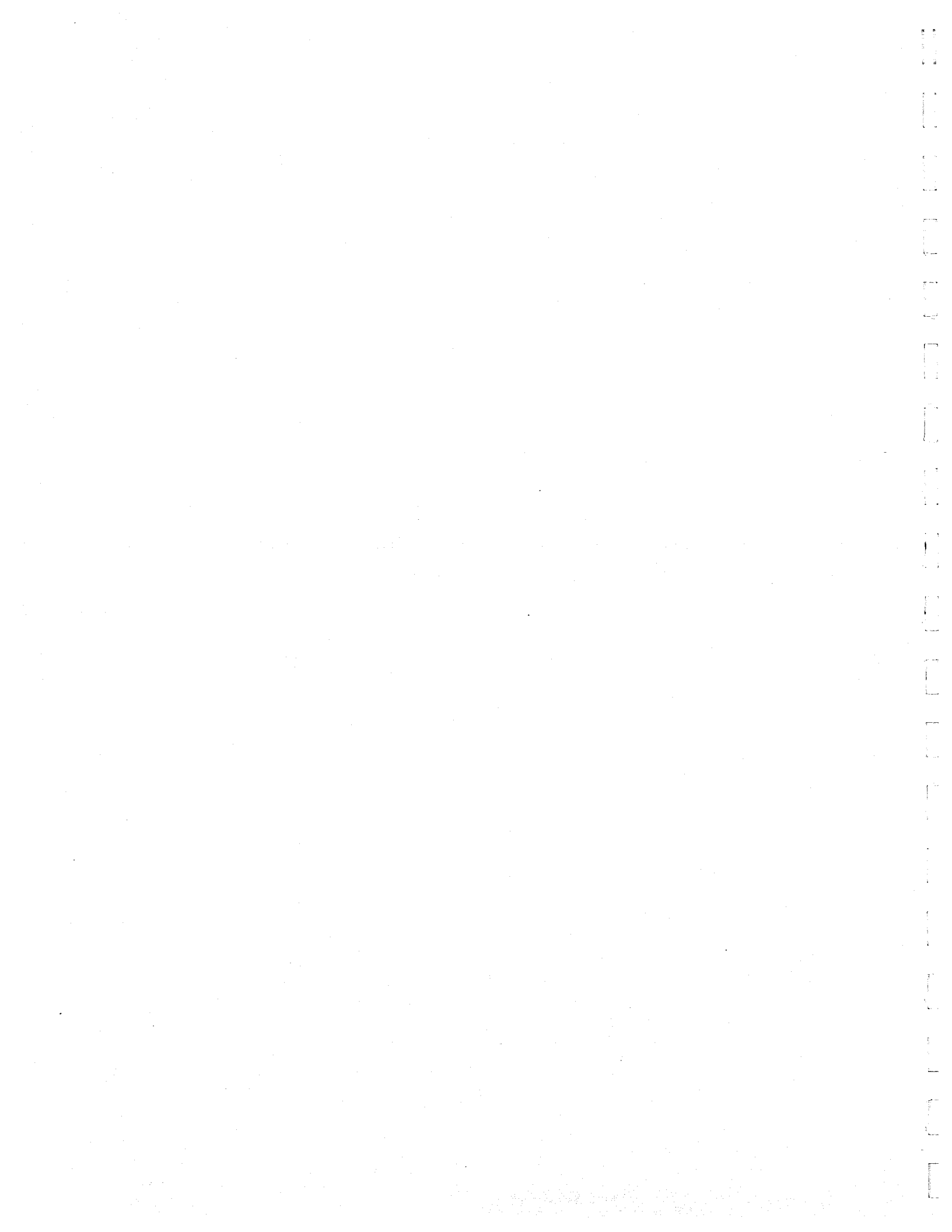


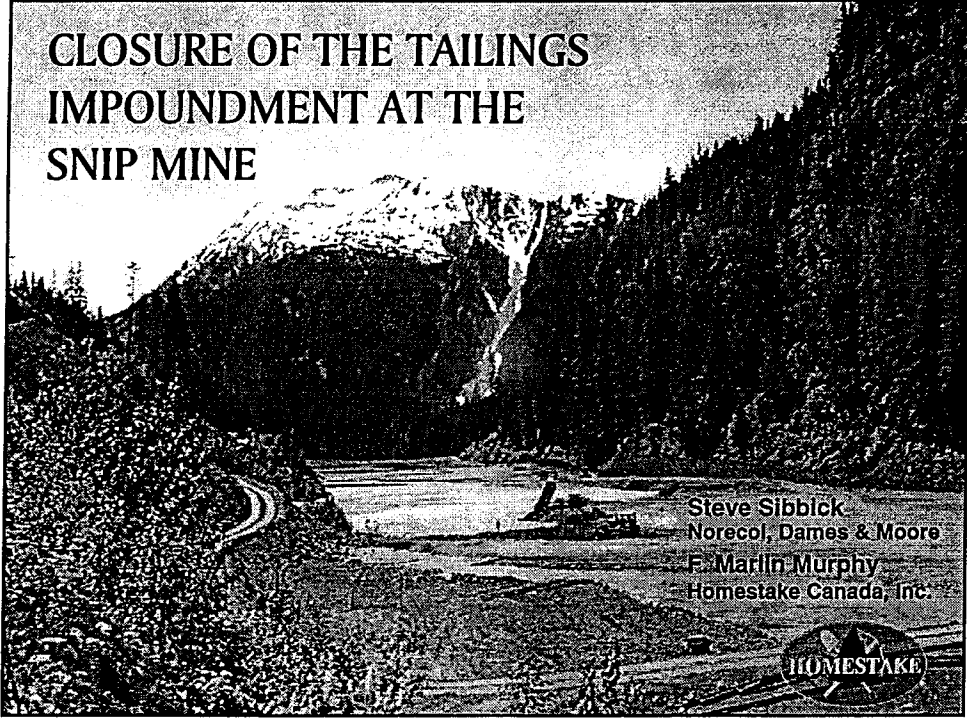
B.5. Closure of the Tailings Impoundment at the  
Snip Mine

*by*  
*Steve Sibbick*  
*Norecol, Dames & Moore*

*and*  
*F. Marlin Murphy*  
