THE CASE OF THE BADLY POSITIONED PLANT

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INTRODUCTION

This is the case of a copper producer, running a heap leaching, SX-EW plant to produce 35,000 tpy of copper cathodes. It is based on a real situation, overall figures have been modified as requested.

The plant, initially located in the most promising mineralized area of the company´s property, started to reduce its treatment rate due to lack of ore, after depletion of the deposits that supported the starting of the project, coming to a critical situation where production has been maintained at a minimum, buying minerals from small miners operating in the surrounding area.

The company owns a large mining property where many orebodies have been identified through preliminary exploration work during the last years. Most of these orebodies have not the volume and grade to justify its processing in the existing plant. In all these cases, exploration has been stopped after first results analysis.

After many efforts, one of the exploration targets showed very successful results, identifying a big orebody, enough to give another 10 years of operation to the plant, at its maximum capacity.

The only negative aspect of this new finding was that it is located at 50 km from the existing plant, fortunately with a good road access. So, even though it was not an impossible option, the treatment of this ore in the existing plant was considered a difficult and expensive alternative. On the other hand, the capital involved for a new plant was estimated to be very high, and the process for permits, engineering, financing and construction to take about three years.

Average grade is about 1.41% giving a total of approximately 7,500 tonnes of daily ore transport.

The management of the company asked for a very quick analysis of the situation to be presented to the board of directors, illustrating the economics of the following options:

- To transport all the mineral to the existing plant.
- To construct a new plant close to the mine, feeding to the existing plant during the three years of construction.
- To reinstall the plant in a new position close to mine. In this case, the mine will start production after three years. There will be no installation for processing during this time.

The scope to be developed included mineable reserves calculation, production plans and NPV calculations.

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The client provided the basic information to run the exercise, including the following parameters:

♦ Mining cost:	0.9 US$/tonne of rock
♦ Plant cost:	3.5 US$/tonne of ore plus 14.15 cUS$/lb of copper produced
♦ Slope angles for pit design:	45º
♦ Metallurgical recovery:	80 %
♦ Crushing capacity:	7,500 tpd
♦ EW capacity:	35,000 tpy
♦ Transport cost:	0.05 US$/tonne-km

- PC-Mine block model, 65 rows, 65 columns, and 50 benches (20m x 20m x 10m), containing cooper grade, rock code, and surface topography.

Capital expenditure for the new plant was estimated to be 80 million US$, while reinstallation of existing plant plus new power and water lines have been estimated at 45 million US$.

Sustaining capital to extend the existing plant life for 10 years more has been estimated at 30 million US$.

Base copper price for the analysis was fixed at 90 ct/lb, with a sensitivity analysis at 75, 80 and 110 ct/lb prices.

METHODOLOGY

The study was developed almost completely using capabilities provided by Whittle 4D programs, to deal with pit optimization, models manipulation and economic analysis.

The speed and simplicity of the 4D set of programs made it an ideal tool to handle the problem, considering the tight schedule required for the client.

The steps followed for the analysis of the different options included:

- Metal model generation starting from a PC-Mine block model, using the available interface of this software (TO4D).
- Parameters file generation (FDED) and Reblocking of original model (FDRB) in Z direction, with a factor of 2.
- Arcs file generation to represent slope angles situation (FDST).
- 4D optimal pit series was constructed for the case of transport to the existing plant (FDOP).
- Analysis of the resulting pit series to different price scenarios, and selection of ultimate pit limits (FDAN).

  For a price of 90 ct/lb, a 3 years pit was selected to represent production in the existing plant, during construction of the new unit.

- 4D series construction for to represent, for different prices the effect of building the plant, considering remaining ore reserve after feeding the existing plant during 3 years.

  For this option, the metal content model was modified using FDRB program as follows:

  - Generation of a Model File starting from Results File of first option run (2.4). Blocks above first 3 years pit were "mined out" of the model (FDRB, option 3).
  - Generation of model for optimization combining previous step Model File with original Model File (FDRB option 1).

  This sequence of activities is shown graphically in figures Nº1a, 1b and 1c and included as appendix to this report.

- Analysis of this option for different price scenarios with selection of ultimate limits (FDAN).
- Construction of new Results File representing the situation of option b) (construction of new plant with transport to existing plant during 3 years), that is:

  - Years 1 to 3, transport to existing plant, cost of processing = 6 US$/tonne.
  - Year 3 ahead, use of new installation, cost of processing = 3.5 US$/tonne.

