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ANDALEX
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M E M O R A N D U M

TO: Randy Harden, UDOGM

FROM: Michael W. Glasson

DATE: May 12, 1989

SUBJECT: Sed Pond Slope Stability

Here is Bill Leeflang's report. I think his conclusion speaks for itself. The "As Built" drawing was a sketch the surveyor had developed which he apparently reduced. We are still working on the final drawing on our autocad system. It will be finished next week.

MWG/lb

cc: File

PALMER WILDING
CONSULTING ENGINEERS - 405 SOUTH 100 WEST - BOUNTIFUL, UTAH 84010 - 295-7372

May 8, 1989

Mike Glasson
Andalex Resources
P.O. Box 902
Price, Utah 84501

Re: Sedimentation Pond Slope Stability

Dear Mike,

At your request, a slope stability analysis was conducted on the newly constructed sedimentation pond in the lower portion of the Andalex Resources mine operation area. The purpose of the analysis was to determine stability of the "As Constructed" slopes. The following report presents the results of our field investigation and engineering analysis.

POND AND SLOPE CONFIGURATION

Based on "As Constructed" drawing of the pond provided by Andalex Resources, the following configuration is presented (see Figure 1). The sediment pond is principally excavated west of the Andalex access road and in part into the west side of the canyon. The pond is approximately 200 feet long, 100 feet wide and 22 feet deep at the deepest location. The excavation of the pond on the west side of the canyon has resulted in a cut slope 44 feet high laid on a 1.4:1 slope (1.4 feet horizontal : 1.0 feet vertical).

The east side and south end (downstream end) of the pond is principally excavated with some fill placed above an imaginary line extending from the decant inlet up to the east end of the emergency spillway (or approximately 14 feet), see Figure 1. The slope of the east cut and embankment is about 2.0:1.

A ditch is located above and around the west side of the pond allowing for a diversion of snow melt and storm runoff around the pond.

FIELD INVESTIGATION

On April 26, 1989 a field examination of the pond and attendant slopes was made. The pond has been excavated in coarse colluvial materials derived from the Cretaceous Blackhawk formation, and consists of gravels, cobbles and boulders including a silty sand/sandy silt soil matrix (GM-GP). The materials also include interpocketing and interlayering of clayey silts/silty clays (CL-ML).

The rock fraction of the excavated slope consisted principally of sandstone gravels, cobbles and boulders. The upper portion consisted of approximately 50% rock fraction. The lower 12 feet of the pond excavation consisted of approximately 60% to 70% rock fraction, with large angular rock fall boulders measuring upwards of 10 feet. Removal of these boulders during construction required drilling and blasting.

The soil matrix was observed to be interpocketed and somewhat interlayered. The cohesive materials had a consistency varying from hard to very hard. The cohesionless materials varied from dense to very dense.

Sampling of slope materials was difficult due to the coarse and dense nature of the site materials. As such, no undisturbed samples were obtained. Five disturbed samples of the soil matrix were obtained for laboratory classification purposes.

STABILITY ANALYSIS

A "Modified Bishops" method of analysis using limiting equilibrium procedures was used to make rigorous solutions and provided the ability to examine numerous cases and failure surfaces for the sedimentation pond stability analysis.

Stability concerns have been raised about two portions of the pond configuration, namely; the west 44 foot high cut slope, and the east cut and fill slope near the embankment.

The east slope has been excavated and filled to a slope of 2:1. The filling operation as reported by Andalex personnel included proper construction practices of filling and compaction. Due to the slope configuration and proper construction practices it is our judgment that the east slope is stable under long term conditions and does not warrant rigorous analysis.

The west slope of the pond was analyzed at the maximum cut height at a slope of 1.4:1. The configuration of the slope is based on the "As Constructed" drawing provided by Andalex Resources, as depicted on Figure 1.

The section was simplified into two general materials sections; namely a lower layer of coarse gravels, cobbles and boulders in a sandy silt soil matrix measuring 12 feet in height above the bottom of the pond, and an upper layer of gravels and cobbles with sandy silt soil matrix.

The strength characteristics of the two soil layers are based on material type and laboratory classification testing, as follows:

Upper Soil Layer (1)	Friction angle = 36^{o}	Cohesion = 100 psf
Lower Soil Layer (2)	Friction angle = 38^{o}	Cohesion = 100 psf

The water elevation, assuming steady state seepage, was maintained at the principal spillway elevation. The phreatic surface within the slope, assuming a draining subsurface, falls off to the west at a moderate slope of approximately 4:1, see Figure 2.

