SECTION B.12

SIMPLIFIED RISK ASSESSMENT OF THE SHEBANDOWAN TAILINGS POND CLOSURE

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SIMPLIFIED RISK ASSESSMENT OF THE SEBANDOWAN TAILINGS POND CLOSURE

by

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SITE HISTORY

- Nickel-copper massive sulphide ore
- operated from 1971 to 1986 , 1989-1992, 1995 to1998
- Located in cottage country on the shores of a major recreational lake
- Key issue for closure-ARD and long term stability

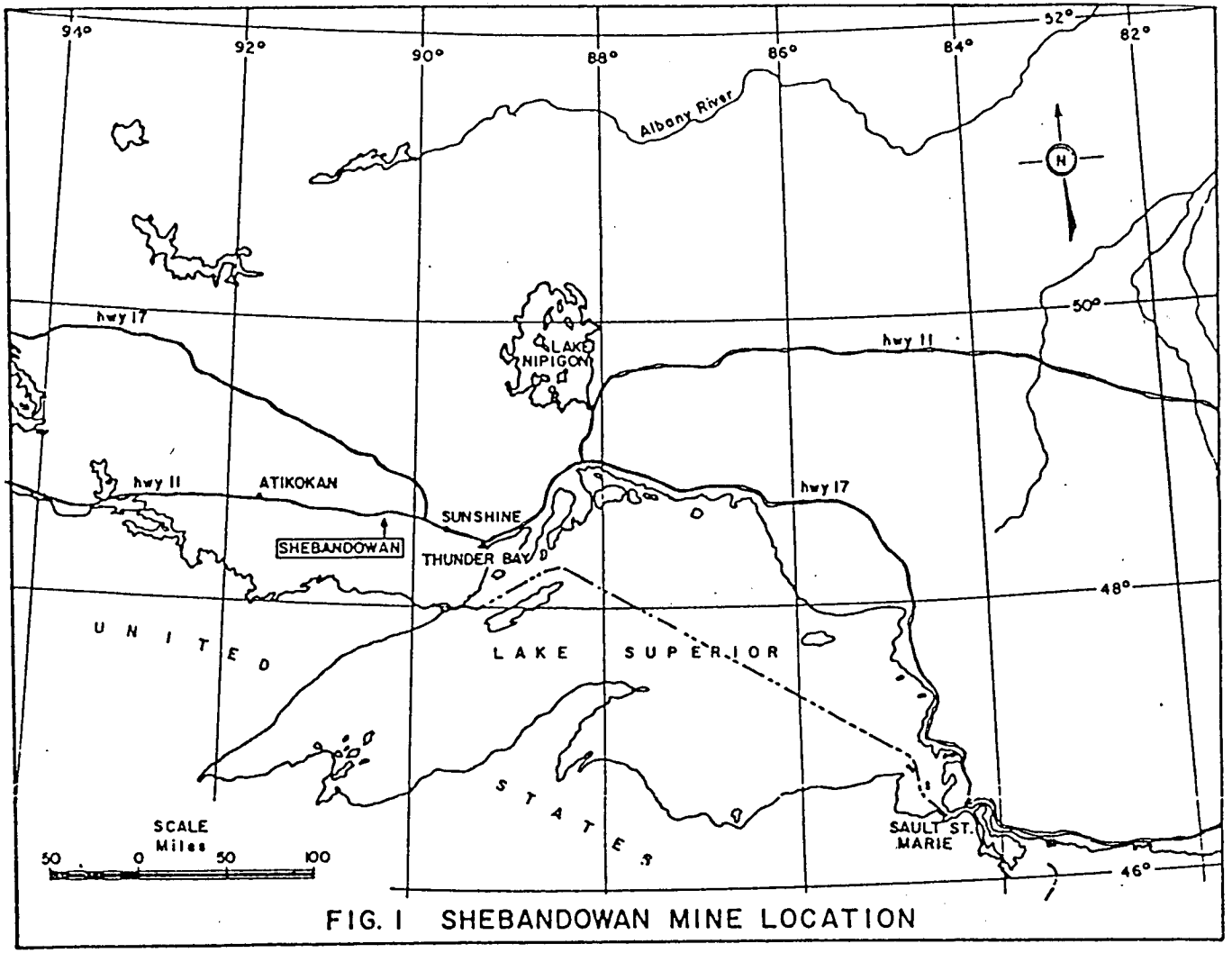

FIG. 1 SHEBANDOWAN MINE LOCATION

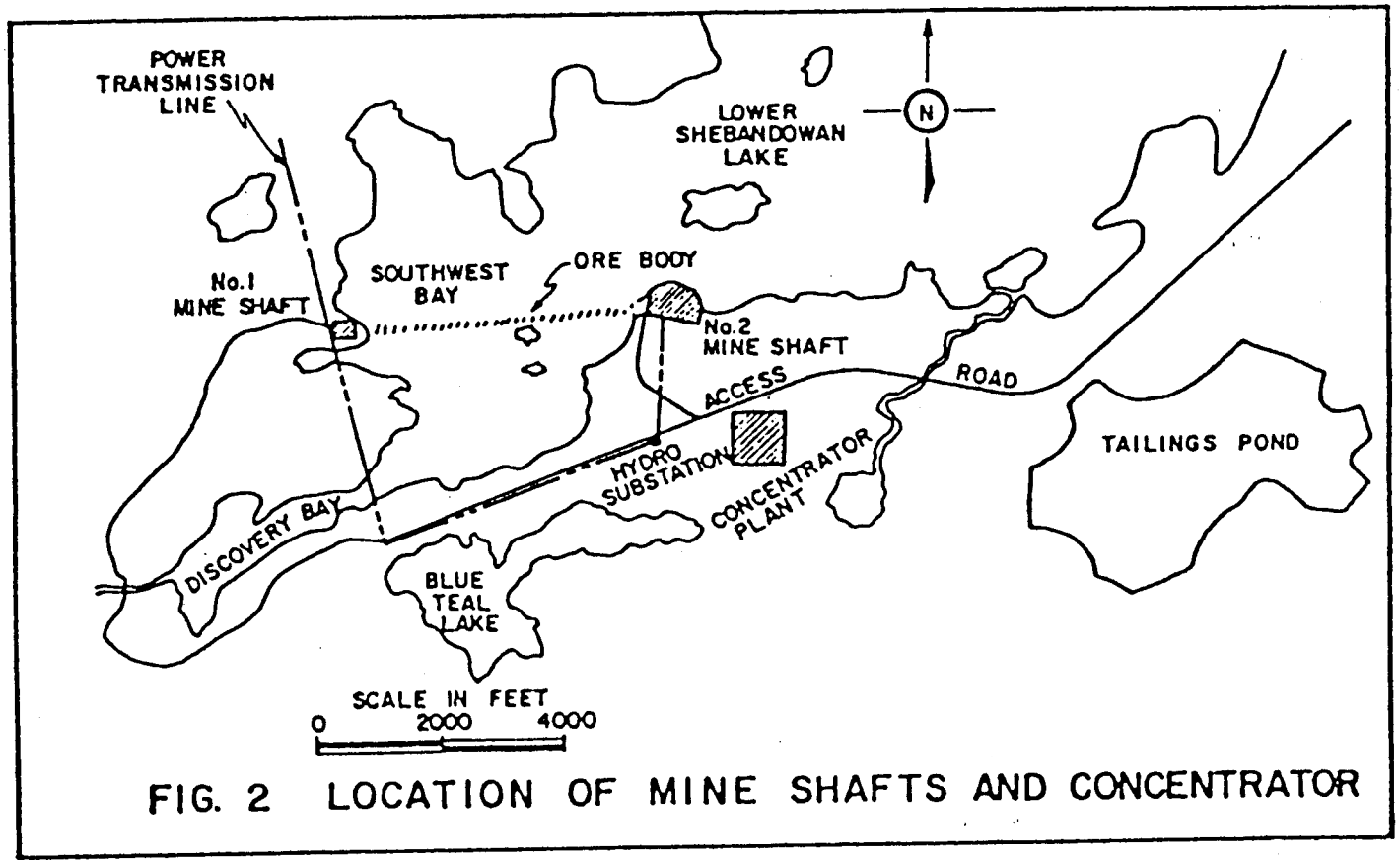

FIG. 2 LOCATION OF MINE SHAFTS AND CONCENTRATOR

TAILINGS POND CHARACTERIISTICS

- Approximately 3 million m^3
- Basin area - 115 ha
- Watershed - 156 ha
- Low lying wetland area bounded by 6 conventional earthfill dams
- Drainage to a small Creek and watershed

TAILINGS CHARACTERISTICS

- Average - AP= 430 kg/t, NP= 37 kg/t, NNP= -393 kg/t
- Major minerals- pyrrhotite, iron hydroxide, gypsum, calcite, mica
- near surface acidic where dry
- all porewater alkaline at depth

CLOSURE PLAN

- Regrade the exposed beaches to below water
- Provide a water cover
- Stabilize the dams
- Implement long term care and maintenance program

RISK ASSESSMENT CONCERNS

- Drought- small watershed
- Flood- overtopping of structures
- seismic events- dam failure
- miscellaneous

