Giant
YELLOWKNIFE MINES LIMITED

MEMO TO: Don Cooper; Sadek El-Alfy

CC: Bryan Cross; Sean Waller; Steve McAlpine

FROM: John Bartrum

DATE: August 22, 1988

SUBJECT: **TREATMENT PLANT PERFORMANCE - REPORT NO. 1**

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1. Following the change in metal accounting technique the problem statement now appears to be "of the 35-40% gold leached from the solids - close to half of this is lost to solution tailings.

2. High solution losses are generally associated with:

   (a) rate of carbon transfer through and out of the CIL tanks;
   (b) returned reactivated carbon barren levels are far too high;
   (c) carbon activity too low;
   (d) other cations Ca, K, Si, Ti, Cu, As, Fe, Mn, Zn, Cr, Ni, Pb and Cd will load on to carbon resulting in poor gold loading and the need to transfer faster;
   (e) very fine dispersions of attritioned carbon can inflate solution loss;
   (f) soluble gold may be occluded in hydrated Fe_2O_3 suspensions;
   (g) soluble gold may be adsorbed by humic acids;
   (h) tank carbon dispersion, suspension, distribution and concentration;
   (i) tank short circuiting;
   (j) presence of "preg robbers" other cyanicides;
   (k) co-precipitation with silver sulphide if silver present;
   (l) insufficient pre-aeration with lime prior to cyanidation;
   (m) the need for carbon loading prior to aeration.

3. As recommended in a previous fax it is essential that a complete and representative 100% chemical analysis be carried out on associated process solutions. For example, we know that the cations in (d) above are in the tailings in major proportions - Ref: Golden Dumps Report No. 98, but not how much is in solution. S, Th, Sr and W are present in minor proportions - but how soluble?

4. The carbon (loaded) should also have a complete analysis to see which of the cations adsorb significantly.

5. It would also be interesting to see what turns up in the bullion.

6. In the meantime carbon transfer rate should be accelerated and carbon loaded in the back end to save the approximate $1.0M CDN/month, and worry about the stripping problem later. There are current physical limitations and these should be addressed urgently.

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7. The other part of the chemical question is "are there any elements in solution that will retard gold dissolution" for example:

   (a) soluble sulphides;
   (b) antimony in solution.

   This simply serves to emphasize the need for 3 above, and as soon as possible.

8. If there is anything in 7 above then this may help to achieve the goal of greater than 35-40% gold recovery.

9. <u>On the mechanical side</u>:

   (a) downcomers keep backing up; problems, agitation indicated
   (b) wood fibre stratifies (?) the carbon;
   (c) There is little carbon in the tops of the tanks and the transfer pump suctions are short;
   (d) There is insufficient air to agitate all 6 tanks properly;
   (e) carbon cannot be transferred fast enough (c) and (d) plus screen problems.

   All these may in fact disappear when the second air compressor is hooked in. The nett result will probably be less short circuiting, better carbon distributions in tanks and along the train and thus less solution losses.

   The other beneficial side effect may be better solids dissolution.

10. The downcomers appear to be short at halfway down the tank, however, the increased agitation from the second compressor may compensate for this. 30-35'

11. <u>Wood pulp/fibre problem</u>. Delkor linear screens are the only answer. However, this may not be up and running before the freeze. The trommel and trash screens appear to have additional capacity at 8,000 t.p.d. Can you go finer on the mesh size? Would speeding the trommel up help? The wash water on the trash screens is so efficient I believe it is washing the fibre through. Is it possible to float the wood off after the trommel or, use a tank with CIL screens in reverse?

12. <u>Better than 35-40% gold recovery</u>. Increased agitation through aeration may improve solids dissolution as a result of improved retention time and cyanide/solid contact. The addition of lead salts if the results of 7 above are significant will contribute. However, there is still a real and urgent need for some extensive electron microscopy. In a fax from Blower to Driscoll mention is made of 1 oz. dirt. There is a need to establish definitely where the gold is distributed. Blower also states "gold losses in calcine residues, dusts and tailings have decreased over the years." As you are mining the tailings in all 3 dimensions anything is possible, for example gravity concentration, magnetic concentration (as per Morton). As there are only 4 (?) seasons left on this project the work must be done now and urgently.

13. On the work of Morton "magnetic separation testwork" is bio-oxidation of the magnetic and flotation concentrate an alternative to roasting/ leaching?

14. There does seem to be a correlation between tonnes processed and recovery 6,000-8,000 t.p.d. gives 30-35% recovery; 8,000-10,000 t.p.d. gives 20-25%. The lower tonnage gives the higher daily gold production. (I understand that the correlation is rough!) It's about 20 ozs. at lower cost.

