OPTIMISATION OF THE PROMINENT HILL FLOTATION CIRCUIT

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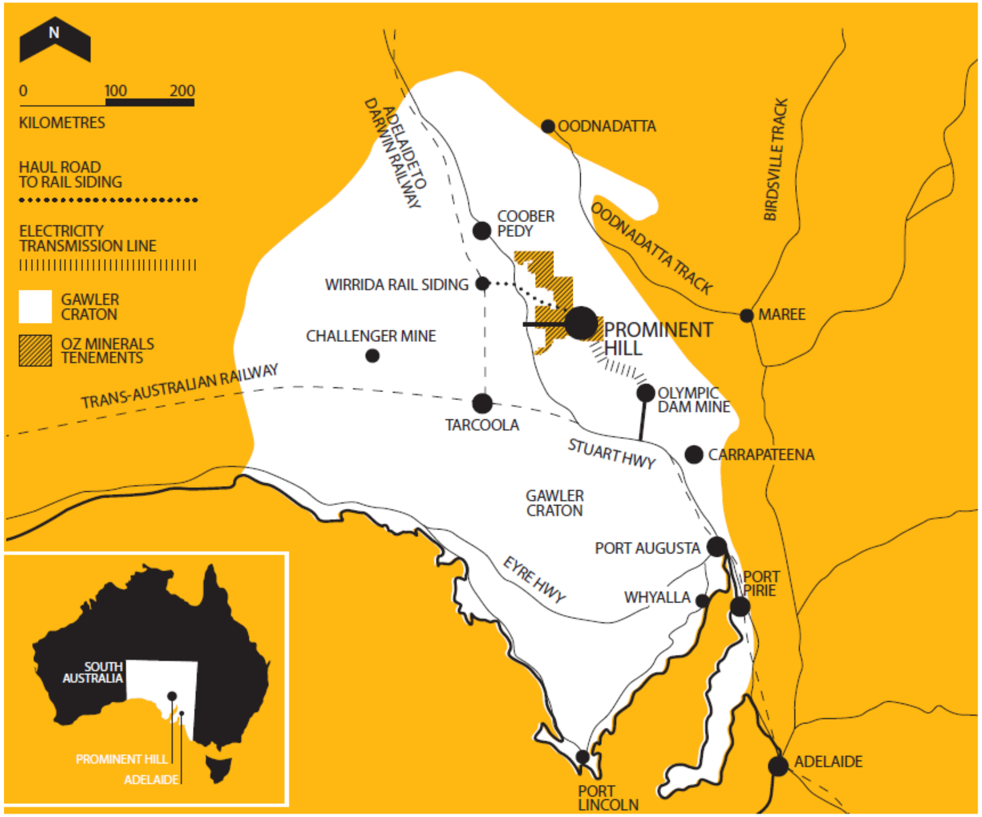
CONTENTS

