



# Northgate Minerals Corporation – Kemess Mine

## Generating Dam Construction Material From Tailings Sand

*MEND 2008, Vancouver, B.C.*

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Environmental Manager





## *Presentation Outline*

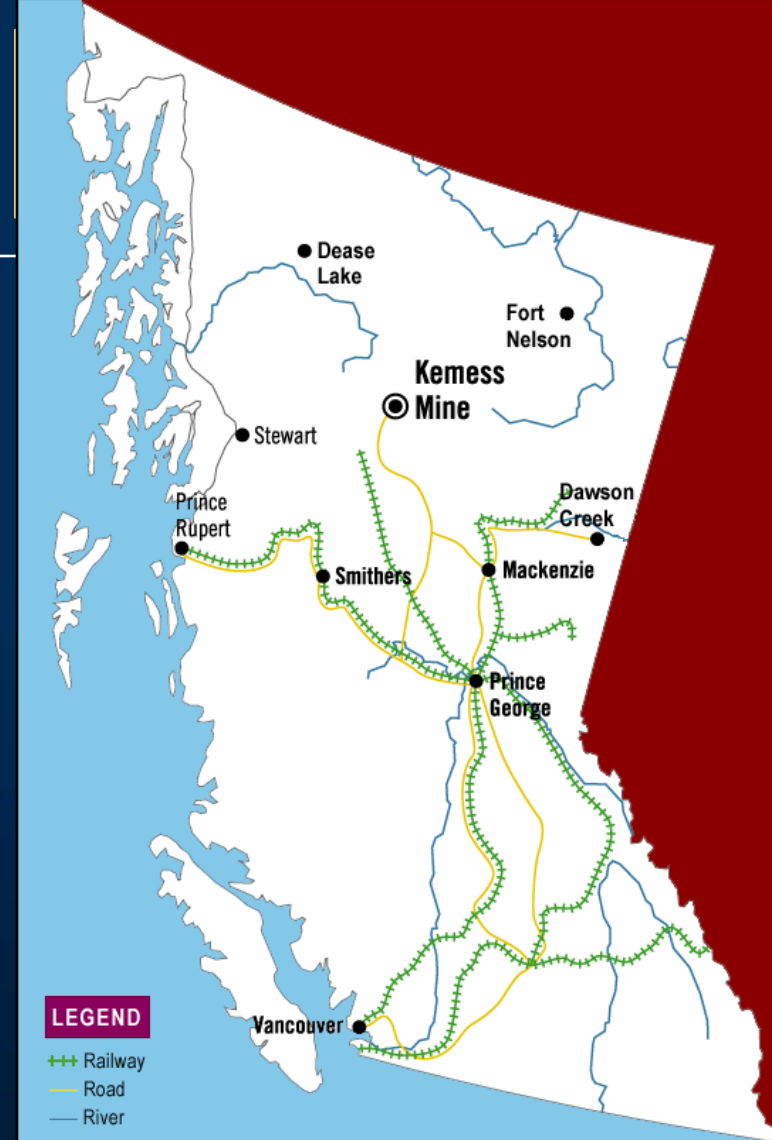
- Program Objectives & Fundamentals
- Evaluation of suitable rock for generation construction material
- Sand Plant Beta Testing - Verification
- Operational Procedures
- Placement of De-sulphidized Sand
- Summary & Benefits



## *Introduction to Northgate*

Located in north-central  
British Columbia

- **Cu – Au Open Pit**
- **Mining rate**
  - 146,000 tonnes / day
- **Mill throughput**
  - 52,325 tonnes / day
- **Life of Mine Reserves (Nov. 1'08 to July 28'11)**
  - >356,000 ounces of gold;
  - >125 million lbs copper



***Today's Kemess South Mine***





## *Fundamental Motivation*

- Capital costs of tailings storage facility (TSF) one of the most significant on the minesite
- The 2002 TSF design required 30 Mt of NAG rock
  - Sourced from the open pit a distance of 7 kms from the TSF,
  - Eliminate dual use of open pit mine fleet (Ore delivery only)
- Reduce & eliminate construction borrow development
- Reduce TSF as less storage is required



