Proceedings of the 13th Annual British Columbia Mine Reclamation Symposium in Vernon, BC, 1989.
The Technical and Research Committee on Reclamation

WATER MANAGEMENT AT BRENDA MINES

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Brenda Mines is *a* low grade copper molybdenum mine located *18* miles north of Peachland, B.C. Work started on the mine construction in 1967 and it officially opened in April 1970. The mine was designed for 24,000 tons per day throughput and the first year's grade was 0.216% copper and 0.064% molybdenum.

At present it is handling nearly 34,000 tons per day with a grade of 0.18% copper and 0.030% molybdenum. The stripping ratio has been approximately 0.6. As of the end of 1988 200 million tons were processed through the mill and delivered to the tailings complex and there are 118 million tons in our waste piles.

When the mine was planned it was decided that the tailings system would be close-circuited, i.e., no tailings water would be released outside the mine area. Initially, the fresh water requirements were estimated to be in the 3,600 USGPM range. While this figure was later reduced considerably the system was designed for this figure.

During the design and construction stage, major emphasis was placed on the tailings complex. At that time (1966 1970) very little was known of problems with rock pile drainage, and what was known dealt with acid mine drainage and high sulphide rock. Since the water above Brenda was and is basic and the rock contained very little sulphide, this was not felt to be a problem. As well, few people, if any, knew that ANFO left traces of nitrate in the blasted rocks. For these reasons rock pile drainage water was allowed to flow into the nearby stream. Even so, the rock pile water was well within any existing standards. Figure 1

This slide shows how the objectives or recommendations for molybdenum and dissolved solids, which are our major problems, have changed over the years.

The mine as it was designed would have met and would still meet the objectives in existence in its early years of operation.

Figure 2 shows the original water courses in relation to the location of the pit and the areas that were to be used for waste rock piles.

As can be seen, the north fork of Peachland Creek went through the pit. It was relocated so that it flowed into the south fork. MacDonald Creek and Long Creek were left in their locations and rock drains were constructed in their beds so that water would continue to flow through them. Originally the water from both these creeks flowed into Trepanier Creek. Because of the need for water in Peachland Lake these creeks were diverted into Peachland Creek.

Peachland Creek originally flowed around Peachland Lake. A ditch approximately 400 yards long and over 50 feet deep was dug to divert Peachland Creek into the lake. The diversion structure that was built just upstream of this ditch allowed the mine to divert Peachland Creek water either into the lake, into its original course, or into both.

A dam was built on Peachland Lake that is 1,400 feet long and 90 feet high in the centre. This dam raised the storage capacity in the lake from approximately 1,000 acre feet to 9,500 acre feet and more than tripled its area. The lake had to supply both the mine and Peachland Irrigation District.

It was felt at that time that more water would be needed than Peachland Lake could supply. The plan called for a dam on Crescent Lake with a canal to be built to carry water into Peachland Lake. With the reduction in water requirements the Crescent Lake Dam was never built and the Crescent Canal has only been used two or three times to carry several hundred acre feet of water into Peachland Lake.

During the 1970's ditches and small dams were built and pumps and pipes installed around the northern perimeter of the pit to reduce the amount of water that was flowing into the pit. As the pit deepened, pumping stations were installed in the bottom of the pit. During this period water sampling and analysis was carried out as required by the Pollution Control Board.

In the late 1970's a great deal of work was carried out by W. Chappel and his associates on molybdenum in Colorado specifically, and the world in general.

The molybdenum level had been rising in Peachland Creek where it entered Peachland Lake, particularly during spring run-off. In 1978 it was 4.5 ppm, although Peachland Lake only rose to 0.2 ppm.

In mid-1978, presumably because of the above factors, the Pollution Control Branch requested that. Brenda construct a diversion system so that water containing molybdenum be diverted to the tailings pond.

