To: R. E. Thurmond

From: H. Lyall Ames

Subject: Visit to Anvil Mining Corporation Limited Mill at Faro June 12-13 and the Vancouver Office June 15

cc: Mr. R.L. Haffner, Mr. N.G. Cornish, Mr. H.H. Cox, Mr. P. Taggart Mr. P.J. Brown

This report covers discussions regarding the proposed Anvil Mill expansion with Mr. Haffner, Mr. Taggart and Mr. Brown at the mine site and Mr. Thurmond in Vancouver. Economic justification for the expansion and in particular the grinding section was carefully studied, in addition to the functional equipment, the flowsheet and some general layout drawings.

It became apparent shortly after a more detailed study of the project was started about the middle of May, that consideration would have to be given to more grinding than was originally envisaged in discussions with the Hardinge Company. On the basis of the metallurgical forecasts listed in Table No. 1 appended, unless a new grinding unit is incorporated into the expansion the concentrate production would fall considerably short of contract commitments, and serious metal losses would be incurred.

Although all the metallurgical data, including ore and concentrate tonnages, are intended to be realistic forecasts, they should be studied carefully by all those concerned and any errors or questionable conclusions should be brought to the attention of Peter Taggart immediately for correction or clarification.

In order to prevent misunderstandings between staff members and process omissions, all steps in the complete ore treatment cycle were discussed to some extent.

The complete mill expansion is considered justified on the basis of concentrate contracts, a desirable increase in milling rate (better unit costs and more concentrate for sale), better metal recoveries, and a smoother operation.

I Concentrate Contracts

The maximum ~~average~~ daily milling rate in the current mill is 9500 tons. This could very well be lower if higher iron content ore is being milled as on June 12, 1972, when the maximum rate was 7800 tons.

Selective metal recoveries at this milling rate and a 9% combined lead and zinc content are estimated at 6%.1% for the lead and 58.1% for the zinc. The yearly production rates of selective lead and zinc concentrates in dry short tons are as follows compared to current contract commitments:

	Lead	Zinc
Contract	128,099	238,529
Estimated from above data	106,452	208,052
Shortage	21,647	30,477

These shortages can be taken care of by milling at a higher tonnage rate and better metal recoveries as indicated in Table No. 1

II Ore

There seems to be no question but that 10,000 TPD can be mined. From the present combined grade of 10.3 - 10.4 it is expected to decrease to 8.96% (pb 3.31% and Zn 5.65%) in 1974. As this is the calculated mine average at this date, there is no assurances that it might not be lower for some periods most likely in 1974 and 1975.

III Crushing

Primary crushing capacity is considered adequate for 10,000 TPD in 1 1/2 shifts. Current secondary and tertiary crushing of 8500 TPD requires a 2 shift operation. For 10,000 TPD part of a third shift will be required but only because of inadequate fine ore storage capacity. Peter Taggart says that as far as actual crushing is concerned, there is adequate capacity for 10,000 TPD or more.

IV Bins

F.O. bin capacity presents an operational bottleneck because although the total bin capacity is 3400 tons during the summer it is only 2000 tons during the winter. At a rate of 10,000 TPD this means that less than one shift is available for regular crusher maintenance. A new third bin is therefore recommended by Peter Taggart and although it is a costly item and not a metallurgical necessity, it is nevertheless a prerequisite to satisfactory crushing plant availability and therefore to a higher milling rate. Outside storage of fine ore was considered all right for real occasional emergencies but not for regular maintenance during the winter months. The idea, however, has not been entirely abandoned.

V Rod Milling

I questioned the capacity of the rod mills but Peter Taggart assured me that when they were operating occasionally at a 10,000 TPD rate even on various types of ore, they always produced a good ball mill feed without excessive oversize from the trommel screens. He is not concerned about their ability to grind 10,000 TPD although at higher rates a third rod mill would be necessary. A crusher product of 80% - ½" which is obtained on Anvil ore is certainly a very acceptable rod mill feed and an even finer product is expected when more rubber screens are installed in the crushing plant.

