Appendix E8

Open Pit – Loss and Dilution

Memo

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Re: KSM - 2012 PFS Loss and dilution calculations

1. Introduction

The KSM project is a large open pit copper-gold porphyry deposit. The ore-body is continuous within the cut-off grade shell. The pits will be mined with large shovels and trucks at an ore mining rate of 120,000 tonnes/day feeding the mill. Typical of large porphyries the large equipment and high mining rates, selective mining methods will not be possible. Blasthole sampling will be used to determine the waste/ore boundaries and the digging limits for the shovels. Blasting will create dilution along waste/ore boundaries and as the material is being loaded to the trucks some ore will be lost to the waste (mining loss) and some waste will be added to the ore (dilution). In some seasons, material will stick or freeze to the inside of the truck boxes and create carry-back. The truck boxes must be cleaned out regularly and if they are hauling in ore, this haul-back material will be wasted (mining loss). Also in some cases a load of ore may be misdirected to the waste dump (mining loss). In order to properly calculate the reserve files for scheduling purposes, mining losses and dilution must be taken into account.

2. 3D Block model and whole block dilution

The 3D block model (3DBM) for KSM was built by RMI with 25mx25mx15m block sizes and called “ksmp15.dat”. MMTS has added some calculated items to the 3DBM. Each block has a calculated recovered grade based on the interpolated grades from RMI and the specified recovery formulae. An NSR value is then calculated from the recovered grades and includes Net Smelter Prices for each metal from the Smelter schedule. The resultant NSR value therefore represents the net $/tonne value of the block after all offsite costs have been taken into consideration, smelter charges and on-site plant recovery. The NSR calculation and smelter terms can be found in the Design Basis Memorandum. The NSR value is used as a cut-off item for breakeven ore/waste selection. Each block in the model has a volume of 9,375 m^3 and weighs approximately 26,000 tonnes. The plant feed will require around 4 ½ blocks per day which is an appropriate selective mining unit for this size of shovel. The interpolation of the metal grades to the 3DBM, averages the composites to a single value for each metal. This smoothing is in effect a numeric dilution where higher composite values are averaged down but conversely lower values are averaged up. Because of the continuous/smooth nature of the mineralization, it is assumed this smoothing down and up averages out around the cutoff grade.

During operations, Ore Control System (OCS) from blasthole sampling will be done on a 8.5m spacing to determine cutoff boundaries for shovel dig limits. These smaller ore/waste blocks will be too small to separate with the large shovels, especially after the material has been displaced by blasting. Therefore the dilution from isolated blasthole blocks will be handled as whole block dilution in the 3DBM. The OCS will define smaller ore/waste zones but these will be smoothed into larger units which the shovels can selectively mine to. These larger units from the OCS are better represented by the 3DBM size blocks and will define contacts between ore and waste. These contact boundaries are approximated by the 3DBM as the smallest sized units the shovels can selectively mine. The 3DBM blocks can therefore be used to define how much contact dilution needs to be accounted for.

3. Contact Loss and dilution

The mining reserves used for scheduling are calculated from grades in the 3D block model using detailed pit designs and the appropriate mining recoveries and dilutions applied. The recoveries and dilutions convert the in-situ ore tonnages into a ROM delivered tonnage to the mill. The ROM delivered tonnes is what the mill will actually "see" and therefore they are used to determine the appropriate production schedule.

There are three main parts to recovery and dilution (as listed above). They are:

a) Dilution of waste into ore where separate ore and waste blasts are not possible
b) Loss of ore into waste where separate ore and waste blasts are not possible
c) General mining losses due to handling (haul back in truck boxes, stockpile floor losses, etc)

Mining Dilution

The Minesight routine "gndiln.dat" (GNDLN) is run to calculate the number of waste blocks which surround an ore block on each bench (blocks on the benches above and below are not considered). Whole block dilution covers most of the effects of the material above and below and this evaluation considers the effects of recovery and dilution as the shovel extracts ore advancing across the bench face. On a particular bench, each block in the 3D block model is surrounded by 8 other blocks but only 4 of these blocks can be considered as "contact" blocks. Therefore the maximum number of waste contact blocks for an ore block on a bench can be 4. When the Minesight procedure is run, it calculates the number of waste contact blocks and stores the value into XTR04 item.