  This analysis considers the following steps:

  - Generation of Result File containing pits of the original series up to year 3. Blocks below this pit were trimmed off the file. Remaining blocks were affected by an adjusting factor to the processing cost of 1.714 (equal to 6/3.5) (FRDB option 2).
  - Pit numbers of the Result File of point 2.6 were changed to match with numbers of the pits to year 3 of the original series (each number was increased by 12 since this was the corresponding number of pit for year 3).
  - The change of numbers was made using an external editor developed by NCL that also considers the change of the initial control lines in the Results File.
  - Generation of a new Results File starting from the Results Files of the previous steps. (FDRB option 2).

  These operations are shown graphically in figures Nº2a, 2b, 2c and 2d included in the appendix.

- 4D pit series generation for reinstallation of plant in a position close to the mine. In this case there will be no production during the first three years.
- FDAN analysis for yearly periods to compare the results of the different options for different price scenarios.

CONCLUSIONS

Finally four results files were obtained, one for each option (a), (b) and (c), and one for which analyze the effects of building the plant considering remnant reserves.

The results obtained from the analysis developed are briefly represented in the figures Nº3 to Nº9 included in the appendix.

Main conclusions are:

- Transport to the existing plant is the best option for any of the scenarios studied. In this case mineable reserves are smaller in the equivalent to one year of production.
- Total ore reach to 21 million tonnes @ 1.41 % Cu, with 2.69 stripping ratio.
- The option of a new plant is more convenient than the reinstallation for higher prices, indicating the importance of non interrupted cash flows during years 1 to 3, even though production cost may be increased. This conclusion is reversed for lower prices.
- At lower prices (75 ct/lb) the existing plant option is very close to the reinstallation option, making difficult to arrive to a decision.
- At lower prices the construction of a new plant results in very low profitability considering the remnant reserves in the pit after a good portion of the copper has been treated in the existing one.

BIBLIOGRAPHY

Whittle Programming. 1993. Four-D Whittle Open Pit Optimization Software. User Manual.

APPENDIX

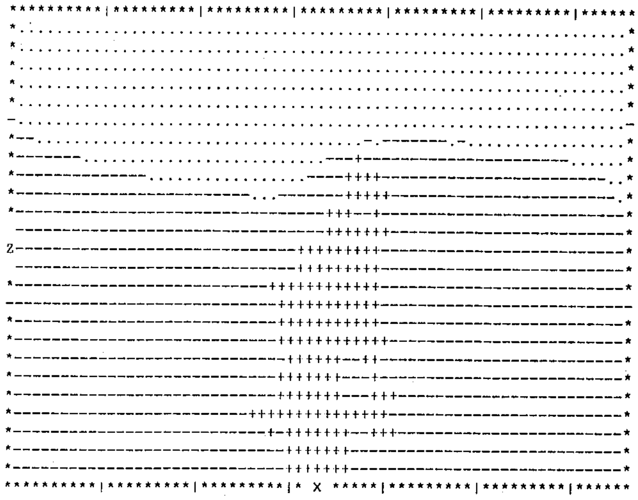

Figure 1.a: Original Topography

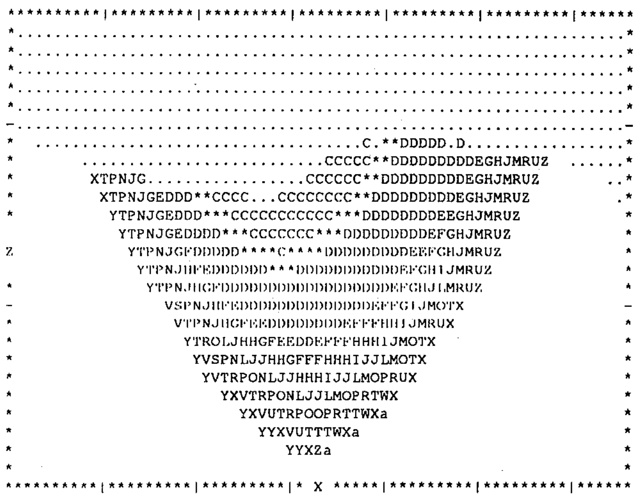

Figure 1.b: Old Plant Sequence (Showing 3 years initial pits)