During 1978 and 1979 we constructed what was known as our Long Lake Diversion System. This system was designed to divert all possible water away from our rock piles. Any water containing molybdenum went to the tailings pond. This was done in normal fashion - small dams, pipes, ditches, etc., These are shown in Figure 3.

After this work was done the molybdenum level of water entering Peachland Lake dropped from 4.5 ppm to .04 ppm. However, as we all know, Murphy's Law exists at all times and for every action there is a reaction. This reaction took several years to

appear. From the start of the mine we had the tailings pond surveyed and the amount of free water calculated. In 1970 this was 1,000 acre feet. During the 1970's the amount rose but stayed in the 2,500 to 3,000 acre feet area/ its rise or fall apparently dependent on precipitation, spring run-off, and evaporation. With rock pile and pit water now going to the tailings pond the free water started to rise steadily. In August 1979 it was 2,900 acre feet. By August 1983 it was 8,050 acre feet. See Figure 4. However, the combination of increased pond area and dam building allowed us to maintain a satisfactory beach and dam height.

At this point a short description of our tailings dam is necessary. This dam is large - 6,000 feet long, 400 feet high, and 1,200 feet wide at the base and is constructed entirely of double cycloned sand. This sand was spigotted into cells that *were* built up using D-6 dozers. The dam was completed in June 1986. While the cells were being built, all possible construction water was piped back into the pond. However, in some cases all this water went into the dam.

The dam has four finger drains which collect construction water, precipitation water, and water that seeps through the beach and releases it to our lower reclaim pond. There it is collected and pumped back to the tailings pond.

In 1983 the economics for copper mines was very poor and had been for several years. It was decided to shutdown the mine on September 30, 1983, until conditions improved.

In the summer of 1983 we were pumping approximately 2,800 GPM or 380 AC feet per month of water from the lower reclaim pond back to the main pond. Since construction water was at least 4,000 GPM we felt that the great majority of this water was construction water and that there was very little water stored in the dam itself.

This was a major error. The above rate continued for several months. From our present knowledge we feel that there was at least 2,000 acre feet of water stored in the dam prior to shutdown. At shutdown we had a freeboard of 10 feet or more and a pond area of about 300 acres. It was evident in December that we were in trouble. It was expected that the water would reach the dam prior to spring run-off. During spring run-off the water normally rose five feet or more. This combination was a definite threat to the structural integrity of the dam and we had no other choice but to release water into Okanagan Lake.

Our problem at that time was how to release water with minimum damage to the environment. Our major problem was that there were domestic water systems on both Peachland and Trepanier Creeks.

The reason that Peachland Creek was chosen as a passage for water to Okanagan Lake was that its domestic intake had a storage volume of several acre feet while the storage of the Trepanier system was negligible. We modified the Peachland Irrigation intake as follows. Figure 5.

1. Built *a* sand bag dam in the creek just above the storage area.

2. Installed a short 34" pipe through the above dam.

3. Installed approximately 1,100 feet of 34" pipe through the above dam that discharged below the domestic intake pond.

4. Valved both pipes.

5. Installed a 24" pipe from our reclaim tank on the minesite into the MacDonald diversion so that water could be sent into Peachland Creek below Peachland Lake. See Figure 2.

Our operating procedure was as follows:

1. Fi11 the domestic reservoir with fresh water.

2. Pump tailings pond water at the rate of 14,000 GPM into upper Peachland Creek around Peachland Lake and thence downstream.

3. This water was then diverted around the domestic intake and into Okanagan Lake.

4. When the water in the domestic intake dropped we stopped pumping tailings water and opened the valve allowing water from Peachland Lake to flush out the stream bed.

5. The Ministry of Environment then checked the water quality and when it was satisfactory we refilled the domestic reservoir.

6. This cycle started February 22 and was repeated seven times until April 15 when spring run-off threatened to overtop our small sandbag dam.

We released over 2,000 acre feet of water.

