November 30, 1994

Mr John Drury, Chairman
CIM Ad Hoc Reserve Definitions Committee
c/o Ontario Securities Commission
Suite 800, 20 Queen Street West
Toronto, Ontario M5H 3S8

Subject : **CIM Recommendations on Reserve Definitions**

Dear Sir:

H G Wells, too, would be disappointed with your Committee's lack of confidence in probability and statistics. Under *Confidence Limits*, perhaps ironically, your Committee submits that resources or reserves cannot be reported with quantified confidence limits. Does your Committee believe that Gallup can report unbiased precision estimates for public opinion polls but that the mining industry cannot do it for resources and reserves?

ISO/Technical Committee 183 – Copper, Lead and Zinc Concentrates, details how to obtain unbiased variance estimates for mass, moisture and grade, and ISO/DIS 13543 describes how to use these variances to calculate the variance of the mass of contained metal as the basic measure for the risk that mines and smelters encounter. Does your Committee believe that the variance of the mass of contained metal can be calculated for one set of variables and variances (wet mass, moisture and grade) but not for another (volume, density and grade)?

Confidence limits can be calculated for every variable and variance of the set that defines a dynamic stochastic system (processing plants and recoveries). Why does your Committee suggest that confidence limits for the variables and variances of the set that defines a static stochastic system (resources and reserves) should not be reported?

Under *Precision*, your Committee suggests that rounding 10 863 000 tonnes to 11 million tonnes, or perhaps 10.9 million tonnes, and 8.23 percent to 8.2 percent, accounts for uncertainty in these estimates. Does your Committee believe that *uncertainties* of +1.3 percent of the mass and −0.4 percent of the grade approximate the variances of masses and grades of resources and reserves as a measure for the risks that mines encounter?

These percentages do not approximate even remotely the uncertainties in measurement chains that quantify volume, density, mass, grade and content of a resource or a reserve. Therefore, the terms *rounding* and *uncertainty* should not be mentioned in the same section let alone in the same sentence.

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Mr John Drury, Chairman – November 30, 1994

I am pleased that your Committee has not conferred on geostatistics the status that its propagators aspired but I am disappointed that probability and statistics are ignored. My opinion on the use and abuse of statistics in geostatistics are well-documented but seldom published in reviewed journals. Given that my opinion is unpopular and unpublishable for reasons that are beyond the scope of this letter, it would be improper to blame your Committee for lack of appreciation and understanding of applied statistics. Therefore, I have put together a package of information that may assist your Members in assessing its power when applied properly.

Until your Committee has become more familiar with statistics without the prefix ***geo***, I recommend that the section on *Confidence Limits* be changed to: "Even if there were widespread acceptance that they can be ***derived in an unbiased manner***, ...". In this context *"accurately derived"* does not make sense because accuracy cannot be quantified but testing for bias quantifies the lack thereof. The absence of bias implies that a measurement procedure was tested for bias and passed a properly designed bias test. In exploration, the sampling stage may be intrinsically biased, the sample preparation stage is prone to insidious bias, and the analytical stage must be tested for bias.

Furthermore, I recommend that the same sentence be changed to read: "..., and ***in the opinion of this Committee*** there is not, ...", to clarify that it merely reflects the opinion of your Members. After all, the widespread acceptance of applied statistics in all scientific and engineering disciplines is indisputable. In mineral processing, smelting and refining, too, applied statistics is an indispensable tool. The question why precision and bias for volume, density, mass, grade and content of a resource or a reserve are the exception is a matter that your Committee ought to address in more detail.

Yours truly,

J W Merks
President

Miscellaneous Enclosures

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MASS AND VARIANCE OF CONTAINED METAL

CRUSHED ORE

$$Me = Mw * MF * AF$$

in which:
- Me = mass of contained metal
- Mw = wet mass
- MF = moisture factor
- AF = grade factor

$$var(Me) = Me^2 [var(Mw)/Mw^2 + var(MF)/MF^2 + var(AF)/AF^2]$$

in which:
- var(Me) = variance of contained metal
- var(Mw) = variance of wet mass
- var(MF) = variance of moisture factor
- var(AF) = variance of grade factor

***ISO/DIS 13543** – Determination of Mass of Contained Metal in the Lot*

INSITU ORE

$$Me = V * ID * AF$$

in which:
- Me = mass of contained metal
- V = volume
- ID = insitu density
- AF = grade factor

$$var(Me) = Me^2 [var(V)/V^2 + var(ID)/ID^2 + var(AF)/AF^2]$$

in which:
- var(Me) = variance of contained metal
- var(V) = variance of volume
- var(ID) = variance of insitu density
- var(AF) = variance of grade factor

"There is no such thing..."

Normand Champigny and five reserve estimation practitioners in Canada and abroad on the additive property of variances in "Geostatistics: A Tool that Works" (The Northern Miner, May 18, 1992) in response to "Geostatistics or Voodoo Science" (The Northern Miner, April 20, 1992).