BIOTEQ
Environmental Technologies Inc

# Commercial Water Treatment Experience in Metal and Sulphate Removal from Acidic Drainage – Canadian Case Studies

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**MEND Winnipeg Workshop**

**Challenges in Acid Drainage**
**For Operating, Closed or Abandoned Mines**

# Presentation outline

- Introduction to BioteQ and its technologies
- Technologies based on sulphide precipitation
  - BioSulphide® Process
  - ChemSulphide™ Process
- Commercial examples of sulphide technologies
- Removal of sulphate from wastewater
  - Sulf-IX™ Process
  - Commercial status of Sulf™-IX

# Who is BioteQ?

- BioteQ is an environmental operating company (BQE-TSX)
- We finance, build, own and operate water treatment plants that recover saleable metals and produce clean water for environmental compliance
- Commercially proven technologies
- We are working with some of the world's largest mining companies

# BioteQ Technologies

**Water treatment for metal recovery and/or environmental compliance**

- BioSulphide® Process
- ChemSulphide™ Process

**Sulphate and TDS removal**

- Sulf-IX™ Technology

**Sulphide reagent supply**

- BioSulphide® for biogenic reagent

# Selection of Treatment Technology - Variations in Acid Mine Drainage

| pH | Fe | Cu | Ni | Co | Zn | Ca | Mg | Al | SO4 |
|---|---|---|---|---|---|---|---|---|---|
| 4.0 | 0.3 | 0.2 | <0.1 | <0.1 | 10 | 200 | 25 | 30 | 1,120 |

Flow 27,250 m3/day  Recoverable metal value = $260K/year

| pH | Fe | Cu | Ni | Co | Zn | Ca | Mg | Al | SO4 |
|---|---|---|---|---|---|---|---|---|---|
| 5-7 | <2 | <0.2 | 3-50 | <0.1 | <0.1 | 10 | 40 | <1 | 200 |

Flow 5,760 m3/day  Recoverable metal value = $1.67M/year

| pH | Fe | Cu | Ni | Co | Zn | Ca | Mg | Al | SO4 |
|---|---|---|---|---|---|---|---|---|---|
| 2-3 | 50 | 300 | 5 | 40 | 5 | 250 | 80 | 50 | 5,000 |

Flow 6,000 m3/day  Recoverable metal value = $8.2M/year

| pH | Fe | Cu | Ni | Co | Zn | Ca | Mg | Al | SO4 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 2,500 | 20 | 1 | <1 | 15 | 400 | 100 | 200 | 10,000 |

Flow 7,500m3/day  Recoverable metal value = $360K/year

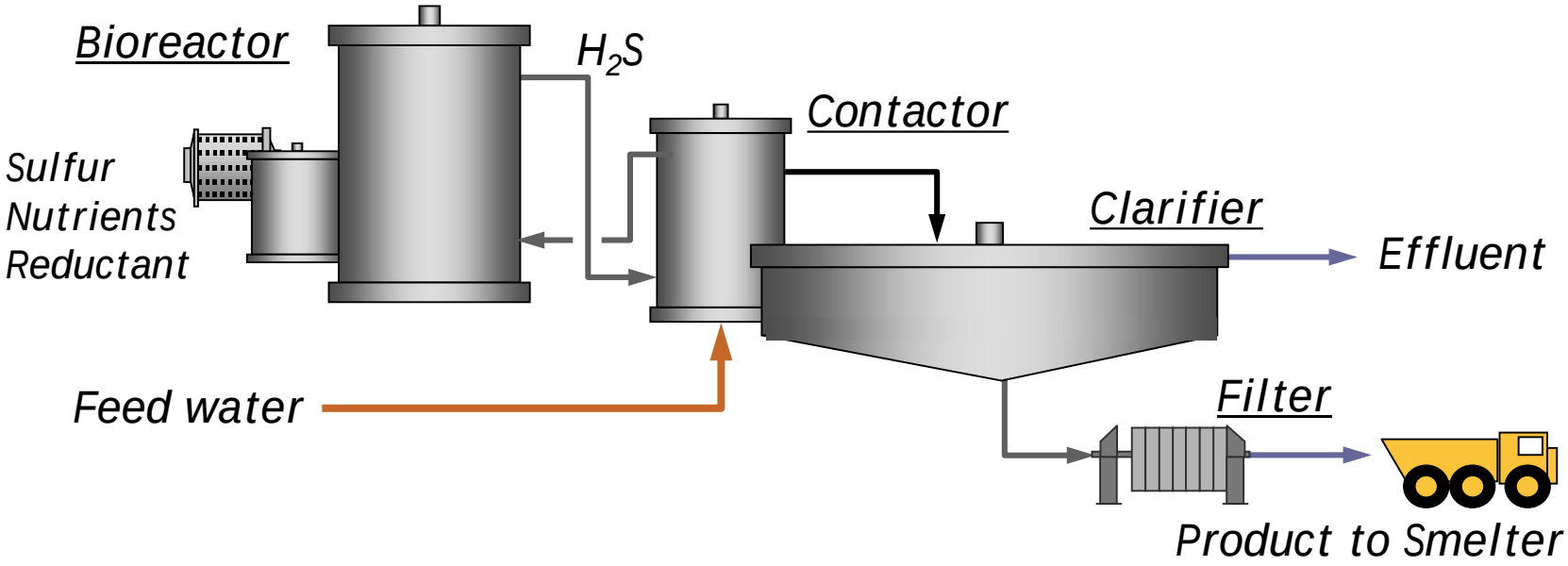
# BioSulphide® Process

- Generation of biogenic sulphide through the reduction of elemental sulphur
- Biogenic sulphide used for selective precipitation:

$$M^{2+} + H_2S \rightarrow MS + 2H^+$$

- High-quality effluents
- Good solid-liquid separation
- Saleable high grade metal sulphide products