This was accomplished with minimal damage to the environment but not without a tremendous outcry from the public. During this period we realized that we had to do everything possible to reduce the amount of water going into our tailings pond. The first item was to build drainage ditches around the tailings pond and use two pumping stations to carry all spring run-off water away from the pond. The second item was to see if we could reduce the amount of fresh water used on the minesite.

With the complete cooperation of all personnel we looked at where we could use rockpile or tailings water instead of fresh water. As well, we found areas in which water could be used twice. An example of this is in using the cooling water in our air compressors for process water. One method that was a little different was to pump rock pile; water into our fire water tank and use it as much as possible. The result of these efforts reduced our fresh water usage from 1,000 GPM to 600 GPM. These efforts plus help from nature (low snowpacks, warm weather) the free water in the tailings has been reduced from high of 10,280 acre feet in 1986 to 7,930 acre feet in 1988.

Since 1984 we have been carrying out fine tuning on our diversion ditches so that we minimize the inflow of fresh water into the rock piles and tailings pond.

We are still operating on the principle that so called "moly water" cannot be released and must go to the tailings pond. Our present major efforts are based on how to handle our moly water when the mine ceases operation 1990.

In conclusion, I would like to mention some statistics on the Brenda Mine operation. While our actual disturbed area is approximately four square miles, or 2,500 acres, and we operate in an area of approximately six square miles we have provided 20 years work for 400 people with wages and benefits of over $190 million. Based on disturbed area this works out to be $76,000 per acre. I feel that this mining operation made good use of the land and was a great asset to the economy of the province.

RBPRES.MO3
March 1989
RB/gm

POLLUTION CONTROL OBJECTIVES IN PPM

1973 OBJECTIVES	1979 OBJECTIVES	1986 PROPOSALS
FRESH WATER DISCHARGE	FRESH WATER DISCHARGE	
MOLYBDENUM	**MOLYBDENUM**	**MOLYBDENUM**
C B A	RANGE	DRINKING WATER
10.0 1.00 0.50*	0.5 TO 5.0	0.25
		IRRIGATION
		<0.10
TOTAL DISS.SOLIDS	**TOTAL DISS.SOLIDS**	**TOTAL DISS.SOLIDS**
C B A	RANGE	DRINKING WATER
<5000 <3500 <2500	2500 TO 5000	<500

