CULLATON LAKE GOLD MINES LTD

FINAL ABANDONMENT AND RESTORATION PLAN

MARCH 1996

SUBMITTED TO:

THE DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT
LAND DIVISION

AND

THE N.W.T. WATER BOARD

PREPARED BY:
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1.0 INTRODUCTION AND INTENT

Homestake Canada Inc. wholly owns and controls the Cullaton Lake Gold Mines property through its Company 759290 Ontario Inc. The Company holds one water use licence (N6L2-0940), 15 mining leases and three surface leases.

The Cullaton Lake mine was in operation for approximately four years before its closure in 1985. The mine has been in a care, maintenance and decomissioning phase since September 1985. The Company has no further intention of mining or milling at the site, therefore the Final Abandonment and Restoration Plan has been developed as the Final Phase of the mining program. As outlined in the DIAND Guidelines[1], this Plan includes a description of location and type of restoration activity, an implementation plan for the restoration program and a schedule for the completion of abandonment and restoration. It is anticipated that the Company will surrender the leases to the Crown once the Abandonment and Restoration Plan is accepted and the decommissioning work completed.

The Abandonment and Restoration Plan was prepared with the intention of "restoring the land as near as possible to its original state" in accordance with the Company's leases. The Company's intent is to ensure that there will be no long term adverse environmental impacts associated with the site, that during decommissioning there will be due care to protect the water resources and wildlife, and that the rehabilitated property will eventually harmonize with the surrounding terrain.

[1]Guidelines for Abandonment and Restoration Planning for Mines in the Northwest Territories. NWT Water Board and Department of Indian Affairs and Northern Development. September 1990.

2.0 SETTING

2.1 Location and Access

The Cullaton Lake property is located at 61° 16' north latitude and 98° 30' west longitude, and is 250 km west of Arviat, Northwest Territories in the district of Keewatin, N.W.T and 670 km north of Thompson, Manitoba (see Figure 1). Access to the property is normally gained by charter air flights from Thompson or Churchill, Manitoba, to the gravel airstrip located north of the mill site.

2.2 Climate and Ecology

The property lies within the Canadian Shield in the zone of discontinuous permafrost. The landscape is barren, with no visible mountains, and is fairly flat with only minor undulations and rocky outcrops. The highest elevations on the mine property occur on a hill (Elev. 289 m) to the northwest of the gravel airstrip and on a hill (Elev. 340 m), 15 km southwest of the mine site. The lowest elevations on the property occur in a small lake (Elev. 215 m) located midway between the mine site and Cullaton Lake, and in the Kognak River. The mine site itself has an elevation of approximately 265 m. The hummocky terrain consists of either bedrock covered with shallow, surficial soils, or a bouldery glacial till cover with localized, shallow soil deposits.

The climate is characterized by low temperatures, low precipitation, strong winds and a short growing season. Although day lengths are long during the short summer, the low angle of incidence of solar radiation at this latitude keeps the temperatures cool.

The area is generally devoid of trees, except in the vicinity of large bodies of water or major rivers ie. Cullaton Lake and Kognak River, where stunted black spruce (*Picea mariana*) and willows (*Salix* spp.) grow. The higher ground is covered with tundra vegetation, predominately mosses, grasses and shrubs. Plant species identified in a 1990 inspection included Arctic Rosebay (*Rhododendron lapponicum*), Dwarf Birch (*Betula glandulosa*), Crowberry (*Empetrum nigrum*) and Bilberry (*Vaccinium ulginosum*).

The following wildlife species may be found in the general area: barren-ground cariboo, moose, black bear, grizzly bear, red fox, Arctic fox, Arctic hare, wolverine, mink, wolf, and raptor species including falcons and hawks.[2]

2.3 Hydrology

This site is characteristic of Canadian Shield topography with its numerous small lakes. Cullaton Lake is located north of the airstrip. It is one of the larger lakes in the area, covering an area of 16 km^2 . A number of small lakes lie between Cullaton Lake and the mine site, most no more than shallow depressions in the bedrock.

The area's major river, the Kognak, is located approximately 2.0 km south of the mill site. It flows in an easterly direction and drains into Hudson Bay. Mine site drainage takes place in a southerly direction toward the Kognak River.

2.4 Geology

The area lies within the Churchill Structural Province of the Canadian Shield in what is termed the Kaminak Subprovince, a Precambrian greenstone belt which extends from the Saskatchewan border to Rankin Inlet.

Two ore zones were mined in the operation, identified as the *B - Zone* and the *Shear Zone*. The B - Zone is located at the mill site and the Shear Zone is located approximately 4 km to the north (see Figure 2).

The B - Zone deposit is situated in a belt consisting of clastic sediments (turbidites), pillow lavas and iron formations. This assemblage is indicative of an eugeosynclinal environment. The B - Zone iron formation consists of four distinct facies, namely; carbonate, silicate, oxide and sulphide. The gold mineralization is confirmed in a strata bound nature to the sulphide facies iron formation. The sulphide facies is found within, or bordering, the oxide facies and ranges in thickness from 0.6 to 17 m. Pyrrhotite and pyrite are the dominant sulphides, with lesser amounts of arsenopyrite and chalcopyrite. The gold occurs free in the non-metalliferous gangue and shows no preference to one sulphide.

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[2]Watterson Lake Base Map. Land Use Information Series. Dept. of the Environment, Ottawa, 1979.

The Shear Zone is located in a discontinuous ridge outcrop of orthoquartzite. The orthoquartzite is white with variations of pink to red, fine-grained to glassy, and varies from thin-bedded to thick-bedded or massive. Typically, the orthoquartzite is composed of 97% or more quartz with only scattered sericite, feldspar and magnetite. Gold occurs in the fractured and sheared orthoquartzite on the Shear Zone property.

2.5 Land Tenure

Homestake Canada holds fifteen mining leases totalling 5,269.3 ha and three separate surface leases totalling 240.6 ha of land at Cullaton Lake Gold Mines (see Figure 3).

The surface lands under lease are not affected by the Inuit Land Claim Agreement. All obligations with respect to these leases are to the Government of Canada as represented by the Department of Indian Affairs and Northern Development.

Lease 3600 (expires 30 April 1996) encompasses 6 parcels of land totalling ±167.3 ha. The camp, mill, fuel tanks, tailings pond, and diamond drill camp are all located on this lease land.
Lease 65 G/8-1-20 (expires 30 April 1996) encompasses one parcel of land totalling ±58.4 ha. Development on this lease land includes the airport and road.
Lease 65 G/7-2-2 (expires 30 April 1999) encompasses one parcel of land and totals ±14.9 ha. The Shear Zone mine portal and associated works are located here.

Mining Leases and Surface Holdings - Cullaton Lake

Mining Lease	Lot Number/Name	Surface Lease	Lot Name
3019	1000 - B Zone 65G/8	3600	Minesite (File 65G/7-1)
3120	1001- Shear Zone 65G/8	65G/7-2-2	Minesite
3151	1000 - Pen 65G/1	65G/8-1-20	Airstrip and Roads
3152	1000 - A Zone 65G/7		
3153	1002 - A Zone 65G/7		
3154	1001 - Corner Tail 65G/8		
3155	1002 - Corner Tail 65G/8		
3310	1004 - Cod 65G/7		
3311	1005 - Bo 65G/7		
3312	1003 - Page 65G/7		
3347	1006 - Fox 65G/7		
3375	1009 - Mac86 65G/7		
3376	1008 - Lew 65G/7		
3377	1007 - Hugh 65G/7		
3378	1003 - Bea 65G/8		

3.0 HISTORY

3.1 General

Cullaton Lake mineralized occurrences have been known since the early 1960's with the discovery of the ore body by Selco Exploration Co. By the 1970's the area's economic potential was under investigation. The mine was partially developed in 1975, by O'Brien Gold Mines, with the development of a 110 metre decline. However, for economic reasons the project was put on a care and maintenance program in 1977 under Land Use Permit N77C703. In 1980 plans were developed to extend the decline and drill to confirm previous metallurgical testwork. Based on the results of this testwork a decision was made to develop the mine.

Cullaton Lake Gold Mines Ltd. operated between the fall of 1981 and the fall of 1985 at 300 tonnes per day, and produced over 100,000 oz of gold. A total of 373,000 tonnes of ore was processed, of which approximately 150,000 tonnes came from the B-Zone and 223,000 tonnes came from the Shear Zone. Most development occurred in the ore zone, limiting the waste rock inventories. In 1985 the property was placed on a care and maintenance program due to depressed gold prices and high operating costs.

The Shear Zone has a known mineral inventory of over 400,000 tonnes of gold ore with over 100,000 ounces of contained gold. However, due to high overhead costs associated with the operation, the property has remained closed since September 1985. Decommissioning activities began in 1990 and are continuing. The Company now intends to finish the decommissioning program and return the leases to the Crown. Currently, the property remains under a water monitoring program and annual reports are regularly submitted to the N.W.T. Water Board.

Three previous restoration plans have been prepared and submitted to the DIAND Land Division as per our lease obligations. The February 1984 plan, prepared by Keewatin Environmental Consulting Service Ltd., was revised in February 1986 by Cullaton Lake Mine personnel to reflect the experience gained from the "temporary" mine closure in September 1985. A draft Abandonment and Restoration Plan was prepared by Corona Corporation and filed with DIAND in February 1990. A third comprehensive Abandonment and Restoration Plan was prepared by Trow Consulting Engineers Ltd. in May 1991. A Draft Final Abandonment and Restoration Plan was presented, by the Company, in May, 1995 to the LAC/TAC. This current submission reflects comments received subsequent to that May 1995 LAC/TAC meeting, and is the Final Abandonment and Restoration Plan.

3.2 Water Monitoring

Yearly Water Licence Reports have been submitted to the Northwest Territories Water Board since the beginning of operations. These reports summarize water quality monitoring data at the mine site. Water quality analysis taken from Cullaton site sampling stations indicate that parameter concentrations have exhibited a stable or decreasing trend since the mine closure. See Appendix 3 for water quality data.

The previous water licence (N6L3 - 0940) from the N.W.T. Water Board was in effect from August 31, 1990 until September 1, 1995. A "B" Licence was then issued (N6L2 - 0940), effective from September 1, 1995 until August 31, 1999.

An amendment to the Surveillance Network Program monitoring was approved in 1993 due to the stable trend indicated by 7 years of data collection, and the frequency of monitoring was reduced to twice per year ie. in the spring and fall. The amendment also reflected additional monitoring of new piezometer installations in the covered tailings area. The new "B" Licence outlines the effluent quality requirements and monitoring regime for the final abandonment and restoration phase of the mining program.

3.3 Restoration and Decommissioning Activities to Date

3.3.1 Tailings Impoundment Area

Decommissioning of the tailings areas commenced in 1991, with the submission of the CANMET report on the acid generation potential of the tailings[3]. Acid rock drainage occurs as a result of the natural oxidation of sulphide material found in tailings or waste rock. The sulphide-containing material reacts with water, oxygen and bacterial activity to form sulphuric acid which leaches metals from the surrounding rock resulting in high metal concentrations in seepage water. Acid generation can be controlled by reducing water infiltration and limiting oxygen access to sulphide-rich material.

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[3]Dave, N.K. Column Leaching Characteristics of Cullaton Lake B and Shear Zone Tailings. CANMET REPORT 1991.

No evidence of acid generation was detected in the tailings area, in either pore water or pond water. However, CANMET test results showed that the tailings readily oxidized in the favourable conditions of the laboratory (the mine waste rock was not acid generating in the laboratory). In order to prevent any possible acid generation in the future, reclamation of the tailings area has involved two oxygen-limiting methods; a water cover overlying the eastern portion of the tailings impoundment area and a till/mine waste rock cover on the remaining Shear and B-Zone tailings area. The application of the till/mine waste rock cover will reduce oxygen infiltration and it will also raise the level of permafrost in the tailings. this will help retain them in a permanently frozen condition which may prevent development of acid drainage.

An extended program, to monitor the thermal regime and general characteristics of the pore water within the tailings area, will evaluate the performance of the two possible mitigation approaches (water cover and mine waste rock cover). See Appendix 4, for the Trow Consulting Engineers 1994 tailings area assessment report.

Decommissioning from 1991 to 1995 consisted of rehabilitation of the Tailings Pond #1 dam including construction of a spillway in the dam, covering of the exposed tailings with water or with mine waste rock and till, and the elimination of Tailings Pond #2 (the polishing pond).

i)1991 Decommissioning Work

Tailings Area #1 received major modifications in 1991 with the lowering of the dams and the flattening of the slopes to increase long term stability. The upstream faces of the dams were subject to sloughing and failure, a condition exacerbated by wave action, however, the 1991 Trow report concluded that a breach of the dam over a long period of time would not occur provided water levels did not rise above historical levels. Therefore, a spillway was constructed in Tailings Dam #1, at the 93.5 m elevation[4], to remove the risk of water levels rising. The dam slopes and crests were constructed to specifications to protect against progressive sloughing and were adequately sloped and contoured. Approximately 2 to 3 m of dam height was removed. The water level in the pond was lowered to 92.9 m with the release of 175,000 m^3 of water. Water quality monitoring accompanied this discharge of water to the environment. Concentrations of measured parameters remained low.

[4]Trow Consulting Engineers Ltd. established a benchmark, located on a concrete slab at the northeast corner of the mill building, with an arbitrarily assigned elevation of 100.0 m. All tailings survey data refers to this benchmark.

Four thermistors were installed in the tailings area to monitor temperatures in the tailings.

ii) 1992 Decommissioning Work

During 1992 approximately 1,200 m^3 of waste rock and till was excavated from Tailings Dam #2 and placed as overburden on Tailings Area #1.

During the 1992 construction season a total of 70,000 tonnes of fill was placed on Tailings Area #1. This overburden was compacted by using heavy construction equipment. By the end of the season the Shear Zone portion of the tailings was completely covered to the desired depth of 1.4 m. Two additional monitoring wells were installed in Tailings Pond #1 at the request of the NWT Water Board. The spillway constructed in 1991, in the east dam of Tailings Pond #1, was lowered to 93.3 m in elevation.

iii) 1993 Decommissioning Work

During the 1993 construction season an estimated 30,000 m^3 (31,130 tonnes) of fill was hauled from Tailings Dam #2 to Tailings Area #1 to cover the B - Zone tailings. By the end of the season the entire tailings area had been covered to the design depth of 1.4 m. and most of the east portions of Tailings Dam #2 had been removed. Rock was placed along the east end of Tailings Pond #1 shore line as a cover for protection against erosion. The north section of Tailings Area #1 was covered with riprap and compacted.
A weir was installed in the spillway to monitor water volumes.
A drainage swale was constructed at the intersection of the B - Zone and Shear Zone tailings.
A small vegetation island located within the tailings impoundment area was growing satisfactorily.

iv) 1994 Decommissioning Work

Additional fill was hauled from Tailings Dam #2 to spread over low spots on Tailings Area #1. Tailings Dam #2 has now been removed and Tailings Pond #2 has been eliminated.

A topographical survey of the Tailings Pond, Polishing Pond and dams was conducted by Trow Consulting Engineers in 1994 (Appendix 4). Based on their inspection, the structures associated with the former tailings disposal system (dams, spillways, etc.) are stable.

1995 Decommissioning Work

A visual inspection of the tailings area was carried out in 1995. No further decommissioning work was required.

3.3.2 Mill Complex

The Company began decommissioning work at the mill site in 1991 by collecting mill reject material and depositing it along the B - Zone tailings beach. Hydrated lime, chloride and caustic soda were also moved from the crusher to the B - Zone tailings beach, and then covered with fill material.

In 1992 lead nitrate from the mill was shipped for recycling to another Homestake Canada Inc. operation.

In 1993 decommissioning work continued at the mine site. Five generator sets (including fuel filter racks and amplifier panels) were removed from the power house, five Main Control Centre units were dismantled and removed from the mill, and 14 buildings were torn down, crushed, burned or buried. The crusher was partially dismantled. The sizing screen and catwalk were removed, as were portions of the conveyor way.

All cables and pipelines including water supply, tailings disposal, reclaim and trestle lines and sewage disposal, were disconnected or dismantled.

In 1995, portions of the mill buildings were dismantled. Inert, non-salvageable material was crushed and placed in the quarry pit. Salvageable equipment (a 250 HP motor, transmission and fuel drums) was flown to Thompson, Manitoba for storage.

3.3.3 Shear Zone

All surface structures, except for the sprung structure and a genset storage trailer, were removed from site in 1993. In 1995, inert, non-salvageable material (including piping, used ventilation ducting, ventilation fan, support structure and equipment chassis) was buried within the waste rock pile.

3.3.4 Kognak River Exploration Camp

The fresh water intake, pump house and pipelines at the old diamond drill camp on the Kognak River were dismantled and removed in 1991. By 1993, all buildings and debris around the drill camp had been removed.

4.0 RESTORATION PROGRAM

It is the Company's intention to decommission the site and reclaim the land such that there will be no long term adverse environmental impacts associated with the site. The objective of this restoration, as per our lease requirements, will be to return the lands to the crown in a condition compatible with the original undisturbed conditions.

The reclamation program will include removing structures, filling or barricading openings and salvaging material. The plan will also include sloping and contouring surface features. Components of the reclamation program are detailed below.

4.1 Air Strip

The gravel air strip (with its east - west orientation) is located approximately 5.5 km north of the mine site. A dirt road links the airstrip with the mine site. The air strip is bounded on the north by a small hill and Cullaton Lake, and on the south by undulating terrain. Upon cessation of operations, mine staff transported 15 units of mobile underground equipment and 8 units of mobile surface equipment to a storage area adjacent to the airstrip (see Photographs 5 & 6). Some of this equipment has since been used during decommissioning activities.

The Company intends to remove all salvageable material from the mobile equipment placed for storage adjacent to the airstrip. All inert, non-salvageable material will be cut and crushed and placed in our selected disposal site. If possible, useable equipment will be removed from the site by back hauling.

As shown in Photograph 10, a number of fuel storage tanks are also stored at this site. These tanks will be crushed and placed in the disposal site. Oil sludge associated with the fuel tanks will be collected and sampled before assessing disposal alternatives.

The airport runway and runway apron will be graded and left in good condition. The airstrip will remain as is. The culverts located at the airstrip will remain in place. The 0.5 m windsocks are in fair condition and will remain.

Airstrip buildings will be dismantled and removed unless Regulatory Agencies request that the small building located near the airstrip remain intact.

4.2 Mill Facility and Camp

The mill facility and camp are located on a barren flat at the northeast end of Tailings Pond #1 (Figure 2, Photographs 1 & 4). The site is approximately 2.0 km north of the Kognak River.

When in operation, the mill employed standard Merrill-Crowe cyanide leaching for extracting the gold in conjunction with a carbon-in-pulp method of removing the gold from solution. A simple flow diagram is shown in Figure 4. The ore was crushed in a jaw-and-cone crusher, then ground in the grinding mill, and passed over jigs to remove coarse gold. The slurry was sent to a thickener. From the thickener the solution entered one of 4 cyanidation tanks for the leaching process where the gold reacted with free cyanide ions to form complex ions. In the 4 carbon-in-pulp tanks the cyanide-gold ions were adsorbed onto the activated carbon. Finally the gold-laden charcoal was treated with a strong alkaline solution to re-dissolve the gold (char-stripping), which then deposited onto steel wool cathodes, and was transferred to the refining furnace. The mill buildings containing the equipment for the above process include the crushing station and the 41 m X 18 m mill building.

Other surface facilities consist of a crusher conveyor, a number of camp buildings and trailers, 2 butler buildings (maintenance sheds), 1 sprung structure (storage), a corrugated ore storage building, and 3 - 10,000 gallon storage tanks. The mine was in the process of expansion construction for additional crushing facilities (Photographs 2 & 3) when the decision to close the operations was made in 1985..

All economically salvageable equipment will be removed from the mine site by back haul flights. All tanks will be drained, cut and crushed, then removed to the disposal site. All inert, non-salvageable material will also be deposited in the disposal site. Extruding piping and rebar will be removed and either salvaged or placed in the disposal site. It is anticipated that the crusher will be salvaged and removed by back haul or winter road.

All remaining mill buildings will be dismantled. Wherever possible, building siding and other reusable material will be salvaged. If it is not possible to salvage the material, both the siding and girders will be placed in a selected disposal site in such a manner as to conserve space. All steel sections and steel plates will be dismantled and placed in the disposal site. Debris from the mill buildings will also be placed in the disposal site.

The machine shop garage will be dismantled, salvageable equipment and material removed, and non-salvageable material placed in the disposal site. The assay lab, the mechanics shop and two adjacent shacks will be dismantled and materials placed in the disposal site, as will the core shop and engineering office. The butler buildings and sprung structure will be dismantled, salvageable material removed and the non-salvageable material will be placed in the disposal site.

The accommodation trailers will be crushed and burnt at the end of decommissioning activities. All inert, non-flammable material from these trailers will be placed in the disposal site.

Concrete foundations will remain intact. They will be limited to 2 m in height, modified where needed to prevent ponding, and, where possible, the foundations will be covered with till, then sloped and contoured.

4.3 B-Zone

B-Zone is located adjacent to the mill site. Located at B-Zone portal are ventilation fans, a sprung structure, trailer and fuel tank.

The B-Zone portal will be capped with fill and the area will be contoured.

The ventilation fans will be dismantled and salvaged if possible, or removed to the disposal site.

The sprung structure will be dismantled and its frames removed to another Homestake Canada Inc. site. Its outer covering will be deposited in the disposal site.

4.4 Shear Zone

The Shear Zone consists of the mine site and the adjacent lake. The Shear Zone mine site is located approximately 4 km north of the mill site, along the airstrip road. Shear Zone structures consist of a portal, a vent raise with chained door, a sprung structure (storage), fuel tanks and a genset storage trailer.

Shear Lake is approximately 90 m west of the Shear Lake Portal. The lake is a shallow depression in the landscape, covering an area of 4,600 m^2. It functioned as a source for mine water discharge during operations. In 1984 the lake was de-watered in order to test mineralized zones located on the lake bottom. At that time the fish in the lake were removed and released alive into Cullaton Lake (see Appendix 4) and the water flow was directed around the lake. Shear Lake currently has water.

The Shear Zone portal will be covered with waste rock and sloped and contoured to blend in with the surrounding environment. The Shear Zone vent raise doors are currently chained shut and will be locked and bolted.

The Shear Zone sprung structure contains a cargo truck, a yellow Toyota, a miner's bus and underground electrical switchgear, 2 electric air compressors, several large mine fans, slushers, and pump accessories. In 1995 most of the equipment was either transported to the airstrip for removal, or buried.

The two fuel tanks will be drained, the fuel salvaged, the tanks cut and collapsed to minimize overall volume, and then removed to the disposal site.

4.5 Tailings Impoundment Area

During operations the tailings area remained relatively small and consisted of a shallow tailings pond and a polishing pond. Tailings material from the tailings pump box in the mill was deposited along the west and southwest side of Tailings Pond #1 to allow for natural degradation of total cyanide. Tailings solution was decanted to Tailings Pond #2, located southeast of Tailings Pond #1. Tailings Pond #2 functioned as a polishing pond. Since mining operations ceased there has been no discharge from Tailings Pond #1 to Tailings Pond #2. The total area of containment was 17.8 ha for Tailings Pond #1 and 30 ha for Tailings Pond #2.

The tailings contain two distinctive types of waste material readily identified by colour. The B - Zone tailings are dark grey, while the Shear Zone tailings are reddish brown.

The tailings dams were constructed predominantly of native till soil from the surrounding ground surface and some mine waste rock. The material is classified as a silty sand with gravel. The material exhibits very little cohesion and behaves as a granular soil. Stability analysis conducted in 1991 by Trow Engineering as required by Part C Subsection 4(d) of Water Licence N6L3-0940, confirmed the stability of the dams. The lowering of the dam crest and the flattening of the slopes in 1992 and 1993 have provided increased stability (Trow Report 1993).

All restoration work has been completed, although thermistor and water quality monitoring will continue.

4.6 Kognak River Exploration Camp

The Kognak River Exploration Camp was located 2.1 km south of the mine site, on the Kognak River. The area is sparsely vegetated with trees (predominately black spruce) of moderate height (max 12 m). Boulders, rock and till line the shoreline of the river.

All buildings have been removed. The gravel dock located at the river will remain intact. The area has been contoured to blend with the surrounding environment. All restoration work has been completed.

4.7 Roads

All site roads will be contoured to blend in with the surrounding terrain. Culverts will be removed and areas where there is a potential for inhibited drainage will be cross ditched.

4.8 Disposal of Petroleum Residues and Other Hazardous Materials

As discussed during the May 1995 meeting with DIAND and the Water Board, B Zone portal will be slushed out and any sludges, petroleum residues, or oily soils will be placed inside and buried. All batteries at the site will be salvaged and removed.

4.9 Disposal Sites

In 1993 the B - Zone portal was opened, slushed out and ventilated by a fan in order to examine the decline for possible placement of non-salvageable debris (see Photographs 7 & 8). An ice barricade prevented access past 25 m, therefore this site was judged inaccessible for the disposal of large amounts of debris. Opening of the Shear Zone portal was also attempted, however access was difficult. It was assumed that similar ice conditions would be found at this location, therefore this site too was discounted as a disposal site.

i) Quarry Pit

During the May, 1995 LAC/TAC meeting, the quarry pit was selected as the main disposal site. The rock quarry pit was blasted out at the southeast corner of Tailings Pond #1 (50 m south of the tailings) during operations, and used to test the natural degradation of cyanide in mine water. The pit is approximately 175 m by 50 m with a maximum depth of 2.0 m and a total volume of approximately 17,000 m^3. The Company has begun placing non-salvageable material in this quarry pit.

Crushed, inert waste material will be pushed into the pit until the space is filled. The waste will then be covered with a minimum of 1 m of overburden stockpiled from the dismantling of Tailings Dam 2 (see Photograph 9). The overburden will be mounded over the waste in a convex manner to allow for settlement.

ii) Tailings Pond

Approximately 202,000 m^3 of disposal space is available in the Tailings Area. Waste material will be placed in the tailings pond and will be completely covered with water. The Company will syphon the water in the pond, if required, in order to prevent the egress of water from the tailings area during waste disposal. Only inert scrap material (scrap steel, foundation material, etc.) will be placed in the pond.

5.0 SCHEDULE

During the 1996 construction season the remaining site buildings will be dismantled and all salvageable material will be stacked for removal throughout the year. Removal will be accomplished by back hauls or dedicated airplanes. Allowance for a winter road for removal of material may be possible. It is anticipated that by the end of the 1996 season all non-salvageable material will have been placed in the Quarry and Tailings Area or, if necessary, in Shear Lake and the Gravel Pit. These areas will then be contoured. (See Table 1 for tentative schedule.)

By 1997 the Company anticipates approval of the restoration work by the Department of Indian Affairs and Northern Development.

Table 1

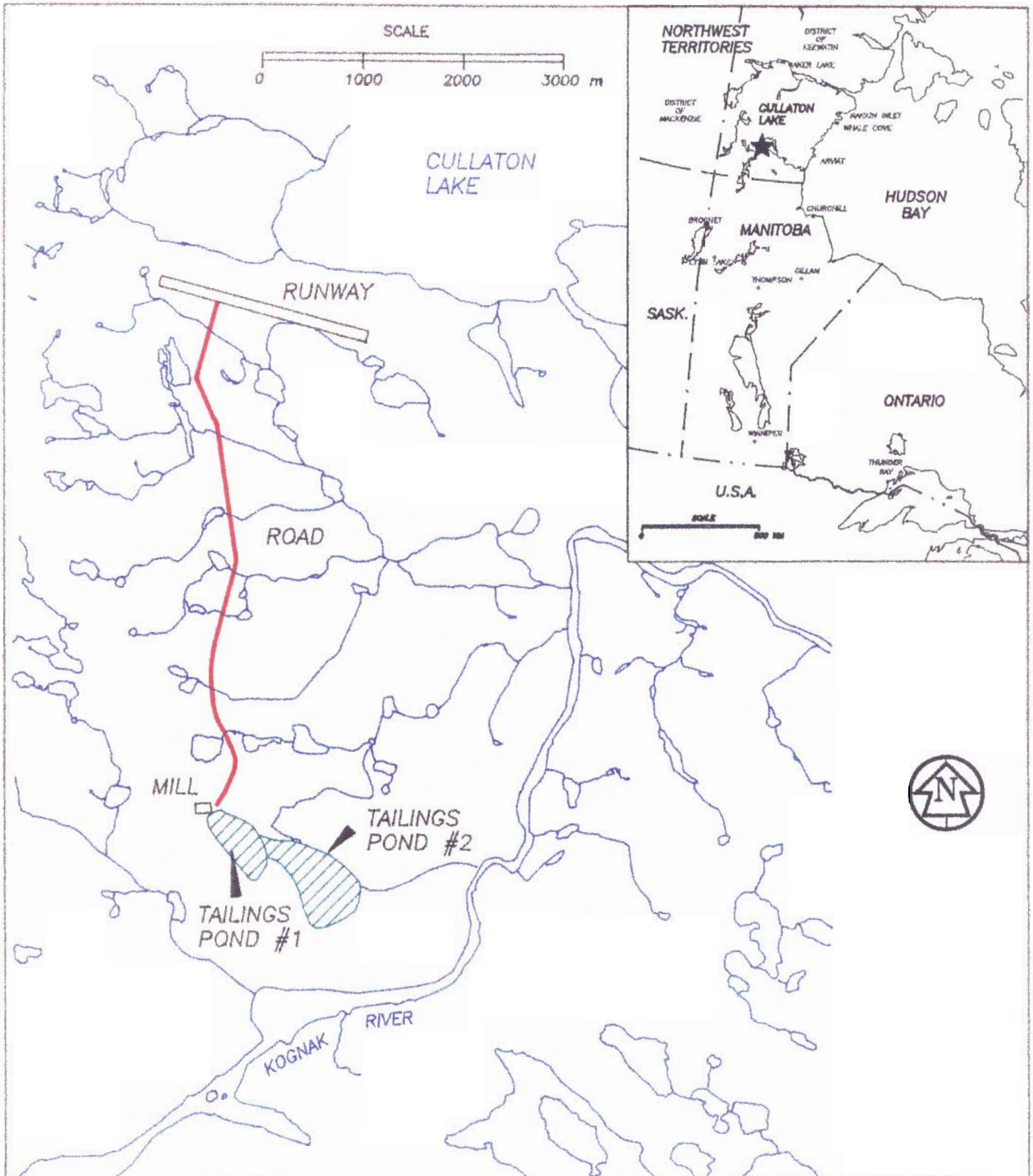
CULLATON LAKE GOLD MINES LTD.
FINAL RECLAMATION AND RESTORATION PLAN
PRELIMINARY PROJECT SCHEDULE
AS OF APRIL 11, 1995

	ITEM DESCRIPTION	1995									1996												1997								
		APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	Submit Abandonment and Reclamtion Plan	■																													
2	Approval in Principle of A & R Plan		■																												
3	Dismantle, Salvage and Dispose Mill Structures			■	■																										
4	Dismantle, Salvage and Dispose Shear Lake Structures					■																									
5	Dismantle, Salvage and Dispose B – Zone Structures					■																									
6	Water Quality and Thermistor Readings			■		■										■		■											■		
7	Remove Salvageable Materials				■	■					■	■																			
8	Final Disposal of Non–Salvageables															■	■														
9	Stabilizing and Topographical Contouring																■	■													
10	Final Inspection and Monitoring																												■		
11	Return Leases to Crown																													■	

NOTE:
1. THE INTENT IS TO DO MOST OF THE DISMANTLING AND DISPOSAL WORK DURING THE SUMMER MONTHS.
2. UNDONE PORTIONS OF ITEMS 3,4 AND 5 WILL BE COMPLETED IN 1996.
3. NON–SALVAGEABLES WILL BE DISPOSED OFF ALSO IN THE SUMMER MONTHS.
4. SALVAGEABLES WILL BE REMOVED FROM SITE EITHER AS BACK–HAULS DURING THE SUMMER MONTHS OR DURING WINTER (WINTER ROAD).
5. WATER AND THERMISTOR MONITORING WILL BE DONE EACH OF THE SCHEDULED YEARS.
6. FINAL INSPECTION AND RETURN OF LEASES TO CROWN IS SCHEDULED FOR SEPTEMBER 1997.