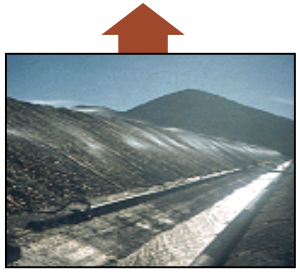
# BioSulphide® Process Schematic





Acid drainage


Mine water


Leach solutions

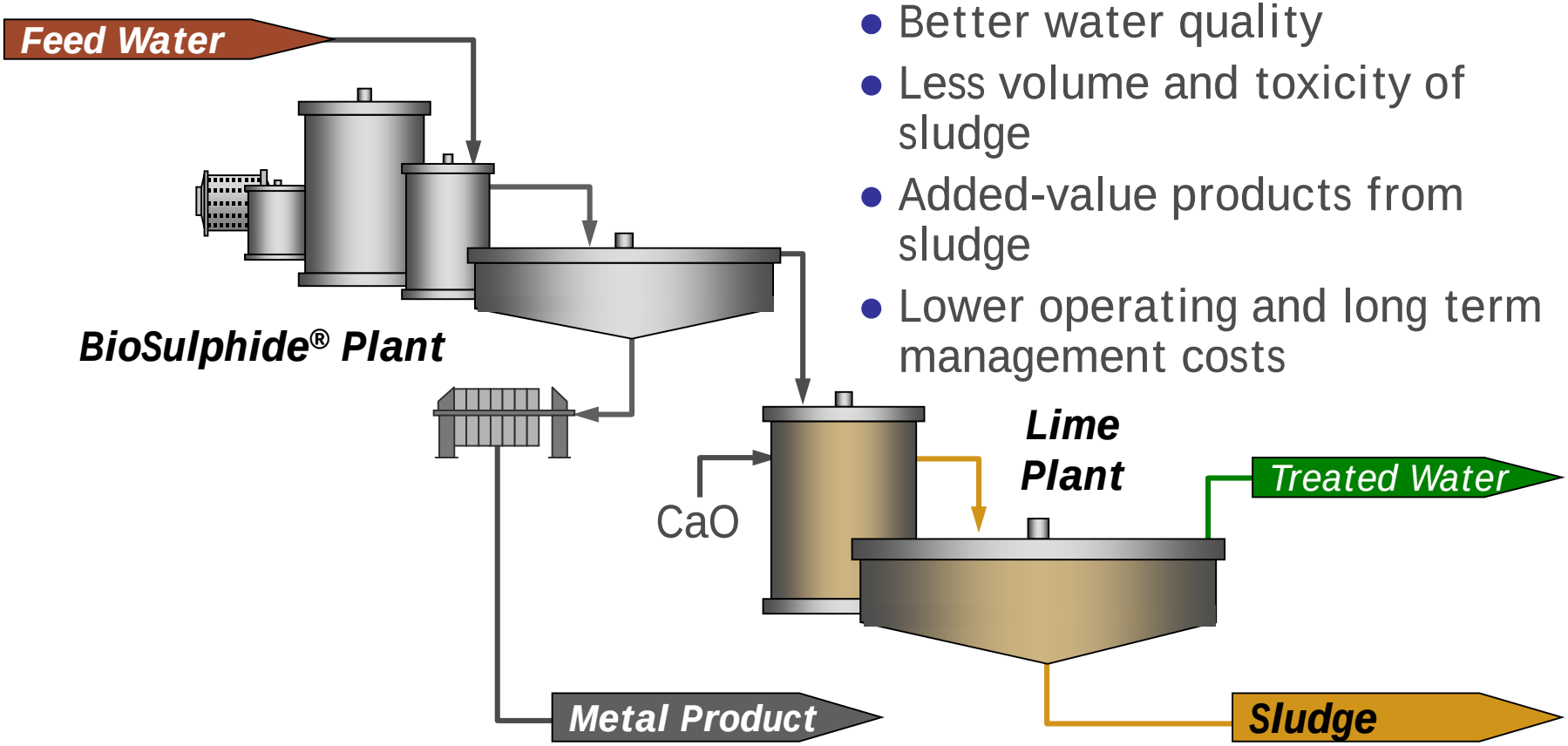

Ground-water


Bleed streams

# Integration of BioSulphide or ChemSulphide with a Lime Plant

Potential Advantages

- Recovery of saleable metal
- Better water quality
- Less volume and toxicity of sludge
- Added-value products from sludge
- Lower operating and long term management costs



# Caribou Project

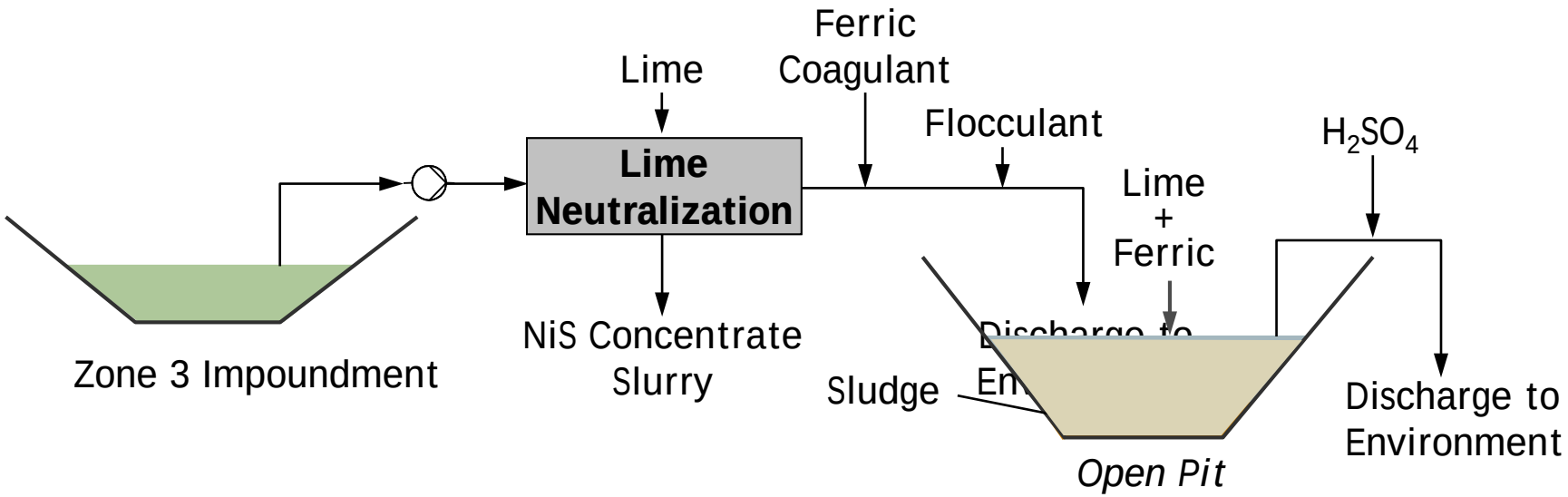

- First BioteQ plant
- Installed upstream of existing lime plant
- 70 m3/h flow
- 450 mg/L Zn, 30 mg/L Cu, pH 2.3
- >99% removal of Zn, Cu, Cd
- High grade Zn-Cu product
- Reduction of sludge volume and toxicity

