

## 7. TAILINGS MANAGEMENT

### 7.1 Introduction

This section includes discussion and comment on the tailings engineering and related aspects associated with the Material Properties. Specifically, detail and comment is focused on the design, construction, geotechnical integrity, remaining capacity and management practices governing the tailings facilities. Key source data for the review comprised the engineering design constraints, where available, as prepared by the appointed tailings dam review consultants at each of the operations. Site-specific issues are summarised below:

### 7.2 Iron Ore

#### 7.2.1 Sishen Mine

Sishen Mine currently has four tailings (slimes) dams and one plant waste rock dump. The tailings dams and waste rock dump are situated on near-horizontal ground. The dams contain iron ore washings. All of the dams are operational, and are used on a rotational basis. The waste rock dump is also operational, receiving coarse reject material from the plant.

Currently, each tailings dam has a top operating surface of approximately 700m by 700m, with the total surface area being 195.6Ha. The dams are about 10m high on average. The average monthly tonnage being deposited on to the operating tailings dam is 150ktpm (dry tonnes), which equates to 1.8Mtpa.

The waste rock dump is about 60m high and currently covers an area of about 1km by 0.7km. Coarse waste is fed from the plant on to the dump via a conveyor at a current rate of approximately 360tph, which equates to 3.1Mtpa.

#### **Current Conditions:**

- **Tailings Dams:** The site inspection revealed that the tailings dams appear to be in good condition. No toe-line seepage was noted. The existing freeboard on the dams is good with the minimum freeboard being about 2.5m above current pool levels. Much of the slurry washings consist of clay, noted at about 26% by mass. The clay has exceptional impermeability qualities, which appears to be the main reason why the designed underdrain outlets and toe-line remain dry. Each dam has its own dedicated ringfeed discharge pipeline. This is a 200NB steel line with spigot holes at 1.0m centres. The holes are plugged using timber wedges. The slurry product has a sand fraction of about 17% by mass, which settles out quickly. This sand fraction forms the perimeter section of the beach and is about 50m wide. It is this sand fraction which provides much of the stability to the ring-dyke system of each dam. The balance of the fines consists of silt, equating to about 57% by mass. The dams do have standpipe piezometers installed in-situ.
- **Plant Waste Rock Dump:** The Sishen waste rock dump is located about 600m N/E of the tailings dam complex and is approximately 60m high. The sides of the dump have a slope angle of about 37°, which is the natural angle of repose of the loose waste rock. Waste rock is delivered to the dump on a conveyor belt system and is end-tipped off the conveyor using a rotatable conveyor section. Visually, the rock varies from about 150mm down to 25mm, although there are areas where a significant amount of fines – down to dust, were noted, hence the reason for erosion seen at the end of the N/W advance. The rock is delivered at about 8.485tpd, which equates to 3.1mtpa. It is estimated that the placed waste rock has an in-situ dry density of about 1,9tpm<sup>3</sup>. The dump was inspected for signs of cracking, sliding and toe-line heave. No abnormal signs were observed in this regard. It is concluded that the waste rock dump is in good condition and stable. However, the following is noted: The base of “inner” depositional area is covered with domestic refuse trucked in from Kathu; felled trees have also been placed in the vee area of the dump’s footprint; and some erosion was noted along the slope of the western flank and at the end of the N/W advance of the dump. While no signs of instability are currently apparent, it should be noted that the domestic refuse and cut vegetation could cause a rock slide should the thickness of domestic waste become excessive and or become saturated. The top (flat) surface of the dump should be inspected on a weekly basis for any signs of slumping/cracking in the placed waste rock, insofar that the conveyor tipping system is threatened. (Conveyor systems forming waste stockpiles have been known to collapse under sudden differential settlements initiated by sliding.)

#### **Tailings Capacity:**

- **Tailings Dams:** Only one dam at a time is used for slurry deposition. Each dam is continuously used for a period of between 12 and 16 months before switching over to the next dam. Approximately 150 ktpm is presently being deposited on the slimes dams on a rotational basis. The current rate of rise (“RoR”) of the operating dam is approximately 1,75m/yr during operations. However, the overall rate of rise of the

4-dam complex is currently 0,44m/yr. No problems are envisaged under the current dispensation. It appears that the average in-situ dry density of the settled tailings is about 2.31tpm<sup>3</sup>. (Six near surface density samples were taken for laboratory testing. The results have been meaned, slightly adjusted and incorporated in the model.) The dams do have standpipe piezometers installed in-situ.