*Homestake Canada, Inc.*



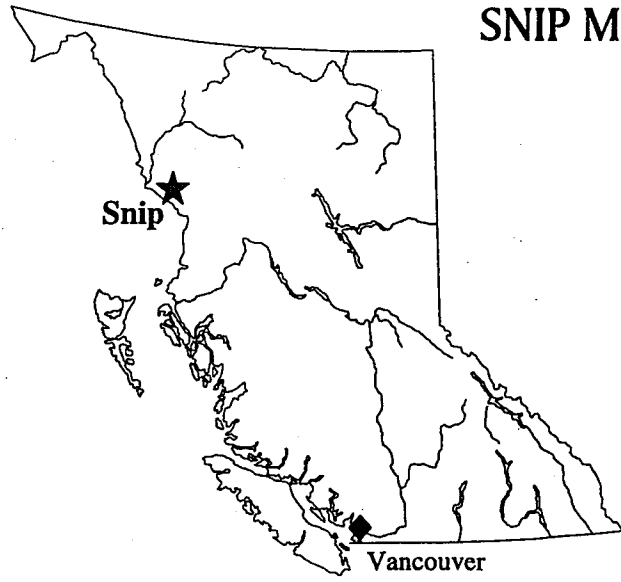
# CLOSURE OF THE TAILINGS IMPOUNDMENT AT THE SNIP MINE



Steve Sibbick  
Norecol, Dames & Moore  
E. Marlin Murphy  
Homestake Canada, Inc.



