10th Annual BC ML / ARD Workshop

Water Treatment at Myra Falls Operations

Gavin C. Dirom, M.Sc., P.Ag. – Environmental Supervisor
Dr. David Mchaina, P.Eng. – Environmental Manager

Boliden Westmin (Canada) Ltd.

December 2003

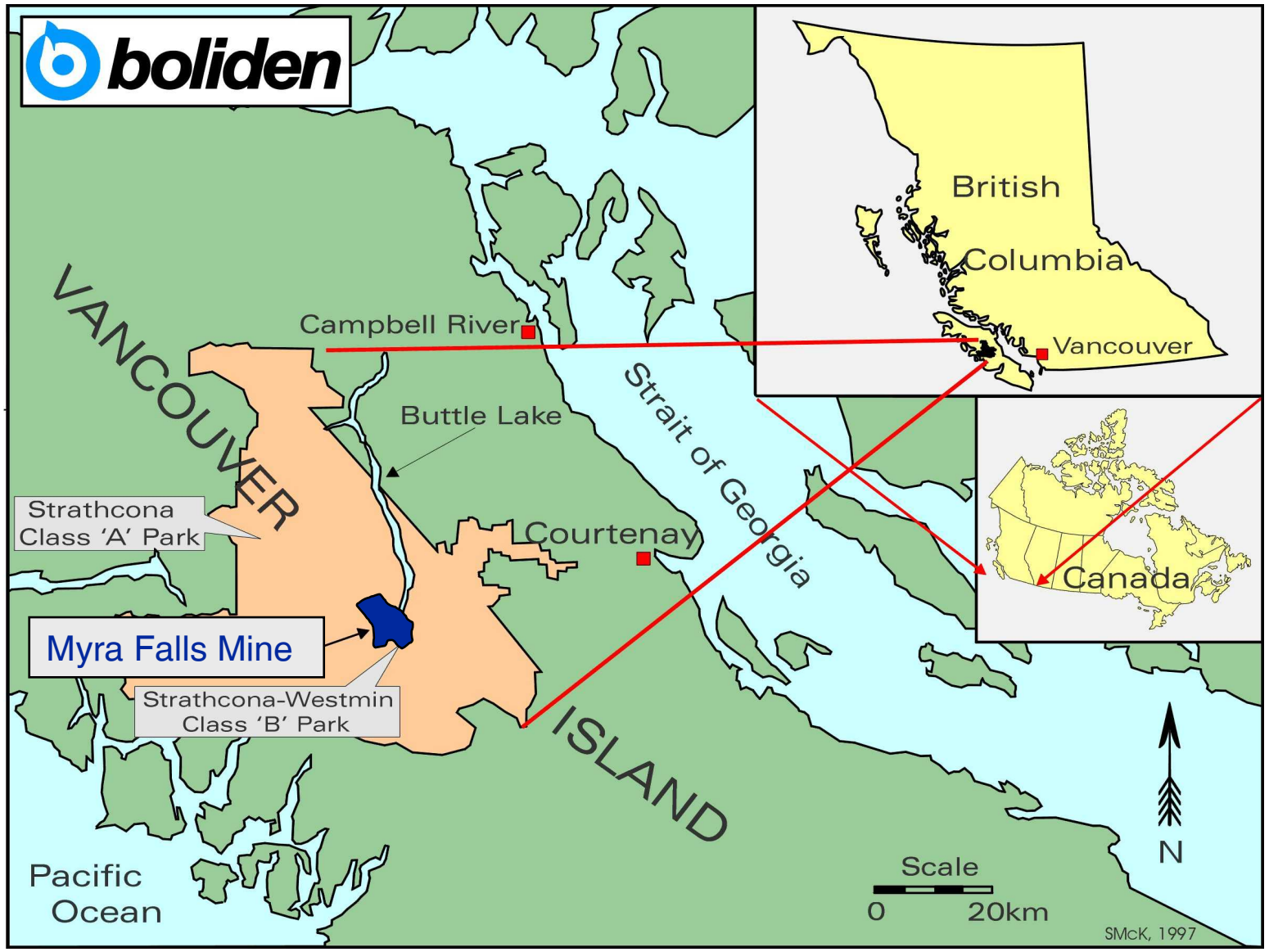
Presentation Outline

1. Introduction to Myra Falls
   - Location / Physical Setting
   - Climatic Conditions

2. Why is Water Treatment Required at Myra Falls?
   - ML / ARD History
   - Known Sources of Seasonal ARD
   - Treatment Systems Introduced

