
teckcominco
KIMBERLEY OPERATIONS
Post Closure ARD Collection & Treatment

Introduction

- Brief History of Operation
- Overview of the Site
- Reclamation Activities to Reduce and Collect ARD at the Mine and Mill
- Mine Filling/Dewatering
- Water Quality changes since Closure
- Post Closure Water Treatment
  - Operating strategy
  - HDS process and improvements
  - Operating Performance

History of Operation

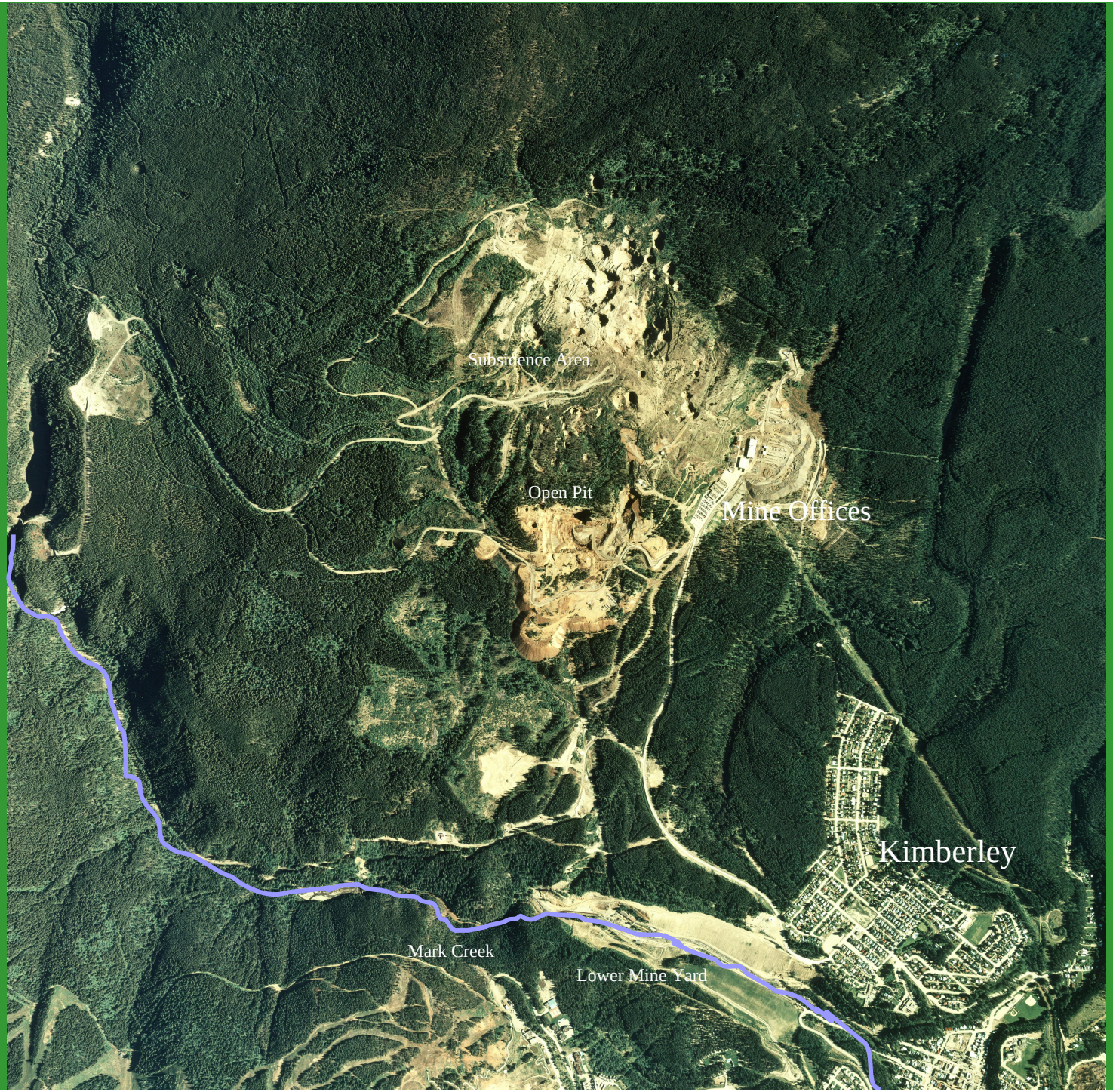
- 1892 - Discovery of the Sullivan Mine
- 1909 - CM&S, now Teck Cominco, gained control
- 1923 - Concentrator commenced operation
- 1925-1949 - Production increased from 2300 tons/day to 10,000 tons/day

History Of Operation

- 1952 - Open pit mining commenced
- 1953 - Fertilizer plant commenced operation
- 1961-1972 - Pig iron and steel plants operated
- 1969 - Reclamation legislation enacted

History Of Operation

- 1979 - Drainage Water Treatment Plant commissioned
- 1987 - Fertilizer Plant shutdown
- 1991 - Closure Plan developed
- 2001 - The doors closed Dec. 21, 400 people laid off.
- 2003 - 10 Employees


Subsidence Area
Open Pit
Mine Offices
Kimberley
Mark Creek
Lower Mine Yard


Kimberley
Sullivan Concentrator
Siliceous Ponds
Active Pond
Old Iron Pond
Gypsum Ponds
Caldine Ponds
Marysville
Water Treatment Plant
St. Mary River
Sludge Pond

