SGS Bateman PGM Capability & Experience

1.1 Introduction

SGS Bateman is a global operating company in the SGS Minerals Division, which is in turn a business within the SGS Group. SGS is the world's leading inspection, verification, testing and certification company. SGS has an annual revenue of approximately USD 6.6 billion and is recognised as the global benchmark for quality and integrity. With more than 97 000 employees, SGS operates a network of over 2 600 offices and laboratories around the world.

Founded in South Africa in 1919, SGS Bateman has served the minerals industry in southern Africa for the last 90 years and the global minerals industry for the last 28. SGS Bateman is a uniquely differentiated project execution Group in terms of its focus on "process engineering" in the minerals industry. This process competence together with an extensive and well proven suite of design and project management systems and procedures equips SGS Bateman well to execute global projects. The group has a worldwide reputation for the development and execution of minerals projects for a large number of Clients, in a range of geographical situations in over 50 countries and under a variety of contractual structures.

A key factor in the success of SGS Bateman projects has been its applied in-house engineering capabilities in unit processes. SGS Bateman's ability to provide cost-effective facilities for processing ores is based strongly upon its technological capability and project know-how of minerals processing, smelting and refining operations.

Accredited to **ISO 9001:2015** and **ISO 45001:2018** SGS Bateman has the competence and experience to support its Clients through the full life cycle of their minerals projects - from initial test work of drill samples, through laboratory and pilot programmes, feasibility studies, front-end engineering, procurement, and construction to commissioning of fully operational plants. These services may be offered on EPCM, EPC or LSTK terms to suit the requirements of Clients.

In all of its developing world project locations SGS Bateman aims to positively engage communities where the projects are sited and to create value and build sustainable capacity within those communities. SGS Bateman sees the community as a vitally important stakeholder in the project and its support as essential to the success of the project as well as the Owner's ongoing business activities.

1.2 PGM Process Capability

1.2.1 PGM Technology

SGS Bateman has leading expertise in the entire range of beneficiation processes for platinum group metals. It is the only independent contractor to have successfully installed all types of PGM process plants – concentrators, smelters and precious metal refineries.

SGS Bateman's expertise covers the fields of:

- Process modelling - incorporating all aspects of ore processing plants
- Materials handling – solutions for conveying (including belt and pipe conveyors), apron feeders, stockyard systems, stackers, reclaimers and load out stations
- Comminution – including all forms of crushers and mills
- Scalping and screening – with the choices of grizzly, vibrating screens, conventional screens, modular screens scrubbers and magnetic separation
- Pre-concentration beneficiation – including dense media separation (DMS), spirals and wet high intensity magnetic separation (WHIMS)
- Flotation, scrubbing and thickening
- Residue and impurity removal
- Ion exchange, solvent extraction and electrowinning
- PGM refining
- Environmental controls - including electrostatic precipitators, bag houses, reverse-pulse bag filters and wet scrubbers
- Waste disposal.

1.2.2 Engineers with PGM Experience

SGS Bateman offers a team with world class PGM experience. Given SGS Bateman's ongoing experience in this field, it has a comprehensive knowledge base and current database for budget estimating. SGS Bateman's process staff is supported by discipline engineers and systems designed to provide accurate and timely project completion. Curricula vitae for some key personnel on permanent staff who have refinery experience are attached. It should be noted that we maintain working relationships with a number of independent consultants who are considered industry experts, such as Geoff Skelton (CV also attached), and other contractors with PMR experience, who would be able to assist with project work where required.

1.3 PGM Project References

SGS Bateman's PGM process experience includes milling, flotation, concentrate drying, smelting, converting, and refining.

Our engineers were involved in the implementation of the MF2 (mill-float-mill-float) flowsheet for UG2 ore, which is now an industry standard. We commissioned the world's most advanced PGM refinery for Impala Platinum, using ion exchange technology. We also commissioned the world's largest PGM refinery for Anglo American Platinum.

SGS Bateman is therefore uniquely positioned to understand the environmental and health issues associated with platinum salts, the hazards involved with existing and new technology, as well as the security aspects of refining operations.

