



GOLD FIELDS



No.1 Milling Unit Grind Optimisation

Jan Matuwane

27 May 2005





GOLD FIELDS

Agenda

- Introduction
- Sampling procedure
- Sample points
- Simulations
- Results and Conclusions
- Recommendations



GOLD FIELDS

Objective

- Improve Mill grind:
 - Mill Discharge Density Optimization
 - Circulating load
 - Grinding Performance
 - Mill power
 - Ball size ratio
- Evaluating cyclone performance by using 100 & 150 mm Spigots



GOLD FIELDS

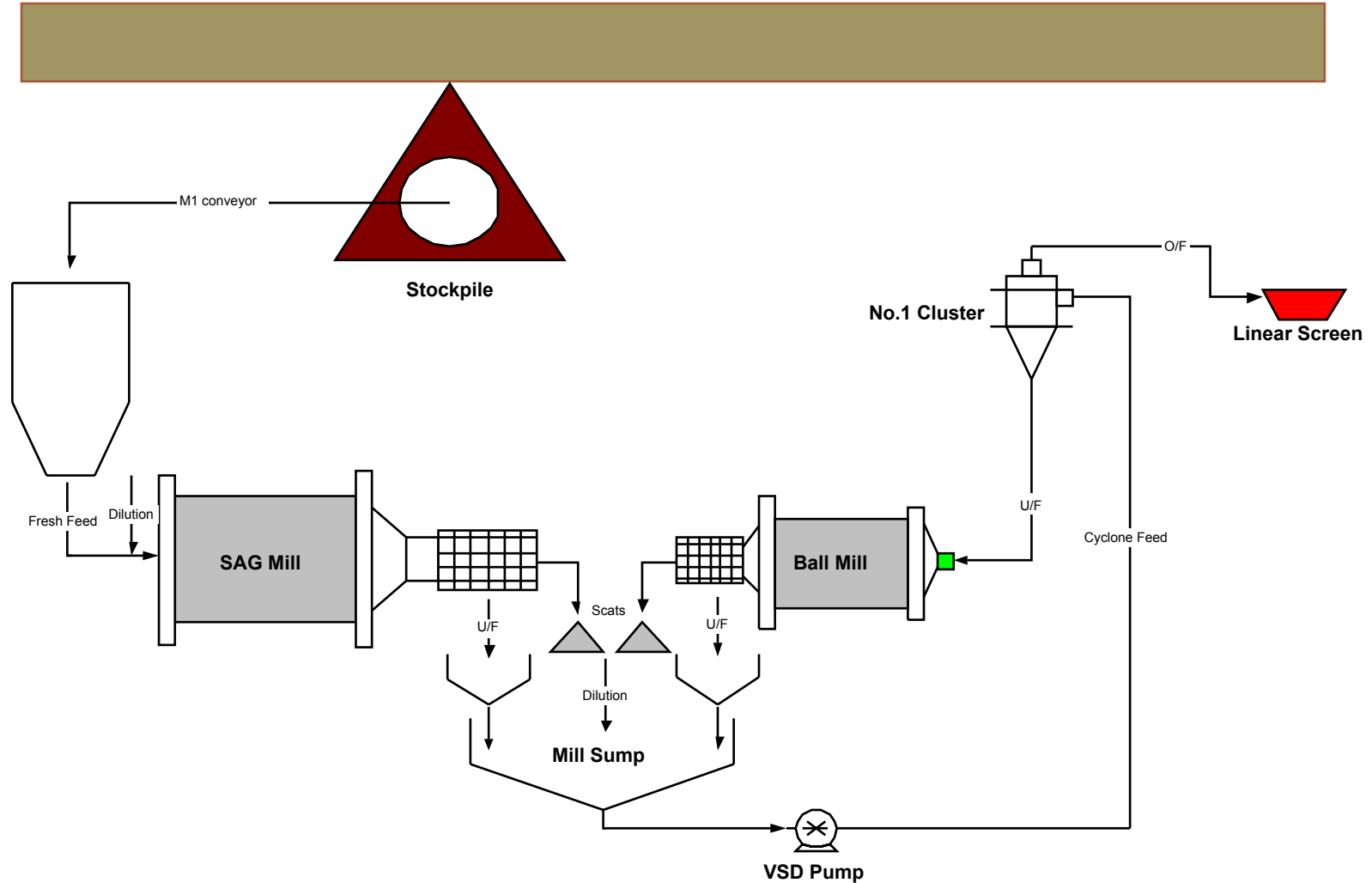
Introduction

- **Ball Mill circuit**
- **Mill variables**
 - Feed size
 - Power consumption
 - Grind
 - Ball charge volume