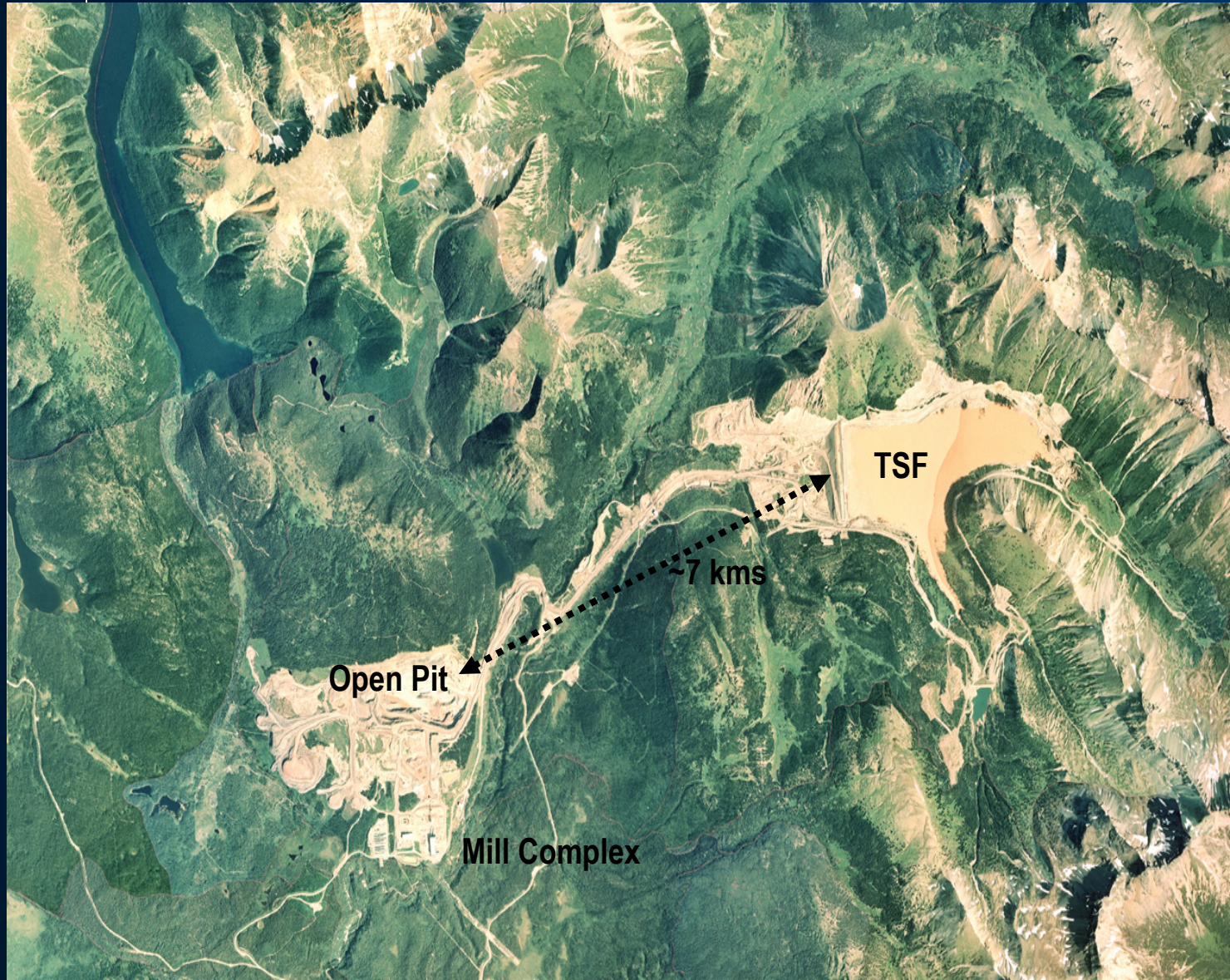


## *Fundamental Objectives*

- Generate construction material from Tailings Sand
  - Replace Earth Fill Construction with De-sulphidized Tailings Sand
- Environmental specifications
  - Produce a construction material that does not generate poor water quality, i.e. ARD/ML considerations
- Engineering specifications
  - Produce a material suitable for d/s buttress zone placement