# ChemSulphide™ Process - Raglan Mine

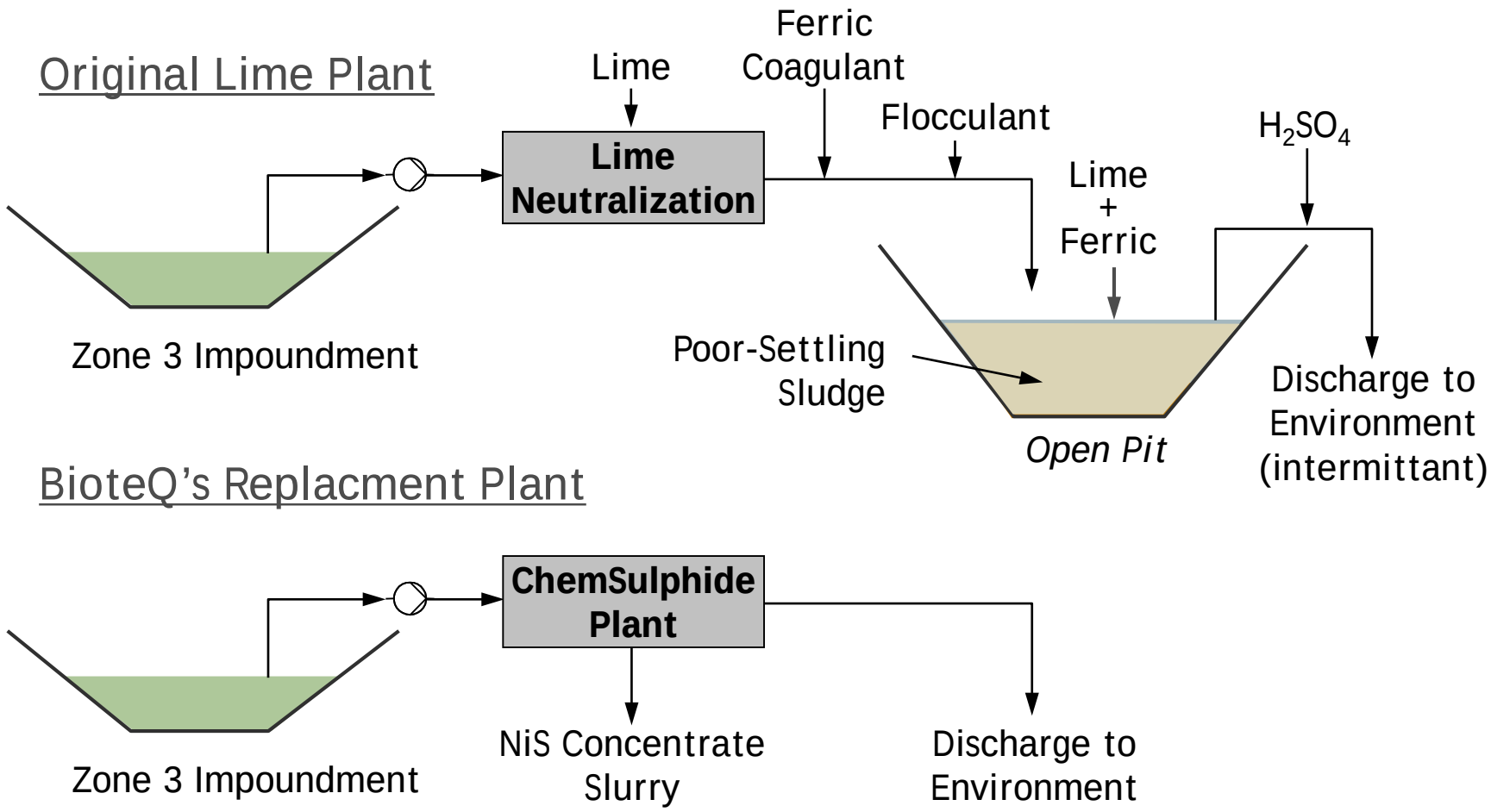
- Built, owned and operated by BioteQ
- Operating since 2004
- Nickel sulphide product recovered with high efficiency from very low grade, cold minewater
- Replaced an existing lime plant
- 920,000 $m^3$ water treated in 2007 (April to November)
- Direct discharge of effluent to sensitive Arctic environment
- Reduction in water treatment costs for Xstrata