At the pre-feasibility stage, only measured and indicated blocks can be classified as ore blocks. An NSR cut-off is also used to classify ore blocks and these cut-offs for the different pits are as follows:

- Mitchell $9.57
- Sulphurets $10.17
- Kerr $9.61

A visual illustration of the concept is shown below. The numerical definition following ORE represents the amount of waste contact blocks:

Waste	Waste	Waste	Waste	Waste
Waste	Waste	Waste	Waste	Waste
ORE1	ORE1	ORE1	ORE1	ORE1
ORE	ORE	ORE	ORE	ORE

Figure 1 - Separate ore and waste blasts

In this case, with a maximum of 1 waste block contact for each ORE1 block contact, the ore and waste can be separated quite easily with very little dilution from neighbouring blocks.

Waste	Waste	Waste	Waste	Waste
Waste	ORE2	ORE1	ORE2	Waste
Waste	ORE2	ORE1	ORE2	Waste
Waste	Waste	Waste	Waste	Waste

Figure 2 - Ore blocks with 1 or 2 waste contact edges

In this case some dilution will happen for the ORE2 blocks (blocks that have 2 waste contacts).

Waste	Waste	Waste
Waste	ORE4	Waste
Waste	Waste	Waste

Figure 3 - Ore block surrounded by waste

This is an example of a singular ore block with 4 waste contacts. Dilution will be high in this case.

Waste	Waste	Waste	Waste	Waste
Waste	ORE3	ORE2	ORE3	Waste
Waste	Waste	Waste	Waste	Waste

Figure 4 - Ore blocks with 2 or 3 waste contacts

Another example where dilution will be higher because of more waste contact blocks per ore block.

A sample bench plan for Mitchell pit is shown below that displays the ore blocks above cutoff grade and the number of waste contact blocks per ore block. The ultimate pit outline is shown with the green line. It can be seen that the orebody in Mitchell is quite continuous and that most of the ore blocks have only 1 or 2 waste contacts.

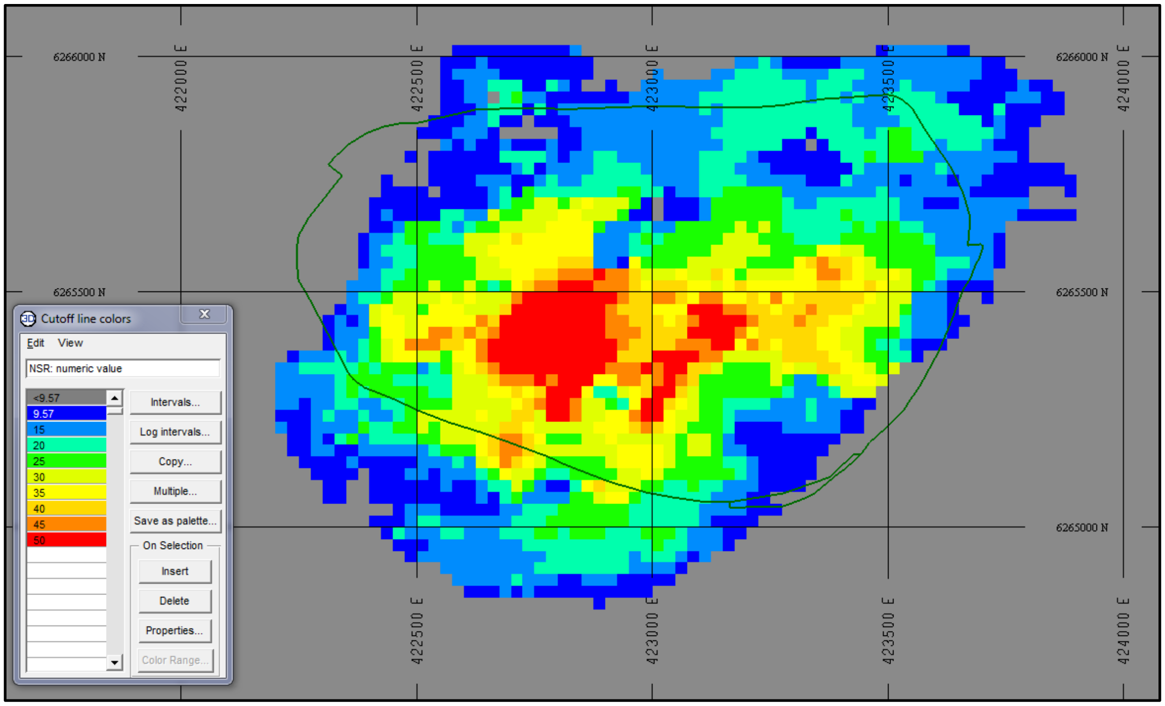

Figure 5 - Mitchell 690 bench with ore blocks greater than cutoff grade

A sample bench plan from Sulphurets is shown below:

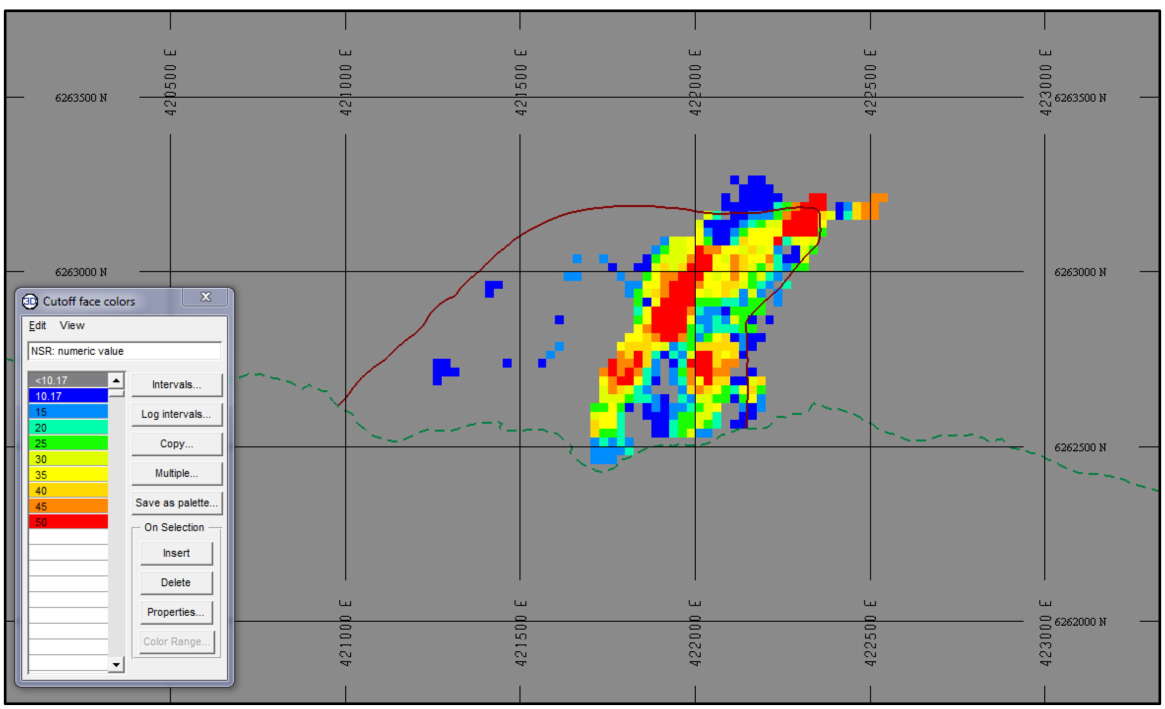

Figure 6 - Sulphurets 1245 bench with ore blocks greater than cutoff grade

A sample bench plan from Kerr is shown below.