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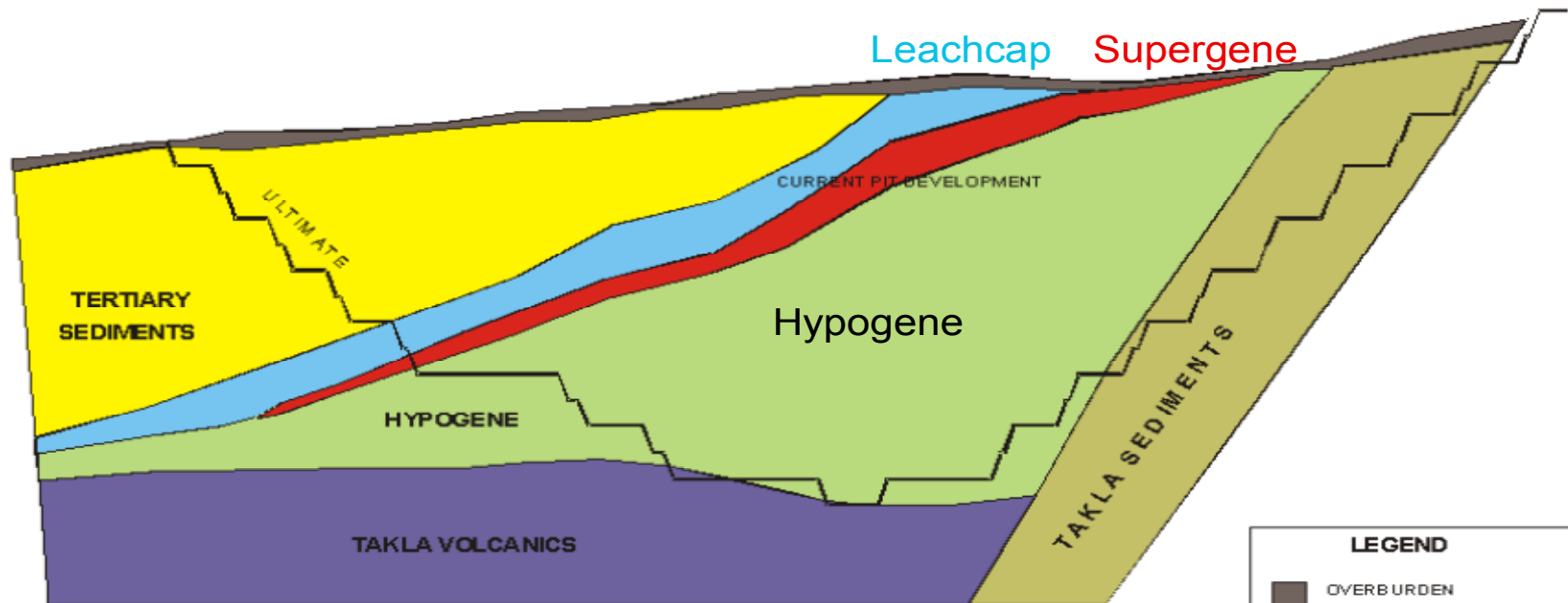


## *Source Material & Analysis Challenges*

- Evaluation of source material – Kemess Ore
  - Leach Cap, Supergene, Hypogene & Takla Volcanic
  - ARD/ML potential of d/s buttress material
  - Time to acidity of u/s beach material
  
- Timely in house analysis & communication
  - Reliable analysis that is responsive to operational constraints
  - Procedures for documentation, verification & reporting