C - EXISTING SHOULD PRESENTLY MEET

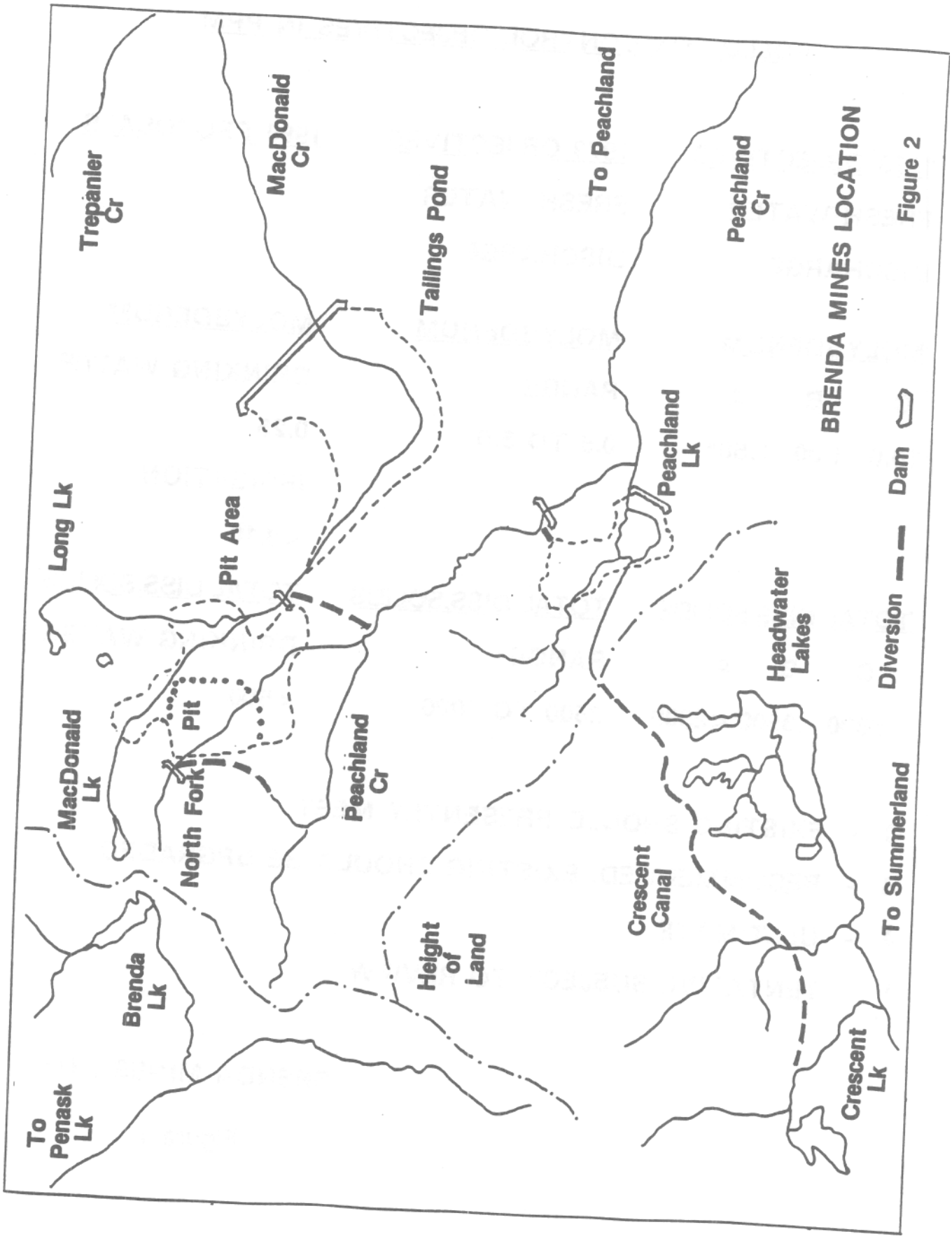
B - RECOMMENDED, EXISTING SHOULD BE UPGRADED