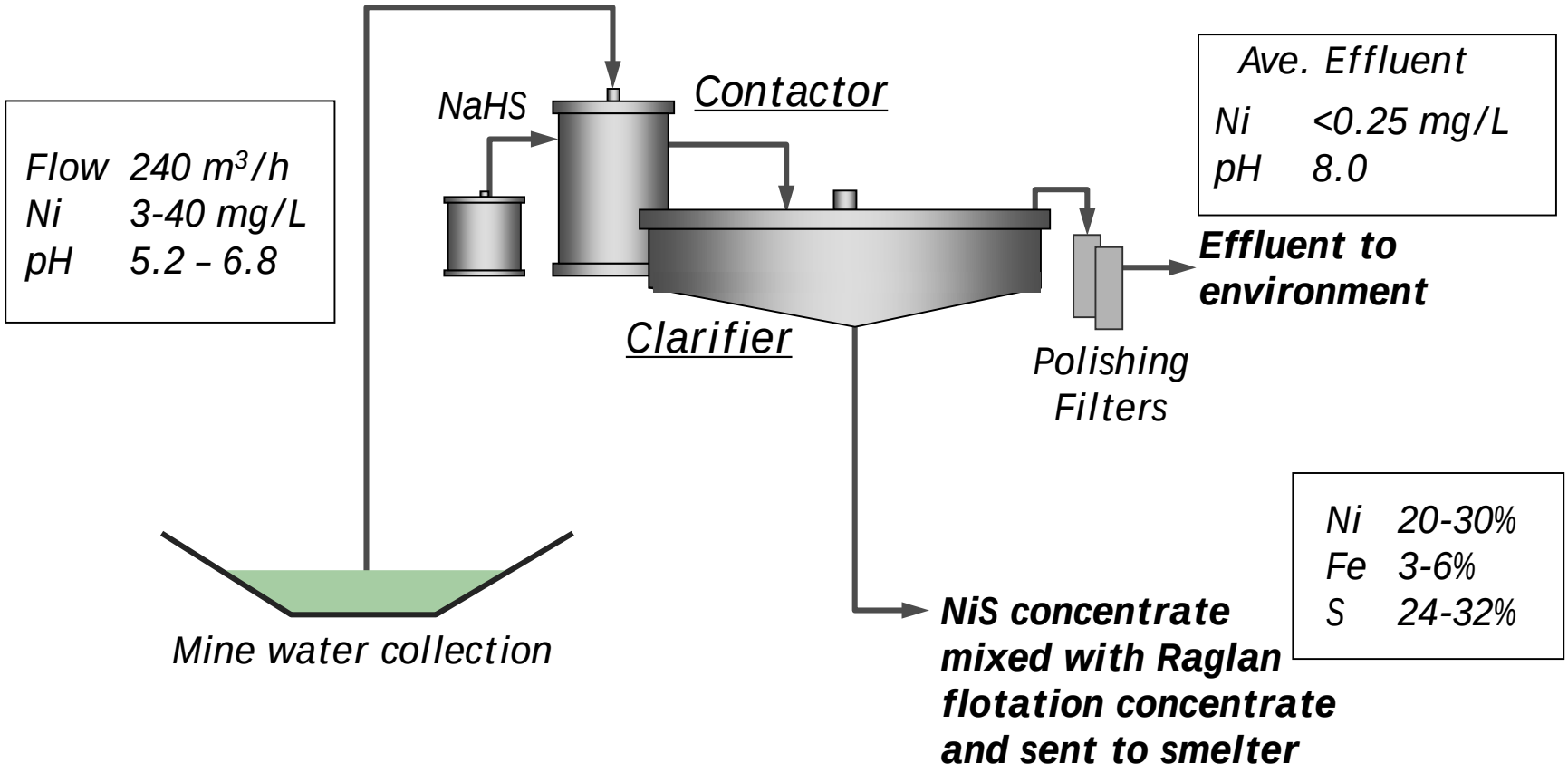
# Water Treatment at the Raglan Mine



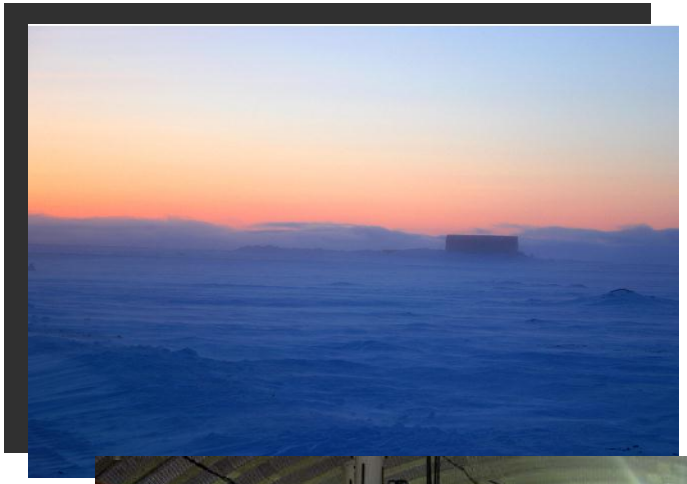
# Water Treatment at the Raglan Mine



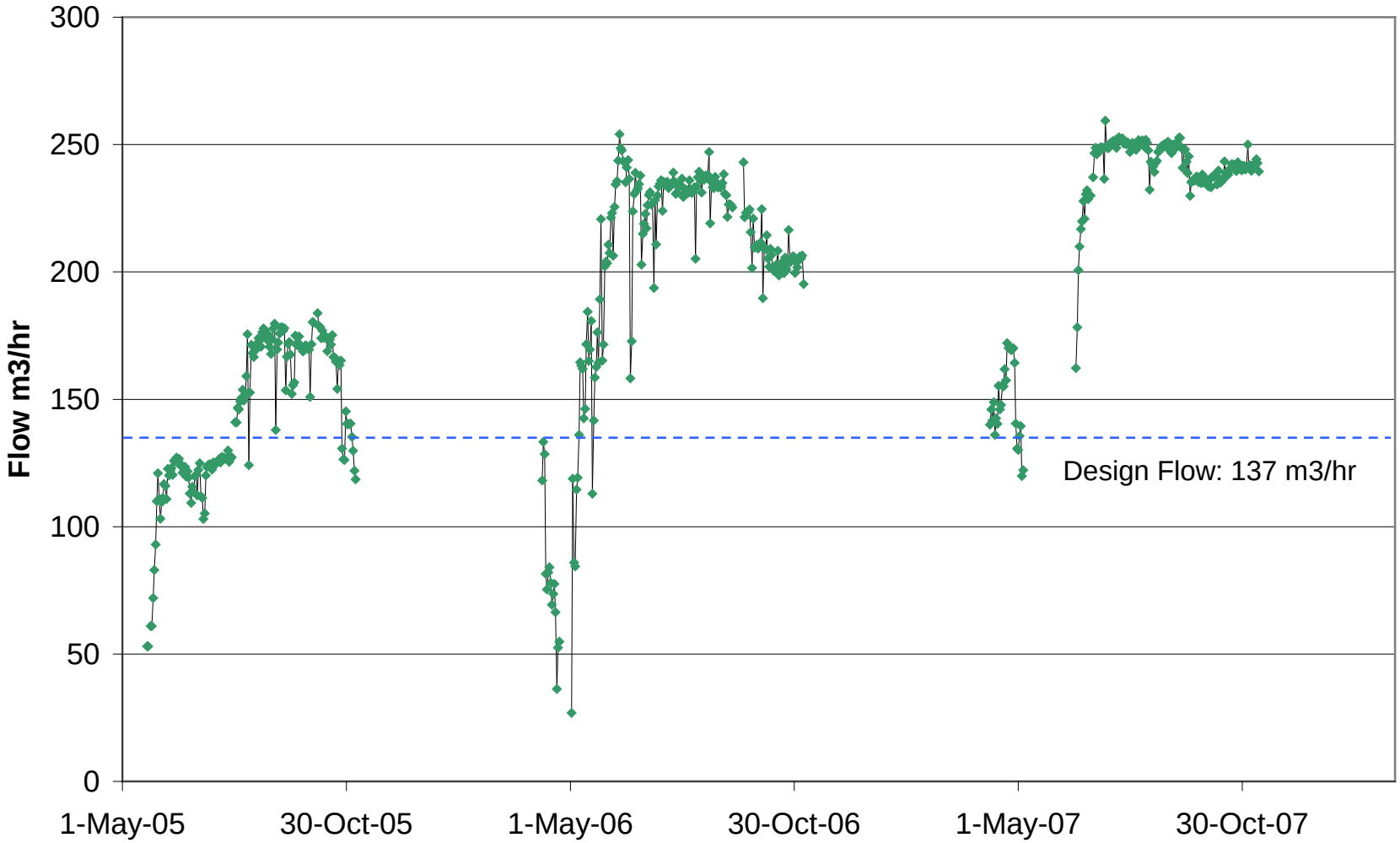
