# 13.0 SAMPLE PREPARATION, ANALYSES, AND SECURITY

## 13.1 Introduction

In order to process a significant amount of kimberlite, Shore Gold purchased and commissioned a batch sampling process plant used to process and recover diamonds. The process plant was designed to simulate a commercial kimberlite ore treatment plant.

Shore Gold's process plant was designed and constructed by Bateman Minerals Pty Limited (Bateman) of South Africa. Bateman has extensive experience in the design, construction and commissioning of modular diamond process plants around the world.

Shore Gold's Bateman process plant (Bateman Reference Number M7007) consists of the following circuits:

- A 30 tonne per hour crushing circuit
- A 10 tonne per hour Dense Media Separation (DMS) circuit which consists of a 250 millimetre DMS cyclone
- A recovery circuit consisting of a Flow Sort® X-Ray diamond sorting machine (Sortex) and a grease table.

## 13.2 Shore Gold's Sample Processing Circuit

The following section is a detailed description of Shore Gold's processing and diamond recovery circuits. Figure 13-1 and Figure 13-2 show a schematic flowsheet for the processing of kimberlite samples from both the underground and LDD drill programs carried out at the Star Kimberlite.

### 13.2.1 Process Plant – Crushing and Scrubbing Circuit

The underground kimberlitic material (stored as individual batches or piles on surface) that was to be processed was hauled by a two cubic metre capacity front-end loader from the storage facility area to the primary static feed bin. As for the LDD mini-bulk samples, each sample interval was processed individually through the process plant.

The horizontal square screen aperture of the primary static feed bin is 250 millimetres. When the primary static feed bin is full (approx. 15–20 tonnes), kimberlite from the pan feeder belt is fed at a constant rate onto the run-of-mine conveyor belt (ROM).