15. Carbon Distribution. Once the second air compressor is hooked in and agitation is improved significantly the following work must be completed as soon as possible:

    - carbon concentrations g/l per tank and thus decision to balance carbon loadings;
    - carbon loadings g/t per tank and solution loss per tank to establish CIL profile and CIL isotherms;
    - checks to make sure that carbon is no longer stratified in the tanks.

16. Stripping rates. The general rule of thumb for zadra process solution flow rates is 4-5 gpm/sq. ft. of cross sectional strip tank area - what's ours?

17. Loaded carbon screen capacity. May have to replace this urgently with a larger deck even after conversion to wire deck. Any spare decks around for parallel operation?

18. Carbon tank transfer pumps. Can these be sped up for the short term, once 17 is okay? 450 gpm. 4-5 hrs to transfer 5 tons.

19. Pilot plant results vs. CIL results. Maybe someone with experience with both operations (B. Cross?) should sit down and analyse what is significantly different, unique or peculiar between the two operations. This may help towards problem solving the CIL circuit.

20. Solution losses. While after so many years of operations, the assay lab should be highly creditable, are the solution assays real: I think they are but they should be checked by an external lab.

21. Ultra fine carbon losses. I think these may be playing a significant role in the overall metal accounting and could be inflating solution losses. Maybe they cancel out feed vs. tail, however, it should be checked.

22. Golden Dumps Research of significance to this problem:

    - Pyrite has been largely oxidized to goethite which should mean some hydrated iron oxides around;

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- There is gold occlusion by goethite;

- Mineral acid treatment viz aqua reqia will give higher gold recoveries by cyanidation but are probably uneconomic;

- Sulphide content of the tailings was 0.1% or 1,000 ppm (?). If some of this is soluble it will give poor leach kinetics.

23. Head grade vs. recovery. To measure this accurately head grade should be measured against solids dissolution recovery. Overall recovery is distorted currently by not absorbing solution gold. Note pilot plant results showed good correlation.

24. Wood fibre adsorption. In the pilot plant this assayed 20-30 ozs/ton. Apparently it is only 5 ozs/ton in the CIL plant - why? Poor contact? Short circuiting, etc., etc.?

25. Froth. There are significant amounts of froth in the CIL tanks apparently as a result of frothing agents, surfactants and sewage dumped into the tailings pond. How damaging are these organics on the carbon? Of the 200 or so tonnes inventory how much is really active??

26. Lab vs. pilot plant and CIL plant. Laboratory results show 48% extraction is possible after 48 hours. The pilot plant achieved 35%, CIL plant? What would cause the 13% drop from lab to pilot plant to CIL plant?

27. Some plants treating reclaimed tailings which contain oxidized pyrite, introduce ferrous ions in solution with detrimental effects on gold recovery. Various solutions are:

    Pre-agitation ahead of cyanidation using:

    (a) portland cement;
    (b) pure oxygen.

28. Finally these suggestions, comments and observations have been made at random over the past 2 days. It is suggested that a meeting be held with the appropriate mining staff to establish which concerns have the highest priority and to set sensible deadlines within which the results can be achieved.

John Bartrum

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APPENDIX TO T.R.P. PERFORMANCE - REPORT NO. 1

What are the Facts as of 22/08/88?

1. Gold solution losses are too high.

2. Carbon loadings are low.

3. Carbon transfer rate is far too low due to physical limitations:

   (a) stratification of carbon in tanks;
   (b) access to carbon through transfer pump suctions;
   (c) carbon (loaded) screen a bottleneck.

4. Agitation via aeration on one compressor is inadequate.

5. The downcomers are far too short.

6. Wood fibre is a problem.

7. The trommel and trash screens have additional capacity at 8,000 tpd.

8. Pyrite has been oxidized to goethite.

9. There is froth in the CIL tanks.

10. CIL performance is less than pilot plant performance.

11. Wood fibre in the pilot plant adsorbed gold to 20-30 ozs/ton yet the CIL plant is only 5 ozs/ton.

12. It has been plant practice to dump unattritioned carbon in the leach tanks with subsequent reporting of super fines to the tailings/return water system.

