Subject: Final Meeting Minutes and Technical Memo

From: Cavallaro, Kathleen <email address removed>
Sent: October 23, 2013 1:42 PM
To: Marathon Mine / Mine Marathon [CEAA]
Subject: FW: Final Meeting Minutes and Technical Memo

Hello Cindy,

Please find attached the meeting minutes from NRCan's August 29, 2013 meeting with EcoMetrix. The meeting was an opportunity for experts to discuss the technical comments NRCan submitted to the panel. This meeting occurred in advance of the panel issuing its decision statement. Also, I would like to note that NRCan received the technical memo, with clarifications from EcoMetrix less than 24 hours before the meeting was to take place, as such the meeting served to exchange information. As you will see, Stillwater did not attend the meeting, and the consultant EcoMetrix presented draft information. NRCan indicated that the information, once finalized should be submitted to the panel for their consideration. Then, should the panel request it, NRCan would review the information.

Please let me know if you have questions or would like to discuss.

Regards,

Kate

Kate Cavallaro
Senior Environmental Assessment Officer
Environmental Assessment Division
Science and Policy Integration
Natural Resources Canada
<personal information removed>

Meeting with EcoMetrix to Discuss NRCan's Sufficiency Review Comments for the Marathon PGM-Cu Mine Project Joint Review Panel

Location: NRCan, Booth Street, Ottawa

Meeting Date: August 29, 2013 – 10:00am-11:15am

Attendees:
Ron Nicholson (EcoMetrix)
Kelly Sexsmith (SRK) by phone

Nand Dave (NRCan)
Kathleen Cavallaro (NRCan)
Charlene Hogan (NRCan)

Meeting Minutes:

**** It should be noted that since this meeting occurred the panel has issued a deficiency statement (Friday August 30, 2013) to Stillwater Canada Inc.**

Backgound: Summary of NRCan's Sufficiency Review: In its response (CEAR # 550 - July 31, 2013) to the panel's request for sufficiency review NRCan indicated that Stillwater had not followed recommended processes for characterizing waste rock and process solids for acid / non-acid generation classification and, as such, may have underestimated the quantity of acid generating rock and process solids that will require management at the site. Additionally, the geochemical testing the proponent has undertaken is not standard and may have contributed to underestimating the potential for acid generation and metal leaching in the waste rock and process solids. NRCan identified, to the joint review panel, that two information requests (9.4.1 and 9.8) concerned information that may change the design of the project, the predictions in the EA documentation and the management strategies for minimizing the project's potential adverse environmental effects.

Purpose of the Meeting: To provide additional clarification regarding the information related to the geochemical characterization of waste rock that Stillwater had included in its EIS, technical supporting documents, and responses to Round I Information Requests. Specifically, EcoMetrix wanted an opportunity to clarify the methods used, and provide additional information and a proposed/draft response to NRCan's sufficiency review and additional information requests # 9.4.1 and # 9.8.

Opening Remarks:
NRCan indicated that it appreciated the opportunity to discuss these items however in terms of process, the panel decides whether information is sufficient to proceed to hearings. If the panel were to decide the information is insufficient, they will also determine what must be provided in terms of additional

information (which may or may not include the additional information requests NRCan submitted to the panel).
Given the information presented (*e.g.* changes to method for classification of waste rock) has some new information and includes possible changes in the approach it should be submitted to the panel for their consideration. Then at the panel's request, NRCan could provide a formal response. As such this meeting should only be considered a meeting to exchange information and discuss technical aspects.

Discussion around NRCan Disposition of IR # 9.4.1:

1. **NP/AP (NPR) Criterion**

- EcoMetrix has agreed to recommend to Stillwater that a carbonate NPR (Carb-NP/AP) = 2 should be used for the classification of type 2 (potentially acid generating) waste rock.
- EcoMetrix indicated that, while not submitted to the panel yet, a new Sulphur block model has been completed.
- EcoMetrix indicated that, with the application of a carbonate NPR = 2 and a sulphur cut-off of 0.3%S , the estimate of type 2 waste rock is approximately 15 Million tonnes with the new Block model results, and is remains below the original estimate of 20 Million tonnes of Type 2 mine rock assessed in the EIS.