Reclamation Activities to Reduce and collect ARD at the Mine

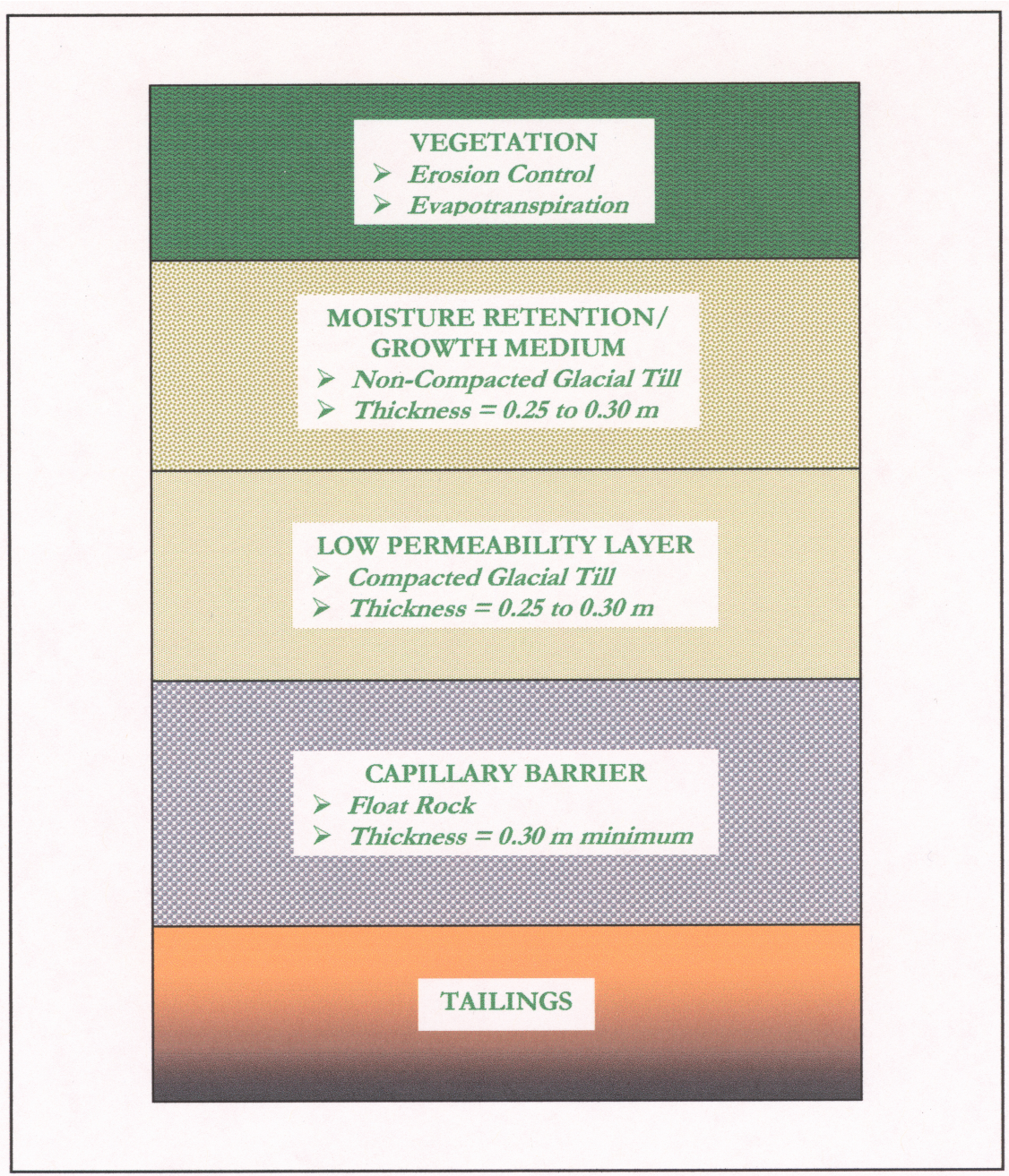
1. Move Open-pit waste dump back into the Pit and cover with glacial till.
2. Remove buildings. Re-profile #1 Shaft Waste Dump and cover with glacial till. Collect seepage in a toe drain connected to the Mine Line.
3. Installed concrete flume in Mark Cr. to isolate ARD.

Reclamation Activities to Reduce and collect ARD at the Mine

4. Re-profiled waste dumps in LMY and cover with glacial till.
5. Collect seepage in a toe drain along the North Waste Dump into a pump sump.
6. Aquifer dewatering pumps.
7. Along the South Waste Dump vertical drains to divert a perched aquifer into the deep aquifer.

Reclamation Activities to Reduce and collect ARD at the Mill

1. Cover tailings areas with glacial till to reduce infiltration.
   a) ARD generating tailings is covered with a complex cover of float rock and glacial till.
   b) Non-ARD generating waste covered only with glacial till.
   c) Near concentrator re-located concentrations of high sulphide materials to the tailings area.