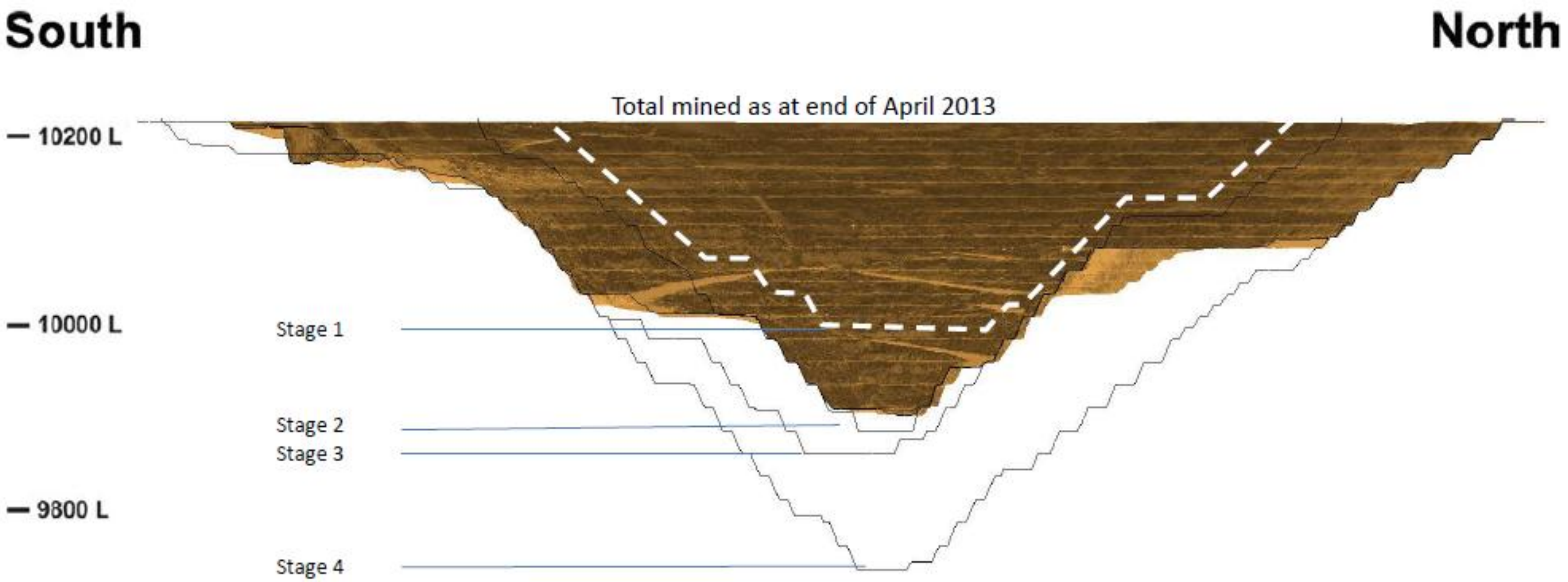
INTRODUCTION
Location



Prominent Hill is located:

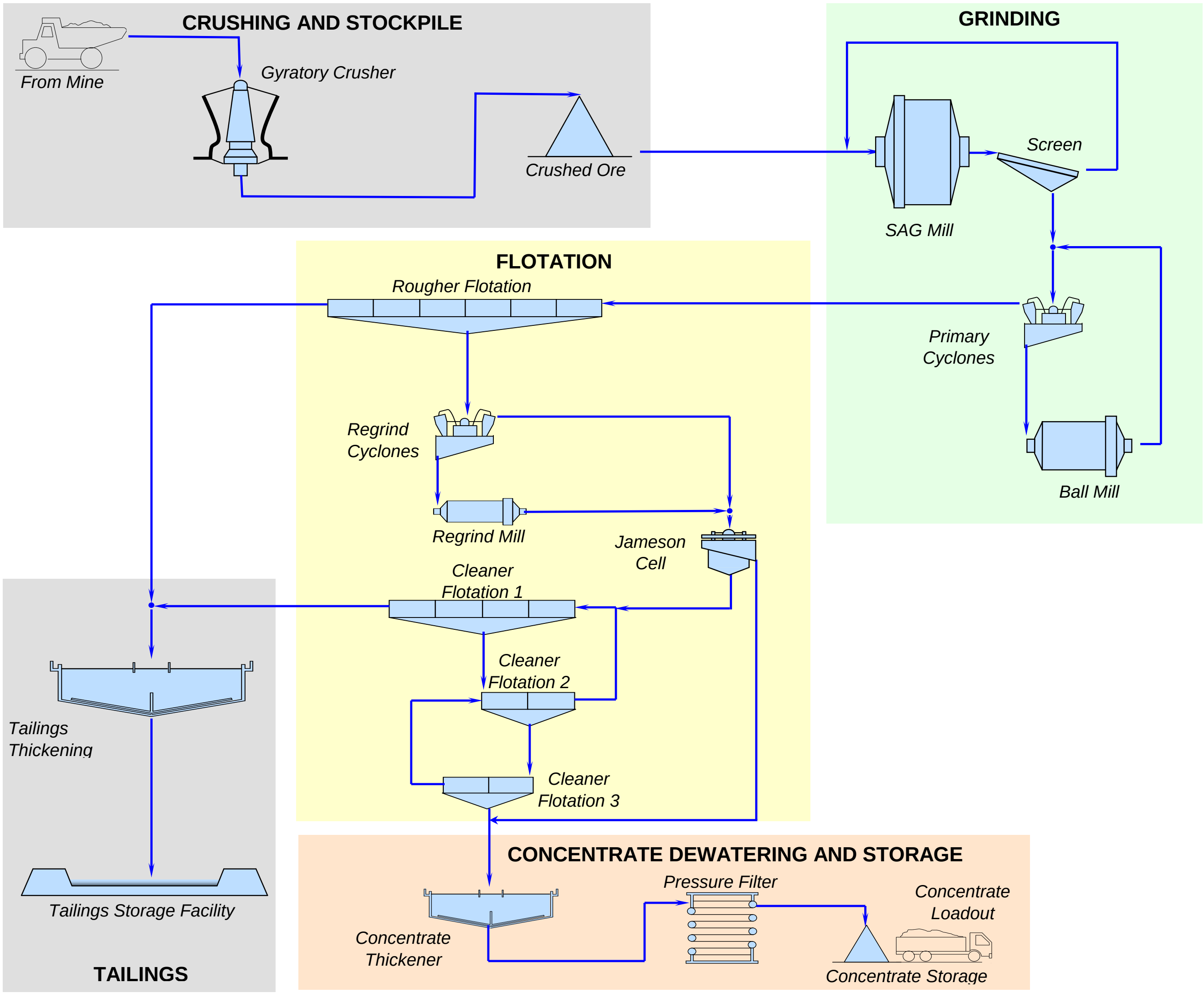
- 650 km north-northwest of Adelaide and 150 km northwest of Roxby Downs (Olympic Dam) in South Australia.