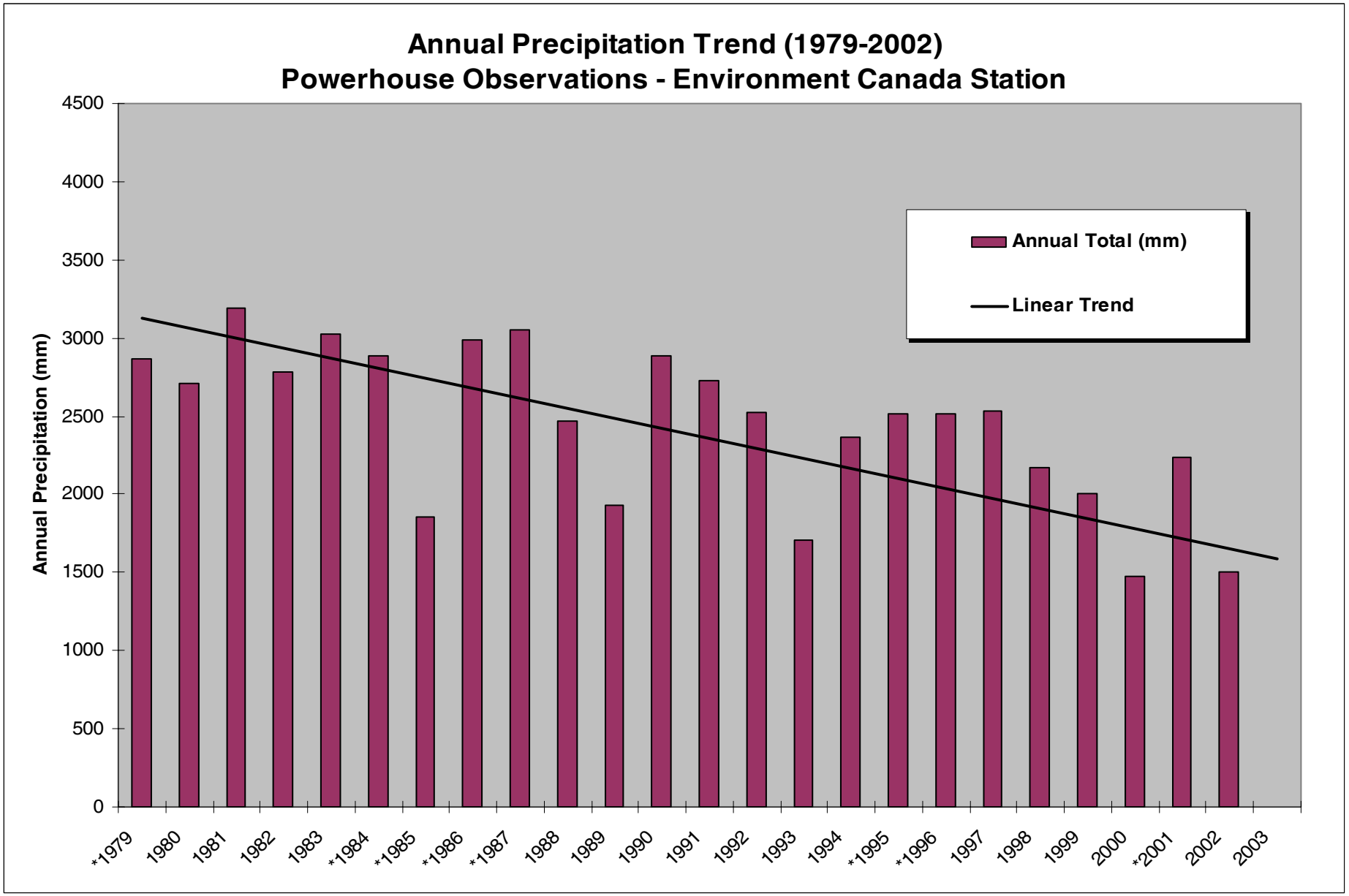
3. Method of Water Treatment and System Layout
   - System Layout
   - Input vs. Output Chemistry
   - Lime Usage (Past, Present and Projected)
   - Downstream Inputs to Treatment System
   - Pond Optimization Project to meet MMER & Closure standards

Myra Falls Operation

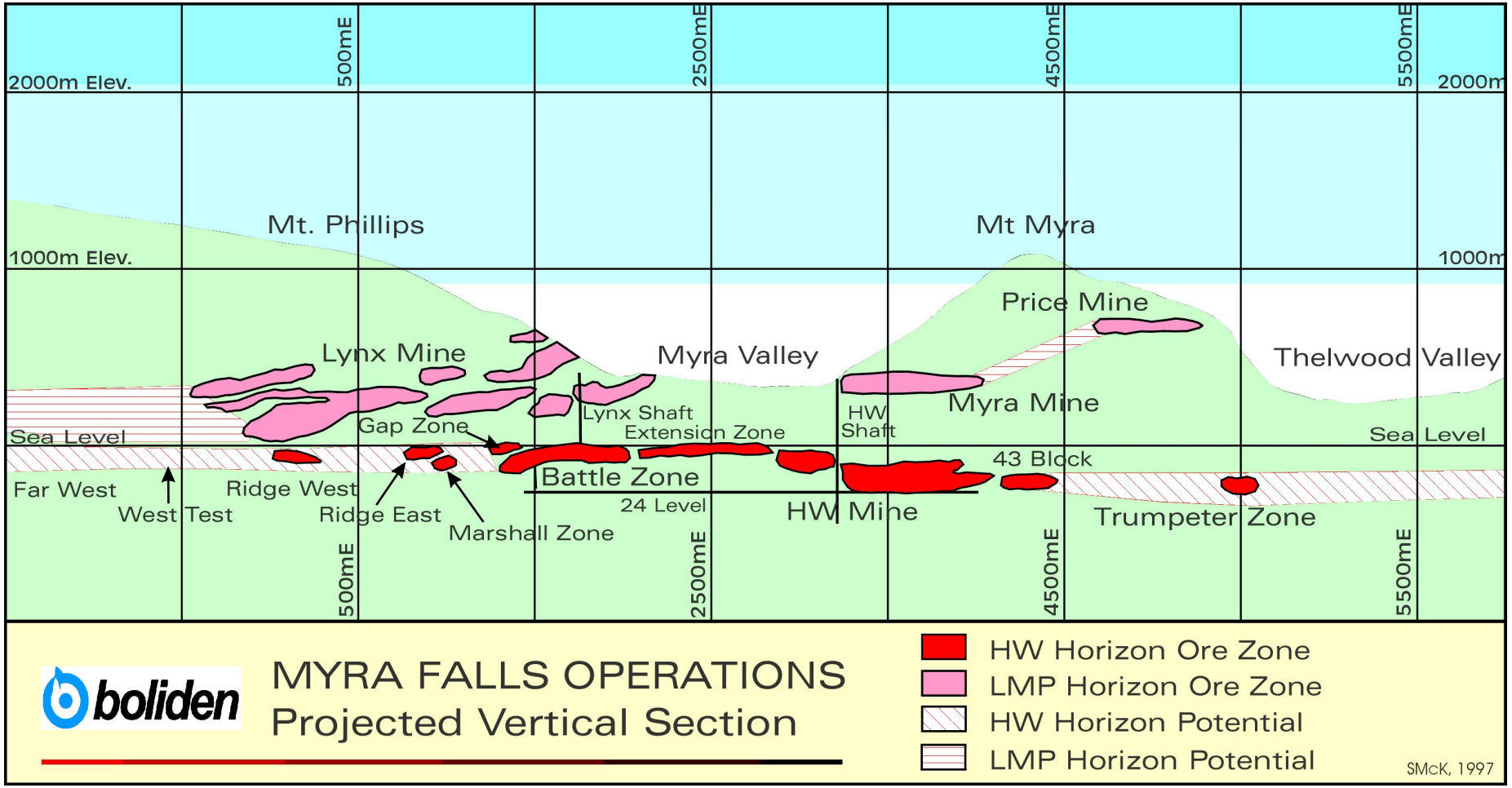


Myra Falls Operation

Polymetallic Underground Mine (Zinc - Copper)