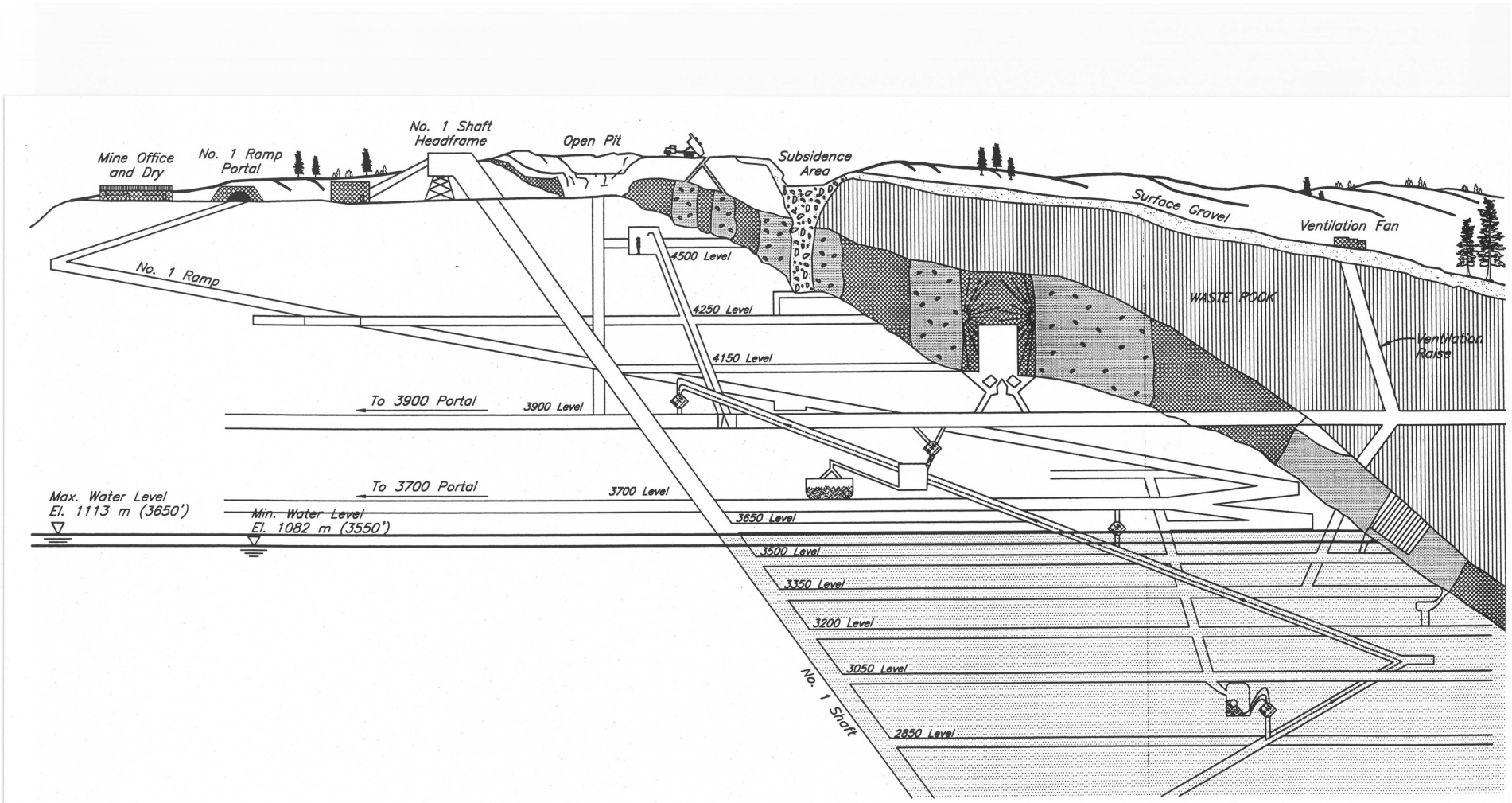


Soil Cover System for Tailing Impoundment Reclamation

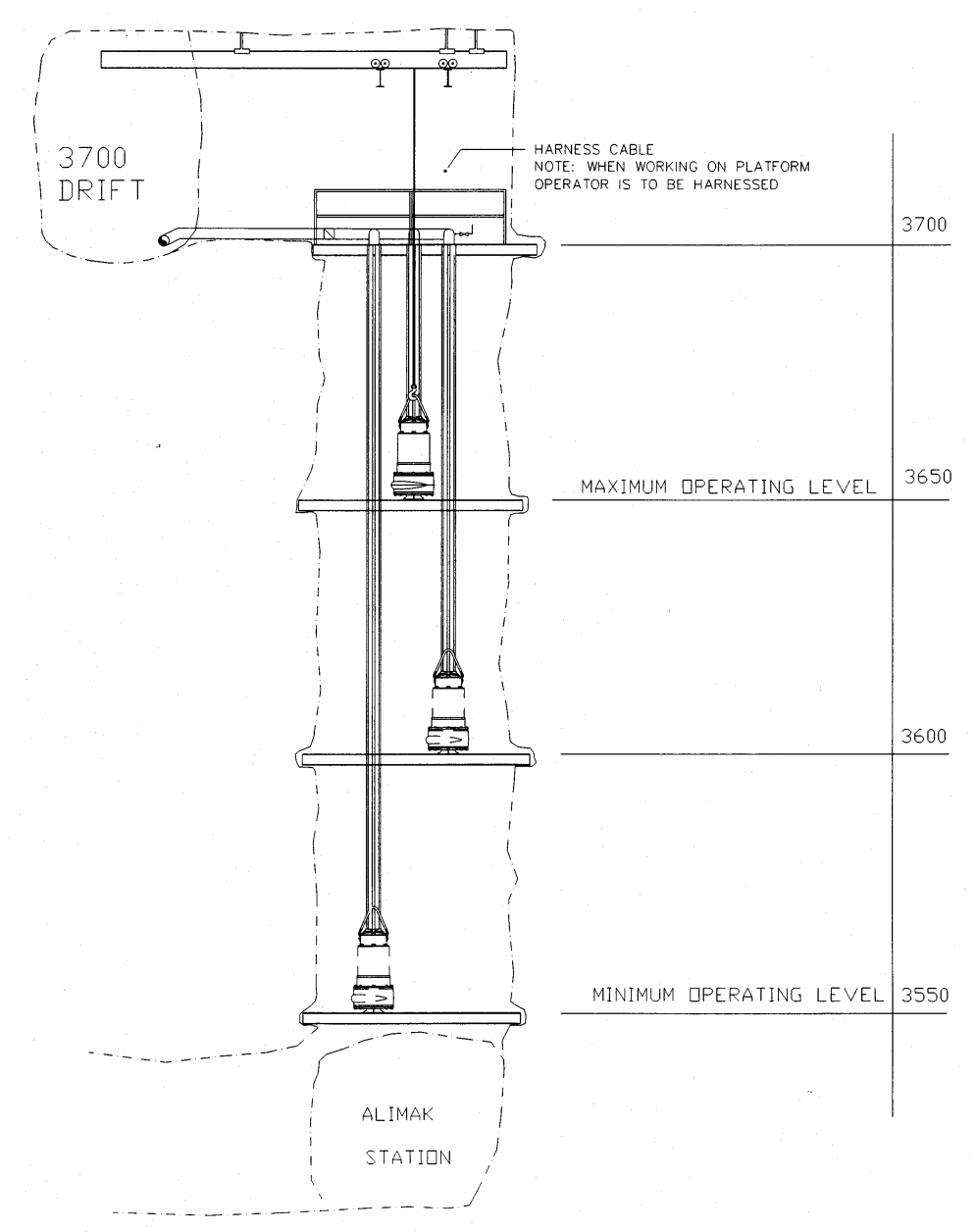
Reclamation Activities to Reduce and collect ARD at the Mill