## SNIP MINE





*Snip Mine Closure*

## SNIP MINE

- **Operated since 1991**
- **No road access (hovercraft/air)**
- **Cominco 1991-1996**
- **Prime Resources/Homestake 1996-present**
- **Mine Shutdown: May 1999**

**Closure: May 1999 to present**



*Snip Mine Closure*

## SNIP MINE

### Geology

- **Intrusion related gold-bearing quartz-carbonate veins**
- **Hosted in feldspathic greywackes, siltstones and mafic tuffs**
- **Sheared veins with alternating pyrite/calcite stringers**
- **Primary sulphide: pyrite**  
(pyrrhotite, chalcopyrite, arsenopyrite, galena)
- **Primary carbonate: calcite**  
(ankerite, siderite)

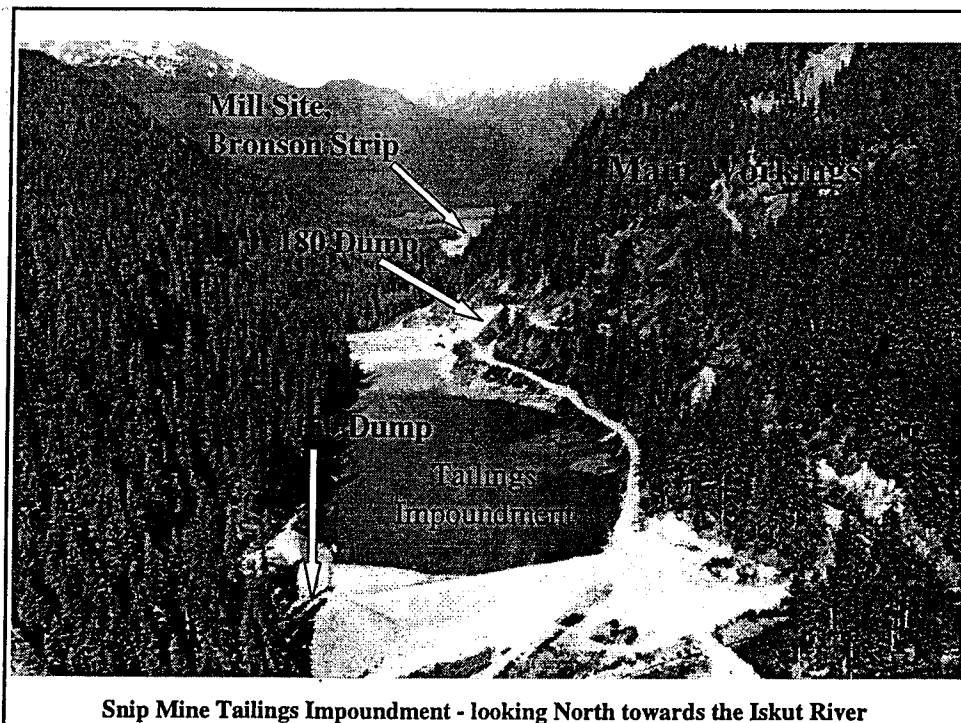


*Snip Mine Closure*

## SNIP MINE

Mining

- **Underground mine (~1.3 M tonnes mined)**
- **Gold/concentrate shipped by hovercraft/air (~1 Moz Au)**
- **Coarse tailings backfilled to mine**
- **Fine tailings discharged to tailings impoundment**
- **Tailings impoundment located at the head of Monsoon and Sky Creeks**



**Snip Mine Tailings Impoundment - looking North towards the Iskut River**



## ARD/ML MONITORING PROGRAM

- Weekly composites of tailings collected between January 1992 and May 1998 (337 samples)
- Tailings beach samples collected annually (42 samples)
- Samples analysed for ABA parameters and ICP metals
- Monthly composites of tailings collected between January 1993 and March 1998 (63 samples)
- Monthly composites analysed for ICP metals only
- Petrographic examination of a tailings composite