Annual Precipitation Trend (1979-2002)
Powerhouse Observations - Environment Canada Station
Annual Precipitation (mm)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Annual Total (mm)
Linear Trend
*1979
1980
1981
1982
1983
*1984
*1985
*1986
*1987
1988
1989
1990
1991
1992
1993
1994
*1995
*1996
1997
1998
1999
2000
*2001
2002
2003

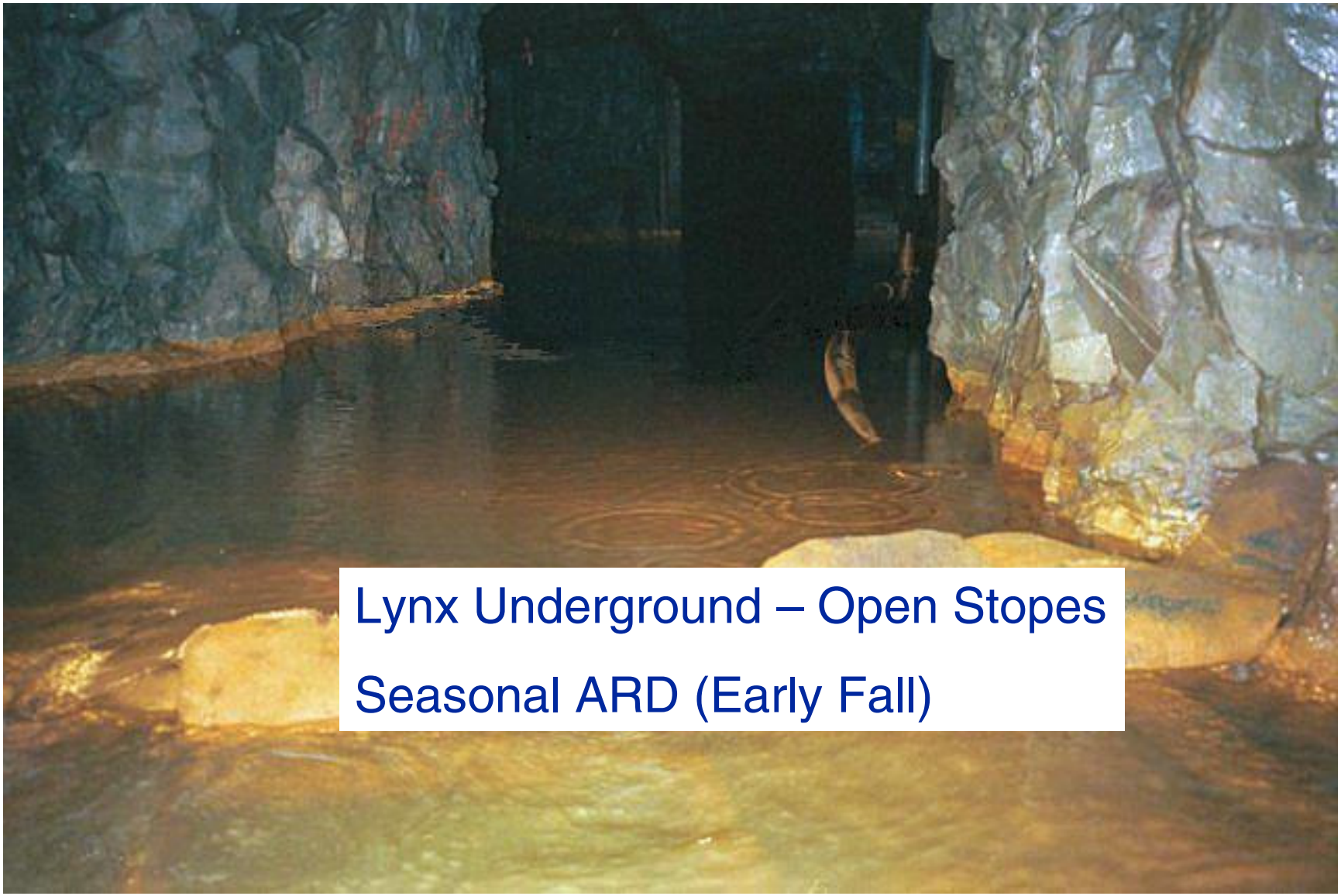
Myra Falls Operation



ML / ARD History

- Volconogenic Massive Sulphide (VMS) deposit
  - Sicker Rock formation altered Rhyolite and Andesite rocks
  - 22M tonnes mined grading: 1.5% Cu, 5% Zn, 2 gpt Au, 52 gpt Ag
  - Key minerals: Chalcophyrite, Bornite, Sphalerite, Pyrite

- Major ML/ARD sources identified:
  - Waste Rock Dumps (year-round)
  - Lynx Mine / Myra Mine (seasonal)
  - Tailings Disposal Facility (TDF)


Lynx Underground – Open Stopes
Seasonal ARD (Early Fall)