INTRODUCTION
Mineralisation / History / Life of Mine



- Iron oxide hosted copper-gold (IOCG) deposit- chalcocite, bornite and chalcopyrite with additional "gold only" ores
- Mining started 2006, process plant commissioned early 2009
- Total reserves currently 69.8Mt with 1.1% Cu and 0.60g/t Au (as at June 2012)
- Extension study underway to increase mine life

INTRODUCTION
Process Flowsheet



INTRODUCTION
Flotation Circuit

INTRODUCTION
Regrind Mill (IsaMill)

INTRODUCTION
Jameson Cell

PROCESS OPTIMISATION
Flotation Optimisation Objectives

- Copper Sulphide Recovery
  - Increased revenue
- Gold Recovery
  - Smelter credits
- Throughput
  - Through improved flotation of coarse materials
- Consumables Costs
  - Reagents

Ongoing diagnostic and mineralogy testwork to determine potential improvements

PROCESS OPTIMISATION
Design Predictions

Ore Type	Predicted Concentrate Grade	Predicted Recovery	
	Cu %	Cu %	Au %
Chalcocite-Bornite	54	88	77
Chalcopyrite-Pyrite	25	83	63
Bornite-Chalcopyrite	34	80	70

- Throughput design is 8Mtpa
- Maximum predicted recovery for a single ore type is 88% for copper and 77% for gold
- Actual recovery would be expected to be lower with blending

REAGENT SCHEME OPTIMISATION
Implementation Process

- Laboratory flotation tests
- Plant trial
- Statistical analysis via paired t-tests

REAGENT SCHEME OPTIMISATION
Statistical Analysis

Shift		Test Status
8/07/2011	Day	404 Off
8/07/2011	Night	404 Off
9/07/2011	Day	404 On
9/07/2011	Night	404 On
10/07/2011	Day	404 Off
10/07/2011	Night	404 Off
11/07/2011	Day	404 On
11/07/2011	Night	404 On
12/07/2011	Day	404 On
12/07/2011	Night	404 Off
13/07/2011	Day	404 Off
13/07/2011	Night	404 Off