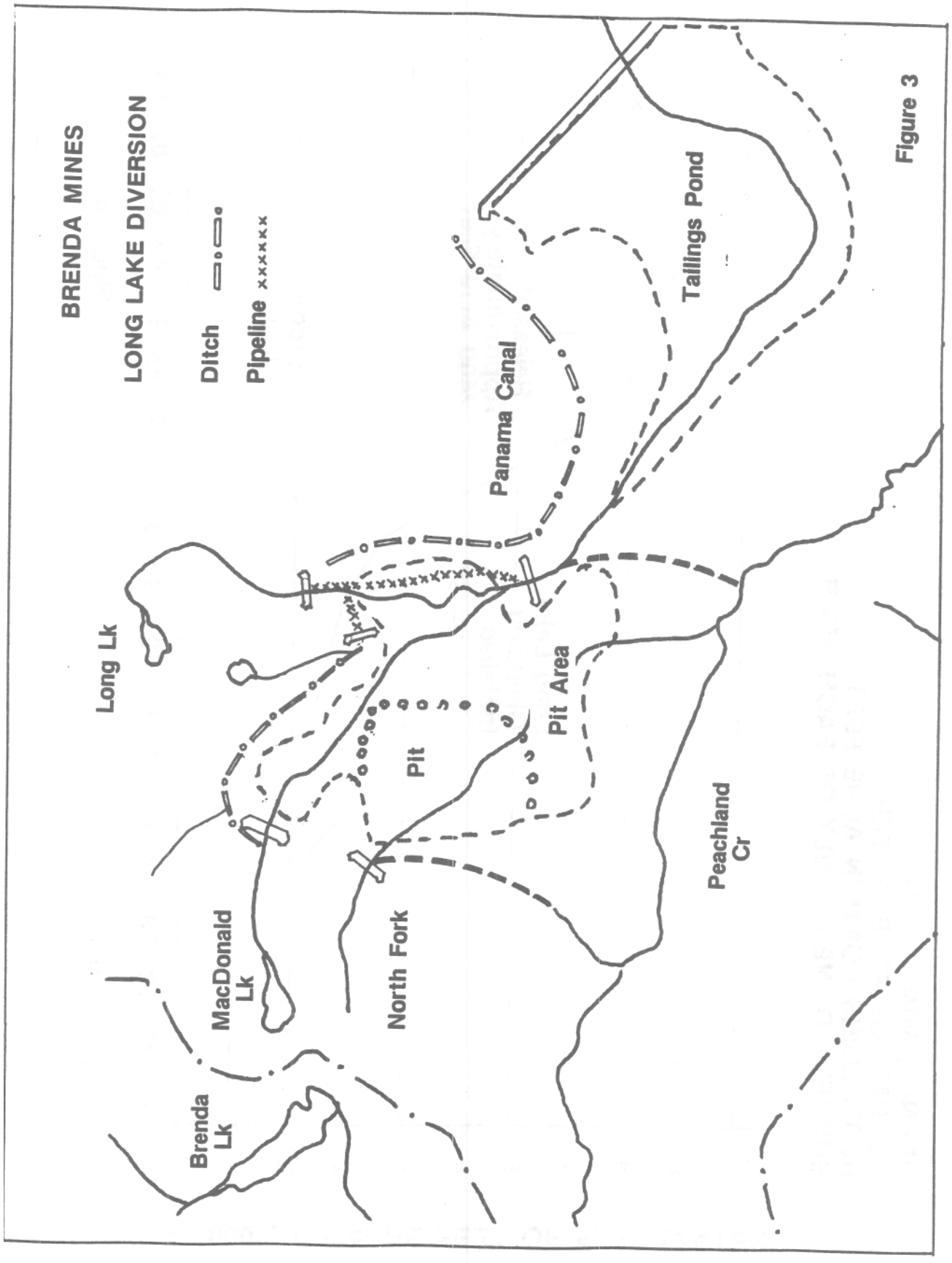
A - ULLTIMATE

* - TENTATIVE SUBJECT TO REVIEW

BRENDA MINES LTD.

Figure 1


Trepanier Cr
MacDonald Cr
Tailings Pond
To Peachland
Peachland Cr
BRENDA MINES LOCATION
Figure 2
Long Lk
Pit Area
Peachland Lk
Diversion
Dam
MacDonald Lk
Pit
North Fork
Peachland Cr
Headwater Lakes
Crescent Canal
Height of Land
To Summerland
To Penask Lk
Brenda Lk
Crescent Lk


BRENDA MINES
LONG LAKE DIVERSION
Ditch
Pipeline
Panama Canal
Tailings Pond
Long Lk
Pit
Pit Area
Peachland Cr
MacDonald Lk
North Fork
Brenda Lk
Figure 3

