MEM 093

The NP depletion rates were calculated for most of the waste rock samples and one of the ore samples (Table 6.2, Appendix 3-A). Please provide the NP depletion rates for the unsaturated ore columns Col-1 and Col-13 and provide a discussion on how this affects the estimated amount of ore that will be NP depleted during the life of mine.

NP depletion rates are based on the assumption that all dissolved sulphate leached comes from pyrite oxidation to assess the stoichiometric carbonate depletion rate. As shown in Table 5-15 of Appendix 3-A, Col-1 and Col-13 have a relatively high sulphate content which will strongly control the sulphate loading rates in the respective leachates. As such, the sulphate concentrations from these cells would primarily reflect the dissolution of gypsum and not the acid generation and buffering mechanisms and as such, were excluded from this assessment.

MEM 106

The low, medium and high-grade ore loading rates were determined from a combination of the unsaturated column (Col-1, Col-9, Col-13 and Col-14) results. Please provide additional discussion to assist MEM in understanding the selection of these results to represent each grade of ore

Although the precise definition of low, medium and high grade ore is not a static definition and will change over time, the samples placed in Col-1, Col-13, and Col-14 were selected to represent a range of copper content that will typically be found in ore materials. While Col-1 and Col-13 represent composite samples from drill core, Col-14 was collected from an ore feed composite sample used for metallurgical testing. Col-9 was initially intended to represent SVHYB uneconomic mine rock, however, the solid-phase analysis revealed that this sample is ore-grade material. The allocation and combination of these kinetic test cells (Table 2-1 of Appendix 3-B) to reflect leachate from the various ore grades was based on a solid-phase analysis considering sulphide-sulphur and Cu contents of the kinetic test cell samples in relation to the ore grade populations.

- Low Grade = 100% Col-13; lowest sulphide and lowest Cu content
- Medium Grade = 50% Col-9 medium grade ore sample and 50% Col-13 from the dominant geologic unit that comprises ore (SLD).
- High Grade = 50% Col-1 highest sulphide content and 50% Col-14 highest Cu content

MEM 107

Please provide the secondary mineral controls employed and summarize the resulting changes to the waste rock, Pit wall and tailings source terms for each affected species. This will assist MEM in determining whether the secondary mineral controls were appropriately applied.

Minerals that were allowed to precipitate during PHREEQC modelling of the output solutions were provided in Table 2-5 of Appendix 3-B. Due to the abundance of calcite and gypsum identified during the geochemical assessment study for Ajax mine rock, these two phases were additionally allowed to be dissolved, which leads to an increase in Ca, SO_4, or alkalinity for some modelled solutions. Table MEM 107 gives an overview of the effects of speciation modelling and a complete breakdown of the geochemical implications of this speciation exercise.

Table MEM 107:
Breakdown of the relative percentage of concentration added or removed as a result of geochemical speciation modelling (PHREEQC)

Before PHREEQC Modelling	SO_4	Al	Ba	Ca	Cu	Fe	Mg	Mn	Si	Sr
TSF MRSF & Main Dam - year 5	1619	0.22	0.84	687	0.023	0.066	153	0.060	124	7.8
TSF MRSF & Main Dam - year 10	2366	0.25	0.79	982	0.028	0.072	182	0.088	126	10
TSF MRSF & Main Dam - year 20	2751	0.27	0.74	1137	0.031	0.074	195	0.10	124	12
TSF MRSF & Main Dam - PC	449	0.25	3.0	577	0.042	0.031	212	0.048	160	8.1
South MRSF & East Dam - year 5	2068	0.40	1.1	975	0.035	0.10	208	0.088	173	11
South MRSF & East Dam - year 10	2452	0.41	1.1	1130	0.037	0.10	221	0.10	173	12
South MRSF & East Dam - year 20	2430	0.41	1.0	1124	0.037	0.10	220	0.10	173	12
South MRSF & East Dam - PC	434	0.38	4.3	768	0.055	0.042	304	0.067	223	12
South MRSF & East Dam - year 5 - new	4465	0.41	1.4	1803	0.051	0.13	334	0.16	225	19
South MRSF & East Dam - year 10 - new	3688	0.41	1.2	1546	0.045	0.12	285	0.14	197	16
South MRSF & East Dam - year 20 - new	4020	0.46	1.3	1697	0.050	0.13	314	0.15	218	18
South MRSF & East Dam - PC - new	748	0.46	5.2	983	0.072	0.053	381	0.087	282	14
East MRSF - year 5	640	0.45	1.2	521	0.029	0.11	160	0.045	180	6.9
East MRSF - year 10	630	0.45	1.2	519	0.029	0.11	159	0.045	180	6.9
East MRSF - year 20	630	0.45	1.2	519	0.029	0.11	159	0.045	180	6.9
East MRSF - PC	131	0.23	2.2	370	0.026	0.021	165	0.036	117	6.0
Backfill - year 20	4986	0.51	1.3	2088	0.057	0.14	353	0.19	227	21
South Dam - EOM	3404	0.32	0.76	1406	0.037	0.086	227	0.13	136	14
South Dam - PC	228	0.13	1.7	327	0.023	0.017	112	0.025	87	4.6
Southeast Dam - EOM	1798	0.17	0.40	743	0.020	0.045	120	0.068	72	7.4
Southeast Dam - PC	120	0.067	0.88	173	0.012	0.0089	59	0.013	46	2.4
Ore Stockpile - max extent	38657	0.13	0.53	13523	0.15	0.081	1158	1.1	280	77
Ore Stockpile - year 17	35355	0.087	0.48	11952	0.12	0.073	1275	0.59	287	70
Pit wall - IMH - operational	156	0.31	0.69	269	0.018	0.068	88	0.022	112	3.7
Pit wall - SLD - operational	5653	0.22	0.43	2104	0.047	0.073	289	0.20	103	20
Pit wall - MAFV - operational	680	0.14	0.84	275	0.019	0.046	76	0.0046	125	5.0
Pit wall - PICR - operational	540	0.046	0.96	149	0.0093	0.042	116	0.014	104	3.0
Pit wall - SLD ore - operational	20464	0.10	0.28	7510	0.092	0.044	431	0.94	122	42
Pit wall - IMH - PC	42	0.14	1.4	229	0.015	0.013	102	0.021	72	3.8
Pit wall - SLD - PC (neutral)	296	0.038	1.3	298	0.023	0.014	69	0.017	66	3.4
Pit wall - SLD - PC (acidic)	790	0.098	1.9	171	7.0	0.0088	177	0.15	271	1.7
Pit wall - MAFV/PICR - PC (neutral)	320	0.14	1.0	192	0.018	0.012	111	0.027	73	2.7
Pit wall - MAFV/PICR - PC (acidic)	855	0.36	1.6	110	5.3	0.0079	287	0.24	303	1.4
Pit wall - SLD ore - PC (neutral)	1071	0.029	0.29	589	0.025	0.0097	46	0.024	53	3.4
Pit wall - SLD ore - PC (acidic)	2860	0.075	0.43	338	7.5	0.0063	117	0.21	219	1.7
TSF Beach runoff (active)	335	0.17	0.37	228	0.018	0.011	63	0.042	33	2.3
TSF Beach runoff/infiltration (inactive)	1975	1.1	3.1	1264	0.10	0.068	378	0.27	190	13
TSF Operations seepage (saturated)	1616	0.047	0.042	612	0.0066	0.030	61	0.087	7.4	3.1