- Test pairs randomly generated to create an "on/off" trial

REAGENT SCHEME OPTIMISATION
Statistical Analysis

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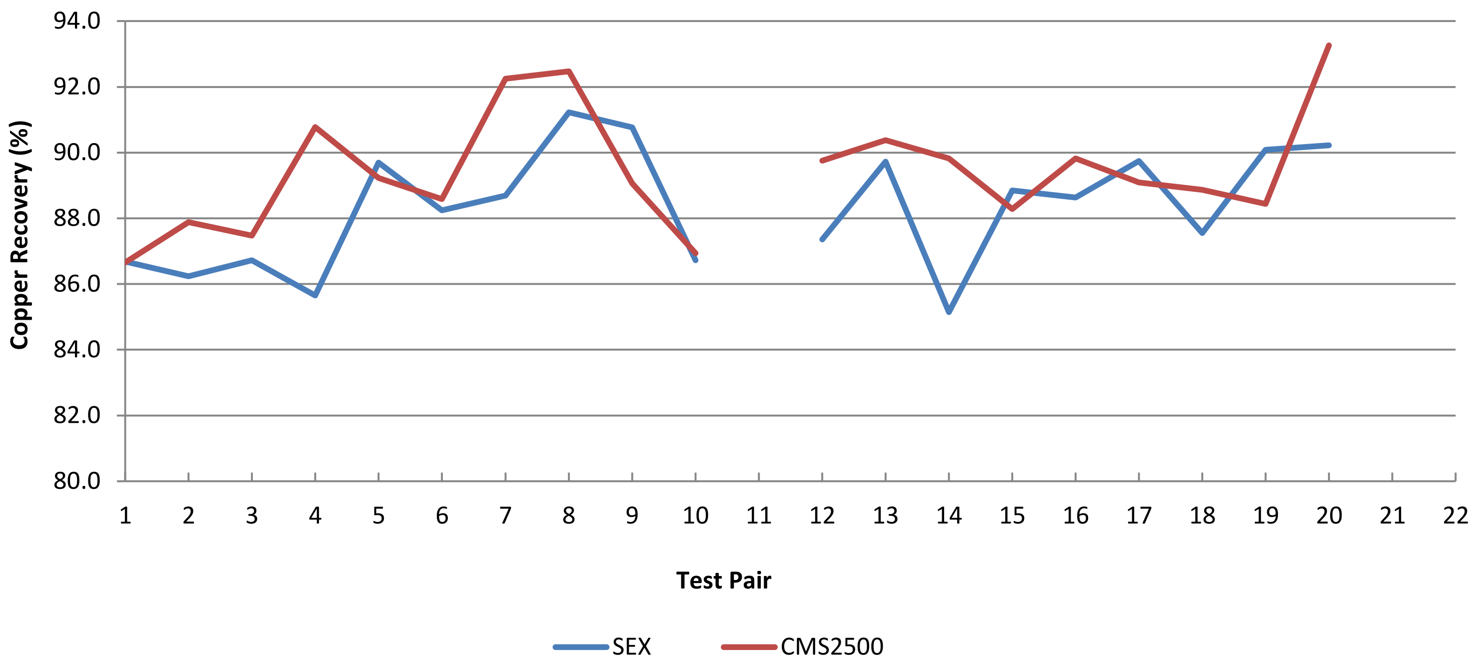
12/07/2011	Day	404 On
13/07/2011	Day	404 Off

- Test pairs randomly generated to create an "on/off" trial
- t-test to compare two means (1 sided)
- The P-value provides the level of confidence with which we can say there is an improvement
- The difference between the mean recoveries provides the best estimate of what that improvement is

REAGENT SCHEME OPTIMISATION
Chemical & Mining Services CMS 2500® Plant Trial



- Thionocarbamate
- CMS 2500® and SEX showed an average of 1.1% copper recovery improvement at 98.8% confidence compared to SEX alone
- Permanently added to the ball mill feed

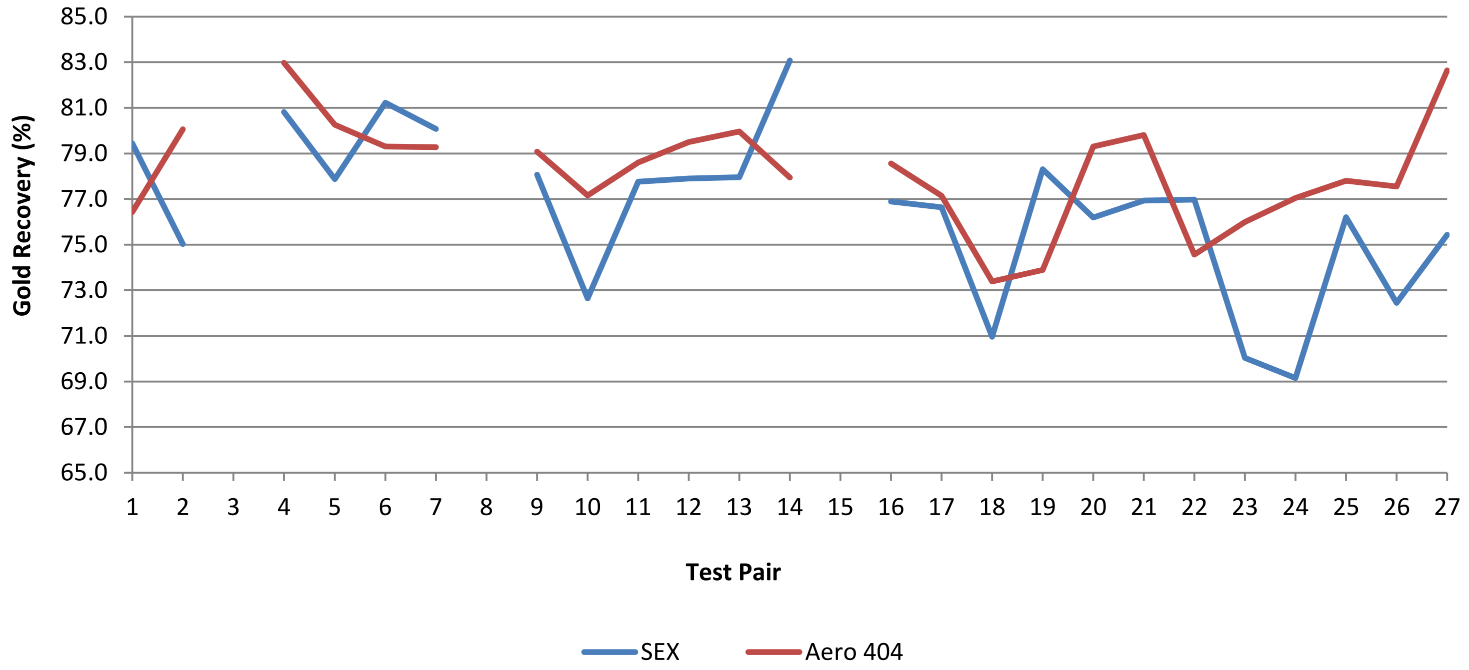
REAGENT SCHEME OPTIMISATION
Chemical & Mining Services CMS 2500® Plant Trial