ML / ARD History

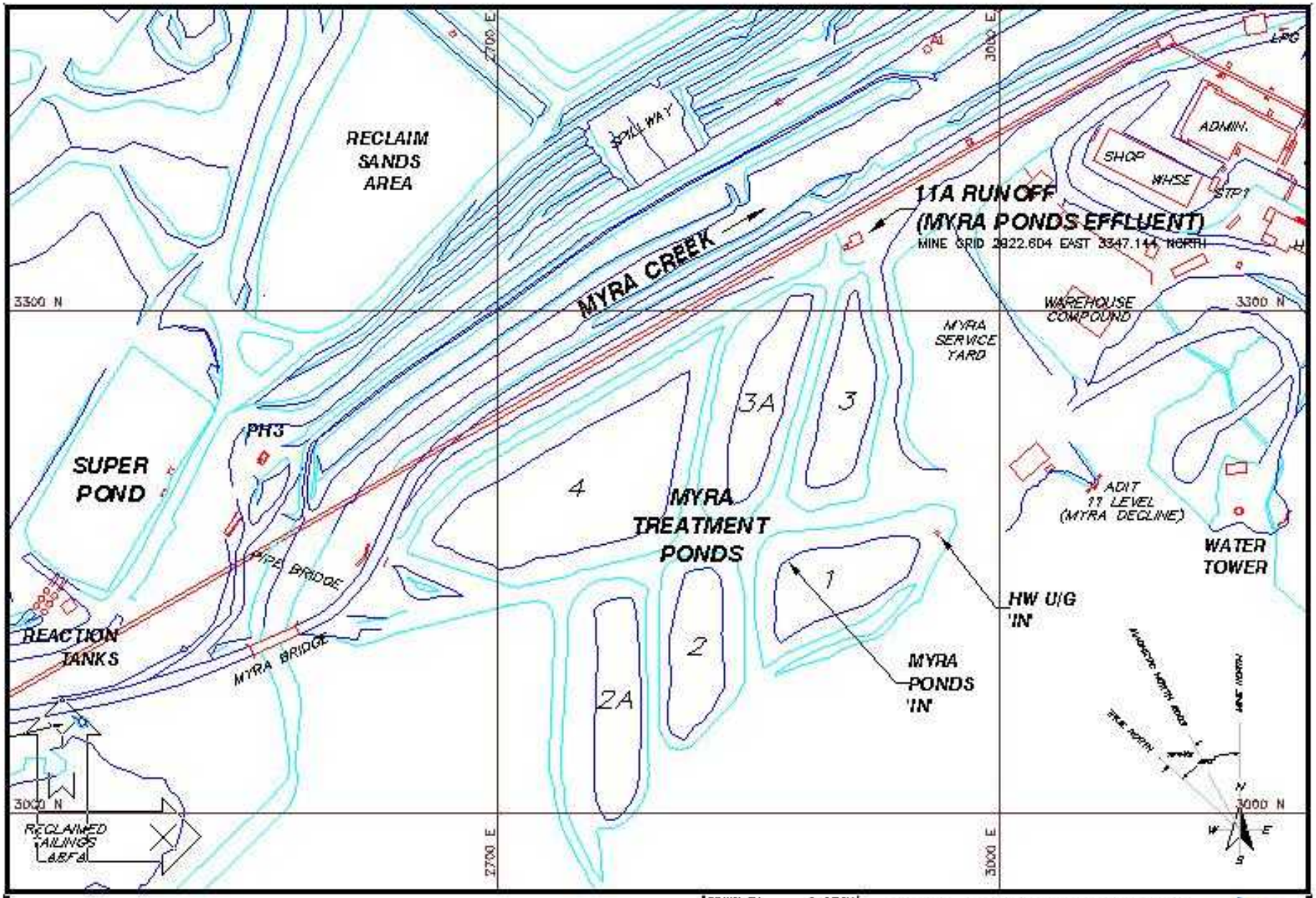
- Major ML/ARD treatment systems put into place during early and mid 1980's
- Constructed primary water treatment pond (Superpond), which uses lime addition / pH adjustment to precipitate metal hydroxides
- Creation of six downstream settling ponds
- Tailings Disposal Facility (TDF) with collection drains and pumps
- Automated control systems introduced
- Re-alignment of Myra Creek

