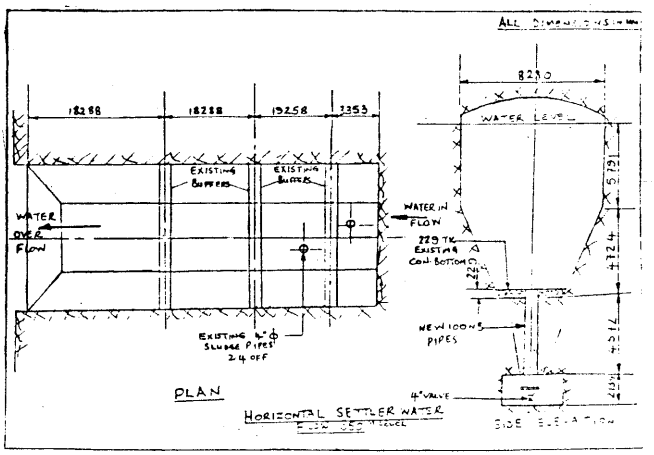
TITLE : Dirty water settling at Konkola Underground

INTRODUCTION : The paper discusses the current dirty water settling arrangements at Konkola prior to pumping underground water, its efficiencies and operating parameters. It only deals with suspended particles in the water and does not deal with dissolved solids which is beyond the scope of this presentation.

SETTLING ARRANGEMENTS : Konkola mine pumps between 270,000 to 300,000 cubic metres of water per day, water from two different shafts (No.1 Shaft & No.3 Shaft) report to three pump stations whose settlers are located at 350mL, 675mL and 960mL. The overflow from the settlers feed clear water sumps. The under flow from the settlers are pumped through a series of slurry pumps into the tailings thickener located at the concentrator for final disposal.

Three types of settlers are used at Konkola mines indicated below:

Settling arrangements at 350mL: Two horizontal flow settlers are mined. The sketch below indicates their basic constructional details.



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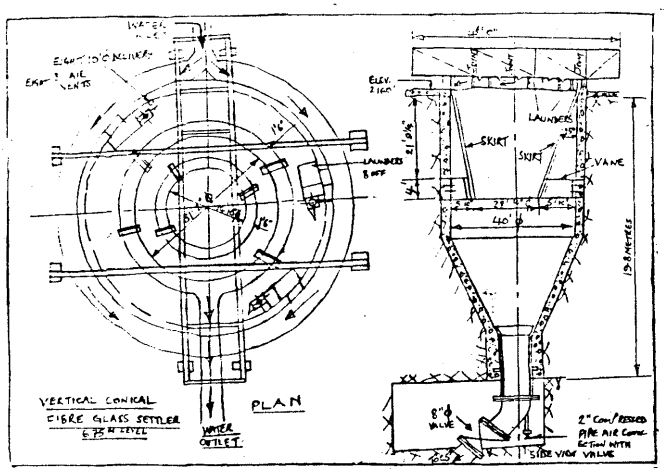
These settlers are 54.9 metres long, 8.2 metres wide and 10.7 meters deep. Their capacity is 4800 cubic meters and the flow each is approximately 80,000 cubic meters per day. Theoretical retention time is 85 minutes.

The water simply flows through horizontaly and, due to the drop in velocity, the larger particles fall to the bottom. The sludge is drawn off through the pipes on a continuous basis. One settler is used all the time and the other settler is dedicated to receive slurry pumped from lower levels.

Settler arrangement at 675mL: Five vertical flow conical settlers are mined. Only three settlers are provided with internals. The two types of settlers used in this level are conical fibre glass settler and ventilation pipe settler whose features are described below:

Conical fibre glass settler: The following figure indicates the general constructional details:



The settler is 19.8 metres deep and 12.3 metres in diametre. The capacity is approximately 1600 cubic metre and the flow rate is 48,300 cubic metres per day. The theoretical rentention time is 48 minutes.

The water enters the settler along a concrete drain drive feeding the inlet launder, which feeds eight delivery boxes via a fibre glass skirting. The water flows out of the delivery boxes and enters the settlers tangentially through a skirting. At the bottom of the skirt are 32 vertical vanes which stop the swirling action of the water before it starts to rise up the center of the settler. The heavy particles continue to fall to the bottom of the settler and clean water rises into the circular outlet of the launders via 58 "v" notches and then flows into the outlet drain drives. The sludge is drawn off from the bottom via pipes provided.