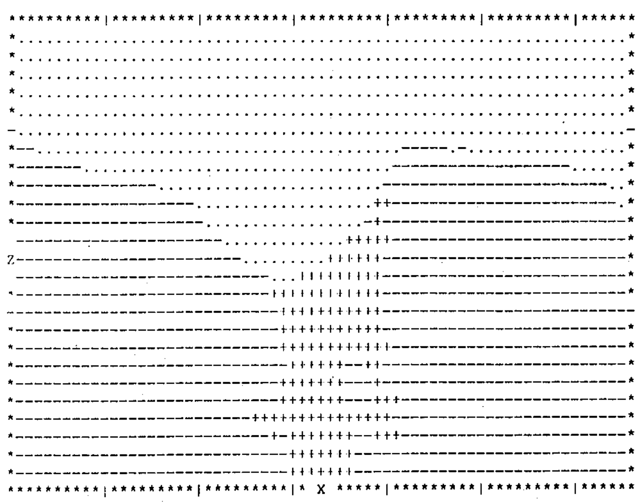

Figure 1.c: New Topography (3 years mined out from old plant sequence)

Sections through row 44

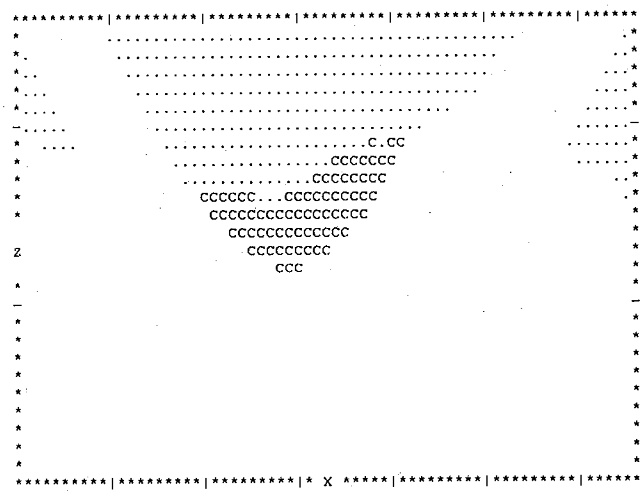

Figure 2.a: Old plant sequence (3 initial years trimmed off from sequence)

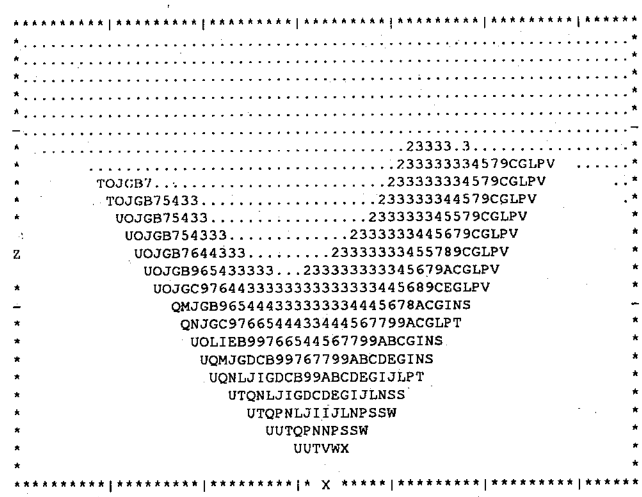

Figure 2.b: New plant sequence (Designed with new topography)

Sections through row 44

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*          faVSNJHGFF..................EFFFFFFGGHJLOSXbh          .*
*           gaVSNJHGFF................EFFFFFFGHHJLOSXbh           *
             gaVSNJHGFFF............EFFFFFFGGHIJLOSXbh            *
Z             gaVSNJIGGFFF........EFFFFFFFGHHJKLOSXbh             *
               gaVSNLIHGFFFFF...EFFFFFFFFFGHIJLMOSXbh             *
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-                 cYVSNLIHGGGFFFFFFFFGGGHIJKMOSUZe                -
*                  cZVSOLJIIHGGGFFGGGHIJJLLMOSXbf                 *
*                   gaXUQNLLJIIHGGHIJJLLMNOSUZe                   *
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*                       gfcZXVUSPOPQSUVXZee                       *
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Figure 2.c: New plant sequence designed with new topography
(Renumbered after old plants 3 year seuqence)