After PHREEQC Modelling	SO_4	Al	Ba	Ca	Cu	Fe	Mg	Mn	Si	Sr
TSF MRSF & Main Dam - year 5	1362	0.0032	0.029	765	0.011	0.00028	54	0.060	6.6	7.8
TSF MRSF & Main Dam - year 10	1338	0.0031	0.030	783	0.011	0.00028	56	0.088	6.6	10
TSF MRSF & Main Dam - year 20	1323	0.0031	0.031	791	0.011	0.00028	56	0.10	6.6	12
TSF MRSF & Main Dam - PC	1104	0.0027	0.046	1086	0.012	0.00033	78	0.048	6.6	8.1
South MRSF & East Dam - year 5	1255	0.0030	0.036	894	0.011	0.00030	64	0.088	6.6	11
South MRSF & East Dam - year 10	1245	0.0030	0.036	904	0.011	0.00030	65	0.10	6.6	12
South MRSF & East Dam - year 20	1244	0.0030	0.036	905	0.011	0.00030	65	0.10	6.6	12
South MRSF & East Dam - PC	1019	0.0026	0.060	1364	0.012	0.00037	99	0.067	6.5	12
South MRSF & East Dam - year 5 - new	1269	0.0030	0.038	934	0.011	0.00031	67	0.16	6.6	19
South MRSF & East Dam - year 10 - new	1258	0.0030	0.037	917	0.011	0.00030	66	0.14	6.6	16
South MRSF & East Dam - year 20 - new	1236	0.0029	0.039	962	0.012	0.00031	69	0.15	6.6	18
South MRSF & East Dam - PC - new	997	0.0025	0.069	1545	0.012	0.00039	112	0.087	6.5	14
East MRSF - year 5	1222	0.0029	0.038	935	0.011	0.00031	67	0.045	6.6	6.9
East MRSF - year 10	1222	0.0029	0.038	936	0.011	0.00031	67	0.045	6.6	6.9
East MRSF - year 20	1222	0.0029	0.038	936	0.011	0.00031	67	0.045	6.6	6.9
East MRSF - PC	1145	0.0028	0.040	967	0.011	0.00031	69	0.036	6.6	6.0
Backfill - year 20	1211	0.0029	0.041	999	0.012	0.00032	72	0.19	6.6	20
South Dam - EOM	1292	0.0031	0.032	824	0.011	0.00029	59	0.13	6.6	14
South Dam - PC	1215	0.0030	0.033	842	0.011	0.00029	60	0.025	6.6	4.6
Southeast Dam - EOM	1383	0.0032	0.026	707	0.011	0.00027	50	0.068	6.6	7.5
Southeast Dam - PC	1333	0.0032	0.027	713	0.011	0.00027	50	0.013	6.6	2.4
Ore Stockpile - max extent	2744	0.0046	0.012	431	0.16	0.00021	29	0.46	6.6	8.4
Ore Stockpile - year 17	2740	0.0046	0.012	430	0.13	0.00021	29	0.46	6.6	8.4
Pit wall - IMH - operational	1279	0.0031	0.032	812	0.011	0.00029	58	0.022	6.6	3.7
Pit wall - SLD - operational	1364	0.0032	0.028	736	0.011	0.00027	52	0.20	6.6	15
Pit wall - MAFV - operational	1477	0.0033	0.025	683	0.011	0.00026	48	0.0046	6.6	5.1
Pit wall - PICR - operational	1495	0.0033	0.025	691	0.0094	0.00026	49	0.014	6.6	3.0
Pit wall - SLD ore - operational	1991	0.0040	0.016	500	0.011	0.00022	34	0.52	6.6	9.8
Pit wall - IMH - PC	1226	0.0030	0.032	819	0.011	0.00029	58	0.021	6.6	3.8
Pit wall - SLD - PC (neutral)	1278	0.0031	0.029	757	0.011	0.00028	54	0.017	6.6	3.4
Pit wall - SLD - PC (acidic)	1794	0.0074	0.021	591	2.9	0.0088	177	0.15	6.5	1.7
Pit wall - MAFV/PICR - PC (neutral)	1368	0.0032	0.029	752	0.011	0.00028	53	0.027	6.6	2.7
Pit wall - MAFV/PICR - PC (acidic)	2041	0.30	0.021	606	5.4	0.0079	287	0.24	6.5	1.4
Pit wall - SLD ore - PC (neutral)	1317	0.0032	0.027	718	0.011	0.00027	46	0.024	6.6	3.4
Pit wall - SLD ore - PC (acidic)	3024	0.022	0.011	404	7.5	0.0063	118	0.21	6.5	1.7
TSF Beach runoff (active)	1356	0.0032	0.026	697	0.011	0.00027	49	0.042	6.6	2.3
TSF Beach runoff/infiltration (inactive)	1018	0.0026	0.059	1350	0.012	0.00036	98	0.27	6.5	13
TSF Operations seepage (saturated)	1519	0.0023	0.023	638	0.0066	0.00040	45	0.087	6.6	3.1

% Difference	SO_4	Al	Ba	Ca	Cu	Fe	Mg	Mn	Si	Sr
TSF MRSF & Main Dam - year 5	-16%	-99%	-97%	11%	-52%	-100%	-65%	0%	-95%	0%
TSF MRSF & Main Dam - year 10	-43%	-99%	-96%	-20%	-60%	-100%	-69%	0%	-95%	0%
TSF MRSF & Main Dam - year 20	-52%	-99%	-96%	-30%	-63%	-100%	-71%	1%	-95%	1%
TSF MRSF & Main Dam - PC	146%	-99%	-98%	88%	-72%	-99%	-63%	0%	-96%	0%
South MRSF & East Dam - year 5	-39%	-99%	-97%	-8%	-67%	-100%	-69%	0%	-96%	0%
South MRSF & East Dam - year 10	-49%	-99%	-97%	-20%	-69%	-100%	-71%	1%	-96%	1%
South MRSF & East Dam - year 20	-49%	-99%	-97%	-19%	-69%	-100%	-71%	1%	-96%	1%
South MRSF & East Dam - PC	135%	-99%	-99%	78%	-78%	-99%	-68%	0%	-97%	0%
South MRSF & East Dam - year 5 - new	-72%	-99%	-97%	-48%	-77%	-100%	-80%	1%	-97%	-1%
South MRSF & East Dam - year 10 - new	-66%	-99%	-97%	-41%	-74%	-100%	-77%	1%	-97%	1%
South MRSF & East Dam - year 20 - new	-69%	-99%	-97%	-43%	-77%	-100%	-78%	1%	-97%	1%
South MRSF & East Dam - PC - new	33%	-99%	-99%	57%	-83%	-99%	-71%	0%	-98%	0%
East MRSF - year 5	91%	-99%	-97%	79%	-61%	-100%	-58%	0%	-96%	0%
East MRSF - year 10	94%	-99%	-97%	80%	-61%	-100%	-58%	0%	-96%	0%
East MRSF - year 20	94%	-99%	-97%	80%	-61%	-100%	-58%	0%	-96%	0%
East MRSF - PC	771%	-99%	-98%	161%	-56%	-99%	-58%	0%	-94%	0%
Backfill - year 20	-76%	-99%	-97%	-52%	-80%	-100%	-80%	1%	-97%	-5%
South Dam - EOM	-62%	-99%	-96%	-41%	-69%	-100%	-74%	1%	-95%	1%
South Dam - PC	433%	-98%	-98%	158%	-52%	-98%	-47%	0%	-92%	0%
Southeast Dam - EOM	-23%	-98%	-93%	-5%	-43%	-99%	-58%	0%	-91%	0%
Southeast Dam - PC	1006%	-95%	-97%	313%	-9%	-97%	-15%	0%	-86%	0%
Ore Stockpile - max extent	-93%	-97%	-98%	-97%	7%	-100%	-97%	-59%	-98%	-89%
Ore Stockpile - year 17	-92%	-95%	-97%	-96%	7%	-100%	-98%	-23%	-98%	-88%
Pit wall - IMH - operational	719%	-99%	-95%	202%	-36%	-100%	-34%	0%	-94%	0%
Pit wall - SLD - operational	-76%	-99%	-94%	-65%	-76%	-100%	-82%	1%	-94%	-26%
Pit wall - MAFV - operational	117%	-98%	-97%	149%	-41%	-99%	-36%	0%	-95%	0%
Pit wall - PICR - operational	177%	-93%	-97%	363%	0%	-99%	-58%	0%	-94%	0%
Pit wall - SLD ore - operational	-90%	-96%	-94%	-93%	-88%	-99%	-92%	-45%	-95%	-76%
Pit wall - IMH - PC	2837%	-98%	-98%	258%	-27%	-98%	-43%	0%	-91%	0%
Pit wall - SLD - PC (neutral)	332%	-92%	-98%	155%	-52%	-98%	-22%	0%	-90%	0%
Pit wall - SLD - PC (acidic)	127%	-92%	-99%	246%	-58%	0%	0%	0%	-98%	0%
Pit wall - MAFV/PICR - PC (neutral)	327%	-98%	-97%	292%	-36%	-98%	-52%	0%	-91%	0%
Pit wall - MAFV/PICR - PC (acidic)	139%	-18%	-99%	450%	0%	0%	0%	0%	-98%	0%
Pit wall - SLD ore - PC (neutral)	23%	-89%	-91%	22%	-55%	-97%	0%	0%	-88%	0%
Pit wall - SLD ore - PC (acidic)	6%	-71%	-97%	20%	0%	0%	0%	0%	-97%	0%
TSF Beach runoff (active)	305%	-98%	-93%	205%	-37%	-98%	-22%	0%	-80%	0%
TSF Beach runoff/infiltration (inactive)	-48%	-100%	-98%	7%	-89%	-99%	-74%	0%	-97%	0%
TSF Operations seepage (saturated)	-6%	-95%	-47%	4%	0%	-99%	-26%	0%	-12%	0%

MEM 108

Concentration maximums were derived for calculated species source terms for waste rock and tailings based on maximum values measured in field based sampling programs. These concentration maximums are included in the final geochemical source term summary (Appendix 3-B, Appendix D). However, the uncapped species source terms were not presented within Appendix 3-B for comparison. Please provide this information, including references for each concentration maximum. Additionally, please provide the rationale for choosing the source term concentrations that were capped.