1.3.1 PGM Concentrator Projects

Project	Client	Mineral / Metal	Year	Location	Contract Type	Description
Blue Ridge Project	Ridge Mining	PGM	2009	RSA	LSTK	Concentrator targeting 125 000 ounces of PGM per year; Bateman Engineering also carried out the PFS and FS for the 115 000 tpm milling and flotation concentrator
Aquarius RKI PGM Concentrator	Aquarius & GB Mining	PGM	2004	RSA	LSTK	250 000 tpa Cr tailings treatment plant for the recovery of PGMs
UG2 Concentrator Expansion	Impala	PGM	2001	RSA	LSTK	60 000 tpm concentrator upgrade and expansion - feasibility study and project execution
Crocodile River Platinum Concentrator	Barplats	PGM	2001	RSA	EPCM	DMS plant and refurbishment of mothballed plant
UG2 Concentrator Expansion	Impala Platinum	PGM	2001	RSA	EPCM	60 000 tpm concentrator upgrade and expansion - feasibility study and project execution (US$15M)
Modikwa (formerly Maandagshoek) UG2 Concentrator	Anglo Platinum	PGM	1999 & 2001	RSA	EPCM	Engineering services and commissioning of 200 000 tpm UG2 milling and flotation concentrator
Crocodile River Refurbishment	Impala	PGM	2000	RSA	EPCM	Refurbish 80 000 tpm plant and install new equipment and instrumentation
Waterval Concentrator Cleaner Circuit	Anglo Platinum	PGM	2000	RSA	EPCM	Engineering services for extension to existing flotation circuit
Bafokeng Rasimone	Amplats	PGM	2000	RSA	EPC	200 000 tpm UG2 plant including ore handling and storage, 2 stage ball milling, primary and secondary

Project	Client	Mineral / Metal	Year	Location	Contract Type	Description
						flotation, de-watering, reagents and utilities
Waterval Extension	Amplats	PGM	2000	RSA	EPCM	Engineering design for a 30 000 tpm extension to an existing concentrator plus study for a pre-concentration DMS plant
Potgietersrus Concentrator Expansion	Anglo American Platinum	PGM	1998	RSA	EPCM	Engineering services for feasibility studies and implementation of project to increase throughput from 270 000 to 425 000 tpm of ore
Hartley Platinum Project	BHP Minerals & Delta Gold	PGM	1997	Zimbabwe	EPCM	Engineering services for 2.1 Mtpa processing plant plus associated infrastructure
Lefkochrysos Platinum Complex Phases 1 & 2	Lefko (Rand Mines)	PGM	1989 & 1991	RSA	EPCM	Feasibility study and project implementation for a 160 000 tpm concentrator, smelter, base metal refinery and PGM refinery for treatment of UG2 ore

1.3.2 PGM Refinery & Other Projects

Project	Client	Mineral / Metal	Year	Location	Contract Type	Description
Hartley BMR Refurbishment	Zimplats	PGM/Cu/ Ni	2016	Zimbabwe	EPCM	Refurbishment of Hartley Base Metal Refinery
Impala Platinum Reagent Plant Upgrade	Impala Platinum	PGM	2007	RSA	EPCM	Design, supply, installation and commissioning of new depressant mixing facility and upgrading of existing depressant dosing systems
RK1 Consortium PGM Concentrator	Aquarius Platinum (Africa)	PGM	2004	RSA	LSTK	Phase 1 of project to establish chrome tailings treatment plant for recovery of PGMs
Impala BMR	Impala Platinum	PGM/Cu/ Ni/Co	2004	RSA	EPCM	Expansion of base metals refinery
Anglo Platinum PMR Expansion	Anglo Platinum	PGM	2004	RSA	EPCM	Expansion of precious metals refinery
Impala Minpro Reagent Facility	Impala Platinum	PGM	2003	RSA	LSTK	New reagent off-loading, make-up and distribution facility to convert flotation plant from using xanthate powder to bulk liquid xanthate
Western Platinum Refinery	Lonrho	PGM	2001	RSA	EPCM	Process design services, upgrading to the ruthenium circuit