# Kemess South Orebody



LEGEND	
	OVERBURDEN
	TERTIARY SEDIMENTS
	LEACH CAP
	SUPERGENE
	HYPOGENE
	TAKLA VOLCANICS
	TAKLA SEDIMENTS







## *Evaluation of Kemess Ore*

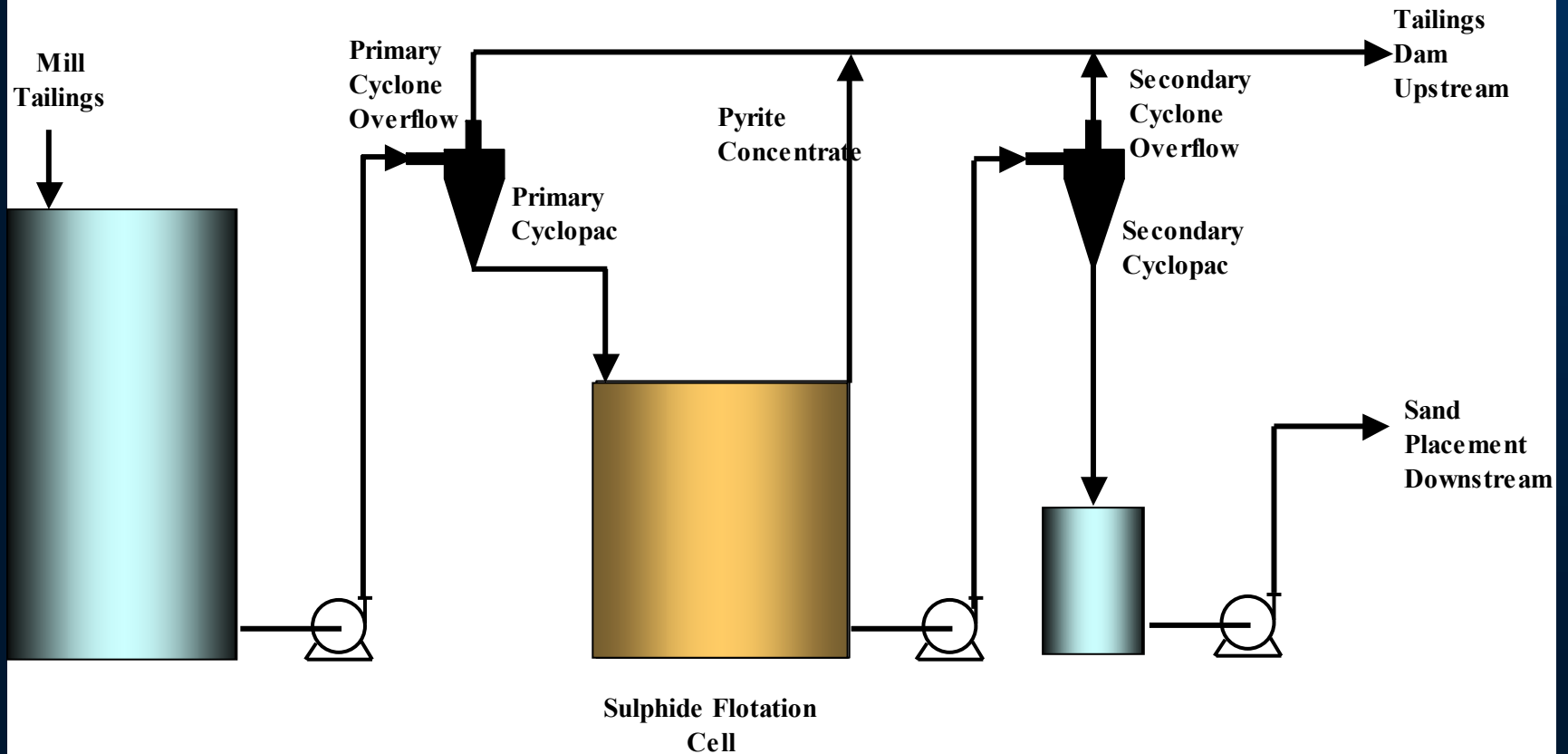
- Hypogene & Supergene/Leachcap Tailing Sands Tested
  - Sand provided from the Cyclone & Flotation Bench Test
  
- ARD/ML Evaluation methods
  - Leach column (Kinetic testing)
  - ICP, ABA & Shake Flask
  - ABA (3 year baseline tails database)
  - TSF supernatant (3 year baseline tails database)





## *Sand Plant Flowsheet*

**Kemess Mines Ltd. - Sand Plant Flowsheet**







## *Environmental Testing*

- Hypogene Tailings Sand
  - No ARD with successful 2 stage Cyclone + Flotation
  - No long-term metal leaching concern
- Supergene/leach cap Tailings Sand
  - No ARD concern (flotation not necessary)
  - A long-term metal leaching concern, Se & Sb
  - Would require additional treatment
- Hypogene Ore tailings sand selected as TSF construction material



## *Criteria & Communication*

- Permit requirement of  $\text{NPR} \geq 2$  and no ML
- Kemess objectives
  - $\text{NPR} \geq 3$  and no ML
  - 6 hour notification b/w Mill & Sand Plant
- Challenge to provide a timely & reliable test procedure



