RESOURCES AND RESERVES BY OPERATION
SOUTH AFRICA – SURFACE OPERATIONS CONTINUED


Free State surface operations

FREE STATE SURFACE SOURCES

The Free State surface source operations comprise the following:

- The Phoenix operation, located adjacent to Harmony's current and historical operations in the Free State, involves the retreatment of tailings from tailings storage facilities in the region to extract any residual gold. The Phoenix operation makes use of the Saaiplaas Plant, located close to the historic Saaiplaas 2 shaft area and in close proximity to Masimong 4 shaft. Phoenix began operating in 2007
- St Helena – in study phase
- Central Plant retreatment project – material reclaimed from the FSS5 tailings facility is to be processed at Central Plant which has adapted for tailings retreatment. Plant commissioning began in June 2017 with ramp-up to capacity of 300 000t a month achieved by the end of July 2017
- Around 4Mt of reserves remain in the form of rock dumps in the vicinity of the Free State operations. A programme, run by Metallurgical Services, to mill and process these dumps as and when there is spare capacity available, began in FY10
- Tailings – Reserves of 548.3Mt of material in the tailings storage facilities in the Free State are estimated to contain around 4Moz of gold

PHOENIX

Phoenix or the Tswelopele Beneficiation Operation makes use of Harmony's Saaiplaas plant.

The Saaiplaas plant was built in 1954, but most of the original structures and equipment were broken down c.1990 and removed, with the exception of the pachuca tanks, which remain in service until the present time. The plant was extended in 1980 with the addition of a ROM milling section, additional pachucas and filters. The old sections have been decommissioned and progressively demolished since the 1990s and the newer sections remain in operation. The plant originally formed part of the Anglo American Free State gold mining operations. The design capacity of Saaiplaas plant was 330 000tpm.

The Saaiplaas plant originally processed ore from Saaiplaas 1, 2 and 3 shafts. Saaiplaas 1 closed c.1980, Saaiplaas 2 c.1996, and Saaiplaas 3 c.2000. At one time, Saaiplaas Plant also processed ore from the Erfdeel (now Masimong) shafts. With the decline of mining in the area, Saaiplaas Plant was relegated to processing un-milled surface source material (waste) at a rate of 110 000tpm under Harmony's ownership until 2007.

The mills were stopped in July 2007. All material currently processed by the plant is recovered by hydro mining from old, desiccated slimes dams in the area, and this requires no crushing or milling. The ore receiving silos, conveying and milling functions have been mothballed or demolished since July 2007, when milling ceased.

The original design life of the slimes retreatment project was five years (to end 2011). This short life was due to restricted deposition capacity for the residues generated at the planned processing rate of 500 000tpm. This was further reduced to 424 000tpm from September 2011 due to stability concerns. A major capital project was undertaken to build a replacement cyclone-deposition dam at St Helena 1, 2 and 3. This dam will allow the deposition of 500 000tpm again, to extend the life of operation to 2029.

Nature of operations

Hydro mining on several slimes dams is conducted under contract. High-pressure monitors are used on the dams being mined to pulp material that then reports to a transfer pump station, from where the material is conveyed to Saaiplaas plant in a separate 450mm diameter rubber-lined pipeline in respect of each of the dams being hydro mined.

The Saaiplaas plant has been downgraded to a slimes retreatment plant. Only hydro-mined material from old, desiccated slimes dams is sent to the plant for processing. The Phoenix project is positioned for low-cost, high profit-margin low-grade tailings reprocessing.

Two more carbon-in-leach (CIL) tanks have been added to increase residence time to achieve optimal dissolution and reduce soluble loss

Location

The Saaiplaas plant is located in the heart of the Free State goldfields near Welkom in the Free State Province of South Africa, at latitude of 28°02'00"S and longitude 26°52'18"E, at an elevation of approximately of 1,600m above mean sea level.

RESOURCES AND RESERVES BY OPERATION
SOUTH AFRICA – SURFACE OPERATIONS CONTINUED

Description of hydro-mining and mineral processing operations

Production plans

Current planned processing rate is 500 000 a month with the new St Helena 1, 2 and 3 cyclone dam in operation as the residue disposal facility. As a result, life has been extended by a further 17 years. Two tanks have been added to increase residence time to achieve optimal dissolution and reduce soluble loss.

Two surface sources are currently being mined:

- Brand-A Dam has had some 30% of its material removed already. It has a grade of 0.37 g/t Au at 45% recovery
- No 21 Dam (which replaced Harmony No 1 Dam as a source from end-2011) has a grade of 0.27 g/t Au at 45% recovery
- At Harmony No 1 Dam, only cleaning-up remains

FSS6, FSS4 and FSS1 dams replaced the old Saaiplaas dams at end 2011 for deposition purposes. Deposition into these dams and Brand D Dam, was stopped with the commissioning of the St Helena 1, 2 and 3 dam which is able to accept the full production of the Saaiplaas Plant.

Saaiplaas Plant began processing material from the St Helena 1, 2 and 3 dam in February/March 2013. This dam is now the sole deposition area for Saaiplaas Plant. The commissioning of the St Helena 1, 2 and 3 dam allowed the planned increase in plant throughput to the required 500 000tpm over the next c.17 years. As St Helena 1, 2 and 3 dam is on an existing site, it did not require any environmental permitting that a new site would have needed.

Hydro mining currently yields recovered slimes at an average in situ grade of 0.300 g/t. Saaiplaas Plant recovers 45% of the contained grade in the recovered pulped material it receives, yielding 70kg Au a month (planned), which represents c.1.5% of Harmony's gold production. The operating unit cost is R39/t at 500 000tpm. The Saaiplaas project is positioned for low-cost, high profit-margin, low-grade tailings reprocessing.