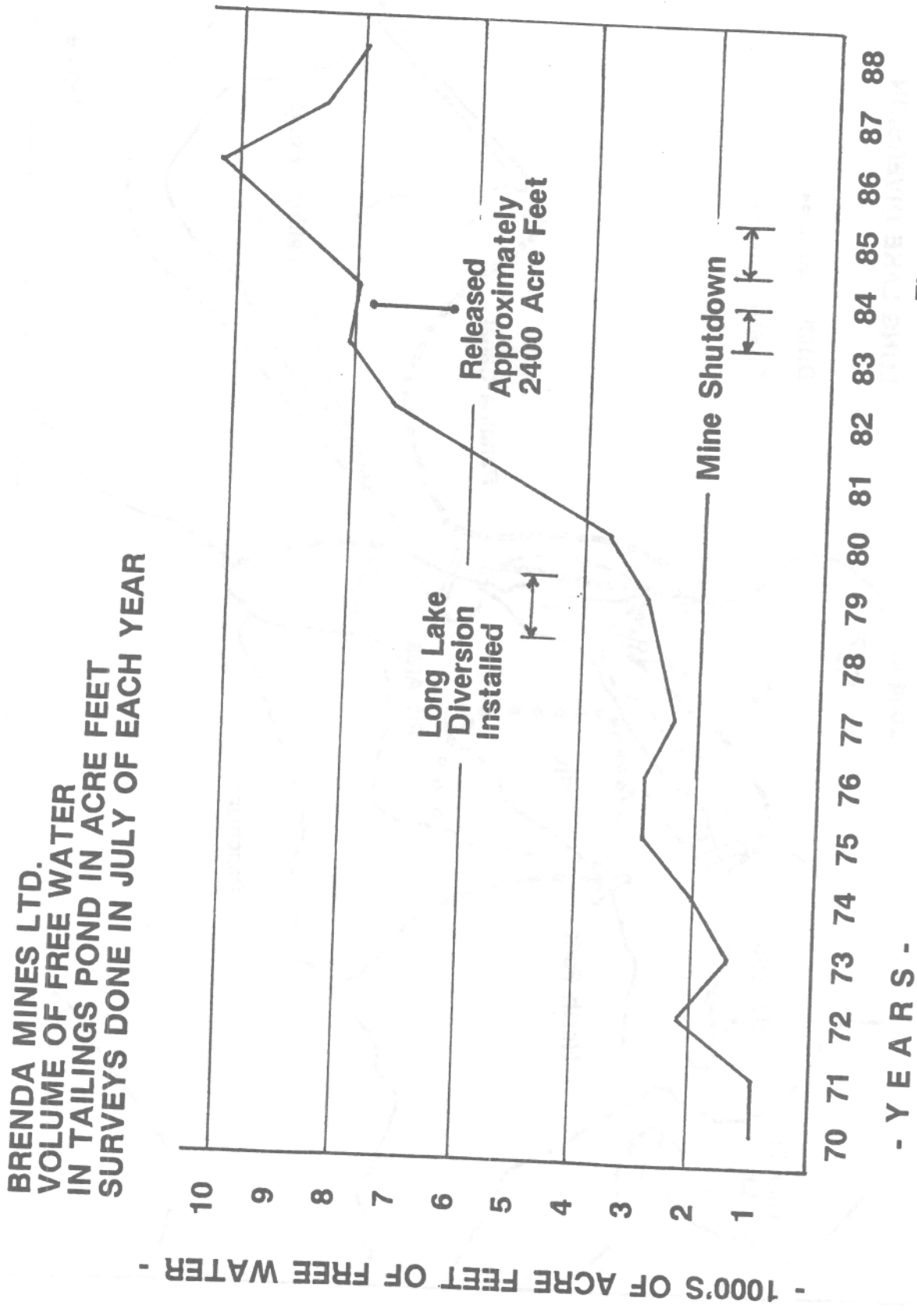

BRENDA MINES LTD.
VOLUME OF FREE WATER
IN TAILINGS POND IN ACRE FEET
SURVEYS DONE IN JULY OF EACH YEAR
- 1000'S OF ACRE FEET OF FREE WATER -
10
9
8
7
6
5
4
3
2
1
Long Lake Diversion Installed
Released Approximately 2400 Acre Feet
Mine Shutdown
70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88
- Y E A R S -

