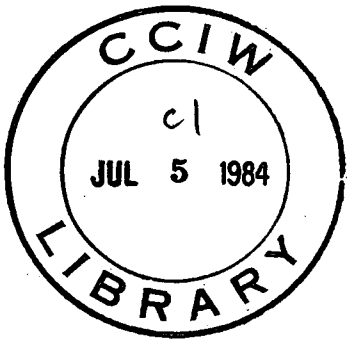
HYDRAULICS DIVISION
TECHNICAL NOTE



DATE: June 1984 **REPORT NO:** 84-18

TITLE: Stability of Drainage Ditch at Madawaska Mines Tailings Pond.

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1.0 INTRODUCTION

As part of a proposal for decommissioning and closing out, the Madawaska Mines are proposing to channel all runoff from their Number One Tailings Pond area through a drainage ditch. The ditch will have a trapezoidal cross-section with bottom width of 3.66 m (12.0 ft.) and side slopes of 1 in 5. The ditch is expected to carry a flowrate of 0.1512 m^3/s (2000 gpm). The stretch of the ditch wihin the tailings pond area will have a milder slope of +0.5% whereas the stretch outside leading to a filter bed will have a steeper slope of +6%. The ditch will be lined with a coarse gravel rip-rap. The following calculations were carried out to determine if both stretches of the ditch will be stable.

2.0 DETAILS OF CALCULATIONS

The flow cross-section of the ditch is shown schematically in Fig. 1.

Let h be the flow depth in metres for the given flow rate, Q of 0.1512 m^3/s, and let the median size of the rip-rap material, D_{50} be 50 mm.

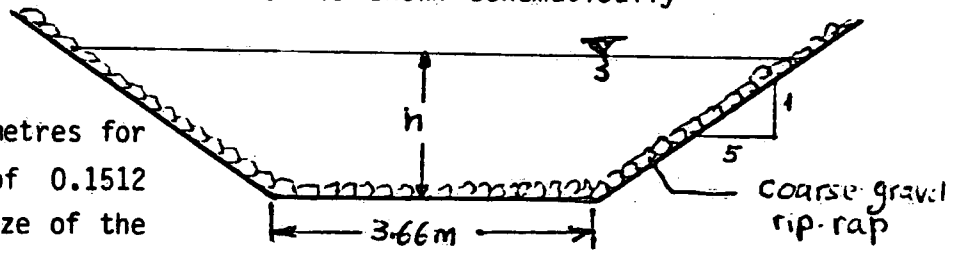

Fig. 1 (not to scale)

The flow cross-sectional area $A = (3.66\ h + 5h^2)\ m^2$

The wetted perimeter $P = (3.66 + 10.2\ h)\ m$

Hydraulic radius $R = \frac{A}{P} = \frac{(3.66\ h + 5h^2)}{(3.66 + 10.2\ h)}\ m$

Using Strickler equation to estimate Manning's n, the value of n can be evaluated as:

$$n = 0.041\ d_{50}^{1/6} \quad (D_{50} \text{ im metres})$$

$$= 0.041 \times (.05)^{1/6} = .025$$

Using Manning's equation:

$$Q = \frac{1}{n} A R^{2/3} S^{1/2}$$

a relation for flow depth h for milder slope ditch can be derived as follows:

$$.1512 = \frac{1}{.025} \times (3.66h+5h^2) \times \left[\frac{3.66h+5h^2}{3.66+10.2h}\right]^{2/3} \times (.005)^{1/2}$$

Solving the above equation, the flow depth for the milder slope ditch is determined as

$$h = 8 \text{ cm}$$

The mobility number, Y can be calculated from

$$Y = \frac{\gamma}{\gamma_s} \cdot \frac{Sh}{d_{50}}$$

where γ is the specific weight of water
and γ_s the submerged specific weight of rip-rap material

Assuming the specific gravity of the rip-rap material as 2.65, the mobility number, Y for this flow becomes:

$$Y = \frac{1}{1.65} \times \frac{.005 \times .08}{.05} = .005$$

The critical mobility number, Y_{cr} can be obtained from Shields diagram. For the size of the rip-rap material Y_{cr} can be read from the Sheild's diagram as

$$Y_{cr} = .05$$

Since the mobility number Y is 10 times less than the critical mobility number the ditch having milder slope will be stable.

3.0 STABILITY OF STEEPER DITCH

The equation for flow depth of the steeper ditch flow is:

$$.1512 = \frac{1}{.025} \times (3.66h+5h^2) \times \left[\frac{3.66h+5h^2}{3.66+10.2h}\right]^{2/3} \times (.06)^{1/2}$$

This gives a value of 3.8 cm for the flow depth.

The mobility number Y becomes

$$Y = \frac{1}{1.65} \times \frac{.06 \times .038}{.05} = .03$$

The mobility numbers for steeper ditch is still lower than the critical mobility but the difference is not very much. Therefore, it is likely that some movement of the rip-rap material in the steeper ditch may occur. It should be pointed out that the evaluation of Manning's 'n' for this case may not be very accurate because the computed flow depth is less than the height of the rip-rap material. This, coupled with any possible uncertainty in the estimation of design flow rate casts further doubts about the stability of the rip-rap in steep ditch. To be on the safe side, a fifty percent increase in the size of rip-rap is recommended.

4.0 CONCLUSIONS

The ditch with milder slope will be stable. The steeper slope ditch might move some material. To ensure full stability in the steeper ditch it is recommended that the size of the rip-rap be increased, at least by 50%.