As indicated in Appendix 3-B of the EA application submission, the caps for mine rock and ore source terms were calculated as the highest 95th percentile value of the following analogue databases:

- Field bin leachates
- Mine rock piezometers in the historic Ajax backfill
- Neutral drainage database from BC porphyry copper minesites
- Historic Ajax tailings pore-water (tailings source terms only)

For tailings source terms, caps were applied if the model solutions (after solubility controls and charge balancing) exceeded the highest 95th percentile value from the tailings analogue databases:

- Laboratory columns (T2, T4)
- Tailings filed bin leachates
- Monitoring wells in the historic Afton TSF

All numerical values for geochemical caps applied, including an indication of the reference database used, are given in Appendix C of Appendix 3-B of the EA application submission.

Application of the caps is considered appropriate for the Ajax project due to the neutral pH, low infiltration rates, and the large scale of the Ajax MRSFs. These conditions lead to solubility controls, rather than linearly-scaled mass loads, being the ultimate processes controlling maximum concentrations of most parameters in the site contact waters. A thorough assessment of the PHREEQC model output led to the finding that several species still showed unrealistically high concentrations. This is due to a limit of ten secondary mineral phases and the lack of adsorption modelling invoked in PHREEQC. Due to these factors it was considered appropriate to cap source term concentrations for all species where an analogue database was available, which is an approach that also provides validation of the modeled concentrations. Using the highest 95th percentile of the analogue databases is considered highly conservative given the low sulphur content of the Ajax mine rocks. A presentation of the uncapped model output solutions as well as the concentration cap applied for each species and the according reference database is given in Table MEM 108.

Table MEM 108:

molar PHREEQC output	SO4	Cl	F	Br	Al	Sb	As	Ba	Be	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li
Uncapped (solubility controlled)																		
TSF MRSF & Main Dam - year 5	1362	8.9	2.4	2.3	0.0032	0.052	2.0	0.029	0.00010	1.8	0.00019	765	0.0035	0.0036	0.011	0.00028	0.0014	0.045
TSF MRSF & Main Dam - year 10	1338	9.7	2.8	2.5	0.0031	0.049	1.5	0.030	0.00012	1.6	0.00023	783	0.0037	0.0055	0.011	0.00028	0.0012	0.049
TSF MRSF & Main Dam - year 20	1323	10	3.0	2.5	0.0031	0.047	1.1	0.031	0.00013	1.4	0.00025	791	0.0037	0.0064	0.011	0.00028	0.0011	0.051
TSF MRSF & Main Dam - PC	1104	2.2	0.91	2.8	0.0027	0.015	0.19	0.046	0.00018	0.52	0.00018	1086	0.0058	0.0017	0.012	0.00033	0.00038	0.076
South MRSF & East Dam - year 5	1255	16	3.8	3.4	0.0030	0.076	1.7	0.036	0.00016	2.0	0.00020	894	0.0048	0.0050	0.011	0.00030	0.00090	0.064
South MRSF & East Dam - year 10	1245	17	4.0	3.5	0.0030	0.074	1.3	0.036	0.00017	1.8	0.00023	904	0.0048	0.0059	0.011	0.00030	0.00084	0.066
South MRSF & East Dam - year 20	1244	17	3.9	3.5	0.0030	0.074	1.3	0.036	0.00017	1.8	0.00022	905	0.0048	0.0059	0.011	0.00030	0.00084	0.066
South MRSF & East Dam - PC	1019	2.9	1.3	3.9	0.0026	0.020	0.21	0.060	0.00025	0.70	0.00017	1364	0.0075	0.0021	0.012	0.00037	0.00060	0.12
South MRSF & East Dam - year 5 - new	1269	16	5.0	4.4	0.0030	0.085	3.1	0.038	0.00020	3.0	0.00045	934	0.0067	0.010	0.011	0.00031	0.00076	0.089
South MRSF & East Dam - year 10 - new	1258	16	4.5	3.9	0.0030	0.078	2.2	0.037	0.00019	2.4	0.00035	917	0.0057	0.0086	0.011	0.00030	0.00079	0.078
South MRSF & East Dam - year 20 - new	1236	18	5.0	4.3	0.0029	0.087	2.3	0.039	0.00021	2.6	0.00038	962	0.0064	0.0094	0.012	0.00031	0.00072	0.086
South MRSF & East Dam - PC - new	997	3.7	1.7	4.8	0.0025	0.027	0.38	0.069	0.00031	0.96	0.00029	1545	0.011	0.0032	0.012	0.00039	0.00068	0.14
East MRSF - year 5	1222	20	3.6	3.5	0.0029	0.089	1.6	0.038	0.00016	2.0	0.000080	935	0.0046	0.0019	0.011	0.00031	0.00091	0.060
East MRSF - year 10	1222	20	3.6	3.5	0.0029	0.089	1.6	0.038	0.00016	2.0	0.000080	936	0.0046	0.0019	0.011	0.00031	0.00091	0.060
East MRSF - year 20	1222	20	3.6	3.5	0.0029	0.089	1.6	0.038	0.00016	2.0	0.000080	936	0.0046	0.0019	0.011	0.00031	0.00091	0.060
East MRSF - PC	1145	1.4	0.68	2.0	0.0028	0.011	0.11	0.040	0.00013	0.37	0.000050	967	0.0039	0.0010	0.011	0.00031	0.00035	0.067
Backfill - year 20	1211	20	5.6	4.6	0.0029	0.086	1.5	0.041	0.00023	2.3	0.00045	999	0.0066	0.012	0.012	0.00032	0.00064	0.093
South Dam - EOM	1292	12	3.6	2.8	0.0031	0.048	0.65	0.032	0.00015	1.2	0.00029	824	0.0041	0.0080	0.011	0.00029	0.00090	0.058
South Dam - PC	1215	1.2	0.45	1.5	0.0030	0.0070	0.062	0.033	0.00010	0.26	0.000090	842	0.0027	0.00082	0.011	0.00029	0.00021	0.042
Southeast Dam - EOM	1383	6.1	1.9	1.5	0.0032	0.025	0.34	0.026	0.000080	0.65	0.00016	707	0.0021	0.0042	0.011	0.00027	0.00047	0.030
Southeast Dam - PC	1333	0.65	0.24	0.82	0.0032	0.0037	0.033	0.027	0.000050	0.13	0.000050	713	0.0014	0.00044	0.011	0.00027	0.00011	0.022
Ore Stockpile - max extent	2744	25	2.4	3.7	0.0046	0.023	0.048	0.012	0.000086	4.3	0.0011	431	0.00083	0.016	0.16	0.00021	0.0017	0.10
Ore Stockpile - year 17	2740	22	2.5	3.3	0.0046	0.022	0.050	0.012	0.000075	3.5	0.00075	430	0.00084	0.011	0.13	0.00021	0.0014	0.097
Pit wall - IMH - operational	1279	14	2.3	2.2	0.0031	0.056	0.47	0.032	0.00010	1.0	0.000020	812	0.0028	0.00076	0.011	0.00029	0.00066	0.037
Pit wall - SLD - operational	1364	3.5	3.9	2.3	0.0032	0.011	0.018	0.028	0.00015	0.62	0.00046	736	0.0038	0.013	0.011	0.00027	0.00044	0.057
Pit wall - MAFV - operational	1477	4.5	2.0	2.0	0.0033	0.030	0.38	0.025	0.000050	1.7	0.00033	683	0.0035	0.00097	0.011	0.00026	0.0039	0.035
Pit wall - PICR - operational	1495	3.1	1.0	1.8	0.0033	0.055	5.1	0.025	0.000040	3.0	0.000090	691	0.0031	0.00073	0.0094	0.00026	0.00071	0.033
Pit wall - SLD ore - operational	1991	13	0.94	1.9	0.0040	0.011	0.019	0.016	0.000041	2.6	0.00077	500	0.00034	0.011	0.011	0.00022	0.0010	0.050
Pit wall - IMH - PC	1226	0.84	0.39	1.2	0.0030	0.0065	0.039	0.032	0.000080	0.20	0.000020	819	0.0021	0.00051	0.011	0.00029	0.00023	0.044
Pit wall - SLD - PC (neutral)	1278	1.1	0.25	1.3	0.0031	0.0030	0.015	0.029	0.000070	0.16	0.00012	757	0.0019	0.00067	0.011	0.00028	0.000080	0.020
Pit wall - SLD - PC (acidic)	1794	1.0	0.24	1.2	0.0074	0.0028	0.0029	0.021	0.00075	0.14	0.0013	591	0.0017	0.49	2.9	0.0088	0.00044	0.050
Pit wall - MAFV/PICR - PC (neutral)	1368	0.81	0.68	1.1	0.0032	0.012	0.33	0.029	0.000070	0.41	0.00010	752	0.0052	0.0016	0.011	0.00028	0.00014	0.027
Pit wall - MAFV/PICR - PC (acidic)	2041	0.76	0.64	0.99	0.30	0.011	0.061	0.021	0.00071	0.34	0.0010	606	0.0049	1.1	5.4	0.0079	0.00075	0.067
Pit wall - SLD ore - PC (neutral)	1317	0.98	0.27	1.3	0.0032	0.0027	0.016	0.027	0.000030	0.21	0.00034	718	0.00049	0.00065	0.011	0.00027	0.000090	0.018
Pit wall - SLD ore - PC (acidic)	3024	0.92	0.25	1.3	0.022	0.0025	0.0030	0.011	0.00031	0.18	0.0037	404	0.00046	0.48	7.5	0.0063	0.00049	0.045
TSF Beach runoff (active)	1356	3.8	0.56	1.1	0.0032	0.0099	0.014	0.026	0.000070	0.15	0.000060	697	0.0018	0.0012	0.011	0.00027	0.00017	0.023
TSF Beach runoff/infiltration (inactive)	1018	19	3.3	6.7	0.0026	0.063	0.077	0.059	0.00044	0.65	0.00044	1350	0.011	0.0070	0.012	0.00036	0.00065	0.13
TSF Operations seepage (saturated)	1519	113	0.42	0.40	0.0023	0.0047	0.0073	0.023	0.00020	0.093	0.00018	638	0.00041	0.00072	0.0066	0.00040	0.00062	0.0066
Cap applied																		
TSF MRSF & Main Dam - year 5	1362	8.9	0.47	1.0	0.0032	0.052	0.081	0.029	0.00010	0.41	0.00019	727	0.0035	0.0036	0.011	0.00028	0.0014	0.034
TSF MRSF & Main Dam - year 10	1338	9.7	0.47	1.0	0.0031	0.049	0.081	0.030	0.00012	0.41	0.00023	727	0.0037	0.0055	0.011	0.00028	0.0012	0.034
TSF MRSF & Main Dam - year 20	1323	10	0.47	1.0	0.0031	0.047	0.081	0.031	0.00013	0.41	0.00025	727	0.0037	0.0063	0.011	0.00028	0.0011	0.034
TSF MRSF & Main Dam - PC	1104	2.2	0.47	1.0	0.0027	0.015	0.081	0.046	0.00018	0.41	0.00018	727	0.0058	0.0017	0.012	0.00033	0.00038	0.034
South MRSF & East Dam - year 5	1255	16	0.47	1.0	0.0030	0.076	0.081	0.036	0.00016	0.41	0.00020	727	0.0048	0.0050	0.011	0.00030	0.00090	0.034