- CMS 2500® used in conjunction with SEX is able to improve flotation of copper sulphide minerals
- Xanthate will tend to form multi-layers around the mineral particles at the more active sites contributing to extreme hydrophobicity and froth instability
- The thionocarbamate reacts at the most active sites but forms mono-layers, leaving SEX to react at less active sites, providing a more uniform collector coverage and stable froth

REAGENT SCHEME OPTIMISATION
Chemical & Mining Services CMS 2500® Plant Trial

- Permanently incorporated into the concentrator reagent scheme via the existing 'Test Reagent' ring main infrastructure
- Minor changes to the existing setup which was similar to the xanthate ring main
- Control of dosage from the DCS

REAGENT SCHEME OPTIMISATION
Cytec Aero 404® Plant Trial



- Dithiophosphate
- Aero 404® showed an average of 1.68% gold recovery improvement at 95.9% confidence compared to the existing scheme (SEX and CMS 2500®)
- Permanently added to the rougher feed and Jameson Cell tailings

REAGENT SCHEME OPTIMISATION
Cytec Aero 404® Delivery System

- Dosed from a self bunded tank
- Two small pumps send to the two dosing points
- Power source for pumps set to trip with the SAG Mill

REAGENT SCHEME OPTIMISATION
Orica DSP110® Plant Trial

Screening (50 reagents) → **Detailed Testing (5 reagents)** → **Plant Trial (DSP 110®)** → **Permanent Addition**

- DSP 110® showed an average of 0.35% copper recovery improvement at 95.0% confidence compared to the existing scheme (SEX, CMS 2500® and Aero 404®)
- Permanently added to the rougher feed
- Thionocarbamate

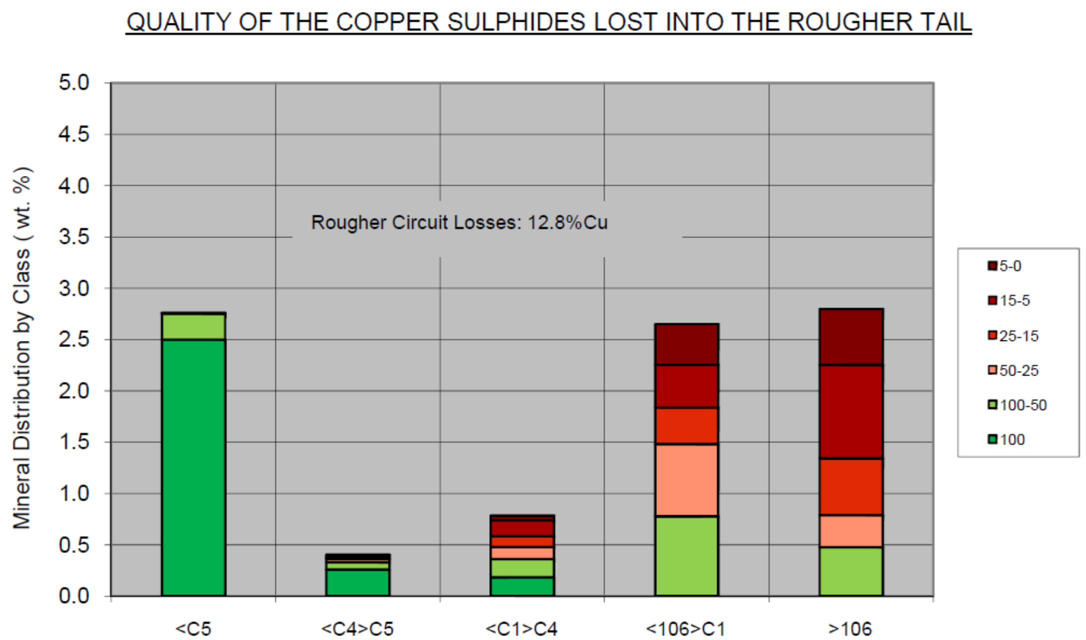
REAGENT SCHEME OPTIMISATION
Collector Scheme Summary

