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May 27, 1980

Cyprus Anvil Mining Corporation
330-355 Burrard Street
Vancouver, British Columbia,
Canada V6C 2G8

Attention: Mr. L. P. Taggart, Manager of Feasibility and
Development

Gentlemen:

This letter-report responds to Mr. J. F. Olk's tele-
phone call and letter to me on January 23, 1980, my tele-
phone discussion with Mr. Olk on January 29, 1980, and our
January 31, 1980 conference call with Mr. Olk - all concern-
ing my acceptance of a Cyprus Anvil assignment to review
the AFE concept to modify and expand the Faro concentrator
for finer grinding prior to treatment of the Faro Type III,
Grum and Vangorda ores, and to report my findings to you.
During the January 31st telephone call it was agreed that
I would engage Mr. H. R. Spedden to critique the laboratory
and other test data supplied by Cyprus Anvil, Mr. Peter
Brown would provide additional data to us for review, then
Spedden's findings from these tests and his resulting re-
commendations would be reported to me for consideration
and comment.

Copies of each of Mr. Spedden's two reports and one
memorandum resulting from his reviews of the material pro-
vided, our two discussions with Mr. Brown, and his subse-
quent meeting with Mssrs. Olk, Brown and you in Vancouver
are attached to each of the six requested copies of this
letter-report. Spedden's first report dated April 25, 1980
is supplemented by his May 14, 1980 letter which comments
on the Mitsui test work, the discussions in Vancouver, and
his further recommendations. His May 23, 1980 memo to me,
copy attached, covers test procedures and the problem of
interpreting possibly misleading flotation results from

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finely ground galena samples.

In addition to the Spedden work and findings, I have gone over and discussed his conclusions, and reviewed as my part of the overall assignment pertinent laboratory and pilot plant test work, the November 1978 Anvil Mill tests, the AFE draft, the as-built (per Expansion No. 2) and Proposed Expansion No. 3 flowsheets and layout drawings, my records from the three meeting discussions, our phone calls and my file data on other fine-grained complex-sulfide milling operations. My conclusions on your Proposed Expansion No. 3 follow:

SUMMARY

The present Anvil concentrator, currently milling Faro Zone II ore, has a nominal capacity of 400 tonnes per hour, equivalent to 3,360,000 tonnes per year on a 350-day, 24-hour daily operating schedule. The grind fineness ahead of the lead rougher flotation circuit is a nominal 80 percent minus 130 microns. Throughput rates vary considerably because of persistent changes in ore characteristics and variations in operating control practices.

Depletion of the Faro Zone II ore and the economic desirability of expanding the Anvil operation will make it necessary to obtain concentrator feed from the development and mining of the Faro Zone III ore body and the nearby Grum and Vangorda Mines prior to the 1982-1983 period. Presently, it appears that mill feed, starting in the second half-1982, will be a mix of Faro Zone III and Vangorda ores. The proposed expanded concentrator has been rated at a 450 tonne per hour capacity.

All available metallurgical information from the Grum and Vangorda drill cores which show much finer grained mineralization than most of the Faro Zone I ore (for which the concentrator was initially designed), indicates that the present mills' 130 micron grind capability will not produce acceptable concentrate recoveries and grades at the desired capacity.

The test work done on samples from the Grum and Vangorda cores is inconclusive for fully reliable predictions of commercial-scale recoveries and grades, because of the way the earlier owners of these ore bodies composited and handled the samples.

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Nevertheless, the work does show that these two ores require much finer grinds (than the present minus 130 micron size) to obtain economic recoveries and grades in both the lead-silver and zinc concentrates. Further, it has been determined that a finer-than-present grind will also be economically beneficial for all or most of the Faro Zone III ores. The same applies to mill feed blends from the Faro III and Grum or Vangorda ores.