**Figure 13-1: Process Plant Flowsheet – Primary Kimberlite Processing**

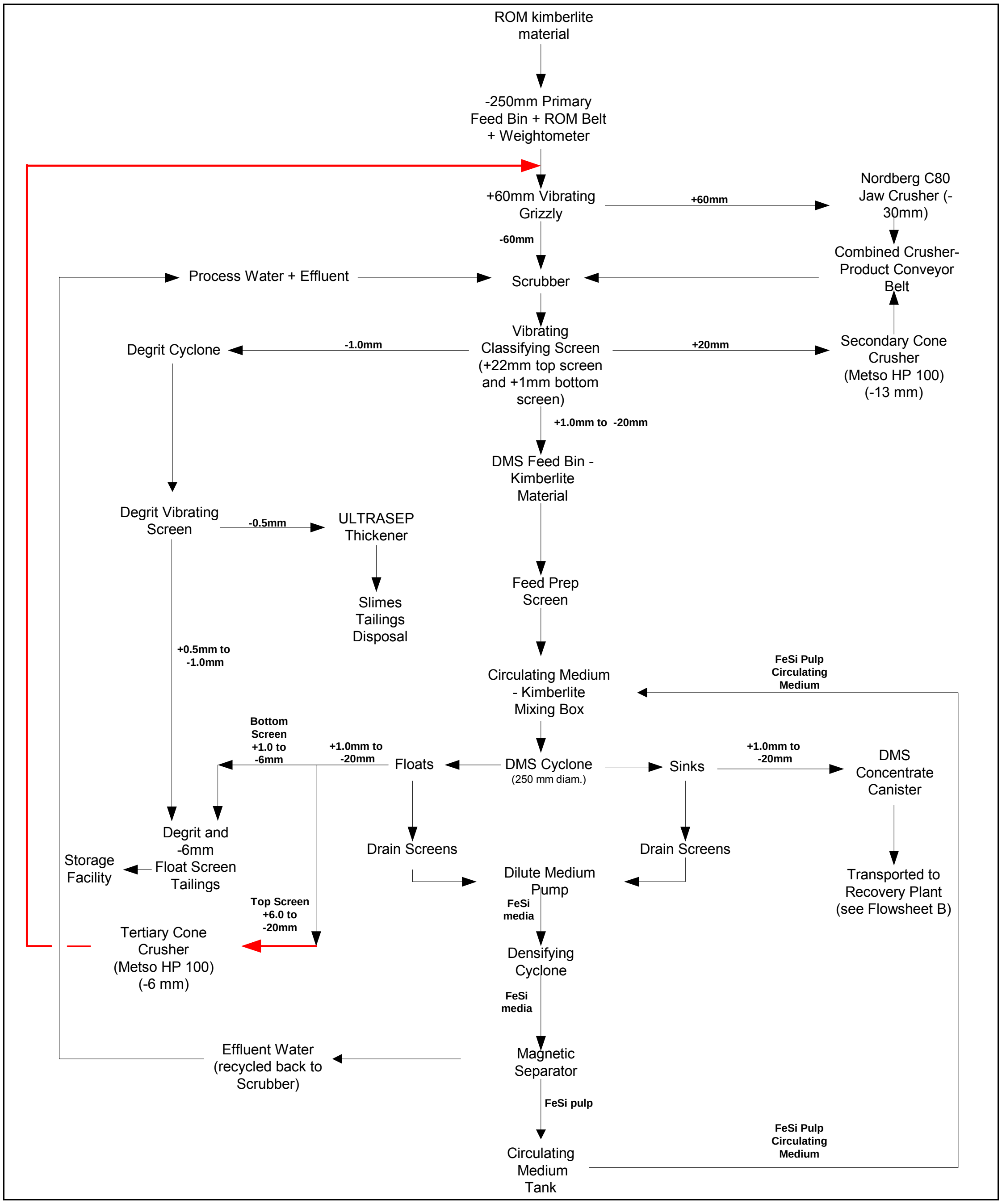
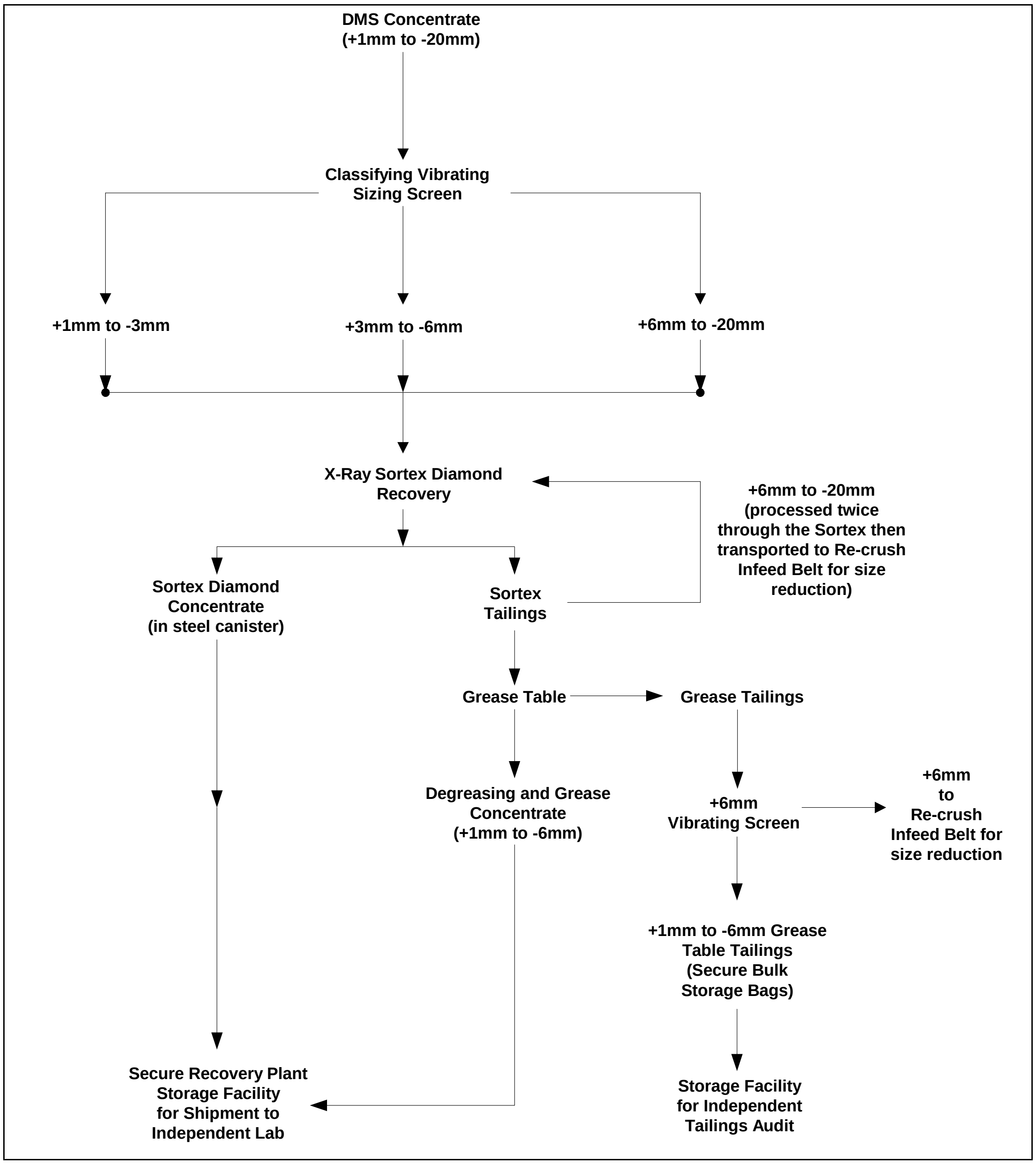