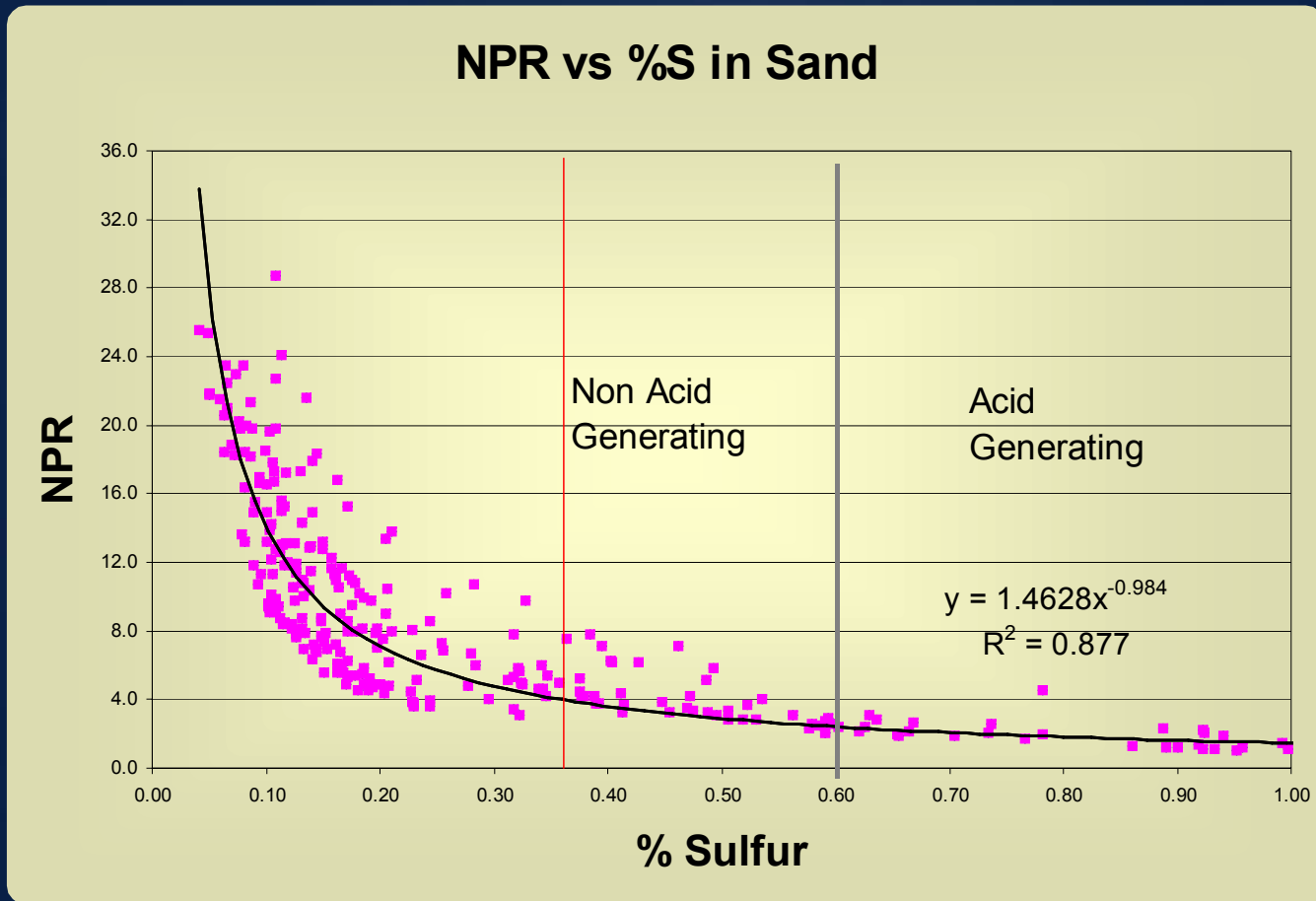
## *Sand Plant Beta Test - Verification*

- Conducted for 2 months
- All materials reported to the TSF
- Objective to meet Permit requirements for continuous 15 day trial period
- Trial construction sand “cell” placement methodology
- Successful in all accounts