GOLD FIELDS

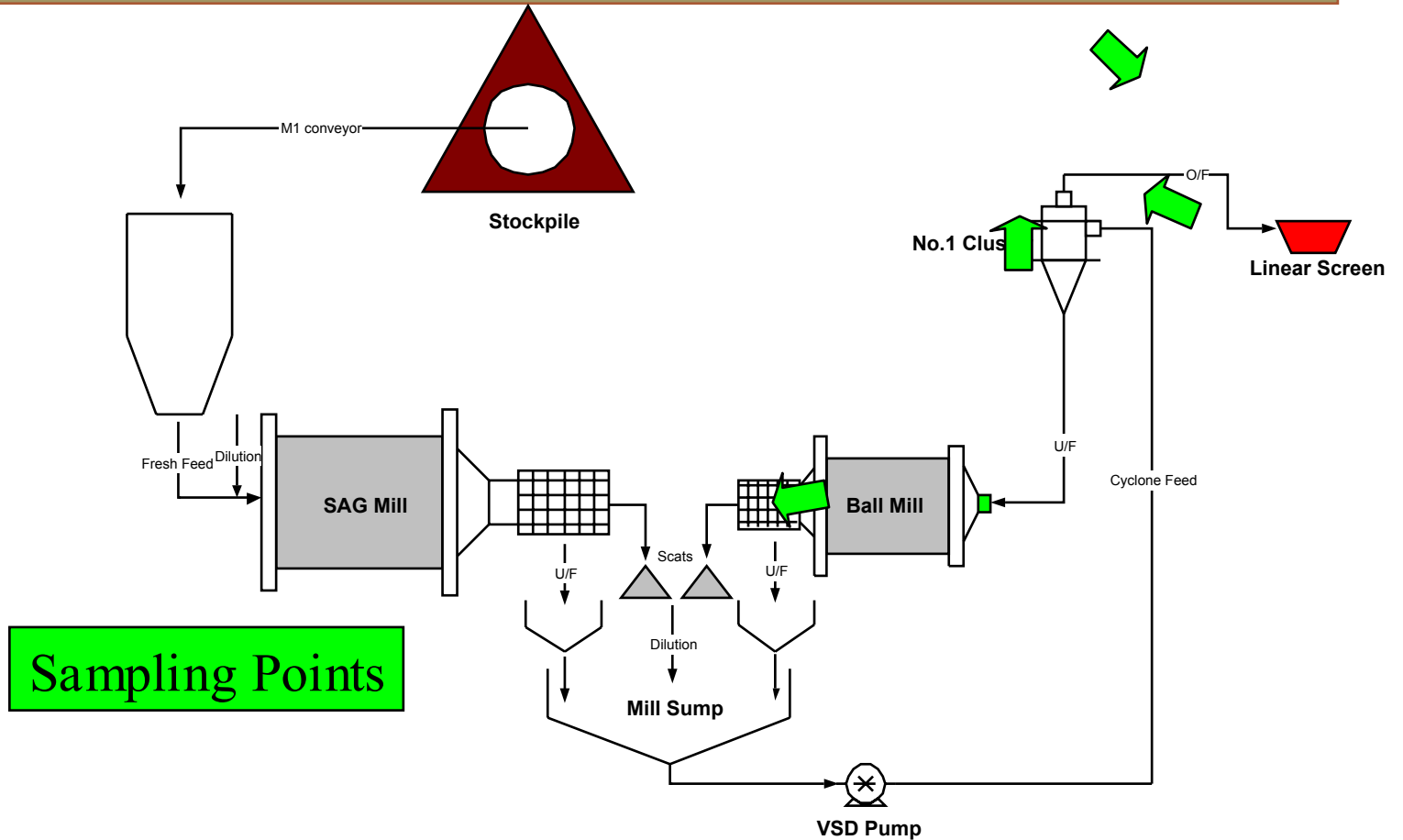
Milling Circuit





GOLD FIELDS

Milling Circuit





Data to be collected

- Ball Mill inlet dilution water flow rate
- Ball Mill Power Consumption (kW)
- Cyclone pressures (kPa)
- Cyclone feed pump output (%)
- Cyclone feed density
- Cyclone feed flow rate (m³/h)



GOLD FIELDS

Test Results

	100 mm Spigots	150 mm Spigots
Power drawn (kW)	1970	1805
Wi (kWh/t)	9.42	3.71
Ball Filling	15%	15%
% solids	81.04	75.06
Mill discharge w/s	0.26	0.33
F80 (micron)	679	474
P80 (micron)	79.57	66.06
Kwh/t -75 micron	30.28	12.70
Kwh/t +150 micron	5.13	10.14
Circulating ratio	0.22	0.77



GOLD FIELDS

Test Results

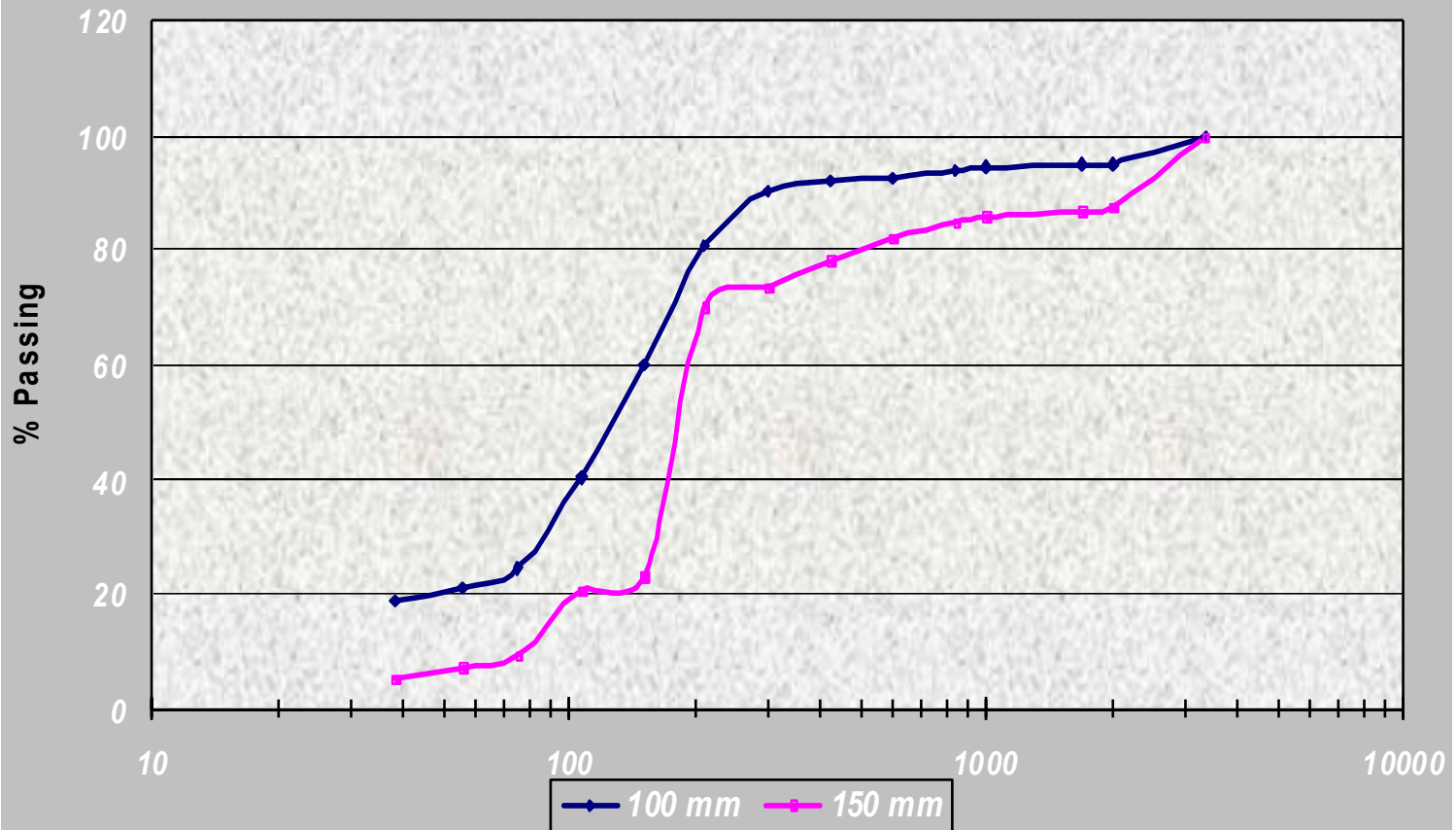
	100 mm Spigots	150 mm Spigots
Power drawn (kW)	2705	2640
Wi (kWh/t)	11.16	4.89
Ball Filling	22%	22%
% solids	77.08	72.00
Mill discharge w/s	0.26	0.33
F80 (micron)	679	474
P80 (micron)	79.57	66.06
Kwh/t -75 micron	30.28	12.70
Kwh/t +150 micron	5.13	10.14
Circulating ratio	0.22	0.77