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Figure 2.d: Global sequence
(3 years for old plant and remnant sequence for new plant)

Sections through row 44

Figure N 3
Cumulative NPV (Price 0.75 US$/Lb)

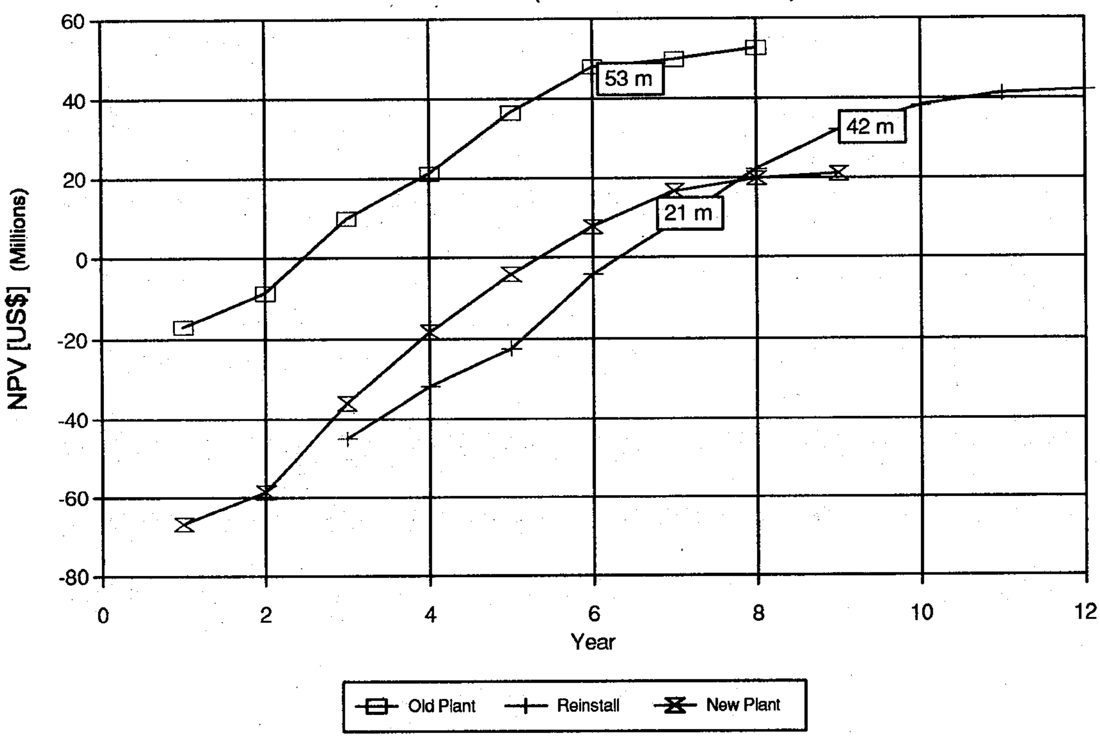

Figure N 4
Cumulative NPV (Price 0.8 US$/Lb)