The inferred conclusion from discussions and reviews of all the available test information is that a more-or-less 80 percent minus 50 micron grind should be provided. However, the information does not give the process design data to determine if the minus 50 micron grind should be made on the total feed to the lead rougher flotation circuit, or if it would be economically (and metallurgically) preferable to grind the lead rougher feed to an 80 to 100 micron range, float it, and then regrind these float tailings to about minus 50 microns and send them to a second lead rougher operation. The latter scheme would decrease sliming of the galena minerals and should increase overall lead-silver recoveries; this is the experience at several other operations and is supported by the recent Mitsui, et al test work done for Anvil.

The presently proposed Anvil AFE includes grinding capacity for a rated 450 tonnes per hour to a minus 50 micron feed size ahead of the lead rougher flotation circuit, i.e., a single-stage grind-float circuit. The proposed grinding capability will produce a much finer float feed at the 450 tonne rate on the softer Vangorda and Grum ores through a naturally obtained differential grind, and increase the hazards of losses from overground (slimed) galena mineralization, particularly on the granular pyritic ore types. This potentially serious problem can be overcome at a probable reasonable cost by adding flowsheet flexibility to the expanded mill design to allow for a switch to a "two-stage" grind-float-grind-float lead rougher circuit. An alternate or preferable supplementary scheme would be to accept the concept of increasing mill feed rates on softer ores to avoid overgrinding the galena. If only the tonnage increase approach is used as the alternate to the two-stage rougher float, there will be the problem of balancing the higher tonnage against the somewhat finer grind needed on the soft pyrrhotitic ore types, and I would expect lower concentrate grades and possible decreases in

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recovery when the operators did not strike an optimum balance between these two parameters.

Since it appears practical to add design flexibility to the proposed expansion plans it would be prudent, in lieu of delaying the project for further drilling and conclusive testing, to proceed with the present Anvil AFE but to include in the design provisions for the above described flowsheet revision.

The added cost to the project for this and the probably desirable plant flowsheet changes should be considerably less than the inflation cost that would be incurred by delaying the project to try to get conclusive test data now on whether the single or two-stage grind-float lead rougher circuit would produce the higher cash flow.

The proposed AFE fine grind ahead of the lead roughers, either with or without the suggested design-flowsheet should be satisfactory for the presently designed zinc concentrating circuits.

A further drilling, sampling and metallurgical testing program, including a pilot plant at Anvil, should be followed concurrently with the expansion project, and I have been told that some of this work has been started. The samples for the further laboratory metallurgical testing should be composited in a manner that can be related directly to each specific time period in the mining plan which Anvil selects. Suggestions to be considered for this program are outlined in the following section of this letter.

Laboratory and Pilot Plant Testing: The surprisingly large amount of test work done by the Galigher, Hazen, Lakefield, Kamloops, Sachtleben, Mitsui and Anvil organizations on the different ore types in the Faro deposit, and the more limited testing done on Grum and Vangorda ores by Lakefield and Kamloops do not provide conclusive data for developing truly reliable AFE predictions of lead-silver-gold and zinc recoveries or lead and zinc concentrate grades on either the Faro Type III, Grum or Vangorda ores, or on blended mill-feed from the Faro Type III and Grum or Faro Type III and Vangorda ore. Nevertheless, the sum total of all the test work clearly demonstrates the absolute need for considerably finer-than-present nominal minus 130 micron grinding to obtain commercially acceptable

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recoveries and concentrate grades on the Grum and Vangorda ores, and to improve recoveries and concentrate grades on the Faro Type III ore compared to past recoveries and grades on the Faro I and present results on the Faro II type ores.

However, the test work is inconclusive for determining the optimum economic grinding and flotation flowsheet scheme and for process design engineering to size equipment for predetermined throughput rates on the various ore types or combinations of them. But the testing does indicate the need to provide additional grinding capacity to reduce the softer Grum and Vangorda ores to about an 80 percent minus 50 micron grind ahead of the final lead cleaner flotation circuit. The AFE plans to achieve either this or a finer grind, depending on the grindability of each ore type, entirely ahead of the lead rougher float circuit.