2. Seepage from the various ponds is collected and pumped to the ARD Storage Pond.
3. The former “Active” Tailings Pond is now used for emergency storage.

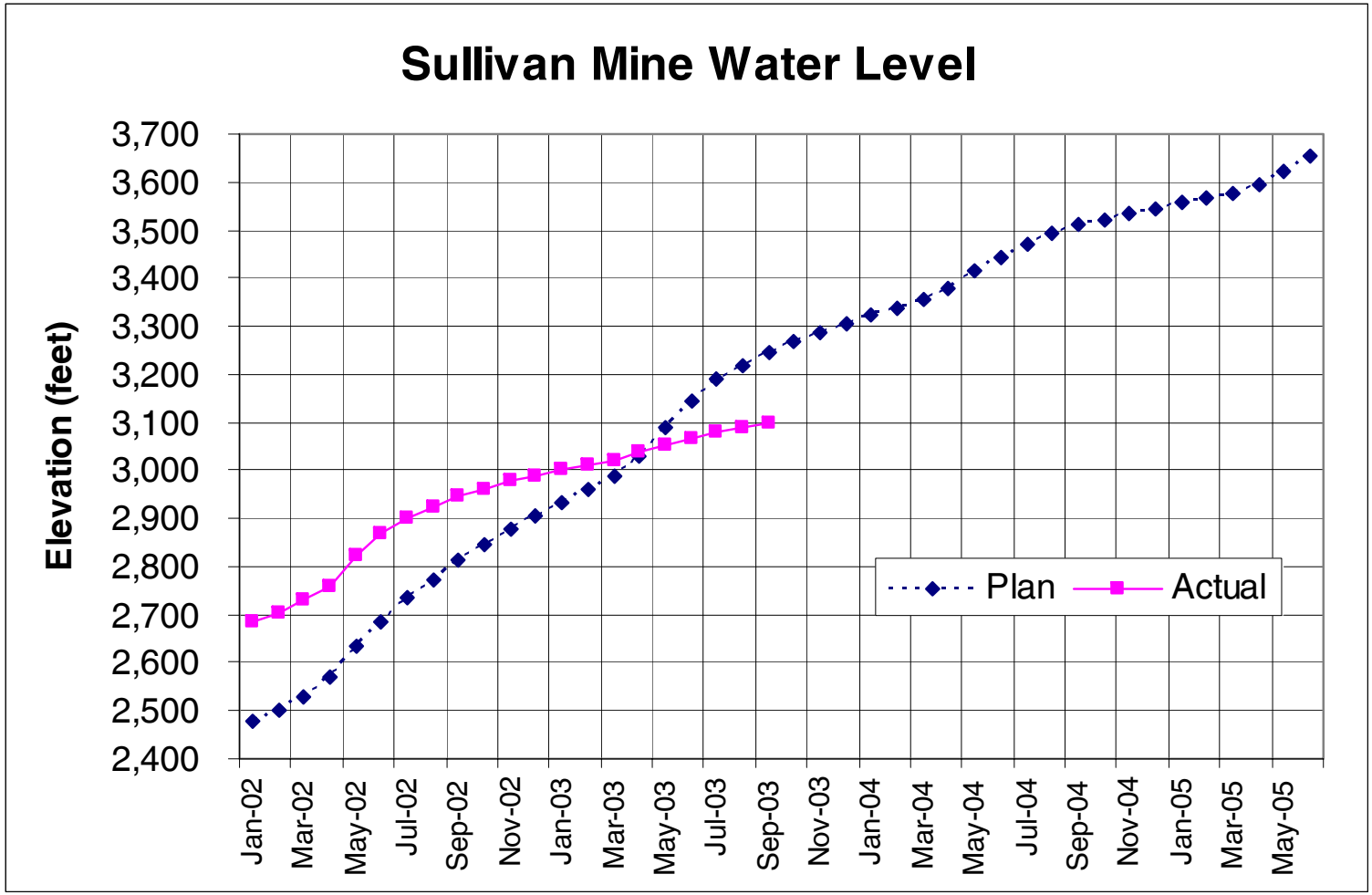