Mill Discharge Size Distribution

GOLD FIELDS

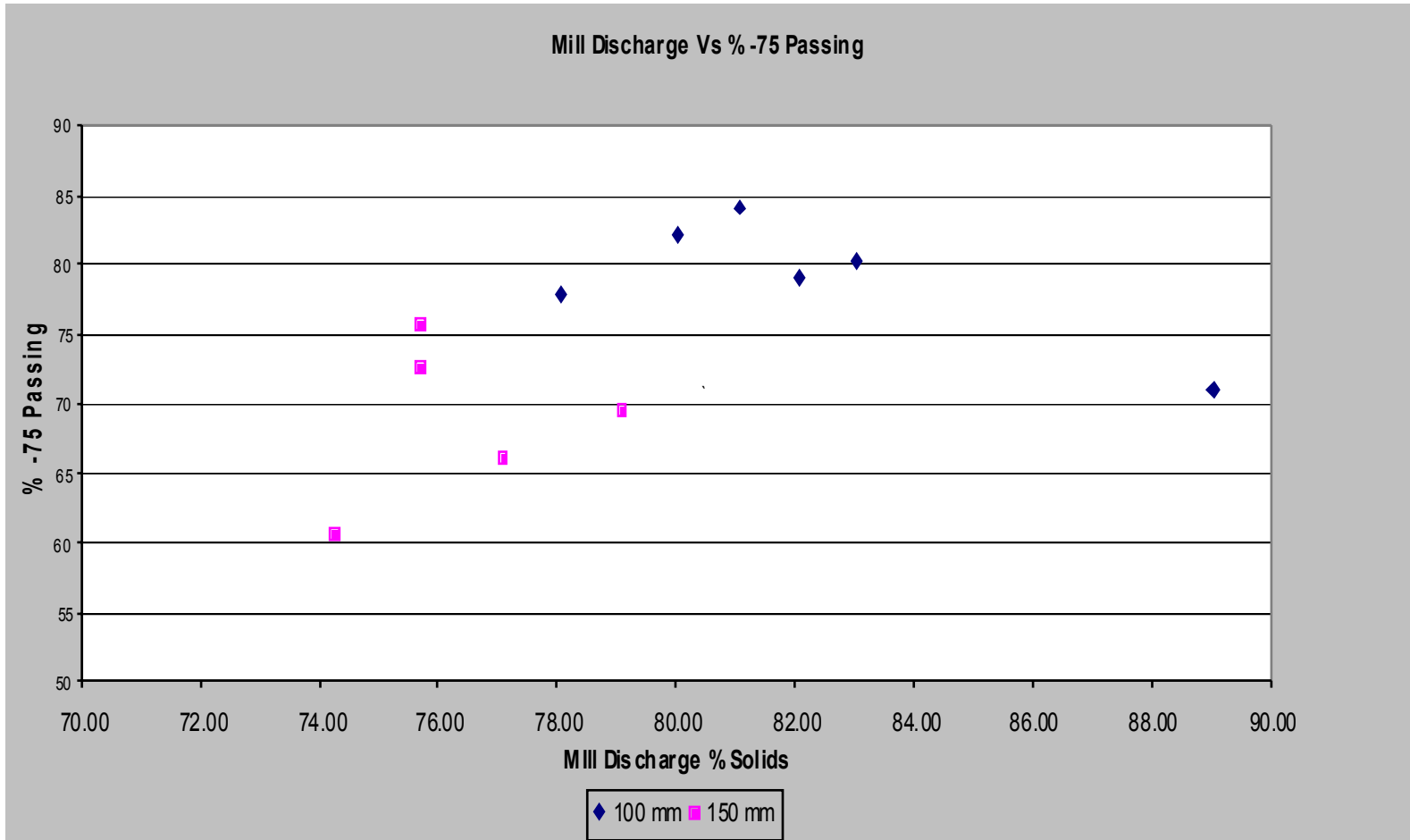
Discharge Particle Distribution





GOLD FIELDS

Mill Performance

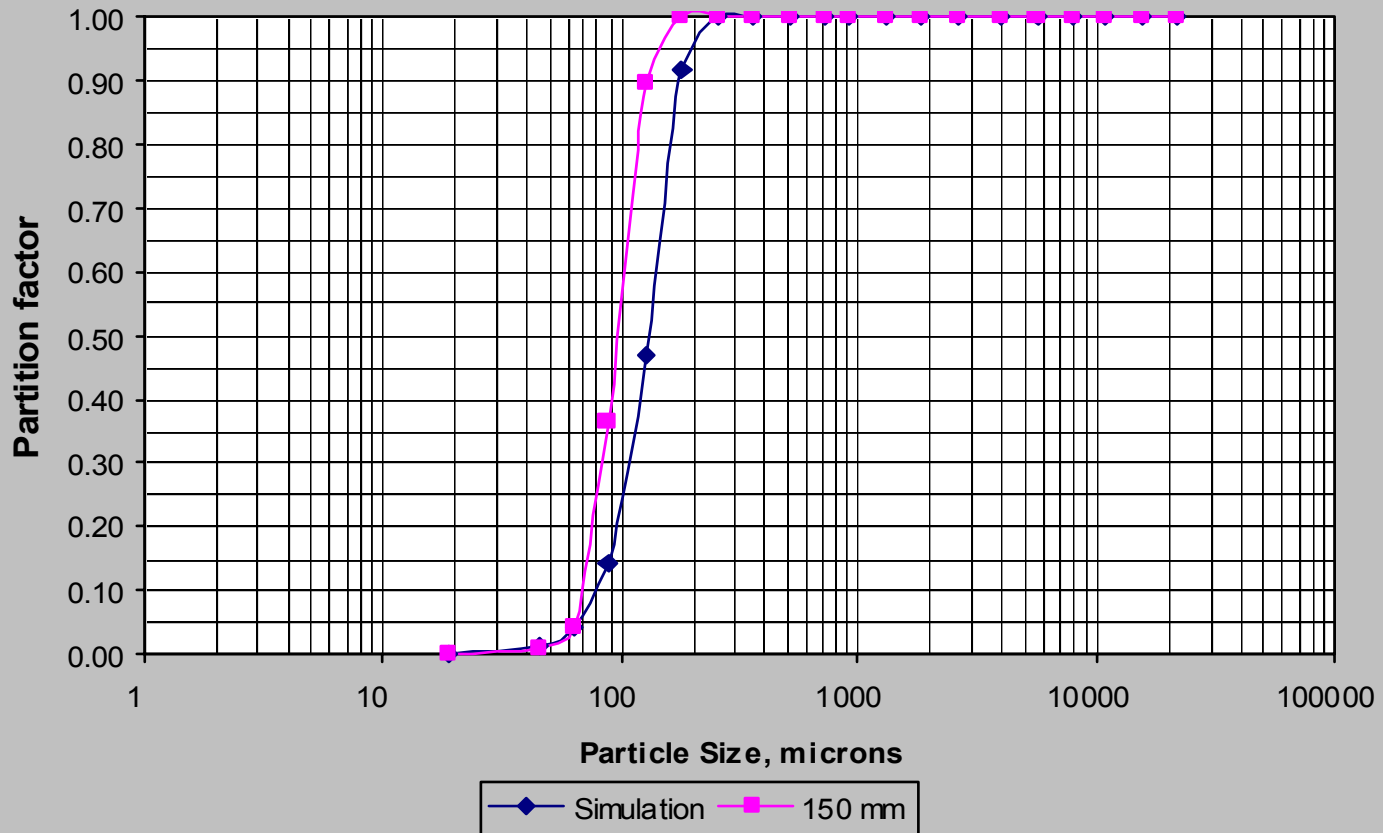




GOLD FIELDS

Tromp Curves (2)