## ARD/ML MONITORING PROGRAM

Form of Neutralization Potential

Estimated using:

modified Sobek NP  
total inorganic carbon (TIC)  
weak-acid leachable Ca, Mg, Fe, Al  
aqua regia ICP Ca+Mg  
petrographic examination

Calcite ( $\text{CaCO}_3$ ) is the primary neutralizing mineral  
(magnesium carbonate, biotite\*, chlorite and  
feldspars)

\* identified using Reitveld-XRD



## ARD/ML MONITORING PROGRAM

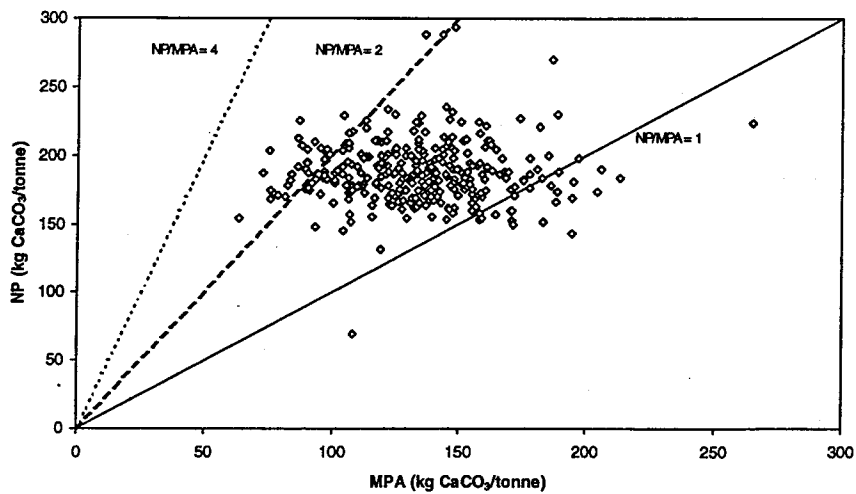
### Tailings ABA Characteristics

Sulphide S = Total S

Total S	4.3%	(2.8% to 5.8%)
MPA	133 kg CaCO <sub>3</sub> /t	(89 to 182 kg CaCO <sub>3</sub> /t)
NP	186 kg CaCO <sub>3</sub> /t	(157 to 231 kg CaCO <sub>3</sub> /t)
NP/AP	1.4	(1.0 to 2.3)



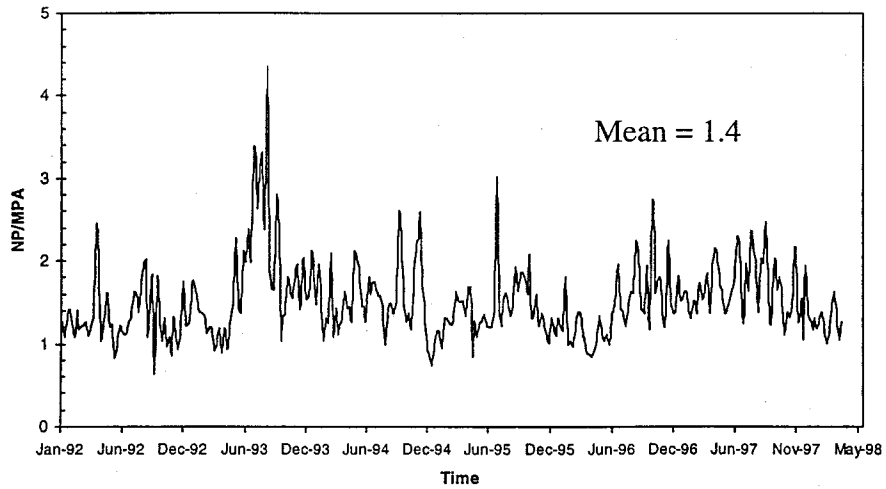
Final Tailings Weekly Composite Samples  
Neutralization Potential (NP) vs Maximum Potential Acidity (MPA)