APPENDIX 1

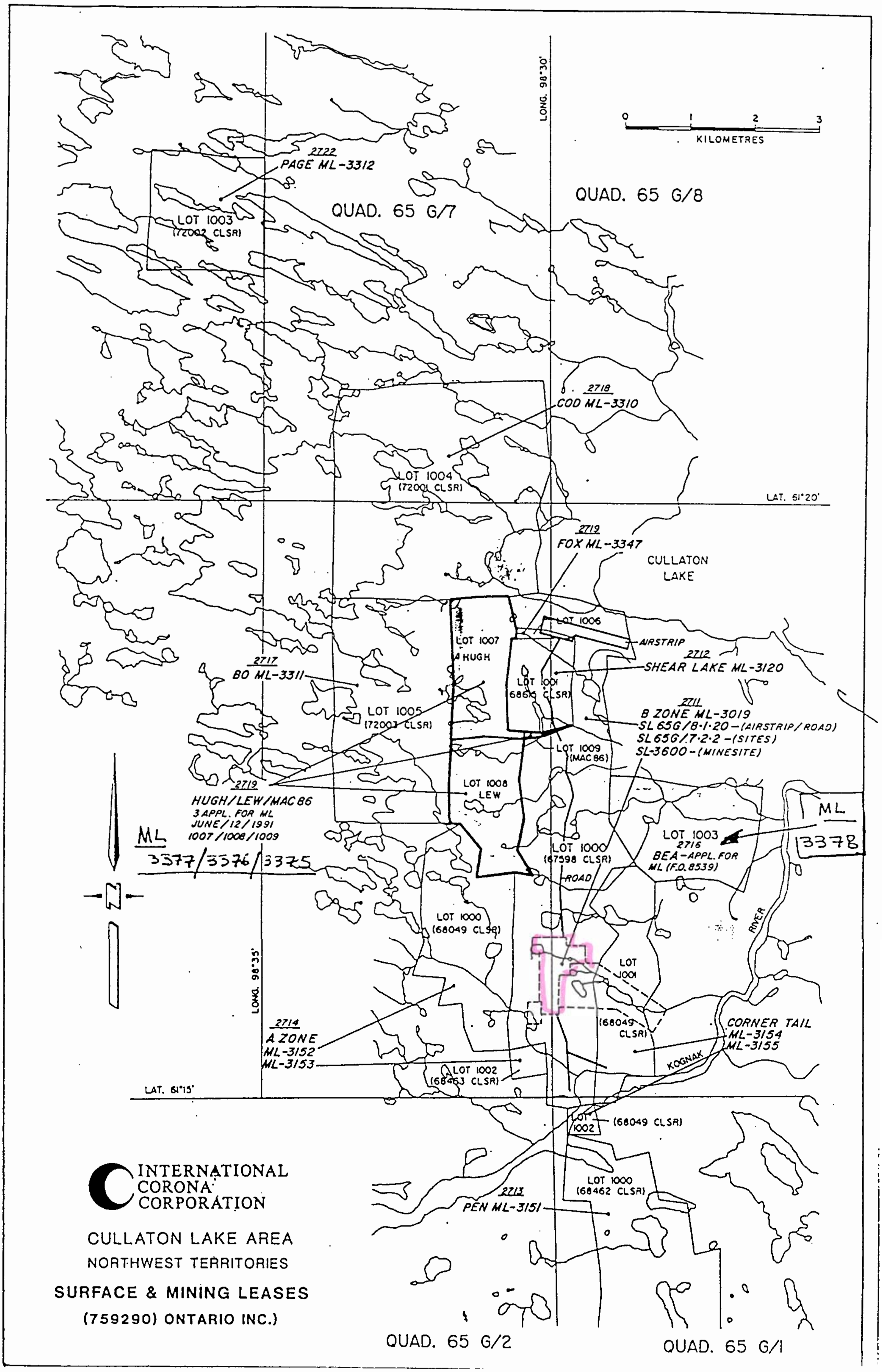
Figures and Drawings



HOMESTAKE

CULLATON LAKE MINE
LOCATION MAP / SITE PLAN

Figure 3



LONG. 98°30'
0 1 2 3
KILOMETRES
2722
PAGE ML-3312
QUAD. 65 G/7
QUAD. 65 G/8
LOT 1003
(72002 CLSR)
2718
COD ML-3310
LOT 1004
(72001 CLSR)
LAT. 61°20'
2719
FOX ML-3347
CULLATON
LAKE
LOT 1006
AIRSTRIP
LOT 1007
HUGH
2712
SHEAR LAKE ML-3120
2717
BO ML-3311
LOT 1001
(68645 CLSR)
LOT 1005
(72003 CLSR)
2711
B ZONE ML-3019
SL 65G/8-1-20 — (AIRSTRIP/ROAD)
SL 65G/7-2-2 — (SITES)
SL-3600 — (MINESITE)
LOT 1009
(MAC 86)
2719
HUGH/LEW/MAC 86
3 APPL. FOR ML
JUNE/12/1991
1007/1008/1009
LOT 1008
LEW
ML
3377/3376/3375
ML
3378
LOT 1003
2716
BEA — APPL. FOR
ML (F.O. 8539)
LOT 1000
(67598 CLSR)
ROAD
LOT 1000
(68049 CLSR)
RIVER
LONG. 98°35'
LOT
1001
(68049
CLSR)
2714
A ZONE
ML-3152
ML-3153
CORNER TAIL
ML-3154
ML-3155
KOGNAK
LOT 1002
(68463 CLSR)
LAT. 61°15'
LOT
1002
(68049 CLSR)
LOT 1000
(68462 CLSR)
2713
PEN ML-3151
INTERNATIONAL
CORONA
CORPORATION
CULLATON LAKE AREA
NORTHWEST TERRITORIES
SURFACE & MINING LEASES
(759290) ONTARIO INC.)
QUAD. 65 G/2
QUAD. 65 G/1

APPENDIX 2

Photographs

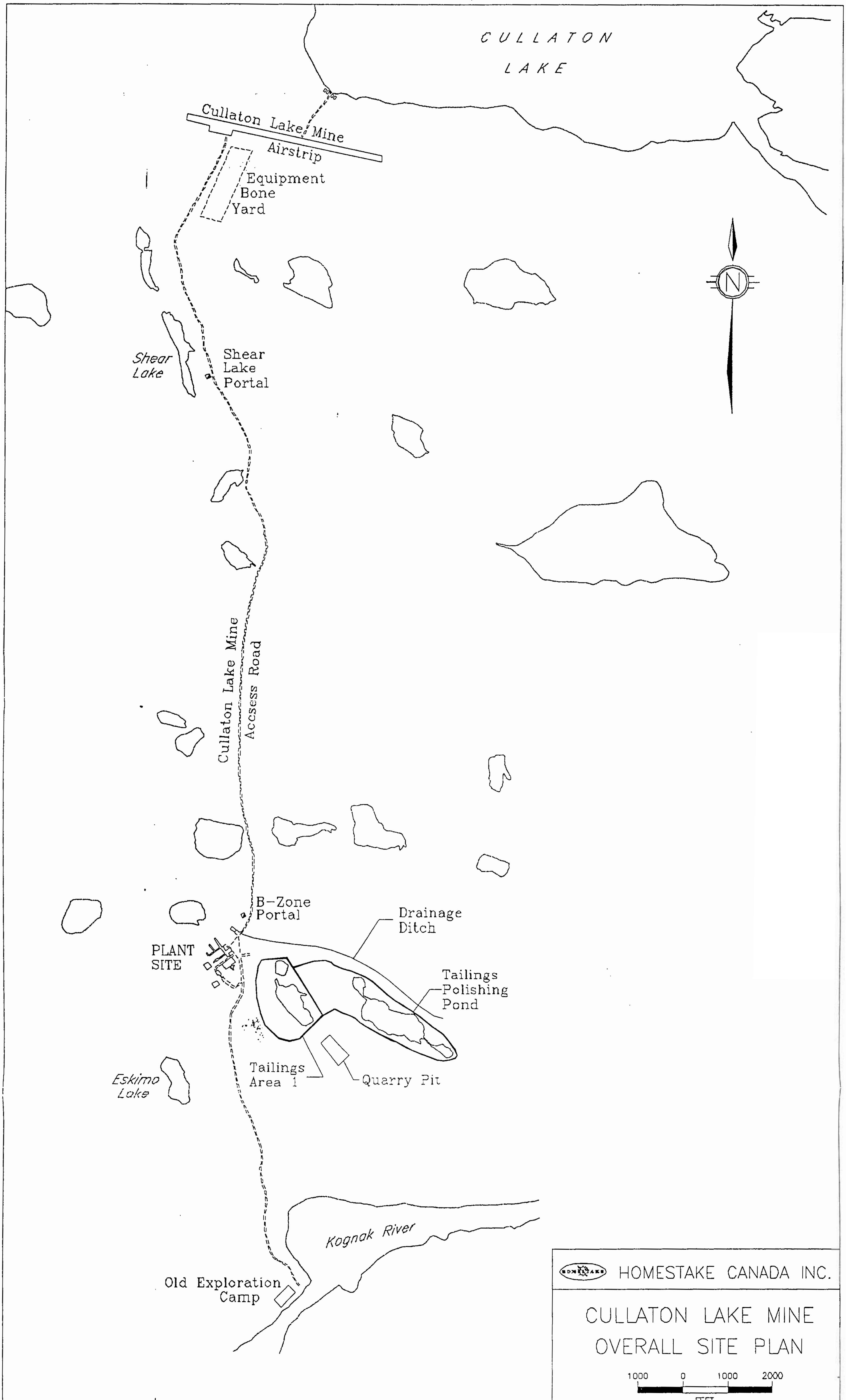

CULLATON LAKE
Cullaton Lake Mine Airstrip
Equipment Bone Yard
Shear Lake
Shear Lake Portal
Cullaton Lake Mine Accsess Road
B-Zone Portal
Drainage Ditch
PLANT SITE
Tailings Polishing Pond
Eskimo Lake
Tailings Area 1
Quarry Pit
Kognak River
Old Exploration Camp
HOMESTAKE CANADA INC.
CULLATON LAKE MINE
OVERALL SITE PLAN
1000 0 1000 2000
FEET

Figure 2

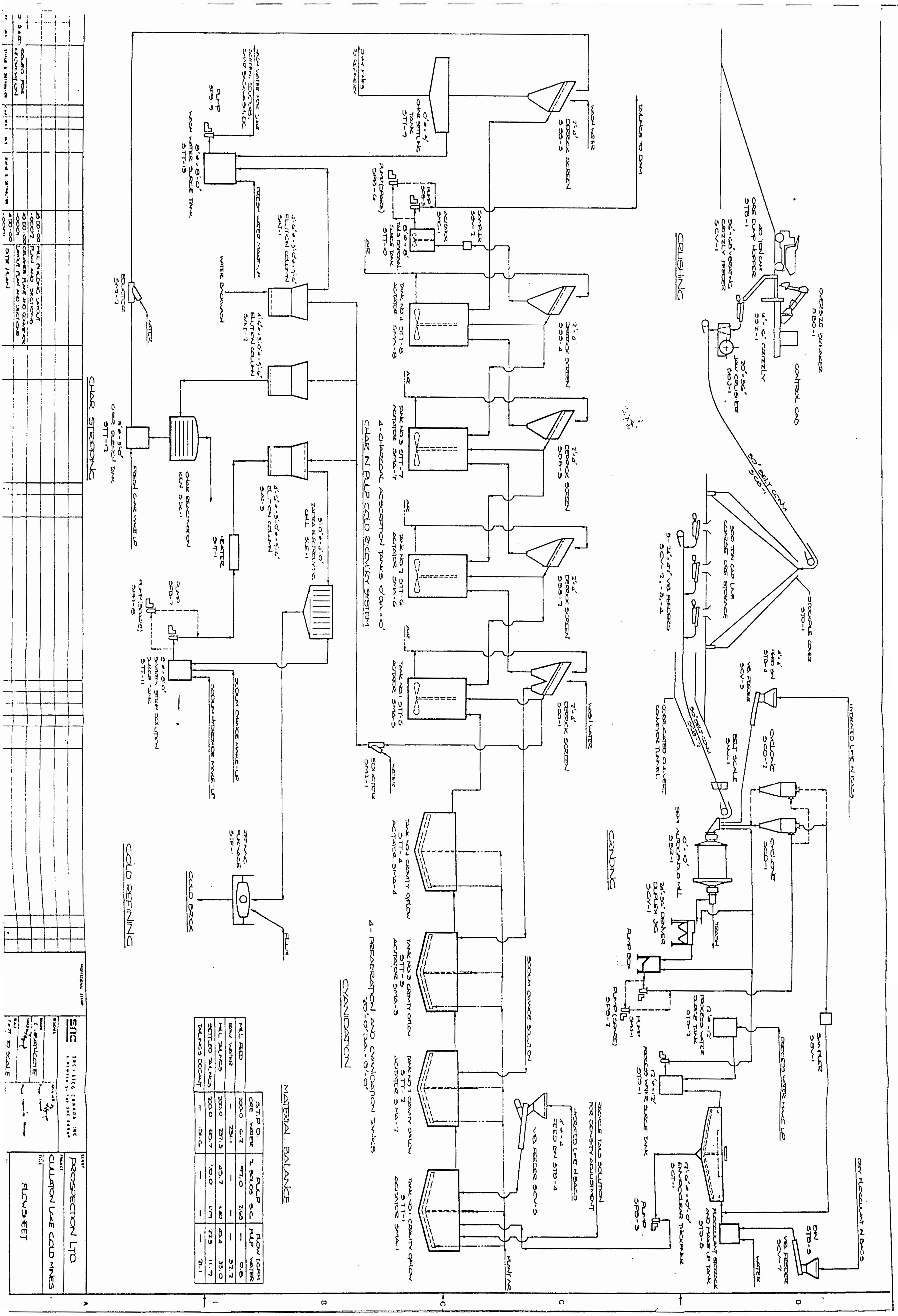


Figure 4

Photo 1. Overview of Mill Site and Tailings Area

Photo 2. New Construction in Background.

Photo 3. New Construction.

Photo 9. Stockpiled Overburden/Till from Tailings Dam 2.

Photo 10. Fuel Storage Tanks near Airstrip.

Photo 7. B - Zone Portal during Slushing.

Photo 8. B - Zone Portal.

Photo 5. Equipment Storage near Airstrip.

Photo 6. Equipment Storage near Airstrip.

APPENDIX 3

Water Quality Monitoring

Thermistor Readings

FILE: CULLATONWATER94

WATER QUALITY RESULTS 1994
CULLATON LAKE MINE

DATE	LOCATION	CONSTITUTENTS MAJOR Total Alkalinity	TRACE Cyanide WAD	Cyanide (t)	Acidity	Hg	TRACE METALS As	Cu	Fe	Ni	Pb	Zn	PHYSICAL PROPERTIES TSS	pH
		mg/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
	detection limits					0.05	0.5	0.001		0.001	0.005	0.005	1	
July 3,94	940-1 Kognak Pump House		1						0.03					
July 31,94		5		2	4.0	0.05	0.5	0.002		0.015	0.005	0.005	1	6.42
Sep 6,94		14		3	5.0	0.05	0.6	0.002		0.001	0.005	0.005	2	6.65
July 3,94	940-2 Pond 1 Discharge	54		19	24.0	0.05	1.9	0.002		0.003	0.005	0.005	1	7.93
July 31,94		64		23	11.0	0.05	3.8	0.002		0.005	0.005	0.005	1	7.89
Sep 6,94		69		17	21.0	0.05	32.0	0.005		0.004	0.005	0.005	57	7.92
July 3,94	940-3 Pond 2 Discharge	55		2	4.8	0.05	2.0	0.007		0.007	0.005	0.005	1	7.73
July 31,94		81		4	1.0	0.05	4.9	0.005		0.009	0.005	0.007	5	8.63
Sep 6,94		82		4	16.0	0.05	4.7	0.007		0.005	0.005	0.011	26	7.82
July 3,94	940-5 Tailings NW corner	68		434	4.8	0.05	2.4	0.006		0.005	0.005	0.005	1	7.84
July 31,94		95		nd	18.0	0.05	4.2	0.007		0.008	0.005	0.005	3	8.20
Sep 6,94		114		86	34.0	0.05	7.8	0.010		0.007	0.005	0.037	13	7.77
July 3,94	940-7 Tailings diversion ditch	64		3	4.8	0.05	1.5	0.003		0.005	0.005	0.005	1	7.82
July 31,94		128		nd	17.0	0.05	14.0	0.002		0.006	0.005	0.005	2	8.20
Sep 6,94		139		14	24.0	0.05	2.2	0.003		0.008	0.005	0.005	12	7.84
July 3,94	940-19 Tailings Pond #1 piesometer	53		16	3.0	0.05	2.1	0.001		0.002	0.005	0.005	1	7.97
July 31,94		64		22	11.0	0.05	4.3	0.003		0.004	0.005	0.009	1	7.86
Sep 6,94		67		13	15.0	0.08	3.3	0.002		0.001	0.005	0.022	2	7.97
July 3,94	940-20 E.side Taling Pond	54		17	3.0	0.05	2.6	0.002		0.004	0.005	0.005	1	7.93
July 31,94		168		5	37.0	0.05	1.6	0.008		0.009	0.005	0.005	3	8.06
Sep 6,94		139		8	55.0	0.05	3.6	0.009		0.008	0.005	0.005	13	7.98

FILE: Cullaton\water

06-Apr-95

WATER QUALITY RESULTS
CULLATON LAKE MINE

* Collected by the Northwest Territories Water Board

		MAJOR CONSTITUENTS (mg/L)		TRACE CONSTITUENTS (ug/L)				NUTRIENTS	PHYSICAL PROPERTIES			TRACE METALS (mg/L)					
		Total Alkalinit	SO4 grav	Acidity mg/L	CN, W.A.D.	CN(t)	Hg	NO3	TSS mg/L	pH	Sp Conduct	As ug/L	Cu	Fe	Ni	Pb	Zn
	Detection Limit						0.05		1			0.500	0.001		0.001	0.005	0.005
	Detection Limit						0.05		1			0.500	0.001		0.001	0.005	0.005
KOGNAK PUMP HOUSE	940-1																
	July 11/92	6		1	1	1	0.05					0.500	0.001		0.001	0.005	0.007
	August 20/92 *	5										0.500	0.002	0.022	0.001	0.001	0.001
	June 29/93 #1	8		1	1	1	0.05		18	6.84		0.500	0.001	0.093	0.001	0.005	0.005
	June 29/93 #2	8		1	1	1	0.05		17	6.86		0.500	0.009	0.098	0.001	0.005	0.005
	July 7/93 prsvd						0.05					2.800	0.001	0.300	0.001	0.005	0.024
	July 17/93 #1	5		2	1	1	0.05		3	6.52		0.500	0.001	0.120	0.002	0.005	0.005
	July 17/93 #2	5		2	1	1	0.05		4	6.34		0.500	0.001	0.100	0.001	0.005	0.005
	August 1/93 #1	5		2	1	1	0.05		2	6.46		0.500	0.001	0.062	0.001	0.005	0.005
	August 1/93 #2	5		2	1	1	0.05		3	6.50		0.500	0.001	0.140	0.002	0.014	0.020
POND #1 AT DISCHARGE	940-2																
	July 6/92	48		2	17	50	0.05					8.100	0.003	1.400	0.003	0.011	0.005
	August 20/92 *	63				0.006	0.45					4.200	0.004	0.305	0.004	0.005	0.002
	June 29/93 #1	43		1		19	0.05		5	7.80		2.200	0.001		0.007	0.005	0.005
	June 29/93 #2	43		1		18	0.05		6	7.82		2.200	0.001		0.008	0.005	0.005
	July 7/93 prsvd						0.05					2.400	0.001		0.006	0.005	0.078
	July 11/93	54		3		24	0.05		2	7.76		3.000	0.005		0.012	0.009	0.005
	July 17/93 #1	55		2		22	0.05		1	7.93		0.500	0.004		0.008	0.005	0.056
	July 17/93 #2	55		2		23	0.05		1	7.92		0.500	0.002		0.007	0.012	0.005
	August 1/93 #1	57		2		34	0.05		13	7.68		3.900	0.001		0.003	0.008	0.011
	August 1/93 #2	57		2		36	0.05		13	7.64		11.000	0.002		0.003	0.005	0.005
POND #2 DISCHARGE	940-3																
	July 6/92	50		2	1	1	0.05					2.700	0.006	0.130	0.001	0.005	0.005
	August 20/92 *	147				0.005	0.02					2.000	0.005	0.288	0.004	0.002	0.004
	June 29/93 #1	46		2		1	0.05		3	7.42		3.300	0.003		0.006	0.005	0.005
	June 29/93 #2	47		2		2	0.05		4	7.48		3.300	0.003		0.001	0.005	0.005
	July 7/93 prsvd						0.05					4.000	0.001		0.003	0.010	0.044
	July 11/93	59		6		1	0.05		2	7.29		1.000	0.004		0.008	0.005	0.005
	July 17/93 #1	64		6		1	0.05		2	7.38		2.300	0.006		0.008	0.010	0.005
	July 17/93 #2	64		5		1	0.05		2	7.36		3.300	0.006		0.008	0.005	0.005
	August 1/93 #1	62		4		3	0.05		4	7.42		5.600	0.005		0.007	0.006	0.010
	August 1/93 #2	61		3		3	0.05		4	7.34		5.900	0.002		0.011	0.010	0.005

FILE: Cullaton\water

06-Apr-95

WATER QUALITY RESULTS
CULLATON LAKE MINE

* Collected by the Northwest Territories Water Board

		MAJOR CONSTITUENTS (mg/L)		TRACE CONSTITUENTS (ug/L)				NUTRIENTS	PHYSICAL PROPERTIES			TRACE METALS (mg/L)					
		Total Alkalinit	SO4 grav	Acidity mg/L	CN, W.A.D.	CN(t)	Hg	NO3	TSS mg/L	pH	Sp Conduct	As ug/L	Cu	Fe	Ni	Pb	Zn
	Detection Limit						0.05		1			0.500	0.001		0.001	0.005	0.005
TAILINGS NW CORNER	**940-5**																
	July 6/92	56		5	9	114	0.06					6.500	0.009	0.290	0.009	0.005	0.005
	August 20/92 *	82				0.011	0.12					2.600	0.007	0.221	0.006	0.002	0.002
	June 29/93 #1	46		1		430	0.05		1	7.70		1.600	0.001		0.001	0.005	0.005
	June 29/93 #2	46		1		460	0.05		2	7.73		1.700	0.003		0.004	0.005	0.005
	July 7/93 prsvd						0.05					1.800	0.001		0.370	0.020	0.038
	July 17/93 #1	62		5		128	0.05		8	7.64		2.300	0.008		0.011	0.005	0.005
	July 17/93 #2	63		3		137	0.05		6	7.60		2.300	0.008		0.013	0.005	0.006
	August 1/93 #1	52		3		720	0.05		15	7.18		7.900	0.008		0.013	0.017	0.045
	August 1/93 #2	53		4		640	0.05		13	7.19		5.200	0.009		0.016	0.011	0.007
POND 2 INFLOW FROM NO. 1 TAIL	**940-6**																
	July 6/92	121		Not Required	20	114	0.07					4.000	0.008	0.600	0.010	0.005	0.005
TAILINGS DIVERSION DITCH	**940-7**																
	August 20/92 *	116				0.013	0.06					2.400	0.005	0.379	0.010	0.002	0.005
	June 29/93 #1	39		1		3	0.05		1	7.46		0.800	0.001		0.002	0.005	0.005
	June 29/93 #2	39		1		3	0.05		3	7.52		0.900	0.006		0.005	0.005	0.005
	July 7/93 prsvd						0.05					0.500	0.001		0.006	0.005	0.068
	July 11/93	50		4		25	0.05		1	7.52		1.700	0.001		0.006	0.005	0.005
	July 17/93 #1	66		5		66	0.05		2	7.39		1.400	0.004		0.006	0.005	0.016
	July 17/93 #2	63		3		134	0.05		1	7.36		1.800	0.002		0.007	0.009	0.006
	August 1/93 #1	37		5		12	0.05		2	7.08		2.500	0.001		0.004	0.011	0.014
	August 1/93 #2	37		5		12	0.05		2	7.08		2.300	0.001		0.004	0.005	0.012
INFLOW KOGNAK RIVER	**940-9**																
	July 6/92	43		2	1	1	0.05					0.500	0.002	0.047	0.001	0.005	0.005
SPILLWAY	**940-18**																
	June 29/93 #1	45		1		21	0.05		3	7.86		2.000	0.001		0.005	0.005	0.005
	June 29/93 #2	44		2		21	0.05		5	7.78		2.200	0.001		0.008	0.005	0.005
	July 7/93 prsvd						0.05					1.500	0.001		0.003	0.005	0.055
	July 11/93	60		2		17	0.05		1	7.77		3.100	0.003		0.008	0.012	0.005
	July 17/93 #1	69		2		20	0.05		4	7.76		3.300	0.004		0.010	0.005	0.005
	July 17/93 #2	69		2		21	0.05		2	7.83		3.300	0.004		0.009	0.005	0.005
	August 1/93 #1	56		3		160	0.05		81	7.63		22.000	0.008		0.021	0.016	0.020
	August 1/93 #2	55		2		170	0.05		35	7.56		32.000	0.011		0.024	0.017	0.044

FILE: Cullaton\water

06-Apr-95

WATER QUALITY RESULTS
CULLATON LAKE MINE

* Collected by the Northwest Territories Water Board

		MAJOR CONSTITUENTS (mg/L)		TRACE CONSTITUENTS (ug/L)				NUTRIENTS	PHYSICAL PROPERTIES			TRACE METALS (mg/L)					
		Total Alkalinit	SO4 grav	Acidity mg/L	CN, W.A.D.	CN(t)	Hg	NO3	TSS mg/L	pH	Sp Conduct	As ug/L	Cu	Fe	Ni	Pb	Zn
	Detection Limit						0.05		1			0.500	0.001		0.001	0.005	0.005
PIEZOMETER STATION TAIL POND 1	940-19																
	June 29/93 #1	42		1		21	0.05		29	7.81		3.000	0.001		0.012	0.006	0.005
	June 29/93 #2	44		1		21	0.05		28	7.77		2.600	0.001		0.008	0.005	0.005
	July 7/93 prsvd						0.06					2.300	0.001		0.018	0.008	0.060
	July 11/93	54		3		25	0.05		4	7.72		4.400	0.003		0.011	0.005	0.015
	July 17/93 #1	56		2		29	0.05		1	7.94		3.700	0.001		0.006	0.005	0.005
	July 17/93 #2	56		2		29	0.05		1	7.95		4.800	0.001		0.004	0.005	0.055
	August 1/93 #1	56		2		30	0.05		90	7.73		12.000	0.003		0.004	0.030	0.014
	August 1/93 #2	56		2		30	0.05		25	7.74		13.000	0.001		0.001	0.011	0.023
	August 1/93 piezom	56		2		30	0.05		18	7.69		11.000	0.001		0.001	0.009	0.007
SEEPAGE EAST SIDE TAIL POND 1	940-20																
	August 20/92 *	167				0.028	0.02					1.400	0.005	0.054	0.006	0.001	0.001
	June 29/93 #1	42	150	1	6	18	0.05	2	8	7.71	8	2.500	0.002	0.390	0.003	0.005	0.005
	June 29/93 #2	44	148	1	6	19	0.05	1.8	7	7.69	7	3.200	0.001	0.430	0.001	0.005	0.005
	July 7/93 prsvd						0.05					1.300	0.001	0.390	0.004	0.005	0.170
	July 11/93	54	186	3	8	25	0.05	2.4	3	7.67	539	3.300	0.002	0.490	0.006	0.009	0.005
	July 17/93 #1	144	510	5	5	11	0.05	0.09	2	8.02	1209	1.400	0.005	0.250	0.007	0.005	0.015
	July 17/93 #2	144	510	5	5	11	0.05	0.09	5	7.98	1214	1.400	0.007	0.280	0.007	0.005	0.028
	August 1/93 #1	84	271	10	400	1460	0.1	11		7.20	758	6.100	0.018	4.500	0.030	0.025	0.025
	August 1/93 #2	84	274	9	390	1520	0.05	11		7.22	751	3.100	0.016	4.200	0.031	0.006	0.041
SEEPAGE NE CORNER TAIL POND 1	940-22																
	June 29/93 #1	42	161	1	7	20	0.05	2.1	9	7.76	447	3.700	0.001	1.000	0.006	0.005	0.005
	June 29/93 #2	42	168	1	7	20	0.05	1.9	5	7.74	440	3.700	0.005	1.000	0.006	0.005	0.005
	July 7/93 prsvd						0.05					2.300	0.001	1.000	0.001	0.009	0.014
	July 11/93	76		4		4	0.05		2	7.78		4.000	0.004		0.005	0.005	0.005
	July 17/93 #1	56		2		28	0.05		1	7.93		6.000	0.001		0.006	0.005	0.015
	July 17/93 #2	56		2		28	0.05		1	7.96		6.500	0.001		0.007	0.005	0.005
	August 1/93 #1	56	201	2	10	30	0.05	2.9		7.76	556	10.400	0.001	1.400	0.001	0.023	0.016
	August 1/93 #2	56	212	2	9	31	0.05	2.8		7.74	551	11.000	0.001	1.200	0.003	0.021	0.023