The diversion ditch passing snowmelt and storm runoff around the west side of the pond is not expected to impact the long term stability of the slope. The ditch potentially will pass flows from an ephemeral drainage located north and west of the pond. Reports from mine personnel indicate that no flows have been observed from the drainage in the past ten years. In the event that drainage does occur from snowmelt or storm runoff, the flows would be transient in nature and would not result in saturation of the slope. This is further aided by the nature of the finer grained and dense/hard consistency of the soil materials, thus minimizing seepage into the subsurface. (The diversion ditch must be maintained to allow the free flow around the pond.)

The lowest factor of safety obtained in the analysis with the specified configuration and strengths was 1.59. Generally, minimum acceptable factors of safety for long term steady seepage have been recognized as 1.5.

CONCLUSION

The results of the stability analysis are adequate and indicate a stable section with respect to shear under static loading conditions.

We appreciate the opportunity of performing this service for you. If you have any questions concerning our findings or report, please call.

Sincerely

PALMER-WILDING CONSULTING ENGINEERS

Willem E. Leeflang, P.E.

WEL/ap

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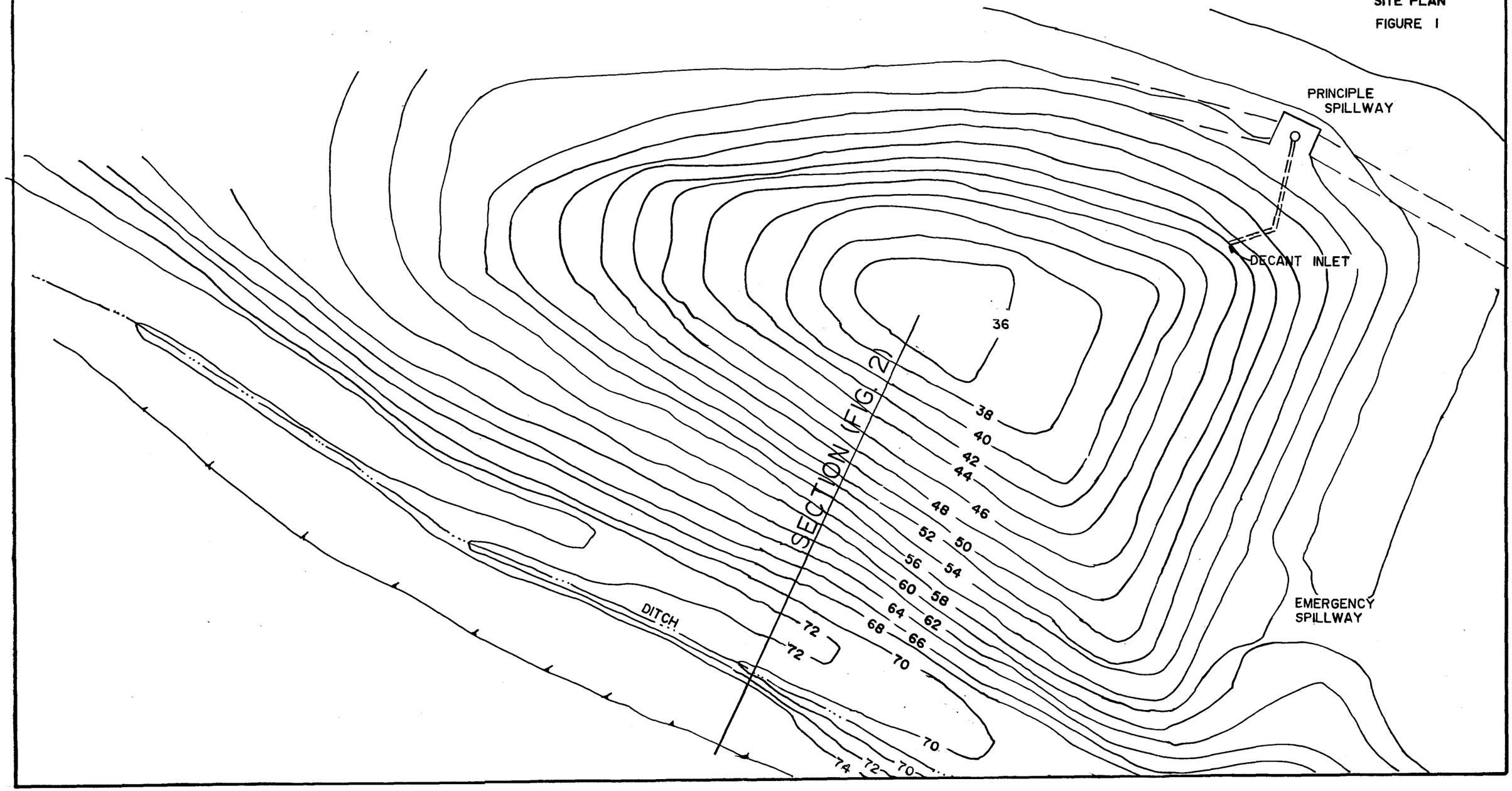
SCALE IN FEET