Cross-Section of the Sullivan Mine



Detail of Pump Raise

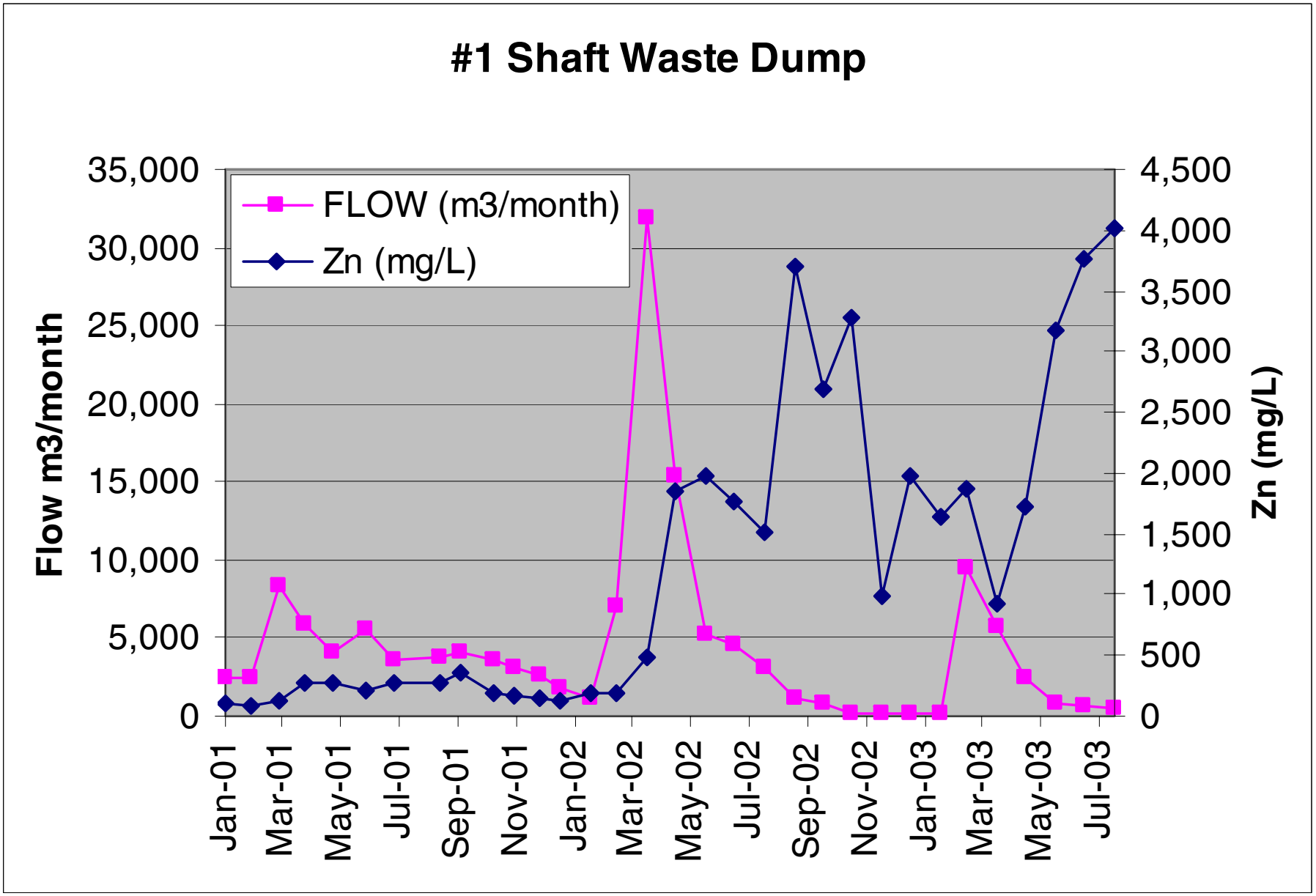


Mine Filling and Dewatering

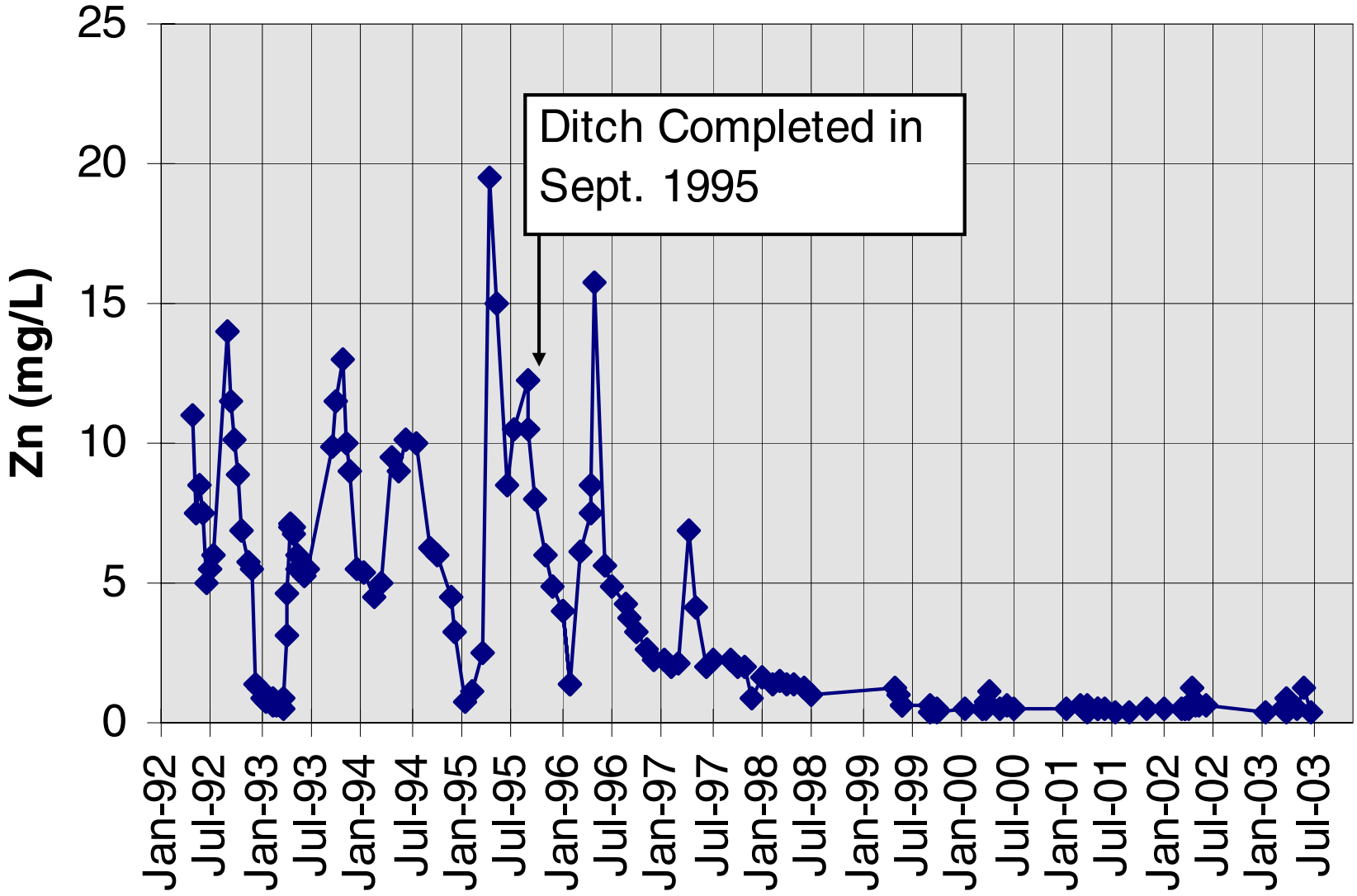