Cullaton Lake Tailings Area

Thermistor Readings

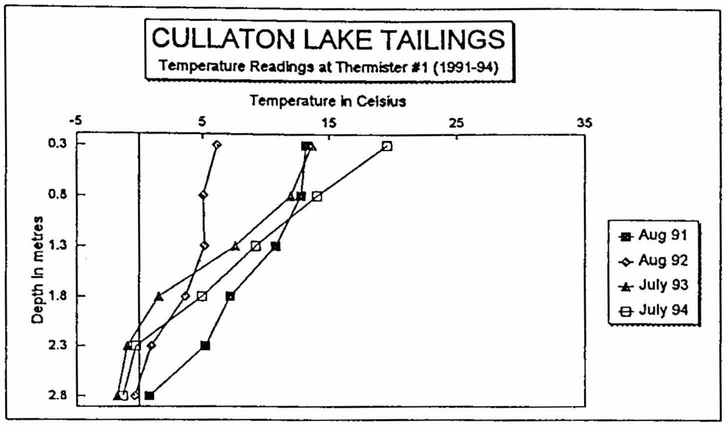
TEMP. AT CULLATON LAKE THERMISTORS (1991 TO 1994)

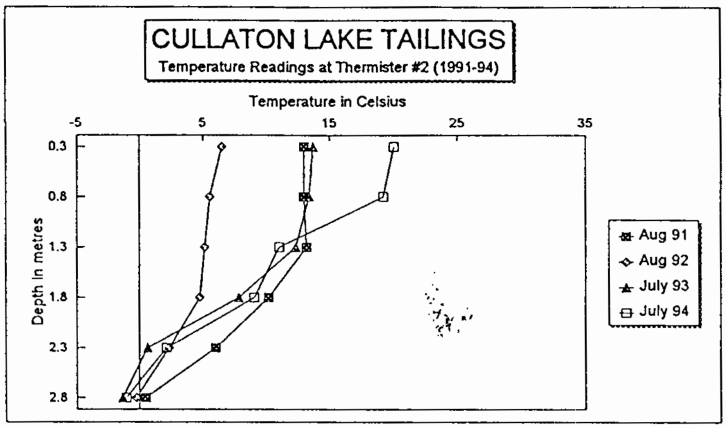
No.1	0.0	1.0	2.0	3.0	4.0	5.0
Aug 91	13.2	12.8	10.8	7.2	5.2	0.8
Sep 91	11.0	11.2	8.8	5.4	3.0	0.5
Jul 92	13.5	13.6	13.5	4.4	-0.9	-2.1
Aug 92	6.2	5.1	5.1	3.6	0.9	-0.4
Jul 93	33.1	16.0	6.8	-0.0	-1.3	-2.1
Jul 93	13.7	12.0	7.6	1.5	-1.0	-1.8
Jun 94	15.6	11.3	5.0	-0.2	-2.1	-3.3
Jul 94	15.6	11.3	4.6	-0.7	-2.6	-3.6
Jul 94	19.6	14.0	9.2	4.9	-0.2	-1.3
Sep 94	23.0	14.0	8.4	4.7	1.1	-0.9

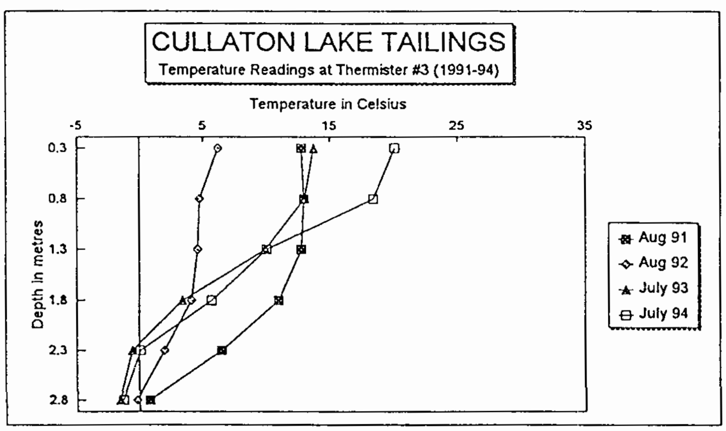
No.2	0.0	1.0	2.0	3.0	4.0	5.0
Aug 91	13.0	13.0	13.2	10.2	6.0	0.5
Sep 91	10.8	11.0	10.0	5.2	3.0	0.4
Jul 92	13.3	13.6	13.4	6.2	-0.5	-2.0
Aug 92	6.5	5.5	5.2	4.7	2.3	-0.2
Jul 93	34.5	29.4	12.4	5.2	-0.5	-1.8
Jul 93	13.7	13.4	12.3	7.8	0.6	-1.4
Jun 94	15.4	15.3	9.3	2.4	-1.1	-3.0
Jul 94	15.4	15.2	8.0	1.7	-1.8	-3.4
Jul 94	20.2	19.3	11.1	9.1	2.2	-1.0
Sep 94	16.9	9.4	7.7	5.5	2.6	-0.2

No.3	0.0	1.0	2.0	3.0	4.0	5.0
Aug 91	12.8	13.0	12.8	11.0	6.5	0.8
Sep 91	9.8	9.2	8.4	5.8	3.2	0.5
Jul 92	12.8	12.6	12.5	5.2	-0.6	-1.9
Aug 92	6.2	4.7	4.6	4.1	2.0	-0.2
Jul 93	32.5	22.0	9.2	1.2	-0.9	-1.9
Jul 93	13.8	13.1	10.0	3.4	-0.6	-1.5
Jun 94	15.3	13.6	7.0	0.1	-1.7	-3.3
Jul 94	15.3	13.6	6.8	0.0	-1.8	-3.5
Jul 94	20.2	18.5	10.1	5.7	0.1	-1.3
Sep 94	21.3	10.0	7.3	4.5	1.6	-0.4

No.4	0.0	1.0	2.0	3.0	4.0	5.0
Aug 91	15.0	14.2	16.8	12.0	6.2	1.0
Sep 91	11.0	11.5	11.0	6.8	4.0	0.6
Jul 92	12.9	13.3	12.7	5.2	-0.7	-1.7
Aug 92	6.0	4.8	4.6	4.5	2.0	-0.2
Jul 93	32.9	22.0	9.2	1.0	-1.0	-1.0
Jul 93	13.4	12.9	10.5	-3.0	-0.7	-1.5
Jun 94	15.4	13.3	6.7	-0.1	-2.0	-3.1
Jul 94	15.4	13.2	6.7	-0.2	-2.0	-3.2
Jul 94	19.5	14.5	6.8	4.2	-0.4	-1.5
Sep 94	23.1	17.5	6.8	4.5	1.0	-0.6


CULLATON LAKE TAILINGS
Temperature Readings at Thermister #1 (1991-94)
Temperature in Celsius
-5
5
15
25
35
Depth in metres
0.3
0.8
1.3
1.8
2.3
2.8
Aug 91
Aug 92
July 93
July 94


CULLATON LAKE TAILINGS
Temperature Readings at Thermister #2 (1991-94)
Temperature in Celsius
-5
5
15
25
35
Depth in metres
0.3
0.8
1.3
1.8
2.3
2.8
Aug 91
Aug 92
July 93
July 94


CULLATON LAKE TAILINGS
Temperature Readings at Thermister #3 (1991-94)
Temperature in Celsius
-5
5
15
25
35
Depth in metres
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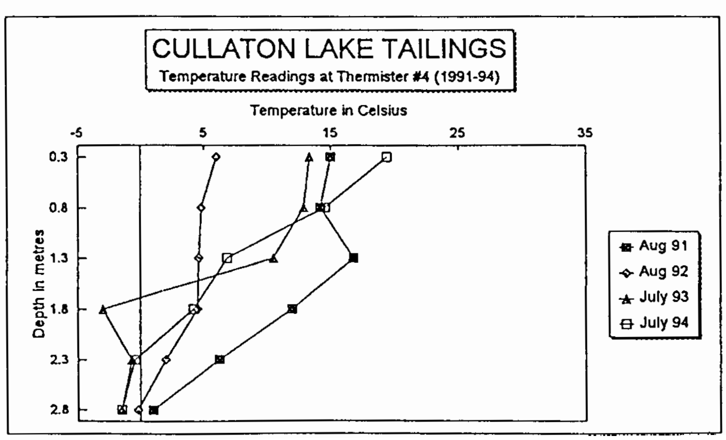
0.8
1.3
1.8
2.3
2.8
Aug 91
Aug 92
July 93
July 94


CULLATON LAKE TAILINGS
Temperature Readings at Thermister #4 (1991-94)
Temperature in Celsius
-5
5
15
25
35
Depth in metres
0.3
0.8
1.3
1.8
2.3
2.8
Aug 91
Aug 92
July 93
July 94

APPENDIX 4

CANMET Report - Column Leaching Characteristics

Shear Lake De-watering and Fish Removal

Trow Consulting Engineers 1994 Tailings Assessment Report

CANMET REPORT

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

CANMET
Canada Centre for Mineral and Energy Technology
Centre canadien de la technologie des minéraux et de l'énergie

COLUMN LEACHING CHARACTERISTICS OF CULLATON LAKE B AND SHEAR ZONE TAILINGS PHASE 1 - ROOM TEMPERATURE LEACHING

N.K. DAVE

ELLIOT LAKE LABORATORY

SEPTEMBER 1991

MINING RESEARCH LABORATORY
DIVISION REPORT MSL 91- (CF)

COLUMN LEACHING CHARACTERISTICS OF CULLATON LAKE B AND SHEAR ZONE TAILINGS PHASE 1 - ROOM TEMPERATURE LEACHING

N.K. Dave*

EXECUTIVE SUMMARY

Column leaching tests were conducted for the Cullaton Lake B and Shear Zone (S Zone) tailings to evaluate kinetically the oxidation potential and leaching characteristics at room temperature. Duplicate columns, filled with well mixed tailings from each zone, were inoculated with Thiobacilli ferro-oxidans and subjected to batch trickle leach and rest cycles. For leaching purposes, well aerated natural lake water was used and the effluent, collected weekly, was analyzed for pH, Eh, Ec, total acidity, alkalinity, SO^{-2}_4, CN^-, Fe, Cu, Ni, Zn, Pb, Hg, Sb and As. Tailings head samples were also analyzed for physical and chemical characteristics. The Cullaton Lake waste rock samples were analyzed for acid/base accounting.

The results showed that although the sulphide contents of both B and S Zone tailings were low, they readily oxidized at the favourable conditions of room temperature which represented a worst case scenario. The effects were more pronounced for the B Zone compared to the S Zone in relation to their geology of iron sulphide formation and trace metal mineralogy.

Both zones, however, also exhibited high water retention capacity and poor drainage characteristics, which controlled the oxidation rate. These conditions permitted a shallow and limited unsaturated zone near the top surface of the column which was subjected to periodic oxidation and leaching. The acidic front, however, migrated to the entire column depth.

The total loading of sulphate, acidity and iron was higher for the B Zone, but because of its low sulphur, iron and other heavy metals, the loading in terms of per cent removal was higher for the S Zone.

A high net average Neutralization Potential (NP) of 48 kg $CaCO_3$/tonne was observed for the Cullaton waste rock combined. Based on the kinetic test data for the tailings, the waste rock will be classified as non-acid generating.

Key words: Acid mine drainage; Leaching; Sulphide tailings.

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INTRODUCTION

The Cullaton Lake Gold Mines Ltd., owned by the International Corona Corporation of Vancouver (acquired in 1985), is located in the District of Keewatin, Northwest Territories at 61^{o} 16′ North latitude and 98^{o} 30′ west longitude. The property is located 416 km northwest of Churchill, Manitoba, and 620 km north of Thompson, Manitoba (Figure 1). The site is at the tree line and in the zone of discontinuous permafrost.

The Company (Cullaton Lake Gold Mines Ltd.) operated a 300 tonnes per day gold mill at the site from October 1981 to August 1985 and produced about 100,000 ounces of gold. The site has been on care and maintenance since September 1985. International Corona Corporation is now planning to decommission the mine and tailings sites.

The ore milled at the site came from two distinct orebodies, namely B and Shear (S) Zones. A total of 373,000 tonnes of ore was processed at the mill, of which 150,000 tonnes came from the B Zone, and the balance of 223,000 tonnes from the Shear Zone. The B Zone is located at the mill site, and the Shear Zone is located approximately 5 km to the north (Figure 2).

The Cullaton Lake B Zone deposit is a gold-bearing iron formation in a turbiditic sedimentary basin which forms part of the Rankin Inlet - Ennadi Archean greenstone belt in the Keewatin district of the Northwest Territories. The belt consists of clastic sediments (turbidites), pillow lavas and iron formations. This assemblage is indicative of an eugeosynclinal environment.

The B Zone iron formation consists of four distinct facies, namely, carbonate, silicate, oxide and sulphide. The gold mineralization is confined in a strata bound nature to the sulphide facies iron formation. Pyrrhotite and pyrite are the dominant sulphides with lesser amounts of arsenopyrite and chalcopyrite. Gold occurs free in the non-metalliferous gangue and shows no preference for any one sulphide [Page 1983; Trow, 1991].

The Shear Zone is located in a discontinuous ridge outcrop of orthoquartzite. Gold occurs in the fractured and sheared orthoquartzite at the Shear Zone deposit. Mineralization is found in altered shears, breccia zones, pyritic shears, and pyritic sericitic impure quartzite [Chataway, 1983; Trow, 1991].

Because of pyrite, pyrrhotite and other reactive sulphide mineralization of the orebodies, the acid mine drainage issue from tailings and waste rock needs to be addressed in preparation for a final decommissioning plan for the site. International Corona Corporation contracted Elliot Lake Laboratory, CANMET, Energy, Mines and Resources Canada, Elliot Lake, Ontario, to conduct detailed kinetic leaching tests on Cullaton Lake B and S Zone tailings (see Appendix A). Results of the column leaching tests performed at room temperature and under conditions of batch leaching and rest cycles are presented here.

These tests represented a worst case scenario of favourable oxidation and leaching conditions at room temperature (25^{o}C). In reality, for most of the year at the northern site, ambient temperatures are quite low where both chemical and biological oxidation processes proceed slowly [Knapp, 1987]. It is further proposed that similar tests be undertaken at cold temperatures to evaluate differences in leaching characteristics, if any.

GEOLOGY AND MINERALOGY

Page [1983], and Chataway and Hanson [1983] have studied the geology and mineralogy of the Cullaton Lake area in detail. A brief summary is provided here for background.

The mine property lies within the Churchill Structural Province of the Canadian Shield in what is termed the Kaminak Subprovince, a Precambrian greenstone belt which extends from the Saskatchewan border to the Rankin Inlet.

The oldest units are intercalated volcanic and sedimentary rocks of Archean Age called the Henik Group. This group consists of heterogeneous volcanic rocks, predominantly andesite and basalt, intercalated with clastic sediments of greywacke and argillite composition.

The Archean Henik Group is separated from the Lower Proterozoic Montgomery Lake Group by a series of plutonic and associated metamorphic rocks. This sequence is comprised of various bodies of granodiorite and monzonite which have transformed the Henik Group rocks into a variety of gneisses and schists.

The lower Proterozoic Montgomery Lake Group lies unconformably above the Henik Group and the intrusive metamorphosed sequence. This group is comprised of a thick series of boulder-conglomerate, greywacke, quartzite and siltstone.

The Hurwitz Group, Aphebian in age, lies unconformably above the Montgomery Lake Group. It is comprised of a broad assemblage of clastic sedimentary rocks, including conglomerate, orthoquartzite, slate, shale, dolomite, greywacke and arkose.

A sequence of middle Proterozoic intrusive rocks consisting of granite, quartz monzonite, granodiorite, gabbro and diabase dykes intrude the rocks of the above-described groups.

B ZONE

Gold mineralization in the B Zone is confined to sulphide iron formations in the sedimentary sequence of the Henik group.

Based on dominant mineralogy, the B Zone iron formation consists of four distinct facies, namely, carbonate, oxide, silicate, and sulphide. The gold mineralization is confined in a strata bound nature to the sulphide facies iron formation. The carbonate iron formation consists of layered chert and ankerite; the oxide iron formation consists of chert, magnetite, and siderite with minor iron sulphides and chlorites, the silicate iron formation consists of chert, chlorite and minor amounts of stilpnomelane, minnesotaite and siderite, and the sulphide iron formation consists of chert, pyrrhotite, pyrite, arsenopyrite, magnetite, siderite, minor chalcopyrite and chlorite. The sulphide facies is found within, or bordering the oxide facies and ranges in thickness from 0.6 to 17.5 m.

The gold occurs free in the non-metalliferous gangue and shows no preference to any one sulphide or arsenide mineral.

The trace element content of the B Zone iron formation is comparable to that of the Algoman type iron formation with the exception of increased amounts of Au and Ag. Au and Ag are enriched in the iron formation in all lithologies, and display a positive correlation with As and S. Sr, Y, Rb, Ce, Ba, Ni and Zn form a group of elements which show a strong positive correlation within the group, and negative correlation with Au, Ag, S and As. Zn, Co, Cu and Sb as in most Algoman type deposits occur in very low abundances, and their distribution does not correlate with that of any other element. It is assumed that the local concentrations of these elements control their abundances.

The veins of the deposit contain low quantities of gold compared to lithologies that they transect.

Approximately twelve iron formations in the Cullaton Lake district occur along a strike length of 30 km and through a stratigraphic thickness of up to 15 km. The lithological control of gold in the B Zone orebody may also be found 1.8 km down strike from the deposit in the same iron formation. The same relationship was also found in an iron formation (the A Zone iron formation) 0.6 km west of the B Zone. The other iron formations of the district were sampled in outcrop and boulders, and it was demonstrated that the high gold content of sulphide lithology persists throughout the district.

The association of economic quantities of gold with sulphide iron formation suggests a sedimentary origin for the gold. The wide geographical and stratigraphic distribution of the high-gold sulphide lithology suggests that gold was introduced into the turbiditic basin in hydrothermal solution for the entire history of the basin. The localization of gold with a discrete lithology suggests that the precipitation of gold was controlled by local chemical-sedimentary conditions within the basin, rather than proximity to a discharge site. It is suggested that gold, arsenic and antimony remained in solution as thio complexes. Precipitation of these elements was prompted by the reduction of reduced sulphur species as a consequence of the local precipitation of iron sulphides.

SHEAR ZONE

The Shear Zone area is underlain by orthoquartzite and slate, shale and siltstone. The former occurs as a discontinuous ridge of outcrop extending almost the length of the property in a north-south direction.

The orthoquartzite is white with variations of pink to red, fine-grained to glassy, and varies from thin bedded to thick bedded or massive. Typically, the orthoquartzite is composed of 97% or more quartz, with only scattered sericite, feldspar and magnetite. Less pure quartzites occurring in the lower part of the unit are commonly sheared and contain sericite and pyrite.

A greywacke underlies the orthoquartzites with a conformable contact indicating the greywacke is a part of the Hurwitz Group and not the Henik volcanic. The thinly bedded shale, slate and siltstone unit occurs stratigraphically above the orthoquartzite and the contact area is an interbedded transition zone of siltstone and quartzites with strong hematitic staining.

Gold occurs in the fractured and sheared orthoquartzite in the Shear Zone orebody. Mineralization is found in: a) altered shears; b) breccia zones; c) pyritic shears; and d) pyritic sericitic impure quartzite.

The altered Shear Zones are extensive and related to the regional structural patterns. Alteration products common to most zones are saponite, limonite, and hematite with occasional chlorite, epidote and sericite. Quartz and tourmaline are present in some zones. Gold occurs as free gold visibly as sheared flecks or as fine nuggets and as a residue after the transformation of auriferous pyrite to limonite.

A vuggy quartz pyritic quartzite breccia containing gold appears within an altered Shear Zone having pyrite with milky white quartz matrix.

Unaltered Shear Zones consisting of closely spaced pyrite-filled fractures are also gold bearing. The pyrite occurs as loosely packed filling in the fractures. Generally, these zones are narrow and appear discontinuous.

A different type of gold mineralization was observed in the impure sheared sericitic quartzite consisting of 5 to 15% pyrite (8% average), disseminated to semi-massive in places. The alteration products of the Shear Zones are not present, but strong sericite and/or epidote is present in the sheared rock, possibly having been introduced post-deformation.

A characteristic feature of the auriferous zones is a pyritic halo extending from 0.5 to 6 m. The pyrite content averages 2 to 3%, but can be as much as 15%. Generally, the pyritic halo has a low gold content.

KINETIC LEACHING TESTS

METHOD

Column lysimeter leaching tests were conducted for both B and Shear Zone tailings at room temperature (25^{o}), to determine kinetically the leaching characteristics at favourable weathering conditions (worst case scenario).

A total of four columns were set-up for these tests, two for each of the B and S Zone. Initially, it was considered to conduct such tests in triplicates, but the quantity of the material at hand permitted tests in duplicates only. Each leaching column consisted of a clear plexiglass tube, 80 cm in height and 12.5 cm in diameter, the bottom of which contained 7.5 cm thick layers of clean gravel and sand for bed support and filter purposes (Figure 3).

Cullaton Lake tailings for B and S Zones were separately homogenized, as received, using a clean cement mixer and were charged into respective columns. Each B and S zone column contained 12.5 and 9.7 kg of tailings, respectively.

For physical and chemical characterization of tailings prior to leaching, appropriate amounts of head samples were collected, homogenized and analyzed for each zone, for moisture content, dry bulk and grain densities, particle size distribution, paste pH, total sulphur, net neutralization potential, and total cyanide, Kjedhal nitrogen, phosphorus and total metals: Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sr, Th, Ti, U, V, Zn.

The leaching procedure consisted of the introduction of water at the column top and collection of the effluent from the bottom of the sand-gravel filter bed. The drainage tube was fitted with a water trap to prevent the entry of air from the bottom and its height was adjusted so that the water table in the column was at the sand-tailings interface. The complete experimental set-up is shown in Figure 4.

At the start of the experiment all the columns were inoculated with 250 mL of underground leaching solution containing various strains of thiobacilli ferro-oxidans, obtained from one of the Elliot Lake area mines employing in situ leaching of pyritic uranium ore. The columns were first allowed to settle and acclimatize for a week to allow the leaching solution to disperse throughout the tailings mass.

The columns were then batch leached by adding 500 mL of fresh water once every week for 34 weeks. For leaching purpose, the water used was collected from one of the area lakes, Gravelpit Lake, on a weekly basis and kept at room temperature and well aerated.

The water percolated freely through the column transporting dissolved oxidation reaction products and other soluble salts, and was collected as an effluent in a narrow neck sample bottle. Progressively with time, the tailings were observed to have increased water retention and poor drainage, causing ponding of water on the tailings surface. This prevented adequate air exposure and establishment of unsaturated conditions within tailings for proper oxidation and leaching. Larger leaching volumes (1 L per week as desired) were thus excluded.

A weekly composite effluent sample was collected, its volume and temperature measured, and analyzed on a weekly basis for 34 weeks. The measured parameters were pH, electrical conductance Ec, redox potential Eh, total acidity and alkalinity, total dissolved cyanide CN^-, and SO_4^{-2}, and total dissolved metals: Fe, Cu, Ni, Pb, Zn, As, Hg, and Sb.

Near the termination of the experiment, it was observed that the columns were retaining (in large amounts) and plugging up with sludge material which caused much reduced drainage. This phenomenon was more pronounced for B Zone than S Zone tailings. All four columns (both B and S Zones) were then flushed with an additional 500 mL of water and drained completely using a vacuum suction. The columns were then leached again for an additional two week period. At the completion of tests, solid core samples were taken from each column and analyzed for moisture content and paste pH.

RESULTS AND DISCUSSION

Tables 1 and 2 show the physicai, chemical and acid-base accounts for the two tailings types. The leaching characteristics in terms of the effluent quantity, quality and chemical composition are shown respectively for B and S Zones in Tables 3 and 4. Figures 5 through 22 and 23 through 40, illustrate the leaching profiles with time for the two zones for weekly effluent volume collected, total accumulated volume, effluent temperature, pH, Ec, Eh, total acidity, total alkalinity, sulphate, total dissolved Fe, Sb, As, Cu, CN_{tot}, Pb, Hg, Ni and Zn, respectively.

The oxidation and mobilization of reaction products are clearly evident for both zones, although markedly different. The B Zone tailings, which were characterized by a dark greenish grey colour, finer particle size (d_{50} = 65 μm, Figure 41), higher iron and sulphur contents and a negative net neutralization potential of -31.6 kg $CaCO_3$/tonne, showed rapid oxidation with pH dropping from 8 to 3 within 20 days. Acidity increased within 15 days from zero to a maximum of 8000 mg/L at 50 days, alkalinity decreased from 140 mg/L to zero within a week with a corresponding increase in parameters such as Ec, Eh, SO_4^{-2}, Fe and trace amounts of Sb. Unlike the continuous oxidation process of the iron sulphide formation, the B Zone leaching trends showed a characteristic peak at approximately 25 to 50 days, depending on the parameter and which gradually decreased to its initial or below initial value. For example, both Ec and SO_4^{-2} peaked at approximately 25 days and dropped below initial values after 100 days.

The pH, however, remained depressed throughout the experiment, except at the termination of the test when unplugging of the columns by suction altered the pH to 7.8 in one of the columns, B-2. This also increased the alkalinity and other trace metal concentrations, for example Cu, Ni and Zn, which were less than 0.1 mg/L throughout the experiment. Pb was present in measurable amounts, around 0.2 mg/L, up to 50 days, decreasing to less than 0.1 mg/L onwards. Trace amounts of As, 0.1 to 0.2 mg/L, were also detected initially, decreasing to below detection (<0.01 mg/L) after acidification. Because of the decreased pH, total CN was absent in the effluent except in occasional trace amounts of <0.05 mg/L. No mercury was detected except in some isolated instances which are attributed to instrumental undercorrection with the varying sample matrix. All these results correlate well with the iron sulphide matrix containing trace heavy metals associated with the gold mineralization of the B Zone. The short term oxidation and a rapid peaking of the parameter concentrations is an anomaly not found in other leaching experiments of low sulphide tailings of Elliot Lake deposits or massive sulphides of base metal mines. For the B Zone, a total of 7.8% S, 0.6% Fe, 0.3% Cu, 0.02% Ni, 0.06% Zn and 0.02% Pb was removed during the leaching period (Table 5).

For the S Zone, with its characteristic brownish-orange tailings, coarser particle size (d_{50} = 100 μm, Figure 42), low iron and sulphur contents and less negative net neutralization potential of -14.29 kg $CaCO_3$/tonne, the oxidation started slowly at around the 100 day mark with decreasing pH, increasing acidity and dissolved metal concentrations. Data for the S Zone also showed a peaking trend but with broad and less distinct peaks compared to those observed for the B Zone. The oxidation was marginal with Fe and SO_4^{-2} increasing from 0 to 300 and 2000 to 3200 mg/L, respectively. Cu, Ni and Zn also showed increased concentrations with decreasing pH. A slight increase in Pb concentration was also observed, but not distinctly. No changes in parameters such as CN, As, Sb, Hg were observed which were already near detection limits. The observed buffering capacity, and hence, the total residual alkalinity of the S Zone was higher than that of the B Zone. For the S Zone a total of 20.2% S, 0.3% Fe, 1.1% Cu, 3.1% Ni, 0.5% Zn and 0.9% Pb was removed during the same leaching period (Table 5).

Common to both the zones were the variations between column duplicates, which were more pronounced for the S Zone. This may be attributable to coarser particle size of S Zone tailings and channelling.

The data clearly showed that although the sulphide contents of both B and S Zones tailings were very low (2.34 and 0.51%, respectively), both tailings oxidized easily under favourable laboratory conditions. The kinetic tests thus confirmed the reactivity of tailings as determined by their net negative neutralization potentials obtained during static acid-base accounting.

The kinetic rate of oxidation, total acidity generated and loadings for iron and sulphate were higher for the B Zone than those for the S Zone tailings. Total loading and percent removal for Cu, Ni, Zn, and Pb, on the other hand, were higher for the S Zone as shown in Table 5 and Figure 43. The rate of sulphate production per kg of waste per week and cumulative percent sulphur consumed are shown in Tables 6 and 7, and in Figures 44 and 47 for B and S Zones, respectively. Although sulphur oxidation rates were lower for the S Zone, the total sulphur consumption was 2.5 times greater than that for the B Zone.

A buffering trend in both systems was observed around pH 3, probably because of their silicate matrix. Carbonate alkalinity was not readily evident from either static or kinetic tests.

Data for moisture and paste pH profiles as a function of depth, for various columns (Tables 8 and 9) at the termination of the experiment, suggested that both B and S Zone tailings in the column tests were in a high degree of moisture saturation near the top and throughout the column depths. Moisture retention and saturation for the S Zone tailings were higher (close to 100%) than those for the B Zone tailings. These conditions were readily evidenced during solid core sampling where the tailings exhibited 'slime-like' characteristics of poor consolidation and rapid liquefaction. The S Zone solid core samples were fluid-like for the entire column depths compared to B Zone tailings where the bottom half samples were partially consolidated. These observations were consistent with the measured moisture profiles (Tables 8 and 9). Calculated pore moisture saturations in excess of 100% are attributed to excess moisture retention by hydrolysis of oxidation reaction products such as Fe^{+3}, metal hydroxide sludge formation and adsorption on tailings solids. Hydrated ferric-oxyhydroxide and other metal hydroxide precipitates are known for their excess water retention capabilities (80-95% by weight).

These conditions of high water retention in the column tests permitted a shallow and limited unsaturated zone close to the tailings surface which was subjected to periodic oxidation and leaching. The rate of oxidation thus may be controlled by the degree of moisture saturation of the pore space, the latter being high for the S Zone, and hence slow oxidation.

It is interesting to note that even with these saturation conditions coupled with a low sulphide content, approximately 20% of the total sulphur was oxidized and removed from the S Zone tailings. The observed characteristic leaching peaks are attributed to the limited capacity of the available influence zone amenable to oxidation.

Saturation conditions prevailing below the exposed and unsaturated zone may be providing the rate determining factor in controlling further oxidation. The transport of oxidation reaction products depended, however, on the buffering capacity of the media.

Sedimentation, adsorption and sludge coating of the type similar to metal hydroxides were visually observable in the sand and gravel filter beds and in the drainage tubes. Because of anaerobic conditions, dark coloured mold and/or fungi was also growing in the clear plastic drainage tubes. These sediments were disturbed when suction was applied to improve drainage of the columns near the completion of the tests which is the most probable cause of increased metal concentrations near the end.

Although the columns were charged weekly with 500 mL of water, the effluent volume collected per week averaged around 350 mL. The balance of 150 mL/week represented loss to evaporation.

The influent volume represented a net precipitation of approximately 39.5 mm per week or 1343 mm for the entire 34 week period. In terms of accelerated leaching, the total volume applied corresponded to 3.36 years of total precipitation at the rate of 400 mm per year for the Collaton Lake site, based on its meteorological data. Assuming a net infiltration rate of 10%, the total accumulated volume of approximately 12 L represented in actuality, precipitation and recharge events of 23.7 years. Based on the measured physical parameters, the total accumulated flow represented pore volume exchanges of 5.2 and 6.74 times respectively for B and S Zones.