Myra Falls Operation

boliden

View of Myra Creek and TDF slope


Lime Storage Silos



DRAWN BY	G. DIRON
CHECKED BY	
DATE	2003/11/30
SCALE	1:3000
DWG. LOC.	
NAME/REF	

MYRA FALLS OPERATIONS
BOLIDEN WESTMIN (CANADA) LIMITED

11A RUNOFF
MYRA PONDS EFFLUENT
FIGURE 3-6

Treatment Pond System

Water Treatment System

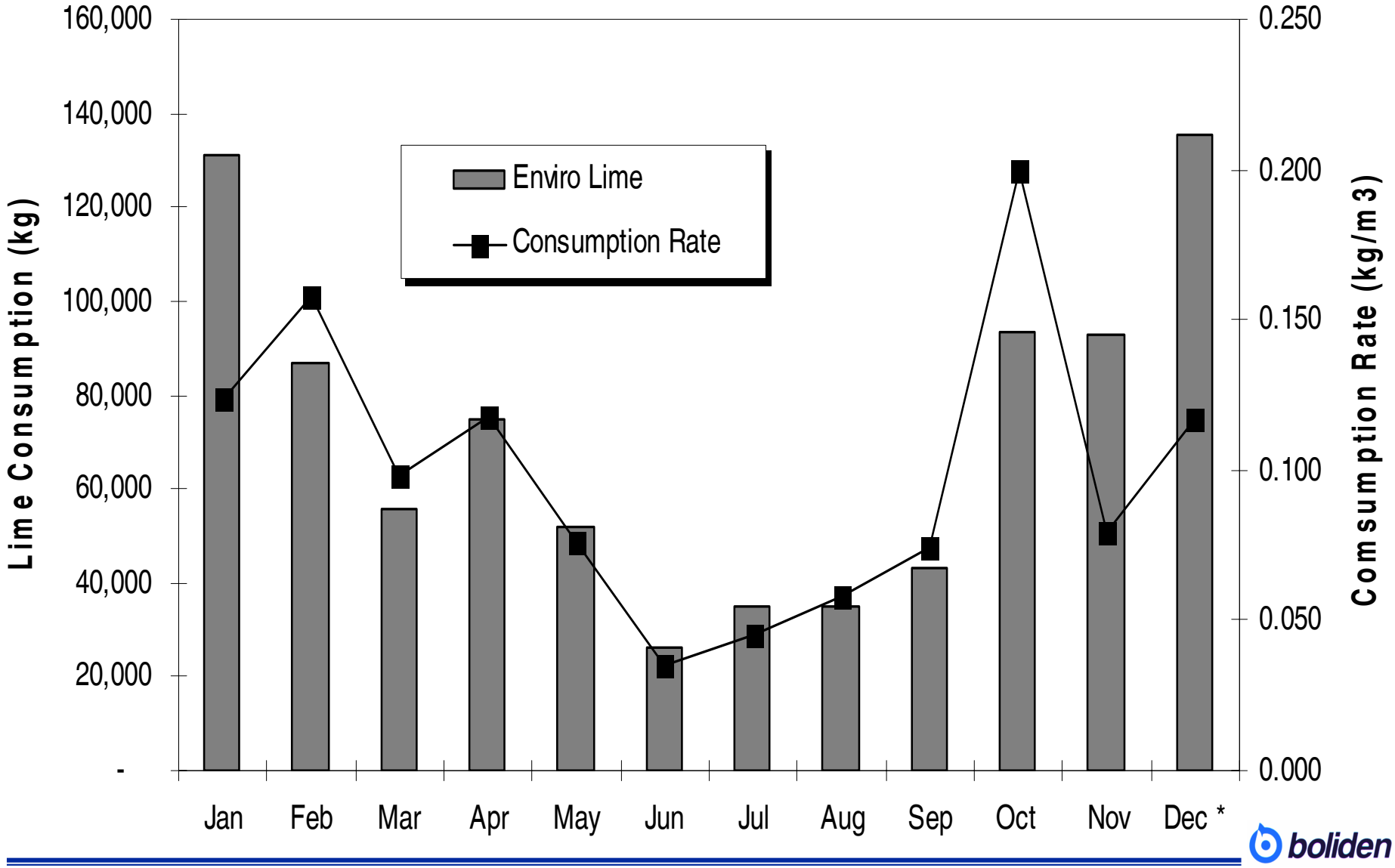
Pre-treatment vs. Post-treatment Sample Chemistry

	pH	TDS g/L	AL-T mg/L	CD-T mg/L	CA-T mg/L	CU-T mg/L	FE-T mg/L	PB-T mg/L	MG-T mg/L	MN-T mg/L	ZN-T mg/L
IN	4.88	0.53	3.3	0.03	142	0.98	7.53	0.44	17.7	2.83	9.57
OUT	10.1	0.62	0.3	<0.01	172	<0.01	0.04	<0.05	2.3	0.03	0.07

IN represents the influent sample above lime reaction tanks

OUT represents final effluent discharge into Myra Creek from Myra Ponds

2002 Lime Consumption



Historical Effluent Volumes (1993-2002)

Month	Myra Effluent by Month Average Volumes (m3 / day)
January	31,309
February	29,857
March	28,989
April	29,760
May	26,419
June	23,708
July	21,635
August	17,622
September	16,131
October	19,773
November	32,401
December	33,426
Annual Average	9,450,359
Daily Average	25,891