2. **Total Sulphur**

- EcoMetrix indicated that when considering the total Sulphur cut-off, lower is better. However in MEND guidance the total Sulphur should be based on whether the material is potentially acid generating (PAG) or non-potentially acid generating (non-PAG) based on the NPR value.
- NRCan – In reviewing this, NRCan looked at the practical aspect. To decide the non-PAG vs. PAG you would look at the geometric mean, which in this case would be the carbonate mean. Based on table 9.4.1-2 of CEAR 433/451, the appropriate geometric mean would be AP value of 4.3 kg $CaCO_3$/tonne and a total Sulphide content of ~ 0.14% to correspond to a carbonate NPR = 2 if only the sulphur content is considered. As such, the total sulphide value for PAG/non-PAG classification boundary should be ~0.14% Sulphur if only a sulphur criterion is considered.
- EcoMetrix responded that they are using two criteria – Sulphur and Carbon to determine Type 1/Type 2 classification, based on Sulphur and Carbon Assays during mining similar to assays that will be completed for grade control. Carbon can be analysed on the same instrument that is used for sulphur analysis and therefore is practical and manageable. This approach has been used for other mine projects. As such it is not necessary to adjust the sulphur boundary to 0.14%S. Because the Carb-NPR values will be determined and used to classify the Type 2 material, the Sulphur cut-off of 0.3%S will ensure that metal leaching will remain low in the Type 1 mine rock in the MRSA.
- Based on the site specific information (most samples had total Suphur contents of less than 0.3%), other than sulphate, the sulphur content has very little effect on the leaching rates below a Sulphur content of 1.0%. The proposed sulphur cut-off of 0.3% will limit metal leaching from the Type 1 rock in the MRSA.

- NRCan responded that if the two criteria (carbon and sulphur) are used then there should be no issue with using 0.3%S as a cut-off as long as carbonate NPR = 2 was used for Type 1/Type 2 rock classification and separation.

Figure 9.4.1-1 of CEAR 451

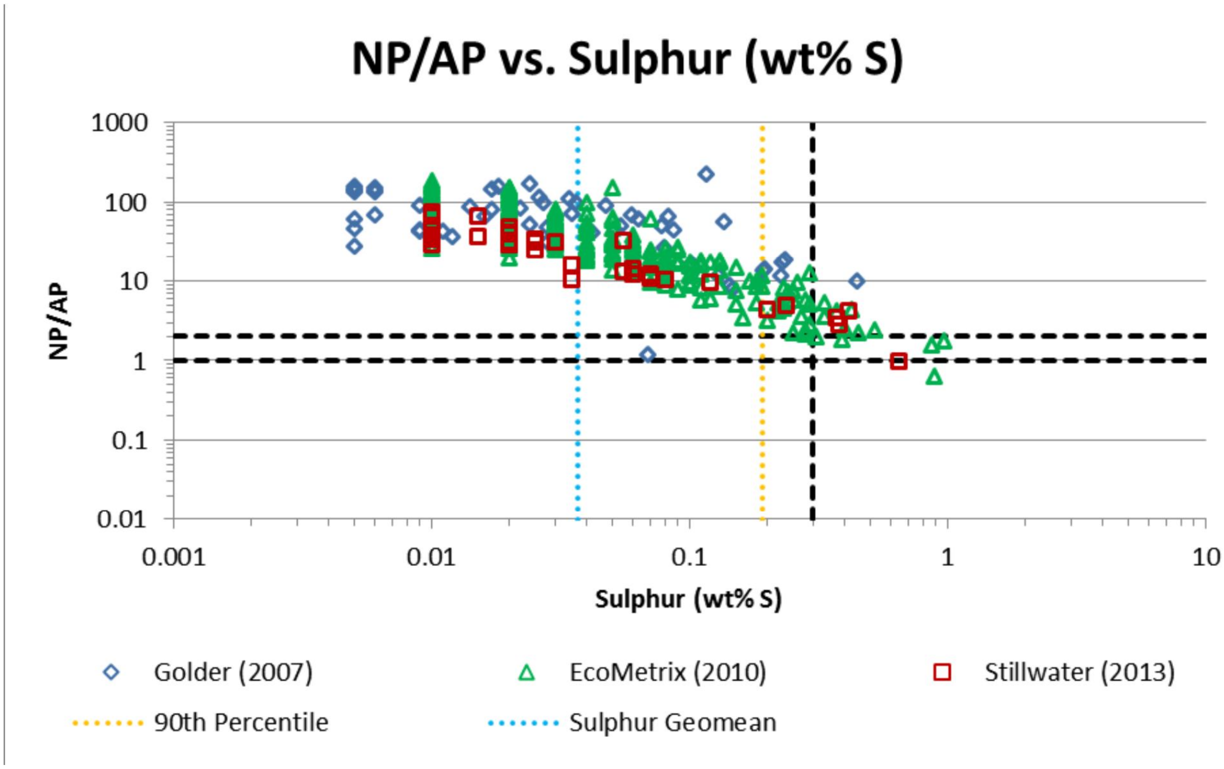
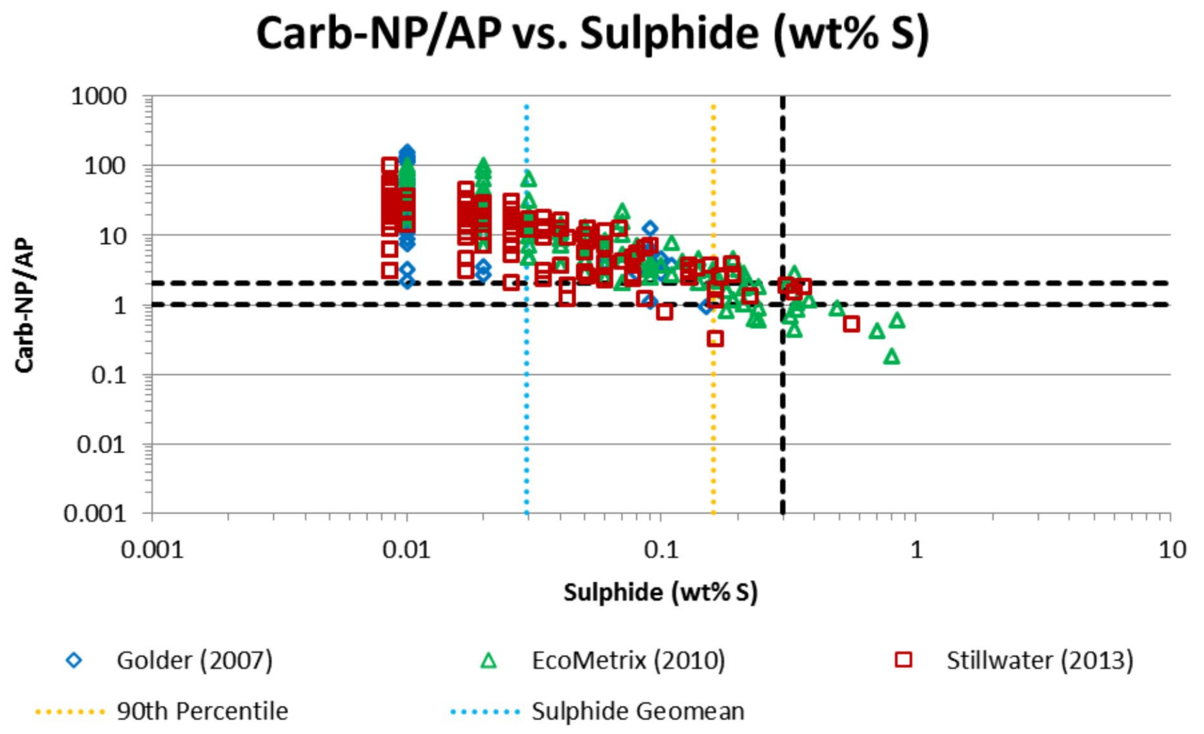