**Table 7.1 Sishen Mine: Tailings Dam Capacities**

Description	Prod. Rate (ktpm)	Final Ht. (m)	Current RoR (m/yr)	Final RoR (m/yr)	Capacity (Mm <sup>3</sup> )	Capacity (Mt)	Life (yr)
Four dams (to 2028)	150	22	0.44	0.55	21.2	44.5	24.7
Four dams and cross (to 2028)	150	18	0.38	0.39	21.5	45.2	25.1
Four dams only	150	35	0.44	0.71	39.6	83.1	46.1
Four dams and cross	150	35	0.38	0.44	57.5	120.7	67.1
Four dams (to 2028)	225	29	0.66	0.94	31.6	66.4	24.6
Four dams and cross (to 2028)	225	23	0.58	0.61	32.4	68.0	25.2
Four dams only	225	35	0.66	1.07	39.6	83.1	30.1
Four dams and cross	225	35	0.58	0.66	57.5	120.7	44.7

The foregoing capacities are based on the tailings dams having step-ins (benches) formed at 7m vertical intervals and being 10m wide. This applies to all flanks of the four tailings dams, giving an overall side slope angle of about 18°. Scenarios relating to 50m heights have not been reviewed in depth, as Scenarios 2 and 6 indicate that the respective tonnages can be placed for 67 and 45 years, beyond July 2005. The current LoM ends in December 2028, some 22.5 years earlier. However, based on the above side slope considerations the capacities to 50m in height are as follows: 4 dams only (56Mm<sup>3</sup> ~ 117.6Mt) and 4 dams and cross (88.5Mm<sup>3</sup> ~ 185.8Mt). It is likely that if the tailings dam complex rises beyond 35m in height, two dams and the cross may have to be operated simultaneously and that more stringent monitoring will also be necessary.

- Plant Waste Rock Dump: SRK has undertaken an evaluation of the remaining capacity of the plant waste rock dump based on the currently defined footprint area, which is almost square in the direction of current advance. The remaining base area is about 500m by 500m. The dump is currently about 60m high. Based on current geometry the dump has a remaining capacity of about 12.0Mm<sup>3</sup>. At an assumed in-situ density of 1.9tpm<sup>3</sup>, the remaining mass volume is 22.8 Mt. At a current delivery rate of about 360tph arising from the plant, it will take 7.25 years to complete. However, with the SEP plant earmarked to come on stream from July 2007, and ramping up to full production by June 2008, the life of the current plant waste rock dump will be less. Taking ramp-up figures into consideration, the existing dump will run out by the end of December 2009. This date assumes that the dump will receive both current and SEP waste; that only the current footprint is used and that the in-situ density is 1.9t/m<sup>3</sup>. In order to further accommodate both current and SEP waste streams till the end of 2028, an additional site will need to be secured. A base area of approximately 267ha will be needed for the new footprint. This equates to a square base having 1.2km long sides. The dump would have side slopes of 1V to 1.5H and be 60m high. The mass volume of this dump will be about 150Mt ~ 80Mm<sup>3</sup>. However, the Mine needs to confirm the actual in-situ density of the waste rock. This should be done on a quarterly basis to monitor trends and to obtain a reliable mean, which can be used to size future disposal zones.

**Tailings Cost Review:**

- Tailings Dams: With regard to operating cost requirements, an additional ZAR0.45mpa should be budgeted from 2006 onwards. This amount will be necessary to cover step-in formation, the cleaning out of existing drainage trenches in the event that bench penstocks are necessary, as well as installing bench penstocks. General operating costs relating to slimes handling at the plant are already included in the plant budget, in the LoM Plan.

In terms of the capital cost requirements the following is noted:

- If the slimes dams continue along the current sliming philosophy, and the product remains unchanged, new elevated penstocks will be required when the dams reach a height of about 25m. Replacement costs at today's prices are estimated at ZAR2m per penstock. The penstock decant system should incorporate a "2-tower arrangement", as this will provide some flexibility if a tower should fail. The base pipeline to the pump-house is also likely to need replacing. It is estimated that the replacement of the base pipeline and valves will be about ZAR2,5m – an amount of ZAR10,5m should be allowed for capital expenditure in 2032;

- An amount of ZAR0.75m should be budgeted to cover design review costs prior to handling of the SEP (and any other washings) that may arise. The study must focus on the impact of the SEP tailings on the current tailings dam complex, the best means to maintain an ongoing level of stability, as well as maintaining acceptable risk levels against failure linked to Zones of Influence.
- If the design review indicates that the preferred way forward is to incorporate the cross into future sliming operations (current plus SEP), then the Capital expenditure amount indicated by Sishen management should be sufficient to cover the incorporation, this amount being ZAR36m.
- Plant Waste Rock Dump: In assessing operating costs for the maintenance of the Plant Waste Rock Dump some additional cost is envisaged over and above that allowed in the plant expenditure. This will be necessary for slope configuration using a bulldozer part-time. It is believed that an additional ZAR0.45mpa should be budgeted from 2010 onwards to achieve such aims. Concerning capital cost requirements for the plant waste rock dump, no immediate capital is necessary. However, for the future expansion of the dump, it is recommended that an amount of ZAR0.05mpHa be set aside for the preparation of the dump base. SRK believes that an area equating to 154Ha should be secured for this purpose. SRK also notes that the proposed waste rock dump as indicated on drawing ALL-PPTT-SSS-D-XX Rev RR has a base area of 202Ha. SRK calculations show that according to information supplied (i.e. future production of 173Mt till December 2028), a base area of about 154Ha should suffice. The side-slope geometry indicated on the above-stated drawing is good. Therefore, a Capital expenditure amount of ZAR7.7m (say ZAR8m) should be allowed for base preparation. This amount can be phased in equal amounts to years 2008, 13, 18 and 23 – in ZAR2m modules.