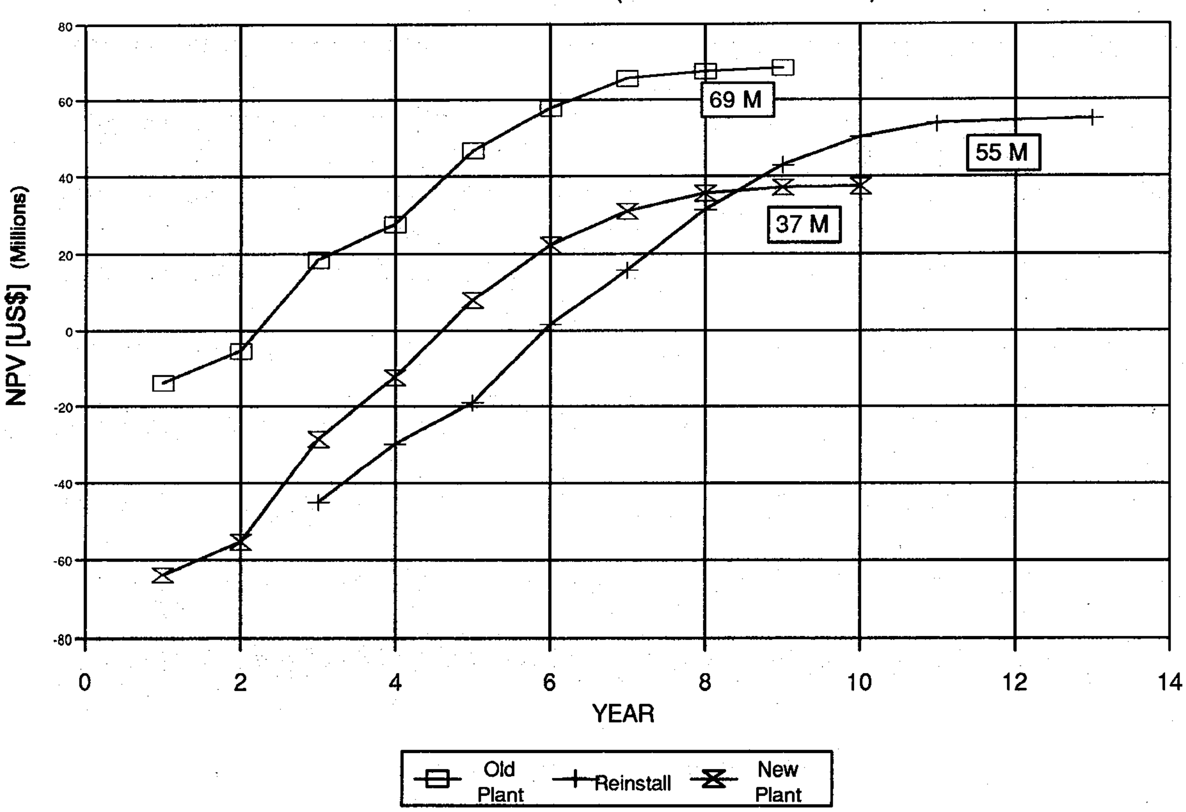

Figure N 5
Cumulative NPV (Price 0.9 US$/Lb)

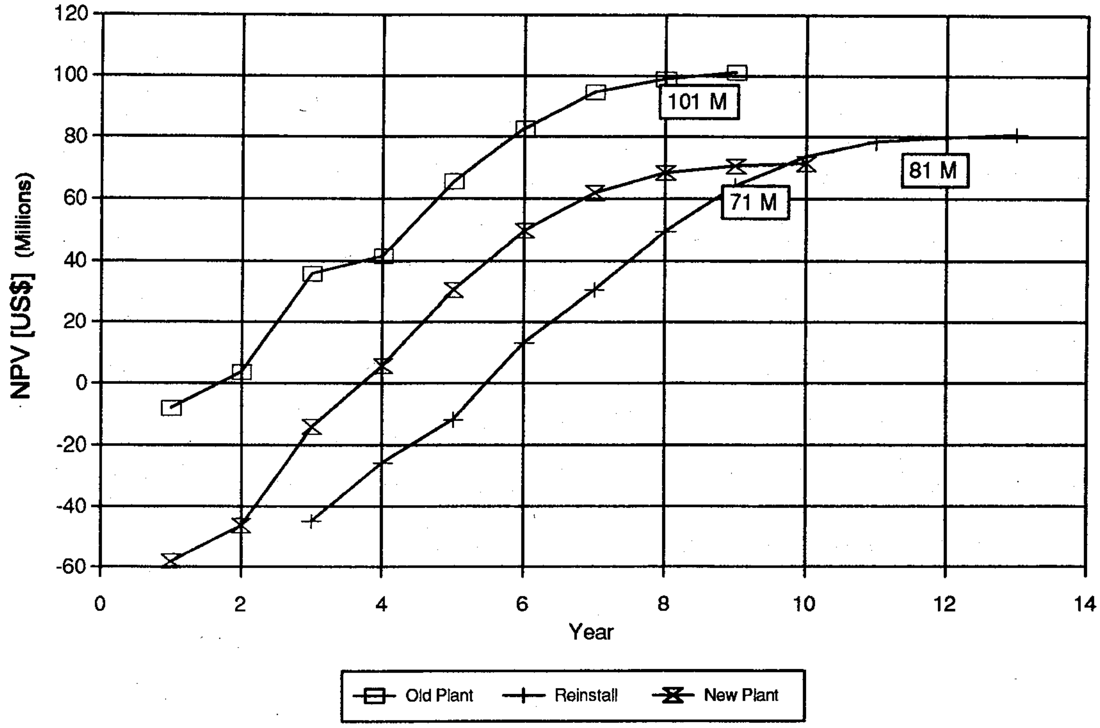

Figure N 6
Cumulative NPV (Price 1.1 US$/Lb)

