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March 25, 1992

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Mr. Bill Dunn, P.Eng.  
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Dear Mr. Dunn:

Re: Geotechnical Review of Faro and Vangorda Pits

INTRODUCTION

As requested, Piteau Associates Engineering Ltd. has completed a review of geotechnical concerns in the Faro and Vangorda Pits. This review and letter report follow similar reviews conducted in the past. The most recent letter report is dated November 9, 1992.

Mr. A. Stewart visited the site on March 5 and 6, 1992. During that time, geologic mapping was reviewed, inspections of the pit walls were made, and results of ongoing pit monitoring were reviewed. Discussions were held with mine personnel regarding these matters.

The following summarizes the results of the geotechnical review. Some general aspects which have already been covered in previous letter reports will not be repeated herein.

FARO PIT

General

At the time of the March 5 and 6 site visit, mining on the east wall was progressing on the 3390 ft level, with most of the remaining mining scheduled for below the northern portion of the calc-silicate area and the southern portion of the north slump area. Access to the east wall was from the main ramp at the south end of the pit. The impact berm that had been established on the 3490/3510 level was performing well, with considerable space available behind the berm to contain rockfalls and ravelling material. A wide safety berm and impact berm had also been left on the 3450 ft level at the southern end of the east wall, thus providing additional rockfall protection for the portion of the slope under the south slump area. At the northern end of the east wall, a waste dump was being advanced from north to south at about the 3630 ft level, buttressing the northernmost portion of the north slump area. Completion of the

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the Faro Pit is understood to be scheduled for early to mid April; however, depending on weather and other factors, it is possible that mining could be extended to early May.

During the site visit, temperatures were well below freezing and the pit slopes were covered in snow. Rockfalls and ravelling were not observed, and the slopes were behaving well. However, the onset of warm weather is expected to lead to increased degradation of the slopes, increased slope movement and a resumption of the rockfall and ravelling activity that occurred during the spring and summer months of 1991.

#### Geologic Mapping and Interpretation

Lithologic and structural mapping that has been completed over the last few months was reviewed and evaluated. In this regard, it appeared that the intersection of two "major structures" (i.e. the Faro Fault and the Northbound Fault) could have a significant influence on slope stability. The Faro Fault strikes almost perpendicular to the east wall and dips moderately steeply to the south, having an average dip direction/dip of  $195^{\circ}/57^{\circ}$ . The Northbound or NB Fault appears as a wide fault zone that strikes slightly obliquely to the east wall and dips moderately to steeply to the west, having a dip direction that ranges from about  $275^{\circ}$  to  $300^{\circ}$ , and a dip of about  $60^{\circ}$  to  $65^{\circ}$ . While neither of these faults would appear to have an orientation that individually would lead to large scale failure of the slope, it is expected that the numerous shear planes within the Northbound Fault zone could cause bench scale instability.

Assessment of the wedge formed by the intersection of these two major structures indicates that such a wedge would plunge at between about  $45^{\circ}$  and  $55^{\circ}$  westward at about grid 9000N/15000E, and thus should not daylight on the overall slope. However, analyses also indicate that the line of intersection would be within about 50 ft of the face at about the 3390 ft level. Thus, this area should be inspected closely for signs of distress caused by a possible wedge failure.

Two strongly developed joint sets were observed in the area where the Faro and Northbound Faults intersect. One set strikes essentially parallel to the Faro Fault, while the other strikes subparallel to the Northbound Fault; both have near vertical dips. While the presence of these two joint sets does not appear to have any kinematic significance, in that they do not appear to define any new kinematically possible failure modes, the frequency of the structures observed in the pit slope will likely cause the slope in this area to behave as a highly broken rock mass. As a result, it is anticipated that it will be difficult to maintain stable bench faces that will not experience an appreciable amount of ravelling and sloughing.

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Lithologically, mapping generally confirms previous interpretations. One small bench scale failure was observed to have occurred toward the north end of the east wall, when phyllite underlying the quartzites and sulphides was exposed and the S2 foliation was undercut. This area is presently being backfilled and buttressed, with waste rock going into the 3630 dump.

As has been discussed in the past, mapping and geologic interpretation should continue as bench faces are exposed. All information should be plotted on plan and on section, and assessed for possible stability concerns.

#### Slope Monitoring

Slope movement rates on the east wall, as determined by prism monitoring, have remained essentially constant or continued to decelerate since our last letter report of November 9, 1991. However, there is very little data on which to base the recent movement rates, with many of the prisms only having been monitored two or three times since early November, 1991. In the north slump area, movement rates are essentially unchanged from last fall, with rates ranging from zero to a maximum of about 30 to 40mm/day.

In the south slump area, where twelve prisms are being monitored, four are not exhibiting any signs of movement. The remaining eight prisms all appear to have decelerated, with the maximum movement rate being about 30 to 40mm/day, and many moving at less than about 12mm/day.

As for the other areas, movement of the calc-silicate area has slowed appreciably. In this regard, monitoring of the six prisms that have been monitored since last summer indicates that little or no movement is taking place, with the maximum rate being about 5mm/day. Four new prisms were installed in the calc-silicate area between about the 3500 and 3550 ft levels on March 4, 1992. However, insufficient data have been gathered to determine if these prisms are experiencing any movement. It should be noted that all of the newly installed prisms have been mounted on bars which have been driven into berms of loose, frozen waste rock. While it is appreciated that these locations were the only ones available from which monitoring could occur, it must be realized that these prisms will yield erroneous data as the berms thaw due to the onset of spring. Careful assessment of this monitoring data will be required.