Vi Ball Mill Grinding

The four existing ball mills are operating at 20.4 rpm (78% critical speed) and are reportedly drawing the full motor load of 450 HP each. Before and during the initial cursory stages of the present project investigation, it was considered their speed could be increased sufficiently for our increased power requirements. As the project developed, we found that an increase of less than 10% in capacity could be obtained in this manner and only then by increasing

the number of pinion teeth by two and widening the ring gear, which Hardinge does not now recommend, and installing all new larger motors. A 10% increase in capacity is not sufficient and even if it were the changes now suggested are costly, complicated and would cause excessive shutdowns.

A new mill likely 13′x 16′driven by a 1500 HP motor and operating in closed circuit with a battery of cyclones (probably 20") on the current flotation feed appears to be the simplest, most effective and the most economical manner to increase the mill capacity to 10,000 TPD along with the necessary fineness of grinding - approximately 70% minus 200 mesh or at least 10% finer than currently being obtained.

It was decided, however, to run two further tests to confirm and evaluate the metallurgical benefits of finer grinding: (1) plant test starting early in July on a reduced milling rate, say 7,500 TPD and (2) a series of special grinding tests in the laboratory starting June 13. However there appears to be ample evidence already, both experimentally and from mill statistics, that metal recoveries would be materially and economically improved sufficiently to warrant proceeding with a new grinding circuit design.

In any case more grinding is required at a 10,000 TPD rate for mechanical reasons alone. Even at lower milling rates considerable lost tonnage is caused by launder blockages, cell build-up and general coarse sand settling out in pump boxes and conditioners.

Metallurgical improvements from finer grinding are given in more detail under paragraphs dealing specifically with zinc and lead.

Although regrinding of the lead circuit tailing has been considered instead of the original flotation feed, it is not recommended. Further grinding at the head of the mill is considered essential to satisfactory operation at the higher milling rates and also increased lead recovery will be significant.

VII Zinc

Additional grinding to 10% more - 200 mesh is alone expected to increase zinc recovery by 3% and this will be augmented still more by up to 5% with more adequate flotation.

(a) April 1972, Pb tailing regrinding	- 3.9%
(b) April 1971, R.M. feed tests	- 4.6%
(c) May 1972, R.M. feed tests	- 2.5%
(d) April 1972	- 1.9%
(e) May 1972, Plant data	- 3.1%
(f) Feb.-Mar. 1971, Plant data	- 2.1%
Average	- 3.0%

The forecasted zinc recoveries for the current mill operating at 9500 TPD on a 5.65% zinc feed are 58.1% selective and 13.9% bulk, making a total of 72.0%. The forecast for the proposed expanded mill are 64.1% selective and 13.3% bulk for a total of 80.0%; i.e. 8% higher in both cases.

VIII Lead

Although there has not been as extensive grinding test work carried out on the lead as the zinc, we believe that the difference in lead recovery obtained in the existing mill at 9500 TPD on a 3.31% lead feed and that for the proposed mill circuits on 10,000 TPD will be in the order of 5%.

IX Economics

The approximate increase in revenue to Anvil between the present circuit if treating an average of 9500 TPD of ore assaying 8.96% combined lead and zinc, and the proposed circuit at 10,000 TPD may be calculated from the following metallurgical forecast and estimated increase in operating costs.

Increase in Revenue

(1) Net profit on 500 TPD.

(2) Increase of 5% in lead recovery on 9,500 TPD.

(3) Increase of 6% in selective zinc recovery on 9,500 TPD.

Increased Operating Costs

(1) Direct fraction of operating costs on 500 TPD, say $1.25 per ton.

(2) Increase in power cost on 9,500 TPD, say $0.05 per ton.

X Engineering

In accordance with project planning of May 10 a draftsman from Wright Engineering was sent to the mine site and by June 16 had completed some general layout drawings as developed by the metallurgical group (L.P.T., P.J.B., and H.L.A.). On June 15, Mr. Thurmond and I discussed the project with Mr. Len Wright in the Anvil Vancouver office.

He was asked to submit the approximate cost of making a preliminary capital estimate of the project on the basis of some drawings made at the mine by Horst Tuetch, our description of the extension and such further data as required from the property.

He did not anticipate any particular difficulty in making this estimate but was asked to advise Mr. Thurmond on the following day how much this would cost. In addition to the capital cost for the extension to 10,000 TPD Mr. Thurmond also requested that some thought be given to a further extension to 15,000 TPD, it being understood, that with much less data on which to base it, the estimate would be considered only as a general order of magnitude. I suggest that it might be advisable to allow more time for this latter estimate, say a few weeks or a month.