**Cyclone Performance Vs Predicted Tromp curve
150 mm - sampling data**

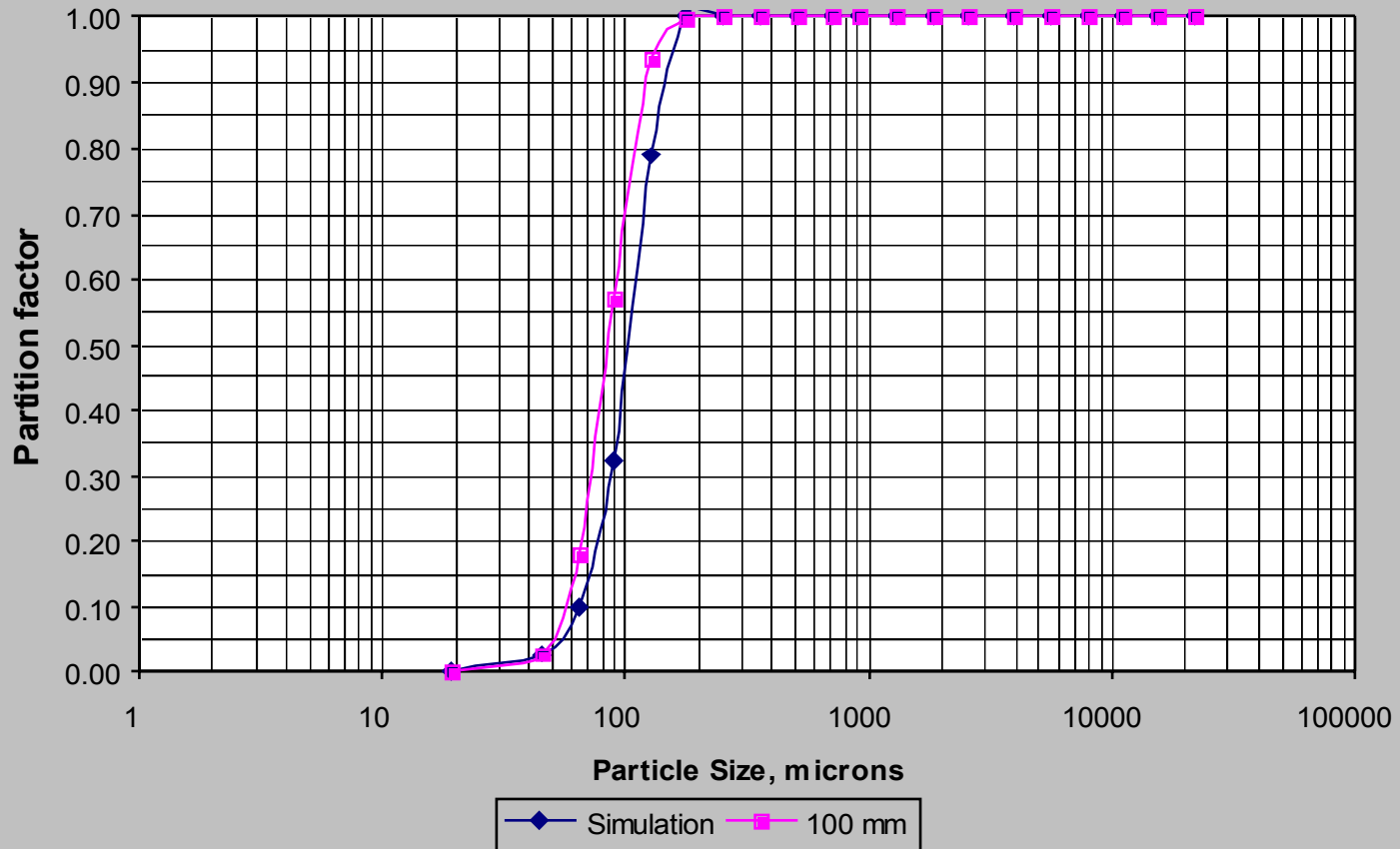




GOLD FIELDS

Tromp Curves (1)

Cyclone Performance Vs Predicted Tromp curve
100 mm - sampling data





GOLD FIELDS

Cyclone performance

Cyclone Performance				
	Plant data		Simulation	
	100 mm Spigots	150 mm Spigots	100 mm Spigots	150 mm Spigots
Imperfection	0.18	0.21	0.25	0.22
Circulating load	238	550	369	526
D50 Corrected(um)	85	95	102	129
Alpha Water	0.18	0.42	0.45	0.27
Feed % Solids	59.81	45.38	46.7	55.7



GOLD FIELDS

Mill performance Simulation

Moly-Cop Tools™

Sample
N° 100 mm

BALLBAL

Grinding Circuit Mass Balance Estimator

Remarks :

Base Case Example

BALL MILL PERFORMANCE

Diameter, ft	16.0	Mill Power, kW (Gross)	2298
Length, ft	30.0	Mill Power, kW (Net)	2068
Speed, % Critical	72.0	Throughput, ton/hr	806.8
App. Density, ton/m ³	3.99	% Solids (by weight)	74.0
Charge Level, %	35.0	Sp. Energy, KWH/ton	3.74
Balls Filling, %	15.0	Reduction Ratio	1.82
Lift Angle, (°)	35.0	F80(micron)	379



GOLD FIELDS

Mill performance Simulation

Moly-Cop Tools™

Sample
N° 150 mm

BALLBAL

Grinding Circuit Mass Balance Estimator

Remarks :