Figure 9.4.1-2 of CEAR 451 -



NRCan: The draft information provided by EcoMetrix has provided some clarification. However, NRCan reiterates that this information should be submitted to the panel. Then NRCan, at the request of the panel, could formally review the information.

Discussion around NRCan Disposition of IR # 9.8:

3. Temperature Correction Factor

- The temperature adjustment factor accounts for differences in loading rates between the lab and field conditions.
- EcoMetrix will recommend to Stillwater to use the temperature adjustment factor of 0.3 recommended by NRCan as a sensitivity calculation to obtain leaching rates and predicted drainage water quality from MRSA. A sensitivity analysis to assess the effects of the temperature adjustment factor on leaching rates and water quality would be conducted.
- NRCan appreciates the additional draft information provided and notes that new information should be included in what is submitted to the panel.

4. Calculation of Specific Surface Areas

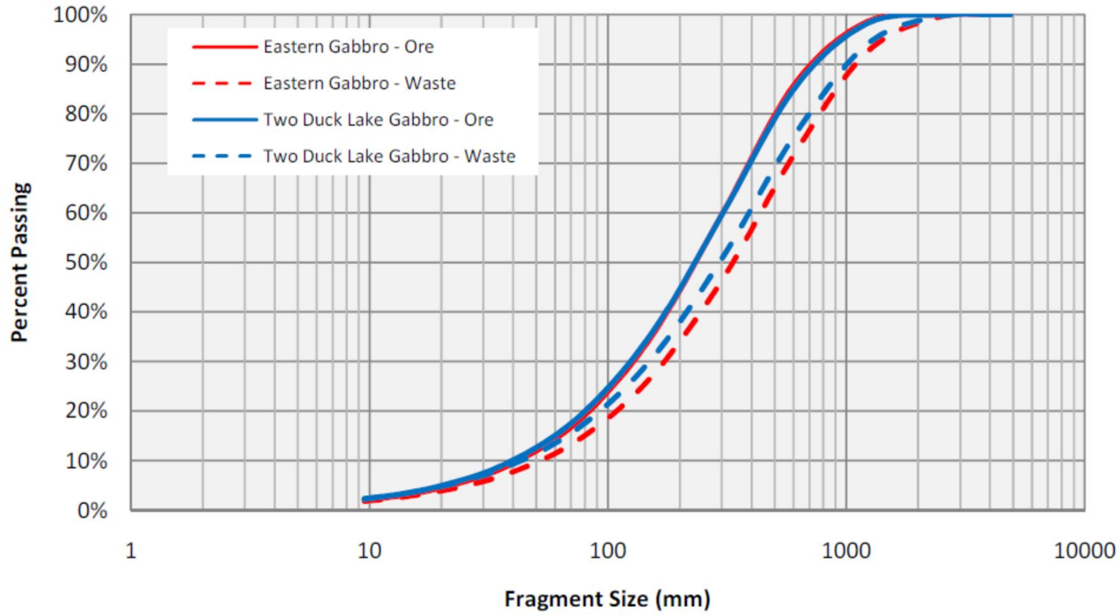
- EcoMetrix and NRCan agree that surface area plays a major role and that fine particles will represent the greater potential loadings to water from metal leaching relative to the coarser rock particles.

- NRCan explained that the disposition related to specific surface area was related to the fact that no data was provided below 4.76mm – as such NRCan postulated that the value was extrapolated. The blasting curve doesn't show the particle size distribution for material less than 4.76 mm. As such, NRCan questioned how accurate the blasting fragment estimate was. NRCan further added that to fill the gap in the data, it would be useful to look for representative field data from another mine.
- EcoMetrix responded that if the rock in question was highly metamorphosed or sedimentary in nature the blasting fragment estimate wouldn't be representative. However in the case of Marathon, most of the rock consists of very hard gabbros, which will not break up or degrade easily. These rocks are very stable in the long term as shown by the rock piles of similar rock type in the Sudbury area.
- SRK representative also mentioned that the fact that this is an open pit mine makes a difference because the blasting results in large fragments whereas an underground mine would have a higher volume of finer grained material.
- EcoMetrix explained that the current mine plan is to minimize the fine grained mine rock, by blasting in such a way that will conserve the maximum size of boulders. EcoMetrix went back to the excel spreadsheet and showed how the fine material (less than 4.76 mm) in the blast rock affects the particle size distribution if we assume that the fines are represented by the same size material that is in the humidity cells. The surface area ratio of the blast rock to that of the humidity cell samples is 0.01 (or 1%) that was used for a particle size adjustment factor in the EIS. It was also shown that the ratios of the surface areas between the blast rock and the humidity cell samples were not sensitive to 1 micron (0.001 mm) size fraction – the ratios stay the same at 1%.
- NRCan indicated that all material less than 4.76 mm should be included for particle size correction factor for the actual waste rock similar to the test material used for humidity cell test. Further NRCan indicated that since there is no data, that EcoMetrix should look to get more realistic data from another mine if possible. NRCan explained that they had looked at the information for a mine in northern Saskatchewan and that particles of less than 10mm = 15%. NRCan explained that getting another source of data would provide better confidence in the blasting fragment curve.
- EcoMetrix explained that the modeled blast rock particle size distribution is the best data available at this time. It is not appropriate to use particle size distributions from other mines with different rock types and data from mines with similar rock types were not available. There are not a lot of data of high to low grain size for blast rock but that this was something they are recommending to Stillwater to collect once they commence mine development. Confirming grain size particle distribution/ grain size analysis of the blast rock at the site will be helpful in confirming the predictions related to water quality. These data can be collected at the start of mining as the pit development begins. Therefore the information can be available early in the operation and adjustments to blasting can be made if required.
- NRCan indicated that this would be a good idea and could also provide information that could inform future EAs. NRCan further noted that EcoMetrix should explain the uncertainties, limitations, and implications of the current information (e.g. blasting fragment estimates) and

then explain what mitigation and monitoring will be put in place to confirm the predictions, including options for adaptive management.