Snip Mine Closure

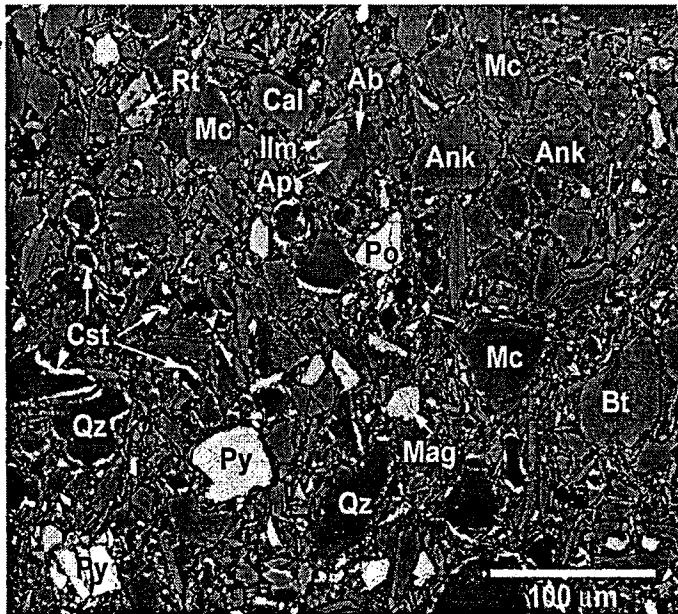
### Final Tailings Weekly Composite Samples NP/MPA vs Time



Snip Mine Closure

### SEM Photograph - Tailings

- Cal - calcite
- Py - pyrite
- Ank - ankerite
- Ab - albite
- Po - pyrrhotite
- Mc - microcline
- Bt - biotite
- Qz - quartz
- Mag - magnetite
- Cst - cassiterite
- Rt - rutile
- Ap - apatite
- Ilm - ilmenite







Snip Mine Closure

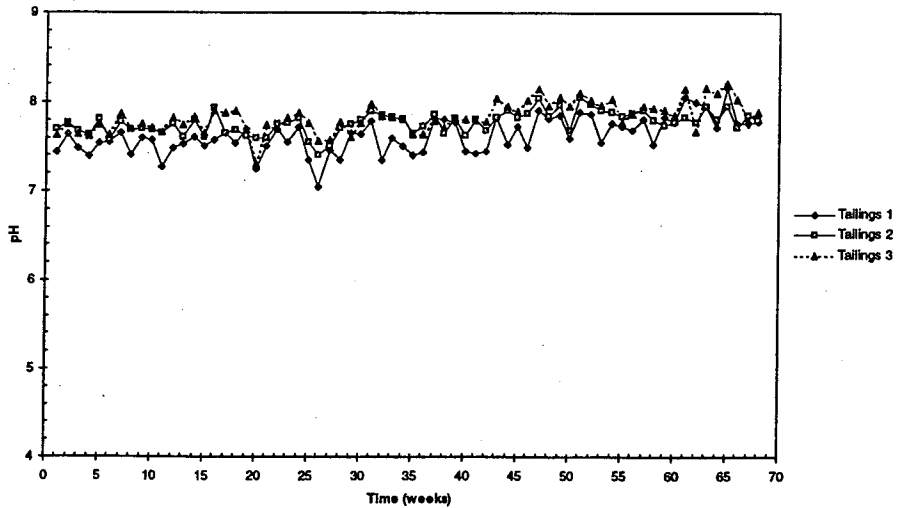
## KINETIC TESTING PROGRAM

- Humidity cells (1991)  
1 tailings and 3 ore samples  
10 weeks - No ARD generation
- Column tests (1994)  
Tailings and waste rock  
42 weeks - No ARD generation
- Humidity cell testwork (1998 to present)  
3 tailings cells  
2 waste rock cells (150 and 180 dumps)  
2 accelerated tailings cells (50% NP depletion)
- SEM-XRD analysis of 3 tailings cell samples