Project	Client	Mineral / Metal	Year	Location	Contract Type	Description
EPMR Phase 2 - Platinum Circuit	Impala	PGM	2000	RSA	EPCM	Integrated Bateman / Client team and shared-savings contract
Impala EPMR	Impala Platinum Limited – Refineries	PGM	1997	RSA	EPCM	Enhanced Precious Metals Refinery - engineering services to nearly double refinery capacity, making it one of the largest in the world
Impala Refineries BMR Small Projects	Impala	PGM/Cu/ Ni/Co	1996	RSA	EPCM	Design and construction of several small projects in BMR
Stillwater	SMC	PGM	1996	USA	EP	Engineering services for concentrator expansion and new leach plant
Impala Mineral Processes Smelter	Impala	PGM	1994	RSA	EPCM	Refurbishment and modifications to a 6-in-line smelting furnace
Western Platinum Base Metal Refinery	Lonrho	PGM/Cu/ Ni	1994	RSA	EPCM	R85M to increase base metal refinery capacity from 18 to 60 tpd smelter matte input
Barplats PMR Project	Rand Mines	PGM	1991	RSA	EPCM	Implementation of an integrated single-stream PGM refining process; not completed when Barplats was sold to Impala Platinum in 1991
SAREF PGM Refinery	Anglo Platinum	PGM	1989	RSA	EPCM	Engineering, procurement and construction management (R300M) for PGM refinery; studies for a planned expansion were commissioned in 2001

1.3.3 PGM Studies

Project	Client	Mineral / Metal	Year	Location	Contract Type	Description
Karo Project	Tharisa Minerals	PGM	2020	Zimbabwe	PFS	PFS for new concentrator, smelter and associated infrastructure
Darwendale Project	Afrexim-bank	PGM	2020	Zimbabwe	Consult-ant	Independent financial / technical / commercial consultant in respect of the Darwendale PGM project
Suhanko Project	Arctic Platinum	PGM	2014	Finland	Study	Technical review
Platreef	Ivanplats	PGM	2012	RSA	PFS	Study of Platsol Process
Lonmin Upgrade	Lonmin	PGM	2007	RSA	Bid	Coordinating proposal to upgrade Lonmin smelter, BMR and PGM refinery
NorthMet	PolyMet	PGM/Cu	2005	USA	FS	Fast-track study for facility to

Project	Client	Mineral / Metal	Year	Location	Contract Type	Description
	Mining					produce 33 000 tpa of copper cathode at NorthMet base and precious metals deposit
Grass Valley	Pan Palladium	PGM	2003/4	RSA	PFS	Test-work management and study for a PGM concentrator
Zimplats BMR	Zimplats	PGM/Cu/Ni	2002/4	Zimbabwe	FS	Study to re-start the refinery
RK1 a tailings stream	Aquarius	PGM	2003	RSA	FS	PGM recovery concentrator from tailings stream
Zimplats BMR	Zimplats	PGM/Cu/Ni	2002	Zimbabwe	OoM	Scoping studies on re-starting the BMR
Norilsk Feasibility Study	Norilsk	PGM/Ni/Co	2001	Russia	Study	Proposed new base metal refinery
Tati Metals Plant	AAC	PGM/Cu/Ni	2000	Botswana	Study	Leach plant treating flotation concentrate
Confidential PMR Study	Impala	PGM	1999	USA	Study	Major proposed precious metal refinery
Nkomati	Avmin	PGM/Ni	1999	RSA	FS	Concentrator and leach plant
East Limb Concentrator	Anglo Platinum	PGM	1999	RSA	Study	250 000 tpa concentrator; later became the Maandagshoek Project
Rasimone/Styldrift Concentrator	Anglo Platinum	PGM	1997/8	RSA	Studies	Multiple studies for PGM flotation concentrators
Potgietersrust Concentrator	Anglo Platinum	PGM	1996	RSA	EPCM	Expansion of concentrator from 155 000 to 425 000 tpm
PMRC , Georgia	PMRC Inc	PGM	1994	USA	Study	Treatment of spent automobile catalytic converters for a Cu/PGM plant
Empress Nickel	Rio Tinto	PGM/Cu/Ni	1993	Zimbabwe	Study	Pressure-leach plant to recover PGMs from copper sulphide
Mimosa Feasibility	Union Carbide	PGM	1992	Zimbabwe	Study	Concentrator and smelter
Southern Cross	Southern Cross	PGM	1992	RSA	Study	Recovery of PGM/Ni/Cu from chromite tailings
Stillwater	SMC	PGM	1991	USA	Study	Base metals refinery
Hartley Studies	BHP & Delta	PGM	1989/93	Zimbabwe	Studies	Feasibility studies plus option studies for concentrator, smelter, refinery and infrastructure