Figure 4

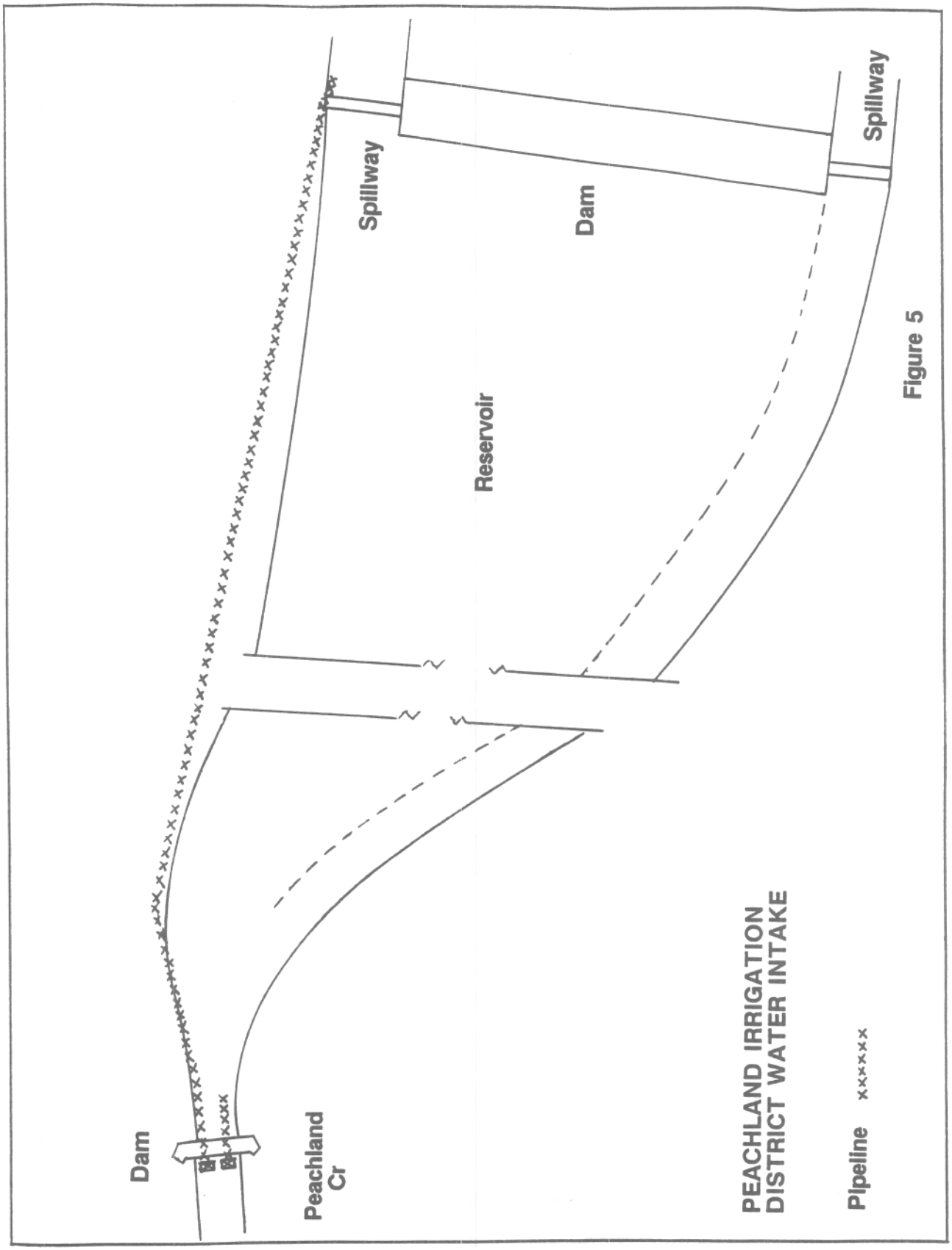

Spillway
Dam
Spillway
Reservoir
Dam
Peachland
Cr
PEACHLAND IRRIGATION
DISTRICT WATER INTAKE
Pipeline

Figure 5