WASTE ROCK ACID/BASE ACCOUNTING

A total of six waste rock samples from the Cullaton Lake site were also analyzed for their total sulphide content, total acid production potential, total alkalinity and the net neutralization potential. Results are shown in Table 10.

Although the sulphur contents (ranging from 0.01 to 1.08 as S) of the waste rock from B and S Zones were comparable to those for the tailings, much higher net neutralization potential values, ranging from 69 to 127 kg $CaCO_3$/tonne, were obtained for the B Zone waste rock because of its carbonate content. Assuming an equal mix of waste rock from B and S Zones, other Cullaton Lake rejects and overburden, a net neutralization potential of approximately 48 kg $CaCO_3$/tonne was obtained for the combined wasterock.

Because of the observed high alkalinity and net neutralization potential of the B Zone waste rock, and the fact that there are no waste rock piles as such at the site, except in the tailings impoundment where the waste rock is disposed of with overburden and other reject fragments, kinetic leaching tests for waste rock are not necessary or advised.

CONCLUSION AND RECOMMENDATIONS

1. Although characterized by very low sulphide contents, both B and S Zones tailings had negative net neutralization potential (NP) and were amenable to oxidation and thus acid mine drainage under favourable laboratory conditions. The effects were more pronounced for the B Zone than the S Zone tailings.

2. Because of their high water retention capacity and poor drainage characteristics, the oxidation rate may have been controlled by the degree of moisture saturation of the pore space. These conditions permitted a shallow and limited unsaturated zone near the immediate top surface which was subjected to periodic oxidation and leaching. The acidic front, however, migrated to the entire column depth.

3. Although total sulphate and metal loadings in the effluent were higher for the B Zone, the total percentage of sulphur and heavy metals removed, was higher for the S Zone.

4. The tailings were significantly reactive and oxidized readily. Decommissioning and acid mine drainage control measures should include oxygen and/or moisture retention barriers. Disposal options incorporating permanent saturation under a water cover or permafrost throughout the entire depth of tailings are believed to be suitable and should be further evaluated for their economic feasibility.

5. Because of the northern location of the site, the ambient temperatures may be too low to support bacterial oxidation of metal sulphides. It is, therefore, recommended that similar kinetic tests be undertaken at lower temperatures (average for the site) to evaluate temperature effects if any.

6. For the Cullaton Lake waste rock, a high net average neutralization potential (NP) of 48 kg $CaCO_3$/tonne was obtained for all the waste rock combined. Kinetic leaching tests similar to those for the tailings are, therefore, not necessary.

REFERENCES

1. Chataway, R.T. and Hanson, W., 1983, "Cullaton Lake Gold Mines Ltd. and Royex Sturgex Mining, Shear Lake property, Cullaton Lake, N.W.T."; Summary Report, Cullaton Lake, December 1983.

2. Knapp, R.A., 1987, "The biogeochemistry of acid generation in sulphide tailings and waste rock"; Proc. Acid Mine Drainage Seminar/Workshop, Halifax, Nova Scotia, March 1987, pp. 47-65.

3. Page, Charles E., 1983, "The geology of the Cullaton Lake B-zone gold deposit, Northwest Territories"; M.Sc. Thesis, University of Waterloo, Ontario, 1983.

4. Trow Consulting Engineers Ltd., 1991, "Abandonment and restoration plan, Cullaton Lake Gold Mines Ltd.", Trow Consulting Engineers, Thunder Bay, Ontario, April 1991.

Table 1 - Physical characteristics of B and S Zone tailings

Parameter	B-Zone	S-Zone
Dry bulk density (kg)	1.85	1.67
Grain density (kg)	2.99	2.53
Moisture content wt.(%)	10.23	10.69
Porosity (%)	38.05	34.02
Wet mass of tailings in column (kg)	12.5	9.7
Total bulk vol. dry tailings (L)	6.07	5.19
Total pore vol. dry tailings (L)	2.31	1.77
% pore vol. moisture saturation	55	59
d_{10} μm	25	28
d_{50} μm	65	100
Colour	Greenish grey	Brownish orange

Table 2 - Chemical characteristics of B and S Zone tailings all units are μg/g (ppm).

Parameter	B-Zone	S-Zone
Total 'S' %	2.34	0.51
Total acid generation potential $CaCO_3$ kg/tonne	73.125	15.94
Total alkalinity, $CaCO_3$ kg/tonne	41.47	1.65
Net neutralization potential $CaCO_3$ kg/tonne	-31.655	-14.29
Ag	<30	<30
Al	20,000	4,000
As	1,600	<100
Ba	100	540
Be	<4	<4
Ca	25,000	1,300
Cd	70	<30
CN	11.1	<2
Co	<40	<40
Cr	<20	<20
Cu	60	20
Fe	190,000	29,000
Hg ppb	<2	<2
K	4,100	1,200
Mg	11,000	600
Mn	1,000	190
Mo	<10	<10
TKN as N	110	<100
Na	1,800	800
Ni	<80	<80
P	600	100
Pb	70	<40
Sr	110	<10
Th	<12	<12
Ti	800	110
U	19	<10
V	40	20
Zn	<80	<80
Zr	50	40

Table 3 - Leachate water quality parameters for the B Zone.

DATE SAMPLED	TIME (d) FROM START	COLUMN B#1 VOLUME (mL)	COLUMN B#2 VOLUME (mL)	COLUMN AVERAGE VOLUME (mL)	COLUMN AVERAGE VOL_ACC (mL)	COLUMN B#1 PH	COLUMN B#2 PH	COLUMN AVERAGE PH	COLUMN B#1 EH (mV)	COLUMN B#2 EH (mV)	COLUMN AVERAGE EH (mV)	COLUMN B#1 EH(NHE) (mV)
CULLATON LAKE	LEACHING TEST: B-ZONE #1 AND #2											
08-Nov-90	0				0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-Nov-90	7	428.0	391.8	409.9	409.9	8.230	7.520	7.875	140.3	145.3	142.8	384.3
22-Nov-90	14	419.7	376.4	398.1	808.0	4.349	5.848	5.099	163.3	54.7	109.0	407.3
29-Nov-90	21	352.8	321.7	337.3	1145.2	3.343	4.004	3.674	265.0	161.3	213.2	509.0
06-Dec-90	28	339.0	368.1	353.6	1498.7	3.314	3.673	3.494	276.0	227.0	251.5	520.0
13-Dec-90	35	407.8	402.0	404.9	1903.6	3.218	3.383	3.301	276.0	254.0	265.0	520.0
20-Dec-90	42	387.6	390.8	389.2	2292.8	3.133	3.216	3.175	281.0	270.0	275.5	525.0
27-Dec-90	49	332.1	354.7	343.4	2636.2	3.069	3.182	3.126	291.0	274.0	282.5	535.0
03-Jan-91	56	345.3	440.8	393.1	3029.3	2.976	3.210	3.093	298.0	261.0	279.5	542.0
10-Jan-91	63	361.0	343.1	352.1	3381.4	2.895	3.176	3.036	315.0	277.0	296.0	559.0
17-Jan-91	70	358.3	355.0	356.7	3738.0	2.899	3.396	3.148	327.0	247.0	287.0	571.0
24-Jan-91	77	341.4	360.6	351.0	4089.0	2.780	2.658	2.719	342.0	289.0	315.5	586.0
31-Jan-91	84	373.6	337.8	355.7	4444.7	2.857	3.537	3.197	350.0	237.0	293.5	594.0
07-Feb-91	91	366.7	374.0	370.4	4815.1	2.479	3.555	3.017	360.0	246.0	303.0	604.0
14-Feb-91	98	362.1	364.1	363.1	5178.2	2.860	3.670	3.265	358.0	225.0	291.5	602.0
21-Feb-91	105	366.4	348.5	357.5	5535.6	2.881	3.637	3.259	359.0	239.0	299.0	603.0
28-Feb-91	112	335.7	363.3	349.5	5885.1	2.891	3.842	3.367	373.0	221.0	297.0	617.0
07-Mar-91	119	362.8	357.5	360.2	6245.3	2.853	3.813	3.333	379.0	220.0	299.5	623.0
14-Mar-91	126	347.1	355.2	351.2	6596.4	2.907	3.861	3.384	380.0	223.0	301.5	624.0
21-Mar-91	133	353.8	332.7	343.3	6939.7	2.938	3.931	3.435	405.0	220.0	312.5	649.0
04-Apr-91	147	342.7	217.9	280.3	7220.0	2.808	3.798	3.303	424.0	211.0	317.5	668.0
11-Apr-91	154	220.7	308.7	264.7	7484.7	2.788	3.779	3.284	452.0	227.0	339.5	696.0
18-Apr-91	161	365.7	343.8	354.8	7839.4	2.878	3.916	3.397	441.0	224.0	332.5	685.0
25-Apr-91	168	360.1	351.2	355.7	8195.1	2.853	4.001	3.427	436.0	220.0	328.0	680.0
02-May-91	175	360.0	357.6	358.8	8553.9	2.822	3.908	3.365	486.0	234.0	360.0	730.0
09-May-91	182	376.6	354.7	365.7	8919.5	2.921	4.017	3.469	490.0	224.0	357.0	734.0
16-May-91	189	372.3	357.5	364.9	9284.4	2.903	3.802	3.353	507.0	257.0	382.0	751.0
23-May-91	196	386.2	391.6	388.9	9673.3	2.937	3.951	3.444	499.0	233.0	366.0	743.0
30-May-91	203	407.2	391.1	399.2	10072.4	2.962	3.944	3.453	501.0	256.0	378.5	745.0
06-Jun-91	210	355.5	297.2	326.4	10398.8	2.929	3.937	3.433	498.0	250.0	374.0	742.0
13-Jun-91	217	398.5	267.0	332.8	10731.5	3.009	4.007	3.508	512.0	246.0	379.0	756.0
20-Jun-91	224	387.5	310.0	348.8	11080.3	2.864	3.115	2.990	542.0	422.0	482.0	786.0
27-Jun-91	231	430.8	420.7	425.8	11506.0	3.203	4.766	3.985	504.0	258.0	381.0	748.0
04-Jul-91	238	458.5	416.8	437.7	11943.7	3.136	7.828	5.482	523.0	247.0	385.0	767.0

Cont.

Table 3 - cont.

DATE SAMPLED	COLUMN B#2 EH (NHE) (mV)	COLUMN AVERAGE EH (NHE) (mV)	COLUMN B#1 EC (US)	COLUMN B#2 EC (US)	COLUMN AVERAGE EC (US)	COLUMN B#1 TEMP (DEG.C)	COLUMN B#2 TEMP (DEG.C)	COLUMN AVERAGE TEMP (DEG.C)	COLUMN B#1 ACIDITY (mg/L)	COLUMN B#2 ACIDITY (mg/L)	COLUMN AVERAGE ACIDITY (mg/L)	COLUMN B#1 ALKALINITY (mg/L)
CULLATON LAKE												
08-Nov-90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-Nov-90	389.3	386.8	7390	7330	7360	25.0	25.0	25.0	0.00	0.00	0.00	140.07
22-Nov-90	298.7	353.0	9260	8570	8915	23.0	23.0	23.0	579.30	256.01	417.66	0.00
29-Nov-90	405.3	457.2	12070	10500	11285	22.0	22.0	22.0	3164.98	1605.86	2385.42	0.00
06-Dec-90	471.0	495.5	20850	18250	19550	23.0	22.0	22.5	4983.46	3455.87	4219.67	0.00
13-Dec-90	498.0	509.0	15470	14520	14995	22.0	22.0	22.0	6686.35	6035.24	6360.80	0.00
20-Dec-90	514.0	519.5	14390	14390	14390	21.0	20.5	20.8	7637.96	7788.22	7713.09	0.00
27-Dec-90	518.0	526.5	13400	13790	13595	24.0	24.0	24.0	7995.68	8414.28	8204.98	0.00
03-Jan-91	505.0	523.5	10960	11290	11125	21.0	21.0	21.0	7462.67	7988.56	7725.62	0.00
10-Jan-91	521.0	540.0	8560	8640	8600	21.0	20.5	20.8	5884.99	6460.97	6172.98	0.00
17-Jan-91	491.0	531.0	7350	7340	7345	23.0	22.5	22.8	4507.65	4883.29	4695.47	0.00
24-Jan-91	533.0	559.5	4930	5680	5305	19.0	19.0	19.0	3556.04	3856.55	3706.30	0.00
31-Jan-91	481.0	537.5	4520	4380	4450	21.0	20.5	20.8	2764.69	2995.08	2879.89	0.00
07-Feb-91	490.0	547.0	4540	4090	4315	22.0	22.0	22.0	2123.60	2394.06	2258.83	0.00
14-Feb-91	469.0	535.5	3850	3740	3795	21.5	21.5	21.5	1943.30	2143.64	2043.47	0.00
21-Feb-91	483.0	543.0	4330	4200	4265	21.5	22.0	21.8	3606.12	1804.32	2705.22	0.00
28-Feb-91	465.0	541.0	4010	3840	3925	21.5	21.0	21.3	1327.25	1464.99	1396.12	0.00
07-Mar-91	464.0	543.5	3800	3610	3705	20.5	20.5	20.5	1126.91	1264.65	1195.78	0.00
14-Mar-91	467.0	545.5	3650	3450	3550	21.0	20.5	20.8	941.25	1029.10	985.18	0.00
21-Mar-91	464.0	556.5	3520	3330	3425	21.5	22.0	21.8	1079.30	898.58	988.94	0.00
04-Apr-91	455.0	561.5	3860	3540	3700	21.0	21.0	21.0	627.50	753.00	690.25	0.00
11-Apr-91	471.0	583.5	3690	3450	3570	20.5	20.5	20.5	426.70	715.35	571.03	0.00
18-Apr-91	468.0	576.5	3270	3060	3165	21.0	21.0	21.0	451.17	671.74	561.46	0.00
25-Apr-91	464.0	572.0	2980	2740	2860	22.0	22.0	22.0	473.73	584.01	528.87	0.00
02-May-91	478.0	604.0	3530	3180	3355	21.5	21.5	21.5	481.25	511.33	496.29	0.00
09-May-91	468.0	601.0	3500	3210	3355	22.0	22.0	22.0	360.94	466.21	413.58	0.00
16-May-91	501.0	626.0	3600	3300	3450	24.5	24.0	24.3	322.14	421.06	371.60	0.00
23-May-91	477.0	610.0	3250	2980	3115	24.0	24.0	24.0	220.68	375.40	298.04	0.00
30-May-91	500.0	622.5	2990	2740	2865	22.5	22.5	22.5	246.04	339.89	292.97	0.00
06-Jun-91	494.0	618.0	3240	2950	3095	21.5	21.5	21.5	225.75	294.23	259.99	0.00
13-Jun-91	490.0	623.0	3360	2890	3125	22.0	22.0	22.0	152.19	291.70	221.95	0.00
20-Jun-91	666.0	726.0	3470	3290	3380	22.5	22.5	22.5	182.63	169.95	176.29	0.00
27-Jun-91	502.0	625.0	3330	3160	3245	25.0	24.5	24.8	121.75	58.34	90.05	0.00
04-Jul-91	491.0	629.0	3660	3440	3550	23.5	23.5	23.5	111.61	0.00	55.81	0.00

Cont.

Table 3 - cont.

DATE SAMPLED	COLUMN B#2 ALKALINITY (mg/L)	COLUMN AVERAGE ALKALINITY (mg/L)	COLUMN B#1 Cu (mg/L)	COLUMN B#2 Cu (mg/L)	COLUMN AVERAGE Cu (mg/L)	COLUMN B#1 Fe TOTAL (mg/L)	COLUMN B#2 Fe TOTAL (mg/L)	COLUMN AVERAGE Fe TOTAL (mg/L)	COLUMN B#1 Ni (mg/L)	COLUMN B#2 Ni (mg/L)	COLUMN AVERAGE Ni (mg/L)	COLUMN B#1 Pb (mg/L)
CULLATON LAKE												
08-Nov-90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-Nov-90	132.97	136.52	0.017	0.007	0.012	0	0	0.08	0.097	0.077	0.087	0.293
22-Nov-90	8.12	4.06	0.020	0.008	0.014	254	80	166.95	0.054	0.083	0.069	0.203
29-Nov-90	0.00	0.00	0.064	0.016	0.040	1480	767	1123.50	<0.002	<0.002	0.000	0.320
06-Dec-90	0.00	0.00	0.000	0.000	0.000	2772	1862	2317.00	0.000	0.000	0.000	0.177
13-Dec-90	0.00	0.00	0.000	0.000	0.000	3676	3249	3462.50	0.000	0.000	0.000	0.247
20-Dec-90	0.00	0.00	0.000	0.000	0.000	4143	4001	4072.00	0.000	0.000	0.000	0.256
27-Dec-90	0.00	0.00	0.000	0.000	0.000	3346	3590	3468.00	0.000	0.000	0.000	0.197
03-Jan-91	0.00	0.00	0.000	0.000	0.000	4029	4199	4114.00	0.000	0.000	0.000	0.240
10-Jan-91	0.00	0.00	0.000	0.000	0.000	3416	3609	3512.50	0.000	0.000	0.000	0.311
17-Jan-91	0.00	0.00	0.000	0.000	0.000	2346	2622	2484.00	0.000	0.000	0.000	0.128
24-Jan-91	0.00	0.00	0.000	0.000	0.000	1678	1998	1838.00	0.000	0.000	0.000	0.133
31-Jan-91	0.00	0.00	0.000	0.000	0.000	1401	1638	1519.50	0.000	0.000	0.000	0.053
07-Feb-91	0.00	0.00	0.000	0.000	0.000	1030	1406	1218.00	0.000	0.000	0.000	0.152
14-Feb-91	0.00	0.00	0.000	0.000	0.000	983.2	1164.0	1073.60	0.000	0.000	0.000	0.078
21-Feb-91	0.00	0.00	0.000	0.000	0.000	789.6	949.0	869.30	0.000	0.000	0.000	0.044
28-Feb-91	0.00	0.00	0.000	0.000	0.000	584.6	777.5	681.05	0.001	0.000	0.000	0.040
07-Mar-91	0.00	0.00	0.000	0.000	0.000	497.6	701.7	599.65	0.000	0.000	0.000	0.062
14-Mar-91	0.00	0.00	0.000	0.000	0.000	418.8	585.8	502.30	0.000	0.000	0.000	0.030
21-Mar-91	0.00	0.00	0.000	0.000	0.000	299.8	473.6	386.70	0.000	0.000	0.000	0.031
04-Apr-91	0.00	0.00	0.003	0.000	0.001	193.700	412.700	303.20	0.012	0.000	0.006	0.035
11-Apr-91	0.00	0.00	0.013	0.000	0.006	89.570	94.690	92.13	0.040	0.000	0.020	0.000
18-Apr-91	0.00	0.00	0.000	0.000	0.000	108.400	343.900	226.15	0.014	0.000	0.007	0.055
25-Apr-91	0.00	0.00	0.000	0.000	0.000	124.500	289.200	206.85	0.002	0.000	0.001	0.046
02-May-91	0.00	0.00	0.000	0.000	0.000	76.660	246.900	161.78	0.000	0.000	0.000	0.000
09-May-91	0.00	0.00	0.000	0.000	0.000	70.660	211.300	140.98	0.000	0.000	0.000	0.000
16-May-91	0.00	0.00	0.022	0.000	0.011	42.320	170.000	106.16	0.015	0.000	0.008	0.015
23-May-91	0.00	0.00	0.001	0.000	0.001	35.190	159.000	97.10	0.002	0.000	0.001	0.000
30-May-91	0.00	0.00	0.003	0.000	0.001	35.130	150.400	92.77	0.002	0.000	0.001	0.000
06-Jun-91	0.00	0.00	0.016	0.000	0.008	30.490	127.600	79.05	0.000	0.000	0.000	0.170
13-Jun-91	0.00	0.00	0.030	0.010	0.020	3.997	118.700	61.35	0.056	0.006	0.031	0.000
20-Jun-91	0.00	0.00	0.640	0.071	0.356	6.093	22.490	14.29	0.325	0.044	0.184	0.045
27-Jun-91	2.54	1.27	0.060	0.113	0.087	1.482	1.553	1.52	0.054	0.029	0.041	0.015
04-Jul-91	66.99	33.50	0.007	0.046	0.026	2.352	0.000	1.18	0.000	0.020	0.010	0.000

Cont.

Table 3 - cont.

DATE SAMPLED	COLUMN B#2 Pb (mg/L)	COLUMN AVERAGE Pb (mg/L)	COLUMN B#1 Zn (mg/L)	COLUMN B#2 Zn (mg/L)	COLUMN AVERAGE Zn (mg/L)	COLUMN B#1 SULPHATE (mg/L)	COLUMN B#2 SULPHATE (mg/L)	COLUMN AVERAGE SULPHATE (mg/L)	COLUMN B#1 As (mg/L)	COLUMN B#2 As (mg/L)	COLUMN AVERAGE As (mg/L)	COLUMN B#1 Hg (mg/L)
CULLATON LAKE												
08-Nov-90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-Nov-90	0.165	0.229	0.020	0.021	0.021	5836.60	5631.69	5734.15	0.183	0.080	0.132	0.020
22-Nov-90	0.188	0.196	0.055	0.012	0.034	7597.07	7818.85	7707.96	0.161	0.080	0.121	0.020
29-Nov-90	0.213	0.267	0.101	0.020	0.061	11040.62	9447.14	10243.88	0.080	0.080	0.080	0.078
06-Dec-90	0.136	0.157	0.072	0.021	0.046	24608.14	11706.84	18157.49	0.000	0.000	0.000	0.000
13-Dec-90	0.223	0.235	0.095	0.036	0.066	14989.35	14349.22	14669.29	0.000	0.000	0.000	0.000
20-Dec-90	0.242	0.249	0.095	0.056	0.076	15477.82	15088.86	15283.34	0.000	0.000	0.000	0.000
27-Dec-90	0.213	0.205	0.071	0.046	0.058	10295.96	11547.55	10921.76	0.000	0.000	0.000	0.000
03-Jan-91	0.249	0.245	0.101	0.058	0.080	11168.01	11005.63	11086.82	0.000	0.000	0.000	0.000
10-Jan-91	0.252	0.281	0.098	0.062	0.080	8635.49	8671.16	8653.33	0.000	0.000	0.000	0.000
17-Jan-91	0.186	0.157	0.067	0.043	0.055	6642.79	6543.58	6593.19	0.000	0.000	0.000	0.000
24-Jan-91	0.172	0.153	0.063	0.047	0.055	5105.38	5433.02	5269.20	0.000	0.000	0.000	0.000
31-Jan-91	0.104	0.078	0.046	0.049	0.048	4451.55	4607.31	4529.43	0.000	0.000	0.000	0.000
07-Feb-91	0.144	0.148	0.151	0.153	0.152	3684.79	3986.71	3835.75	0.000	0.000	0.000	0.000
14-Feb-91	0.135	0.106	0.142	0.135	0.138	3503.37	3371.41	3437.39	0.000	0.000	0.000	0.000
21-Feb-91	0.073	0.058	0.114	0.112	0.113	3123.84	3192.51	3158.18	0.000	0.000	0.000	0.000
28-Feb-91	0.060	0.050	0.112	0.100	0.106	2962.71	2905.38	2934.05	0.000	0.000	0.000	0.000
07-Mar-91	0.087	0.075	0.095	0.097	0.096	2728.02	2717.16	2722.59	0.000	0.000	0.000	0.000
14-Mar-91	0.045	0.037	0.081	0.104	0.092	2507.35	2548.28	2527.82	0.000	0.000	0.000	0.000
21-Mar-91	0.076	0.053	0.061	0.086	0.073	2350.89	2322.40	2336.65	0.000	0.000	0.000	0.000
04-Apr-91	0.047	0.041	0.031	0.062	0.047	2202.52	2147.07	2174.80	0.000	0.000	0.000	0.000
11-Apr-91	0.050	0.025	0.013	0.070	0.041	2029.01	2092.84	2060.93	0.000	0.000	0.000	0.000
18-Apr-91	0.012	0.033	0.015	0.051	0.033	2116.50	2171.58	2144.04	0.000	0.000	0.000	0.000
25-Apr-91	0.048	0.047	0.005	0.069	0.037	2197.93	2143.64	2170.79	0.000	0.000	0.000	0.000
02-May-91	0.045	0.023	0.022	0.047	0.035	1951.07	2024.49	1987.78	0.000	0.000	0.000	0.000
09-May-91	0.040	0.020	0.026	0.049	0.037	1867.49	1974.11	1920.80	0.000	0.000	0.000	0.000
16-May-91	0.016	0.016	0.030	0.060	0.045	1706.53	1683.06	1694.80	0.000	0.000	0.000	0.000
23-May-91	0.016	0.008	0.036	0.025	0.031	1654.89	1667.03	1660.96	0.000	0.000	0.000	0.000
30-May-91	0.203	0.102	0.019	0.032	0.026	1758.97	1751.51	1755.24	0.000	0.000	0.000	0.000
06-Jun-91	0.127	0.148	0.015	0.020	0.018	1600.02	1586.30	1593.16	0.000	0.000	0.000	0.000
13-Jun-91	0.023	0.012	0.028	0.052	0.040	1693.81	1606.35	1650.08	0.000	0.000	0.000	0.000
20-Jun-91	0.000	0.022	0.127	0.144	0.135	1752.11	1612.55	1682.33	0.000	0.000	0.000	0.000
27-Jun-91	0.016	0.015	0.019	0.041	0.030	1676.46	1582.48	1629.47	0.000	0.000	0.000	0.000
04-Jul-91	0.008	0.004	0.003	0.008	0.006	1609.06	1683.45	1646.26	0.000	0.000	0.000	0.000

Cont.

Table 3 - cont.

	COLUMN B#2	COLUMN AVERAGE	COLUMN B#1	COLUMN B#2	COLUMN AVERAGE	COLUMN B#1	COLUMN B#2	COLUMN AVERAGE
DATE SAMPLED	Hg (mg/L)	Hg (mg/L)	Sb (mg/L)	Sb (mg/L)	Sb (mg/L)	CN (mg/L)	CN (mg/L)	CN (mg/L)
CULLATON LAKE								
08-Nov-90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-Nov-90	0.020	0.020	0.097	0.076	0.087	0.000	0.000	0.000
22-Nov-90	0.020	0.020	<0.05	<0.05	0.000	0.000	0.000	0.000
29-Nov-90	0.020	0.049	0.367	0.126	0.247	0.050	0.039	0.045
06-Dec-90	0.000	0.000	0.000	0.464	0.232	0.031	0.011	0.021
13-Dec-90	0.000	0.000	0.396	0.523	0.459	0.048	0.010	0.029
20-Dec-90	0.000	0.000	0.323	0.374	0.348	0.010	0.011	0.011
27-Dec-90	0.000	0.000	0.259	0.229	0.244	0.010	0.010	0.010
03-Jan-91	0.000	0.000	0.325	0.272	0.298	0.010	0.010	0.010
10-Jan-91	0.000	0.000	0.000	0.000	0.000	0.010	0.010	0.010
17-Jan-91	0.000	0.000	0.000	0.000	0.000	0.010	0.010	0.010
24-Jan-91	0.000	0.000	0.000	0.000	0.000	0.010	0.005	0.008
31-Jan-91	0.000	0.000	0.000	0.000	0.000	0.005	0.008	0.007
07-Feb-91	0.000	0.000	0.000	0.000	0.000	0.004	0.006	0.005
14-Feb-91	0.000	0.000	0.000	0.000	0.000	0.004	0.006	0.005
21-Feb-91	0.000	0.000	0.000	0.000	0.000	0.004	0.006	0.005
28-Feb-91	0.000	0.000	0.000	0.000	0.000	0.040	0.010	0.025
07-Mar-91	0.000	0.000	0.000	0.000	0.000	0.040	0.011	0.026
14-Mar-91	0.000	0.000	0.000	0.000	0.000	0.040	0.090	0.065
21-Mar-91	0.000	0.000	0.000	0.000	0.000	0.040	0.015	0.028
04-Apr-91	0.000	0.000	0.000	0.000	0.000	0.040	0.013	0.027
11-Apr-91	0.000	0.000	0.000	0.000	0.000	0.004	0.009	0.007
18-Apr-91	0.000	0.000	0.000	0.000	0.000	0.005	0.011	0.008
25-Apr-91	0.000	0.000	0.000	0.000	0.000	0.006	0.010	0.008
02-May-91	0.000	0.000	0.000	0.000	0.000	0.005	0.007	0.006
09-May-91	0.000	0.000	0.000	0.000	0.000	0.005	0.008	0.007
16-May-91	0.000	0.000	0.000	0.000	0.000	0.006	0.004	0.005
23-May-91	0.000	0.000	0.000	0.000	0.000	0.006	0.006	0.006
30-May-91	0.000	0.000	0.000	0.000	0.000	0.005	0.007	0.006
06-Jun-91	0.000	0.000	0.000	0.000	0.000	0.005	0.006	0.006
13-Jun-91	0.000	0.000	0.000	0.000	0.000	0.004	0.006	0.005
20-Jun-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
27-Jun-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
04-Jul-91	0.000	0.000	0.000	0.000	0.000			ERR

Table 4 - Leachate water quality parameters for the S Zone.