1.4 Selection of Other Current & Recent Projects

Project	Client	Country	Contract Type	Project Value US$ M	Status/ Completion
Siguiri Gold Project	AngloGold Ashanti	Guinea	EPCM	115	2019
West Rand Tailings Retreatment	Sibanye	South Africa	EPCM	400	On hold
Lift II Copper Concentrator Project	Palabora Copper	South Africa	EPCM	100	2018
Husab Uranium Project	Swakop Uranium	Namibia	EPCM	2500	2018
Base Metal Refinery Refurbishment	Zimbabwe Platinum Mines	Zimbabwe	EPCM	120	2017
Large Diamond Recovery Pilot Plant	Debswana	Botswana	DFS	-	2015
Cut 9 Project	Debswana	Botswana	Concept Study	-	2015
Nickel Bioleach FEED	Mondo minerals	Finland	FEED	23	2015
Khysanera Precious Metals Refinery	Khyrsanera Limited	Cyprus	Scoping	-	2015
West Rand Tailings	Sibanye	RSA	DFS	-	2015
AngloGold Ashanti	Siguiri	Guinea	PFS	-	2015
Husab SX Plant	Swakop Uranium	Namibia	EPCM	10	2015
Lead-zinc DFS	North River	Namibia	DFS	-	2014
Boabab Tete Iron Ore	Baobab Resources	Mozambique	DFS	-	2014
Large Diamond Recovery	Debswana	Botswana	PFS	-	2014
Marampa 10 Iron Ore	London Mining	Sierra Leone	DFS	-	2013
Namakwa Sands UMM	Exxaro	RSA	EPC	16	2013
Madaouela Uranium Heap Leach	GoviEx	Niger	PFS	-	2013
Trekkopje Maxi Uranium Heap Leach	Areva	Namibia	EPCM	650	2012
Marampa 2 Iron Ore	London Mining	Sierra Leone	DFS	-	2012
Jwaneng Cut 8	Debswana	Botswana	E	450	2012
Trekkopje Midi Uranium Heap Leach	Areva	Namibia	EPCM	120	2011
Cooke Dumps Uranium	Rand Uranium	RSA	FEED	400	2011
Ext 8 Debottlenecking	Foskor	RSA	EPCM	71	2011
Marampa Iron Ore Project	Cape Lambert	Sierra Leone	PFS	-	2010
Zanaga Iron Ore	Jumelles/Xstrata	Congo	Study	-	2010
Ambatovy Sulphuric Acid Plant	Dynatec Madagascar	Madagascar	EPC	150	2010

Project	Client	Country	Contract Type	Project Value US$ M	Status/ Completion
Blue Ridge Platinum Concentrator	Blue Ridge	RSA	EPC	60	2009
Hindustan Zinc Concentrator	HZL	India	EPC	35	2009
Avebury Nickel Concentrator	Allegiance Mining	Tasmania	EPCM	140	2008
Sishen Expansion Project	Kumba Iron Ore	RSA	EPCM	475	2008
Lumwana Copper Concentrator Project	Equinox Minerals	Zambia	EPC	408	2008
Moma Mineral Sands Project	Kenmare Resources	Mozambique	EPC	265	2008
Ferrochrome Sintering & Pelletizing	IFM	RSA	EPC	48	2007
Finsch Concentrator Upgrade	De Beers	RSA	Hybrid LSTK	64	2007
Venetia Primary Crusher	De Beers	RSA	Hybrid LSTK	36	2006
Birla Nifty Copper Project	Birla Nifty	Australia	EPCM	25	2006
Rustenburg PMR Expansion (various)	Anglo Platinum	RSA	EPCM	194	2005
Impala BMR Expansion (Phase 1)	Impala Platinum	RSA	EPCM	62	2005
Sepon Copper Project	Oxiana	Laos	EPCM	167	2005
Elizabeth Bay Upgrade	De Beers	Namibia	Hybrid LSTK	65	2004
Skorpion Zinc Project	Anglo	Namibia	EPCM	450	2003
SA Chrome Project	Xstrata	RSA	EPC	95	2003
Modikwe UG2 Concentrator	Anglo Platinum	RSA	EPCM	60	2002