Your people report that the proposed minus 50 micron grind ahead of the lead roughers will not cause sufficient sliming of the galena mineralization to have any measurable adverse affects on lead (plus silver and gold) recovery, or on final concentrate grades. Wide experience elsewhere, backed by major theoretical studies and meticulous sampling and analyses of fine grained sulfide ores from operating plant intermediate and final products, on ore types like most of the Anvil ores, indicates at least a two-stage grinding/flotation circuit ahead of the cleaning circuitry does minimize galena sliming, and thereby produces higher recoveries, and generally better final concentrate grades.

The indicated preferability of a two-stage grind and lead rougher float is also covered in the Sachtleben and Mitsui reports. Sachtleben recommends "Tests to recover premium lead concentrate by coarse primary grinding, and followed by secondary lead (rougher) concentrate by re-grinding of the lead scavenger feed." Here the semantics differ from my preceeding comments but the meaning is the same. The Mitsui report makes similar comments and implies their strong concern about the adverse affects of increased galena slime production from very fine grinds ahead of rougher flotation. The conclusion to be drawn from both reports is that further work is needed to determine the validity of the grind-float-grind-float lead rougher circuit concept. The earlier Galigher and Hazen mineralogical-metallurgical work on Faro Zone I ore samples tends to further support the comments in the above two reports.

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However, the project schedule, the equipment commitments already made, and the immediate inability to obtain proper ore samples do not allow time for further testing without seriously delaying and increasing the cost of the expansion program. Therefore, the only practical alternative is to accept the variations in the grindability and flotation for the Faro Type III ores and the softer Grum and Vangorda ores, and work with the engineering contractor to ensure that the presently designed mill expansion will be reviewed and revised to include the design flexibility that would permit an economic shift to a two-stage grinding and rougher lead flotation circuit - if you agree that, at the very least, some of your near-future ore types could slime badly enough with a single-stage 50 micron primary grind and float to have an adverse affect on lead-silver recoveries. Spedden's April 25, 1980 letter shows one of several possible specific flowsheet variations to your present design that should be considered to minimize this galena sliming problem. Page 7 of his May 14, 1980 letter refers to the previously mentioned same overall recommendation on this by Mitsui, and he also comments therein on a flowsheet variation that should be evaluated.

The Spedden May 23, 1980 memorandum to me, copy attached, covers some very pertinent information that needs to be considered in designing your flotation tests on the more finely ground feeds and interpreting the test results for commercial concentrate production. His information is particularly relevant to the Kamloops and other tests now underway or planned with finely ground flotation feeds from the soft Vangorda and Grum ores.

The maximum degree of flexibility that should be worked into the detail design work underway should encompass the comments in this letter but, for practical reasons, must now be based on the experienced judgment from a combination of your staff, the contractor, and others you may call on. Nevertheless, it is obvious that the essential test information required to optimize the flowsheet should be programmed for the earliest practical completion, and as each phase of the testing is completed and evaluated, the practical and economically desirable modifications should then be worked into any uncompleted or not-yet-frozen detail design drawings and related specifications. For this, the sampling and test program outlined below is recommended for your consideration and, if acceptable, for further detailing and determination of the test procedures.

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1. As a helpful first step to define the causes of present concentrator losses, it is recommended that careful samples of intermediate middlings and tailings and final tailings be taken, sized, and chemically and microscopically analyzed to quantify and locate the sulfide losses and determine the degree of "unlocking" on each sample at each size fraction.
2. Because the Vangorda ore will, in all probability, be mined and milled before the Grum ore body is ready for ore production, a series of locked cycle flotation tests should be run at various primary grinds on fresh Vangorda samples. The purpose would be to determine the affects of galena sliming on recovery at lead rougher feed sizes ranging from about a 70 or 80 micron grind down to a grind in the area of minus 25 to 30 microns. These tests should be supplemented by several comparative two-stage grind-float-grind-float tests at about the same final grinds to compare the metallurgy of the single and two-stage float circuits.

The commercial-scale metallurgy for each set of test results should then be projected, and the operating costs and revenues estimated to determine the optimum grinding and flotation flowsheet and operating parameters.

If the Vangorda ore body is found to include sufficiently different ore types, the above tests should be run on feed samples composited according to the mining plan if such samples can be made available. Otherwise another series of tests with properly composited samples should be run as soon as they can be obtained. This information will be needed not only for meaningful testing but also to forecast revenues for each budgeting period.