South MRSF & East Dam - year 10	1245	17	0.47	1.0	0.0030	0.074	0.081	0.036	0.00017	0.41	0.00023	727	0.0048	0.0059	0.011	0.00030	0.00084	0.034
South MRSF & East Dam - year 20	1244	17	0.47	1.0	0.0030	0.074	0.081	0.036	0.00017	0.41	0.00022	727	0.0048	0.0059	0.011	0.00030	0.00084	0.034
South MRSF & East Dam - PC	1019	2.9	0.47	1.0	0.0026	0.020	0.081	0.060	0.00025	0.41	0.00017	727	0.0075	0.0021	0.012	0.00037	0.00060	0.034
South MRSF & East Dam - year 5 - new	1269	16	0.47	1.0	0.0030	0.080	0.081	0.038	0.00020	0.41	0.00045	727	0.0067	0.0063	0.011	0.00031	0.00076	0.034
South MRSF & East Dam - year 10 - new	1258	16	0.47	1.0	0.0030	0.078	0.081	0.037	0.00019	0.41	0.00035	727	0.0057	0.0063	0.011	0.00030	0.00079	0.034
South MRSF & East Dam - year 20 - new	1236	18	0.47	1.0	0.0029	0.080	0.081	0.039	0.00021	0.41	0.00038	727	0.0064	0.0063	0.012	0.00031	0.00072	0.034
South MRSF & East Dam - PC - new	997	3.7	0.47	1.0	0.0025	0.027	0.081	0.069	0.00031	0.41	0.00029	727	0.011	0.0032	0.012	0.00039	0.00068	0.034
East MRSF - year 5	1222	20	0.47	1.0	0.0029	0.080	0.081	0.038	0.00016	0.41	0.000080	727	0.0046	0.0019	0.011	0.00031	0.00091	0.034
East MRSF - year 10	1222	20	0.47	1.0	0.0029	0.080	0.081	0.038	0.00016	0.41	0.000080	727	0.0046	0.0019	0.011	0.00031	0.00091	0.034
East MRSF - year 20	1222	20	0.47	1.0	0.0029	0.080	0.081	0.038	0.00016	0.41	0.000080	727	0.0046	0.0019	0.011	0.00031	0.00091	0.034
East MRSF - PC	1145	1.4	0.47	1.0	0.0028	0.011	0.081	0.040	0.00013	0.37	0.000050	727	0.0039	0.0010	0.011	0.00031	0.00035	0.034
Backfill - year 20	1211	20	0.47	1.0	0.0029	0.080	0.081	0.041	0.00023	0.41	0.00045	727	0.0066	0.0063	0.012	0.00032	0.00064	0.034
South Dam - EOM	1292	12	0.47	1.0	0.0031	0.048	0.081	0.032	0.00015	0.41	0.00029	727	0.0041	0.0063	0.011	0.00029	0.00090	0.034
South Dam - PC	1215	1.2	0.45	1.0	0.0030	0.0070	0.062	0.033	0.00010	0.26	0.000090	727	0.0027	0.00082	0.011	0.00029	0.00021	0.034
Southeast Dam - EOM	1383	6.1	0.47	1.0	0.0032	0.025	0.081	0.026	0.000080	0.41	0.00016	707	0.0021	0.0042	0.011	0.00027	0.00047	0.030
Southeast Dam - PC	1333	0.65	0.24	0.82	0.0032	0.0037	0.033	0.027	0.000050	0.13	0.000050	713	0.0014	0.00044	0.011	0.00027	0.00011	0.022
Ore Stockpile - max extent	1785	20	0.47	1.0	0.0046	0.023	0.048	0.012	0.000086	0.41	0.0011	431	0.00083	0.0063	0.11	0.00021	0.0017	0.034
Ore Stockpile - year 17	1785	20	0.47	1.0	0.0046	0.022	0.050	0.012	0.000075	0.41	0.00075	430	0.00084	0.0063	0.11	0.00021	0.0014	0.034
Pit wall - IMH - operational	1279	14	0.47	1.0	0.0031	0.056	0.081	0.032	0.00010	0.41	0.000020	727	0.0028	0.00076	0.011	0.00029	0.00066	0.034
Pit wall - SLD - operational	1364	3.5	0.47	1.0	0.0032	0.011	0.018	0.028	0.00015	0.41	0.00046	727	0.0038	0.0063	0.011	0.00027	0.00044	0.034
Pit wall - MAFV - operational	1477	4.5	0.47	1.0	0.0033	0.030	0.081	0.025	0.000050	0.41	0.00033	683	0.0035	0.00097	0.011	0.00026	0.0036	0.034
Pit wall - PICR - operational	1495	3.1	0.47	1.0	0.0033	0.055	0.081	0.025	0.000040	0.41	0.000090	691	0.0031	0.00073	0.0094	0.00026	0.00071	0.033
Pit wall - SLD ore - operational	1785	13	0.47	1.0	0.0040	0.011	0.019	0.016	0.000041	0.41	0.00077	500	0.00034	0.0063	0.011	0.00022	0.0010	0.034
Pit wall - IMH - PC	1226	0.84	0.39	1.0	0.0030	0.0065	0.039	0.032	0.000080	0.20	0.000020	727	0.0021	0.00051	0.011	0.00029	0.00023	0.034
Pit wall - SLD - PC (neutral)	1278	1.1	0.25	1.0	0.0031	0.0030	0.015	0.029	0.000070	0.16	0.00012	727	0.0019	0.00067	0.011	0.00028	0.000080	0.020
Pit wall - SLD - PC (acidic)	1794	1.0	0.24	1.2	0.0074	0.0028	0.00060	0.021	0.00075	0.14	0.0013	591	0.0017	0.49	2.9	0.0088	0.00044	0.050
Pit wall - MAFV/PICR - PC (neutral)	1368	0.81	0.47	1.0	0.0032	0.012	0.081	0.029	0.000070	0.41	0.00010	727	0.0052	0.0016	0.011	0.00028	0.00014	0.027
Pit wall - MAFV/PICR - PC (acidic)	2041	0.76	0.64	0.99	0.30	0.011	0.00060	0.021	0.00071	0.34	0.0010	606	0.0049	1.1	5.4	0.0079	0.00075	0.067
Pit wall - SLD ore - PC (neutral)	1317	0.98	0.27	1.0	0.0032	0.0027	0.016	0.027	0.000030	0.21	0.00034	718	0.00049	0.00065	0.011	0.00027	0.000090	0.018
Pit wall - SLD ore - PC (acidic)	2440	0.92	0.25	1.3	0.022	0.0025	0.00060	0.011	0.00031	0.18	0.0037	404	0.00046	0.48	7.5	0.0063	0.00049	0.045
TSF Beach runoff (active)	1356	3.8	0.56	1.0	0.0032	0.0027	0.0033	0.026	0.000070	0.15	0.000060	537	0.0018	0.0012	0.011	0.00027	0.00017	0.023
TSF Beach runoff/infiltration (inactive)	1018	19	0.57	1.0	0.0026	0.0027	0.0033	0.059	0.00044	0.65	0.00044	537	0.0079	0.0068	0.012	0.00036	0.00065	0.051
TSF Operations seepage (saturated)	1519	112	0.42	0.40	0.0023	0.0047	0.0073	0.023	0.00020	0.093	0.00018	612	0.00041	0.00072	0.0066	0.00040	0.00062	0.0066
capped species																		
Caps																		
Mine Rock & Ore																		
Cap (neutral)	1785	20	0.47	1.0	1.4	0.080	0.081	0.19	0.0012	0.41	0.0070	727	0.023	0.0063	0.11	1.6	0.0036	0.034
Data Reference	*MW12-02*	*MW12-01*	*MW12-02*	*MW12-01*	*Field Bin 4*	*Porphyry DB*	*Field Bin 1*	*Field Bin 4*	*Field Bin 2*	*Field Bin 1*	*Porphyry DB*	*Porphyry DB*	*Field Bin 4*	*Field Bin 4*	*Field Bin 7*	*Field Bin 4*	*Porphyry DB*	*MW12-02*
Cap (acidic)	2440				40		0.0006				0.04	793			340	3	0.02	
Data Reference	*Porphyry DB*				*Porphyry DB*		*Porphyry DB*				*Porphyry DB*	*Porphyry DB*			*Porphyry DB*	*Porphyry DB*	*Porphyry DB*	
TSF																		
Unaturated cap	2501	39	0.57	1.0	3.4	0.0027	0.0033	0.10	0.0010	0.87	0.00045	537	0.0079	0.0068	0.028	3.6	0.069	0.051
Data Reference	*Field Bin*	*M5 202*	*M5 301*	*CPT 14-46*	*M5 301*	*T4*	*M5 301*	*M5 301*	*M5 203*	*M5 203*	*M5 202*	*Field Bin*	*M5 301*	*Field Bin*	*M5 301*	*M5 301*	*M5 301*	*Field Bin*
Saturated cap	1616	112	3.3	1.0	0.51	0.0047	0.20	0.047	0.00020	0.41	0.00018	612	0.00099	0.00072	0.056	0.35	0.00062	0.012
Data Reference	*Supernatants*	*Supernatants*	*CPT 14-46*	*CPT 14-46*	*CPT 14-27*	*Supernatants*	*CPT 14-46*	*CPT 14-32*	*Supernatants*	*CPT 14-27*	*aturated colum*	*Supernatants*	*CPT 14-27*	*Supernatants*	*CPT 14-27*	*CPT 14-27*	*Supernatants*	*CPT 14-27*