As discussed during the site visit, and as experienced in 1991, increased slope movements are anticipated during spring thaw. Thus, prism monitoring frequency should be increased to at least twice a week for all prisms immediately above the working area, with particular attention being paid to obtaining background data for the four new prisms. At the extreme north and south ends of the east

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wall, where there is adequate catchment available on wider than normal safety berms, and/or there is no mining activity directly downslope, it is recommended that monitoring frequency be about once a week. As has been done in the past, visual monitoring should continue on a daily basis. Rockfalls and ravelling are expected to increase significantly in the coming weeks.

### VANGORDA PIT

#### General

At the time of the site visit, mining had been completed in the southern half of the pit and had reached as low as the 1110m level in the northern portion. The pushback of the north end wall of the pit had been completed, and the Vangorda Creek flume had been relocated up to about 30m north of its previous location.

#### Cross Fault on West Side of Pit

As discussed in our report of November 9, 1991, a fault identified as the "Cross Fault" has been mapped on the west side of the pit at about Section 12. Furthermore, the fault appeared to dip between  $40^\circ$  and  $62^\circ$  toward  $348^\circ$  on average, an orientation that could adversely affect the stability of the west wall of the pit in the immediate area of the haulroad at about Section 8 to 10. Since this initial assessment, one additional measurement of the fault has been obtained on the 1110 level that indicates that the fault has a somewhat steeper dip (i.e. dipping  $70^\circ$  toward  $340^\circ$ ). If this recent measurement is representative of the overall average orientation of the fault, there may not be a significant concern with respect to the Cross Fault being undercut in the area of the haulroad. However, there is still very little data on which to base a geotechnical assessment of the influence of the Cross Fault on pit wall stability. Thus, as discussed in our report of November 9, 1991, it is recommended that ongoing mapping and assessment of this structure be carried out as each bench is exposed.

In addition to having the potential for being a continuous "major structure", the Cross Fault is likely a wide fault zone rather than a single fault plane. This is supported by the highly broken nature of the rock on the pit slope in the vicinity of the fault. Thus, as can already be seen on the pit wall in the vicinity of Section 12, it is anticipated that considerable sloughing and ravelling will be experienced in the area of the fault. The convex shape of the slope at about Section 12 will likely exacerbate the amount of instability in this area.



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### Northwest Fault

The Northwest Fault has been interpreted to cut off the Vangorda orebody at the north end of the pit. However, it has not been exposed on any pit walls, and its exact nature, location, orientation and impact on wall stability have never been accurately determined. To help define these parameters, existing diamond drillhole intersection data were reviewed by Peter Ledwidge, and a preliminary structural contour map of the fault was constructed. The results of this review indicate that four old diamond drillholes may have intersected the fault which, like the Cross Fault, appears to be a fault zone. Furthermore, the fault zone seems to dip about  $58^{\circ}$  to  $68^{\circ}$  towards a dip direction of about  $099^{\circ}$  to  $117^{\circ}$ , although it is likely somewhat wavy in both strike and dip.

At its presently interpreted orientation and location, the Cross Fault is projected to intersect the proposed main ramp on the north wall and northwest corner at about the 1060m elevation, possibly causing some instability. It may also combine with S2 foliation to create bench scale stability problems in the northeast corner of the pit. However, considering the limited amount of data that are available concerning this fault, it is not possible to definitively evaluate the potential for instability as a result of encountering the Cross Fault on the pit wall. Thus, as discussed during the site visit, it is recommended that ongoing mapping and interpretation of this fault be carried out, and that stability assessments be updated on a regular basis as more geologic information becomes available.

-Northwest?

-Northwest?

### Cracking on Interim Haulroad

During the site visit, cracking was reported along the shoulder of an internal interim haulroad in the northern portion of the pit. On inspection, it appeared that the edge of the haulroad was founded on frozen, loose overburden with an appreciable root and organics content, and that the cracking was probably the result of consolidation and squeezing of the overburden at the edge of the road. Possibly blasting and dynamic loading from the haultrucks also contributed to the cracking.

Based on the brief inspection, it is concluded that sloughing of the haulroad is likely to occur (i.e. particularly if warmer temperatures cause the overburden to thaw). However, such sloughing is expected to be restricted to the shoulder of the road, and it is not expected that the main travel portion of the road will be in jeopardy. Nonetheless, this portion of the haulroad should be visually monitored on a daily basis until it is mined out. Access to the bench immediately below the area in question should be restricted such that men and equipment are kept a safe distance away from the slope.

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Slope Monitoring

Slope monitoring, using prisms and regular visual inspections of the pit walls, should be instituted in the northern portion of the pit as the pit slopes are established. At the present time, it is recommended that prisms be installed approximately every 60 to 80m along the bench on which the Vangorda Creek flume is located. Early detection of any movement of this bench will be critical to the prevention of slope failures that could jeopardize the integrity of the flume. Visual inspections of this bench should be carried out at least every second day and after any blasts in the area.

I hope the above is sufficient for your needs at this time. If you have any questions concerning the above, please do not hesitate to contact us.

Yours very truly,

PITEAU ASSOCIATES ENGINEERING LTD.



Alan F. Stewart, P.Eng.

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