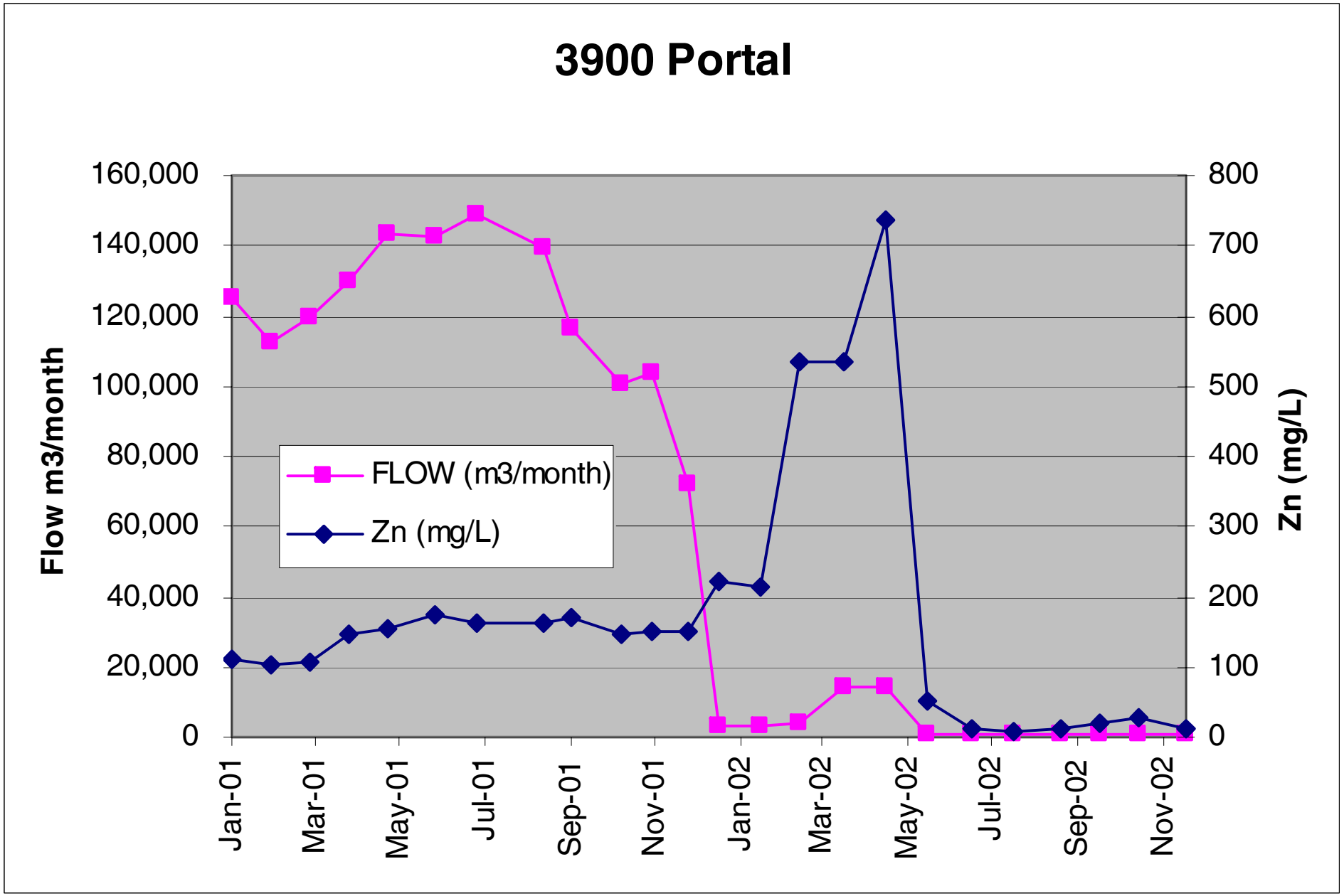
Water Quality Changes since Closure

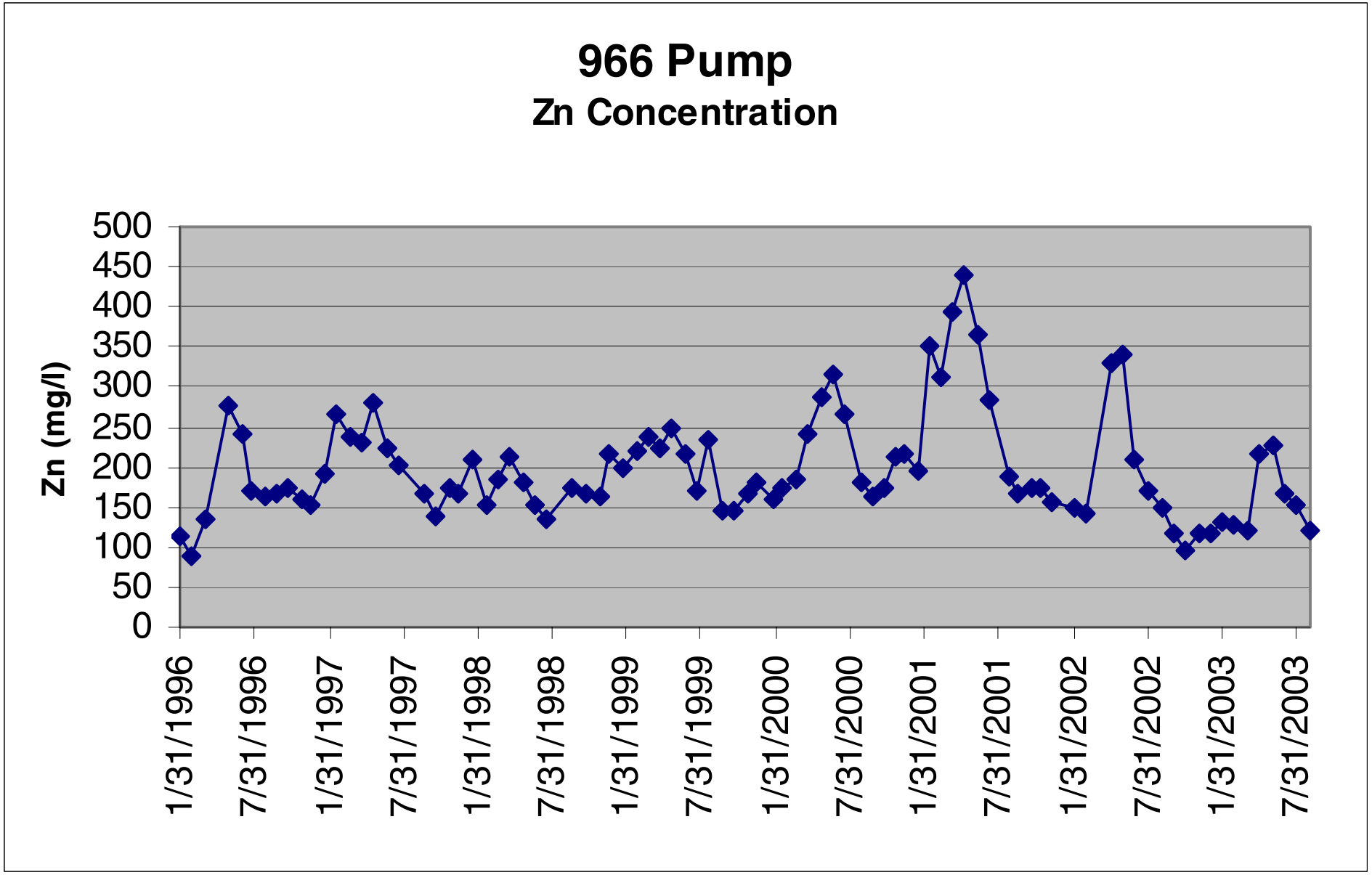
- No. 1 Shaft Waste Dump
- Lois Creek
- 3900 Portal
- 966 Aquifer Pump
- Mark Cr.
- DWTP Feed