Collector	Type	Addition Points	Dosage (g/t)	Purpose	Recovery Gain
Sodium Ethyl Xanthate (SEX)	Xanthate	Primary hydrocyclone feed hopper Rougher circuit Jameson Cell First cleaner circuit	10-30	Selective sulphide collector	-
Interfroth CMS2500®	Thionocarbamate	Ball mill	1.5-3.5	Copper recovery	1.10% Cu
Cytec Aero 404®	Dithiophosphate	Rougher circuit head Cleaner circuit head	3	Gold recovery	1.68% Au
Orica DSP110®	Thionocarbamate	Rougher circuit head	0.25	Copper recovery	0.35% Cu

- Sodium ethyl xanthate as the main collector
- Additional collectors proven to aid in recovery
- Currently no activators or depressants employed

CELL DESIGN OPTIMISATION

Targeted Recovery Improvements



- Mineralogical test work showed that rougher losses occurred in coarse (>100μm) and fine (<C5) fractions
- These losses could be targeted by retrofitted designs intended to enhance mixing and suspension
- Installations were completed in stages during planned shut down periods

Source: Shouldice, T and Ma, W, 2010, Mineralogical Assessment of the Prominent Hill Flotation Streams March 2010 – KM2641, technical report (unpublished), G&T Metallurgical Services, Kamloops.,

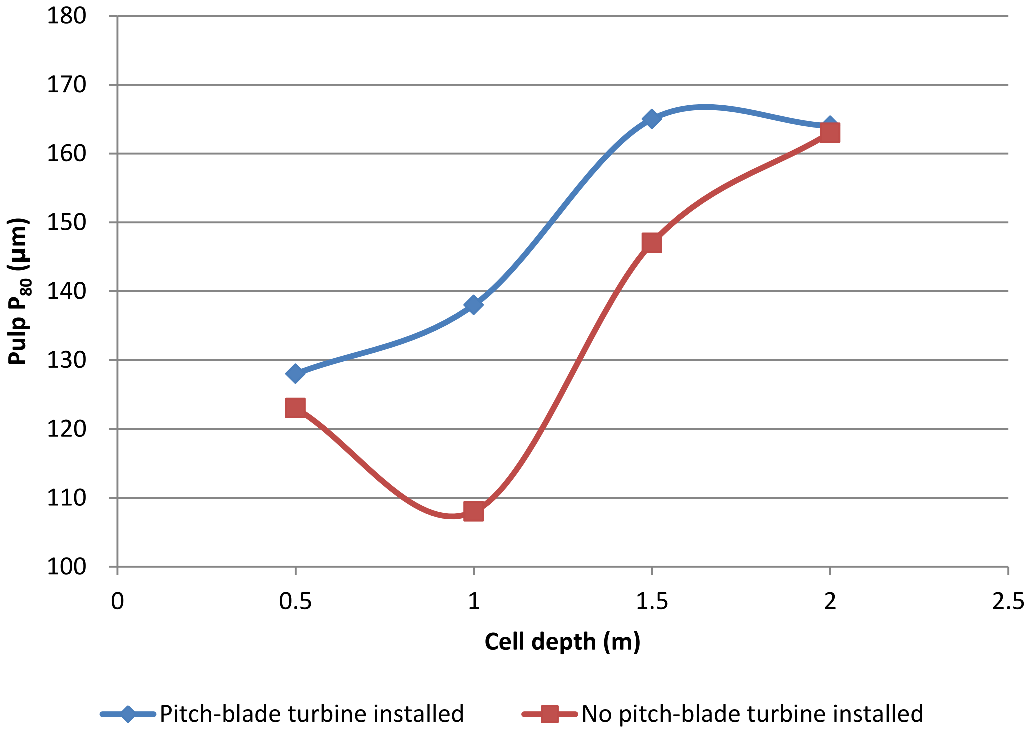
CELL DESIGN OPTIMISATION
Rotor-Stator Design (Outotec FloatForce®)