### 7.2.2 Sishen South Project

It is noted from documentation provided that it is intended to operate the Sishen South Project on a direct shipping ore basis and for this reason no tailings dams will be required at the Sishen South Project. It is noted that provision has only been made for waste rock stockpiles strategically placed on the site. An initial capital amount of ZAR1m should be budgeted for footprint preparation and thereafter an operating cost amount of ZAR0.25mpa for shaping of the waste rock dumps.

### 7.2.3 Thabazimbi Mine

Thabazimbi Mine currently has four tailings (slimes) dams. These are hillside tailings dams accommodating iron ore washings. Three of the dams are currently operational and one is dormant. The following indicates current conditions:

**Table 7.2 Thabazimbi Mine: Tailings Dams, Current Operating Specifications**

Description	Prod. Rate (ktpm)	Height (m)	RoR (m/yr)
Dam 1 – Operational	9.6	80	1.57
Dam 2 – Dormant		18	
Dam 3 – Operational	19.4	65	1.56
Dam 4 – Operational	11.0	40	1.56
<b>Total</b>	<b>40.0</b>		<b>1.56</b>

**Tailings Capacity:** SRK has reviewed what is perceived to be the remaining current capacity on the tailings dams, based on our site inspection and documentation at hand. During the site visit, a number of near surface in-situ “undisturbed” samples of tailings were taken for laboratory testing. The samples were taken from the beach adjacent to the catwalk on dam 1. Returned results indicate that the finer material in the dam has a near surface in-situ dry density of 1.75t/m<sup>3</sup>. This value has been used in the SRK model to determine the RoR and remaining life of the dams. While it is understood that the average tonnage for the past 18 months has been about 23ktpm, the highest monthly value was 42.5ktpm. As the variation spread is large, SRK has elected to use 40ktpm as the baseline value. With the above-stated in mind, the remaining life of the dams is as follows:

- 40ktpm scenario distributed *pro rata* on surface areas – with dam 2 dormant – 5.96 years. Say 6 years (2.86Mt ~ 1.63Mm<sup>3</sup>); and
- 40ktpm scenario distributed *pro rata* on surface areas – with dam 2 recommissioned – 6.6 years (3.17Mt ~ 1.81Mm<sup>3</sup>).

SRK has selected the preferred rate of rise based on the assumption that no materials characterisation records are available, neither slope stability analyses. From the tables set out below, it can be seen that the recommissioning of dam 2 will provide some respite to the current RoRs and will also help to lower risk.

**Tailings Cost Review:** With regard to operating cost requirements, an additional handling cost of ZAR1.75/t of dry solids deposited as presented by Fraser Alexander Tailings is considered a reasonable rate (excludes VAT). This rate includes plant for raising the perimeter paddock walls which is also required. In terms of the capital cost requirements the following is noted:

- Undertake a detailed stability review (piezocone tests as applicable) and report compilation. (Continuation report) on all 4 dams and return water dam. Estimated cost of ZAR0.3m;
- Upgrade the operating manual, including appropriate topographical survey for the existing complex. Estimated cost of ZAR0.275m;
- Upgrade Code of Practice for the existing complex. Estimated cost of ZAR0.075m; and
- Install piezometers, including supervision and survey on all 4 dams. Estimated cost of ZAR0.08m.

A total additional capital cost of ZAR1.1m is estimated.

**Table 7.3 Thabazimbi Mine: Tailings Dams Capacities**

Description	Dam 2 Dormant			Dam 2 Operational		
	Prod. Rate (ktpm)	Current RoR (m/yr)	Future RoR <sup>(1)</sup> (m/yr)	Prod. Rate (ktpm)	Current RoR (m/yr)	Future RoR <sup>(1)</sup> (m/yr)
Dam 1	9.6	1.57	2.15	8.6	1.40	1.92
Dam 2				4.0	1.40	1.73
Dam 3	19.4	1.56	1.73	17.5	1.41	1.56
Dam 4	11.0	1.56	1.75	9.9	1.41	1.58
<b>Total</b>	<b>40.0</b>	<b>1.56</b>	<b>1.84</b>	<b>40.0</b>	<b>1.41</b>	<b>1.66</b>

<sup>1</sup>SRK's preferred RoR is 1.00m/yr and is based on the following:

- No designed under-drains under the current tailings dams;
- Fine (predominantly clay) material seen in the perimeter wall make-up. Operating techniques can be improved; and
- No stability analysis seen at the time.