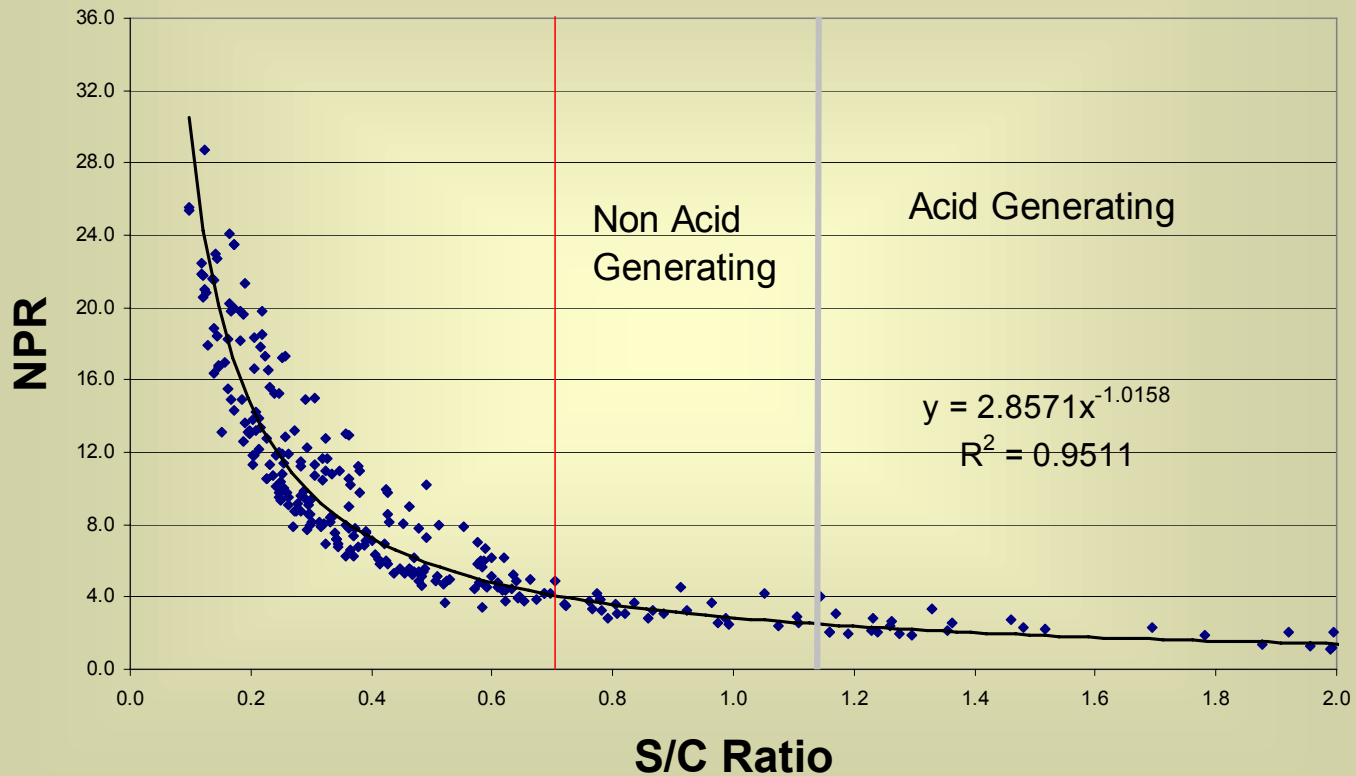
## *NPR and %TS Relationship*





## *NPR and TS/TC Relationship*

### NPR vs S/C Ratio



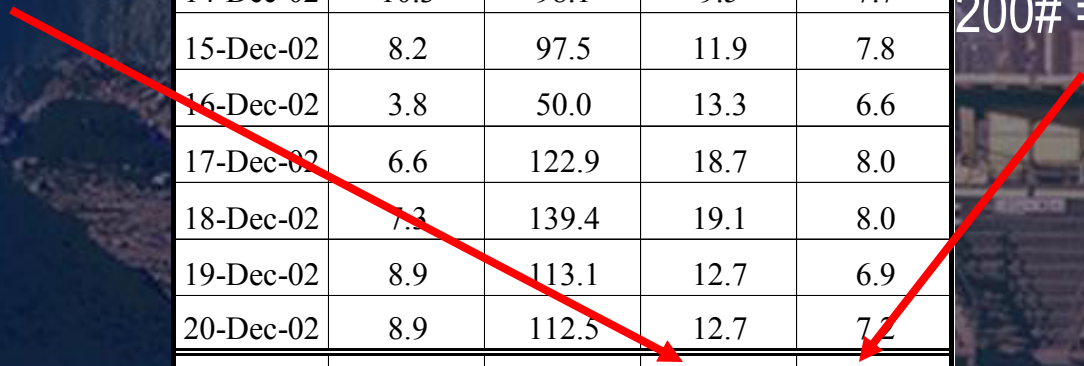


# Beta Test Results

Date	MPA	Sobek NP	NPR <sub>tc</sub>	Fines Fraction% 200
06-Dec-02	4.2	49.4	11.8	7.0
07-Dec-02	8.8	91.9	10.4	9.2
08-Dec-02	8.7	92.5	10.7	7.9
09-Dec-02	14.8	61.8	4.2	5.2
10-Dec-02	9.5	61.5	6.5	10.2
11-Dec-02	6.5	98.8	15.3	6.0
12-Dec-02	11.0	92.5	8.4	7.8
13-Dec-02	13.4	100.0	7.4	7.5
14-Dec-02	10.3	98.1	9.5	7.7
15-Dec-02	8.2	97.5	11.9	7.8
16-Dec-02	3.8	50.0	13.3	6.6
17-Dec-02	6.6	122.9	18.7	8.0
18-Dec-02	7.3	139.4	19.1	8.0
19-Dec-02	8.9	113.1	12.7	6.9
20-Dec-02	8.9	112.5	12.7	7.2
Averages	8.7	92.1	10.6	7.5