- Replaced MultiMix® design with half length stators
- Allows increased slurry circulation
- Allows improved mixing efficiency at higher air rates

CELL DESIGN OPTIMISATION
Impeller Shaft Design (Outotec FlowBooster®)

- Bi-directional pitch-blade turbine on shaft exerts downwards force
- Enhances mixing in large cells such as the 150m^3 OK-150s
- Improves coarse particle mixing and recovery
- Installed in cells 1 to 3 in December 2010 and 4 to 6 in March 2012

CELL DESIGN OPTIMISATION
Improved Coarse Particle Suspension



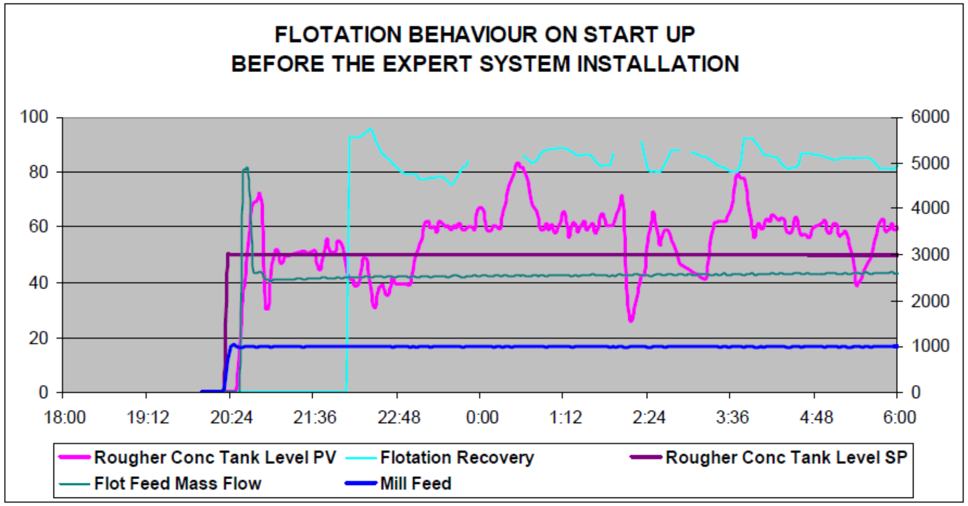
- P_{80} measured before and after pitch blade installation
- Samples taken at four cell depths
- Demonstrates improved coarse particle suspension

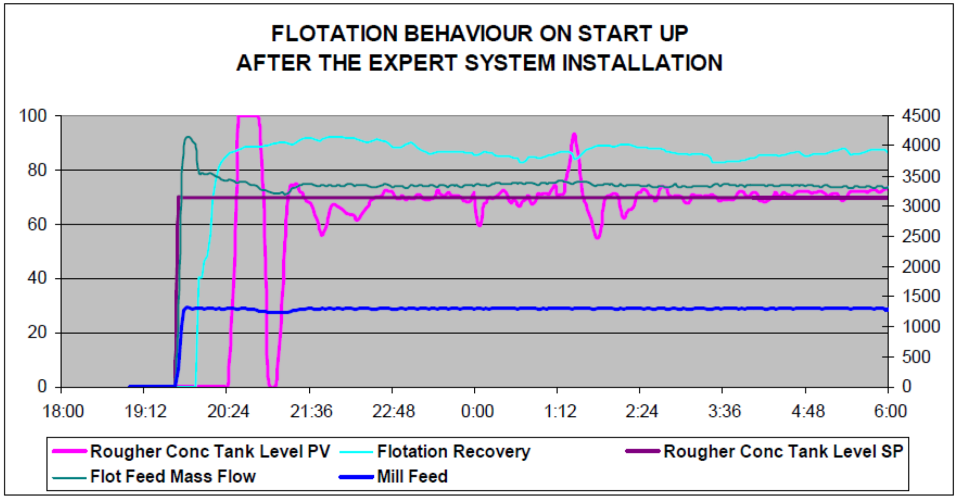
CELL DESIGN OPTIMISATION
Results Summary – 2010 and 2011