- EcoMetrix explained that if the adjustment for loading rates is off by a factor of 2 to 3, then the concentrations of COPCs in water draining from the rock would change by a factor of 2 to 3.
- EcoMetrix explained that what they have done to account for NRCan's comment is to fill in the gap (i.e. the finer particle sizes) with the information from the humidity cell test results. This would account for 1.1% of the blast rock material.
- NRCan agreed that often the fine material is not measured, but for water quality predictions this information is important. Further, NRCan reiterated that at this point it is difficult to tell how accurate the modelling blasting curve is (see Figure 9.8-2 below). If the curve is not 1%, but closer to 10% it would change results from a water quality perspective.
- EcoMetrix agreed on the need to conduct a sensitivity analysis on the grain size distribution for the blasting curve. EcoMetrix will also explain the implications of the uncertainties with respect to particle size distribution. They also agreed to recommend that a fragmentation or particle size analysis be conducted on the blasted rock when mine development starts. The data on particle size for the blast rock from the mine will then be used to confirm the predicted values and, if required, will be used to adjust the water quality estimates. Blasting parameters can then be adjusted if required. In addition, the early excavated mine rock will be used in field scale test cells to assess metal leaching and water quality for field conditions. These tests will remove the uncertainties related to adjustments from the lab (humidity cell tests) to field conditions.
- NRCan mentioned that including the timing of when this would occur (early in mine development) would be an important consideration as it would be used to confirm water quality predictions.
- NRCan appreciates that additional clarification provided.

Figure 9.8-2: Modelled Particle size Distribution for the Two Main Mine Rock Types – Noted as “Waste” in the Plots (from DynoConsult, 2012)



MEMO

To:	Kate Cavallaro Nand Davé	From:	Ron Nicholson
Ref:	**Discussion regarding the NRCan Comments Submitted to the Panel in July 2013 Regarding the Marathon PGM EIS**	Date:	28 August 2013

NRCan submitted comments to the Joint Review Panel (JRP) in July 2013 on the sufficiency of Stillwater Inc. responses to panel information requests, including the response to Information Requests (IR) 9.4.1 related to Type 2 rock criteria and IR 9.8 related to adjustment factors for loadings to scale rates from humidity cells to the field scale. The following information will be used to provide information and facilitate discussions with NRCan in order to provide clarification on the responses that were previously provided to the JRP, which formed the basis of NRCan's July 2013 submission. NRCan comments related to the response to IR 9.41 submitted to the Panel at the end of July 2013:

1. **NRCan requests that the PAG and non-PAG materials classification boundary be selected based on carbonate NP and set at NPRcarb of 2 or higher to account for weathering related carbonate minerals dissolution and loss irrespective of the acid generation process.**
2. **Based on the geometric mean, NRCan, therefore, requests that SCI should reconsider the total sulphide cut off boundary of ~ 0.1% S for PAG (Type 2) and non-PAG (Type 1) classification of mine rock.**

Discussion (related to IR 9.4.1)

As presented in the response to IR 9.4.1, all samples, with the exception of one outlier, that had total sulphur contents less than 0.3%S also had NP/AP (or NPR based on the modified Sobek method) ratios greater than 2. And the use of 0.3%S provided a measure that would ensure that the Type 1 rock would have an NPR greater than 2. NRCan suggested to the JRP that a more conservative approach would be to have the criteria based on the Carb-NPR of 2 to account for some loss of dissolved carbonate during neutralization. I am prepared to recommend this to SCI and to use a Carb-NPR of 2 to distinguish Type 1, (non-potentially acid generating) from Type 2 rock. This is consistent with guidance by MEND (Price, 2009). The use of the Carb-NP/AP ratio means that we need a measure of the Carb-NP and sulphur content in order to calculate the Carb-NP/AP ratio rather than just a measure of sulphur alone. As discussed below, this is practically achievable and can be managed during the mining operation.

The cut-off of 0.3%S for Type 1 rock that was previously proposed is therefore not related to potential acid generation which will be addressed with the Carb-NPR, as noted above. The sulphur content is, however, relevant to manage the risk of metal leaching. Other than sulphate, the sulphur content has little to no effect on leaching rates below a sulphur content of 1%S. Therefore the use of 0.3%S to minimize metal leaching in Type 1 rock is considered to be conservative and reasonable.

It is also relevant that the sulphide-sulphur content is approximately 86% of the total-sulphur content. A total sulphur cut-off of 0.3%, therefore, represents a sulphide content of 0.26%S. Therefore there is a level of conservatism already inherent in the proposed total sulphur cut-off value.

The proposed approach for the identification of Type 2 rock will be to measure the sulphur and carbon contents on the blast-hole samples that will be used for assays and grade control during mining. The carbon content can be measured on the same induction furnace equipment (eg. Leco) that is used to measure sulphur, and therefore can be completed in a timely manner during the mining operation. The data show that all carbon in the rock represents carbonate. Therefore a carbon/sulphur ratio will determine the Carb-NP/AP ratio so that rock will be classified as Type 2 if the Carb-NP/AP ratio is less than 2. The sulphur content of 0.3%S will also be considered as a threshold value for Type 1 rock to ensure that the Type 1 rock will have minimal metal leaching at neutral pH.