Average NPR = 10.6

Average Percent Passing 200# = 7.5%







## *Sand Plant Operation*

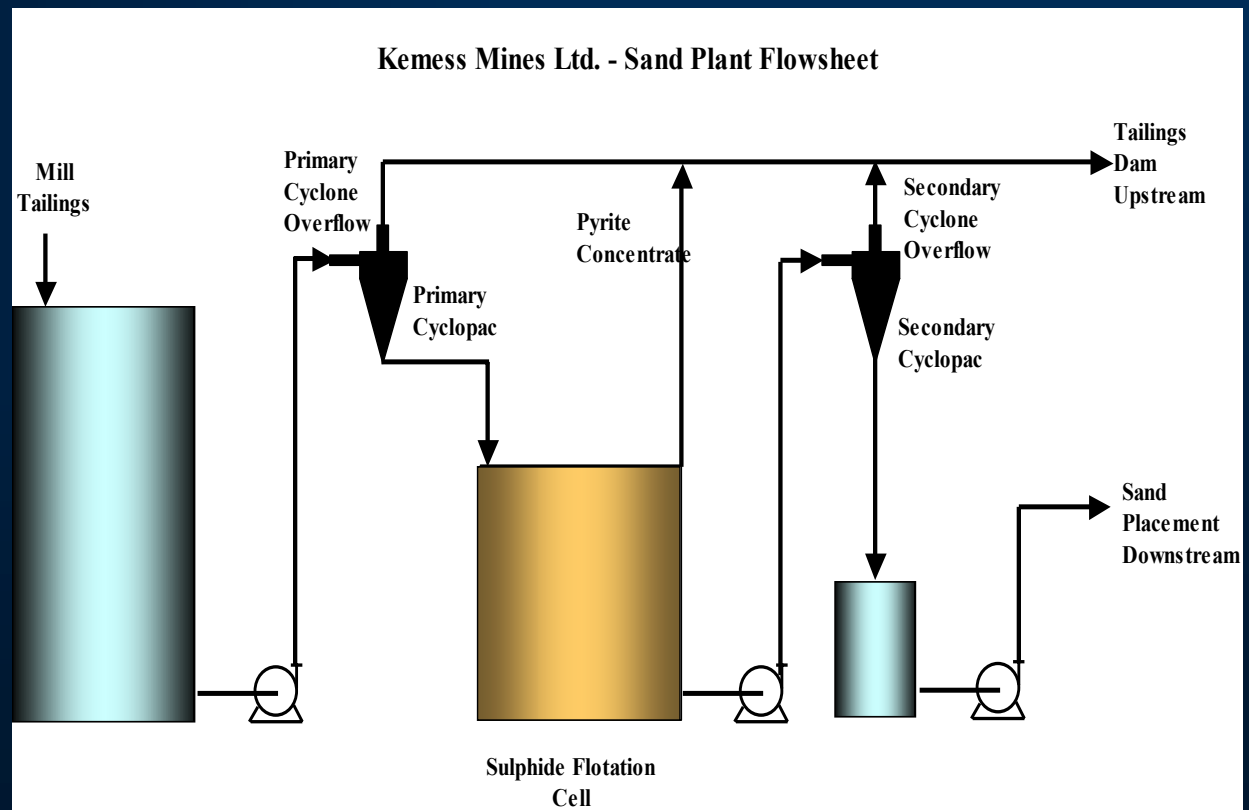
- Based upon the supporting data and studies
  - TS/TC ratio of 0.7:1 equates to NPR 4
  - TS & TC analysis completed ~ 2hours
  - Communication of results within 6 hrs to Sand Plant Operator





## *Sand Plant Operation cont'd*

- Overflow from Cyclone 1 & 2 is mixed with sulphide float and pumped to TSF
- D/s construction material from 2 stages of cyclone + flotation
- Geotechnical specification up to 15% fines (75 microns)
- Projected to convert 28% of total tailings sand into buttress construction material





## *Plant Operation cont'd*

- Upset conditions or change in ore types
- Divert tails to TSF until continuous operation at specification achieved
  - minimum 5 days of operation meeting specification
  - Reduced to 2 days, 24 hours and to 12 hours with plant operational experience and data