	Average rougher copper losses by size range (%)				
Year	>106	106-C1	C1-C4	C4-C5	<C5
2010	4.3	2.1	0.8	0.2	2.3
2011	3.3	1.4	0.8	0.2	1.6
Total reduction	1.0	0.7	0.0	0.0	0.7

- Both fine and coarse fraction losses were reduced across this period
- Increased coarse recovery allows greater feed P_{80} and therefore greater throughput (9.9Mtpa in 2011)
- From mineralogy reports, total copper and gold rougher losses reduced by 2.4% and 1.0% respectively

PROCESS CONTROL OPTIMISATION
Mintek FloatStar® (Level Stabilisation)

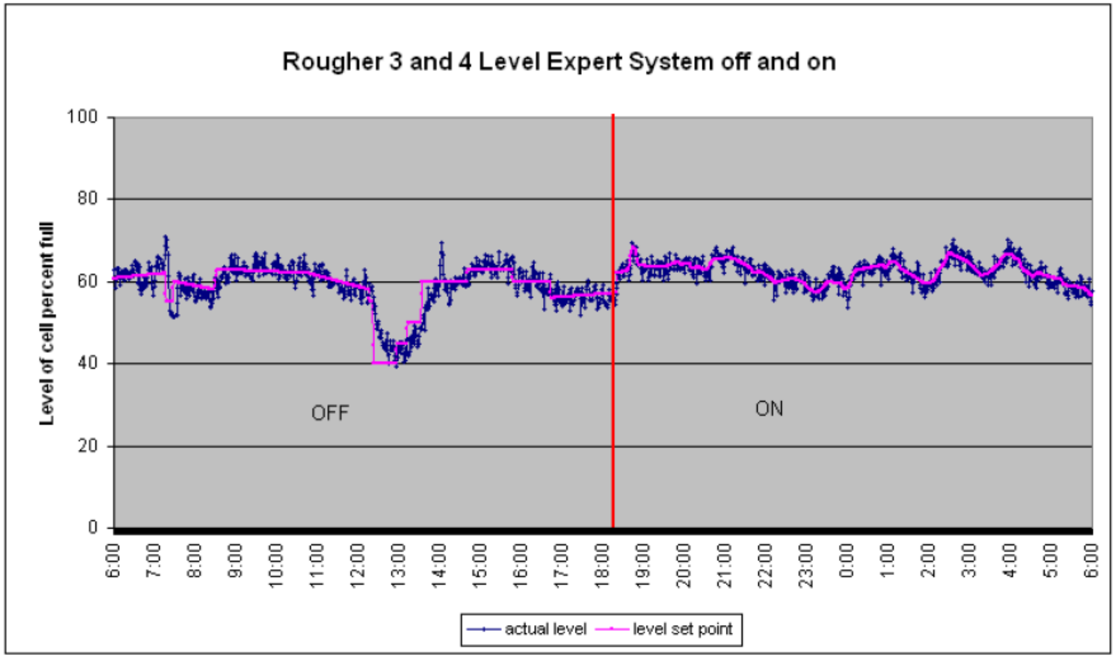




- Multi-variable feed forward control system
- Applied to cell and intermediate hopper level controllers
- Limits propagation of disturbances downstream

Source: Lombardi, J, Weidenbach, M and Muhamad, N, 2011. Flotation Process Control Optimisation at Prominent Hill, *Proceedings MetPlant 2011*, pp 602-614 (The Australian Institute of Metallurgy and Mining: Melbourne).

PROCESS CONTROL OPTIMISATION
Mintek FloatStar® (Flow Optimisation)



- Metallurgist sets mass pull and operator controls air settings on cells
- Flow Optimiser controls relative mass pull of each cell using the level controls
- Consistent feed to concentrate pump ensuring stable flow downstream

Source: Lombardi, J, Weidenbach, M and Muhamad, N, 2011. Flotation Process Control Optimisation at Prominent Hill, *Proceedings MetPlant 2011*, pp 602-614 (The Australian Institute of Metallurgy and Mining: Melbourne).

CONCLUSIONS

- Increased throughput in 2011 of 9.9Mtpa (24% above design capacity of 8Mtpa)
- Improved copper recovery in 2011 of 90.5% (design maximum of 88%)
- Rigorous approach to reagent trials using statistical analysis
- Improved coarse particle recovery
- Improved circuit stability due to expert process control systems