ANDULEX RESOURCES
SITE PLAN

FIGURE 1



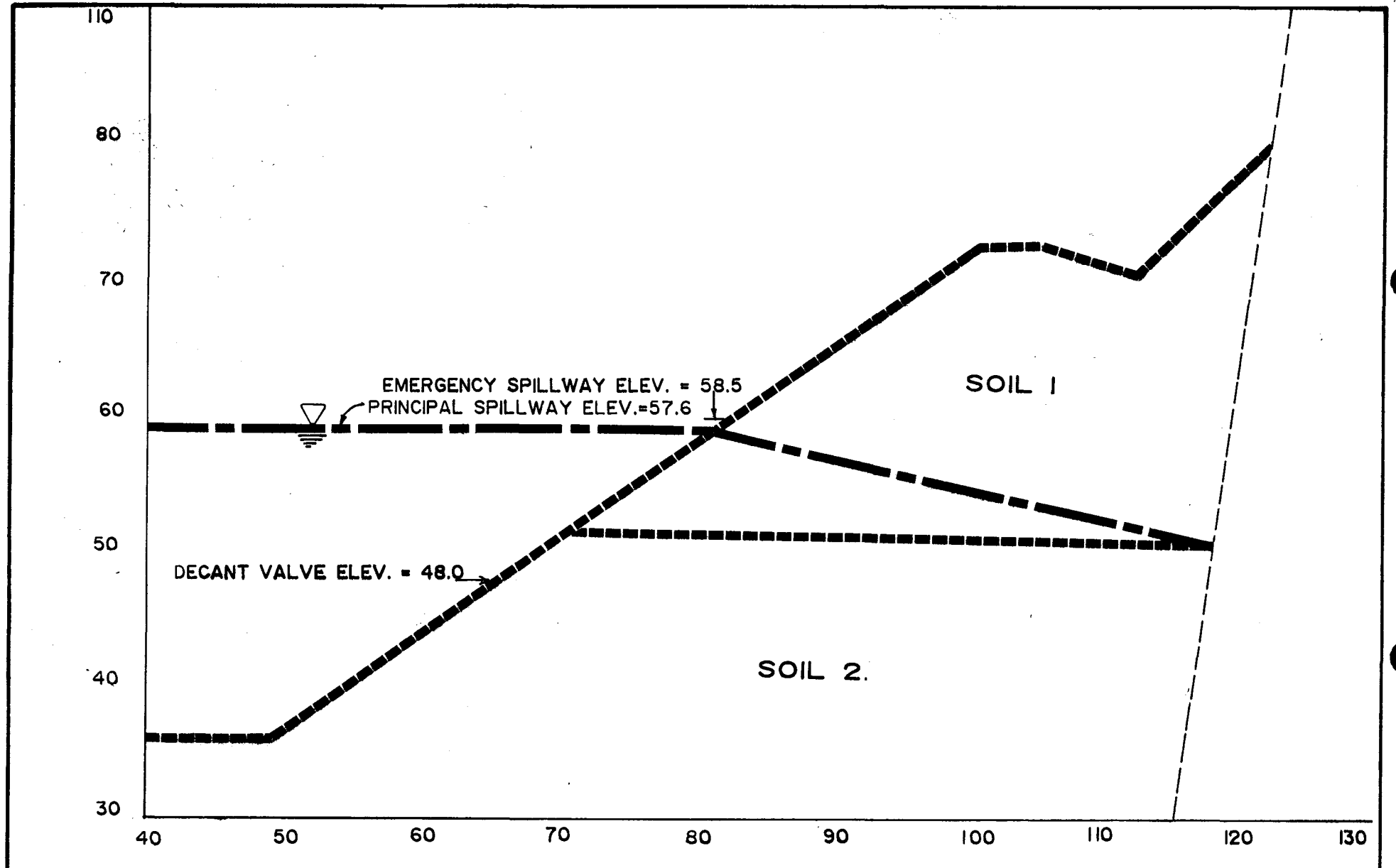


FIGURE 2

ANDULEX RESOURCES
SLOPE STABILITY ANALYSIS