The data suggest that if the Carb-NP/AP criterion of 2 is used (and a sulphur content greater than 0.3%S is considered for metal leaching), the total amount of Type 2 rock will be on the order of 15 Mt. This is well within the amount of 20 Mt that was conservatively assumed for the EIS and can be appropriately managed in the manner described in the EIS.

<u>NRCan comments related to the response to IR 9.8 submitted to the Panel at the end of July 2013:</u>

1. **NRCan requests that the proponent provide the methodology used for obtaining the specific and total surface areas for various particle size fractions of the humidity cell test samples given in Table 9.8-1 and for the modeled waste rock particle size distribution given in Table 9.8-2.**
2. **NRCan requests that the proponent provide an explanation for the reported differences between the respective values of specific and total surface areas given as 1,179,260 m^2/tonne and 15,3330 m^2 in Table 9.8-1 and the corresponding 31,059 m^2/tonne and 331 m^2 in Table 9.8-2 for the very fine, silt and clay size fractions of diameter 0.001 mm.**
3. **As such, NRCan requests that the proponent remove the additional correction factor of 0.01 pertaining to the very fine particle size fractions applied to obtain the field COPCs mass loading of waste rock in the MRSA. This would increase the calculated waste rock COPCs load by a factor of 100.**
4. **NRCan requests that for a conservative estimate, the calculated waste rock COPCs loads should further be multiplied by an additional factor of ~2 to account for the difference in the temperature correction factor of 0.17 in EcoMetrix (2010) and the MEND (2006) recommended value of 0.31 as per the proponent's response in the column to the left. The temperature correction factor of 2 should also be applied to type 1 and 2 process solids drainage water quality predictions and the resulting COPCs load to the environment.**

Discussion (related to IR 9.8 and SIR 4)

The specific surface area (A_s) is calculated as;

$$A_s = 6/(\text{density x diameter}) \qquad \text{(Eq 1)}$$

taken from Nicholson (1994) in which "density" is the particle density (2800 kg/m^3) and "diameter" is the particle diameter. The measured particle diameter distributions for the humidity cell samples are presented in Table 9.8-2 below. The particle size distribution for the blast rock is presented in Table 9.8-3 below. The original modelled grain size distribution presented in the response to IR 9.8 has been supplemented by adding the humidity cell grain size distribution for the less than 4.76 mm size fraction and that distribution is shown as highlighted values in Table 9.8-3. The calculated geometric mean of the particle diameters for each grain size interval is also shown in the tables.

The apparent discrepancies in the surface areas are related to the selection of the midpoint of the particle diameter in any grain size interval. The values in Tables 9.8-2 and 9.8-3 have now been revise to be consistent. The differences in values in the table in the response to IR 9.8 do not alter any conclusions related to surface area effects for the particle size distributions in humidity cell samples and blast rock material.

NRCan comment 3 relates to the adjustment factor that was applied to account for the differences in particle sizes between the rock in the humidity cell tests and the rock that will be present in the stockpile. NRCan suggested that the unit mass loading (or leaching) rate in the humidity cell should be applied directly to the rock in the stockpile because both contain a similar fraction of particles that are 0.001 mm in diameter.

NRCan presented mathematical equations to illustrate the relationship between the loading rates for the humidity cells to those in the mine rock stockpile. This is illustrated with the use of fractions f1, the fraction of 0.001 mm size material in the humidity cell samples, and f2, the fraction of 0.001 mm size material in the blast rock that will represent the mine rock stockpile. The value of f1 is 1% as measured in the grain size analysis. NRCan assigned a value of 1% to f2 however this is not the appropriate value. The 1.1% in the blast rock represents the fraction of material that has a grain diameter less than 4.5 mm, similar to that in the HC sample. Therefore the value of f2 should be close to 1% of f1 or about .01%. Using this correct value for f2 gives an adjustment factor of 0.01 for the humidity cell loading rate to derive the mine rock stockpile loading rate.

The leaching rates that are measured in humidity cell tests are surface controlled as is the case with reactions with solids and water. Although the rates are expressed as mass of COPC released per unit time per mass of sample tested (mg/kg/wk), a more appropriate measure is a rate per unit surface area of the rock expressed as mass of COPC released per unit time per surface area of rock ($mg/m^2/wk$). This was shown in Tables 4.3 and 4.7 in EcoMetrix (2010) to summarize loading rates that can be applied to rock with known surface areas. The leaching rates are proportional to the surface area of the rock and as shown in the response to IR 9.8, the surface area increases with decreasing particle size.