DATE SAMPLED	TIME (d) FROM START	COLUMN S#1 VOLUME (mL)	COLUMN S#2 VOLUME (mL)	COLUMN AVERAGE VOLUME (mL)	COLUMN AVERAGE VOL_ACC (mL)	COLUMN S#1 PH	COLUMN S#2 PH	COLUMN AVERAGE PH	COLUMN S#1 EH (mV)	COLUMN S#2 EH (mV)	COLUMN AVERAGE EH (mV)	COLUMN S#1 EH (NHE) (mV)
CULLATON LAKE	LEACHING TEST: S-ZONE #1 AND #2											
08-Nov-90	0				0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-Nov-90	7	427.6	428.4	428.0	428.0	5.930	5.430	5.680	216.0	239.0	227.5	460.0
22-Nov-90	14	464.1	391.6	427.9	855.9	7.229	6.805	7.017	113.5	136.7	125.1	357.5
29-Nov-90	21	382.8	364.4	373.6	1229.5	7.338	3.334	5.336	123.7	459.0	291.4	367.7
06-Dec-90	28	355.8	391.3	373.6	1603.0	3.342	3.737	3.540	372.0	462.0	417.0	616.0
13-Dec-90	35	379.8	439.0	409.4	2012.4	7.537	7.201	7.369	141.7	166.3	154.0	385.7
20-Dec-90	42	356.9	368.4	362.7	2375.1	7.466	7.360	7.413	109.5	132.5	121.0	353.5
27-Dec-90	49	340.3	377.9	359.1	2734.2	7.419	7.414	7.417	146.0	164.3	155.2	390.0
03-Jan-91	56	373.7	348.8	361.3	3095.4	7.341	7.294	7.318	117.7	146.3	132.0	361.7
10-Jan-91	63	331.6	334.4	333.0	3428.4	7.274	4.328	5.801	135.0	390.0	262.5	379.0
17-Jan-91	70	373.7	375.5	374.6	3803.0	7.198	3.267	5.233	128.5	482.0	305.3	372.5
24-Jan-91	77	375.0	334.7	354.9	4157.9	7.358	4.869	6.114	131.5	325.0	228.3	375.5
31-Jan-91	84	345.9	381.2	363.6	4521.4	7.337	4.054	5.696	197.3	435.0	316.2	441.3
07-Feb-91	91	357.4	354.0	355.7	4877.1	7.349	3.634	5.492	165.7	458.0	311.9	409.7
14-Feb-91	98	362.1	360.3	361.2	5238.3	7.273	3.321	5.297	187.7	405.0	296.4	431.7
21-Feb-91	105	388.2	364.9	376.6	5614.9	7.247	3.095	5.171	176.5	403.0	289.8	420.5
28-Feb-91	112	378.9	359.0	369.0	5983.8	7.070	2.936	5.003	233.0	435.0	334.0	477.0
07-Mar-91	119	360.2	345.5	352.9	6336.7	4.452	2.769	3.611	356.0	541.0	448.5	600.0
14-Mar-91	126	357.0	365.2	361.1	6697.8	3.680	2.687	3.184	430.0	574.0	502.0	674.0
21-Mar-91	133	331.8	336.0	333.9	7031.7	3.492	2.698	3.095	412.0	581.0	496.5	656.0
04-Apr-91	147	361.1	340.0	350.6	7382.2	3.166	2.594	2.880	525.0	595.0	560.0	769.0
11-Apr-91	154	201.1	198.3	199.7	7581.9	3.099	2.629	2.864	429.0	589.0	509.0	673.0
18-Apr-91	161	354.8	358.3	356.6	7938.5	3.086	2.671	2.879	441.0	602.0	521.5	685.0
25-Apr-91	168	347.6	356.8	352.2	8290.7	2.977	2.630	2.804	446.0	610.0	528.0	690.0
02-May-91	175	364.1	349.6	356.9	8647.5	2.873	2.596	2.735	477.0	607.0	542.0	721.0
09-May-91	182	380.9	358.9	369.9	9017.4	2.825	2.626	2.726	582.0	609.0	595.5	826.0
16-May-91	189	357.0	354.5	355.8	9373.2	2.805	2.587	2.696	589.0	611.0	600.0	833.0
23-May-91	196	397.3	394.3	395.8	9769.0	2.773	2.562	2.668	602.0	618.0	610.0	846.0
30-May-91	203	376.9	384.0	380.5	10149.4	2.770	2.529	2.650	593.0	612.0	602.5	837.0
06-Jun-91	210	403.1	388.0	395.6	10545.0	2.722	2.584	2.653	585.0	603.0	594.0	829.0
13-Jun-91	217	382.8	421.3	402.1	10947.0	2.759	2.579	2.669	583.0	603.0	593.0	827.0
20-Jun-91	224	199.3	196.8	198.1	11145.1	2.472	2.393	2.433	591.0	610.0	600.5	835.0
27-Jun-91	231	431.6	396.8	414.2	11559.3	2.766	2.447	2.607	603.0	623.0	613.0	847.0
04-Jul-91	238	389.9	403.4	396.7	11955.9	2.740	2.447	2.594	478.0	616.0	547.0	722.0

Cont.

Table 4 - cont.

DATE SAMPLED	COLUMN S#2 EH(NHE) (mV)	COLUMN AVERAGE EH(NHE) (mV)	COLUMN S#1 EC (US)	COLUMN S#2 EC (US)	COLUMN AVERAGE EC (US)	COLUMN S#1 TEMP (DEG.C)	COLUMN S#2 TEMP (DEG.C)	COLUMN AVERAGE TEMP (DEG.C)	COLUMN S#1 ACIDITY (mg/L)	COLUMN S#2 ACIDITY (mg/L)	COLUMN AVERAGE ACIDITY (mg/L)	COLUMN S#1 ALKALINITY (mg/L)
CULLATON LAKE												
08-Nov-90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-Nov-90	483.0	471.5	3450	3280	3365	25.0	25.0	25.0	82.34	89.82	86.08	15.23
22-Nov-90	380.7	369.1	4650	4330	4490	23.0	23.0	23.0	118.24	113.19	115.72	21.32
29-Nov-90	703.0	535.4	5200	5130	5165	22.0	22.0	22.0	203.09	174.85	188.97	30.45
06-Dec-90	706.0	661.0	5320	5390	5355	22.5	22.5	22.5	300.51	225.38	262.95	0.00
13-Dec-90	410.3	398.0	4700	5260	4980	22.0	22.5	22.3	134.82	109.24	122.03	45.68
20-Dec-90	376.5	365.0	4270	4750	4510	20.5	20.0	20.3	107.52	122.10	114.81	44.66
27-Dec-90	408.3	399.2	4150	4500	4325	24.0	24.0	24.0	90.67	111.65	101.16	49.74
03-Jan-91	390.3	376.0	3780	3840	3810	21.0	21.0	21.0	108.91	146.00	127.46	27.41
10-Jan-91	634.0	506.5	3370	3320	3345	20.5	20.0	20.3	95.81	166.95	131.38	25.37
17-Jan-91	726.0	549.3	3300	3470	3385	22.5	23.0	22.8	110.19	247.33	178.76	21.32
24-Jan-91	569.0	472.3	2430	2460	2445	19.0	19.0	19.0	81.72	176.90	129.31	26.39
31-Jan-91	679.0	560.2	2420	2560	2490	22.0	22.0	22.0	120.50	269.98	195.24	26.39
07-Feb-91	702.0	555.9	2270	2540	2405	22.0	22.0	22.0	125.83	250.43	188.13	43.65
14-Feb-91	649.0	540.4	2250	2630	2440	21.5	21.5	21.5	112.07	153.58	132.83	24.36
21-Feb-91	647.0	533.8	2700	3370	3035	22.0	22.0	22.0	130.26	288.97	209.62	21.32
28-Feb-91	679.0	578.0	2670	3500	3085	21.5	21.5	21.5	171.71	487.52	329.62	14.21
07-Mar-91	785.0	692.5	2700	3680	3190	20.5	20.5	20.5	217.21	669.39	443.30	0.00
14-Mar-91	818.0	746.0	2780	3510	3145	20.5	20.5	20.5	282.94	833.66	558.30	0.00
21-Mar-91	825.0	740.5	2880	3800	3340	21.5	22.0	21.8	343.57	954.92	649.25	0.00
04-Apr-91	839.0	804.0	3290	4340	3815	21.0	21.0	21.0	389.05	1079.30	734.18	0.00
11-Apr-91	833.0	753.0	3270	4140	3705	20.0	20.0	20.0	439.25	1129.50	784.38	0.00
18-Apr-91	846.0	765.5	3010	3770	3390	21.0	21.0	21.0	446.16	1147.98	797.07	0.00
25-Apr-91	854.0	772.0	2850	3500	3175	21.5	21.5	21.5	478.74	1245.73	862.24	0.00
02-May-91	851.0	786.0	3460	4210	3835	21.5	21.5	21.5	486.26	1215.65	850.96	0.00
09-May-91	853.0	839.5	3620	4200	3910	22.0	22.0	22.0	566.47	1198.11	882.29	0.00
16-May-91	855.0	844.0	3770	4360	4065	24.0	24.0	24.0	578.32	1143.96	861.14	0.00
23-May-91	862.0	854.0	3390	3870	3630	24.0	24.0	24.0	512.37	999.38	755.88	0.00
30-May-91	856.0	846.5	3120	3570	3345	22.5	22.5	22.5	591.00	859.87	725.44	0.00
06-Jun-91	847.0	838.0	3320	3510	3415	21.5	21.5	21.5	537.74	771.10	654.42	0.00
13-Jun-91	847.0	837.0	3310	3600	3455	22.0	22.0	22.0	519.98	743.19	631.59	0.00
20-Jun-91	854.0	844.5	3890	3780	3835	22.5	22.5	22.5	446.42	662.03	554.23	0.00
27-Jun-91	867.0	857.0	3190	4040	3615	24.5	25.0	24.8	446.42	862.41	654.42	0.00
04-Jul-91	860.0	791.0	3560	4330	3945	23.5	23.5	23.5	471.79	877.63	674.71	0.00

Cont.

Table 4 - cont.

DATE SAMPLED	COLUMN S#2 ALKALINITY (mg/L)	COLUMN AVERAGE ALKALINITY (mg/L)	COLUMN S#1 Cu (mg/L)	COLUMN S#2 Cu (mg/L)	COLUMN AVERAGE Cu (mg/L)	COLUMN S#1 Fe TOTAL (mg/L)	COLUMN S#2 Fe TOTAL (mg/L)	COLUMN AVERAGE Fe TOTAL (mg/L)	COLUMN S#1 Ni (mg/L)	COLUMN S#2 Ni (mg/L)	COLUMN AVERAGE Ni (mg/L)	COLUMN S#1 Pb (mg/L)
CULLATON LAKE												
08-Nov-90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-Nov-90	5.08	10.16	0.000	0.016	0.008	0.000	0.077	0.039	0.563	0.806	0.685	0.000
22-Nov-90	7.11	14.22	0.018	0.004	0.011	0.062	0.000	0.031	0.923	0.586	0.755	0.150
29-Nov-90	0.00	15.23	0.014	0.000	0.007	0.085	1.529	0.807	0.927	0.550	0.739	0.168
06-Dec-90	0.00	0.00	0.029	0.030	0.030	8.000	0.989	4.495	0.821	0.846	0.834	0.193
13-Dec-90	22.33	34.01	0.013	0.009	0.011	0.064	0.040	0.052	0.748	0.716	0.732	0.148
20-Dec-90	34.51	39.59	0.016	0.012	0.014	0.075	0.155	0.115	0.769	0.836	0.803	0.135
27-Dec-90	29.44	39.59	0.027	0.015	0.021	0.093	0.079	0.086	0.684	1.040	0.862	0.195
03-Jan-91	23.35	25.38	0.027	0.015	0.021	0.070	0.101	0.086	0.733	1.000	0.867	0.177
10-Jan-91	0.00	12.69	0.037	0.000	0.018	0.000	0.000	0.000	0.493	0.700	0.596	0.010
17-Jan-91	0.00	10.66	0.019	0.046	0.032	0.000	0.000	0.000	0.462	0.814	0.638	0.000
24-Jan-91	1.02	13.71	0.092	0.030	0.061	0.168	0.152	0.160	0.647	1.270	0.959	0.165
31-Jan-91	0.00	13.20	0.051	0.095	0.073	0.052	0.199	0.126	0.668	1.770	1.219	0.162
07-Feb-91	0.00	21.83	0.079	0.134	0.107	0.516	1.880	1.198	0.752	2.400	1.576	0.163
14-Feb-91	0.00	12.18	0.039	0.225	0.132	0.079	22.900	11.490	0.827	3.110	1.969	0.177
21-Feb-91	0.00	10.66	0.013	0.132	0.072	0.000	33.770	16.885	0.707	2.976	1.841	0.000
28-Feb-91	0.00	7.11	0.013	0.223	0.118	0.000	55.350	27.675	0.881	3.788	2.334	0.000
07-Mar-91	0.00	0.00	0.025	0.212	0.119	0.000	80.690	40.345	1.164	3.697	2.431	0.016
14-Mar-91	0.00	0.00	0.014	0.234	0.124	0.000	149.400	74.700	1.424	4.267	2.846	0.000
21-Mar-91	0.00	0.00	0.060	0.287	0.174	3.290	219.900	111.595	1.839	3.925	2.882	0.021
04-Apr-91	0.00	0.00	0.100	0.346	0.223	4.690	231.800	118.245	2.271	4.379	3.325	0.069
11-Apr-91	0.00	0.00	0.074	0.459	0.267	17.400	237.200	127.300	2.520	4.274	3.397	0.000
18-Apr-91	0.00	0.00	0.062	0.437	0.249	22.970	247.000	134.985	2.604	4.190	3.397	0.154
25-Apr-91	0.00	0.00	0.000	0.654	0.327	39.180	306.100	172.640	2.714	3.895	3.305	0.152
02-May-91	0.00	0.00	0.062	0.564	0.313	46.920	224.400	135.660	2.573	3.422	2.998	0.315
09-May-91	0.00	0.00	0.050	0.439	0.028	65.970	288.900	177.435	2.757	2.899	2.828	0.318
16-May-91	0.00	0.00	0.047	0.482	0.264	70.470	239.200	154.835	2.531	2.914	2.723	0.338
23-May-91	0.00	0.00	0.044	0.328	0.186	76.530	219.600	148.065	2.319	2.752	2.536	0.336
30-May-91	0.00	0.00	0.030	0.230	0.130	94.600	173.800	134.200	2.253	2.046	2.150	0.355
06-Jun-91	0.00	0.00	0.020	0.182	0.101	84.500	175.100	129.800	1.929	1.547	1.738	0.321
13-Jun-91	0.00	0.00	0.057	0.273	0.165	90.860	149.300	120.080	1.862	1.639	1.751	0.328
20-Jun-91	0.00	0.00	0.382	0.763	0.572	38.590	61.750	50.170	2.141	1.362	1.752	0.484
27-Jun-91	0.00	0.00	0.514	0.803	0.659	50.190	119.100	84.645	2.302	1.646	1.974	0.637
04-Jul-91	0.00	0.00	0.301	0.653	0.477	64.110			2.086	1.603	1.845	0.776

Cont.

Table 4 - cont.

DATE SAMPLED	COLUMN S#2 Pb (mg/L)	COLUMN AVERAGE Pb (mg/L)	COLUMN S#1 Zn (mg/L)	COLUMN S#2 Zn (mg/L)	COLUMN AVERAGE Zn (mg/L)	COLUMN S#1 SULPHATE (mg/L)	COLUMN S#2 SULPHATE (mg/L)	COLUMN AVERAGE SULPHATE (mg/L)	COLUMN S#1 As (mg/L)	COLUMN S#2 As (mg/L)	COLUMN AVERAGE As (mg/L)	COLUMN S#1 Hg (mg/L)
CULLATON LAKE												
08-Nov-90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-Nov-90	0.140	0.070	0.167	0.487	0.327	2062.28	1946.83	2004.56	0.000	<0.08	0.000	0.000
22-Nov-90	0.000	0.075	0.133	0.288	0.211	2943.06	2684.81	2813.94	<0.08	0.000	0.000	<0.02
29-Nov-90	0.000	0.084	0.087	0.136	0.112	3421.10	3173.16	3297.13	<0.08	0.000	0.000	<0.02
06-Dec-90	0.204	0.199	0.073	0.157	0.115	3302.49	3446.49	3374.49	<0.08	<0.08	0.000	<0.02
13-Dec-90	0.152	0.150	0.050	0.088	0.069	2978.81	3298.99	3138.90	<0.08	<0.08	0.000	<0.02
20-Dec-90	0.143	0.139	0.054	0.062	0.058	2870.18	3257.95	3064.07	<0.08	<0.08	0.000	<0.02
27-Dec-90	0.171	0.183	0.056	0.119	0.088	2424.01	3022.40	2723.21	<0.08	<0.08	0.000	<0.02
03-Jan-91	0.182	0.180	0.070	0.101	0.086	2322.60	2603.55	2463.08	<0.08	<0.08	0.000	<0.02
10-Jan-91	0.000	0.005	0.035	0.061	0.048	2457.33	2442.03	2449.68	0.000	0.000	0.000	0.000
17-Jan-91	0.008	0.004	0.030	0.073	0.052	2161.82	2163.55	2162.69	0.000	0.000	0.000	0.000
24-Jan-91	0.232	0.199	0.064	0.132	0.098	2064.50	2103.18	2083.84	<0.08	<0.08	0.000	<0.02
31-Jan-91	0.211	0.187	0.066	0.169	0.118	1730.21	2039.41	1884.81	<0.08	<0.08	0.000	<0.02
07-Feb-91	0.318	0.241	0.080	0.236	0.158	1746.23	2120.21	1933.22	<0.08	<0.08	0.000	0.079
14-Feb-91	0.481	0.329	0.073	0.349	0.211	1798.25	2099.57	1948.91	<0.08	<0.08	0.000	0.097
21-Feb-91	0.083	0.042	0.043	0.360	0.201	1631.60	2169.97	1900.79	0.000	0.000	0.000	0.000
28-Feb-91	0.174	0.087	0.052	0.570	0.311	1764.48	2238.96	2001.72	0.000	0.000	0.000	0.000
07-Mar-91	0.304	0.160	0.109	0.674	0.391	1870.85	2322.27	2096.56	0.000	0.000	0.000	0.000
14-Mar-91	0.285	0.142	0.121	0.800	0.460	1854.59	2522.86	2188.73	0.000	0.000	0.000	0.000
21-Mar-91	0.424	0.222	0.144	0.780	0.462	1838.12	2616.38	2227.25	0.000	0.000	0.000	0.000
04-Apr-91	0.413	0.241	0.148	0.835	0.491	1939.76	2633.19	2286.48	0.000	0.000	0.000	0.000
11-Apr-91	0.361	0.181	0.187	0.903	0.545	1957.61	2647.7	2302.66	0.000	0.000	0.000	0.000
18-Apr-91	0.411	0.282	0.203	0.881	0.542	1795.72	2635.11	2215.42	0.000	0.000	0.000	0.000
25-Apr-91	0.377	0.264	0.229	0.934	0.581	2022.90	2863.57	2443.24	0.000	0.000	0.000	0.000
02-May-91	0.465	0.390	0.284	0.840	0.562	1965.43	2734.21	2349.82	0.000	0.000	0.000	0.000
09-May-91	0.406	0.362	0.327	0.734	0.530	2041.42	2499.76	2270.59	0.000	0.000	0.000	0.000
16-May-91	0.376	0.357	0.324	0.674	0.499	1810.48	2283.88	2047.18	0.000	0.000	0.000	0.000
23-May-91	0.388	0.362	0.311	0.636	0.474	1698.69	2009.32	1854.01	0.000	0.000	0.000	0.000
30-May-91	0.404	0.380	0.339	0.500	0.419	1844.89	1763.72	1804.31	0.000	0.000	0.000	0.000
06-Jun-91	0.422	0.371	0.318	0.400	0.359	1623.04	1703.57	1663.31	0.000	0.000	0.000	0.000
13-Jun-91	0.586	0.457	0.320	0.447	0.383	1560.65	791.18	1175.92	0.000	0.000	0.000	0.000
20-Jun-91	1.343	0.914	0.412	0.463	0.438	1444.31	1319.79	1382.05	0.000	0.000	0.000	0.000
27-Jun-91	1.269	0.953	0.537	0.543	0.540	1399.99	1628.25	1514.12	0.000	0.000	0.000	0.000
04-Jul-91	1.052	0.914	0.488	0.526	0.507	1343.60	1562.30	1452.95	0.000	0.000	0.000	0.000

Cont.

Table 4 - cont.

DATE SAMPLED	COLUMN S#2 Hg (mg/L)	COLUMN AVERAGE Hg (mg/L)	COLUMN S#1 Sb (mg/L)	COLUMN S#2 Sb (mg/L)	COLUMN AVERAGE Sb (mg/L)	COLUMN S#1 CN (mg/L)	COLUMN S#2 CN (mg/L)	COLUMN AVERAGE CN (mg/L)
CULLATON LAKE								
08-Nov-90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-Nov-90	<0.02	0.000	0.000	<0.05	0.000	0.000	0.000	0.000
22-Nov-90	0.000	0.000	0.051	0.000	0.026	0.000	0.000	0.000
29-Nov-90	0.000	0.000	0.051	0.000	0.026	0.086	0.020	0.053
06-Dec-90	<0.02	0.000	<0.05	<0.05	0.000	0.053	0.010	0.032
13-Dec-90	<0.02	0.000	<0.05	<0.05	0.000	0.050	0.010	0.030
20-Dec-90	<0.02	0.000	<0.05	<0.05	0.000	0.010	0.010	0.010
27-Dec-90	<0.02	0.000	<0.05	<0.05	0.000	0.010	0.010	0.010
03-Jan-91	<0.02	0.000	<0.05	<0.05	0.000	0.010	0.010	0.010
10-Jan-91	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.005
17-Jan-91	0.000	0.000	0.000	0.000	0.000	0.011	0.010	0.011
24-Jan-91	<0.02	0.000	<0.05	<0.05	0.000	0.018	0.007	0.013
31-Jan-91	0.045	0.023	<0.05	<0.05	0.000	0.008	0.005	0.007
07-Feb-91	0.096	0.088	<0.05	<0.05	0.000	0.006	0.004	0.005
14-Feb-91	0.195	0.146	<0.05	<0.05	0.000	0.006	0.004	0.005
21-Feb-91	0.000	0.000	0.000	0.000	0.000	0.005	0.004	0.005
28-Feb-91	0.000	0.000	0.000	0.000	0.000	0.005	0.004	0.005
07-Mar-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
14-Mar-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
21-Mar-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
04-Apr-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
11-Apr-91	0.000	0.020	0.000	0.000	0.000	0.004	0.004	0.004
18-Apr-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
25-Apr-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
02-May-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
09-May-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
16-May-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
23-May-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
30-May-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
06-Jun-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
13-Jun-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
20-Jun-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
27-Jun-91	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.004
04-Jul-91	0.000	0.000	0.000	0.000	0.000			ERR

Table 5 - Total loadings and mass balance of various parameters for B and S Zone tailings.

Parameter	B Zone Total Loading (mg)	B Zone % Removal of Total	S Zone Total Loading (mg)	S Zone % Removal of Total
S	10,456.8	7.8	8,970.8	20.2
Fe	12,810.9	0.6	710.4	0.3
Cu	0.22	0.03	1.85	1.1
Ni	0.18	0.02	21.70	3.1
Zn	0.57	0.06	3.72	0.5
Pb	1.29	0.02	3.25	0.9
Acidity $CaCO_3$ equivalent	25,990.8	--	5,511.0	--
Alkalinity $CaCO_3$ equivalent	80.7	--	104.6	--

Table 6 – Sulphate production and loadings for the B Zone.

		COLUMN B#1	COLUMN B#2	COLUMN B#1	COLUMN B#2	COLUMN B#1	COLUMN B#2	COLUMN AVERAGE	PRODCTN RATE	CUMMLTV LOADING	CUMMLTV LOADING	CUMMLTV LOADING
DATE SAMPLED	TIME (d) FROM START	VOLUME (mL)	VOLUME (mL)	SULPHATE (mg/L)	SULPHATE (mg/L)	SULPHATE LOADING (g/week)	SULPHATE LOADING (g/week)	SULPHATE LOADING (g/week)	SULPHATE (g/Kg/week)	SULPHATE LOADING (g)	SULPHUR CONSUMED (g)	SULPHUR CONSUMED (%)
COULTON LAKE LEACHING TEST: B-ZONE #1 AND #2												
08-Nov-90	0			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-Nov-90	7	428.0	391.8	5836.60	5631.69	2.50	2.21	2.35	0.21	2.35	0.78	0.30
22-Nov-90	14	419.7	376.4	7597.07	7818.85	3.19	2.94	3.07	0.27	5.42	1.81	0.69
29-Nov-90	21	352.8	321.7	11040.62	9447.14	3.90	3.04	3.47	0.31	8.89	2.96	1.13
06-Dec-90	28	339.0	368.1	24608.14	11706.84	8.34	4.31	6.33	0.56	15.21	5.07	1.93
13-Dec-90	35	407.8	402.0	14989.35	14349.22	6.11	5.77	5.94	0.53	21.15	7.05	2.69
20-Dec-90	42	387.6	390.8	15477.82	15088.86	6.00	5.90	5.95	0.53	27.10	9.03	3.44
27-Dec-90	49	332.1	354.7	10295.96	11547.55	3.42	4.10	3.76	0.34	30.86	10.29	3.92
03-Jan-91	56	345.3	440.8	11168.01	11005.63	3.86	4.85	4.35	0.39	35.21	11.74	4.47
10-Jan-91	63	361.0	343.1	8635.49	8671.16	3.12	2.98	3.05	0.27	38.26	12.75	4.86
17-Jan-91	70	358.3	355.0	6642.79	6543.58	2.38	2.32	2.35	0.21	40.61	13.54	5.16
24-Jan-91	77	341.4	360.6	5105.38	5433.02	1.74	1.96	1.85	0.17	42.46	14.15	5.39
31-Jan-91	84	373.6	337.8	4451.55	4607.31	1.66	1.56	1.61	0.14	44.07	14.69	5.59
07-Feb-91	91	366.7	374.0	3684.79	3986.71	1.35	1.49	1.42	0.13	45.49	15.16	5.77
14-Feb-91	98	362.1	364.1	3503.37	3371.41	1.27	1.23	1.25	0.11	46.74	15.58	5.93
21-Feb-91	105	366.4	348.5	3123.84	3192.51	1.14	1.11	1.13	0.10	47.87	15.96	6.08
28-Feb-91	112	335.7	363.3	2962.71	2905.38	0.99	1.06	1.03	0.09	48.89	16.30	6.21
07-Mar-91	119	362.8	357.5	2728.02	2717.16	0.99	0.97	0.98	0.09	49.87	16.62	6.33
14-Mar-91	126	347.1	355.2	2507.35	2548.28	0.87	0.91	0.89	0.08	50.76	16.92	6.44
21-Mar-91	133	353.8	332.7	2350.89	2322.40	0.83	0.77	0.80	0.07	51.56	17.19	6.55
04-Apr-91	147	342.7	217.9	2202.52	2147.07	0.75	0.47	0.61	0.05	52.17	17.39	6.62
11-Apr-91	154	220.7	308.7	2029.01	2092.84	0.45	0.65	0.55	0.05	52.72	17.57	6.69
18-Apr-91	161	365.7	343.8	2116.50	2171.58	0.77	0.75	0.76	0.07	53.48	17.83	6.79
25-Apr-91	168	360.1	351.2	2197.93	2143.64	0.79	0.75	0.77	0.07	54.25	18.08	6.89
02-May-91	175	360.0	357.6	1951.07	2024.49	0.70	0.72	0.71	0.06	54.97	18.32	6.98
09-May-91	182	376.6	354.7	1867.49	1974.11	0.70	0.70	0.70	0.06	55.67	18.56	7.07
16-May-91	189	372.3	357.5	1706.53	1683.06	0.64	0.60	0.62	0.06	56.29	18.76	7.15
23-May-91	196	386.2	391.6	1654.89	1667.03	0.64	0.65	0.65	0.06	56.93	18.98	7.23
30-May-91	203	407.2	391.1	1758.97	1751.51	0.72	0.69	0.70	0.06	57.63	19.21	7.32
06-Jun-91	210	355.5	297.2	1600.02	1586.30	0.57	0.47	0.52	0.05	58.15	19.38	7.38
13-Jun-91	217	398.5	267.0	1693.81	1606.35	0.67	0.43	0.55	0.05	58.71	19.57	7.45
20-Jun-91	224	387.5	310.0	1752.11	1612.55	0.68	0.50	0.59	0.05	59.29	19.76	7.53
27-Jun-91	231	430.8	420.7	1676.46	1582.48	0.72	0.67	0.69	0.06	59.99	20.00	7.62
04-Jul-91	238	458.5	416.8	1609.06	1683.45	0.74	0.70	0.72	0.06	60.71	20.24	7.71

Table 7 - Sulphate production and loadings for the S Zone.

DATE SAMPLED	TIME (d) FROM START	COLUMN S#1 VOLUME (mL)	COLUMN S#2 VOLUME (mL)	COLUMN S#1 SULPHATE (mg/L)	COLUMN S#2 SULPHATE (mg/L)	COLUMN S#1 SULPHATE LOADING (g/week)	COLUMN S#2 SULPHATE LOADING (g/week)	COLUMN AVERAGE SULPHATE LOADING (g/week)	PRODCTN RATE SULPHATE (g/Kg/week)	CUMMLTV LOADING SULPHATE LOADING (g)	CUMMLTV LOADING SULPHUR LOADING (g)	CUMMLTV LOADING SULPHUR LOADING (%)
COULTON LAKE LEACHING TEST: S-ZONE #1 AND #2												
08-Nov-90	0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-Nov-90	7	427.6	428.4	2062.28	1946.83	0.88	0.83	0.86	0.10	0.86	0.29	0.65
22-Nov-90	14	464.1	391.6	2943.06	2684.81	1.37	1.05	1.21	0.14	2.07	0.69	1.56
29-Nov-90	21	382.8	364.4	3421.10	3173.16	1.31	1.16	1.23	0.14	3.30	1.10	2.49
06-Dec-90	28	355.8	391.3	3302.49	3446.49	1.18	1.35	1.26	0.15	4.56	1.52	3.44
13-Dec-90	35	379.8	439.0	2978.81	3298.99	1.13	1.45	1.29	0.15	5.85	1.95	4.41
20-Dec-90	42	356.9	368.4	2870.18	3257.95	1.02	1.20	1.11	0.13	6.96	2.32	5.25
27-Dec-90	49	340.3	377.9	2424.01	3022.40	0.82	1.14	0.98	0.11	7.95	2.65	6.00
03-Jan-91	56	373.7	348.8	2322.60	2603.55	0.87	0.91	0.89	0.10	8.83	2.94	6.67
10-Jan-91	63	331.6	334.4	2457.33	2442.03	0.81	0.82	0.82	0.09	9.65	3.22	7.28
17-Jan-91	70	373.7	375.5	2161.82	2163.55	0.81	0.81	0.81	0.09	10.46	3.49	7.89
24-Jan-91	77	375.0	334.7	2064.50	2103.18	0.77	0.70	0.74	0.09	11.20	3.73	8.45
31-Jan-91	84	345.9	381.2	1730.21	2039.41	0.60	0.78	0.69	0.08	11.89	3.96	8.97
07-Feb-91	91	357.4	354.0	1746.23	2120.21	0.62	0.75	0.69	0.08	12.58	4.19	9.49
14-Feb-91	98	362.1	360.3	1798.25	2099.57	0.65	0.76	0.70	0.08	13.28	4.43	10.02
21-Feb-91	105	388.2	364.9	1631.60	2169.97	0.63	0.79	0.71	0.08	13.99	4.66	10.56
28-Feb-91	112	378.9	359.0	1764.48	2238.96	0.67	0.80	0.74	0.09	14.73	4.91	11.11
07-Mar-91	119	360.2	345.5	1870.85	2322.27	0.67	0.80	0.74	0.09	15.47	5.16	11.67
14-Mar-91	126	357.0	365.2	1854.59	2522.86	0.66	0.92	0.79	0.09	16.26	5.42	12.27
21-Mar-91	133	331.8	336.0	1838.12	2616.38	0.61	0.88	0.74	0.09	17.00	5.67	12.83
04-Apr-91	147	361.1	340.0	1939.76	2633.19	0.70	0.90	0.80	0.09	17.80	5.93	13.43
11-Apr-91	154	201.1	198.3	1957.61	2647.70	0.39	0.53	0.46	0.05	18.26	6.09	13.78
18-Apr-91	161	354.8	358.3	1795.72	2635.11	0.64	0.94	0.79	0.09	19.05	6.35	14.37
25-Apr-91	168	347.6	356.8	2022.90	2863.57	0.70	1.02	0.86	0.10	19.91	6.64	15.02
02-May-91	175	364.1	349.6	1965.43	2734.21	0.72	0.96	0.84	0.10	20.75	6.92	15.65
09-May-91	182	380.9	358.9	2041.42	2499.76	0.78	0.90	0.84	0.10	21.59	7.20	16.29
16-May-91	189	357.0	354.5	1810.48	2283.88	0.65	0.81	0.73	0.08	22.31	7.44	16.84
23-May-91	196	397.3	394.3	1698.69	2009.32	0.67	0.79	0.73	0.08	23.05	7.68	17.39
30-May-91	203	376.9	384.0	1844.89	1763.72	0.70	0.68	0.69	0.08	23.73	7.91	17.91
06-Jun-91	210	403.1	388.0	1623.04	1703.57	0.65	0.66	0.66	0.08	24.39	8.13	18.40
13-Jun-91	217	382.8	421.3	1560.65	791.18	0.60	0.33	0.47	0.05	24.86	8.29	18.75
20-Jun-91	224	199.3	196.8	1444.31	1319.79	0.29	0.26	0.27	0.03	25.13	8.38	18.96
27-Jun-91	231	431.6	396.8	1399.99	1628.25	0.60	0.65	0.63	0.07	25.76	8.59	19.43
04-Jul-91	238	389.9	403.4	1343.60	1562.30	0.52	0.63	0.58	0.07	26.33	8.78	19.87

Table 7 - Moisture distribution and paste pH for B Zone columns as a function of column depth at the termination of the experiment.