Base Case Example

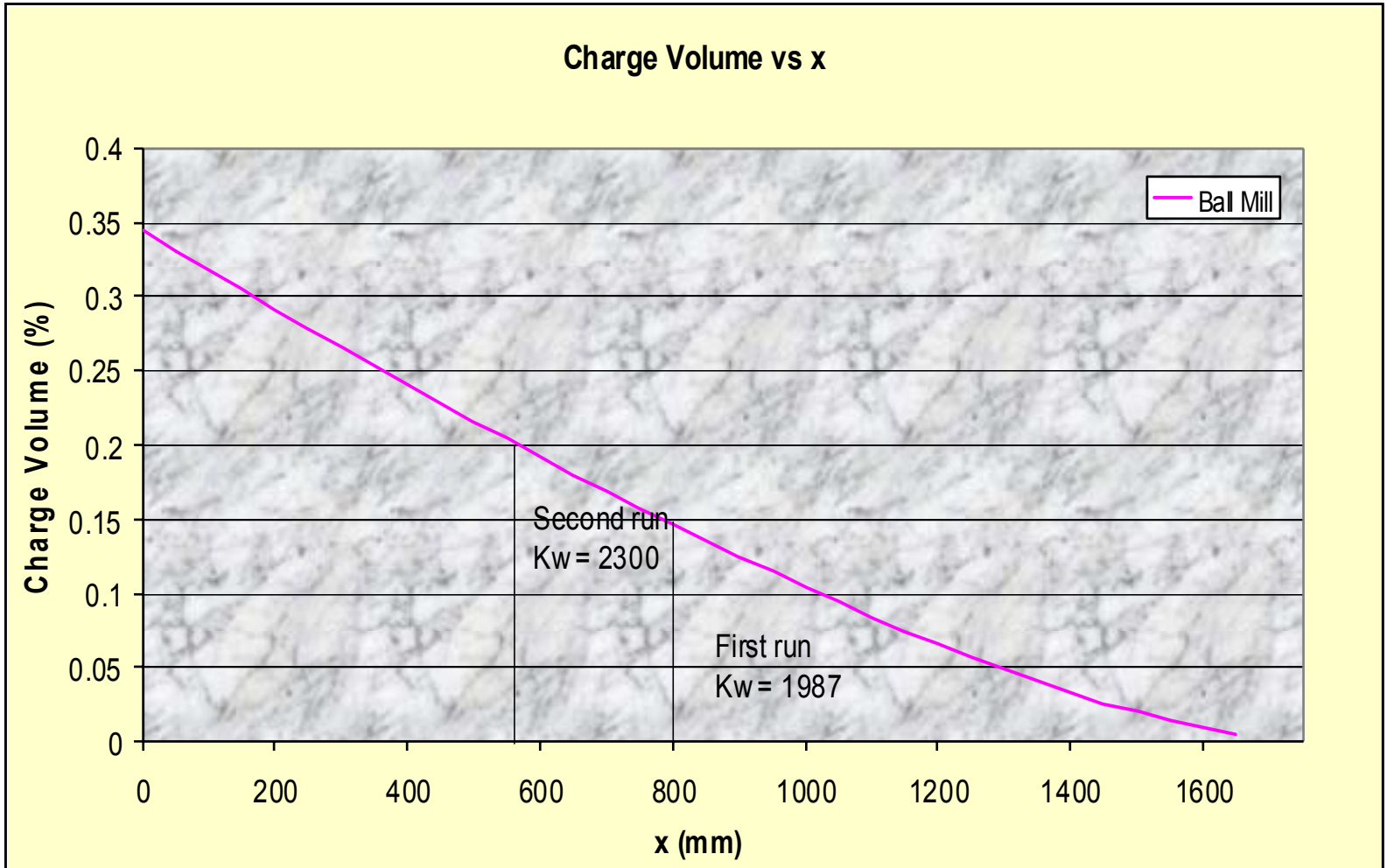
BALL MILL PERFORMANCE

Diameter, ft	16.0	Mill Power, kW (Gross)	3002
Length, ft	30.0	Mill Power, kW (Net)	2702
Speed, % Critical	72.0	Throughput, ton/hr	7780
App. Density, ton/m ³	4.08	% Solids (by weight)	71.3
Charge Level, %	35.0	Sp. Energy, KWH/ton	0.39
Balls Filling, %	22.0	Reduction Ratio	1.19
Lift Angle, (°)	35.0	F80(micron)	501



GOLD FIELDS

Charge Level Estimation

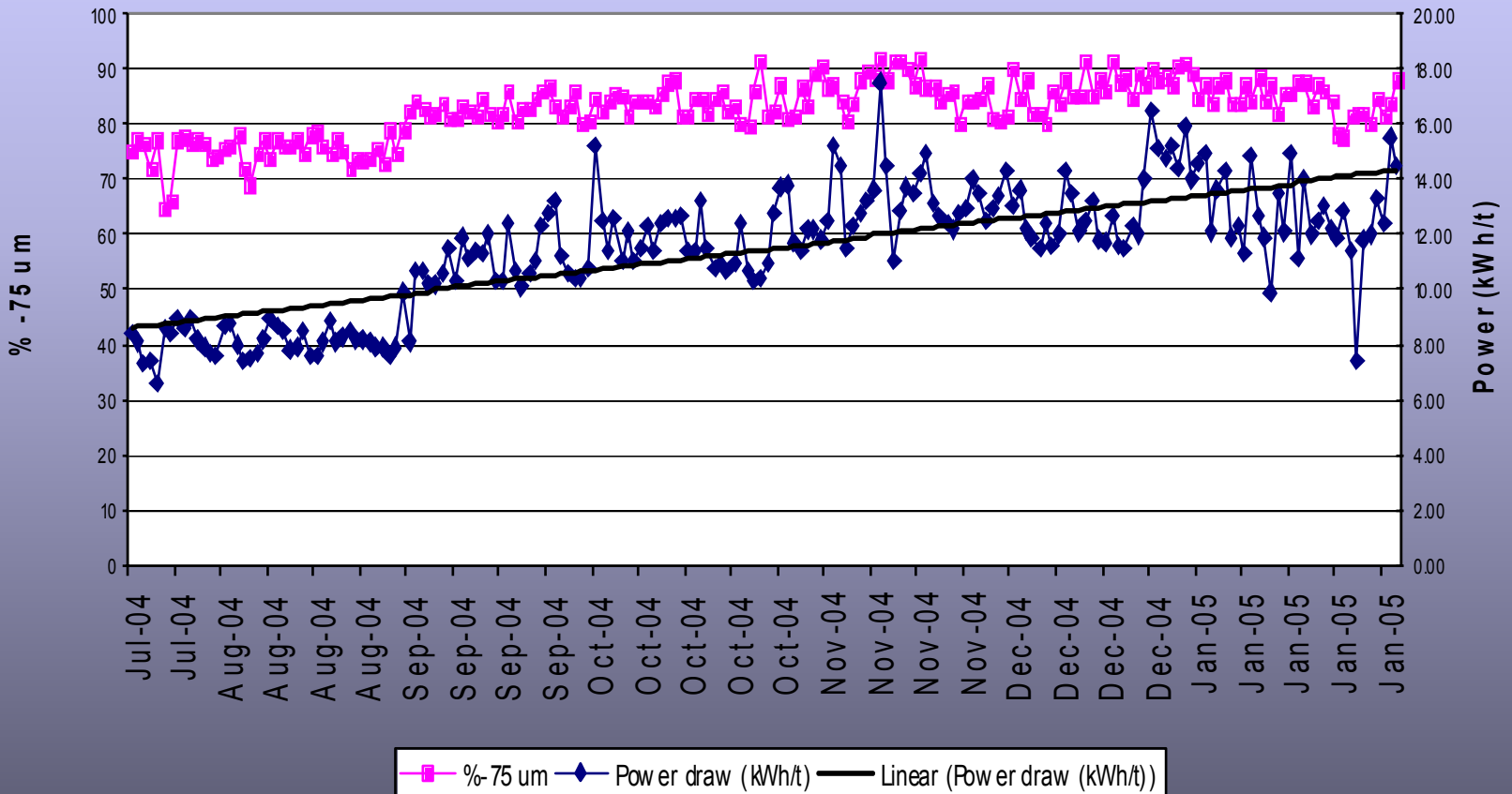




GOLD FIELDS

Mill Power Utilization

%-75um (O/F) Vs Power draw (kWh/t)