**Figure 13-2: Recovery Plant Flowsheet**



Kimberlite on the ROM belt is then weighed and recorded by a Ramsey belt scale system (i.e. weightometer). The weightometer is calibrated on a daily basis. Kimberlite is then delivered directly to the +60 millimetre vibrating grizzly. Flow of kimberlite from the pan feeder belt onto the ROM conveyor belt is controlled by a variable speed drive motor. This in turn controls the feed rate of kimberlite through the vibrating grizzly and jaw crusher. All of the +60 millimetre material reports to the Metso® C80 jaw crusher, where all of the oversize is crushed to -30 millimetres. The -60 millimetre kimberlite reports directly to the scrubber.

All kimberlite (-60 millimetre) reporting to the scrubber–primary double deck vibrating classifying screen unit undergoes attrition, and is subsequently washed, and screened to remove fines. Kimberlite from the scrubber passes over the primary double deck vibrating classifying screen. Slimes (-1 millimetre) pass over both the -22 millimetre square aperture top screen and the -1 millimetre dewatering bottom screen for de-sliming. The size fraction that reports to the DMS circuit is thus +1.0 millimetre to -22 millimetre. During the processing of Batches 1 to 95, the top screen utilized in the process plant was an 18 millimetre square aperture screen, and a 22 millimetre square aperture top screen size was utilized for Batches 96 to 237 as well as for all LDD mini-bulk samples (Star and FalC Joint Venture) sample processing programs.

At this point, the -1.0 millimetre de-grit and slimes report to the slimes pump box and are pumped directly to the de-grit plant's cyclone and vibrating de-sliming screen. This screening reduces the amount of fines reporting to the DMS circuit, thus aiding in the stabilization of the specific gravity of the ferrosilicon circulating medium (CM). The +0.5 millimetre to -1 millimetre material reports to the de-grit–floats conveyor belt (i.e. coarse reject kimberlite tailings), whereas the -0.5 millimetre fines are treated in a thickener tank with flocculent and are then pumped to the settling pond.

The +20 millimetre oversize material retained on the primary double deck classifying screen reports to the secondary cone crusher conveyor belt to be crushed to -15 millimetre size by a Metso® HP 100 cone crusher. The crushed material from both the jaw and cone crushers then report to the combined crusher product conveyor belt in order to be re-introduced into the scrubber unit.

### 13.2.2 DMS Circuit

The +1.0 millimetre to -20 millimetre sized kimberlitic material from the primary double deck vibrating classifying screen is pumped from the transfer pump box, dewatered and then stored in a five tonne capacity DMS surge bin for product separation into light and heavy mineral fractions. The material is then fed in a wet state to the DMS circuit by the combined vibrating pan feeder and DMS feed pump and then dewatered once again by a vibrating feed prep screen. The kimberlitic material is mixed with a dense circulating medium (CM) consisting of ferrosilicon powder (FeSi) and water. Both the kimberlite and CM are introduced into a mixing box which is then pumped at a constant cyclone inlet velocity pressure to the 250 millimetre diameter cyclone mounted atop the DMS circuit. Separation of the 'heavy' and 'light' particles (i.e. product) is achieved on the basis of the specific gravity of the minerals.

Both the heavy and light products exiting the cyclone are screened and then washed to recover the FeSi. The CM recovered from both the floats and sinks screens report to the dilute medium pump box FeSi recovery circuit. The diluted CM is pumped to a densifying cyclone for separation and then recovered as a thick pulp by the magnetic roll separator unit. The FeSi pulp is then re-directed back via gravity to the CM tank for reuse.