RISK OF DROUGHT

- Scenarios considered
  - average year (+25% evaporation)
  - driest year on record
  - driest year predicted
  - 5 months with zero precipitation
  - average year +20% increased evaporation
  - driest year predicted +20% increased evaporation

RESULTS OF ANALYSIS

BASIN WATER BALANCE

SCENARIO	Annual Surplus (M3)	Maximum drawdown-mm
1. average year	165000	160
2. driest year recorded	-145000	300
3. driest year predicted	-273000	400
4. zero precip. 5 mo.	-450000	560
5. average +20% evap	-430000	240

DROUGHT EFFECTS

- Exposure for short periods minimal concern
  - high water table
  - historic exposure of wet tails produced no acid
  - tailings contain 3 to 5 % $CaCO_3$
  - exposure likely to occur late fall/early winter when basin will be frozen

REMEDIAL MEASURES

- Minimal requirement- Pond water level recovery would be slow (years)
- Batch liming a possibility if ever required. At 100 mg/L, 2 truckloads at a cost of perhaps $10000.

RISK OF FLOOD

- Average flow 165000 M^3/a
- Storm events
  - 50 year return- 112mm/24 hours
  - 100 year return- 125mm/24 hours
  - design storm- 193 mm/12 hours
  - PMP- 420 mm
  - 200 year runoff event- 420 mm
  - wettest year runoff- 470 mm

FLOOD ANALYSIS

(spillway blocked)

Event	Yield–mm	Pond Rise-Metres	Freeboard Metres
Regional Storm	193	0.26	1.26
PMP	420	0.56	0.96
200 year runoff	420	0.56	0.96
Wettest year	470	0.63	0.89

REMEDIAL MEASURES

- Minimal requirement as adequate freeboard exists even with spillway blocked
- Remedial options could include:
  - monitoring of spillways
  - construction of dry spillway
  - internal berms to reduce wave induced erosion

RISK OF EARTHQUAKE

- Zone 0 seismic classification
- Maximum credible earthquake 0.02g
- Conventional low head engineered structures on competent foundations
- Geotechnical opinion- seismicity can be ignored

RISK OF OTHER DAM FAILURE MODES

- Approach was to use precedent experience
- Examples:
  - Lalonde (1980)- modern dams after 10 years, have a frequency of failure< $1*10^{-5}$/year
  - Golder 1995- detailed risk analysis of damage to a dam at an Elliot Lake mine was $3*10^{-6}$/year with semi-annual inspection/maintenance

DAM FAILURE RESULTS

Dam #	Height-ft	Tailings Depth-ft	Breach Depth-ft	Tailings loss- t
1	36	28.5	26	19000
2	41	33.5	31	38000
3	24	16.5	14	1300
3a	20	12.5	10	500
4	19	11.5	9	400
5	16	8.5	6	150

SUMMARY OF RESULTS

- Losses could be significant at dam 1 and 2 with losses of up to 40000 t
- Losses could be greater if tailings eroded outside the zone of depression around the breach (+4000 t if pond water contained an additional 5kg/M^3)
- deposits expected along banks of creek- ARD likely with substantial impact

REMEDIAL MEASURES

- Two options considered
  - upstream rip-rap blankets to minimize erosion
  - downstream rock berms to control depth of the breach
  - latter option selected as preferred and required raising of rock toe berms 4 to 5m with coarse rock. The projected cost was $190,000 and reduced the loss to < 500 t.

COST/BENEFIT

- Future costs for dam failure/clean-up/repair
  - clean-up @ 20$/t, dam repair $25/m^3$
  - studies and monitoring +25%
  - total cost- $700,000 to $1,300,000
  - likelihood of occurrence over 1000 years at annual risk of $<1*10^{-5}$ is <1% in 1000 years
  - estimated average NPV @ 3% discount <$1000 for future clean-up and repair

CARE AND MAINTENANCE COSTS

Item	NPV 3%
Inspections	$1,000,000
Maintenance activities	$139,000
Dam repair/clean-up	$1000
Total care and maintenance cost	$1,140,000

CONCLUSIONS

- The risk of adverse environmental impact after mine closure is minimal if the site is maintained
- Loss of water cover is unlikely under severe drought. Consequences of tailings exposure are minor and readily addressed.
- With maintenance , the likelihood of any dam failure is <1 in 100000/year

CONCLUSIONS CONT'D

- Maximum tailings loss was estimated at 19000 to 38000 t. Remedial measures at $190,000 could reduce losses to <1000 t. This compares with NPV of <$1000 for future clean-up and repair of the dams. Therefore remedial works are not economic.
- Long term care and maintenance costs were estimated at $1,140,000.