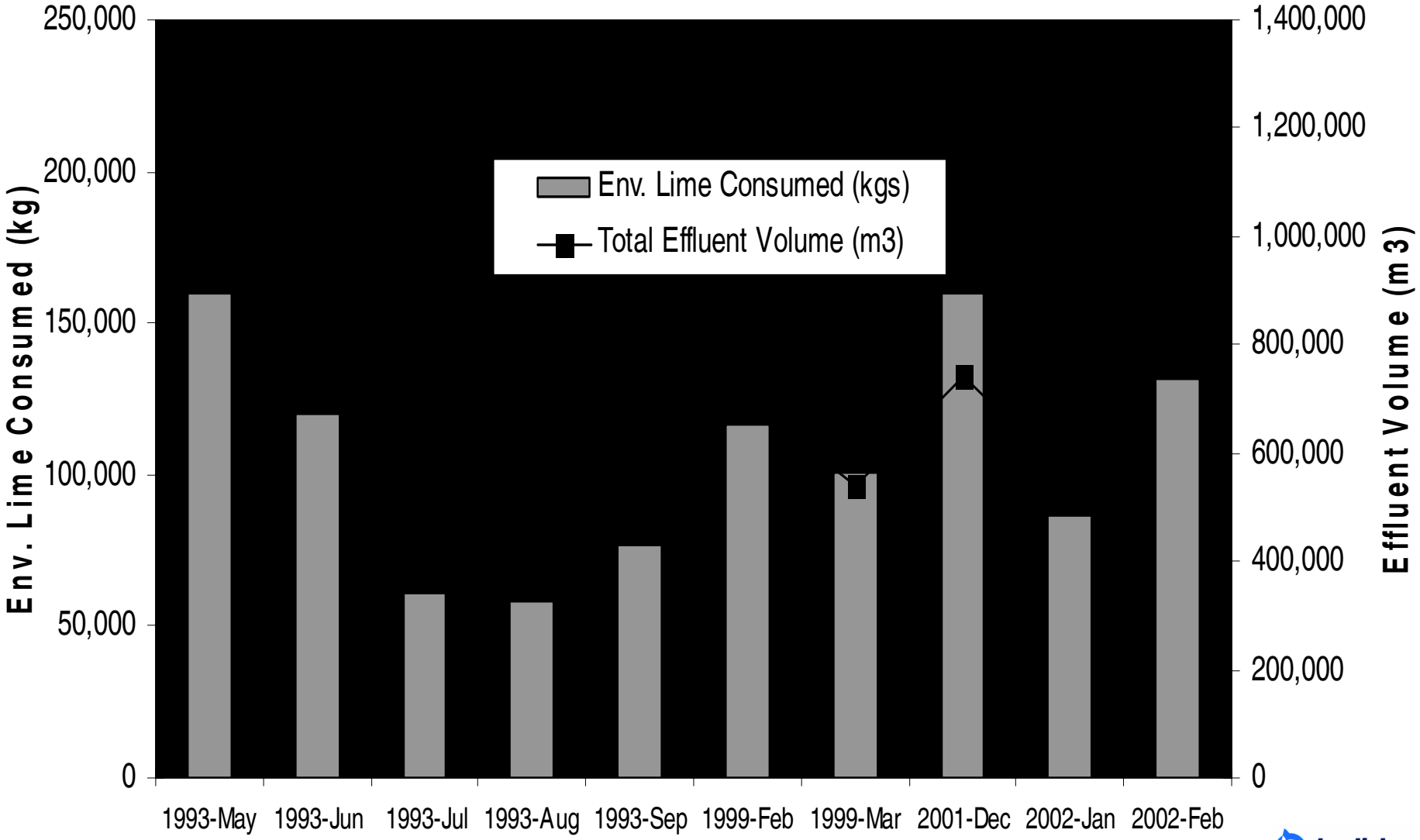
Lime Consumption – 1995 to 2002

Year	Env.Lime Consumption (kg/m3 effluent)	Total Effluent Volume (m3)	Env. Lime Used (kgs)	Budget Process Lime Consumption (kg/tonne milled)	Budget Env. Monthly Lime Consumptions (kg/tonne milled)
2002	0.096	8,975,056	860,710	2.0	0.5-1.5
2001	0.116	7,827,519	909,742	2.0	1.1-1.8
2000	0.131	7,057,306	922,079	2.0	1.2-1.8
1999	0.097	7,725,458	732,384	2.2	0.5-1.0
1998	0.098	7,183,135	702,788	2.2	
1997	0.092	7,636,207	700,239	2.4	
1996	0.121	9,644,313	813,339	2.4	
1995	0.065	13,722,748	1,012,483	2.4	
8-year Mean	0.102	8,721,468	831,720	2.2	

Lime Use during Mine / Mill Shutdowns

Year - Month	Environmental Lime Consumption (kg/m3 effluent)	Total Effluent Volume (m3)	Env. Lime Consumed (kgs)
2002-Feb	0.124	1,060,045	131,200
2002-Jan	0.158	551,292	86,900
2001-Dec	0.216	741,830	160,100
1999-Mar	0.187	540,361	101,010
1999-Feb	0.167	695,919	116,320
1993-Sep	0.16	470,170	76,580
1993-Aug	0.12	486,460	58,580
1993-Jul	0.10	606,130	60,550
1993-Jun	0.13	908,170	120,110
1993-May	0.12	1,338,810	160,280

Lime vs. Effluent Volume in Shutdown



Typical Monthly Lime Budget (kg/Tonne Milled)

Month	Budgeted Env. Lime Consumption (kg / Tonne Milled)
Jan	1.5
Feb	1.5
Mar	1.5
Apr	1.5
May	.5
June	.5
July	.5
August	.5
Sept	1.0
Oct	1.5
Nov	1.5
Dec	1.8
Annual Average	1.0

Lime Usage Assessment

- The lime numbers suggest that the largest use of lime occurs during and shortly after fall rains and spring freshet periods.

- The increase use of lime in the fall is attributed to the requirement to treat flushed ARD, whereas the spring use of lime is attributed to maintaining a pH at optimum in the treatment ponds during the inputs of large, neutral pH freshet water.

- Monthly environmental lime consumption numbers are really reflective of monthly effluent volumes and not of mill throughput, as monthly tonnage does not change significantly.

- For example, MFO uses 3 times the amount of lime per tonne in November as compared to August due to effluent volumes, not changes in tonnes milled.

Lime Consumption Economics

Rationale:

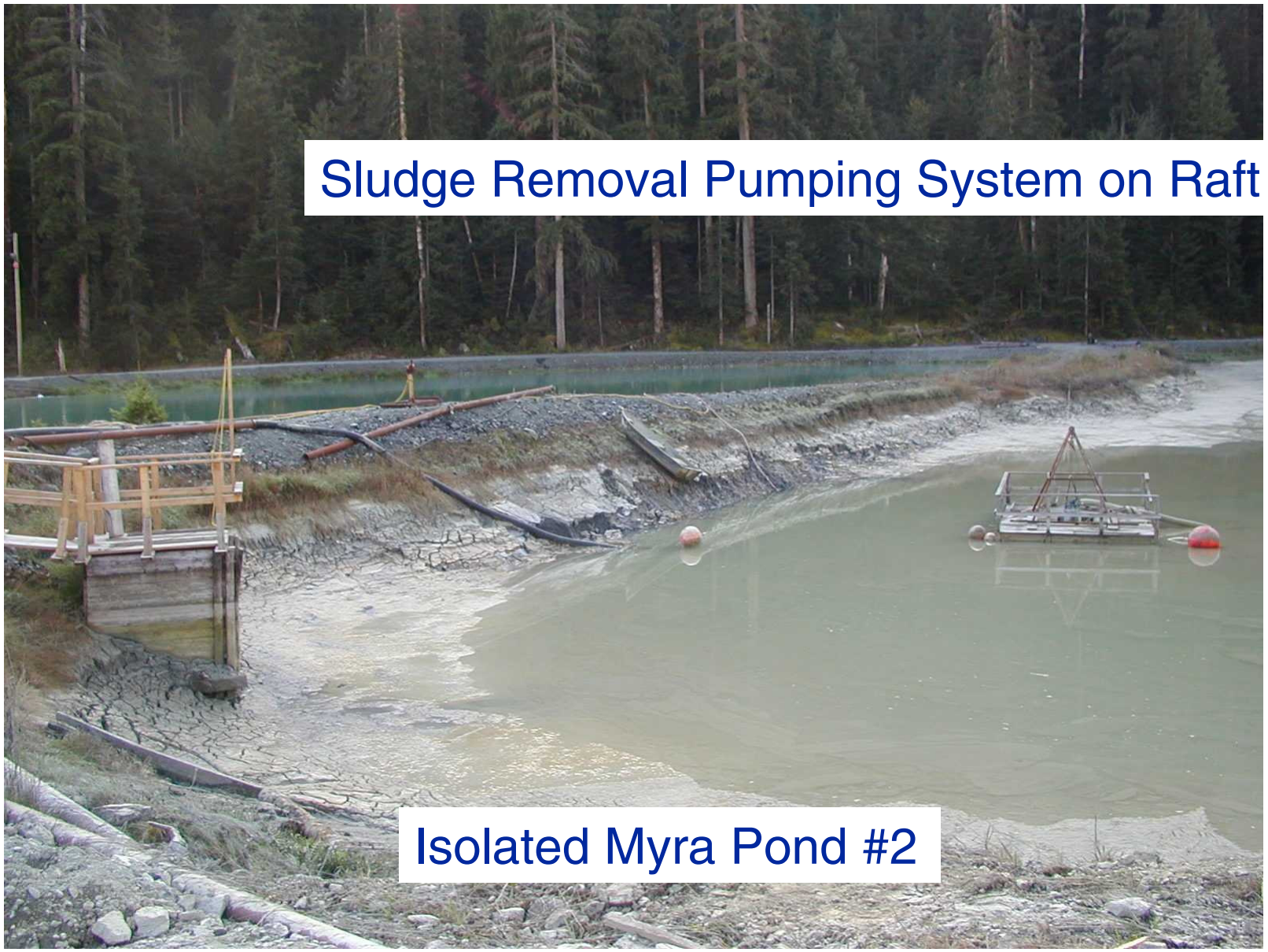
- **In 2002, lime cost $0.11/kg. ($110/T) delivered to minesite (bulk pneumatically unloaded).**
- **8-year mean consumption is 830,000 kgs/yr.**
- **Equals approx. $91,300/year in lime water treatment costs**
- **Thus, a conservative $100,000 per year lime cost for water treatment is reasonable to expect in closure conditions**