The mine group, Mr. Haffner, Mr. Taggart, and Mr. Brown, were advised by phone in the afternoon of the above meeting. Mr. Thurmond stressed the utmost importance of not spending any more money than was absolutely essential to satisfactory metallurgy and low operating costs. He questioned the need for another ore bin, as large a space for repairs, and several other items, all of which will be given very careful consideration.

XI Miscellaneous

(1) Davcra Flotation Cell: I do not recommend that this cell be investigated at this time.

(2) Autogenous Grinding: I do not think that this type of grinding would be advantageous on Anvil ore and anyway now is not an opportune time to consider it.

(3) Aerator: Space should be left for installation of one aerator on secondary cyclone overflow.

(4) Copper Flotation: Space should also be left somewhere for a small copper circuit ahead of the lead circuit in the extension.

XII Grinding Calculations

Harding's recommendation in their letter of June, 1972, is that a 13' x 16' ball mill with a 1500 HP drive is required to grind an average of 10,000 TPD (I have used 10,526 TPD rate in my calculations to allow for 5% down time) to 70% -200 mesh. However this is based on the assumptions that the present grinding circuit will grind 8,000 TPD to 65% -200 mesh or 10,000 TPD to 50% -200 mesh, neither sizing of which is sufficiently complete for a calculation of this importance. Therefore, although the 13' x 16' mill appears a logical size to me, I think that a more accurate and complete screen analysis of the flotation feed together with watt-meter power readings should be obtained and the required additional power for the new circuit be recalculated before establishing the ball mill size definitely.

My grinding-power calculations all indicate that either the Work Index of reportedly 9.44 is too high or the product sizing reported

for current operations is too fine. It should be possible to check all these data and correct them if necessary within a few weeks and in any case negotiations may go ahead with the ball mill manufacturers for a mill at least in the size range of 13' x 16'.

TABLE NO.1

Metallurgy - Various Operating Parameters

L.P.T. - P.J.B. - H.L.A., June 13, 1972

	Feed TPD Rate	Bulk TPD	Assay Heads Pb	Assay Heads Zn	Assay Bulk Pb	Assay Bulk Zn	Assay Select Pb	Assay Select Zn	Assay Tail Pb	Assay Tail Zn	Lead Recovery Sel.	Lead Recovery Bulk	Lead Recovery Total	Zinc Recovery Sel.	Zinc Recovery Bulk	Zinc Recovery Total	Total Production Year SDT at 95% Available Pb	Total Production Year SDT at 95% Available Zn	Total Production Year SDT at 95% Available Bulk
1972																			
J	7,792	258	4.33	6.16	18.5	28.5	70.2	51.0	.52	1.47	77.2	8.8	86.0	65.1	9.1	74.2			
F	6,761	258	4.12	5.47	18.9	28.9	69.2	50.8	.50	1.31	71.2	16.2	87.4	55.7	19.4	75.1			
M	8,622	274	4.55	6.36	18.0	29.6	70.1	51.3	.60	1.60	74.3	11.7	86.0	60.4	13.7	74.1			
A	8,630	258	4.47	6.25	19.4	27.5	72.6	51.9	.67	1.79	70.4	14.5	84.9	57.3	14.7	72.0			
M	8,360	300	4.47	5.74	19.6	28.0	70.3	50.7	.63	1.57	72.4	12.7	85.1	58.0	14.2	72.2			
Existing Mill															Contract:		128,099	238,529	88,513
	9,500	250	3.31	5.65	18.9	29.8	70	52	.56	1.63	68.1	14.9	83.0	58.1	13.9	72.0	106,452	208,050	86,688
	9,500	150	3.31	5.65	18.9	29.8	70	52	.64	1.80	72.0	9.0	81.0	60.7	8.3	69.0	112,347	217,412	52,017
*Complete Expansion																			
	10,000	250	3.31	5.65	18.9	29.8	70	52	.40	1.29	73.1	14.2	88.0	64.1	13.3	80.0	119,976	241,685	86,688
	10,700	250	3.31	5.65	18.9	29.8	70	52	.40	1.29	73.1	14.2	88.0	64.1	13.3	80.0	128,099	258,048	88,513

* Complete Expansion - additional 1500 H.P. for grinding flotation feed plus proposed flotation circuit expansion