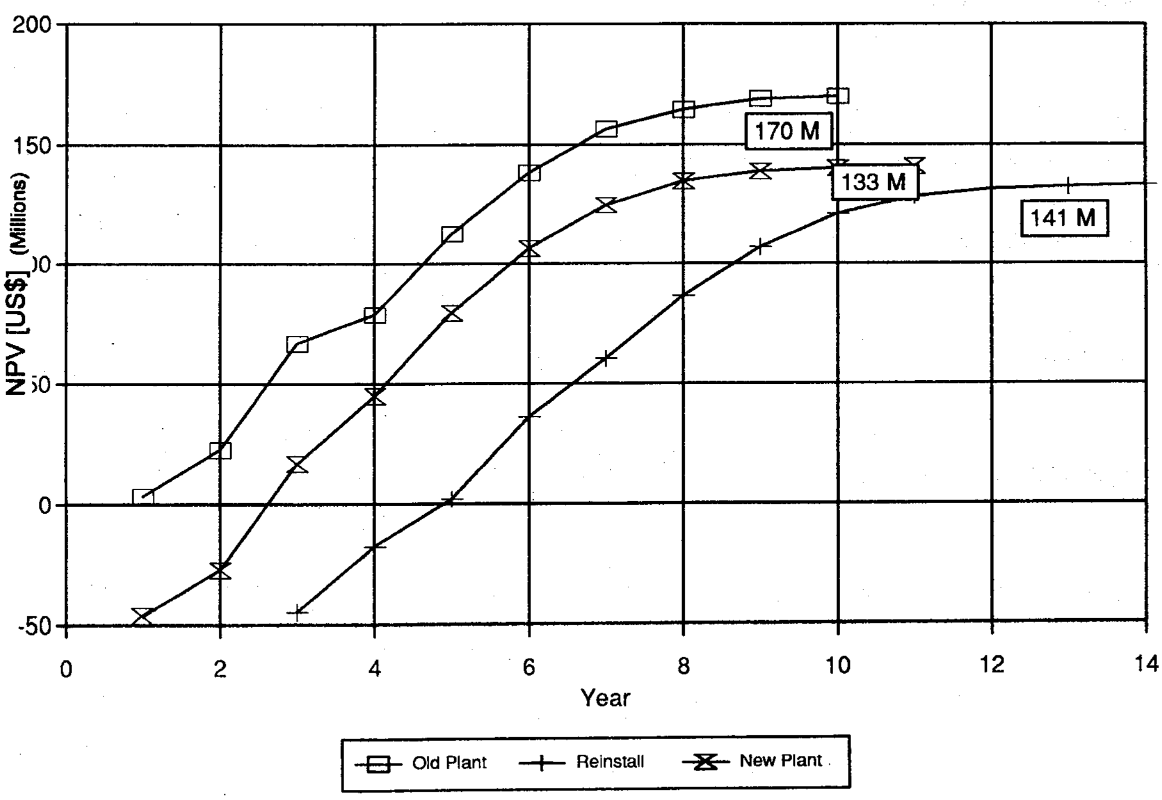

Figure N 7
Operating Cash Cost

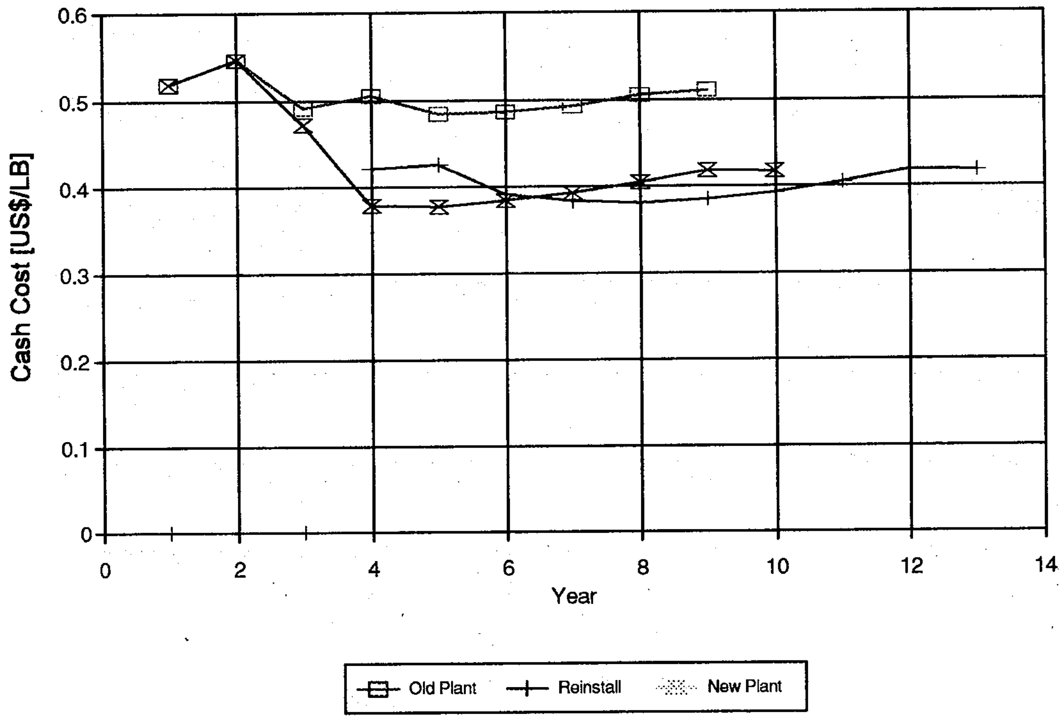