Sample No.		Depth (cm)	Wet Weight (g)	Dry Weight (g)	Weight Moisture wt (%)	Pore Vol. Moisture Saturation (%)	Paste pH
B Zone-1	1	1.25	35.37	29.06	17.84	105.4	6.420
	2	3.75	34.88	29.20	16.28	93.3	6.346
	3	6.25	35.65	30.04	15.74	90.6	6.338
	4	8.75	34.94	29.66	15.11	86.4	6.481
	5	11.25	33.28	28.21	15.23	87.2	6.162
	6	13.75	32.82	27.70	15.60	89.7	6.133
	7	16.25	33.25	27.94	15.97	92.2	6.353
	8	18.75	37.78	31.78	15.88	91.6	6.145
	9	21.25	43.24	36.34	15.96	92.1	6.423
	10	23.75	41.76	35.26	15.57	89.5	6.377
	11	26.25	34.98	29.31	16.21	94.9	6.804
	12	28.75	--	--	--	--	--
B Zone-2	1	1.25	39.02	32.40	16.97	99.2	6.878
	2	3.75	36.69	31.04	15.40	88.3	6.848
	3	6.25	38.07	32.38	14.95	85.3	6.806
	4	8.75	39.58	33.63	15.03	85.8	6.985
	5	11.25	41.35	34.98	15.41	88.4	6.902
	6	13.75	40.86	34.53	15.49	88.9	7.174
	7	16.25	44.16	37.22	15.72	90.5	7.296
	8	18.75	39.76	33.52	15.69	90.3	7.186
	9	21.25	40.34	34.01	15.69	90.3	7.093
	10	23.75	42.49	35.98	15.32	87.8	7.268
	11	26.25	36.06	30.68	14.92	85.1	7.335
	12	28.75	37.68	32.18	14.60	82.9	7.078

Table 9 - Moisture distribution of paste pH for S Zone columns as a function of column depth at the termination of the experiment.

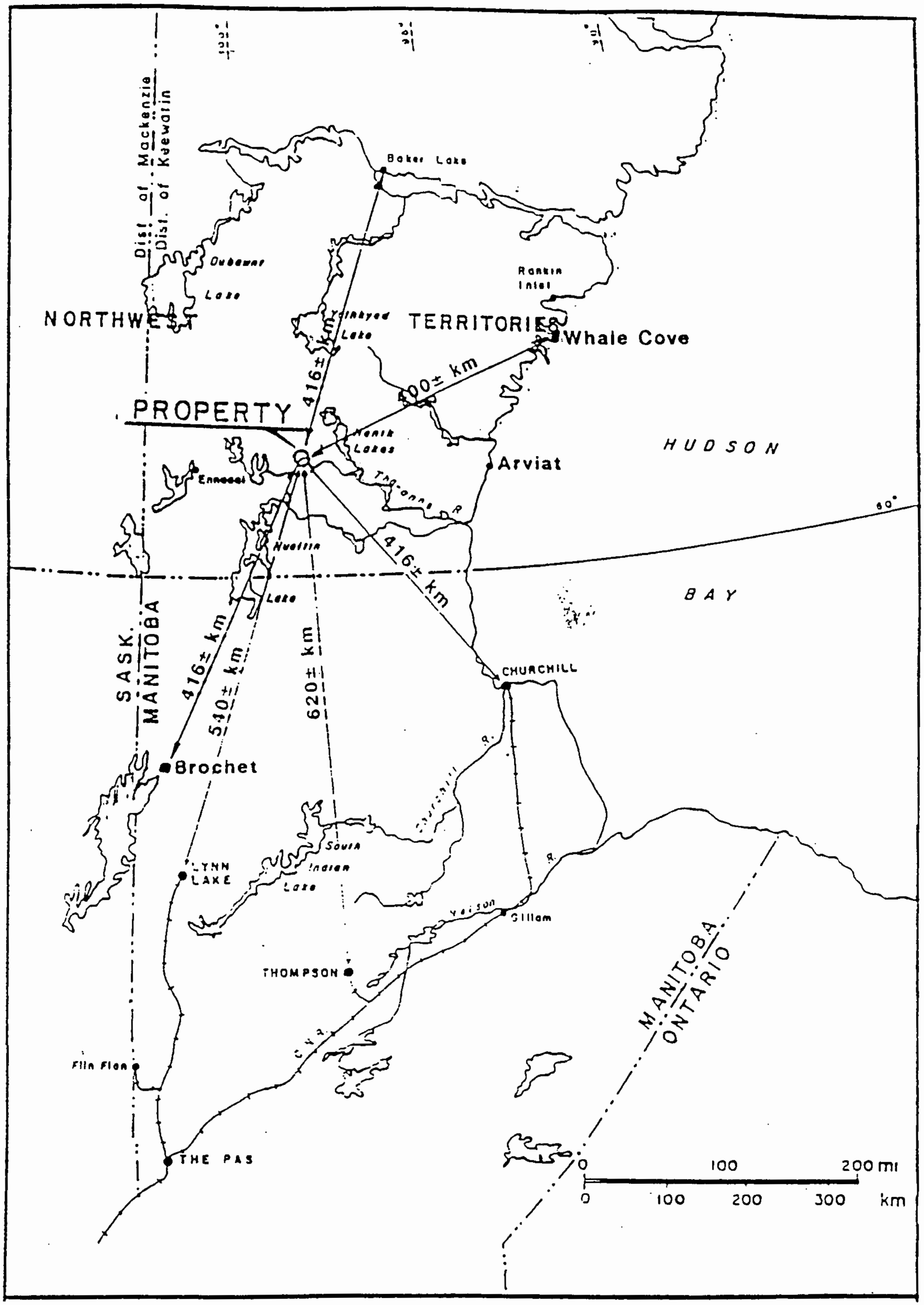
Sample No.		Depth (cm)	Wet Weight (g)	Dry Weight (g)	Weight Moisture wt (%)	Pore Vol. Moisture Saturation (%)	Paste pH
S Zone-1	1	1.25	17.24	13.75	20.24	124.7	3.799
	2	3.75	19.21	15.76	17.96	107.5	4.216
	3	6.25	15.66	12.77	18.45	111.1	3.325
	4	8.75	19.65	16.01	18.52	111.7	3.319
	5	11.25	13.50	10.93	19.04	115.5	3.635
	6	13.75	14.45	11.70	19.03	115.5	3.954
	7	16.25	13.96	11.43	18.12	108.7	4.087
	8	18.75	16.69	13.71	17.86	106.8	4.155
	9	21.25	14.84	12.29	17.18	101.9	4.572
	10	23.75	24.62	20.63	16.21	95.1	4.481
	11	26.25	20.83	17.48	16.08	94.1	4.657
	12	28.75	13.95	11.69	16.20	95.0	4.818
S Zone-2	1	1.25	15.08	12.12	19.63	120.0	2.642
	2	3.75	13.30	10.84	18.50	111.5	2.668
	3	6.25	11.25	9.24	17.87	106.9	2.978
	4	8.75	12.46	10.11	18.86	114.2	3.042
	5	11.25	17.84	14.72	17.49	104.1	2.987
	6	13.75	19.31	15.75	18.44	111.1	2.983
	7	15.25	15.68	12.84	18.11	108.6	3.148
	8	18.75	16.98	13.84	18.49	111.4	3.092
	9	21.25	24.19	19.85	17.94	107.4	3.047
	10	23.75	24.35	20.16	17.21	102.1	3.171
	11	26.25	9.26	7.70	16.85	99.6	3.650
	12	28.75	9.17	7.69	16.14	94.6	3.722

Table 10 - Results for Cullaton waste rock/acid base accounting

Sample No.		Percent S	Total Acid Production kg $CaCO_3$/tonne	Total Alkalinity kg $CaCO_3$/tonne	Net Neutralization Potential (NP) kg $CaCO_3$/tonne	AP/N
1	S Zone	0.11	3.44	7.12	+3.68	2.1
2	S Zone	0.11	3.44	3.42	-0.02	1.0
3	B Zone	0.04	1.25	70.59	+69.34	565
4	B Zone	0.01	0.31	127.38	127.07	410.9
5	B Zone	1.08	33.75	123.74	89.99	3.67
6	Rejects	0.12	3.75	0.98	-2.77	.26
	Average	0.25	7.66	55.54	47.88	7.3
35	S-Zone	.25	7.810	15.37	7.56	2.0
36	B Zone	.20	6.25	37.94	31.69	6.0
	AVERAGE		59.9	386.53		6.5

NATIVE Soil

NATIVE Soil	.102	4.95	3.19	-1.76
ORGANICS N.	2.14	66.88	0	-66.88
ORGANICS SE	1.3	40.63	1.85	-38.78



CULLATON LAKE, DISTRICT OF KEEWATIN, N.W.T. - KEY PLAN

Fig. 1 - Location of Cullaton Lake Mines, Northwest Territories.

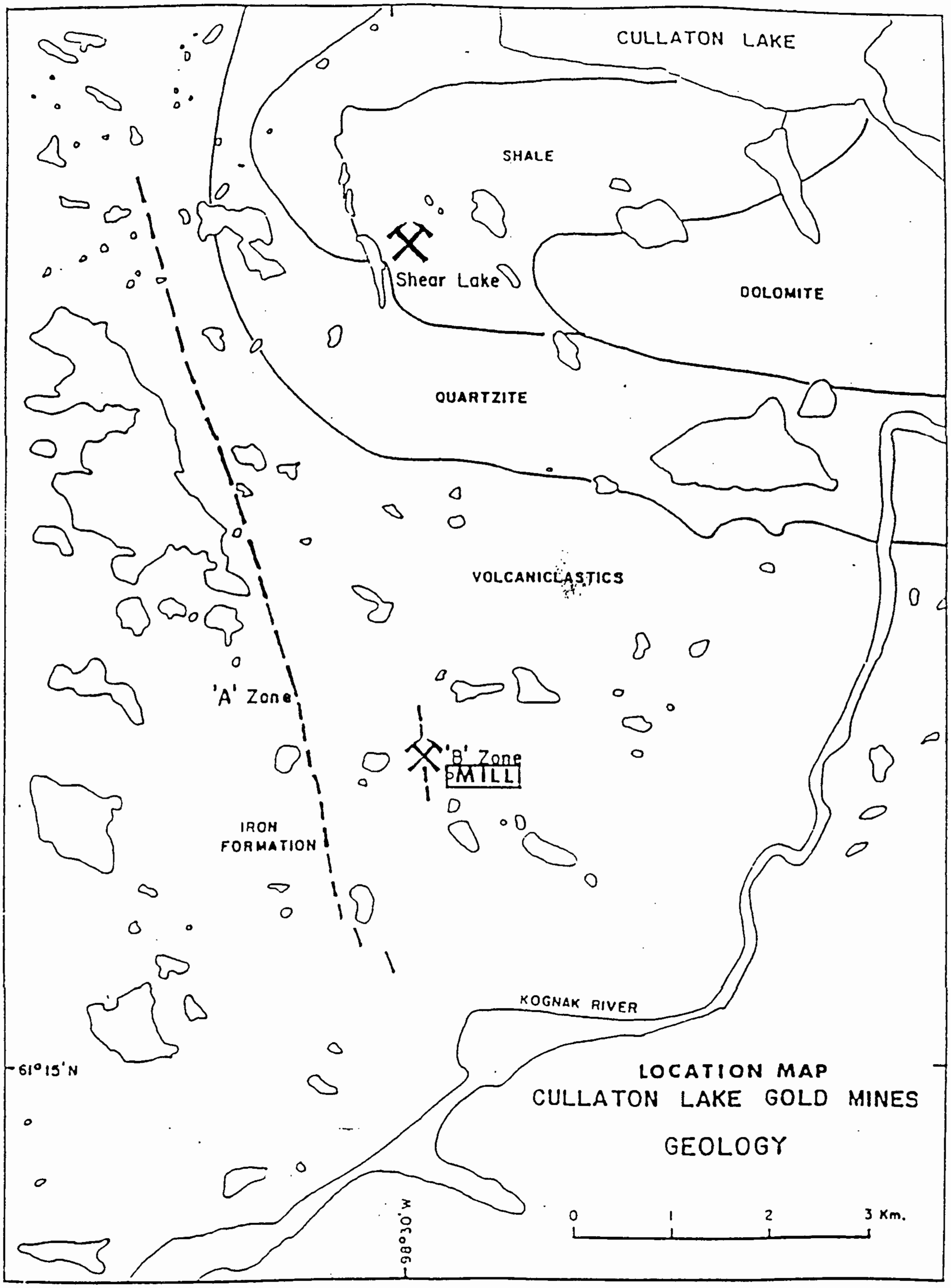


Fig. 2 - Location of B and Shear Zones at the Cullaton Lake Mine property.

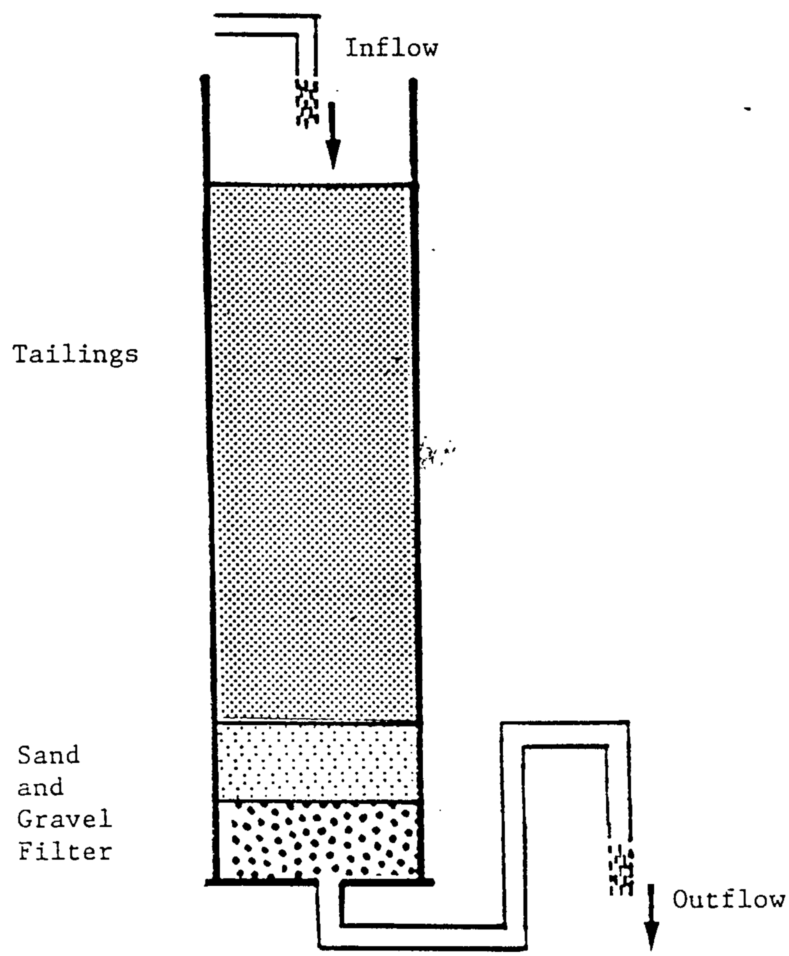


Fig. 3 - Leaching column experimental set up.

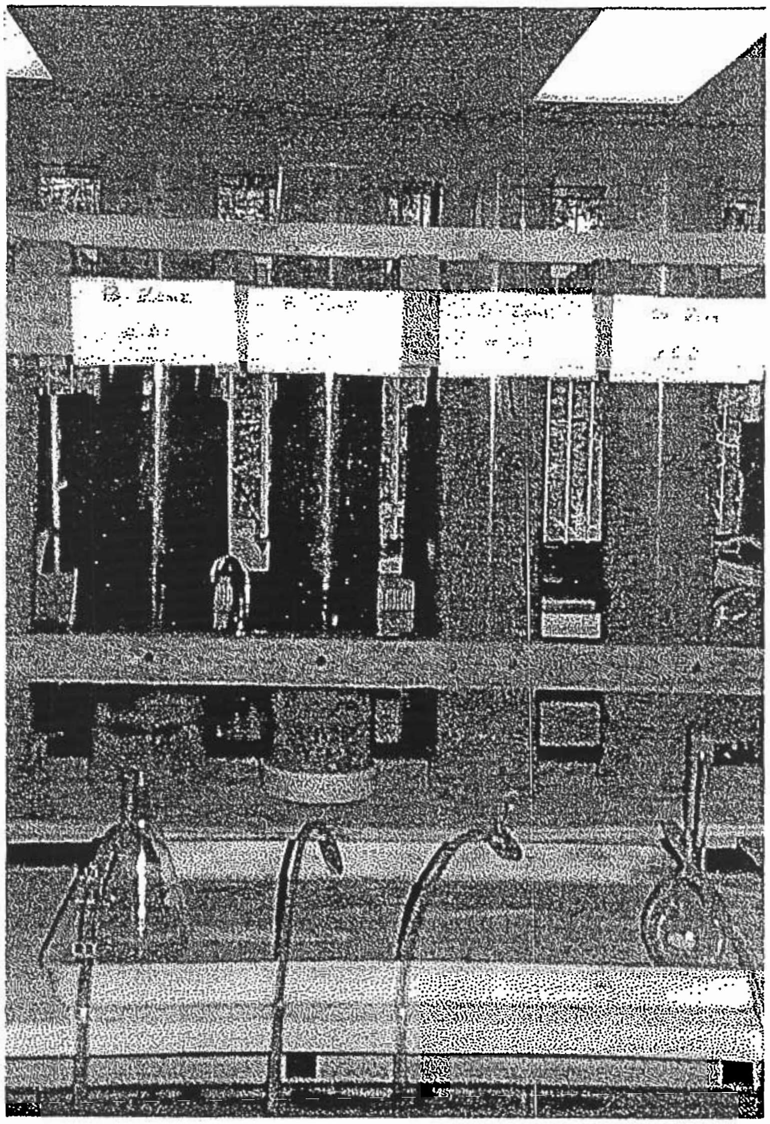


Fig. 4 - Leaching columns experimental arrangement for B and Shear Zone tailings.

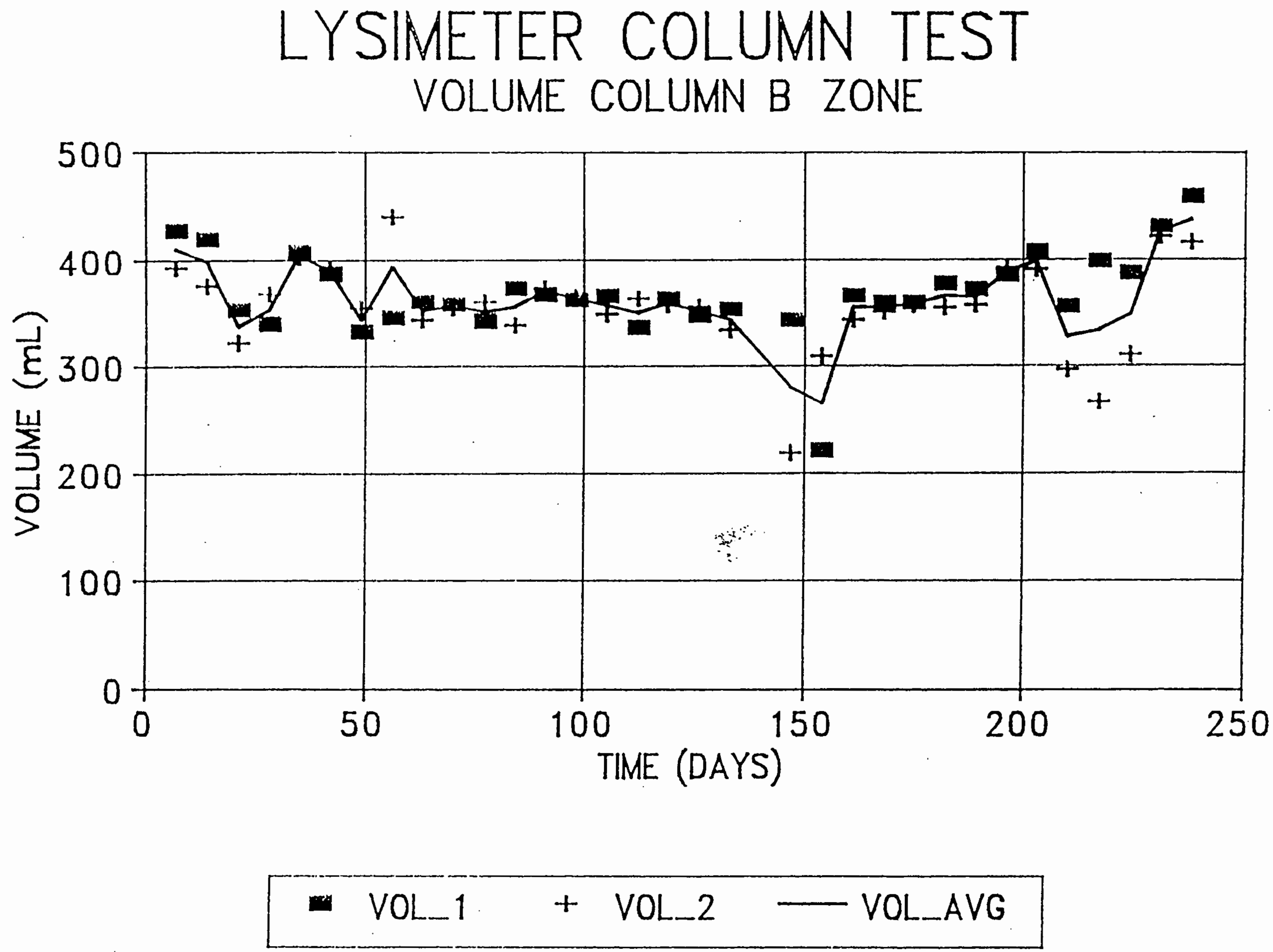


Fig. 5 - Weekly leachate flow volumes for B Zone columns.

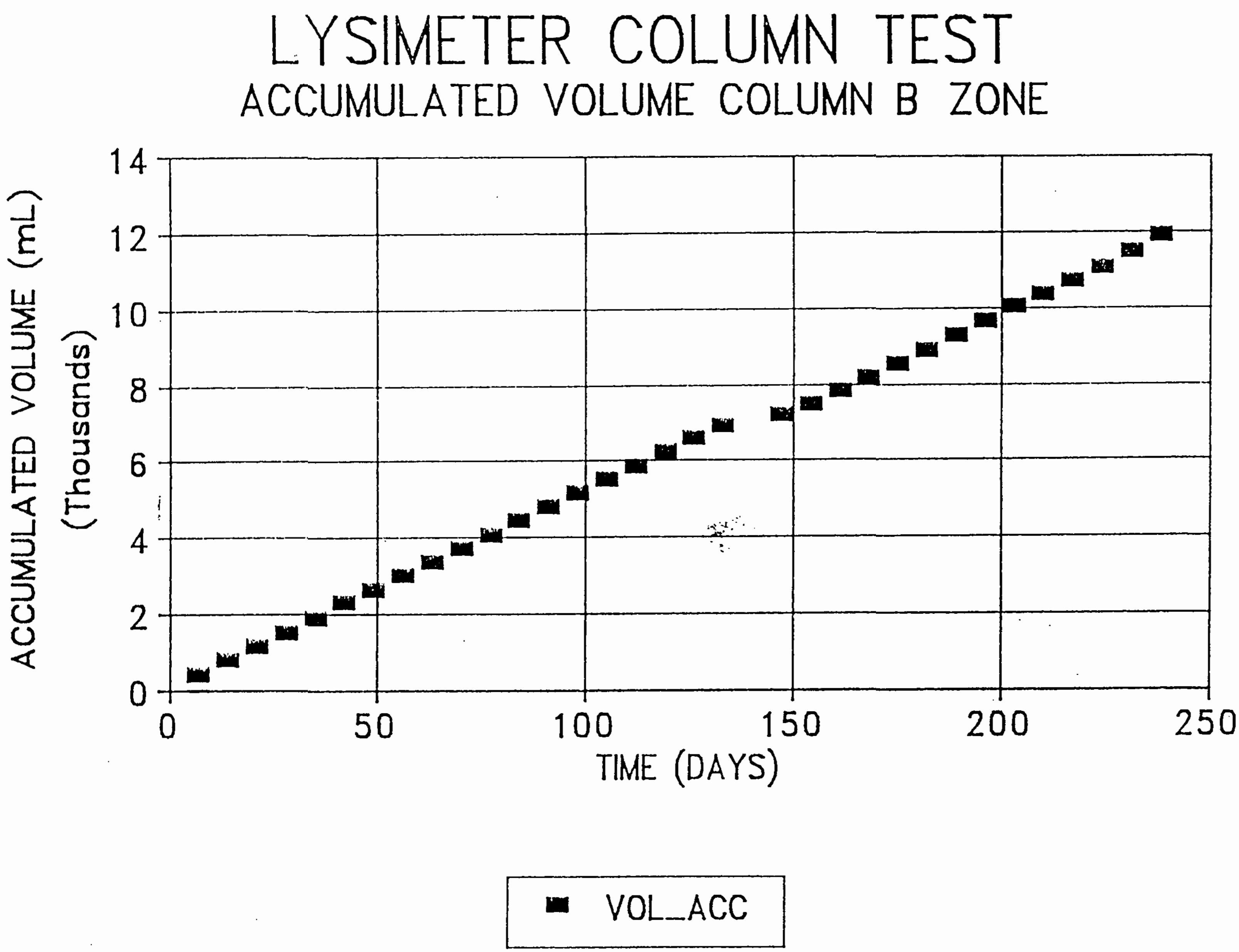


Fig. 6 - Total accumulated volume (average) per column for B Zone.

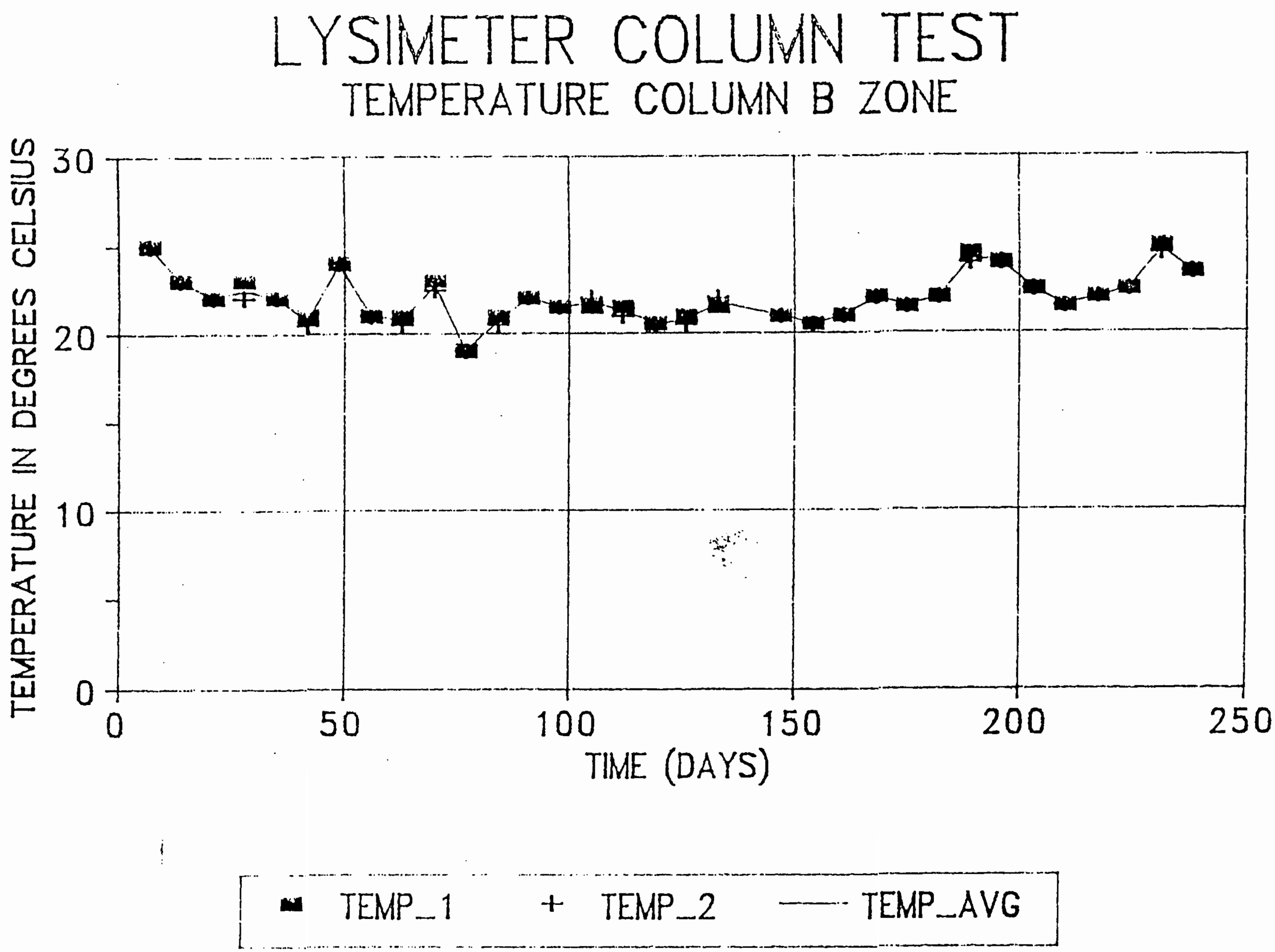


Fig. 7 - Effluent temperature for B Zone columns.