3. Anvil's plan to re-drill the Grum ore body this summer and run laboratory tests on the new cores has been mentioned in your telephone discussions with me. I suggest the same type of test program outlined in "2" above should be followed with the samples from this drilling program.

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4. Because the Vangorda and Grum ores are considerably softer and require finer grinding than the harder Faro Type III ore, check tests should be run on mixes of Faro III and Vangorda, and Faro III and Grum samples blended in the same ratios as the ores will be processed. The differential grinding that will be inevitable in a mix of the Faro and Vangorda or the Faro and Grum ores at any given final grind size, should be pinned down in terms of lead recoveries and grades. There should be little or no affect in the zinc circuit.

5. As soon as enough Faro Zone III (or mineralogically equal) ore can be mined to provide enough feed for capacity runs in the present concentrator, plant-scale tests should be undertaken at several different grinds between 130 and about 50 microns. Concurrently taken splits of the mill heads should be used in laboratory locked cycle single and two-stage grind-float tests at the same final lead rougher circuit grinds. The results of the plant-scale and laboratory tests should then be used to develop comparative operating costs and revenues for the two flowsheets at each fineness of grind tested.

Several of the laboratory tests outlined in the above paragraphs should be run to produce enough products to check out the lead cleaner and zinc circuits for assurance that the fine grinds in the two alternative lead rougher circuits do not produce adverse affects in the final cleaner concentrates.

Under the present circumstances, this outlined test program is believed adequate to provide the minimum information needed to develop a project plan to achieve an ultimate optimum balance between concentrate grades and recoveries and total plant operating costs.

The first two concepts outlined below may have been considered and rejected by Anvil for sound reasons but I am not aware of any studies and conclusions on either. They should be examined and evaluated if this has not yet been done.

Differential grinding affects on blends on Faro III and Vangorda or Faro III and Grum ores will create inevitable

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mine ore control and mill operating control problems which will require compromises in recoveries and grades for practical resolutions. Simpler and better plant performance would result from separate milling of each ore under optimum predetermined grinding and flotation parameters. The obvious, but possibly not economically logical concept (in terms of mining plans and cash flows) is to deplete and mill the Faro open pit minable reserve in a continuation of the current operation, then shift to the Vangorda or Vangorda and Grum ores. If there is a good potential for increasing the "on strike" minable reserve in the Faro area, this concept seems particularly attractive. The further advantages could be a concentration of the mining operation and probable lower costs for at least the next 8.5 years. This would also allow ample time to shift equipment as the Faro deposit depletes to the Vangorda limited-life deposit and, or to pre-strip the larger Grum ore body. Also, if the higher grade DY inferred reserve becomes proven with better economic feasibility, that ore might be used as a sweetener to the mill feed or possibly as a total high-grade mill feed when the Faro ore body is worked out.

An alternative to this sequential mining concept would be to operate the expanded mill with two discrete grinding and float sections at least through the lead rougher circuits. This seems feasible from review of the AFE layouts by making relatively minor design revisions. The resulting higher mill operating and control costs could well be overbalanced by improved lead-silver-gold recoveries and higher overall concentrate grades.

The major differences in the grinding hardnesses and mineral unlocking sizes between the three ore bodies and apparently within each ore body (based on limited reliable information from tests on the Faro Zone III, and the Vangorda and Grum ores) make the grind-float-grind-float lead rougher circuit concept the most attractive indicated alternative if sequential mining of the several deposits or the two separate lead rougher circuits are found impractical. The following comments are directed to that alternative.

The general arrangement drawings do indicate that the presently designed grinding and lead rougher sections could be modified readily for flowsheet flexibility.

It also appears that the grind-float-grind-float lead rougher circuit could be adopted at reasonable cost; confirmation would require a review of the present detailed

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design and a cost estimate for the equipment, piping, etc. involved, since the layouts show a fairly "tight" installation.