The +1.0 millimetre to -20 millimetre heavy mineral concentrate (DMS concentrate) that reports to the sinks screen is collected in 40 litre stainless steel canisters. When a steel canister is full, the canister is locked then transported, with security escort, to the recovery plant for particle sizing and diamond recovery. Prior to January, 2007 this process was performed by A.C.A. Howe personnel and two Shore Gold security personnel. Post January 2007, transportation was undertaken by a Shore Gold recovery technician, and two Shore Gold security personnel. The +1.0 millimetre to -6 millimetre light fraction (coarse reject kimberlite) is disposed outside of the process plant via conveyor belt. A front-end loader is then used to transport the coarse reject kimberlite to a dedicated storage area and stockpiled on a per batch basis.

During the Phase 1 processing program, the DMS's +6 millimetre oversize light fraction product from the floats screen reported by conveyor to a dedicated re-crush storage facility. Once the primary material for a batch was fed into the process plant, this re-crush material was re-inserted into the crushing circuit via the primary static feed bin. The re-crush reported to the ROM belt, where it was weighed and recorded by the Ramsey belt scale system (i.e. weightometer). The re-crush was fed by the ROM conveyor belt to the vibrating grizzly which then reported directly to the scrubber. From the scrubber, the re-crush reported to the primary double deck vibrating classifying screen fitted with a six millimetre square aperture top screen. Since all of the re-crush is +6 millimetre to -16 millimetre in size, the material reported directly to the Metso® HP100 cone crusher where it was wet crushed to -6 millimetres. The wet crushed product reported back via the combined crusher product conveyor to the scrubber unit and DMS circuit for reprocessing to recover possible locked diamonds. As with the primary kimberlitic material, all -1.0 millimetre slimes generated by the re-crush material reported to the de-grit plant. Any remaining +6 millimetre re-crush material was returned to the Metso® HP100 secondary cone crusher until all material passed through the primary double deck vibrating classifying screen's +6 millimetre square aperture top screen.

In the summer of 2005, Shore Gold modified the re-crush flowsheet to eliminate the separate re-crush processing cycle to improve plant efficiency. The revised flowsheet is such that the +6 millimetre oversize product from the float screen can be crushed and re-inserted simultaneously into crushing-scrubbing circuit with incoming kimberlite ROM feed from the same batch sample. As such, the +6 millimetre oversize product from the float screen reports via conveyor to a tertiary cone crusher to be crushed to -6 millimetre size by a Metso® HP 100 cone crusher. The crushed -6 millimetre-sized material reports back to the scrubber and DMS circuit via the outfeed conveyor belt and ROM belt for reprocessing to recover possible locked diamonds (Figure 13-2).

The specific gravity (SG) of the CM is monitored electronically and in real time with a DebTech® dense medium controller system and manually with a densitometer scale. Density tracer tests are carried out with the use of cube shaped epoxy tracers with specific gravities ranging from 2.70 to 3.53 and sizes from two millimetres, four millimetres, and eight millimetres. Density tracer tests are carried out on a daily basis to monitor the separating effectiveness of the DMS cyclone. The density tracers that report to the floats or sinks screen are counted separately, and a Tromp curve is plotted in order to obtain the percentage of density tracers versus particle specific gravity. An estimate of the effective separation of light and heavy fractions, including diamond, can be determined from the shape and slope of the Tromp curve. The separating specific gravity (or cut point) is determined as the point where the curve has a value of 50 percent.

### 13.2.3 Slimes Tailings and Settling Pond

The -1.0 millimetre de-grit material from the primary double deck vibrating classifying screen is pumped to a dewatering cyclone for handling ease and disposal. The +0.5 millimetre to -1.0 millimetre de-grit material from the dewatering cyclone reports to a vibrating dewatering screen and the -0.5 millimetre slimes from the dewatering cyclone is pumped to a thickening tank. The -0.5 millimetre slimes contained in the thickening tank are doused with flocculent, and when the desired specific gravity of the slimes is reached, the slimes are pumped out to the settling pond located south and southeast of the process plant.

### 13.2.4 Diamond Recovery Plant Sample Handling and Processing Procedures

As soon as a full canister of DMS concentrate arrives in the recovery plant, the gross weight (wet) and arrival time are recorded on a pre-designed sheet by A.C.A. Howe (pre-January, 2007) and Shore Gold security personnel. Pre-January, 2007, the DMS concentrate canister was loaded by A.C.A. Howe and Shore Gold recovery personnel into a steel cradle, hoisted with an electric chain block, and the contents were emptied into the recovery plant hopper (Figure 13-2). Post January 2007, the process was undertaken by Shore Gold recovery and security personnel.