Until such time as it can be proved through adequate engineering analyses that a higher RoR is not detrimental to the stability of the existing tailings dams, SRK does not advocate a higher RoR. Even our RoR limitations should be reviewed, but for the interim it does set a conservative limit, which will help in lowering the current risk of failure. SRK's RoR recommendation will also bring on stream a new tailings dam which, as we see it, is necessary in lowering risk on the existing tailings dams.

## 7.3 Coal

### 7.3.1 Grootegeluk Mine

**Waste Disposal:** There are a number of discard dumps situated around the mine. The status of the various discard dumps are as follows:

- Dump Nos. 1, 2 and 3: This consists of three separate discard dumps adjacent to each other. The dumps were constructed using mainly open pit coarse discard and overburden. The dump covers an area of approximately 76.1Ha and is approximately 60m high and was decommissioned in 1981. The dump has been capped with sandy material and some vegetation established. The vegetation is sparse however as a result of the spontaneous combustion taking place within the dump. The capping material is being eroded away by wind and rainfall and this is allowing the spontaneous combustion to continue. The burning taking place within the dump is being monitored by the Grootegeluk Mine.
- Dump No. 4: The current production of plant coarse discard is being disposed of on this dump via a conveyor and spreader system. The discard is being placed via an upper and lower bench conveyor system. Capping of the outer face of the lower bench system is being carried out using the sandy soil from the borrow area in close proximity to the dump.

Currently 80% of the plant coarse discard is disposed of on the lower bench and 20% on the upper bench. At the current rate of deposition of the plant coarse discard, the lower bench has a life of approximately 6.5 years while the upper bench has a life of about 27 years. Grootegeluk Mine intends to change the deposition rates in about 2010 to 60% to the lower bench and 40% to the upper bench. The Mine is also planning to move the lower bench conveyor to the in-pit disposal area in approximately 2011 and then the upper bench conveyor system in 2021. After this date all plant and pit coarse discard will be disposed of in the open pit. Dump No. 4 is approximately 60m high at present. Grootegeluk Mine is busy replacing capping material to the lower bench in areas where the previous capping material has been eroded away. Some areas on this dump are also burning and this is being monitored by the mine.

- Dump No. 5: This dump is still operational and is situated adjacent to dump No. 4. Originally plant discard was placed at the base of this dump. Pit overburden is now being placed on the dump mechanically with haul trucks and dozing and the discard is being covered. Burning within this dump is also occurring and this is being addressed by the Mine by placing of the pit overburden to cover the discard. Storm water management at the dump is also being investigated to try and prevent erosion of the cover material from the dump. The dump is approximately 80m high and covers an area of approximately 551.7Ha when combined with dump No. 4.
- Dump No. 6: This dump was decommissioned in 1987. The dump is approximately 50m high and covers an area of approximately 87.8Ha. The dump consists mainly of pit overburden with some interburden having been placed on the eastern side. The dump has been capped with material, however vegetation establishment has not been implemented. Burning is taking place within the dump and this is being addressed by Grootegeluk Mine by covering these areas with soil material to try and extinguish the burning locations. An approved permitted domestic landfill waste site has been established on top of this dump and is being used by the mine. Two effluent water/silt ponds are located at the toe of this dump to collect the polluted storm water run off from the plant and to allow for the fine silts to settle out prior to removal. The polluted water system is being efficiently managed by the mine and the ponds were dry at the time of the inspection. The mine is also busy with a number of projects in order to better manage and control all storm water run off from around the various areas at the plants and to use this water as part of the process system, thereby reducing their requirement for potable water.
- Dump A: Dump A is situated adjacent to Dump Nos. 4 and 5. The dump is being constructed mechanically using haul trucks and spreading with a dozer. The dump is being constructed with overburden material from the pit. The dump is currently approximately 10 – 15m high.
- Renoster Dump (Dump B): This is a fairly new dump and is also referred to as Dump B. This dump is also being constructed using haul trucks and loosely tipping the overburden discard over the side slopes at the angle of repose. No formal compaction is being applied to the dump. This dump is approximately 40m high at present and covers an area of approximately 54.6Ha.
- Tyre Dump: This dump has been partially decommissioned and was constructed with interburden and overburden material from the pit as well as silt material from the de-silting operations. The dump is approximately 15m high and was constructed with some underdrainage system. The dump has been capped and rehabilitation test work is being carried out on this dump in order to try and establish the requirements for the other dumps to be rehabilitated around the Grootegeluk Mine. This dump will need to be removed in about 40 years time due to the proposed future mining operations at the Mine.
- Backfill Dump: The backfill dump is situated in the pit and commenced on a small scale in 2000. It is currently being constructed using the interburden from the open pit and then covering with the overburden from the pit excavations. A large amount of research has been carried out by the mine in order to determine the optimum operating and placement conditions for the discard in order to try and eliminate the spontaneous combustion problems associated with this type of work. The discard material is placed in cells and covered with overburden material at present it is not susceptible to spontaneous combustion. The cover material is being placed within a period of eight weeks to prevent combustion taking place. As stated earlier, the mine propose to dispose of part of the plant discard to the Backfill Dump in 2011 and after 2021 it is proposed that all discard being produced will be disposed of back into the pit. The mine is actively pursuing the planning and programming to ensure that this can be achieved. Furthermore it is also being proposed by the mine to mix some ash material from The Matimba Power Station with the discard being placed into the cells in order to try and further reduce the spontaneous combustion problem. An input dewatering return water dam and sump has also been prepared in the pit adjacent to the backfilling operation in order to collect and store the polluted storm water run off water for re-use at the Grootegeluk Mine.