50/80 mm ratio Ball Addition

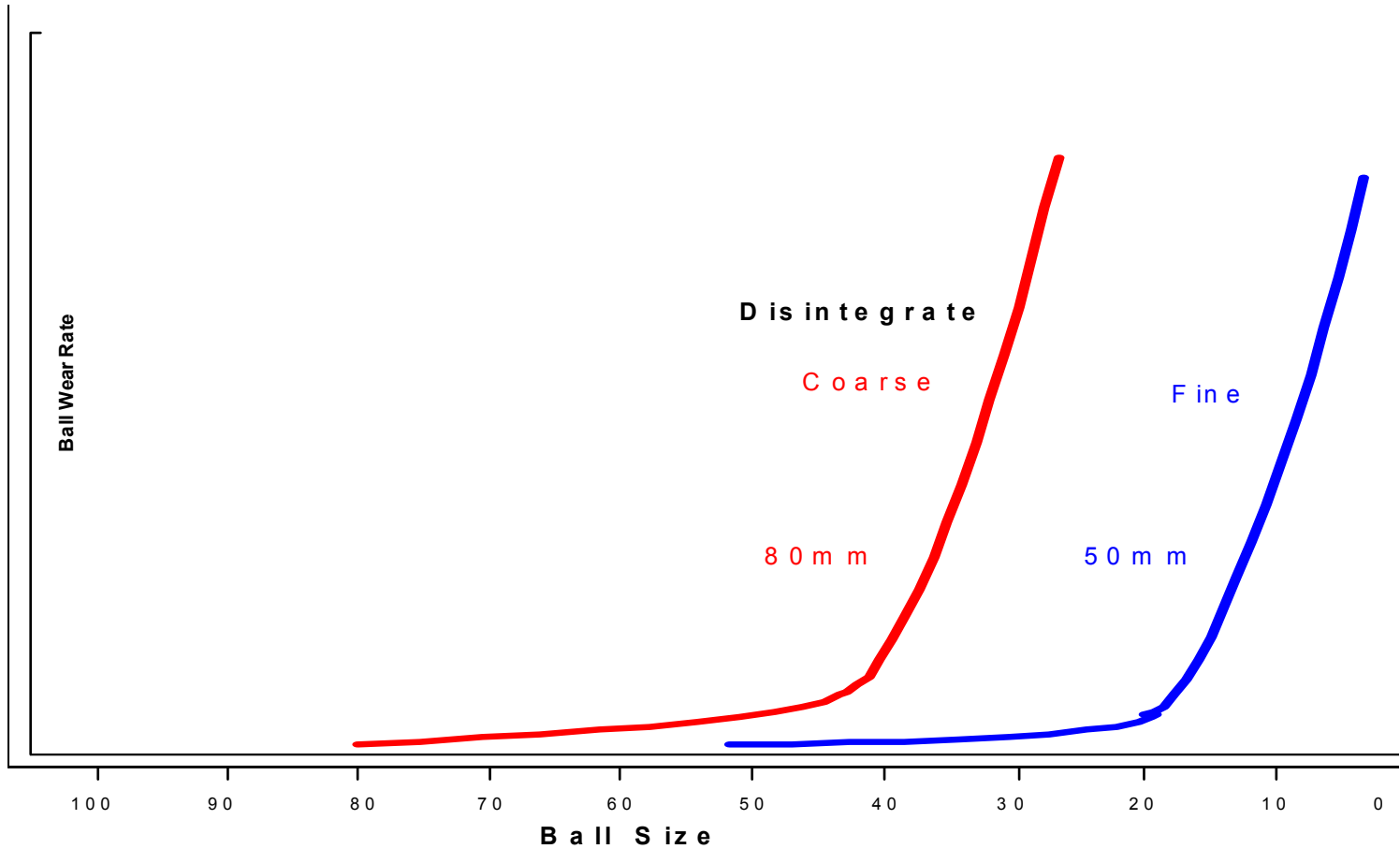
GOLD FIELDS

- Ineffective reduction of +150 μ m fraction in Ball mill
- Simulation indicated larger dia ball required for coarser material
- Intent to mill both fractions
- 80 mm added 50/50 ratio with 50 mm (Trial and Error)