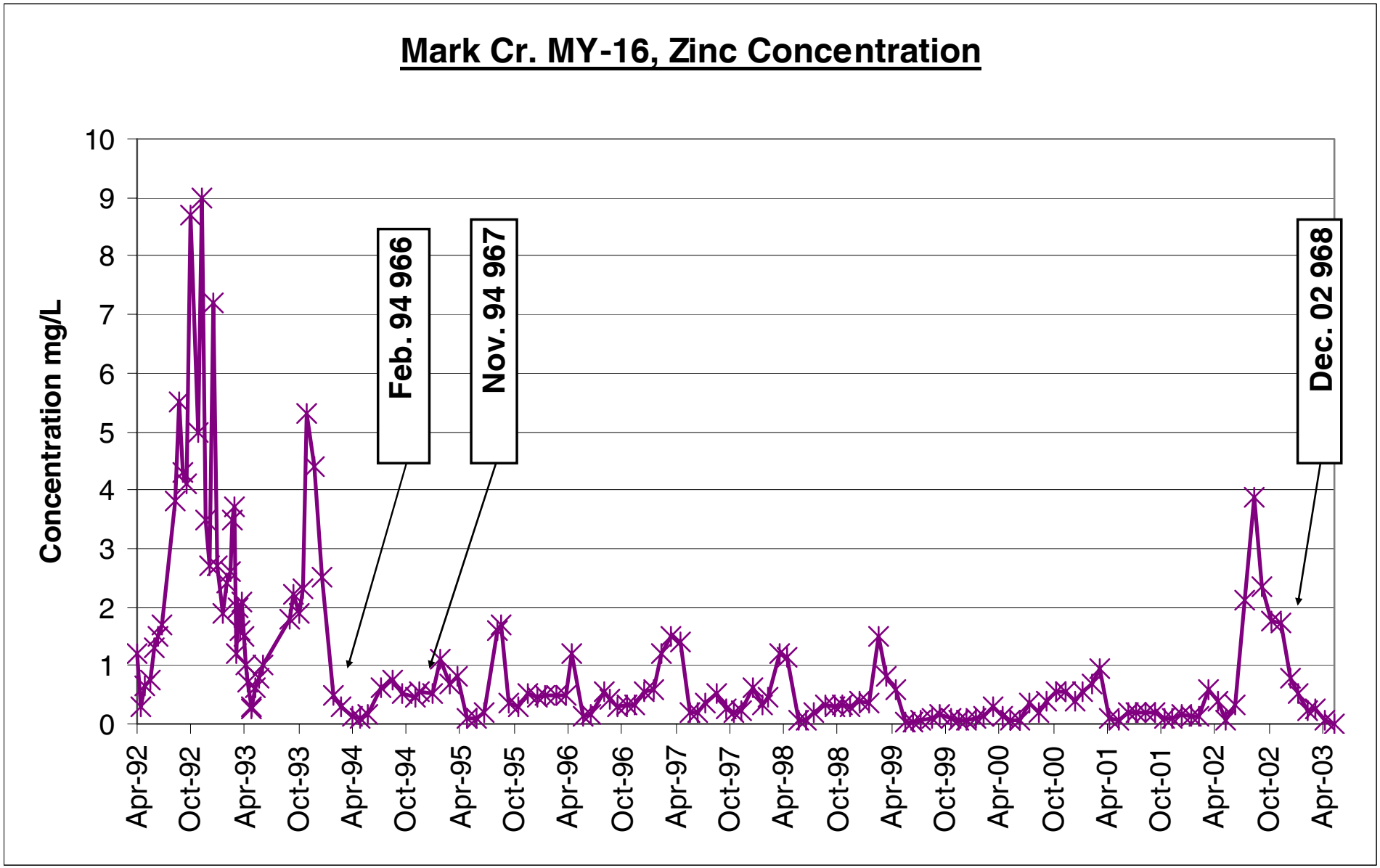

#1 Shaft Waste Dump
FLOW (m3/month)
Zn (mg/L)
Flow m3/month
Zn (mg/L)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-01
Mar-01
May-01
Jul-01
Sep-01
Nov-01
Jan-02
Mar-02
May-02
Jul-02
Sep-02
Nov-02
Jan-03
Mar-03
May-03
Jul-03

Zinc Concentration in Lois Creek




3900 Portal
Flow m3/month
Zn (mg/L)
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
800
700
600
500
400
300
200
100
0
FLOW (m3/month)
Zn (mg/L)
Jan-01
Mar-01
May-01
Jul-01
Sep-01
Nov-01
Jan-02
Mar-02
May-02
Jul-02
Sep-02
Nov-02


966 Pump
Zn Concentration
Zn (mg/l)
500
450
400
350
300
250
200
150
100
50
0
1/31/1996
7/31/1996
1/31/1997
7/31/1997
1/31/1998
7/31/1998
1/31/1999
7/31/1999
1/31/2000
7/31/2000
1/31/2001
7/31/2001
1/31/2002
7/31/2002
1/31/2003
7/31/2003


Mark Cr. MY-16, Zinc Concentration
Concentration mg/L
10
9
8
7
6
5
4
3
2
1
0
Feb. 94 966
Nov. 94 967
Dec. 02 968
Apr-92
Oct-92
Apr-93
Oct-93
Apr-94
Oct-94
Apr-95
Oct-95
Apr-96
Oct-96
Apr-97
Oct-97
Apr-98
Oct-98
Apr-99
Oct-99
Apr-00
Oct-00
Apr-01
Oct-01
Apr-02
Oct-02
Apr-03

DWTP Feed

	pH	Pb mg/L	Zn mg/L	Fe mg/l	SO4 mg/l
2000	4.4	3.9	48	155	1,972
2001	4.3	2.2	37	106	1,616
2002	3.0	0.7	119	293	2,953
2003	3.0	0.2	83	348	2,948

Post Closure Water Treatment
Operating Strategy

- Two reservoirs: the mine and surface pond
- Spring and Fall Operating periods
  - Flow rate to minimize impact on St. Mary R.
- Operating period 7 weeks in the spring and 4 weeks in the fall.

Post Closure Water Treatment
HDS Process and Improvements

- High Density Sludge Process