# ChemSulphide™ Process at Raglan



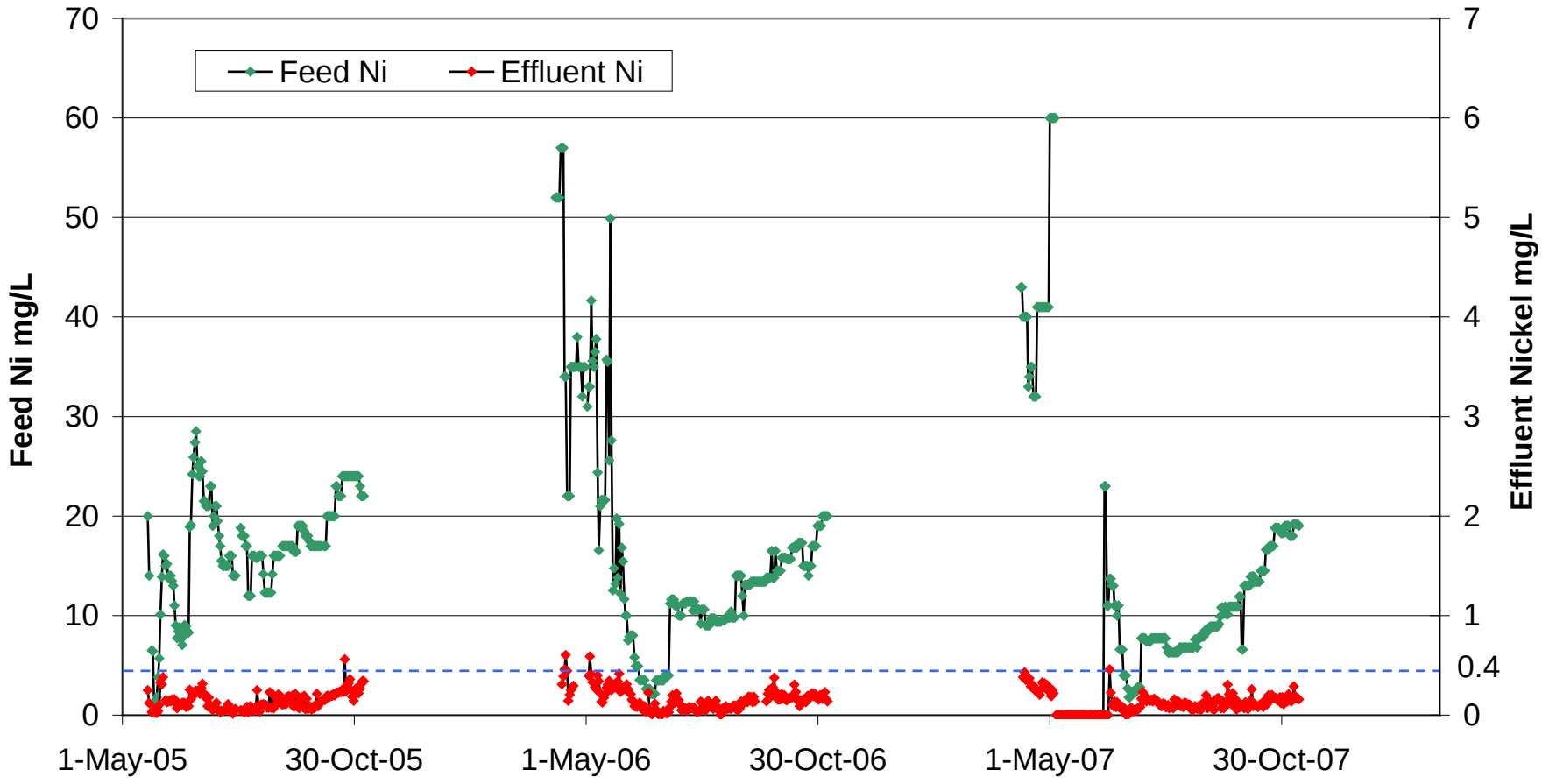
# BioteQ Plant at Raglan



# Raglan – Flow to plant 2005 - 2007



# Raglan – nickel in feed and effluent



# Bisbee