molar PHREEQC output	Mg	Mn	Hg	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	Tl	Sn	U	V	Zn
Uncapped (solubility controlled)																	
TSF MRSF & Main Dam - year 5	54	0.060	0.000090	0.47	0.085	0.080	293	0.011	6.6	0.000040	174	7.8	0.00027	0.0090	0.0069	0.40	0.029
TSF MRSF & Main Dam - year 10	56	0.088	0.00010	0.71	0.10	0.10	274	0.012	6.6	0.000050	172	10	0.00028	0.0100	0.0097	0.45	0.033
TSF MRSF & Main Dam - year 20	56	0.10	0.00011	0.83	0.11	0.12	253	0.012	6.6	0.000060	168	12	0.00028	0.011	0.011	0.47	0.035
TSF MRSF & Main Dam - PC	78	0.048	0.000090	1.3	0.056	0.081	431	0.022	6.6	0.000090	24	8.1	0.00054	0.0053	0.0058	0.54	0.026
South MRSF & East Dam - year 5	64	0.088	0.00013	0.64	0.083	0.13	302	0.012	6.6	0.000070	258	11	0.00029	0.018	0.0099	0.76	0.043
South MRSF & East Dam - year 10	65	0.10	0.00014	0.76	0.094	0.15	287	0.012	6.6	0.000080	256	12	0.00030	0.019	0.011	0.79	0.044
South MRSF & East Dam - year 20	65	0.10	0.00014	0.75	0.093	0.15	285	0.012	6.6	0.000080	257	12	0.00029	0.019	0.011	0.79	0.044
South MRSF & East Dam - PC	99	0.067	0.00013	1.1	0.052	0.11	531	0.026	6.5	0.00013	33	12	0.00056	0.0092	0.0067	0.84	0.038
South MRSF & East Dam - year 5 - new	67	0.16	0.00018	1.3	0.20	0.18	538	0.023	6.6	0.000091	300	19	0.00054	0.016	0.018	0.71	0.059
South MRSF & East Dam - year 10 - new	66	0.14	0.00016	1.1	0.15	0.17	414	0.018	6.6	0.000091	272	16	0.00042	0.017	0.015	0.73	0.052
South MRSF & East Dam - year 20 - new	69	0.15	0.00018	1.2	0.17	0.19	450	0.020	6.6	0.00010	304	18	0.00046	0.019	0.017	0.83	0.058
South MRSF & East Dam - PC - new	112	0.087	0.00016	2.3	0.12	0.14	825	0.038	6.5	0.00016	41	14	0.0010	0.0094	0.0093	0.93	0.047
East MRSF - year 5	67	0.045	0.00012	0.22	0.029	0.12	244	0.0074	6.6	0.000070	294	6.9	0.00021	0.023	0.0050	0.95	0.039
East MRSF - year 10	67	0.045	0.00012	0.21	0.029	0.12	242	0.0074	6.6	0.000070	294	6.9	0.00021	0.023	0.0050	0.95	0.039
East MRSF - year 20	67	0.045	0.00012	0.21	0.029	0.12	242	0.0074	6.6	0.000070	294	6.9	0.00021	0.023	0.0050	0.95	0.039
East MRSF - PC	69	0.036	0.000070	0.36	0.025	0.059	283	0.011	6.6	0.000070	17	6.0	0.00026	0.0057	0.0024	0.46	0.021
Backfill - year 20	72	0.19	0.00019	1.5	0.19	0.22	430	0.021	6.6	0.00011	311	20	0.00048	0.021	0.021	0.92	0.064
South Dam - EOM	59	0.13	0.00012	1.0	0.12	0.14	247	0.013	6.6	0.000070	180	14	0.00029	0.013	0.014	0.55	0.041
South Dam - PC	60	0.025	0.000050	0.54	0.015	0.045	178	0.011	6.6	0.000050	13	4.6	0.00021	0.0031	0.0036	0.32	0.014
Southeast Dam - EOM	50	0.068	0.000060	0.55	0.064	0.075	130	0.0067	6.6	0.000040	95	7.5	0.00015	0.0066	0.0075	0.29	0.021
Southeast Dam - PC	50	0.013	0.000030	0.29	0.0081	0.024	94	0.0060	6.6	0.000030	6.9	2.4	0.00011	0.0016	0.0019	0.17	0.0073
Ore Stockpile - max extent	29	0.46	0.00013	0.83	0.043	0.037	242	0.012	6.6	0.000021	165	8.4	0.00018	0.0086	0.026	0.38	0.023
Ore Stockpile - year 17	29	0.46	0.00011	0.75	0.037	0.033	232	0.0096	6.6	0.000021	153	8.4	0.00014	0.0081	0.028	0.42	0.015
Pit wall - IMH - operational	58	0.022	0.000070	0.075	0.0041	0.077	106	0.0027	6.6	0.000050	190	3.7	0.00010	0.016	0.0026	0.67	0.025
Pit wall - SLD - operational	52	0.20	0.00014	1.8	0.18	0.15	247	0.018	6.6	0.000081	80	15	0.00035	0.0033	0.024	0.18	0.045
Pit wall - MAFV - operational	48	0.0046	0.000070	0.27	0.13	0.019	262	0.010	6.6	0.000010	172	5.1	0.00035	0.00091	0.0057	0.37	0.039
Pit wall - PICR - operational	49	0.014	0.000060	0.050	0.075	0.018	458	0.015	6.6	0.000010	141	3.0	0.00030	0.0019	0.00023	0.024	0.011
Pit wall - SLD ore - operational	34	0.52	0.000062	0.42	0.024	0.019	114	0.0066	6.6	0.000010	82	9.8	0.00011	0.0040	0.0098	0.14	0.017
Pit wall - IMH - PC	58	0.021	0.000040	0.038	0.0029	0.037	133	0.0058	6.6	0.000040	10	3.8	0.000080	0.0040	0.0014	0.32	0.013
Pit wall - SLD - PC (neutral)	54	0.017	0.000040	0.66	0.0060	0.036	83	0.011	6.6	0.000040	11	3.4	0.00016	0.00082	0.0052	0.21	0.0080
Pit wall - SLD - PC (acidic)	177	0.15	0.000040	0.015	1.1	0.011	49	0.029	6.5	0.00015	13	1.7	0.00019	0.00043	0.00044	0.0082	0.060
Pit wall - MAFV/PICR - PC (neutral)	53	0.027	0.000040	1.5	0.12	0.032	520	0.014	6.6	0.000040	9.0	2.7	0.00075	0.00030	0.00097	0.062	0.013
Pit wall - MAFV/PICR - PC (acidic)	287	0.24	0.000030	0.034	21	0.010	304	0.037	6.5	0.00013	11	1.4	0.00090	0.00016	0.000080	0.0024	0.097
Pit wall - SLD ore - PC (neutral)	46	0.024	0.000040	2.1	0.0018	0.040	77	0.026	6.6	0.000020	9.3	3.4	0.00021	0.21	0.0024	0.087	0.0049
Pit wall - SLD ore - PC (acidic)	118	0.21	0.000040	0.047	0.32	0.013	45	0.066	6.5	0.000070	11	1.7	0.00026	0.11	0.00020	0.0035	0.036
TSF Beach runoff (active)	49	0.042	0.000040	0.20	0.0052	0.034	69	0.011	6.6	0.000040	23	2.3	0.000090	0.0025	0.0022	0.015	0.0077
TSF Beach runoff/infiltration (inactive)	98	0.27	0.00022	1.0	0.029	0.20	354	0.066	6.5	0.00022	103	13	0.00055	0.013	0.013	0.090	0.045
TSF Operations seepage (saturated)	45	0.087	0.000060	0.35	0.0059	0.13	32	0.0021	6.6	0.00020	78	3.1	0.000020	0.00028	0.0091	0.0046	0.015
Cap applied																	
TSF MRSF & Main Dam - year 5	54	0.060	0.000090	0.47	0.085	0.080	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.0069	0.11	0.029
TSF MRSF & Main Dam - year 10	56	0.088	0.00010	0.71	0.10	0.10	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.0097	0.11	0.033
TSF MRSF & Main Dam - year 20	56	0.10	0.00011	0.83	0.11	0.12	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.011	0.11	0.035
TSF MRSF & Main Dam - PC	78	0.048	0.000090	1.3	0.056	0.081	80	0.045	6.6	0.000025	24	3.6	0.00025	0.00025	0.0058	0.11	0.026
South MRSF & East Dam - year 5	64	0.088	0.00013	0.64	0.083	0.13	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.0099	0.11	0.043
South MRSF & East Dam - year 10	65	0.10	0.00014	0.76	0.094	0.15	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.011	0.11	0.044
South MRSF & East Dam - year 20	65	0.10	0.00014	0.75	0.093	0.15	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.011	0.11	0.044
South MRSF & East Dam - PC	99	0.067	0.00013	1.1	0.052	0.11	80	0.043	6.5	0.000025	33	3.6	0.00025	0.00025	0.0067	0.11	0.038
South MRSF & East Dam - year 5 - new	67	0.16	0.00018	1.3	0.20	0.18	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.015	0.11	0.059
South MRSF & East Dam - year 10 - new	66	0.14	0.00016	1.1	0.15	0.17	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.015	0.11	0.052
South MRSF & East Dam - year 20 - new	69	0.15	0.00018	1.2	0.17	0.19	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.015	0.11	0.058
South MRSF & East Dam - PC - new	112	0.087	0.00016	2.3	0.12	0.14	80	0.075	6.5	0.000025	41	3.6	0.00025	0.00025	0.0093	0.11	0.047
East MRSF - year 5	67	0.045	0.00012	0.22	0.029	0.12	80	0.064	6.6	0.000025	160	3.6	0.00021	0.00025	0.0050	0.11	0.039
East MRSF - year 10	67	0.045	0.00012	0.21	0.029	0.12	80	0.063	6.6	0.000025	160	3.6	0.00021	0.00025	0.0050	0.11	0.039
East MRSF - year 20	67	0.045	0.00012	0.21	0.029	0.12	80	0.063	6.6	0.000025	160	3.6	0.00021	0.00025	0.0050	0.11	0.039
East MRSF - PC	69	0.036	0.000070	0.36	0.025	0.059	80	0.013	6.6	0.000025	17	3.6	0.00025	0.00025	0.0024	0.11	0.021
Backfill - year 20	72	0.19	0.00019	1.5	0.19	0.22	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.015	0.11	0.064
South Dam - EOM	59	0.13	0.00012	1.0	0.12	0.14	80	0.080	6.6	0.000025	160	3.6	0.00025	0.00025	0.014	0.11	0.041
South Dam - PC	60	0.025	0.000050	0.54	0.015	0.045	80	0.023	6.6	0.000025	13	3.6	0.00021	0.00025	0.0036	0.11	0.014
Southeast Dam - EOM	50	0.068	0.000060	0.55	0.064	0.075	80	0.080	6.6	0.000025	95	3.6	0.00015	0.00025	0.0075	0.11	0.021
Southeast Dam - PC	50	0.013	0.000030	0.29	0.0081	0.024	80	0.012	6.6	0.000025	6.9	2.4	0.00011	0.00025	0.0019	0.11	0.0073
Ore Stockpile - max extent	29	0.46	0.00013	0.83	0.043	0.037	80	0.080	6.6	0.000021	160	3.6	0.00018	0.00025	0.015	0.11	0.023
Ore Stockpile - year 17	29	0.46	0.00011	0.75	0.037	0.033	80	0.080	6.6	0.000021	153	3.6	0.00014	0.00025	0.015	0.11	0.015
Pit wall - IMH - operational	58	0.022	0.000070	0.075	0.0041	0.077	80	0.016	6.6	0.000025	160	3.6	0.00010	0.00025	0.0026	0.11	0.025
Pit wall - SLD - operational	52	0.20	0.00014	1.8	0.18	0.15	80	0.080	6.6	0.000025	80	3.6	0.00025	0.00025	0.015	0.11	0.045
Pit wall - MAFV - operational	48	0.0046	0.000070	0.27	0.13	0.019	80	0.068	6.6	0.000010	160	3.6	0.00025	0.00025	0.0057	0.11	0.039
Pit wall - PICR - operational	49	0.014	0.000060	0.050	0.075	0.018	80	0.054	6.6	0.000010	141	3.0	0.00025	0.00025	0.00023	0.024	0.011
Pit wall - SLD ore - operational	34	0.52	0.000062	0.42	0.024	0.019	80	0.080	6.6	0.000010	82	3.6	0.00011	0.00025	0.0098	0.11	0.017
Pit wall - IMH - PC	58	0.021	0.000040	0.038	0.0029	0.037	80	0.0042	6.6	0.000025	10	3.6	0.000080	0.00025	0.0014	0.11	0.013
Pit wall - SLD - PC (neutral)	54	0.017	0.000040	0.66	0.0060	0.036	80	0.030	6.6	0.000025	11	3.4	0.00016	0.00025	0.0052	0.11	0.0080
Pit wall - SLD - PC (acidic)	177	0.15	0.000040	0.015	1.0	0.011	49	0.079	6.5	0.00015	13	1.7	0.00019	0.00043	0.00044	0.0082	0.060
Pit wall - MAFV/PICR - PC (neutral)	53	0.027	0.000040	1.5	0.12	0.032	80	0.032	6.6	0.000025	9.0	2.7	0.00025	0.00025	0.00097	0.062	0.013
Pit wall - MAFV/PICR - PC (acidic)	180	0.24	0.000030	0.030	1.0	0.010	112	0.080	6.5	0.00013	11	1.4	0.00090	0.00016	0.000080	0.0024	0.097
Pit wall - SLD ore - PC (neutral)	46	0.024	0.000040	2.1	0.0018	0.040	77	0.080	6.6	0.000020	9.3	3.4	0.00021	0.00025	0.0024	0.087	0.0049
Pit wall - SLD ore - PC (acidic)	118	0.21	0.000040	0.030	0.32	0.013	45	0.080	6.5	0.000070	11	1.7	0.00026	0.11	0.00020	0.0035	0.036
TSF Beach runoff (active)	49	0.042	0.000040	0.20	0.0052	0.034	55	0.011	6.6	0.000040	23	2.3	0.000090	0.0011	0.0022	0.015	0.0077
TSF Beach runoff/infiltration (inactive)	98	0.27	0.000046	1.0	0.017	0.20	55	0.041	6.5	0.000050	103	6.1	0.00032	0.0011	0.0091	0.016	0.020
TSF Operations seepage (saturated)	45	0.087	0.000056	0.35	0.0059	0.13	32	0.0021	6.6	0.00020	78	3.1	0.000020	0.00028	0.0091	0.0046	0.015
capped species																	
Caps																	
Mine Rock & Ore																	
Cap (neutral)	317	4.0	0.00043	3.5	0.21	0.30	80	0.30	15	0.000025	160	3.6	0.00025	0.00025	0.015	0.11	0.80
Data Reference	*MW12-02*	*Porphyry DB*	*Porphyry DB*	*MW12-01*	*Porphyry DB*	*Field Bin 1*	*Field Bin 4*	*Porphyry DB*	*Field Bin 7*	*Field Bin 4*	*MW12-02*	*MW12-02*	*Field Bin 2*	*Field Bin 2*	*MW12-01*	*Field Bin 1*	*Porphyry DB*
Cap (acidic)	180	26	0.0006	0.03	1.0		112	0.08		0.01	64						4.0
Data Reference	*Porphyry DB*	*Porphyry DB*	*Porphyry DB*	*Porphyry DB*	*Porphyry DB*		*Porphyry DB*	*Porphyry DB*		*Porphyry DB*	*Porphyry DB*						*Porphyry DB*
TSF																	
Unaturated cap	299	0.39	0.000046	3.5	0.017	2.2	55	0.041	9.3	0.000050	796	6.1	0.00032	0.0011	0.0091	0.016	0.020
Data Reference	*M5 202*	*Field Bin*	*M5 301*	*T2*	*Field Bin*	*M5 202*	*Field Bin*	*Field Bin*	*M5 202*	*M5 203*	*M5 203*	*Field Bin*	*Field Bin*	*M5 203*	*Field Bin*	*M5 301*	*M5 301*
Saturated cap	61	0.19	0.000056	0.86	0.0059	19	32	0.0021	7.4	0.00020	532	3.1	0.00010	0.00028	0.0091	0.0086	0.015
Data Reference	*Supernatants*	*CPT 14-32*	*Supernatants*	*CPT 14-32*	*Supernatants*	*CPT 14-46*	*Supernatants*	*Supernatants*	*Supernatants*	*Supernatants*	*CPT 14-27*	*Supernatants*	*T1*	*Supernatants*	*Supernatants*	*CPT 14-46*	*Supernatants*