Only one settler is provided with this type of internals due to the following:

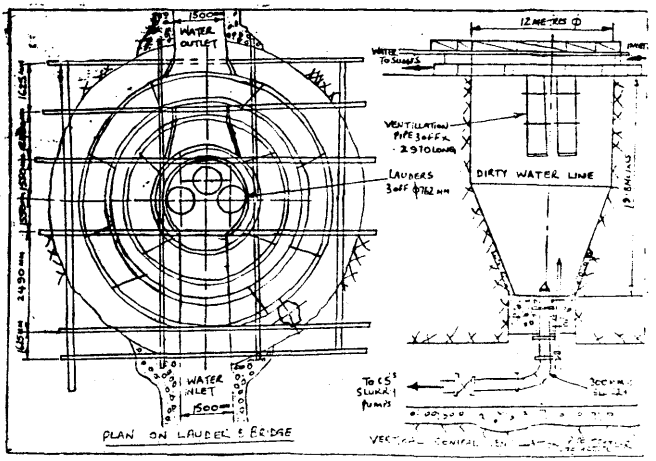
. Installation and modifications were difficult

. This type of settler is designed to be used with flocculent and no flocculent can be used at Konkola due to large volume of water and high rising velocities.

. The capital costs of the internals were high

Hence a simplified settler arrangement was designed.

Ventilation pipe settler: The following figure indicates the general constructional details:



The water enters the settler along a steel launder and flows down in three 30 inch vent pipes. The larger particles continue to fall and clear water rises to the top and flows via 'V' notches into the launder and out, along the drain drive. All other dimensional parameters are as indicated for conical fibre glass settlers.

Out of the five settlers three are equipped with internals, one without internals are dedicated to receive slurry pumped from lower levels and one is kept empty to provide storage during emergency.

Settler arrangement at 960mL: Five vertical conical settlers are mined and are equipped with ventilation pipe settlers. Normally four settlers are in operation and one is kept empty to provide storage capacity during emergency.

Why settling is required: Dirty water is required to be settled to remove the suspended particles in water for two reasons which are:

. In order to avoid excessive wear on centrifugal pumps

. The draft Mining Regulations (Pollution Abatement) indicates that the total suspended solids contained in fluid effluent discharged into Kafue river will conform to proposed second schedule (Regulaiton 15) as shown below. It is to be noted that when settlers were initially designed the main criteria was to protect pumps from wear at lowest cost. Hence further test work was recently performed to determine current state of operation with regard to pollution abatement.

SECOND SCHEDULE
(REGULATION 15)

PART 1

Authorised levels of deleterious substances
(in milligrams per litre)

Item	Substance	Column 1 Maximum authorised monthly arithmetic mean Concentrator	Column 2 Maximum authorised concentrator in a composite Sample	Column 3 Maximum authorised concentrator in a grab Sample
1	arsenic	0.5	0.75	1.0
2	copper	0.3	0.45	0.6
3	lead	0.2	0.30	0.4
4	nickel	0.5	0.75	1.0
5	zinc	0.5	0.75	1.0
6	cobalt	0.25	0.35	0.45
7	TSS	25	37	50

Effect of particle size: In a Sulzer HPH 54/25 pump it has been reported that the wear rate rapidly increases for particles >25 microns. Hence all test work was done with this factor in mind.

Determination of settler efficiency: In order to determine the efficiency of test work inlet and outlet water samples were taken for a seven continuous days at 2 hour intervals and analyzed using a coulter Counter whose results are summarized as follows.

SUMMARY OF % OF PARTICLES SETTLED

	> 50 Microns	> 25 < 50 Microns	> 5 < 25 Microns	> 5 Microns
1150L Settler	26.5%	7.3%	14.6%	15%

	> 50 Microns	> 25 < 50 Microns	> 5 < 25 Microns	> 5 Microns
Fibre Glass Conical Settler	49.7%	40.7%	37%	38.9%
Ventilation n pipe Conical Settler	29.6%	29.6%	25.8%	26.6%

It was also found during test work that the particle sizes generally were as follows:

Number of particles > 50 microns = 860/CC

Number of particles > 25 < 50 microns = 630/CC

Number of particles > 5 < 25 microns = 6250/CC

The test work results indicated the following:

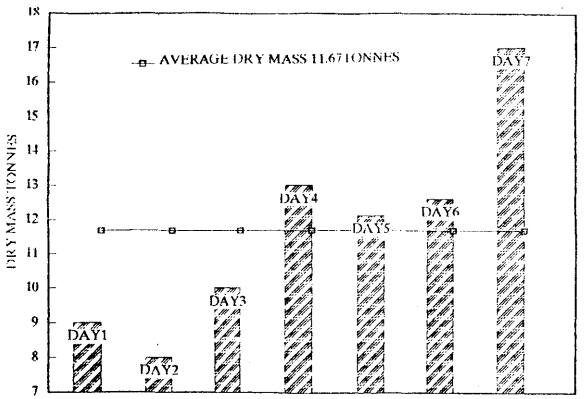
- All the samples indicated the ratio of the number of particles < 25 microns, to the number > 25 microns was approximately 4:1. This fact tends to nullify the effects of increased wear rates due to larger particles. History indicates at Konkola that pumps are overhauled after 20,000 hours which is considered satisfactory.
- Ventilation pipe settlers settled the different sized particles fairly uniformly.

Fibre glass settlers provided the best overall efficiency;

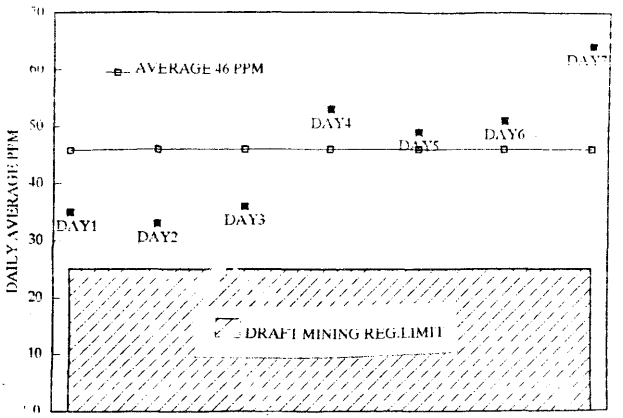
However it is the most expensive to install.

Current Operating Parameters: Test work was recently conducted to determine the current settling efficiencies and the quality of underground water discharged to Kafue river. The results are indicated as follows:

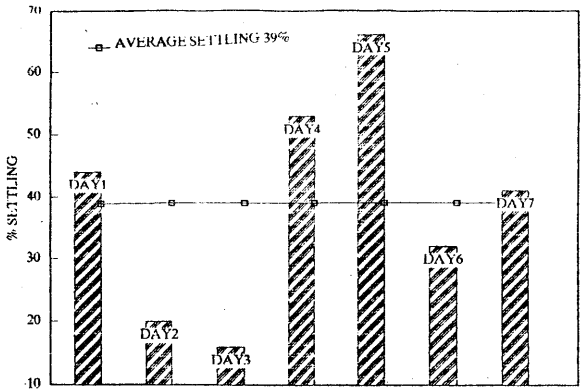
The following graph indicates the dry mass of total suspended particles discharged into Kafue river during a seven day cycle of water pumped from underground.



The following graph indicates the average PPM of total suspended particles discharged into Kafue river during a seven day cycle of water pumped from underground.



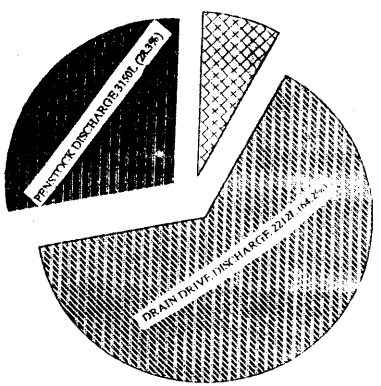
The overall system efficiencies of settling underground are indicated below:



TSS = TOTAL SUSPENDED SOLIDS

$$\text{SYSTEM EFFICIENCY} = \frac{(\text{TSS FROM ALL SOURCES} - \text{TSS INTO KAFUE})}{\text{TSS FROM ALL SOURCES}} \times 100$$

The following graph indicate the various sources of suspended solids underground.



It can be seen from the above graphs that:

. Water from No.3 Shaft contributes to 71% of the total suspended particles although the water contribution is about 30%.

. The average overall efficiency of settling underground is 39%.

Conclusion: The settling is adequate to suit the needs of operating equipment.

If the draft Mining Regulations (Pollution Abatement) are to be adhered to, it is anticipated that the following actions may be required.

. Investigate why the No.3 Shaft water is very dirty and contain the same.

. Some surface settling arrangements may have to be provided to meet the new stringent requirements.

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Draft Mining Regulations letter dated 12 November 1992.

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