Project, Arizona (50/50 JV with Freeport McMoRan

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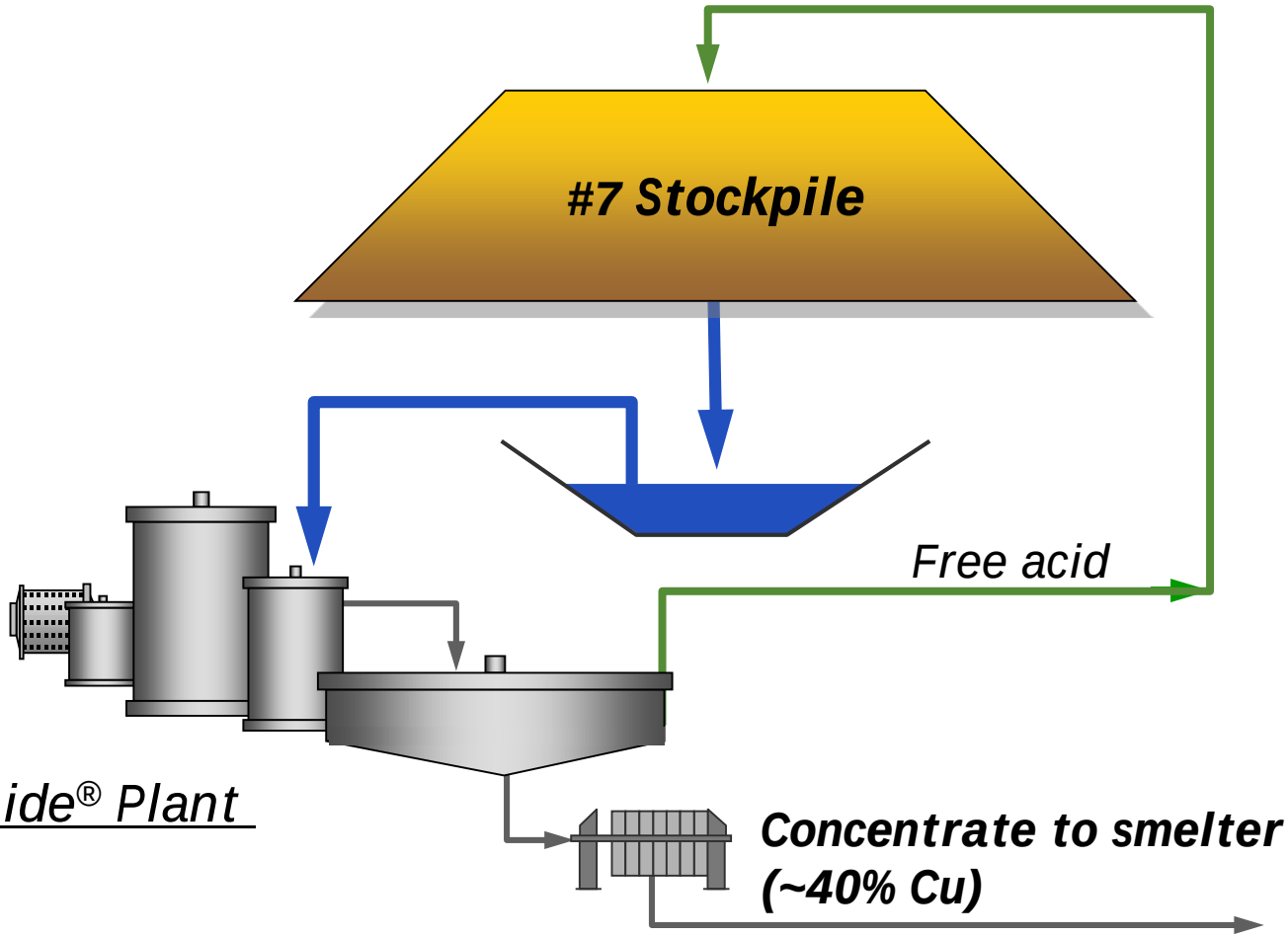
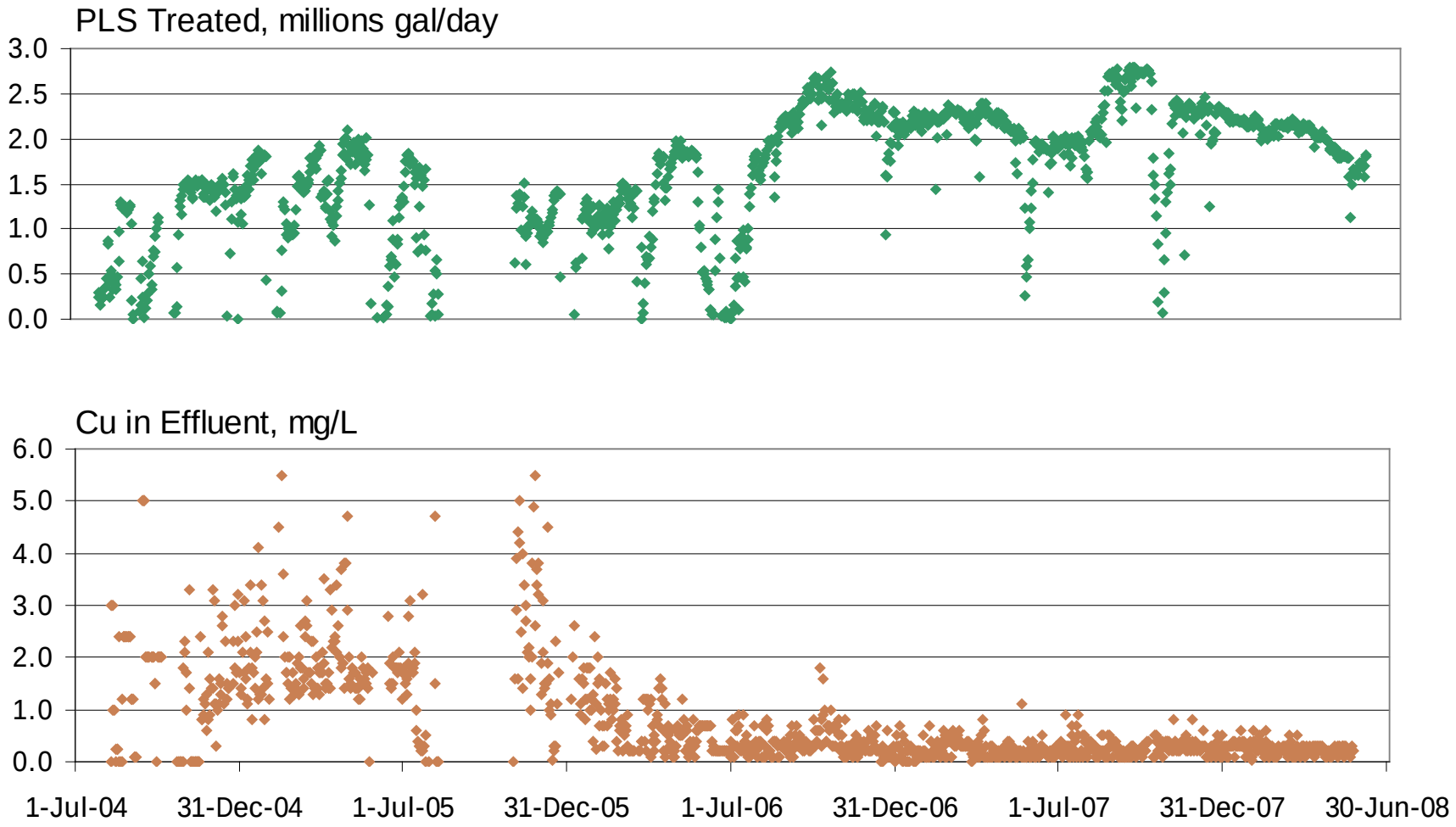
# Bisbee Flowsheet