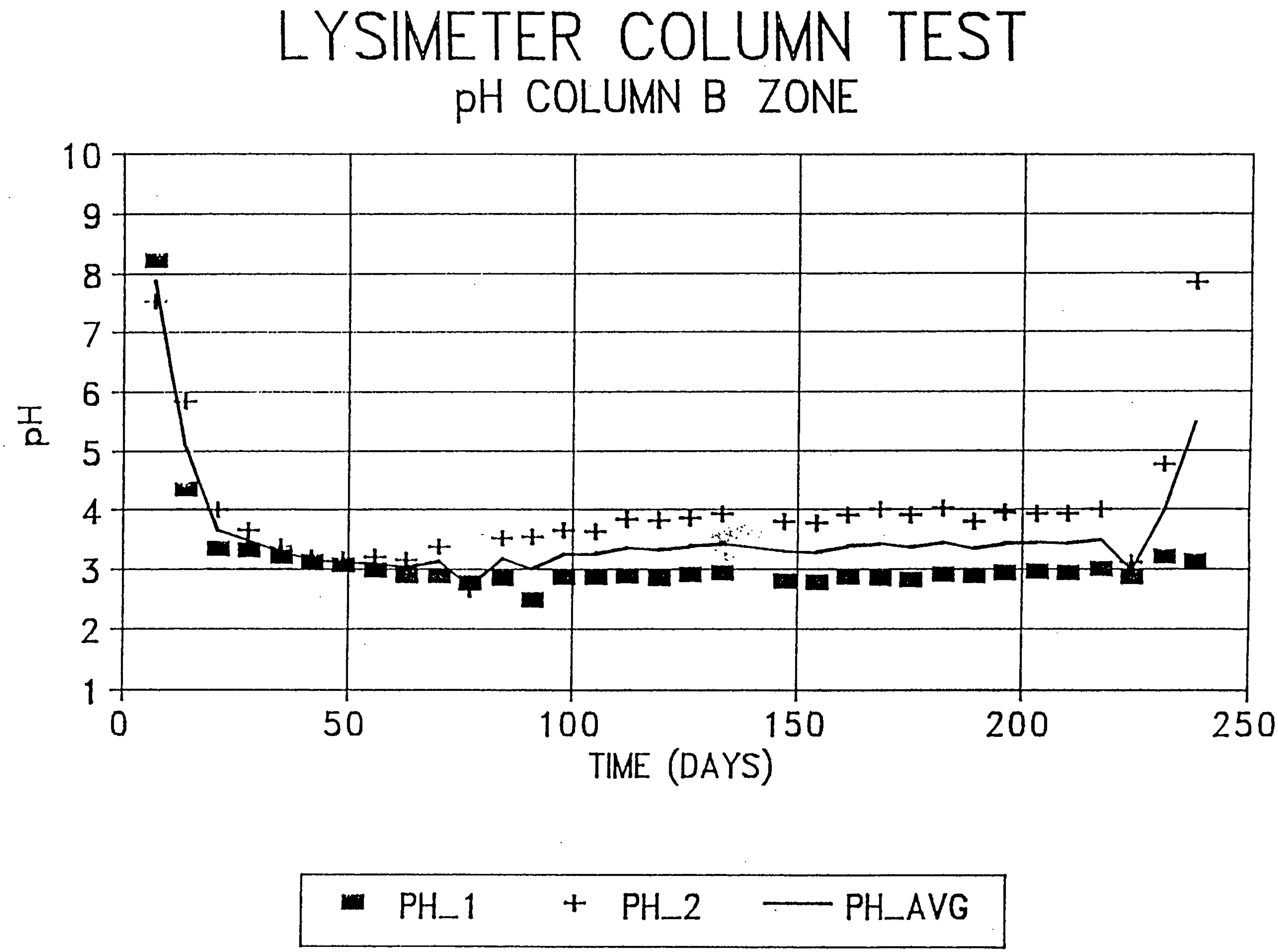


Fig. 8 - Effluent pH for B Zone columns.

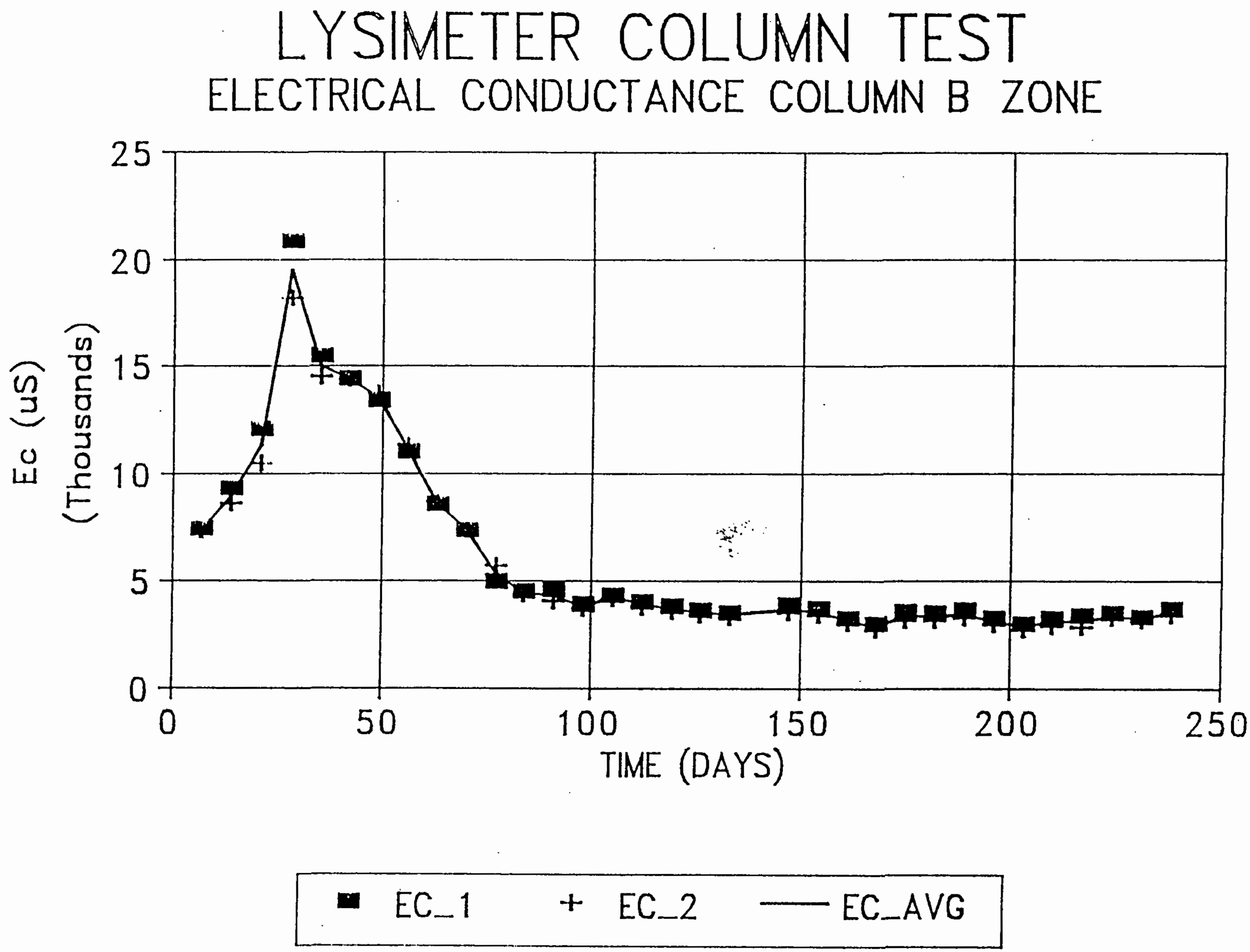


Fig. 9 - Effluent electrical conductance 'Ec' for B Zone columns.

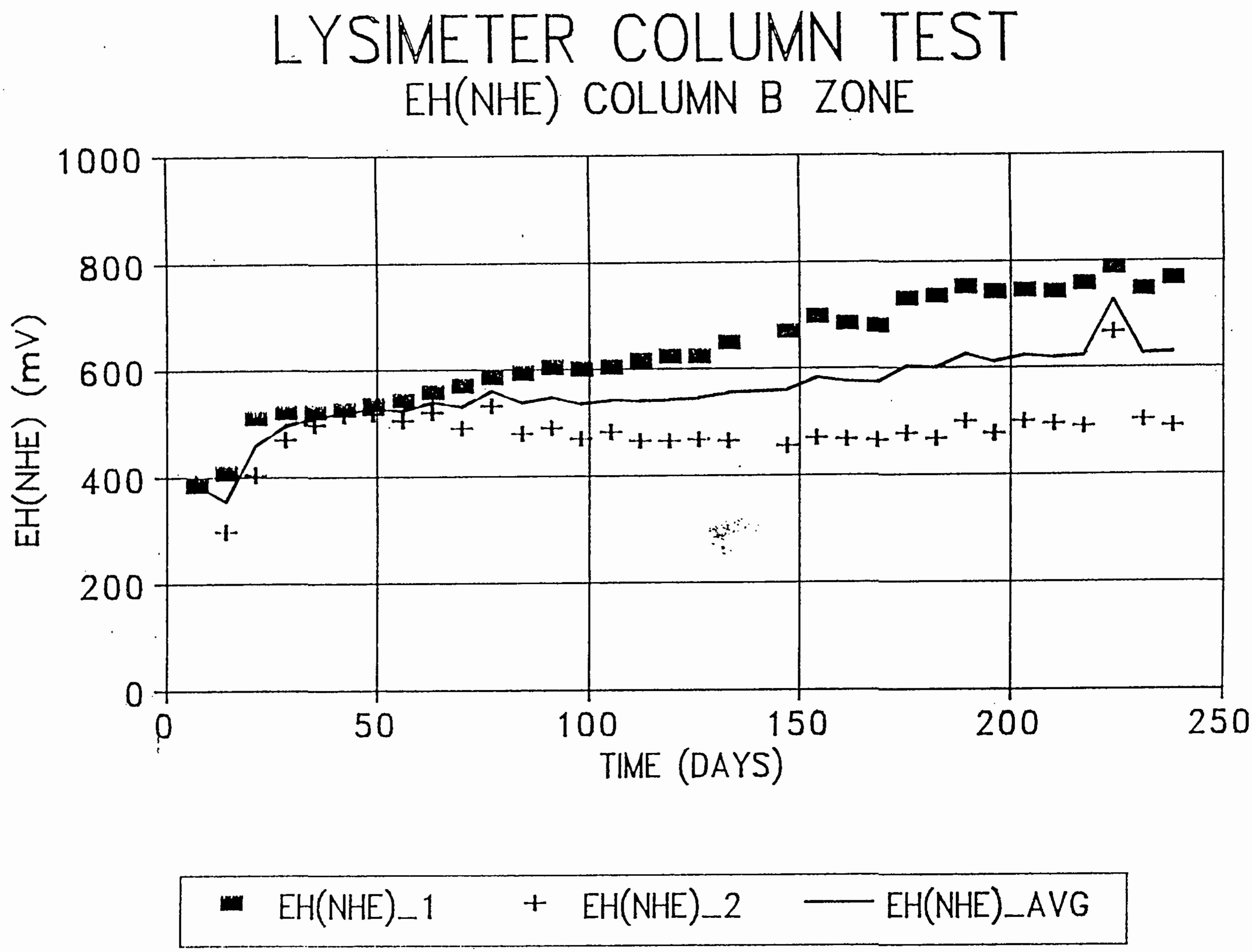


Fig. 10 - Effluent redox potential 'Eh' (absolute) for B Zone columns.

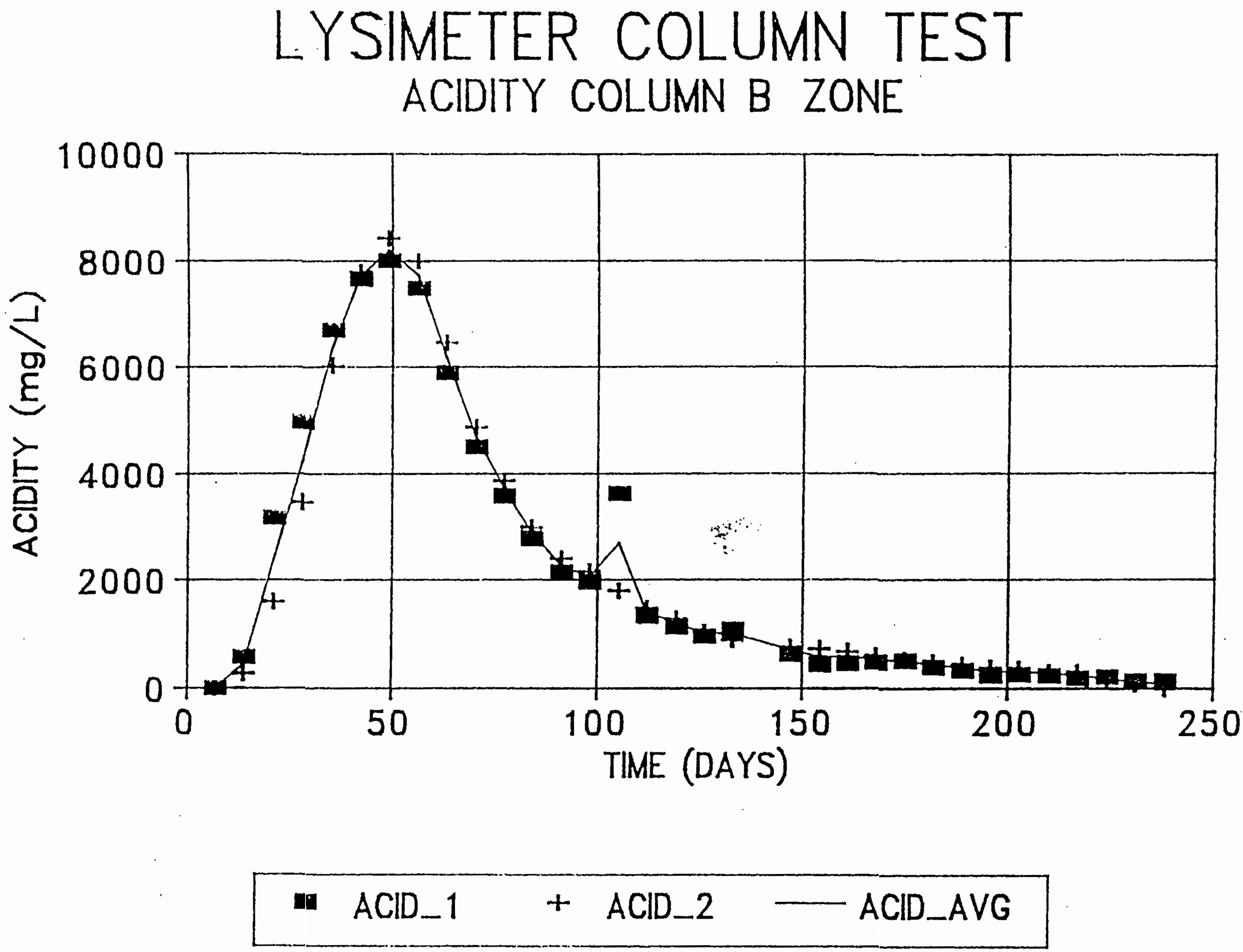


Fig. 11 - Effluent acidity for B Zone columns.

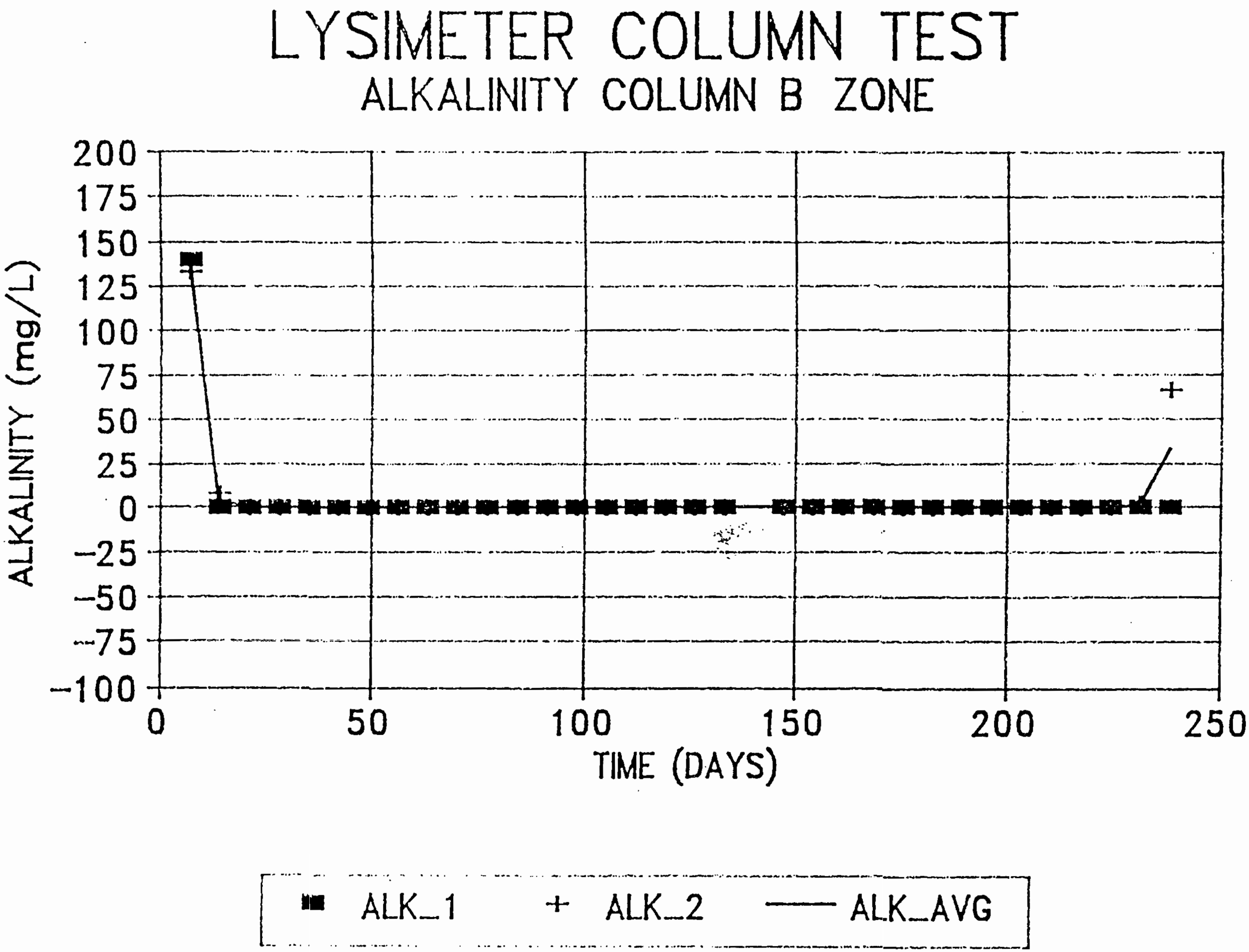


Fig. 12 - Effluent alkalinity for B Zone columns.

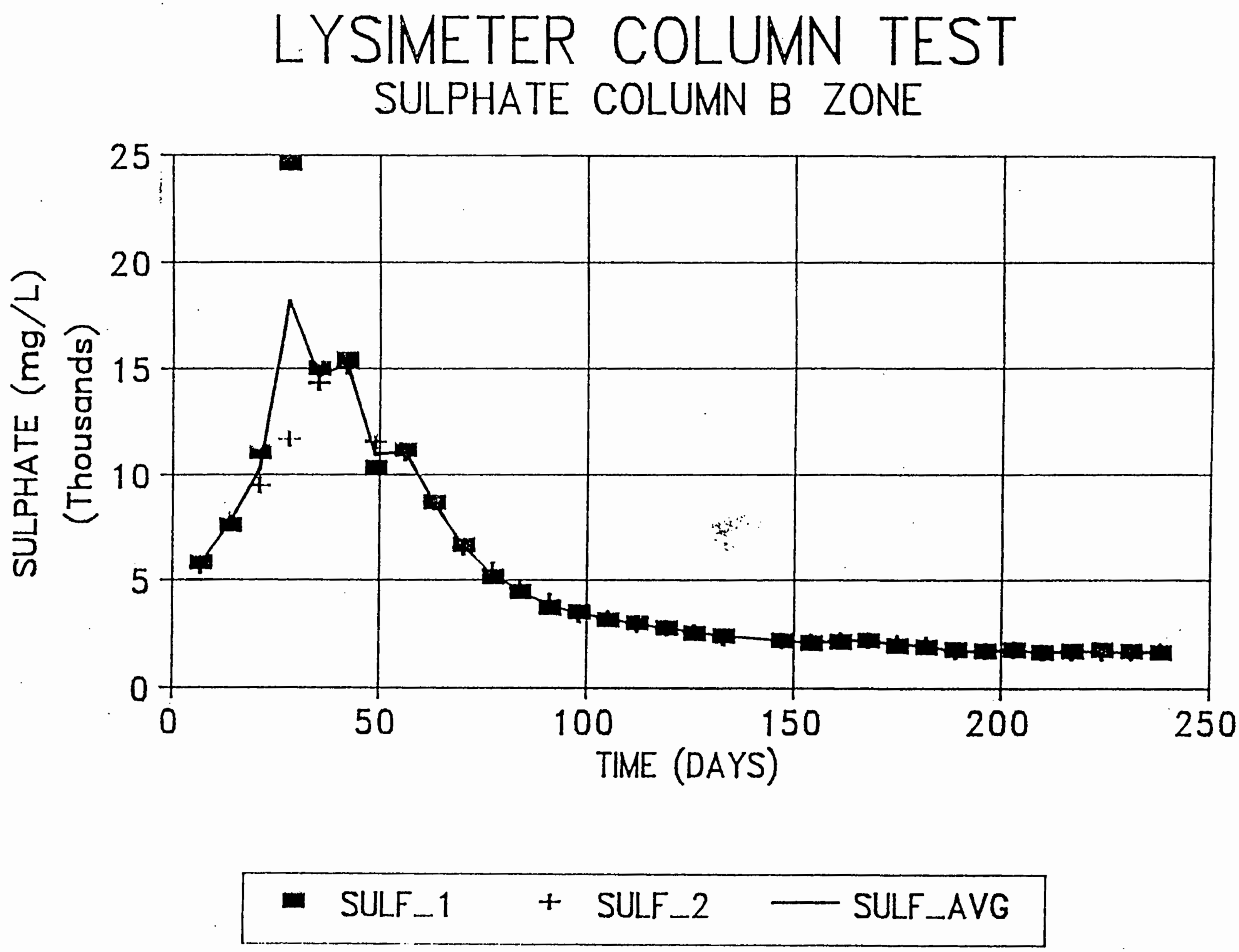


Fig. 13 - Effluent total sulphate (SO_4^{-2}) concentration for B Zone columns.

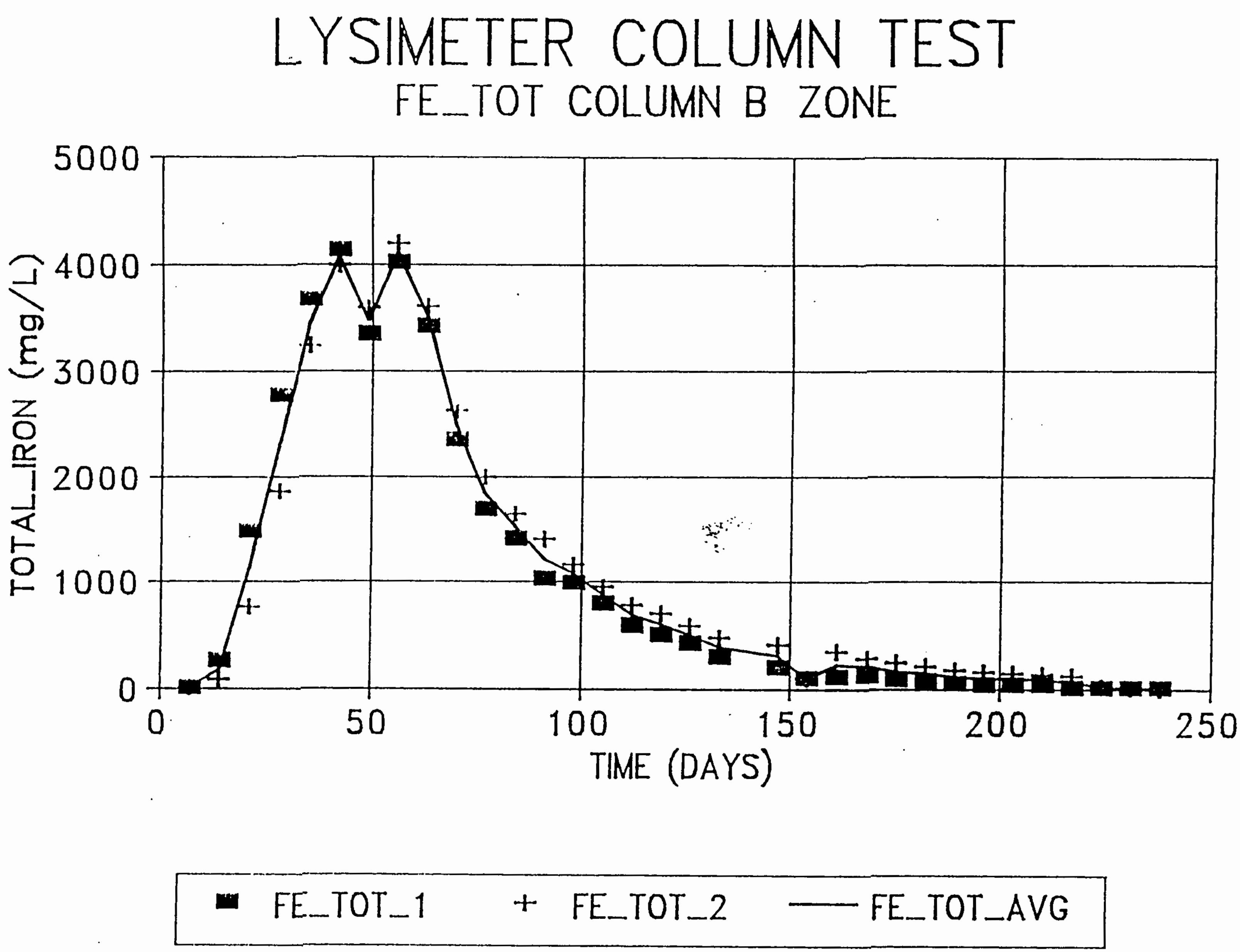


Fig. 14 - Effluent total iron (Fe) concentration for B Zone columns.

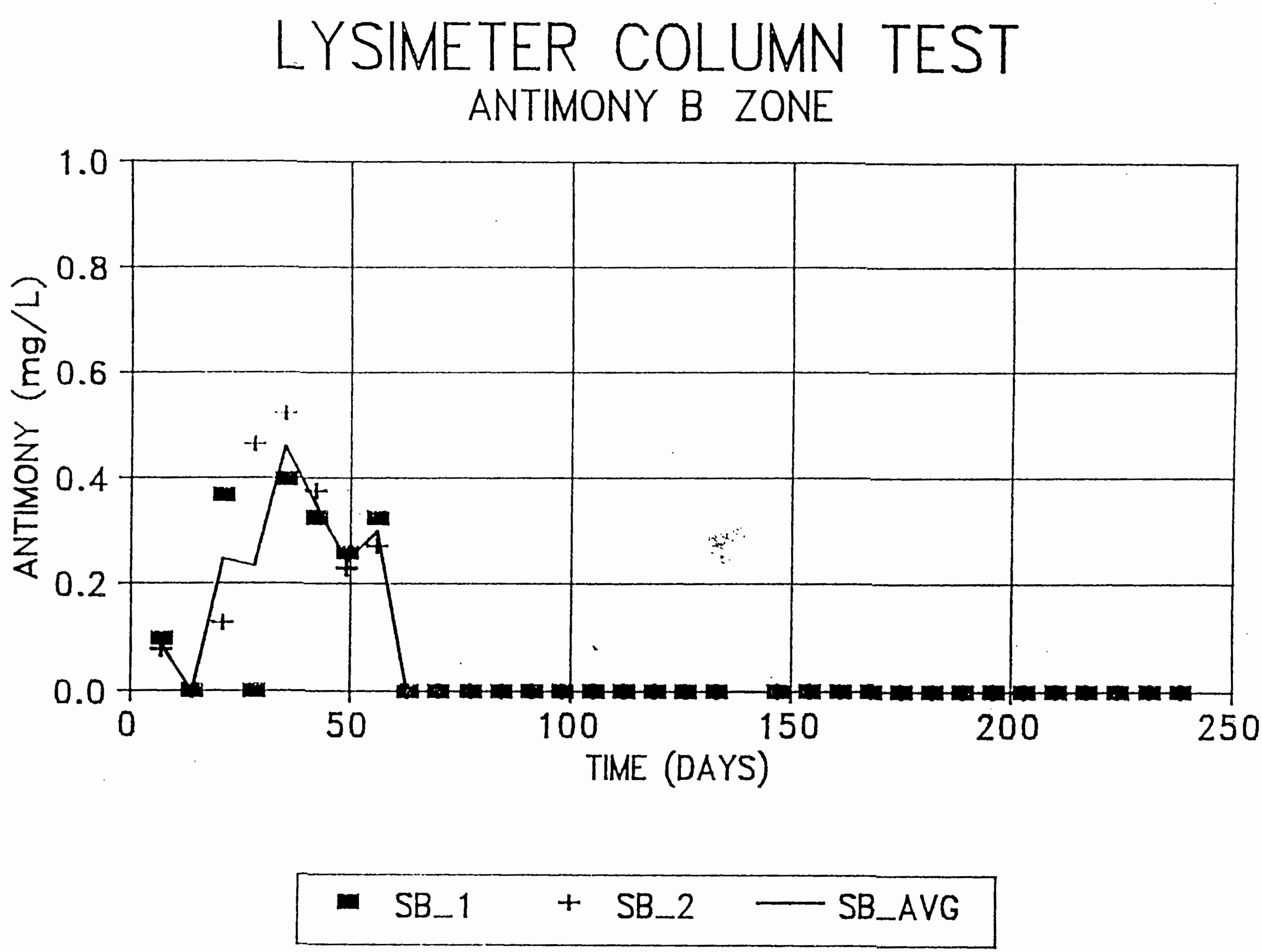


Fig. 15 - Effluent total antimony (Sb) concentration for B Zone columns.