As indicated by the particle size distributions in IR 9.8 and reproduced below (Table 9.8-2), the humidity cell test samples contained material that was likely less than 0.001 mm in diameter as measured by the Hydrometer analysis (see lab analysis sheet attached to IR 9.8). These fine particles would have been produced during crushing of the drill core samples to produce the material used in the humidity cell test. A geometric mean of the particle diameter of 0.0014 mm was used to be conservative even though the Hydrometer test indicated that the particles were less than 0.001 mm. If a particle diameter of 0.001 mm had been used, the total surface area of the humidity cell samples would increase from 24,469 m^2 to 36,995 m^2 (an increase of 51%).

The particle size distribution for the blast fragments provided in the response to IR 9.8 and presented below (Table 9.8-3) indicates that roughly 1% (more precisely, 1.065%) of the material would pass a 4.76 mm sieve. The results of the particle size distribution for the HC sample for grain sizes less than 4.5 mm (that is similar to 4.76 mm for the smallest blast rock shown in Table 9.8-2) was used to fill in the distribution between 4.76 and 0.001 mm with the same surface area calculation that is highlighted in Table 9.8-3. The 1.065% of material smaller than 4.5 mm was distributed with the same percentage distribution and is shown as highlighted text in Table 9.8-3 below, that was modified from the response to IR 9.8 to clarify the calculations. For example, the humidity cell samples had an average of 27.0 % of the mass in the 4.5 to 2.0 mm size interval (Table 9.8-2). Therefore, the percent of blast rock with this particle size should be approximately 27% x 0.01065 or 0.32%.

The specific area calculation gives a value of 320 m^2/t for the blast rock (Table 9.8-3) compared to a specific area for the humidity cell samples of 24,469 m^2/t (Table 9.8-2). The blast rock has a calculated surface area that is 1.3% of the humidity cell sample. Therefore, the ratios of the surface areas agree well with the estimate based on mass that indicates that the mine rock in the stockpile will have only about 1% of material as fine as the humidity cell material and therefore the loading rates for the rock in the stockpile will be about 1% of those measured in the humidity cell based on the particle size distributions.

the relative surface areas or ratios between the surface areas for the humidity cell samples and the blast rock material are not sensitive to the presence of material with particle diameters less than 0.001 mm. If the 0.001 mm fraction is removed from both the humidity cell and blast rock materials, the overall surface areas of each material deceases but the ratio of the blast rock to humidity cell surface areas remains at 1%.

When the surface area per tonne is known, the leaching rate from the humidity cell results can be used to calculate the unit leaching rate for the stockpile. Because the unit rate based on surface area is used, the stockpile will have a unit rate that is 1% of the humidity cell rate in agreement with the ratio of the specific surface areas for the respective materials that were applied in EcoMetrix (2010).

NRCan comment 4 suggests an alternate adjustment factor to leaching rates for temperature difference between the lab and the field based on MEND (2006). I will recommend to SCI that we apply NRCan's recommended adjustment factor for temperature and provide a sensitivity calculation to assess the effects on leaching rates and water quality associated with the East mine rock stockpile. The sensitivity calculations will be completed with those for the particle size adjustment factor prior to the Panel hearings.

References

MEND (Mine Environment Neutral Drainage) 2006. Update on Cold Temperature Effects on Geochemical Weathering. MEND Report 1.61.6.

MEND (Mine Environment Neutral Drainage) 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials by Price W.A., MEND Report 1.20.1.

Nicholson, R.V. 1994. Iron-Sulphide Oxidation Mechanisms: Laboratory Studies. In J.L. Jambour and D.W. Blowes (Eds.) Short Course Handbook on Environmental Geochemistry of Sulphide Mine Waste, Miner. Assoc. Canada, Vol. 22, p. 163-183.

Reference: Discussion regarding the NRCan Comments Submitted to the Panel in July 2013 Regarding the Marathon PGM EIS– DRAFT FOR DISCUSSION

TABLE 9.8-2: Grain Size Distribution and Calculated Surface Area of Rock Samples in Humidity Cells (revised for memo to NRCan 03 Sept 2013).