GOLD FIELDS

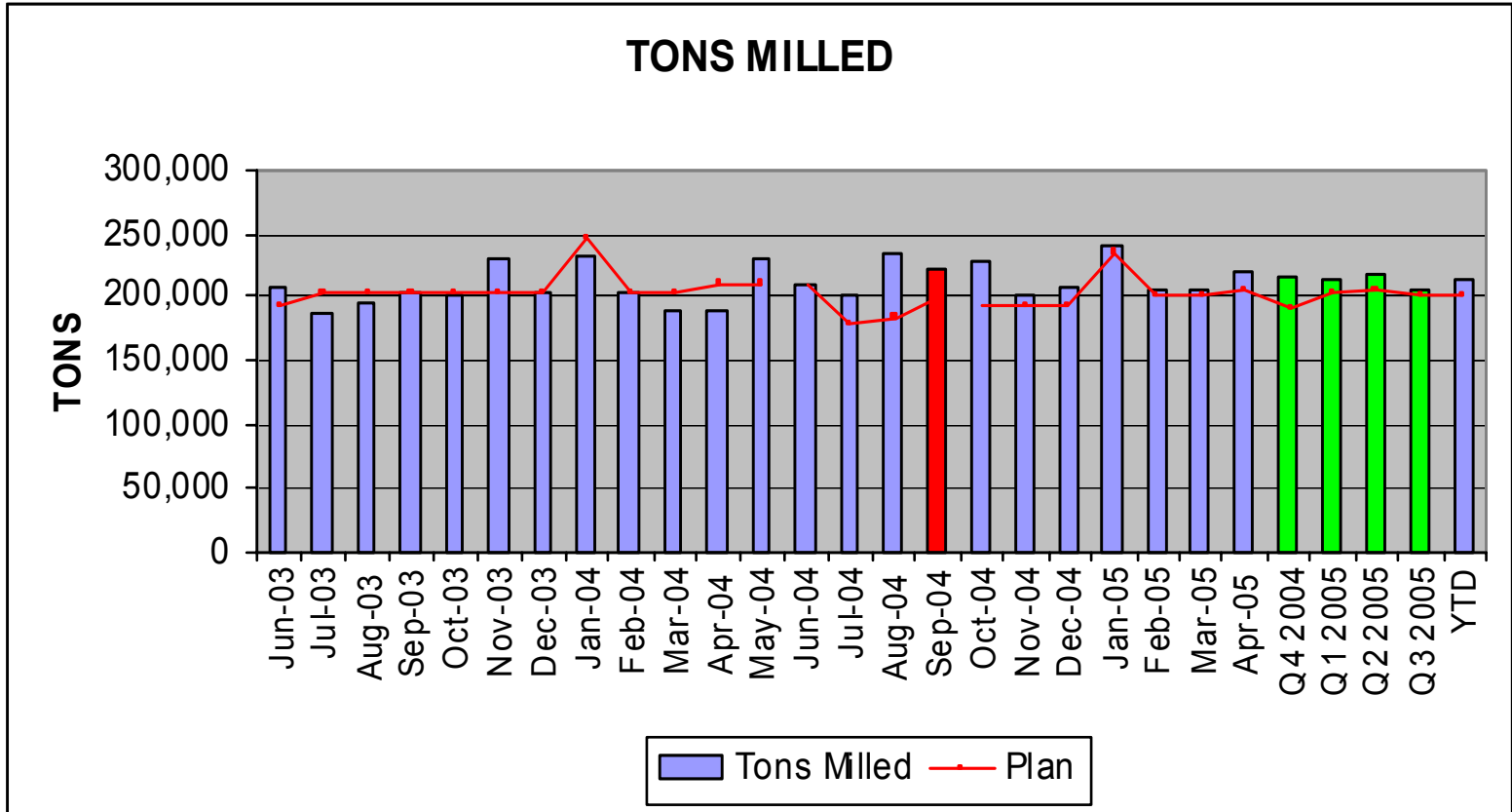
Grind theory





GOLD FIELDS

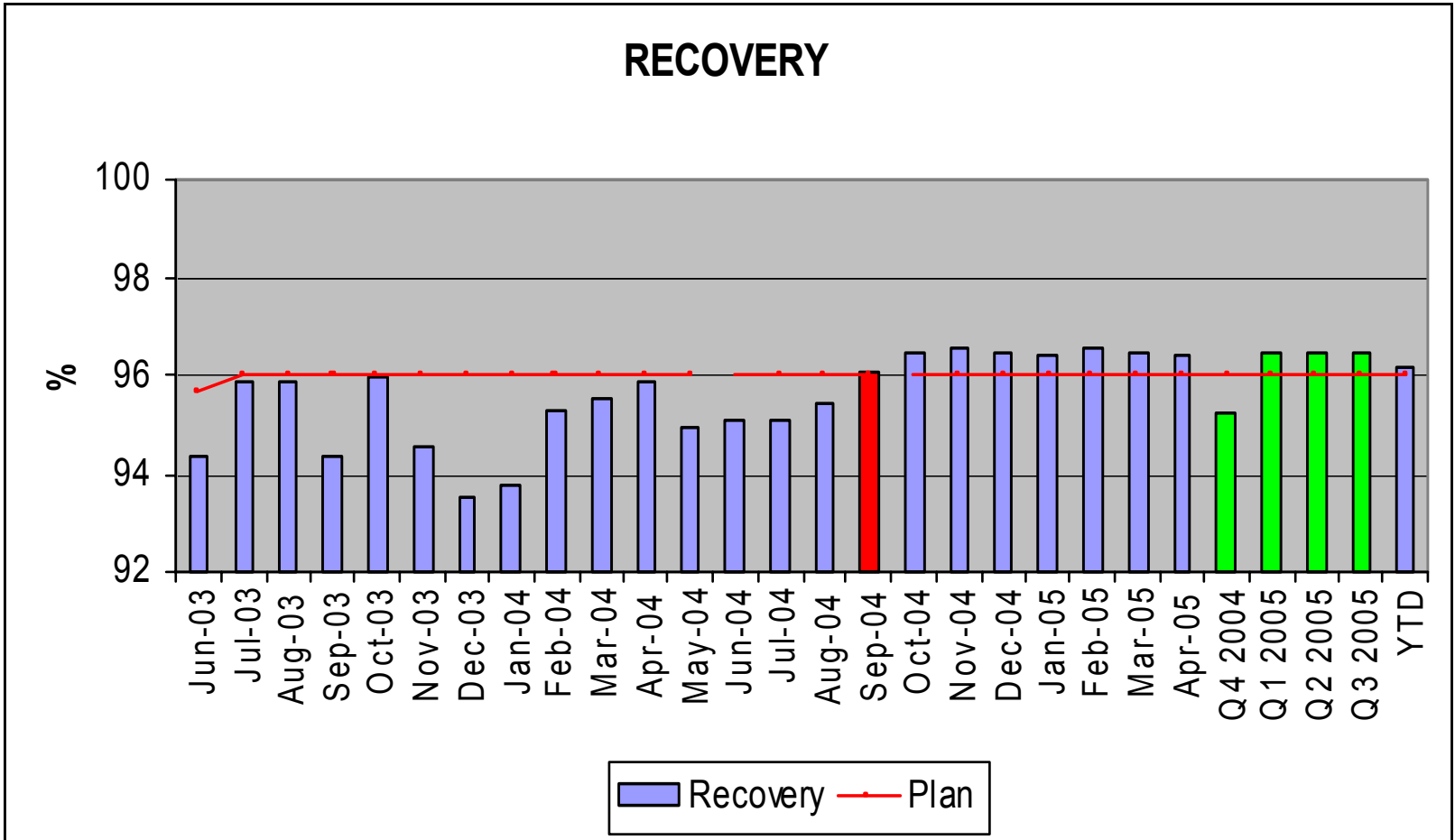
Tons milled





GOLD FIELDS

Recovery





GOLD FIELDS

Feasibility Study

Base data			Monthly
Current tons milled		tons	223417
Forecasted tons milled per month		tons	223417
Steel addition @ 1.0 kg/t	1.00	tons	223.417
Steel ball cost		R/t	3977
Steel ball cost for make up		R/t	3977
Amount of steel used for make up		tons	25
Cost of steel make up		R	99,425
Steel cost/month @ 1.00 kg/t		R	888,529
Head Grade		g/t	5.42
Gold Produced @ 94 % Recovery before make up		kg	1,138.00
Gold Produced @ 96.4 % Recovery after make up		kg	1,167.00
Extra Au extracted		kg	29.00
Gold price		R/kg	85,000
Extra revenue achieved		R	2,465,000
Thus profit @ 1.00 kg/t addition (Including make up)		R	1,477,046



GOLD FIELDS

Recommendations

- Maintain Optimum Mill Discharge
- Research Mill **Feed Variation**
- Investigate Liner Wear - Screen failure due to over-charge
- Continue **50/80** mm steel ball blending
- Different ratio (100% 80 mm)



GOLD FIELDS



Thank you