Snip Mine Closure

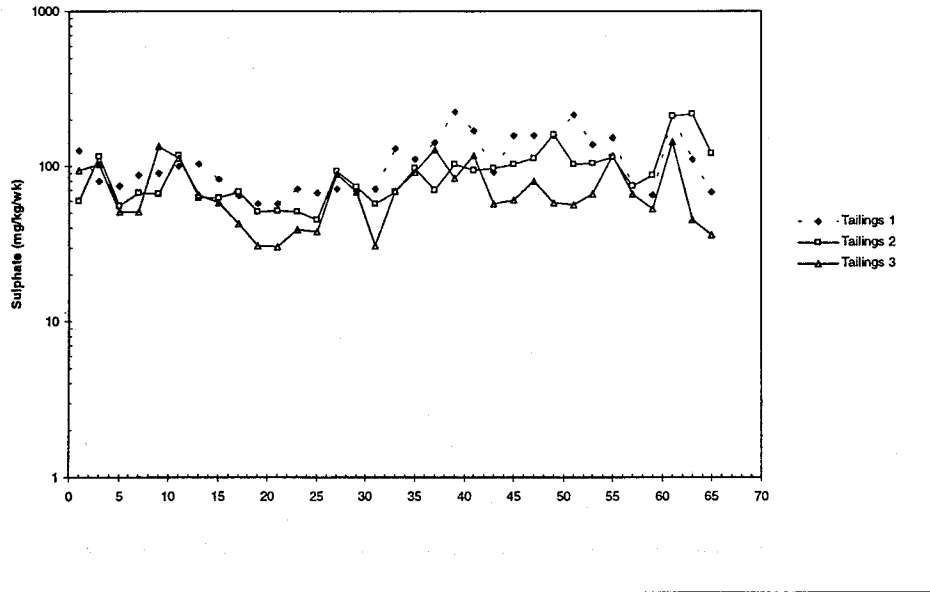
Tailings Humidity Cells  
pH





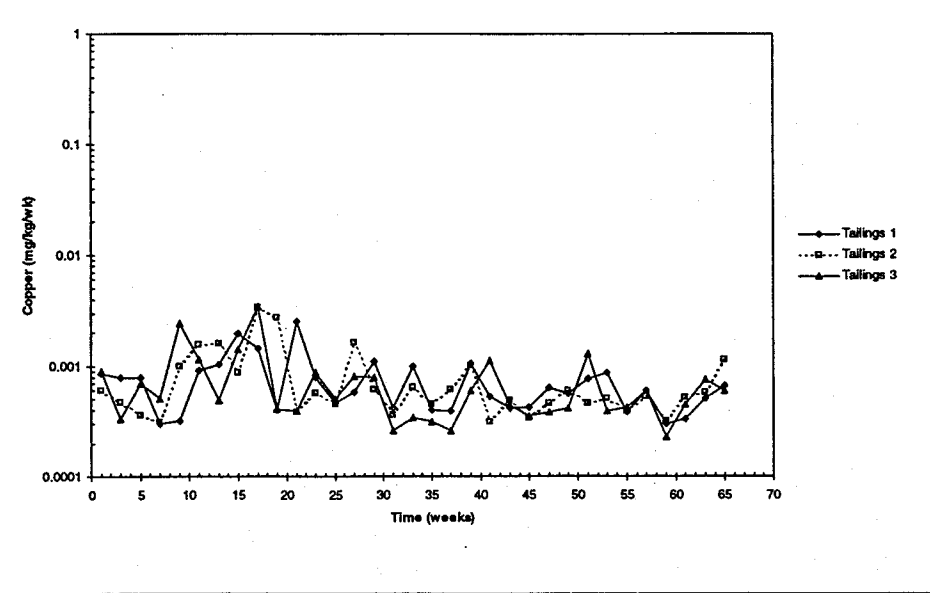
Snip Mine Closure

### Tailings Humidity Cells Sulphate



Snip Mine Closure

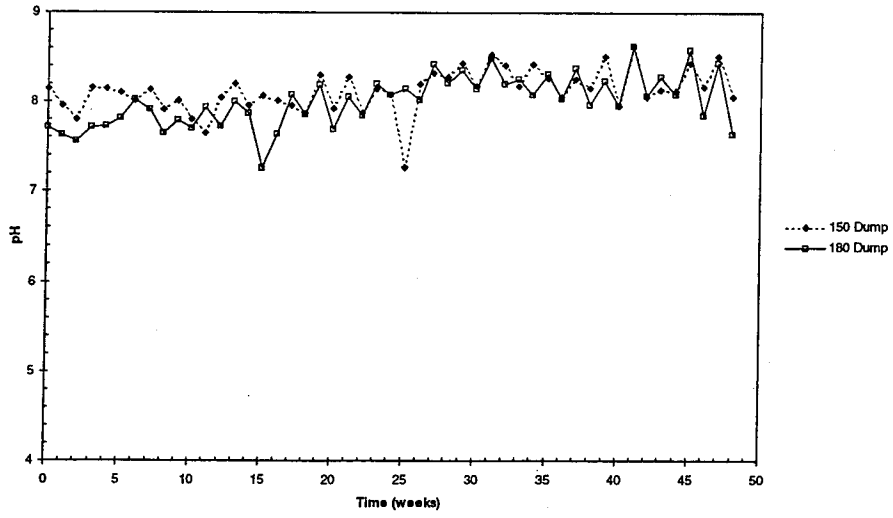
### Tailings Humidity Cells Copper





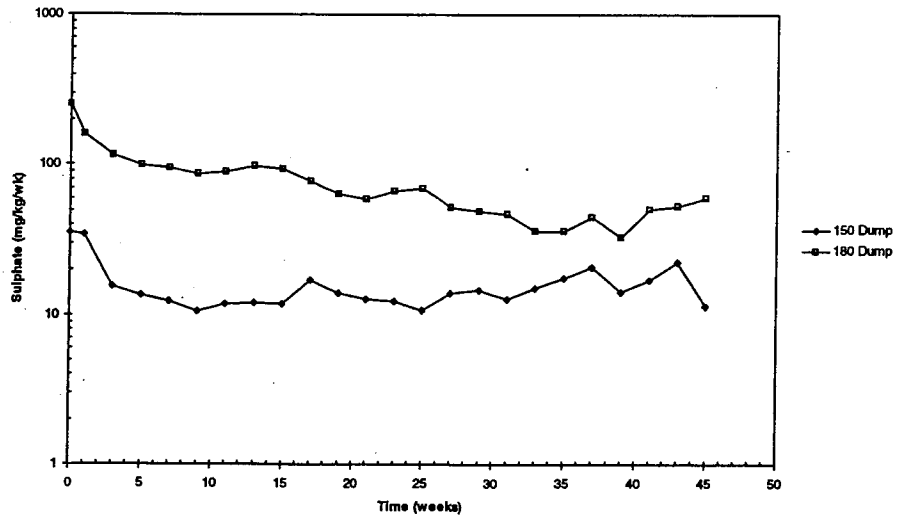
Snip Mine Closure

### Snip Mine - Waste Rock pH



Snip Mine Closure

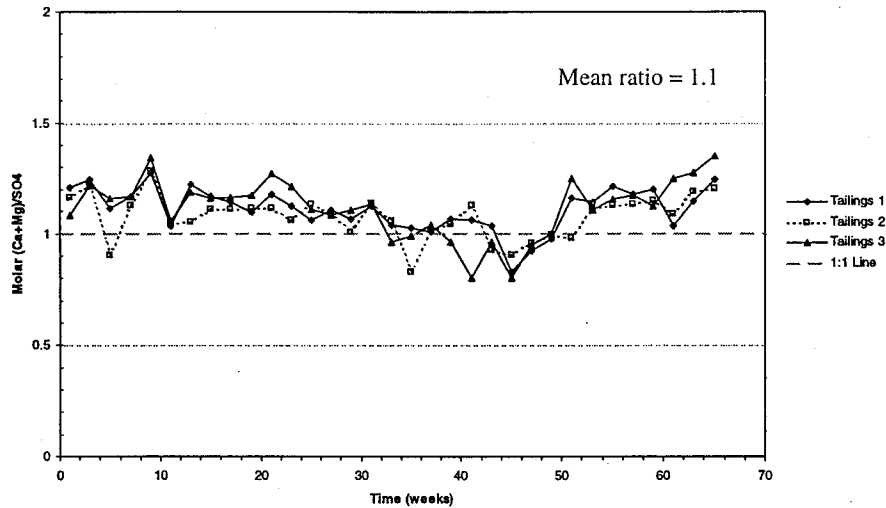
### Snip Mine - Waste Rock Sulphate





*Snip Mine Closure*

### Tailings Humidity Cells Molar (Ca+Mg)/Sulphate Ratios



*Snip Mine Closure*

## RESULTS AND INTERPRETATION

- **Tailings are non-acid generating**
- **Waste rock (150+180 dumps) are non-acid generating, likely acid consuming**
- **Low metals leaching rates from all materials**
- **NP exhaustion estimated at 13 to 35 years in tailings**