In addition to the above, Anvil should consider installing its own "test row" or pilot plant at the concentrator to operate on a split feed of mill heads, or as a wholly integrated small-plant for meaningful testing of future flowsheet improvements for the Faro, Vangorda, Grum, and DY ores, and for developing economic and design data from bulk sampling at the Cirque and other future Anvil discoveries. I believe the deposits in the Anvil District are sufficiently valuable and metallurgically complex to justify a captive pilot plant.

Concentrator Plant Design: The assignment made in Mr. Olk's January 23, 1980 letter was limited to a "review of our conclusion with regard to the treatment of Faro and Grum ores by finer grinding." This was expanded during our subsequent telephone conversation to include the Vangorda ore and blends from the Faro and Vangorda and the Faro and Grum ores. However, the assigned review made it necessary to consider the several features of concentrator design that are directly involved with "finer grinding." The matter of an alternative stage grinding and rougher flotation circuit design has already been discussed but there are several other design factors that need comment.

With the presently proposed expansion flowsheet, the cyclone classification circuitry will have to be set to overflow a given fine size of rougher float feeds for the Vangorda and Grum ores, and this will create the hazard of oversliming the more granular Faro galena. Short-term swings in the blend proportions and in the ore types will result in corresponding variations in circulating loads in the grinding-classification circuits, with the likely affect of aggravating the probability of overgrinding some of the granular ore types like that from Faro Zone III.

To minimize the operating control problem caused by these conditions, with either the grind-float or the grind-float-grind-float flowsheets, it would be preferable to replace the presently designed manual grinding circuit controls of the expansion with grinding circuit sump-level

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controls and variable speed pumps. This will help maintain grinding mill circulating loads within a far better range than by purely manual controls, and in conjunction with rod mill feed rate adjustments to suit variable ore hardness will provide more uniform cyclone overflows to rougher flotation. There is ample float cell capacity to accommodate a wide range of input tonnages.

Consideration should also be given to using smaller diameter trash-screen protected cyclones in the fine grinding mill circuits; these will give sufficiently more efficient classification (than the larger diameter cyclones presently planned) to overbalance their additional but minor operating problems.

It is also possible that the lead cleaner circuit re-grind mill may have insufficient capacity to produce the highest practical lead concentrate grade at high recovery. However, without reliable and complete test data and evaluations of the type outlined in this letter, it appears preferable to stay with the present design for this circuit until either the recommended test data are in hand or an evaluation can be made of the performance of the expanded concentrator. All available tests and their inferred results indicate that the present designs for zinc concentrate production should be adequate.

No analytical review has been made by either Spedden or me for the dewatering or tailings unit operations, as these are not thought critical in affecting grinding or flotation performance and are beyond the scope of the present assignment.

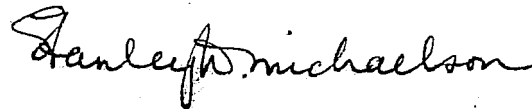
In your consideration of this letter and the attached Spedden reports, it should be noted that we hold a comparatively low level of confidence in the validity of a number of the samples and their compositing for the testing and data provided us. Moreover, we have been faced with some conflicting and inconclusive test information, and have had to rely partly on information from other operations with similar mineralization, and judgement based on experience for reviewing the test data. In other words, we have had to "read between the lines" and then use the limited valid test data and inferences from it to forecast potential

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problem areas in the proposed expansion, and to try to develop reasonable solutions for handling ores with many unquantified characteristics. In this connection, it is of interest to note that the limited data on hand from the Anvil mill operation tend to support the comments in this letter.

With the above in mind, we would be pleased to try to provide any requested further information to add to or clarify any of the points discussed herein or during our telephone conversations and meetings. Additionally, if you think you might want further assistance on the proposed additional testing or in specific areas of plant design and process control, it can be provided on a mutually convenient schedule. I would, however, want to visit the operation at Faro before doing any further work on this interesting and complex project. In any event, I want to thank Mr. Olk and you for the opportunity given me to work on this expansion AFE.

Sincerely yours,

A handwritten signature in cursive script that reads "Stanley Michaelson". The signature is written in dark ink and is positioned to the right of the typed name.

SDM:sgw