Figure N 8
NPV vs Copper Price

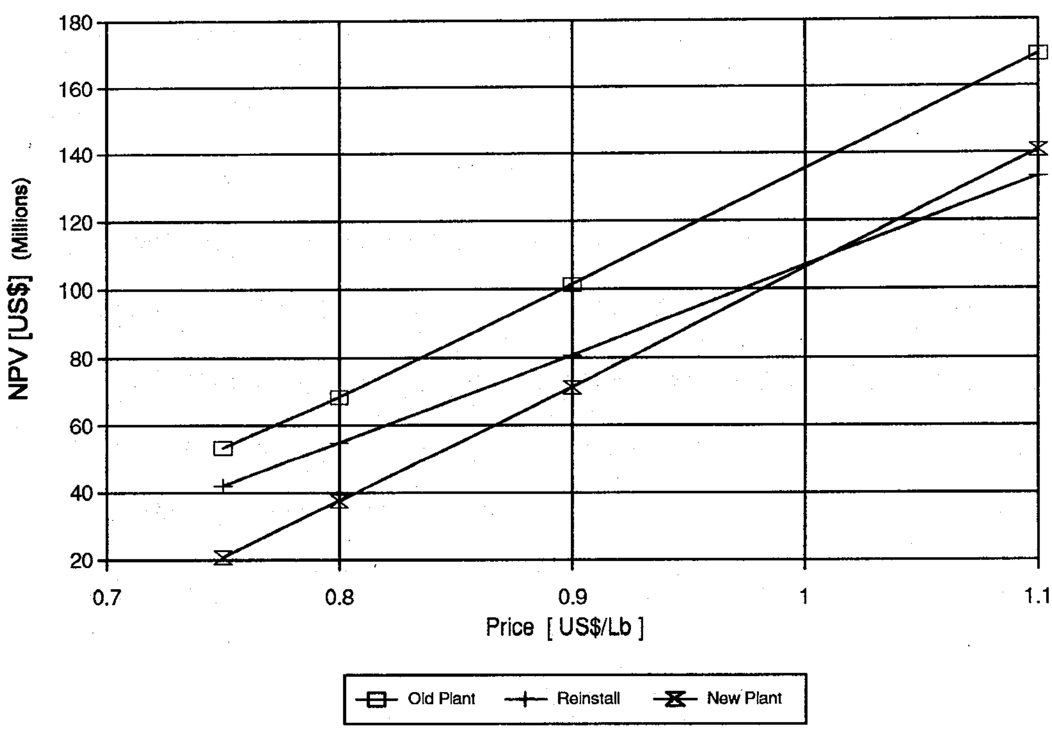

Figure N 9
New Plant Remnant Reserves After Year 3