020408

February 28, 1986
P7745

Kilborn Limited
2200 Lake Shore Blvd West
Toronto, Ontario
M8V 1A4

Attention: Mr. E. I. Jurgens
Project Engineer

Gentlemen:

Rose Creek Dam Raising
Faro Mine, Yukon
Initial Design

We have completed the goetechnical and hydrological review of the initial design considerations regarding the raising of the Rose Creek dam as received from you on February 24, 1986.

The dam section as proposed by Kilborn Limited would appear to be satisfactory. However, we would note that certain modifications are required to ensure a safe and acceptable design. These modifications are outlined in the attached notes, the main requirements being summarized in the following.

Geotechnical requirements include

- the inclusion of a pressure relief system
- the addition of filter/drainage zones on the downstream slope of the existing dam, and
- the addition of flexible couplings on the extended portion of the outlet pipe.

The hydrological and hydraulic review indicated that the proposed dam and spillway configuration is acceptable. However, the optimization of design may lead to large economies. An optimization based on the presently available study results will give a more economical dam and spillway configuration. The preliminary review indicates that the following could be achieved.

ACRES INTERNATIONAL LIMITED
5259 Dorchester Road, P.O. Box 1001, Niagara Falls, Ontario, Canada L2E 6W1
Telephone 416-354-3831 Telex 061-5107 Cables ACRESCAN NFS
Vancouver, Calgary, Winnipeg, Toronto, Burlington, Halifax, Sydney, St. John's

- Reduction in the increase of dam height by 2 to 3 m. Instead of 6.5-m increment, it could be 3.5 to 4.5 m.

- Elimination of new spillway.

- Instead of demolishing the entire existing spillway, leave 10-m length at a crest el 1097 and gate this section. Such an arrangement can pass in excess of 10 000-year flood, while providing adequate live storage to meet the mine water requirements.

Considering the potential savings in dollars it is recommended that these suggestions be reviewed prior to any final commitment on concept of dam configuration.

Yours very truly,

A. L. McKechnie
Project Manager

Encl

cc - Mr. H. M. Visagie
Curragh Resources

GEOTECHNICAL CONSIDERATIONS

1 - Zoning of the Rose Creek Dam

The zoning on the upstream side of the core may be too narrow and may result in instability of the slope at low reservoir levels. If so, then a more vertical core with a horizontal connection to the existing Zone 1 fill may resolve this concern (see attached sketch). In addition a more vertical core would be less susceptible to distress due to possible settlement of the slightly softened foundation downstream from the dam.

We would recommend that a drainage zone be extended along the downstream face of the existing dam and connected to a horizontal blanket which would extend to the toe of the raised dam. This would thus ensure the presence of a pervious zone which currently may not be provided by the existing Zone 2 fill. (See attached sketch.) The thickness of the transition zone can however be reduced from the 10 ft shown on the drawing.

We would suggest that all the zones in the raised portion of the dam be renamed to avoid confusion with existing fill.

2 - Effects of Raising Reservoir

Raising of the reservoir by some 20 ft will result in the following alterations to the geometry and design elements of the dam.

- Hydraulic gradient increases across both the upstream blanket core connection and across the core. Both of which are not felt to be of critical importance to the integrity of the dam.

- An increase in underseepage through the dam foundation proportional to the head increase. This is not felt to be of critical importance with regard to reservoir storage capacities.

- Artesian pressures in the dam foundation will increase proportionally to the increase in head and may present significant impact with regard to stability and piping of the foundation. We would thus strongly recommend that a pressure relief system be incorporated below elevation 3646 along the downstream side of the dam extending some 10 ft into bedrock. El 3646 represents the elevation above which the upstream cutoff trench was taken to bedrock as shown on the Simons Drawing D1575-058-005, Rev 2. Provisions to ensure that the pressure relief system is not affected by freezing in the winter should be considered.

3 - Dam Design Considerations

(a) Geotechnical Design Parameters

In the absence of any shear strength data on any of the fill zones or overburden foundation, we would concur with your use of an effective angle of internal friction of 35 deg and zero cohesion for all zones, excepting Zone 1 fills which we would suggested by reduced to, say 28 deg. Shear strength and Atterberg testing should be carried out for the Zone 1 fills.

Gradation of the various zones suggested for use in raising the dam would seem to be appropriate, and filter design criteria should be satisfied.

Design parameters for pressure relief design and seepage quantity calculation may be more difficult to assume as minor variations in permeability have considerable effect on analysis. However, foundation permeabilities can be assumed to be in the order of 5 x 10-3 cm/s for initial design.

Settlement analysis in both the short and long term both for the fill and foundation should be analyzed in the detailed design phase.

(b) Loading Conditions

The following loading conditions should be included for the design of the Rose Creek dam.