Reaction Tanks above Superpond

All inputs need to above lime reaction tanks – some downstream inputs require pumping or pipe re-location

Downstream vs. Upstream Inputs to System

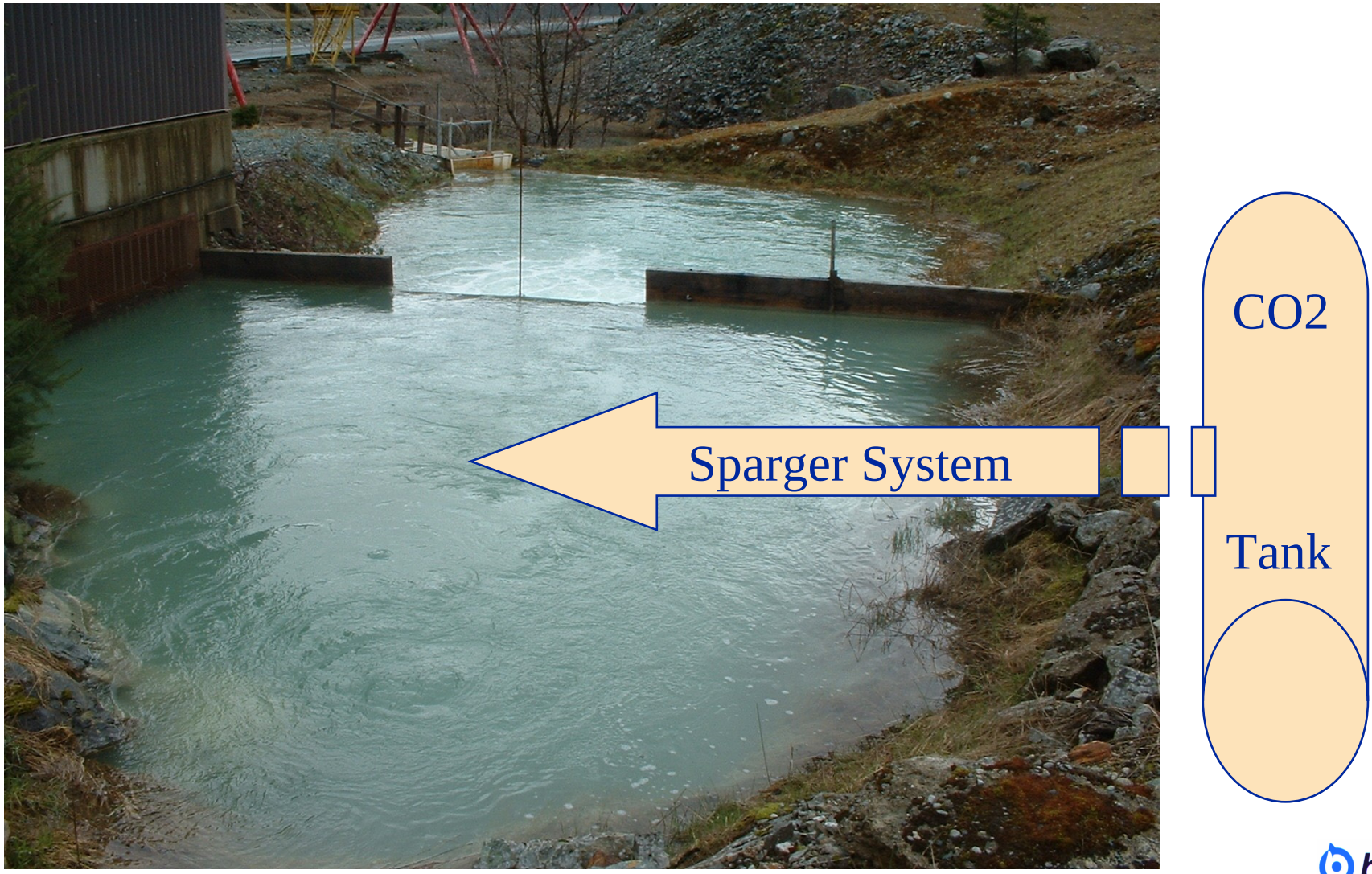
	Input Name	% of Total Flow	Location of Input
	# 3 Pump Discharge	25.00%	Upstream
	# 4 Pump Discharge	21.00%	Upstream
	Lynx 10L Discharge	19.00%	Upstream
*	**Paste Plant Discharge**	**10.90%**	**Downstream**
	80'/Mill Overflow	9.00%	Upstream
*	**Myra Mine to Myra Ponds**	**6.00%**	**Downstream**
*	**HW Inflow to Myra Ponds**	**4.50%**	**Downstream**
	Lime Slaker Discharge	3.00%	Upstream
	Lynx Open Pit	1.60%	Upstream
*	**No. 25 Sump O/F**	**0.03%**	**Downstream**
*	**ARD Pipe from Waste Rock**	**0.00%**	**Downstream**
	Total Discharge	**100.0%**	
*	**% Downstream**	**21.43%**	