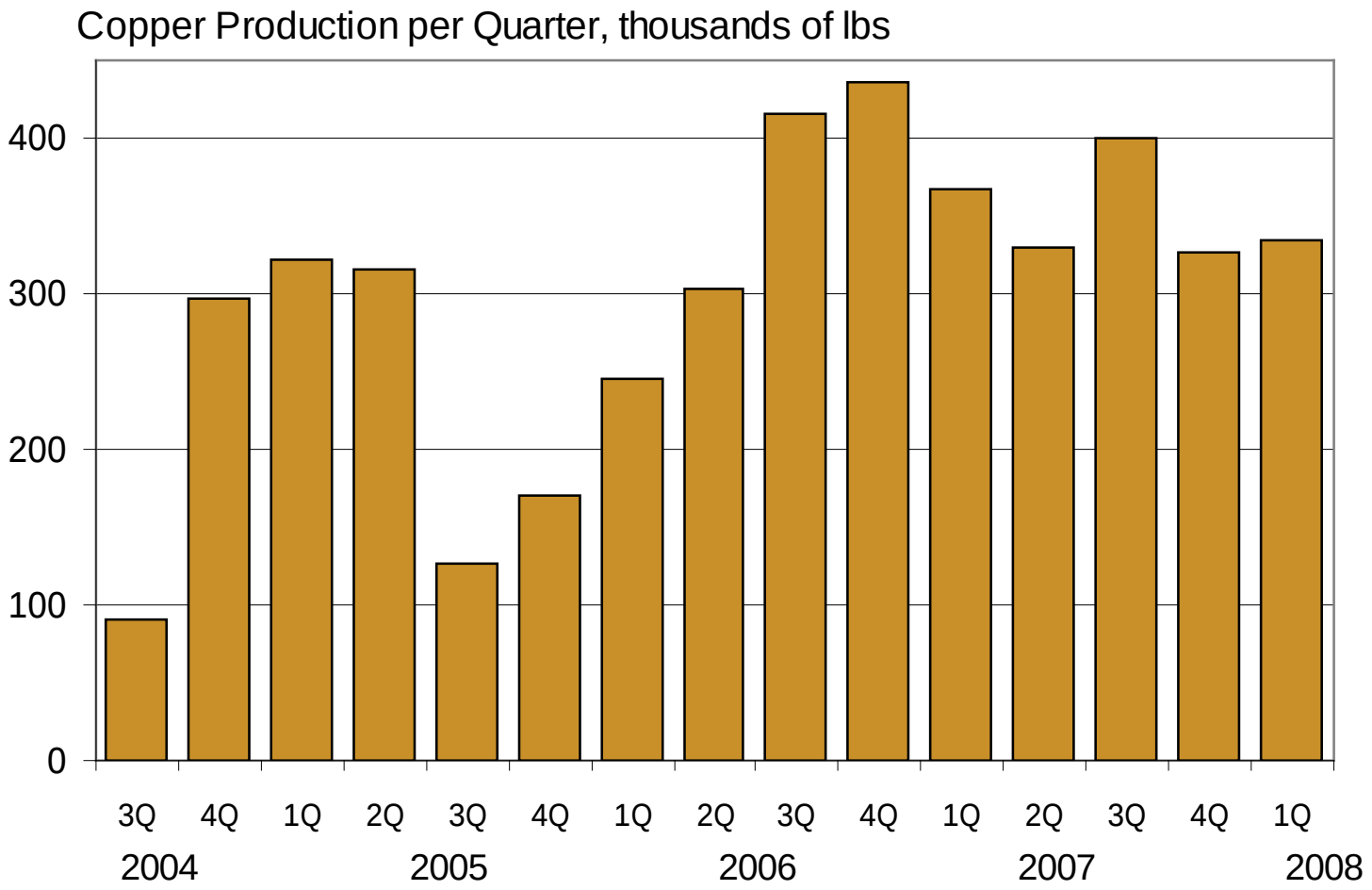
# Bisbee BioSulphide® Plant

- 2000 gpm (10,900 m3/day)
- 220 – 400 mg/L Cu
- Bioreactor design 3.7 t/day $S^{2-}$
- >99.8% Cu recovery
- >98% plant availability
- Currently 120,000 lb Cu/month
- Direct Opex $1.17/lb Cu
- Capex US$3.2 million
- Capital repaid in <3 years

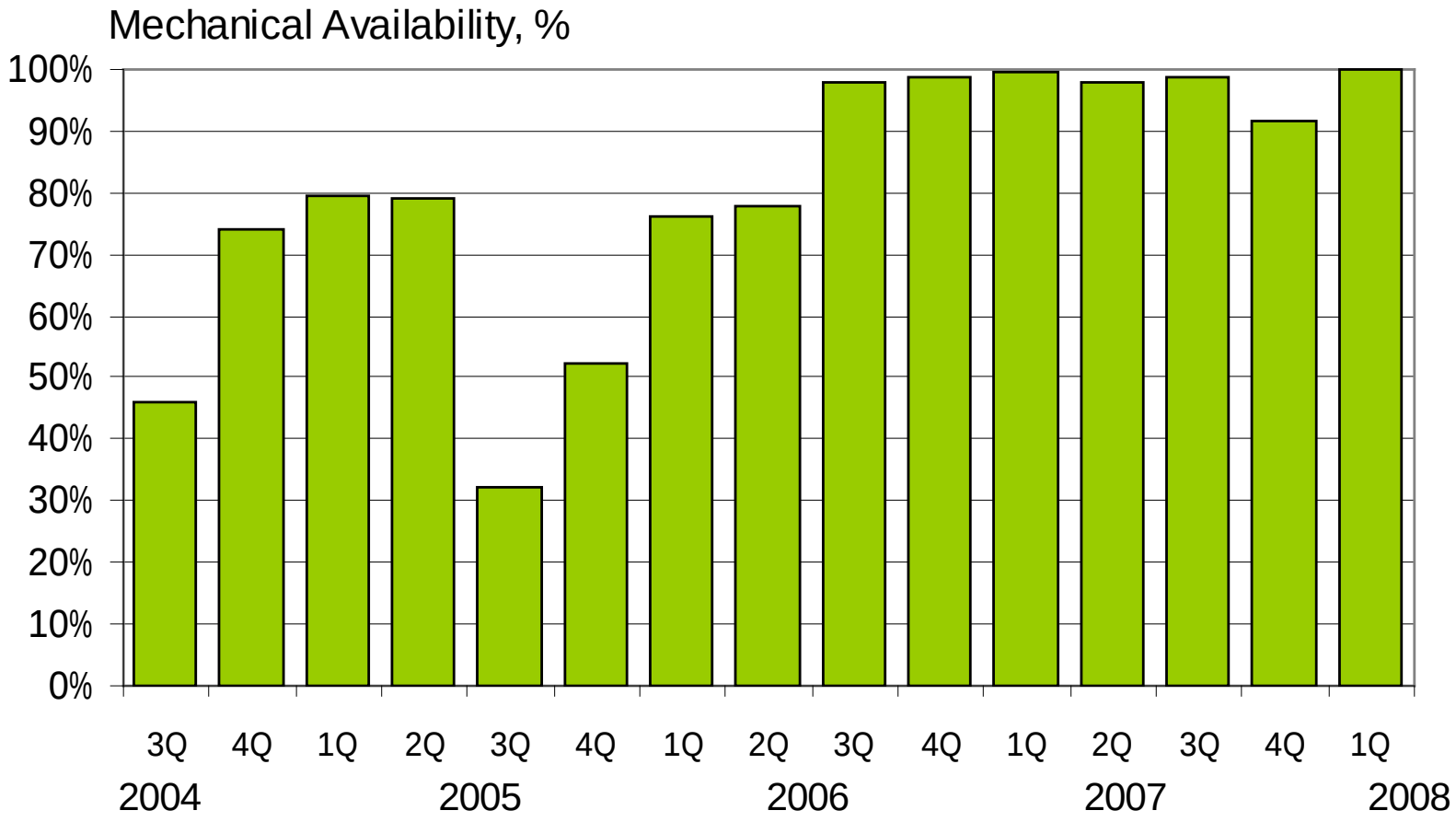
# Bisbee – Flow and copper in effluent



# Bisbee – Copper production



# Bisbee plant – mechanical availability



# Dexing Project - China

- 24,000 m3/d
- 250 mg/L Cu, 150 average
- 725 mg/L $Fe^{3+}$
- Up to 4.4 million lb Cu/year
- Capex $3.2 M
- JV with Jiangxi Copper
- BioteQ is operator