Hydro-mining

The hydro-mining (monitoring) process consists of the use of water monitors (cannons) to re-pulp the hardened slimes to a relative density of around 1.4. 100mm and 150mm diameter high-pressure monitors are in use on the dams. The re-pulped slimes flows under gravity to a penstock suction to a transfer pump which delivers to one of two vibrating screens to remove oversize and the underflow falls into a sump. A separate pump station at each dam pumps the pulp via 450mm diameter rubber lined pipelines to the plant.

The slimes pumps are Envirotech D-frame 3-5 stage units (depending upon the distance to be pumped).

Oxygen is injected into the transfer pipeline to the plant to neutralize cyanide consuming components and so optimise gold dissolution in the plant.

Free State surface operations

RESOURCES AND RESERVES BY OPERATION
SOUTH AFRICA – SURFACE OPERATIONS CONTINUED

Upon receipt of the pulp at the plant, lime is added to adjust the pH to 10.5. From the receiving tower, the slimes are transferred into one of the four thickeners located at the plant. Each of the thickeners has a maximum throughput capacity of 150,000t. After thickening, the desired relative density of the material is 1.450.

There is no mechanical agitation, all agitation being by means of air. The insured advises that this has the advantage of keeping the carbon in suspension. The methodology employs standard CIL technology. Simultaneous gold leach and adsorption occurs with the carbon in each of the six tanks in each train.

Thickener underflow is pumped to one of two linear screens above the mass flow tanks to remove grid and woodchips larger than 800µm to create a clear size cut between slurry and carbon particle sizes. Cyanide is added at the mass flow conditioning tanks to facilitate pressure leaching which takes place in the pipeline. Pregnant carbon can then be recovered in the CIL process. Oxygen is injected in the pipeline to CIL to optimise the overall leach reaction.

The material is then pumped to one of two sets of six tanks each. These are operated on the carousel-basis, with the numbering of the tanks rotating with use. Total residency time for the material to pass through the five tanks in each train is around 10 hours.

A residue linear screen is used to recover leaked carbon. Residue from the tank is pumped the currently active tailings dam by tailings disposal pumps. Loaded carbon is screened out via a linear screen at the mass flow section, pumped into a transport carbon tanker and sent to Central Plant. Regenerated carbon is returned to Saaiplaas Plant for re-use in the process.

RESOURCES AND RESERVES BY OPERATION
SOUTH AFRICA – SURFACE OPERATIONS CONTINUED

FREE STATE SURFACE SOURCES

Gold – Mineral resources

	Measured resources				Indicated resources				Inferred resources				Total mineral resources			
	Tonnes		Gold		Tonnes		Gold		Tonnes		Gold		Tonnes		Gold	
	(Mt)	(g/t)	(000kg)	(000oz)	(Mt)	(g/t)	(000kg)	(000oz)	(Mt)	(g/t)	(000kg)	(000oz)	(Mt)	(g/t)	(000kg)	(000oz)
Phoenix	73.0	0.28	20	646	–	–	–	–	–	–	–	–	73.0	0.28	20	646
St Helena	191.3	0.27	52	1 656	–	–	–	–	–	–	–	–	191.3	0.27	52	1 656
Central Plant	–	–	–	–	67.3	0.27	18	574	–	–	–	–	67.3	0.27	18	574
Other:																
- Waste rock dumps	–	–	–	–	3.9	0.51	2	64	19.8	0.42	8	270	23.7	0.44	10	334
- Tailings	–	–	–	–	548.3	0.23	125	4 028	15.5	0.19	3	94	563.8	0.23	128	4 122
Grand total	**264.4**	**0.27**	**72**	**2 303**	**619.6**	**0.23**	**145**	**4 666**	**35.3**	**0.32**	**11**	**364**	**919.2**	**0.25**	**228**	**7 333**

Modifying factors

	MCF (%)	PRF (%)
Phoenix	100	45
St Helena	100	45
Central Plant	100	52
Other	100	52

Gold – Mineral reserves

	Proved reserves				Probable reserves				Total mineral reserves			
	Tonnes		Gold		Tonnes		Gold		Tonnes		Gold	
	(Mt)	(g/t)	(000kg)	(000oz)	(Mt)	(g/t)	(000kg)	(000oz)	(Mt)	(g/t)	(000kg)	(000oz)
Phoenix	73.0	0.28	20	646	–	–	–	–	73.0	0.28	20	646
St Helenaa	108.6	0.27	29	933	–	–	–	–	108.6	0.27	29	933
Central Plant	–	–	–	–	67.3	0.27	18	574	67.3	0.27	18	574
Other:												
– Waste rock dumps	–	–	–	–	3.9	0.51	2	64	3.9	0.51	2	64
– Tailings	–	–	–	–	548.3	0.23	125	4 028	548.3	0.23	125	4 028
Total	**181.6**	**0.27**	**49**	**1 580**	**619.6**	**0.23**	**145**	**4 666**	**801.1**	**0.24**	**194**	**6 245**

Uranium – Mineral resources

	Measured resources				Indicated resources				Inferred resources				Total mineral resources			
	Tonnes		U_3O_8	U_3O_8	Tonnes		U_3O_8	U_3O_8	Tonnes		U_3O_8	U_3O_8	Tonnes		U_3O_8	U_3O_8
	(Mt)	(kg/t)	(Mkg)	(Mlb)	(Mt)	(kg/t)	(Mkg)	(Mlb)	(Mt)	(kg/t)	(Mkg)	(Mlb)	(Mt)	(kg/t)	(Mkg)	(Mlb)
Total	–	–	–	–	178.8	0.10	17 817	39	–	–	–	–	178.8	0.10	17 817	39