Life of Mine Discard Tonnage: Currently Grootegeluk Mine produces some 18Mtpa of discard material from the plant area. This discard is reactive and prone to spontaneous combustion and is being disposed of at Dump No. 4 at present. There is also approximately 7.5Mtpa of interburden (pit discard) being produced at the Grootegeluk Mine. This discard is also reactive and prone to spontaneous combustion. This discard is currently being disposed of in the Backfill Dump in cells as part of the testing programme. At a later stage Grootegeluk Mine proposes to add ash from the power station to coarse discard in order to try and reduce the spontaneous combustion problem further. Grootegeluk Mine also currently produces some 13.5Mtpa of overburden material from the pit workings which is non-reactive. This material is mainly being used to cover the discard dumps.

Life of Discard Dumps: Based on the current production rate of plant coarse discard material it can be seen that there is sufficient life on Dump No. 4 lower bench for the plant discard up to 2011, after which the lower bench conveyor will be moved to the Backfill Dump in the pit for future disposal. Also the Dump No. 4 upper bench has sufficient capacity for the balance of the plant coarse discard from 2011 to 2021, after which the upper bench conveyor will also be moved to the Backfill Dump in the pit. From 2021 all the plant and pit coarse discards will be disposed of in the cell system in the pit. The future planning and targets for the backfill operations are well advanced to show that this is feasible for the life of the Mine.

#### ***Tailings Disposal:***

The status of the various slimes dams are as follows:

- Dam Nos. 1 and 2: These ring dyke slimes dams have been consolidated into one operating dam. The fine coal slimes is pumped to the dam and then deposited via an HDPE pipe around the dam. Holes have been drilled into the HDPE distribution pipe to deposit the slimes using a spigot deposition method, which allows for beaching and settlement of the suspended solids. Supernatant water then gravitates to the centrally located penstock decant system for removal and pumping back to the plant. The solution trench around Dam Nos. 1 and 2 is concrete lined, and overgrown in some areas. There are no paddocks around the tailings dam to contain run-off of fine slime discard from the side slopes. Very little fine slime discard run-off however was noted around the dam. Two step-ins have been constructed around the perimeter of the consolidated dam. Two test panels for drying of the fine discard have been installed on the western flank upper step-in of the dam by Jones and Wagener. Erosion gullies have occurred down the slope of the dam in these areas where decant pipes have been installed. This will require some maintenance. The existing penstock decant system and pipeline has shown signs of failure on three occasions in the past. The last occurrence took place early in 2004. Following a camera inspection of the inlet structures by Fraser Alexander Tailings ("FAT") the dam operators, it was recommended to replace the system with a new elevated penstock pipeline and inlet system. This new elevated penstock system is currently being completed and comprises of a double inlet system on the dam with a steel outlet pipe to the outer edge of the dam, which changes to a 500mm diameter HDPE pipe which conveys the decanted supernatant water to the sump. Once the new penstock system becomes operational, the old penstock pipe will be concrete grouted and the inlets sealed. Seepage was noted along the northern flank of the dam. This is as a result of the under drainage pipes in this area being blocked and covered with slimes when Dam No. 4 existed. This seepage must be monitored to ensure that erosion from the slopes of the dam do not become excessive. The dam is equipped with piezometers which are monitored monthly by FAT.
- Dam No. 3: This slimes dam is currently being re-mined mechanically and the fine coal discard transported to the plant for blending with the coal supplied to the Matimba. The re-mining of the fine coal discard is taking place at the rate of 15.000ktpm. Once this dam has been re-mined, the Grootegeluk Mine intends to convert the dam to a drying bed system whereby the fine coal discard will be deposited into paddocks for drying and then re-mined for blending with the coal to Matimba on an ongoing basis. As part of this operation, a conveyor system will be installed to convey the dried fine discard to a mixing plant prior to conveying to the power station. Test work relating to the drying of the fine discard and the final design of Dam No. 3 drying beds is currently in progress and is being carried out by Jones and Wagener. It is proposed to implement this drying process during 2007. This system will result in no further slimes dams being required at Grootegeluk Mine.
- Dam No. 5: This dam covers an area of 14.8Ha and has a top area of 13Ha at present. The maximum height of the dam is approximately 3.5m. The dam is currently dormant, but could be used in the case of an emergency. It is proposed by the mine to start re-mining the fine coal slimes discard in approximately 2007.
- Return Water Holding Facility and Sump: Decanted water from the slimes dams reports to the concrete lined sump from where it is pumped back to the plant via a floating barge pump in the sump and pipelines. Excess rain water from the solution trenches and area around Dams Nos. 1 and 2 report to a small earth holding facility adjacent to the sump. This water drains into the sump or the Mamba Return Water Dam. The sump and Mamba Return Water facilities are linked with a pipeline.
- Mamba Return Water Dam: The Mamba Return Water Dam was designed and constructed to contain a 1-in-50 year 24-hour storm event from the slimes dams. The dam is lined with Hyson Cells filled with concrete. The dam has been equipped with an inlet area on the southern side and a spillway on the northern side. An under drainage system has been installed below the liner and seepage water is pumped back into the dam.