Diameter (mm)	Mar07-15 % in Interval	Mar07-96 % in Interval	Average % in Interval	Mass Rock in HC (kg)	Geometric Mean Particle Diameter for Interval (mm)	Average Specific Surface Area (m^2/kg)	Average Specific Surface Area (m^2/t)	Total Surface Area in one Tonne (m^2)
9.500	0.000	0.000	0.0	0.00	-	0.2	226	0.00
4.500	9.670	11.670	10.7	0.11	6.54	0.3	328	35
2.000	29.030	25.000	27.0	0.27	3.00	0.7	714	193
0.850	18.220	13.330	15.8	0.16	1.30	1.6	1643	259
0.425	8.280	6.670	7.5	0.07	0.60	3.6	3565	267
0.250	8.280	6.670	7.5	0.07	0.33	6.6	6574	491
0.150	6.630	8.330	7.5	0.07	0.19	11	11066	828
0.075	4.970	5.000	5.0	0.05	0.11	20	20203	1007
0.053	13.630	22.020	17.8	0.18	0.06	34	33988	6058
0.037	0.000	0.000	0.0	0.00	0.04	48	48390	0
0.026	0.000	0.000	0.0	0.00	0.03	69	69088	0
0.019	0.000	0.000	0.0	0.00	0.022	96	96412	0
0.014	0.000	0.000	0.0	0.00	0.016	131	131387	0
0.010	0.000	0.000	0.0	0.00	0.012	181	181104	0
0.007	0.000	0.000	0.0	0.00	0.008	256	256120	0
0.005	0.000	0.000	0.0	0.00	0.0059	362	362209	0
0.003	0.000	0.000	0.0	0.00	0.0039	553	553283	0
0.002	0.000	0.000	0.0	0.00	0.0024	875	874818	0
0.001	1.300	1.300	1.3	0.013	0.0014	1179	1179260	15330
Totals			**100.0**	**1.0**				**24469**

Reference: Discussion regarding the NRCan Comments Submitted to the Panel in July 2013 Regarding the Marathon PGM EIS– DRAFT FOR DISCUSSION

TABLE 9.8-3: Modelled Grain Size Distribution and Calculated Surface Area of Blast Rock During Mining (modified for memo to NRCan 03 Sept 2013).

Diameter (mm)	Eastern Gabbro		Two Duck Lake Gabbro		Average	Geometric Mean Particle Diameter for Interval	Mass of Rock per Tonne	Average Specific Surface	Average Specific Surface	Total Surface Area in one Tonne
	Percent passing	Percent in Interval	Percent passing	Percent in Interval	Percent in Interval	(mm)	(kg)	Area (m^2/kg)	Area (m^2/t)	(m^2)
4876.800	100.000	0.000	100.000	0.000	0.0	-				
2438.400	99.450	0.550	99.610	0.390	0.5	3448.4	4.70	0.001	0.6	0.003
1219.200	92.410	7.040	93.980	5.630	6.3	1724.2	63.35	0.001	1.2	0.08
914.400	85.440	6.970	87.960	6.020	6.5	1055.9	64.95	0.002	2.0	0.1
609.600	72.130	13.310	75.860	12.100	12.7	746.6	127.05	0.003	2.9	0.4
304.800	46.900	25.230	51.270	24.590	24.9	431.1	249.10	0.005	5.0	1.2
152.400	26.900	20.000	30.480	20.790	20.4	215.5	203.95	0.010	9.9	2.0
76.200	14.390	12.510	16.800	13.680	13.1	107.8	130.95	0.020	20	2.6
38.100	7.410	6.980	8.880	7.920	7.5	53.9	74.50	0.040	40	3.0
19.050	3.740	3.670	4.600	4.280	4.0	26.9	39.75	0.080	80	3.2
9.525	1.870	1.870	2.350	2.250	2.1	13.5	20.60	0.16	159	3.3
4.760	0.930	0.940	1.200	1.150	1.0	6.7	10.45	0.32	318	3.3
2.000					0.32	3.1	3.22	0.69	695	2.2
0.850					0.19	1.3	1.88	1.6	1643	3.1
0.425					0.09	0.60	0.89	3.6	3565	3.2
0.250					0.09	0.33	0.89	6.6	6574	5.9
0.150					0.09	0.19	0.89	11	11066	9.9
0.075					0.06	0.11	0.59	20	20203	12.0
0.053					0.21	0.063	2.13	34	33988	72.2
0.037					0.000	0.044	0.00	48	48390	0.0
0.026					0.000	0.031	0.00	69	69088	0.0
0.019					0.000	0.022	0.00	96	96412	0.0
0.014					0.000	0.016	0.00	131	131387	0.0
0.010					0.000	0.012	0.00	181	181104	0.0
0.007					0.000	0.0084	0.00	256	256120	0.0
0.005					0.000	0.0059	0.00	362	362209	0.0
0.003					0.000	0.0039	0.00	553	553283	0.0
0.002					0.000	0.0024	0.00	875	874818	0.0
0.001	0.000	0.930	0.000	1.200	0.015	0.0014	0.15	1179	1179260	182.8
Totals					**100.0**		**1000.0**			**310**