MEM 109

Porewater concentrations for samples collected from the historic Afton tailings were used to develop concentration limits for tailings pore water source terms in Section 2.2. Please provide additional information regarding how these concentrations were determined, including sample location, age, collection method, and analytical methods used. Additionally, please provide information that demonstrates these tailings are similar to the future Ajax tailings. This will assist MEM in evaluating the suitability of using these concentrations as source term concentration maximums.

The historic Ajax tailings were processed in the Afton mill and deposited in the historic Afton tailings impoundment. The concentration caps applied to the Ajax TSF source terms were derived from pore water samples from the historic Afton TSF. A total of 6 monitoring locations were considered for this assessment, the locations of which are illustrated in Figure MEM-109. “M5” monitoring wells were considered for the capping reference database of unsaturated TSF seepage and runoff at Ajax. These wells are located slightly west of the historic Afton TSF and, based on geochemistry data, collect oxygenated TSF seepage and groundwater. A total of 11 samples were collected from each of these locations between March 2011 and June 2013. Monitoring locations labelled “CPT” provided a total of 19 water samples in 2014 from the saturated zone within the tailings column directly and were therefore used as a reference database for the saturated Ajax TSF source terms.

In 2007, 8 tailings samples were collected from test pits within the historic Afton TSF. These samples were recovered from a variety of depths, ranging from surficial (oxidized), to > 1m depth (partly oxidized to fresh). A geochemical comparison of this historic tailings material with metallurgical test samples expected to represent the future Ajax tailings composition (Table MEM 109) shows that considerable geochemical variability exists within the historic TSF. Although the total sulphur content of the Afton tailings lies within the range of the Ajax metallurgical tailings samples, several other species also have fall below or exceed the geochemical range calculated for the metallurgical Ajax tailings population. Elements that tend relatively enriched in historic tailings over the metallurgical test sample population include Mn, Sb, and Zn, therefore providing a conservative proxy for tailings generated in the future Ajax operations. Overall, in combination with supernatant analyses obtained from metallurgical testing, the historic Afton pore water should provide a good indication of future Ajax TSF pore water and seepage.

Table MEM 109:
Geochemical comparison of samples collected at the historic Afton TSF and statistical values calculated for metallurgical Ajax tailings samples

		Paste pH	Total S	Sulphate S	Sulphide S	Insol. S	CaNP	Mod. NP	Ag	Al	As	Ba	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Mg	Mn	Mo	Na	Ni	P	Pb	Sb	Se	Sr	Th	Ti	U	V	Zn
			%	%	%	%	kg $CaCO_3$/t	kg $CaCO_3$/t	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	%	%	ppm	ppm	%	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Ajax Tailings	*n=*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*	*11*
min		7.9	0.10	0.020	0.020	0.033	55	59	0.090	1.3	3.6	92	3.0	0.010	14	54	367	2.3	0.10	0.070	1.3	249	5.9	0.033	46	0.099	0.80	0.10	0.90	53	0.40	0.066	0.39	93	10
10th PCTL		8.0	0.13	0.020	0.020	0.036	58	62	0.10	1.6	4.0	98	3.1	0.030	15	109	370	2.4	0.10	0.10	1.5	252	6.5	0.040	60	0.10	0.90	0.11	1.0	66	0.40	0.12	0.40	120	13
median		8.3	0.19	0.020	0.090	0.056	73	80	0.12	1.7	6.0	121	3.6	0.040	25	176	421	3.3	0.14	0.14	1.8	301	28	0.050	98	0.12	1.3	0.21	1.0	72	0.50	0.13	0.45	132	17
90th PCTL		8.4	0.31	0.16	0.22	0.081	87	98	0.19	2.0	11	145	4.2	0.070	30	403	799	4.2	0.21	0.26	2.1	316	35	0.050	195	1300	2.9	0.32	1.0	81	0.60	0.16	0.55	202	23
max		8.6	0.31	0.17	0.25	0.090	93	127	0.20	2.3	12	163	4.5	0.10	31	450	923	4.6	0.28	0.53	3.5	318	48	0.060	246	1320	3.9	0.41	1.0	81	0.60	0.19	0.55	221	25
Afton TSF tailings																																			
T1-1		*8.8*	0.17	*<0.01*	0.050	*0.12*	63	74	0.10	*1.0*	*3.1*	*78*	*2.8*	*<.1*	*8.2*	66	*1178*	*1.3*	0.17	0.090	*1.0*	*190*	8.2	0.044	*39*	0.10	*0.30*	0.10	*0.50*	*43*	0.40	0.068	*0.30*	*66*	10
T2-1		8.2	0.16	0.030	0.080	0.050	*96*	*173*	0.20	1.9	*23*	120	4.1	*0.20*	*31*	106	545	3.0	0.18	0.15	2.2	*764*	27	0.057	72	0.12	3.8	*2.2*	*0.80*	*113*	0.60	0.089	*0.60*	134	*68*
T2-2		8.2	0.25	0.040	0.17	0.040	*22*	*133*	0.10	2.0	7.6	*88*	4.1	*<.1*	*36*	191	*272*	2.8	*0.080*	0.17	2.5	*428*	26	*0.076*	108	0.12	1.2	*0.60*	*0.60*	69	*0.70*	0.11	*0.60*	125	*28*
T2-3		8.6	0.12	0.040	0.050	*0.030*	72	86	0.20	1.9	*79*	150	*2.9*	*0.30*	25	102	495	3.0	*0.090*	0.21	2.3	*1115*	7.5	*0.14*	57	0.10	*6.7*	*6.4*	*0.70*	*122*	*0.70*	0.076	0.50	144	*128*
T2-4		8.3	0.25	0.060	0.17	*0.020*	*95*	92	0.10	1.7	8.0	*81*	3.8	*<.1*	*35*	179	*288*	2.6	*0.090*	0.13	2.4	*412*	25	*0.063*	103	0.11	1.2	*0.70*	*0.70*	68	0.60	0.092	*0.60*	110	*28*
T3-1		*8.7*	0.28	*0.19*	0.060	*0.030*	*108*	*231*	0.20	1.8	8.6	108	*4.9*	0.10	27	84	581	2.7	*0.32*	0.16	2.2	*417*	15	*0.22*	74	0.12	1.2	*0.50*	*0.50*	74	0.60	0.11	0.50	135	25
T3-2		8.2	0.14	0.050	0.050	0.040	82	88	0.10	1.3	*3.1*	101	3.9	*<.1*	16	77	564	*1.8*	*0.34*	0.10	1.5	279	8.9	0.059	58	0.12	*0.50*	0.10	*0.50*	57	0.40	0.083	0.40	*91*	13
T3-3		8.3	0.14	0.030	0.070	0.040	78	87	*<.1*	*1.2*	*2.8*	113	4.0	*<.1*	15	*43*	475	*1.4*	0.15	0.080	*1.2*	271	12	0.051	*40*	0.12	*0.50*	0.20	*0.50*	*49*	0.40	*0.062*	0.40	*77*	10

Notes: Values indicated in orange and green fall below and exceed the range the geochemical calculated for Ajax tailings, respectively.