# Mt. Gordon Project - Australia

- 6,000 m3/d
- 300 mg/L Cu,35 Co, 10 Ni
- 500 mg/L Fe
- 1.45 million lb Cu/year, 135,000 lb Co/year
- Capex $8.8M
- BioteQ owns and operates

# Wellington-Oro Project - Colorado

- 2000 $m^3$/day acidic seepage
- 270 mg/L Zn, 1.0 Cd
- Effluent to meet 0.23 mg/L Zn and 0.004 mg/L Cd
- No sludge
- Selected by EPA as Best Available Technology

# La Lluvia - Mexico

- Copper recovery and cyanide recycle at gold mine
- 8000 $m^3$/day
- Approx 200 mg/L Cu as cyanide complex in barren solution
- 800,000 lb Cu/year
- Capex $5.2 M

# Sulphate Reduction Technology

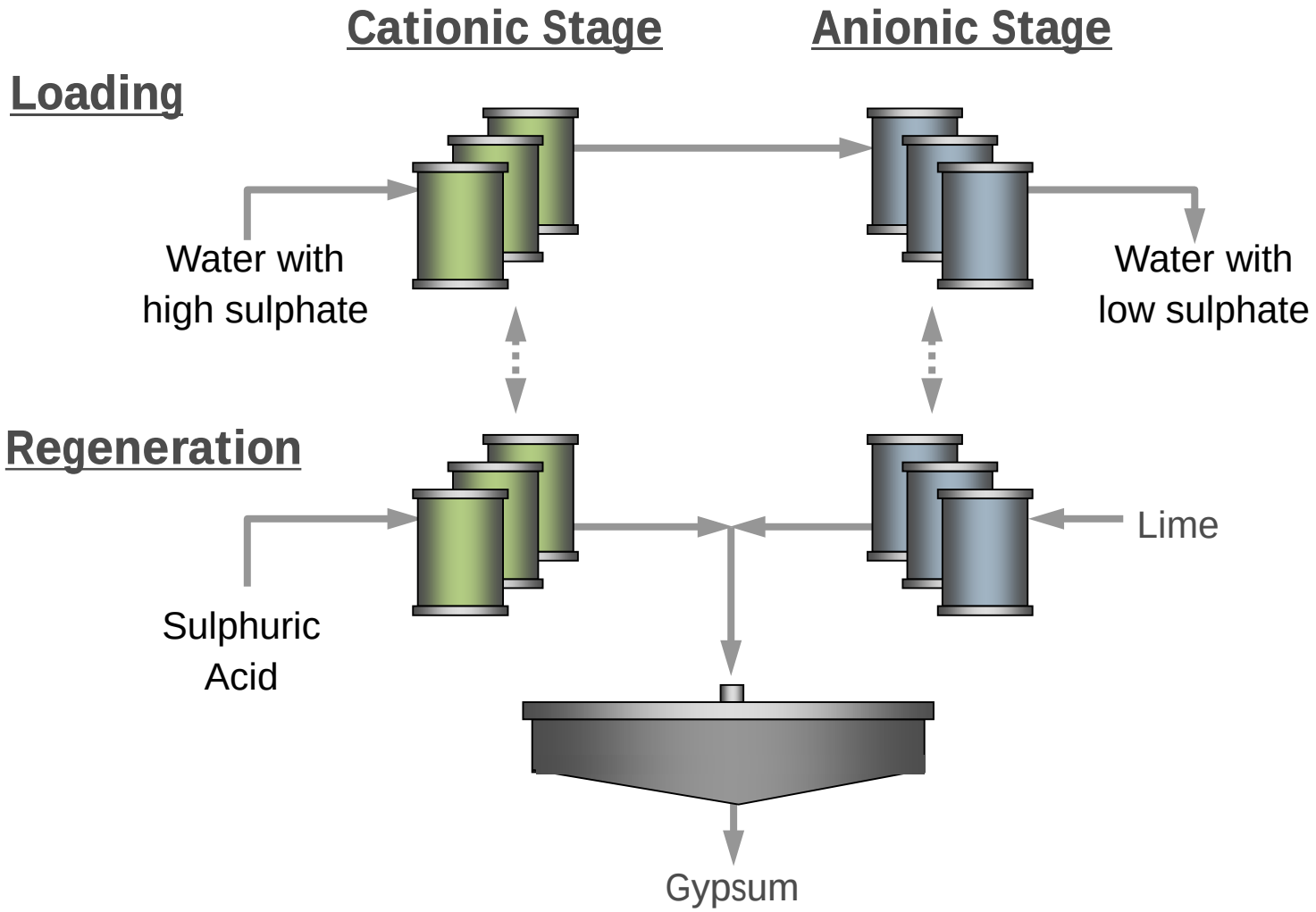
# Sulphate Reduction/Removal

- The removal of sulphate from water is being regulated in an increasing number of jurisdictions around the world to meet standards for environmental discharge, irrigation, and domestic and animal water supply
- Sulphate and TDS control may also be required to allow recycle of effluents to processes

# Requirements for Sulphate Removal Processes

- Can manage high flows
- Can manage solutions saturated with gypsum (scaling)
- Effective management of solids present in feed or produced during processing
- Low cost of disposal of secondary products
- Low capital and operating costs
- Simple and robust chemistry and pyhsics

# Sulf-IX™ Process Schematic



# Sulf-IX™: Key Features

- Capacity to treat high volumes of water
- Efficiant management of solids and scaling – very suitable for lime plant effluents
- Products are only clean water and clean gypsum
- Low operating costs – lime and sulphuric acid are used to regenerate resins
- Low capital costs

# Commercial Status of Sulf-IX™

- 3 pilot plants available (0.2 m3/h and 25 m3/h) currently in operation in Vancouver and Santiagoo
- Construction and Operating Agreement with Molymet, Chile, for a commercial plant to replace an existing reverse osmosis plant
- A plant is in construction (25 m3/h) for process demonstration at a mine site in the United States (Sierrita – Freeport McMoRan)
- Other projects in various stages of development

# Sulf-IX™ – Pilot Studies

# Sulf-IX™ Test IX Column

# Summary

- BioteQ has commercialized the BioSulphide® and ChemSulphide™ processes in Canada and elsewhere in the world
- The plants demonstrate the ability to produce high quality water while recovering saleable metal products
- Water treatment can be profitable
- BioteQ is also commercializing its Sulf-IX™ process for sulphate removal and which is particularly applicable to lime plant effluents