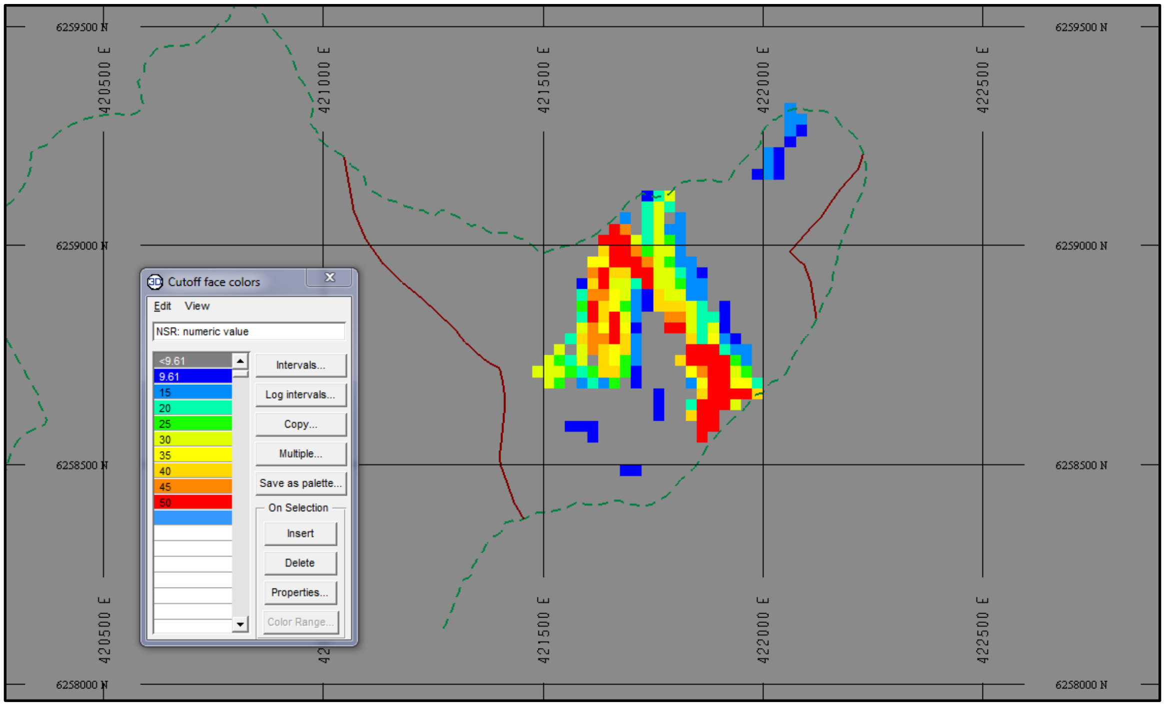

Figure 7 - Kerr 1575 bench with ore blocks greater than cutoff grade

It is assumed that ore blocks with only 1 waste contact have a minimum mining dilution and almost 100% mining recovery because they can be mined in separate blasts. Ore blocks with 2, 3 or 4 waste contacts will incur dilution and a lower mining recovery because they are less likely to be blasted or mined separately from the surrounding waste blocks.

In order to quantify the amount of dilution for the blocks that have 2, 3 or 4 waste contacts, the following description is used:

The 80 tonne class dippers on the proposed shovels attempt to separate the ore and waste after a blast (when there is a mixed blast). The selectivity along the contact is influenced by over digging and under digging by the operator and also by mixing from the blast throw. The bucket size is approximately 30m^3, with an approximate lip width of 6m. Therefore the bucket size is about 2.5m deep x 2m high. Assuming that the operator digs along the edge of a contact block with a +/- 2 dipper depths (including the mixing effect) into the contact face, and half the time this is dilution and half the time its mining loss, the amount of diluted material along each edge of a block is as follows:

$$\left(\frac{2X2.5m}{2} \times 25m \times 15m \times 2.77\right) = 937.5 \text{ BCM} \times 2.77 = 2{,}597 \text{ tonnes}$$

Each block has an approximate 26,000 tonnes. For blocks with 2, 3 or 4 waste contact edges the following dilution applies:

- 2 edge blocks = 2 x 2,597 tonnes = 5,194 tonnes (20% of total block)
- 3 edge blocks = 3 x 2,597 tonnes = 7,791 tonnes (30% of total block)
- 4 edge blocks = 4 x 2,597 tonnes = 10,388 tonnes (40% of total block)

After the GNDLN is run on the LG shells generated for each area using the appropriate waste/ore cut-off grade, a pitres report is run that separates the ore blocks by number of waste contact edges and calculates the total tonnage. A summary for each pit is shown below:

Table 1 Mitchell pit dilution (mdil.rpt)

M685		Block	Diluted Tonnes
	ROM kT	Dilution	Added (kT)
1 edge	61,389	0%	0
2 edges	34,035	20%	6,807
3 edges	3,951	30%	1,185
4 edges	430	40%	172
Total (kT)	**99,805**		**8,164**
% of orebody with contact edges	**(10.1%)**		**Dilution %**
Mitchell total reserves (kT)	**991,337**		**0.82%**