Life of Mine Slimes Tonnage: The current remaining LoM at Grootegeluk Mine based on the current production is approximately 50 years. This excludes the five undeveloped farms which are still available for mining. With these additional farms the life of mine could extend to over 100 years. The current planned fine

coal discard slimes production rate is 60ktpm (720ktpa). Modifications to the plant are being proposed. Once these have been implemented (anticipated 2010) the amount of fine slimes discard will reduce to approximately 45.833tpm (550ktpa). The current planned re-mining of fine coal discard from the tailings dams is at the rate of 15.000tpm (180ktpa). This will increase to 45.833tpm (550ktpa) in 2010 when the cyclic operated slimes dam is in operation.

Life of Tailings Dams: Based on the tailings dam annual monitoring report prepared by FAT in November 2004, the planned slimes production rate is shown as 34,000tpm (408ktpa) while the actual tonnage deposited was in the order of 80,400tpm (964.8ktpa). The top area of the dam is currently approximately 818m x 515m = 421,270m<sup>2</sup>. This is based on the survey drawing provided by the mine. The current rate of rise of the dam is therefore approximately 2.23m/yr. This is similar to the rate of rise given by FAT in their annual report. The above indicates that the current tailings dams Nos. 1 and 2 have a limited life (October 2006) at the current production rate of approximately 80,000tpm. The Grootegeluk Mine is currently investigating alternative deposition options to resolve this problem.

### 7.3.2 Leeuwpan Mine

**Discard and Slimes:** Leeuwpan Mine produces two principal sources of mine waste from the Leeuwpan plant, namely coarse discard and slimes. Coarse discard is produced dry and is transported to the pit for disposal. The method of disposal within the pit is dependent on the availability of tipping area. The primary method involves tipping directly within the pit, where the material is placed, spread, levelled and compacted, thus minimising the potential for spontaneous combustion. When availability in the pit is limited, end tipping is used, however as lower placed densities are achieved the risk of spontaneous combustion is increased.

The spontaneous combustion has been effectively controlled through compaction and covering of the discard with overburden. Slimes disposal facilities at Leeuwpan Mine included four slurry ponds where slimes were deposited in these ponds hydraulically and allowed to settle out of suspension. The heights of these ponds differ with a maximum height of about 3m. Penstock systems in these ponds allowed for supernatant water to be decanted into the return water facility. The intention here was that fines, once dried would be removed and sold to the brick making industry. The process had however been somewhat hampered by the inadequate drying and consolidation of the slimes material. Consequently, and due to the inability of the additional capacity to meet targets, Leeuwpan Mine has installed a filter process to dewater the slimes at the main plant area. This advanced technology of the filter press allows the mine to re-use process water very efficiently and enables direct disposal of the dried slimes with the coarse discard in the pit areas. Therefore the slurry ponds are currently dormant with no future intention of slimes being deposited onto these ponds again.

**Other Stockpiles:** Dried slurry previously removed from the slurry ponds was stockpiled. Solution trenches were constructed around these stockpiles capturing the storm run-off. The solution does not drain anywhere and water is left to evaporate. Currently the mine plans to topsoil and grass these stockpiles in order to rehabilitate them and to control dust. There are topcoal stockpiles located adjacent to the old plant, which the mine plans to reprocess within the next two years. The discard material resulting from this process will be placed within the Kenbar Pit.