Downstream Slope

- End of construction
- Long term (maximum reservoir)
- Long-term with seismic (maximum reservoir)

In addition the beneficial effect of pressure relief on the above analysis should be performed.

Upstream Slope

- End of construction
- Long term (low reservoir)
- Drawdown
- Long term with seismic.

Seismic loading using pseudostatic analysis should be used. A value of 0.15 g would seem to be appropriate, however, this should be assessed in more detail for this specific site.

4 - Outlet Structures

Extension of the 42-in. pipe to the new valve house should be founded on bedrock to avoid any differential settlements, and thus cracking of the pipe. Should this not be possible, flexible couplings are strongly recommended at the transition of bedding from bedrock to overburden and other critical points. We would recommend that the pipe be encased in concrete if founded on bedrock, with additional consideration if it is not on bedrock.

We would suggest that a comprehensive check on the existing details and condition of the pipe be carried out to ensure the integrity of the system and to ensure no chance of differential settlement or cracking.

5 - Spillway

The geotechnical design for the spillway is satisfactory.

HYDROLOGICAL CONSIDERATIOS

In March 1985 Acres, Calgary, prepared a hydrology study for the Rose Creek reservoir.

The purpose of this study was to

- determine the reliability of increased long-term supply of water for the mine requirements given a selected dam height and hence the associated reservoir size.

- determine the latest start date for the impoundment while still guaranteeing to meet the mine water requirements during the first year of operation.

- determine the flood flows and to review the size of the spillway.

In order to achieve the above objectives, a 25-year synthetic streamflow sequence was developed using standard procedures. The methodology used was as follows.

- Correlation of Rose Creek below Faro Creek and Ross River at Ross River.

- Prorating of Rose Creek reservoir inflows on the basis of drainage area ratios from the derived data for Rose Creek below Faro Creek.

The inflows derived from such an analysis are adequate for the final design of the structures. No further work is required to develop the streamflow sequence.

For the analysis of the floods, two independent approaches were used.

- Regional flood frequency analysis
- Unit hydrograph analysis.

Both these methods yielded approximately the same results. Both snowmelt/rainfall and pure rainfall generated floods were considered in the analysis. The methodology adopted is adequate for final design. The 10 000-year return period event has been derived using standard statistical procedures. The analysis appears to be well done, and therefore it is reasonable to assume that these flood magnitudes are in the correct range. A review of other studies carried out for the Northwest Territories indicates that the statistically derived flood magnitudes are in the correct range. However, the probable maximum flood computed by using AES data appears to be about 5 times that of the 10 000-year return period event. Experience in other rivers is such that the 10,000-year return period event is on the average 50% to 65% of the PMF. No details are available on the PMP analysis. Therefore, it is recommended that the PMF be briefly looked at again if it is considered necessary for the structures to be designed to be safe against the PMF. If the 10 000-year event were to be adopted for the design, then no further work is necessary.

The studies carried out do not recommend any particular value for design purposes. After the review of PMF analysis is carried out, it would be possible to define appropriate flood mangitudes for spillway design. The choice of flood will dictate length of spillway.

The methodology adopted to determine the latest possible impoundment data is a standard one and is adequate for final design. No further work is necessary.

The conclusion would be that the hydrological analysis is adequate for final design except for the suggested reviews associated with the PMF. The dam and spillway configuration proposed is acceptable and adequate.

However, it should be noted that the proposed configuration is not optimal, i.e., not the least cost solution. It appears that if the problem were to be restated at this point in the following manner

"Given this hydrology, what would be the optimal arrangement of structures to meet the same mine water requirements?"

The answer would be different from the proposed configuration with substantial savings in the total cost of the project.

what about cost of gated spillway?

The 24-year simulation indicates the reservoir fluctuates between 1089.3 m and 1102.5 m using about 6.4 million cubic meters. Since the reservoir can be allowed to go down to 1087 without causing any vortex problems, the optimal reservoir would go down to this elevation at least once during the 25-year simulation period. In addition, the flood magnitudes being low, a gated spillway structure at the location of the present structures but much shorter in width would be able to handle the floods. Starting from 1087 the same 6.4 million cubic meters would be mobilized between el 1101.5 and 1087. With the spillway crest raised by 1 m to allow for new profile to handle slightly higher head, the crest will be at el 1097. With a 4.5-m head, a gated structure of about 8 to 10 m will be capable of passing the flood flows up to 150 cubic meters per second.

Allowing for nominal freeboard the dam crest could be set at 1103.5 m. Thus a reduction in dam height increase of 2 m could be achieved. The necessity of building a new spillway will be eliminated.

These aspects would need to be confirmed in detail before final firm commitments are made if a least cost solution is desired.

The other recommendations concerning the low-level outlet valve chamber apparatus, particularly the replacement of the plug valve with a more smoothly operating system, less prone to cavitation, should be taken into consideration for the final design and construction.