Table 2 Sulphurets pit dilution (sdil.rpt)

Sulphurets (PIT13)		Block	Diluted Tonnes
	ROM kT	Dilution	Added (kT)
1 edge	63,372	0%	0
2 edges	46,706	20%	9,341
3 edges	6,942	30%	2,083
4 edges	1,332	40%	533
Total (kT)	**118,352**		**11,957**
% of orebody with contact edges	**(38.5%)**		**Dilution %**
Sulphurets total reserves (kT)	**307,552**		**3.89%**

Table 3 Kerr pit dilution (kdil.rpt)

Kerr (PIT13)		Block	Diluted Tonnes
	ROM kT	Dilution	Added (kT)
1 edge	55,702	0%	0
2 edges	31,815	20%	6,363
3 edges	3,992	30%	1,198
4 edges	268	40%	107
Total (kT)	**91,777**		**7,668**
% of orebody with contact edges	**(37.6%)**		**Dilution %**
Kerr total reserves (kT)	**242,782**		**3.16%**

It can be seen that a much higher percentage of the ore in the Sulphurets and Kerr areas have waste contact edges than in Mitchell (approximately 37%-39% compared to approximately 10%).

Dilution grades are estimated by determining the grades of the envelope of waste contacts with the ore blocks. For the KSM project the waste blocks with NSR greater than $5/tonne and less than the cut-off grade where chosen. Inside each pit limit a reserve report is run separating out the waste blocks that satisfy the criteria and the average grades are reported. Shown below is a table summarizing the results.

Table 4 Dilution grades by pit

	5<NSR<9.57	5<NSR<10.17	5<NSR<9.61
	Mitchell	**Sulphurets**	**Kerr**
NSR ($/t)	7.55	8.19	7.60
CUIDW (%)	0.043	0.056	0.106
AUIDW (g/t)	0.229	0.333	0.141
RCU (%)	0.021	0.028	0.069
RAU (g/t)	0.136	0.160	0.077
AGIDW g/t)	1.45	0.59	0.78
MOIDW ppm)	59.4	19.0	0
RAG (g/t)	0.67	0.18	0.24
RMO (ppm)	20.6	3.3	0

Mining Loss

Mining losses must also be taken into consideration. As mentioned above, these can include carry-back material and misdirected loads.

Assuming for 4 months of the year, an estimated 10% of the truck boxes will have a build up of frozen ore. This material will have to be cleaned out regularly (say each day) using a backhoe. It is assumed the cleaned out, frozen ore will not be able to be salvaged as it will be a small amount and it will likely be highly diluted if it is set down on the ground and picked back up again. Therefore this ore will be counted as a mining loss for the purpose of reserve reporting. An estimation of the percentage is shown in the calculation below:

$$\frac{120 \text{ days} * 40 \text{ trucks} * 10\% * 345 \text{ tonnes}}{43,200,000 \text{ tonnes/yr}} = 0.38\%$$

The lack of visual distinction between the waste and ore will result in misdirected loads as happens in all mines. The frequency of misdirected loads will be reduced by utilizing a fleet management system combined with GPS based or field staked ore/waste dig limits from the Ore control system. Nevertheless, misdirected loads will still happen. An allowance of 1% of misdirected ore loads to the RSF dumps is included.

The last type of mining loss is contact block loss and is similar to dilution in the shovel loading face. Just as waste is included in the ore and counted as dilution, some ore will be lost along the edges to the surrounding waste blocks. The same methodology used for the dilution calculations can be applied for the mining loss calculations; therefore this type of mining loss is equal to the dilution.

Total mining loss = Carry-back loss + misdirected loads + contact block loss (same as dilution)

A table showing the summary of loss and dilution for each area is shown below:

Table 5 Total Summary of Loss and Dilution by pit area

Pit	Handling Loss	Contact block Loss	Total Loss	Dilution
Mitchell	1.38%	0.82%	**2.2%**	**0.8%**
Sulphurets	1.38%	3.89%	**5.3%**	**3.9%**
Kerr	1.38%	3.16%	**4.5%**	**3.2%**