13. On the basis of general plant practice regenerated gold barren levels of 2 ozs/ton carbon are too high.

14. Significant levels of competing cations have been identified in the solids by X.R.D. Soluble levels are not known.

15. Sulphide levels in the tailings have been assayed at 1,000 ppm Soluble levels are not known.

16. Both CIL and pilot plant results are less than laboratory results.

17. We're losing $1.0M CDN per month.

ASSUMPTIONS AS OF 22/08/88

1. Humic acids are generally associated with rotten vegetation. Tannins

2. Soluble sulphide ions are normally present from rotten vegetation.

3. Stratification of carbon in CIL tanks probably gives poor contact with gold in solution.

4. Downcomers being too short associated with insufficient agitation due to insufficient aeration may contribute to short circuiting.

5. Carbon activity has been downgraded due to the presence of organics.

6. Carbon loadings will be significantly affected by competing cations.

7. Soluble sulphides are usually a by product of the oxidation of pyrite.

8. Solution losses appear to be aggravated by tonnages higher than 7,000 t.p.d.

9. Fine carbon losses may be causing metal accounting problems.

10. Hydrated iron oxides are generally associated with oxidation of pyrite to geothite.

11. There may be significant amounts of antimony in solution.

12. Improved air agitation will improve carbon dispersion, suspension and distribution in tanks.

13. At this critical stage all recycled carbon should be acid washed and regenerated.

14. The current metal accounting technique is correct.

15. There may be a need to pre-aerate with lime and portland cement/pure O_2 prior to cyanidation.

16. The water sprays of the trash screens are pumping wood fibre through the mesh.

17. Gold lost to wood fibre should be included in the metal accounting. 5 ozs. lost per day is significant if only 1 tonne of wood fibre in 8,000 tonnes of ore. Wood fibre is also lost prior to the CIL feed.

18. Some coarse free gold maybe short circuiting inflating solids loss.

ACTION AS OF 22/08/88 BASED ON FACTS/ASSUMPTIONS

1. Improve agitation through increased aeration.

2. Carbon transfer rate has to be accelerated urgently. Address bottlenecks:

   (a) loaded carbon screen;
   (b) transfer to stripping;
   (c) stripping performance;
   (d) others.

3. Downcomers to be extended, if 1 above fails to prevent short circuiting.

4. Examine smaller mesh on trommel, trash screens and address possible spray problem.

5. Examine why CIL performance is less than pilot plant performance.

6. Attrition all carbon returned to the process. Aug 21

7. Try to aim for the lowest possible gold loading on returned activated carbon within the constraints of stripping limitations.

8. Extend carbon transfer pump suctions. Aug 21

9. Carry out a complete organic/inorganic analysis of the process solutions. IN PROCESS

10. While addressing above problems load carbon into the back end of the process.

11. Maintain tonnages 6,000-8,000 t.p.d. until solution loss is under control.

12. Examine metal accounting with respect to fine carbon losses and wood fibre losses.

13. Acid wash and regenerate all recycled carbon.

14. Examine pre-aeration prior to cyanidation.

15. Examine gold distribution in tailings using electron microscopy.

16. Complete analysis of loaded carbon required.

17. density control

18. $LiCl$, $Pb.SO_4$

19. Assays.

Aug 22. Slides

COMPLETION DATES FOR ACTION PLAN

1. In progress - compressor installed August 22nd.

2. To increase rate of carbon transfer:

   a) Tank to tank transfer

      - must improve densities - current range is 38-43% which is good;

      - improve agitation - done by installation of compressor - carbon distribution as of August 23 results in a calculated tonnage of 255 whereas actually have added 230 - very close - good dispersion;

      - extend transfer pump suctions by 5 ft. - 5 of 6 pumps done by August 23.

   b) CIL tanks to plant, i.e. loaded carbon

      - improve feed rate and slurry removal on loaded carbon screen - plan to change to 35 mesh woven wire screen. Simplicity to contact Don Cooper on August 24 for prices and delivery - should take 3 hours to transfer 5 tons.

   c) Acid Wash

      i) - deleted for time being - calcium is 0.14% still low;

         - Cu also low at 0.05%;

         - metal contents to be monitored weekly - will not let Ca exceed 0.50% - increased from 14 ppm at end of June to 1400 ppm at mid August - average 28 ppm per day - may have 128 days;

         - must note that acid wash can have significant effects on activity even without regeneration;

      ii) speed up carbon washing by doing 2 b) above for slurry removal - changeover of Derrick screens to wire mesh will eliminate entrance of excessive wood on new production - done August 19;

      iii) speed up of eduction process from acid wash vessel to strip vessel - minor problem now 4-6 hours required may be reduced to 2-3 hours depending on operating changes or replacing with larger eductors or by pumps - examine August 25.