Sludge Removal Pumping System on Raft
Isolated Myra Pond #2

Paste Plant

Plant producing a 65-70% solids paste tails product

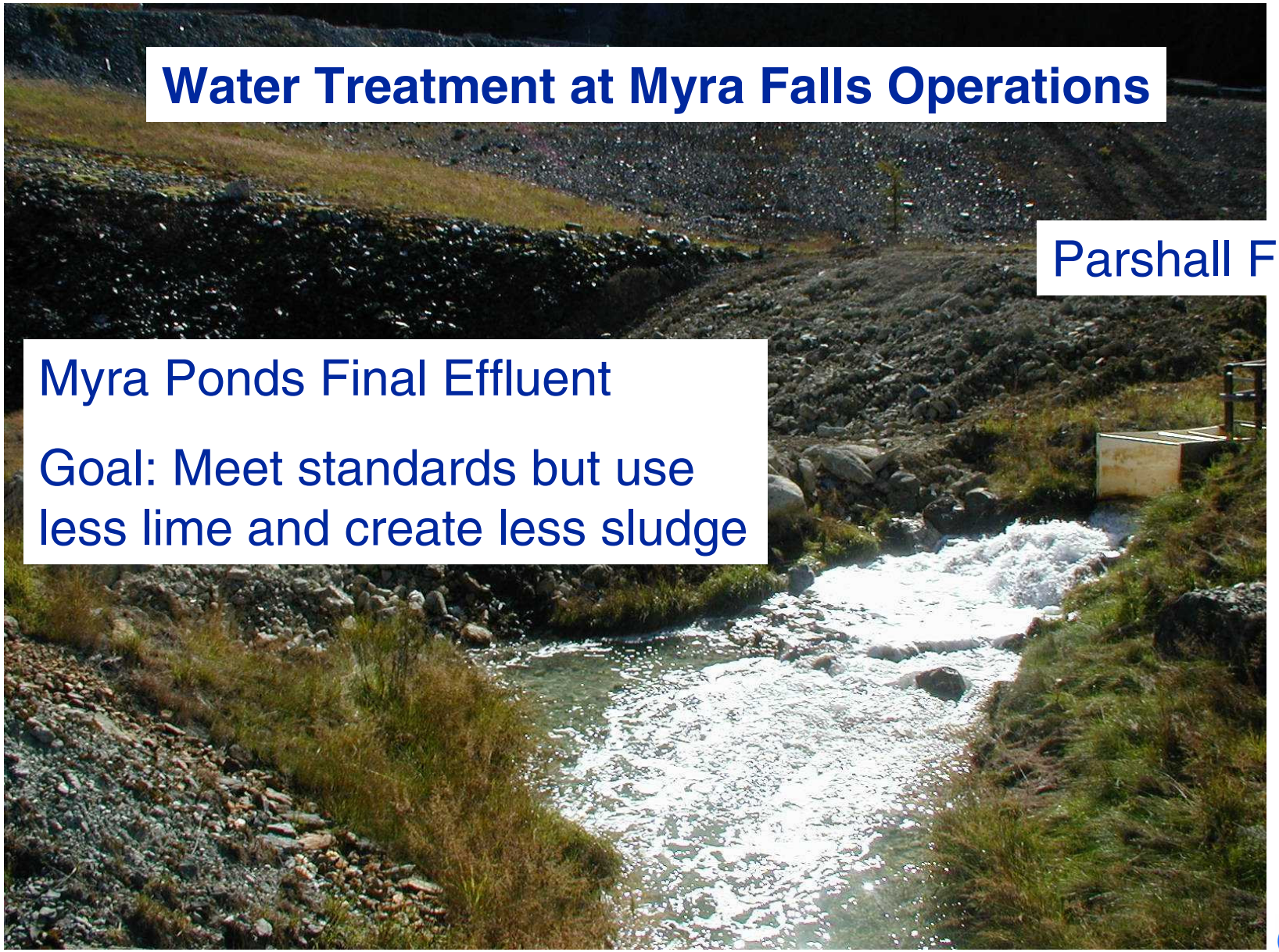
Possible Future CO2 injection site



Ponds Improvements Considered

- Move/pump downstream inputs to above Lime Reaction tanks: (HW U/G, Myra Mine, Paste Plant O/F, and ARD Pipe)
- Re-circulate pond sludge (perhaps 5%) to the head of the water treatment ponds to act as “seed” material.
- Integrate pond sludge into Paste tails product
- Improve monitoring, add more pH sensors, flow sensors and TDS monitoring systems
- Re-locate CO2 injection system to final discharge location
- Improve the Lime Reaction tank mixing (new larger tanks and mixers)
- Optimize Lime Slaker temperature range (71 to 85C)

Benefits - Reduce lime required and sludge created


Water Treatment at Myra Falls Operations
Parshall Flume
Myra Ponds Final Effluent
Goal: Meet standards but use less lime and create less sludge