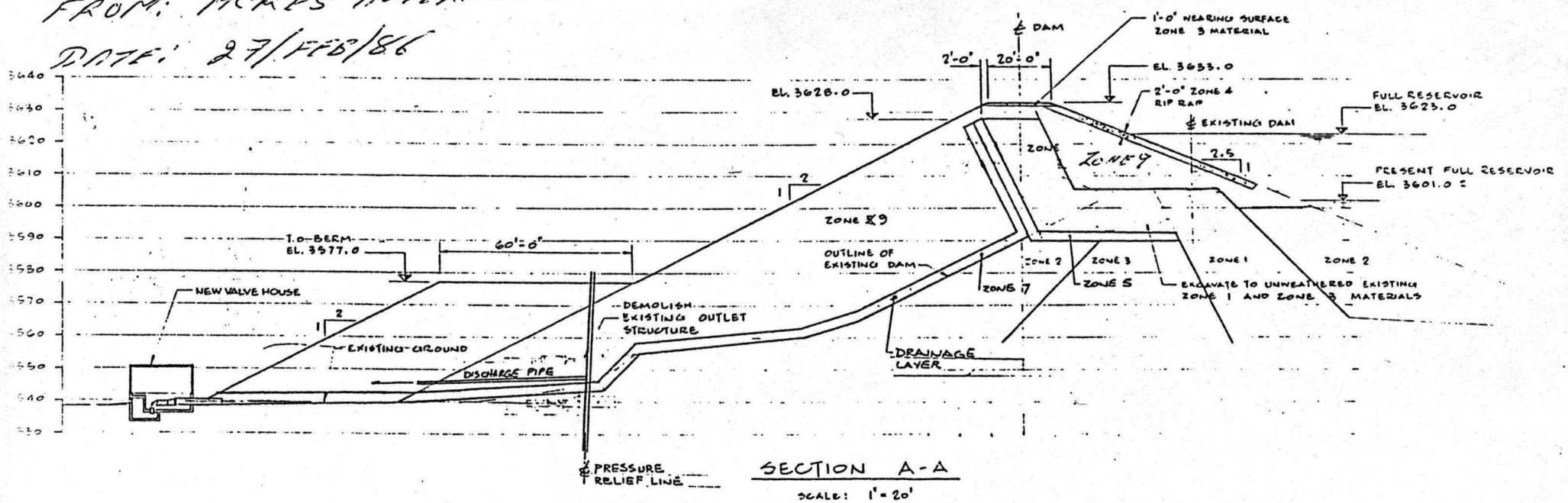
ROSE CREEK DAM, FARO MINE, YUKON
ZONING MODIFICATIONS

E F G H J K

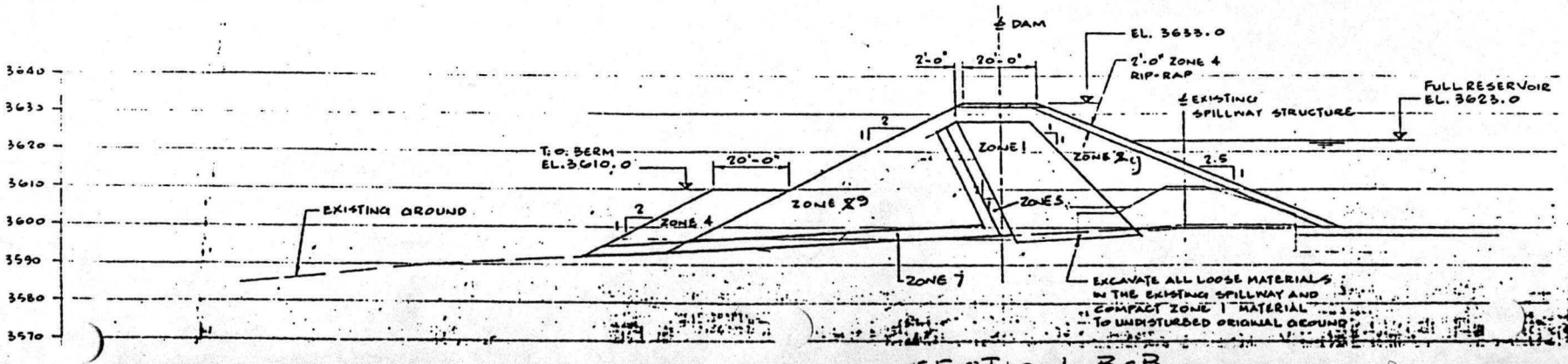
TO: MR E. I. JURGENS
HILBORN LTD

FROM: ACRES INTERNATIONAL LTD

DATE: 27/FEB/86



SECTION A-A
SCALE: 1" = 20'



SECTION B-B