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d) Stripping - extensive research required over a few days will be required to determine plan of action here. In addition, changes to each batch of carbon processed will be going. Current strip times used are 12 hours. Should be 8 hours.

i) increase stripping rate - try increasing flows;

ii) maximize temperature;

iii) maximize electrowinning efficiency - affected adversely by increased flow - increase number of cathodes or steel wool;

iv) eduction of carbon from strip vessel - maximize.

e) Regeneration - increase transfer rate of carbon by deleting this step while doing activity tests - to be monitored weekly - minimum acceptable activity 80% of fresh carbon - tests August 23/24.

Circuit Retention Times (target ranges)

1.	transfer loaded carbon to acid wash	3 hrs.
2.	acid/caustic wash, etc.	1.5 hrs.
3.	educting to strip vessel	2-3 hrs.
4.	stripping and heat up/cool down	8-12 hrs.
5.	educt from strip vessel	2-3 hrs.
6.	regeneration (500 lbs./hr. design)	20 hrs.
	Total	16.5 to 22.5 hrs.

A time study is required to determine how often regeneration can be done for the various time ranges since 2 strip vessels are used - August 24.

3. May not be necessary - if determined to be will be done after shut down.

4. i) Finer mesh already in place on Derrick Trash screens 45 mesh wire for 2 of 3 panels on each screen deck. Urethane panels were 20 mesh slots - completed August 19;

ii) Trommel screen - new screens will be on site by end of month to replace worn out units on trommel screen - August 31;

iii) Order conical sprays - check volume rating on existing sprays - August 24;

iv) Order spare screens for trash screens - check for finer mesh sizes August 24;

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5. Examine pilot plant - tank sizes, impeller type, diameter, distance from bottom, baffle dimensions, feed downcomer diameter and distance from bottom agitator horsepower and rpm, blower rating - Sean and Bryan August 24.

6. Carbon added initially and that added to tanks 2 and 3 later on were added directly. Since that time any extra carbon has been attritioned 1/2 hour in the attrition tank prior to pumping to CIL.

7. Is being done to the best of our current ability on limited data from few strip batches. Stripped carbon ranges from 2 to 5 oz/ton Au and averages about 3 oz. Au/ton. Maximum flows through strip circuit is about 60 to 65 USGPM which is limited by the electrowinning cells and pressure control system as well as possibly the heat exchange system. Normal flow rates used are 45 to 50 USGPM. J. Bartrum suggests 80 to 100 USGPM or 4 to 5 gpm/ft^2 of column area should be used.

8. Five of six pumps completed August 23, remainder will be done by August 25.

9. a) The following samples were sent out for analysis August 23:

   CIL Feed Solution
   CIL Tails Solution
   Loaded Carbon
   Stripped Carbon.

   The following will be sent during the next strip cycle when samples can be collected:

   Electrowinning Cell Feed (Pregnant Solution)
   Electrowinning Cell Tails (Barren Solution)

   Analyses: Ca, K, Si, Ti, Cu, As, Fe, Mn, Zn, Cr, Ni, Pb, Cd, Au and Ag
   S, Th, Sr and W - soluble portions
   tannic and humic acids.

   b) Tails to be checked for carbonaceous fines - August 24;

   c) Take samples on wood pulp at trommel and Derrick Trash Screens, Tank No. 6 - check for Au - August 24;

   d) Order 5 kg of lithium chloride August 24
   Lead Nitrate or Lead Acetate for removal of possible soluble sulphide effects - check prices based on 0.05 lb/ton and 0.25 lb/ton addition rates (400 to 2000 lbs./day) - August 24;

   e) Do lab tests using 0.01, 0.05, 0.25, 1.0 lbs./ton dosage of lead salt at pH 10.0 to 10.5, 24 hours, 40% solids and 1.0 lb/ton sodium cyanide additions - August 25/26;

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10. Carbon addition was commenced August 21 and is ongoing such that 5 tons minimum of a combination of fresh and stripped carbon is being added per day.

11. As of August 22 the tonnage is being held to a maximum of 8000 tpd.

12. See 9 b) above - assay solution before/after fine filtering - August 24. Find out assay lab technique for solution assays.

13. We disagree only to the point that the activity will be monitored closely. J. Bartrum has agreed to this only because of the necessity of increasing carbon transfer.

14. Dissolved oxygen levels to be checked at trommel screen, trash screens, feed to surge tank and CIL No. 1 feed August 24.

15. Sample of plant feed to be collected and sent out for analysis. This is not as critical at this time as the other items. To be sent by August 28/29.

16. See 9 a) above.

17. The importance of receiving assays over the weekend for the next month cannot be over emphasized. Check with Bill Richardson to have personnel available August 24.