Figure MEM-109

MEM 111

Please provide additional information supporting the selection of the contact water scaling factors for each WRSF to assist MEM in evaluating their suitability and degree of conservatism appropriateness for these facilities.

The contact water scaling factors for the various MRSFs internally calibrated based on the ratio of tonnage/footprint. Due to the formation of preferential flow paths, a relatively smaller amount of the MRSF would be contacted by infiltrating water if the tonnage/footprint ratio is higher (*i.e*., if the facility is built higher). The absolute values applied were based on findings from inverse modelling at site analogues where kinetic test, MRSF dimension, flow and drainage chemistry information was available (*e.g*., Kirchner and Mattson, 2015).

MEM 112

Infiltration rates for WRSFs were calculated assuming that the particle size distribution (PSD) determined for the waste rock used in the Field Bin investigations were representative of WRSF waste rock PSDs (Water Balance Model, Appendix 6.4-C). Please provide a sensitivity analysis that demonstrates the sensitivity of the source terms to a change in the PSD. This will assist MEM in understanding the implications of this assumption on the waste rock source terms and water quality predictions.

While the precise impact of the particle size on the infiltration rate is modelled by others, the source term model would be, to a degree, affected by a change in the infiltration rate, as this information is required to convert calculated loading rates into predicted concentrations. For example, if the scaling factors were left unaltered, a twofold increase in infiltration rate would result in source term concentrations (before speciation and capping) to be reduced by one half. However, the infiltration rate is strongly tied to the geotechnical properties of a mine rock facility which are accounted for in the upscaling of geochemical solutions. As such, an increase in infiltration rate would, from a modelling perspective, also be accompanied by an increase in the contact water factor, albeit likely not proportionally. The model output concentrations would therefore fall somewhere in between half the original values and the original values (if in the worst case, the contact water factor was also increased twofold). For strongly solubility-limited and capped species, the decreased theoretical concentration may still exceed the geochemically adequate threshold, such that the final source term concentrations may remain unchanged.

MEM 113

A cover consisting of a 2 m layer of NPAG waste rock is proposed for the TSF and included in the source term development. Please indicate what type of NPAG waste rock was used in the *source term calculations. Will there be sufficient amounts of this material at the end of operations for use in cover construction? Which WRSF will it be sourced from?*

The current mine rock schedule indicates the South MRSF has sufficient NPAG rock on the upper lift that can be re-handled to be used as cover material for the TSF. NPAG mine rock used to cover the TSF at closure will be removed from the upper lift of the South MRSF. Source terms were developed with the assumption that the mine rock cover would consist of 50% SLD and 50% IMH. The mine rock schedule in the ML/ARD Management Plan (Table 11.6-9) indicates that 12 Mt of mine rock will be placed on the South MRSF in the final year of its construction and that >95% of this mine rock will be NPAG.

MEM 115

Is the water quality model sensitive to the amount and/or depth of the waste rock cover being used?

Yes, the thickness and type of material used for the TSF cover layer was considered in geochemical TSF closure seepage modelling. It was conservatively assumed that cover material will be composed of a 2 m thick mine rock layer containing equal amounts of IMH and SLD rock. The geochemical impact of water-cover interaction was subsequently modelled and included in the TSF source terms if the resulting concentrations exceeded those predicted for the TSF closure seepage without a cover. The predicted concentrations of the species affected (increased in concentration) by the TSF cover included: Sb, As, Cu, Hg, Mo, U, V, and Zn.

MEM 116

Were there any instances where the calculated waste rock or tailings source term for individual species were substantially (one or more orders of magnitude) lower than concentrations observed in field samples? If so, please provide discussion on the appropriateness of these calculated source term for those species

For both tailings and waste rock, Fe was consistently predicted to be lower than in the median field bin value reported in Appendix 3-B. The comparably high Fe values reported for the field bin leachates can primarily be attributed to high detection limits (0.03 mg/L in earlier and 0.01 mg/L in later leachate analyses). Thus, although the median field bin value was reported to be higher due to detection limits, these concentrations were not actually measured in the field bin leachate. Overall, available mine drainage data from the historic Ajax materials show that Fe is not a parameter of concern under the expected neutral conditions.

High detection limits for field bin leachate analyses are also responsible for significant discrepancies between several mine rock source terms and field bin concentrations for Be and P. Similar to Fe, the higher field bin concentrations are due to analytical limitations and are not considered "real" geochemical under predictions.

Arsenic and Mo were found to be significantly lower in acidic pit wall source terms relative to the median field bin concentrations measured. This can be explained by the geochemical behaviour of these species and their lower solubility in slightly acidic environments compared to the neutral drainage reflected by the field bin leachates. Acidic pit wall runoff predictions were capped by the conservative value (90th percentile) of compiled drainage data from the porphyry copper deposits in British Columbia.

MEM 117

An acid factor was proposed and outlined for the conversion of source terms for MAFV and PICR derived from non-acidic loading rates to acidic loading rates (Section 2.3.1.2). A summary of the conversion factors for each species and discussion of the appropriateness of applying SLD results to MAFV and PICR waste rock should be provided so that MEM can assess this approach.

As discussed in Appendix 3-B, only one of the pre-leached kinetic test cells (HC4) has produced silicate-buffered (pH~5) drainage during the course of the kinetic test program. This kinetic test cell was constructed with high-S SLD material and represents a carbonate-depleted duplicate sample of HC2. To provide a conversion proxy for PAG material within the MAFV and PICR pit wall zones, an acid factor was introduced in which all species were multiplied with the respective acid factor calculated as:

$$L_{i\text{-}HC4}/L_{i\text{-}HC2}$$

Where L is the loading rate for a given species i.

This approach is based on the assumption that, in particular for species whose solubility is strongly dependent on pH, the increase (or decrease) of drainage concentration from the MAFV and PICR unit as these materials turn acidic, is comparable to the trends seen for the SLD unit. While a relatively high uncertainty is recognized for this approach, this acid factor was considered the most adequate geochemical proxy given the limited acidic drainage data at hand. A breakdown of the acid factors applied for the MAFV and PICR pit wall source terms is given in Table MEM 117.

Table MEM 117:

<table>
<tr><th rowspan="5">Acid Factor (HC4/HC2)</th><th>Alkalinity</th><th>SO_4</th><th>Cl</th><th>F</th><th>Br</th><th>Al</th><th>Sb</th><th>As</th><th>Ba</th><th>Be</th><th>B</th><th>Cd</th><th>Ca</th><th>Cr</th><th>Co</th><th>Cu</th><th>Fe</th><th>Pb</th><th>Li</th></tr>
<tr><td rowspan="4">0.080</td><td rowspan="4">2.7</td><td>0.94</td><td>0.94</td><td>0.94</td><td>2.6</td><td>0.94</td><td>0.19</td><td>1.5</td><td>10</td><td>0.83</td><td>11</td><td>0.57</td><td>0.94</td><td>729</td><td>303</td><td>0.65</td><td>5.5</td><td>2.5</td></tr>
<tr><th>Mg</th><th>Mn</th><th>Hg</th><th>Mo</th><th>Ni</th><th>P</th><th>K</th><th>Se</th><th>Si</th><th>Ag</th><th>Na</th><th>Sr</th><th>Tl</th><th>Sn</th><th>U</th><th>V</th><th>Zn</th></tr>
<tr><td>2.6</td><td>8.9</td><td>0.94</td><td>0.022</td><td>179</td><td>0.32</td><td>0.58</td><td>2.6</td><td>4.1</td><td>3.7</td><td>1.2</td><td>0.50</td><td>1.2</td><td>0.53</td><td>0.084</td><td>0.040</td><td>7.4</td></tr>
</table>