  - Lime neutralization (pH 9.4)
  - Sludge Re-cycle (RR 15-20)
  - Iron Oxidation
  - Flocculation/Clarification

Post Closure Water Treatment
HDS Process and Improvements

- Improvements
  - Sludge conveyor installation
  - Redundant mass flow measurement on sludge recycle
  - Redundant Lime flow measurement
  - Redundant flocculant flow measurement
- Presently manning the plant 16 hrs/day and looking to reduce further.

Post Closure Water Treatment
Operating Performance

- Peak TSS on start-up 5 - 10 mg/l
- Normal operating TSS 3 - 6 mg/l
- LT50 96 Hour – 100% Survival in undiluted effluent

Post Closure Water Treatment
Operating Performance

	Effluent	Permit	MMER		% of Permit
	mg/L	T mg/L	Grab	Monthly	%
TSS	4	30	30	15	13
pH	9.4	8 - 10	6 - 9.5	6 - 9.5	
Ammonia	0.8	8			10
As	<0.001	0.05	1.0	0.5	<2
Pb	0.004	0.25	0.4	0.2	1
Zn	0.31	0.8	1.0	0.5	39
Fe	0.82	5			16
F	3	6			50
Cu	0.004	0.05	0.6	0.3	8
Cd	0.001	0.002			60

Post Closure Water Treatment
Operating Performance

	Influent mg/L	Effluent mg/L	Metal Removal %
Pb	0.6	0.004	99.4
Zn	112	0.312	99.7
Fe	290	0.820	99.7
Mn	35	0.290	99.2
Cu	0.3	0.004	98.6
Cd	0.3	0.001	99.6

Post Closure Water Treatment
Operating Performance

DWTP Reagent Usage/Sludge Produced

	Lime gm/L	Flocculant gm/m^3	Sludge Produced gm/L
1999	0.57	1.20	0.89
2000	0.49	1.19	0.76
2001	0.33	1.61	0.50
2002	0.95	2.04	1.36
2003	0.80	1.68	1.21

Closing

Historical mining practices have resulted in an ARD generating mine site where efforts have been made to mitigate the generation of ARD and to collect and treat ARD in perpetuity.