DMS concentrate is then separated into three particle size fractions by a vibrating classifying screen deck unit beneath the recovery plant hopper. The size fractions obtained are +1 to -3 millimetres, +3 to -6 millimetres, and +6 to -20 millimetres respectively. During the sizing process, the respective size fractions are collected in individual 40 litre stainless-steel canisters located below the vibrating classifying screen deck. Once the particle sizing is completed, each sized canister is left to dewater as much as possible. The gross weight (wet) of each sized canister is then weighed and recorded on a pre-designed sheet by A.C.A. Howe (pre- January, 2007) and/or Shore Gold security personnel and readied for diamond processing.

### 13.2.5 X-ray Sortex Diamond Sorter

DMS concentrate size fractions (+1 to -3 millimetres, +3 to -6 millimetres and +6 to -20 millimetres) are processed separately, wet, in a Flowsort® X-Ray Diamond Sorter Unit (Model XR 2/19 DW; Sortex). All three individual sized fractions are manually fed to the Sortex receiving hopper for processing. The +6 millimetre to -20 millimetre sized fraction is processed twice through the Sortex unit. After this largest size fraction is processed twice, the rejected portion (X-ray tailings) is deposited with the grease table tailings in a bulk sample bag as described below. This material is kept for auditing purposes.

The Sortex unit is designed on the principle of diamonds fluorescing/luminescing when bombarded by X-rays. Wet diamond bearing concentrates slide past photomultiplier tubes that detect fluorescent material (i.e. particles emitting light) that has been irradiated by X-rays. Excitation of the photomultiplier tubes triggers the ejector gate doors to open forcing the diamond (and other fluorescent material plus gangue) into a stainless steel canister from the gangue minerals. Sortex tailings are collected in a 40 litre steel canister to be reprocessed by grease table.

Each size fraction is processed individually; however, diamonds ejected for each size fraction are collected in a single stainless steel canister that is locked in place below the Sortex unit. Once a batch sample has been processed, the stainless steel canister is removed, locked, escorted, and then stored in Shore Gold's secure safe-house facility located within the recovery plant until it is delivered to SGS Lakefield Research (SGS Lakefield) for diamond sorting. Security was provided by Shore Gold's security personnel under A.C.A. Howe's supervision (pre-January, 2007) and by video surveillance while in the Shore Gold facility. Since January 2007, sample handling procedures have been performed by Shore Gold personnel, with no third party involvement. Since January 2007 A.C.A. Howe has acted as an external QA/QC provider and has made periodic audits of the Shore Gold processing plant.

### 13.2.6 Grease Table (Oleophilic) Diamond Recovery

A two-stepped (one metre wide) grease table is employed to concentrate the smaller sized Sortex tailings in the following order: +3 millimetre to -6 millimetre and +1 millimetre to -3 millimetre. The larger size fraction (+6 millimetre to -20 millimetre) is not processed through the grease table, but processed twice through the Sortex. Most diamonds are hydrophobic (i.e. non-wettable) and will adhere to grease specially formulated for diamond recovery.

The +6 millimetre to -20 millimetre material is transported to the in-feed conveyor reporting to the tertiary cone crusher to be crushed to -6 millimetre size by a Metso® HP 100 cone crusher. The crushed –6 millimetre sized material reports back to the scrubber and DMS circuit via the outfeed conveyor belt and ROM belt for reprocessing to recover possible locked diamonds.

Each individual size fraction is manually fed into the grease table receiving hopper for processing. The two-stepped grease table surface is covered with an evenly coated layer of grease approximately 4 millimetres to 6 millimetres thick. Warm water heated by a 30 litre hot water heater forces and assists in the movement of the wetted material across the grease. A feed control gate is used to manually control the feed rate of material onto the grease table. The diamonds adhere to the grease on first contact and the flow of concentrate over the adhering diamonds causes them to be pushed further into the grease.

All non-adhering (i.e. hydrophylic) material reports to the grease table tailings belt for storage in one cubic metre Endurapak® canvas bulk sample storage bags.

Removal and application of fresh grease is dependent upon the amount of grease adherent material in the concentrate. More particles adhering to the grease reduces the effective surface area for diamonds to adhere to. When the effective surface area is less than 50 percent, the grease and grease concentrates are scraped off the grease table and placed into pre-numbered, sealed plastic buckets.

During the bulk sampling program, auditing of the X-ray and grease table efficiency/recovery with the use of ‘test diamonds’ or ‘marked diamonds’ inserted into the concentrate feed was not carried out.