- **Tailings sulphide 'burnout' near or before NP exhaustion**
- **130 and 440 waste rock dumps potentially acid generating**



## SITE CONSIDERATIONS FOR CLOSURE

- **Isolated Location**  
Infrequent monitoring  
Difficult/expensive to access after Closure
- **ARD Potential of Materials**  
(tailings, waste rock)
- **Physiography**  
(Precipitation, seismic activity, etc.)
- **Regulatory requirements**
- **Company requirements**



## TAILINGS CLOSURE

Options

- **Flooded Impoundment**  
Minimum risk of ARD  
Increases risk of dyke failure  
Beavers
- **Engineered Dry Cover**  
Insufficient construction materials  
( > surface disturbance than mine)
- **Thin Soil Cover / Partial Water Cover**  
'As is' solution - minimum reclamation  
Minimum contingencies
- **Saturated Cover**

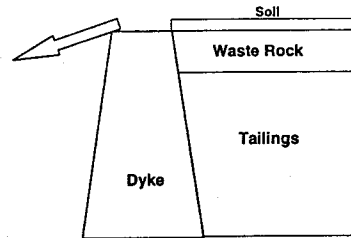


*Snip Mine Closure*

## TAILINGS CLOSURE

Saturated Cover

- **Maintain water-saturated anoxic conditions with tailings**
- **Minimize water ponding on surface**
- **Water table maintained within waste rock cap above tailings**
- **Organic soil cover provides growth medium**
- **Final closure as meadow/wetland**



*Snip Mine Closure*

## TAILINGS CLOSURE

Saturated Cover

- **Regrading of tailings to 0.15% slope towards Sky Creek**
- **130 and 440 waste rock placed deep in tailings**
- **Cover with 50 cm of NAG waste rock**  
**150 and 180 waste dumps**
- **Cover with 15 cm of soil**  
**till + organic material**



## TAILINGS CLOSURE

Saturated Cover

- **Construction of Spillway to Sky Creek**  
french drain to retard beaver dam construction  
spillway designed for dam construction if flooding required
- **Impoundment cover allowed to revegetate naturally**
- **Ongoing monitoring (field and lab)**



## Tailings Impoundment Cross Sections