## *Continuous Operational Monitoring*

<b>Sample Schedule</b>	<b>Analytical Parameters</b>	<b>Material for Testing</b>	<b>Permit Section</b>
<b>Every 6 hours</b>	<b>TS, TC</b>	<b>Secondary Cyclone Underflow</b>	<b>7</b>
<b>1 per week for 2 mos. (then monthly)</b>	<b>Bulk NP (Sobek), ICP, Se, Sb</b>	<b>Sand Plant Feed Secondary Cyclone Underflow</b>	<b>7</b>
<b>1 per month</b>	<b>ABA, Sobek NP, pH, TS, SO4-S, TC, ICP, Se</b>	<b>Sand Plant Feed Sand Plant Tails Secondary Cyclone Underflow</b>	<b>5, 7, 9</b>
<b>Quarterly</b>	<b>Mineralogy – Rietveld XRD</b>	<b>Sand Plant Feed Secondary Cyclone Underflow</b>	<b>5, 7, 9</b>

## **Sand Plant Monitoring After Operational Changes**

<b>Sample Schedule</b>	<b>Analytical Parameters</b>	<b>Material for Testing</b>	<b>Permit Section</b>
<b>Every 6 hours</b>	<b>TS, TC</b>	<b>Sand Plant Feed Secondary Cyclone Underflow</b>	<b>8</b>
<b>Every 2<sup>nd</sup> Day</b>	<b>Bulk NP (Sobek), ICP, Se, Sb</b>	<b>Sand Plant Feed Secondary Cyclone Underflow</b>	<b>8</b>



## *Fail Safe Procedures*

- Fully automated system monitored from the Mill Control room
- Cyclone inefficiencies possible if significant volume changes
  - Self-adjusting Pressure & Flow level Sensors to correct tonnage variance
- Disruption in reagent system affecting Flotation
  - Automated alarm system provide immediate Mill Control Room notification
- Regular visual inspections by Plant Operator
- In all cases Tailings sand can be diverted quickly into the TSF





Tailings Beach

Sand Plant

Cycloned Sand Fill

Summer 2003



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June 2006



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July 2008





Sept 2008





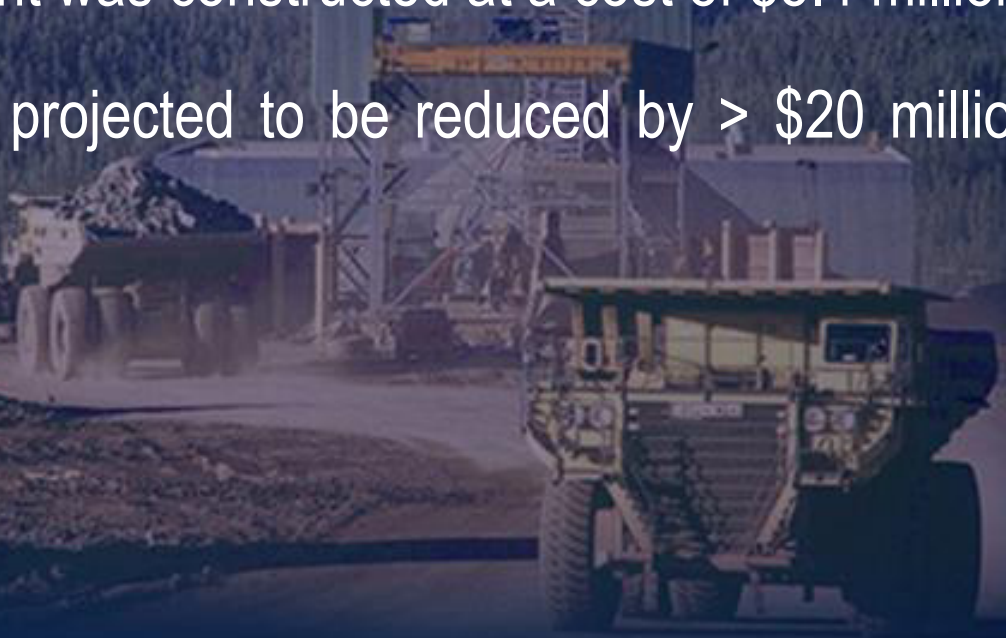
## *Summary & Benefits*

- Required ~ 2 yrs from the initial concept - testing - design - and permitting to startup of the cyclone plant
- Identified Hypogene tailings sand as construction material, via 2 Stage cyclone + Flotation
- Developed an effective TS/TC & NPR relationship that met operational constraints



## *Summary & Benefits Realized Cont'd*

- De-sulphidized sand construction placement occurred from May 2003 until July 2008.
- The tailings cyclone plant was constructed at a cost of \$5.4 million.
- Dam construction cost projected to be reduced by > \$20 million over remaining L o M.





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Thank You