### 7.3.3 Tshikondeni Mine

The Tshikondeni Mine produces two principal sources of mine waste, namely coarse discard and tailings. The mine currently operates two disposal facilities located adjacent to the plant and consists of an old discard dump which was recently converted into a co-disposal facility and will operate this way for the remainder of its safe operating life. The second co-disposal facility adjoins the old facility and has been in operation since November 2003. The old facility is currently at the point of decommissioning and closure and all the tonnage produced on the mine will then be discharged on the new operating facility towards the end of 2005.

The tailings disposal facility is contained within the discard dump which is continuously raised during construction to ensure adequate containment of the tailings discharge. The discard is transported mechanically using vehicles and compacted in 150mm layers to reduce the risk of spontaneous combustion. The tailings material is pumped into the tailings facility (containment area) via HDPE pipes from the plant in slurry form and allowed to consolidate. The tonnage split between tailings and discard is currently in the region of 16% tailings. Currently the tonnages are split between both the old and the new facilities. The old facility has however nearly reached its safe maximum capacity. The new facility was formally designed and constructed according to good practice and in-line with the industry norm and allowance was made for an internal drainage system with effluent return infrastructure. The design was approved by all the necessary authorities and it was agreed that the facility will reach a final closure elevation of 379mamsl. The internal drainage system will control phreatic levels, increase the effluent return to the plant and create safe and stable conditions. The seepage collected from these drains is channelled via an HDPE lined earth channel into

a single HDPE lined pond (return water dam). From the return water dam the effluent is returned via pumps located next to the facility back to the plant. The return water dam was constructed with a spillway and was designed with a total capacity of 27,000m<sup>3</sup> and includes an 800mm freeboard as required by legislation.

#### **7.3.4 Arnot Colliery**

The waste stream generated from the Arnot Colliery operation is discard. The slurry (fines) that is produced is reprocessed in the plant, no fines are disposed of. The plant produces approximately 10,000 dry tonnes of discard per month, which is disposed of in open cast voids. The discard is trucked to the open cast pits and compacted to reduce the risk of spontaneous combustion of the discard. The cost of trucking the discard is carried by Eyesizwe, while the placing and compacting cost is carried by Eskom. The mine indicated that there had been no spontaneous combustion problems in the past and no spontaneous combustion problems were evident on the day of inspection.

A model of the terrain has been developed and a volumetric assessment of the voids has been completed. There are seven voids that could be utilised for discard disposal. The volumetric assessment indicated that six voids would be utilised for the Eyesizwe LoM Plan. The capacity of the voids should be assessed on an annual basis in order to determine whether there is any deviation from the LoM Plan in terms of discard generated.

#### **7.3.5 Matla Colliery**

The waste stream generated from the Matla operation is discard. The slurry (fines) that is produced is pumped back to the storage stockpiles at the plant and reprocessed. The plant produces approximately 10,000 dry tonnes of discard per month, which is trucked and deposited onto Eskom ash dams. If no trucks are available, a concrete bay is used to store any discard temporarily. Containment walls have been constructed around the concrete bay area to contain any surface run off from the stockpile. A capacity assessment of the ash dams should be undertaken to ensure that there is suitable storage space available for the discard in terms of the LoM Plan. A deposition strategy and slope stability assessment must also be undertaken as part of the assessment of the ash dams.

#### **7.3.6 New Clydesdale Colliery**

The waste stream generated from the New Clydesdale operation is discard and slurry. The slurry is pumped and disposed of in the underground workings, while the discard is trucked and disposed of in open cast voids. The discard is compacted to reduce the risk of spontaneous combustion. The mine indicated that there had been no spontaneous combustion problems in the past, and no spontaneous combustion problems were evident on the day of inspection. At closure, a capping layer of material and grassing will be placed on the discard area. The discard will be placed in a manner that will enable the area to be self-draining at closure. The mine indicated that, as part of its five year LoM Plan, there are enough voids available to contain the discard and that the potential for on-surface discard facilities is low. The capacity of the voids should be assessed on an annual basis in order to determine whether there is any deviation from the LoM Plan in terms of discard generated.

### **7.4 Heavy Minerals**

#### **7.4.1 Hillendale Mine**

The Hillendale Mine produces two separate waste streams. One is a fine product of < 45µm which is generally classified as slimes or residue, and the other is a > 45µm fraction which is generally referred to as the sand fraction or tailings. The tailings are used for backfilling mining voids and the construction of the outer perimeter walls of the residue storage facility (slimes dam). The slimes can be either deposited on the backfilled tailings to suppress dust, or co-disposed of with the tailings in the mining void, but is mostly disposed of on the residue storage facility which is located in the flood plain of the Mhlathuze River.

#### **7.4.2 Fairbreeze Project**

The proposed Fairbreeze Project Mine will produce two separate waste streams as with Hillendale Mine. One is a fine product of <45µm which is generally classified as slimes or residue, and the other is a >45µm fraction which is generally referred to as the sand fraction or tailings. The tailings are used for backfilling mining voids and the construction of the outer perimeter walls of the residue storage facility (slimes dam).

The slimes can be either deposited on the backfilled tailings to suppress dust, or co-disposed of with the tailings in the mining void, but it is planned that the majority of the slimes will be disposed of in one of the two slimes dam sites that will be located west of the plant and on the northern side of the N2 National Highway.

## 7.5 Base Metals

### 7.5.1 Rosh Pinah

The Rosh Pinah tailings dam is located 1.5km South and down gradient of the plant area. Slurry residue is currently pumped to the dam at a rate of approximately 80tph in either one of the two existing 180mm diameter steel or HDPE pipelines. It is estimated that the in-situ density of the tailings will be in the order of 1.5t/m<sup>3</sup> therefore deposition on an annual basis will be approximately 660,000tpa or 440,000m<sup>3</sup> p.a. based on a plant efficiency of approximately 94%.

The tailings dam layout is split into three compartments, two of which are located at the top surface of the dam at an elevation of 376.00 mamsl (24m high). The third compartment is an extensive tailings buttress located on the southern and south western flanks of the dam at an elevation of 362.00mamsl (18m high). All three compartments had elevated penstocks installed in 1998, before this time water was stored on top of the dam and allowed to either evaporate or seep into the sub surface sandy gravelly soils underlying the tailings dam. The elevated penstocks discharge into an unlined solution trench on the eastern side of the dam. The solution trench transport the decanted supernatant water to an unlined evaporation dam located immediately south of the tailings impoundment. There are currently no facilities in place to pump this water back to the plant for use in the process circuit.

The machine packed division wall between the two compartments located on the top of the tailings dam has been machine breached in several places with the objective of forming a single compartment with a total surface area of approximately 24,3Ha. The lower compartment has a current deposition surface area in the order of 14.2Ha. The overall area available to deposit the Rosh Pinah tailings is therefore 38,6Ha. The current rate of rise will be in the order of 1.25mpa if the total available deposition area is utilized. It is estimated that the closure rate of rise after five years using the entire surface area of the tailings dam to deposit tailings will be 1.35mpa. Both rates of rise are acceptable.

It is understood that tailings disposal will be outsourced to a contractor at the end of August. Preliminary discussions between mine management and the contractor would indicate that there is a suggestion to restrict the deposition of tailings for the next five years onto the southern buttress dam with the objective of bringing all compartments to the same elevation. If this option is pursued the rate of rise on the lower compartment will increase to 3,4mpa.

### 7.5.2 Zincor

Zincor currently uses two disused gold tailings dams as disposal sites for their process waste products, namely solids and liquids arising from Zn production. These gold tailings dams are registered with the DME as Dam 7L3 and Dam 7L4. Dam 7L3 is situated closest to the Zincor process plant and receives both solid and liquid plant waste, whereas 7L4, which is situated about 2km from the plant is used solely as an evaporative facility for treated effluent. The solid waste products are basically chemical precipitate in the form of crystals and a fraction of the calcium that never leached. The crystals do change in size periodically. This means that there is almost a constant change in the material characteristics, the results of which are seen during routine deposition on 7L3.

### 7.5.3 Chifeng

Chifeng recently constructed a new hazardous waste disposal facility. Construction has involved excavation of a pit and then lining the pit with a 2mm HDPE liner. Although, the liner was not properly keyed in during construction with the result that the liner has slumped, it appears that following the remedial work to repair the liner, the disposal site will be adequate for the disposal of residue generated. It must be noted that in terms of this assessment the slumping of the liner is not seen as a liability as it is currently being remediated from operating capital. There do not appear to be any boreholes around this site to monitor the efficiency of containment. These need to be implemented as part of a monitoring network. Currently, all waste generated on site is being hauled away by third parties who are processing the residues to remove the metals contained in the residue. The implication of this is that the residues are being stored on site until they are removed. This storage is potentially compounding the contamination of soils and groundwater at the plant.

## 7.6 Industrial Minerals

### 7.6.1 Glen Douglas

Glen Douglas Mine currently produces no material that can be classified as mine residue. Fines produced at Glen Douglas Mine plant are ultimately sold as agricultural lime. Fines are pumped from the plant to a series of evaporation dams and reclaimed in accordance with sales forecasts. Water is reclaimed through penstocks and pumped back to the processing plant. SRK considers that whilst remedial work of a routine nature is required, all facilities are operated and managed in a responsible manner with deposition conducted in accordance with normal practice.