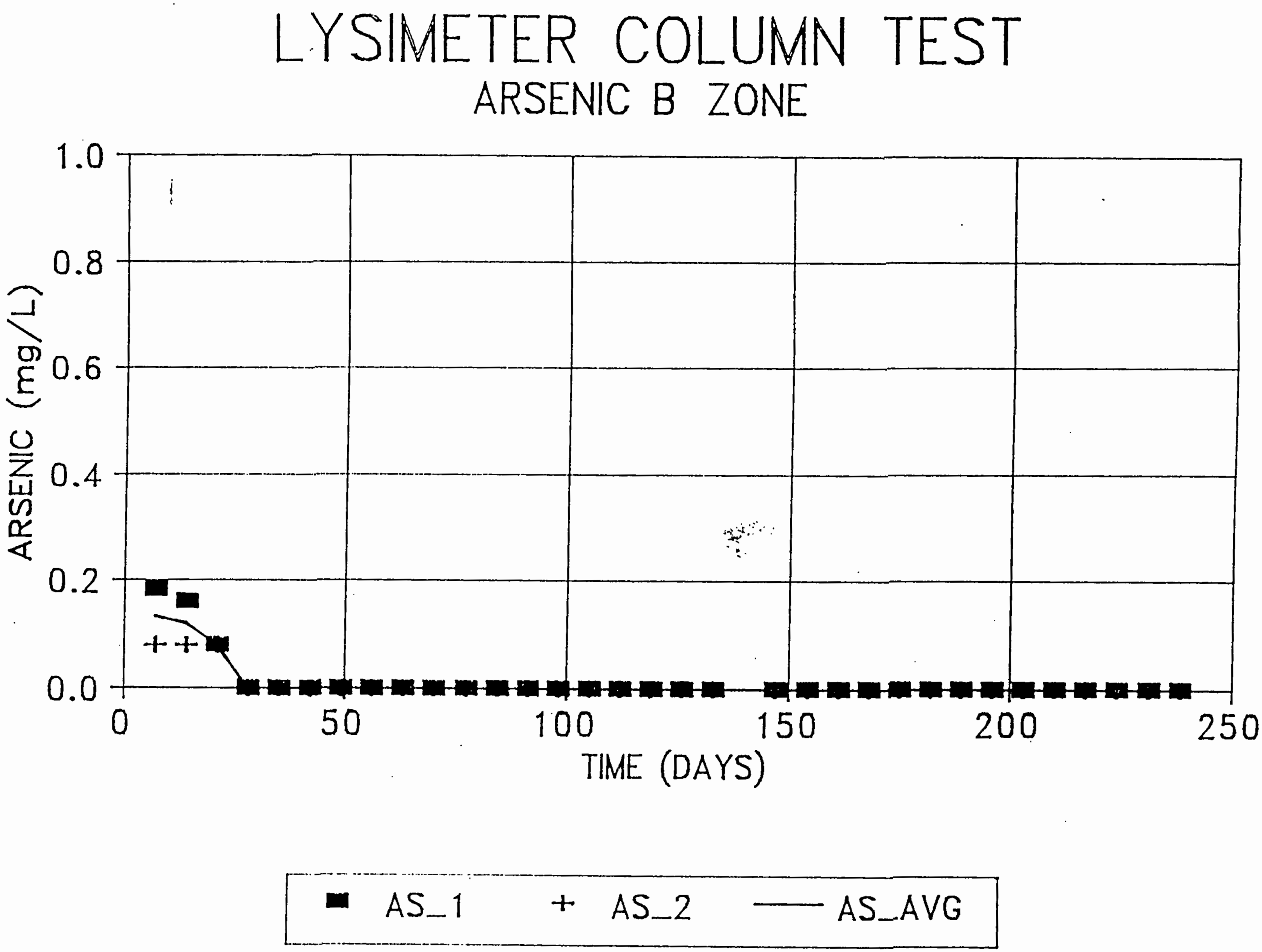


Fig. 16 - Effluent total arsenic (As) concentration for B Zone columns.

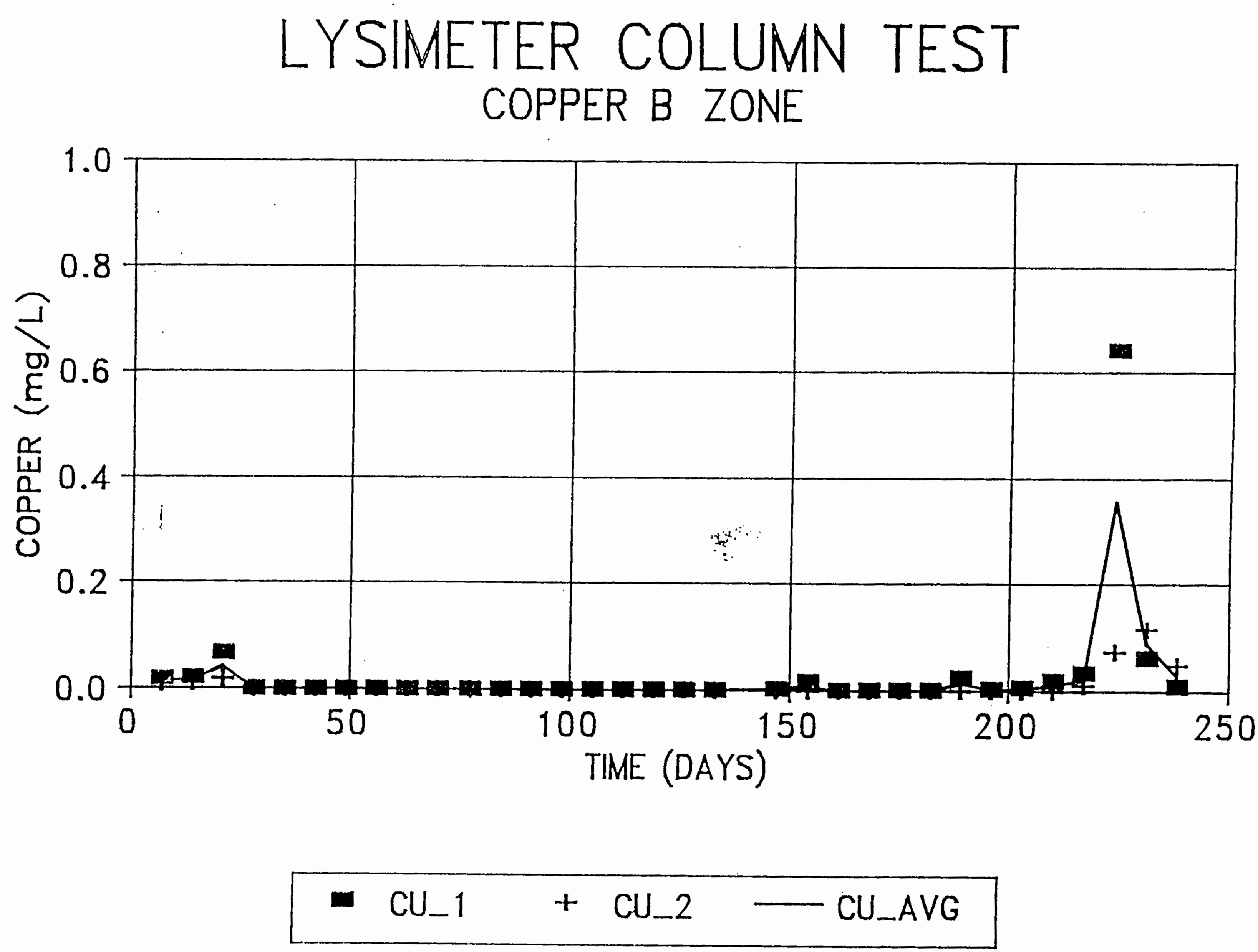


Fig. 17 - Effluent total copper (Cu) concentration for B Zone columns.

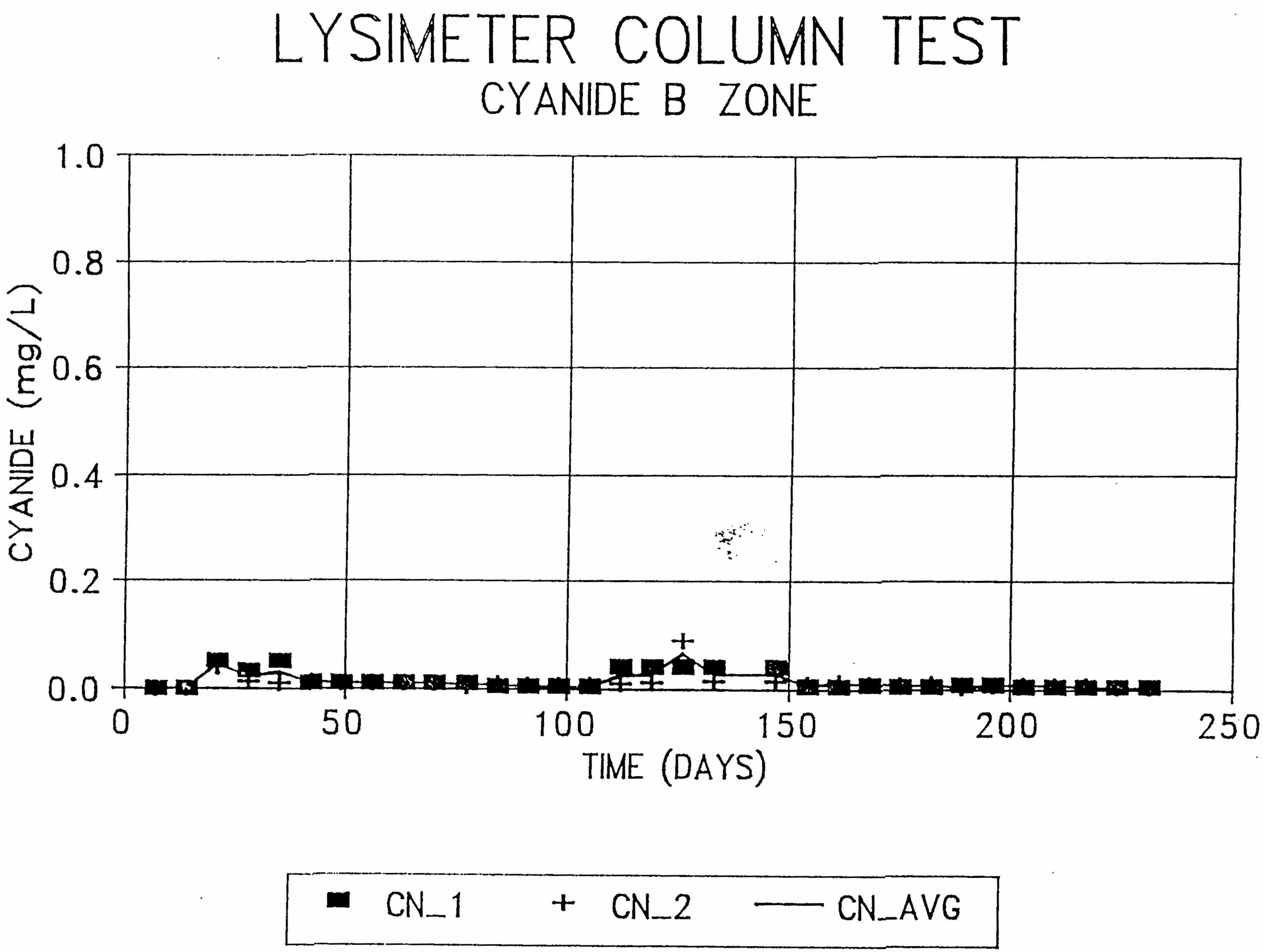


Fig. 18 - Effluent total cyanide (CN^-) concentration for B Zone columns.

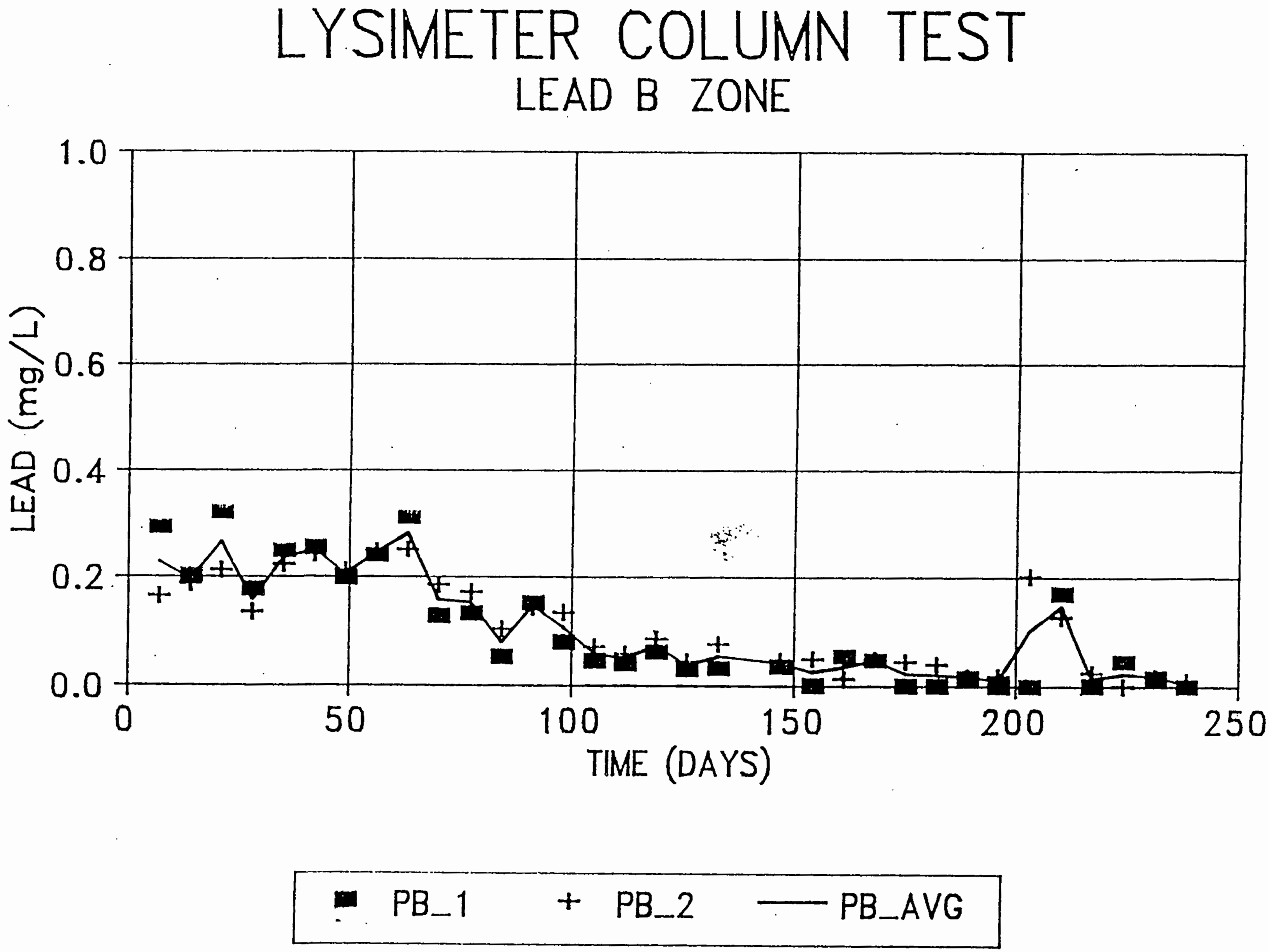


Fig. 19 - Effluent total lead (Pb) concentration for B Zone columns.

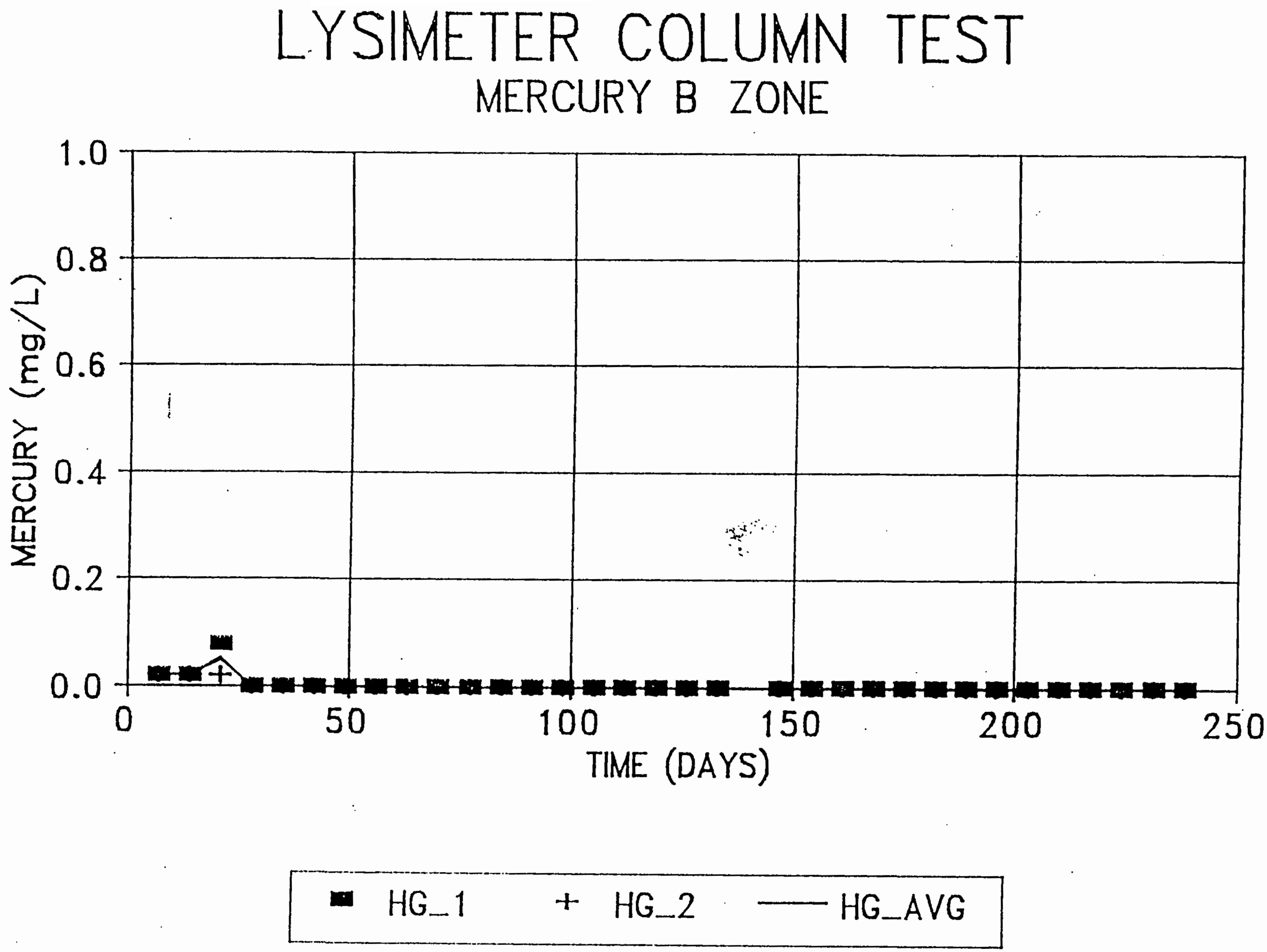


Fig. 20 - Effluent total mercury (Hg) concentration for B Zone columns.

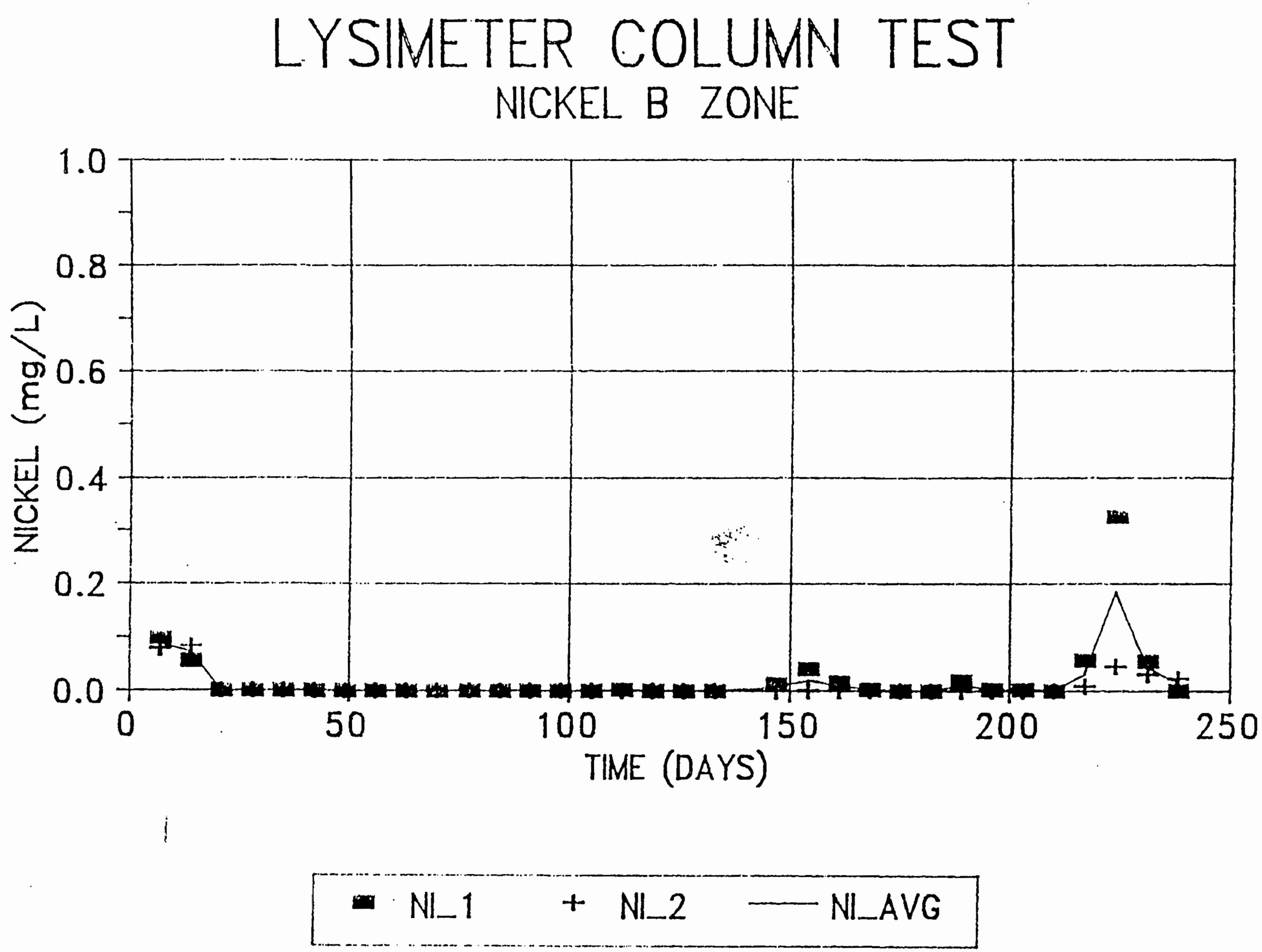


Fig. 21 - Effluent total nickel (Ni) concentration for B Zone columns.

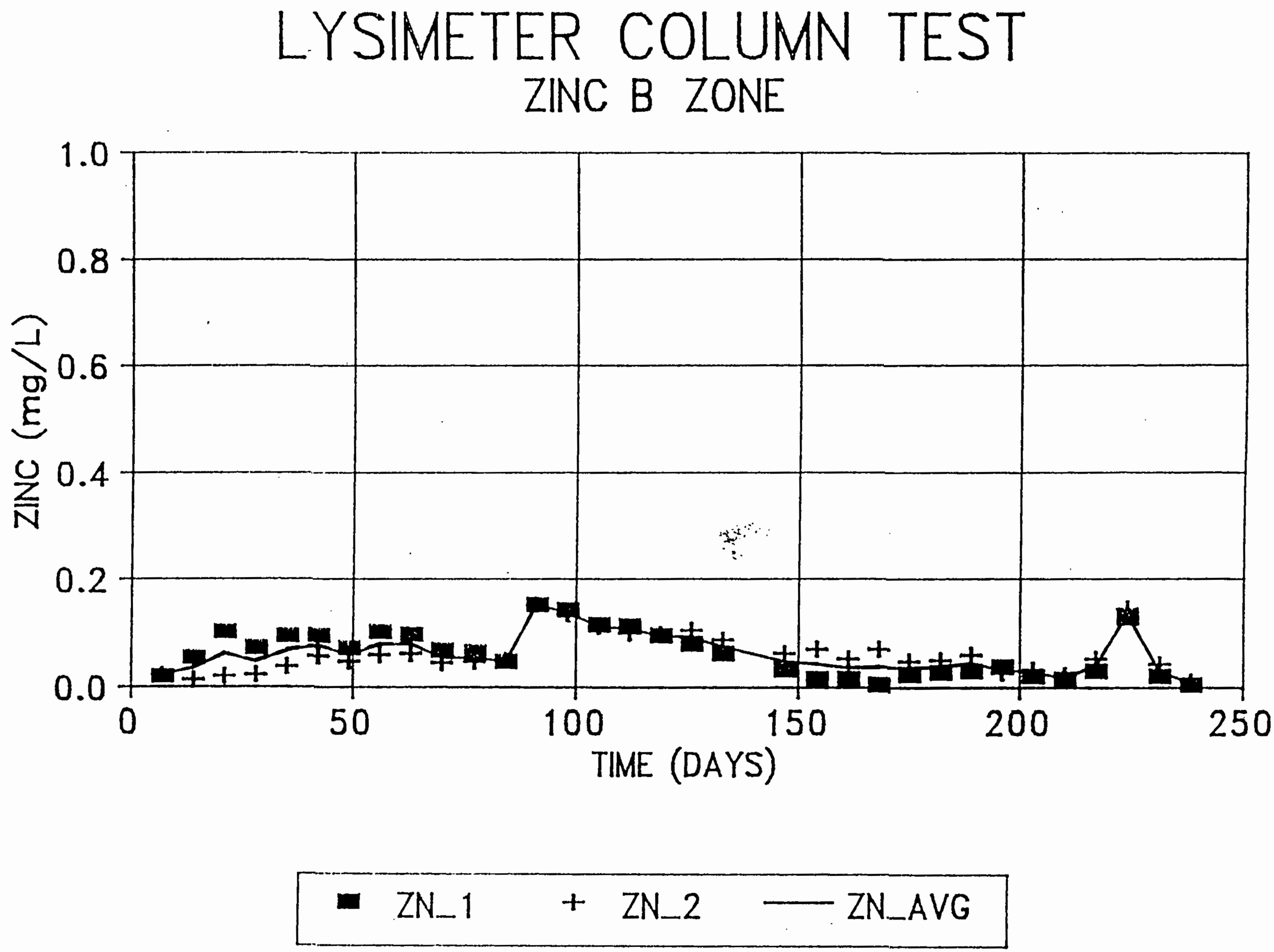


Fig. 22 - Effluent total zinc (Zn) concentration for B Zone columns.

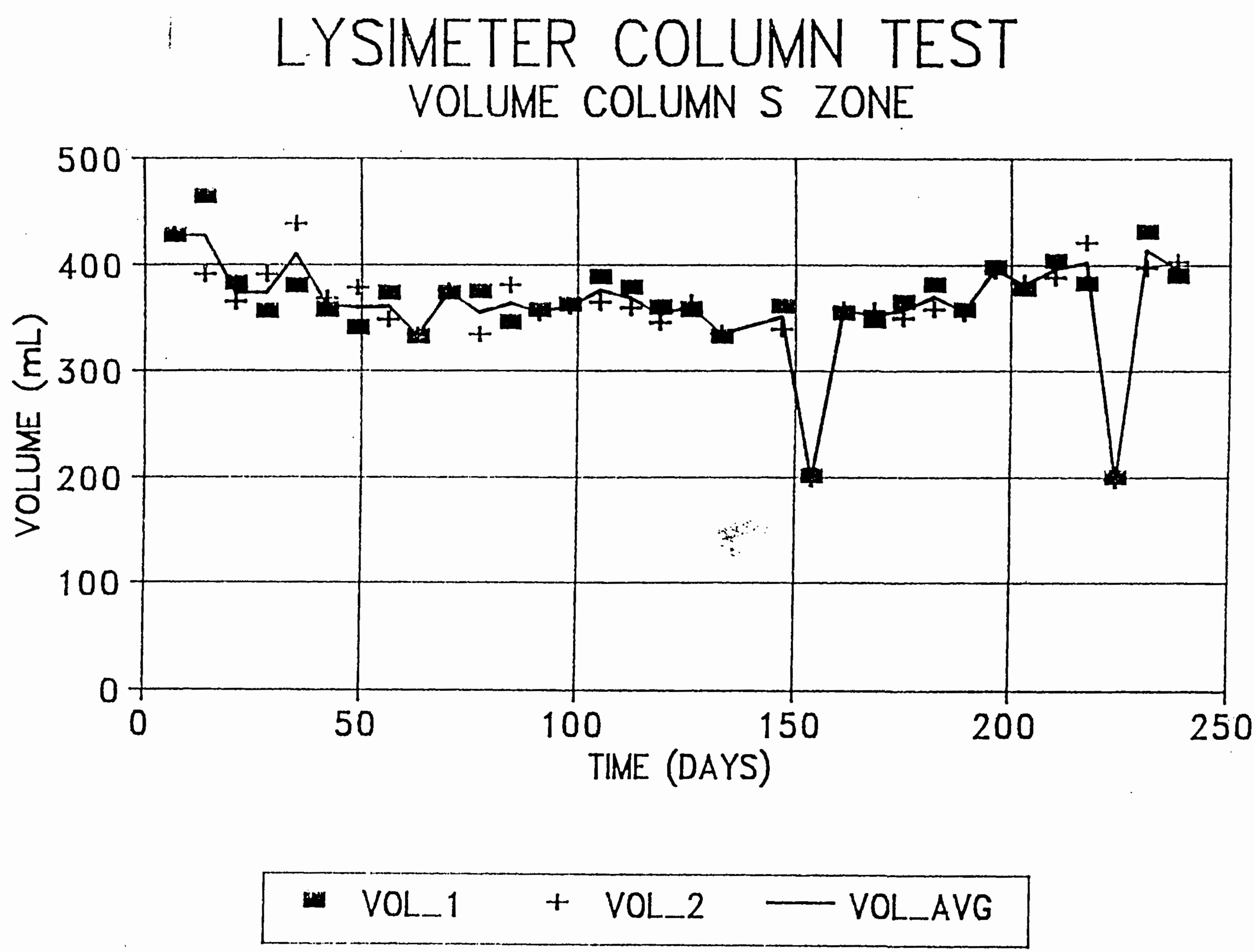


Fig. 23 - Weekly leachate flow volume for S Zone column.

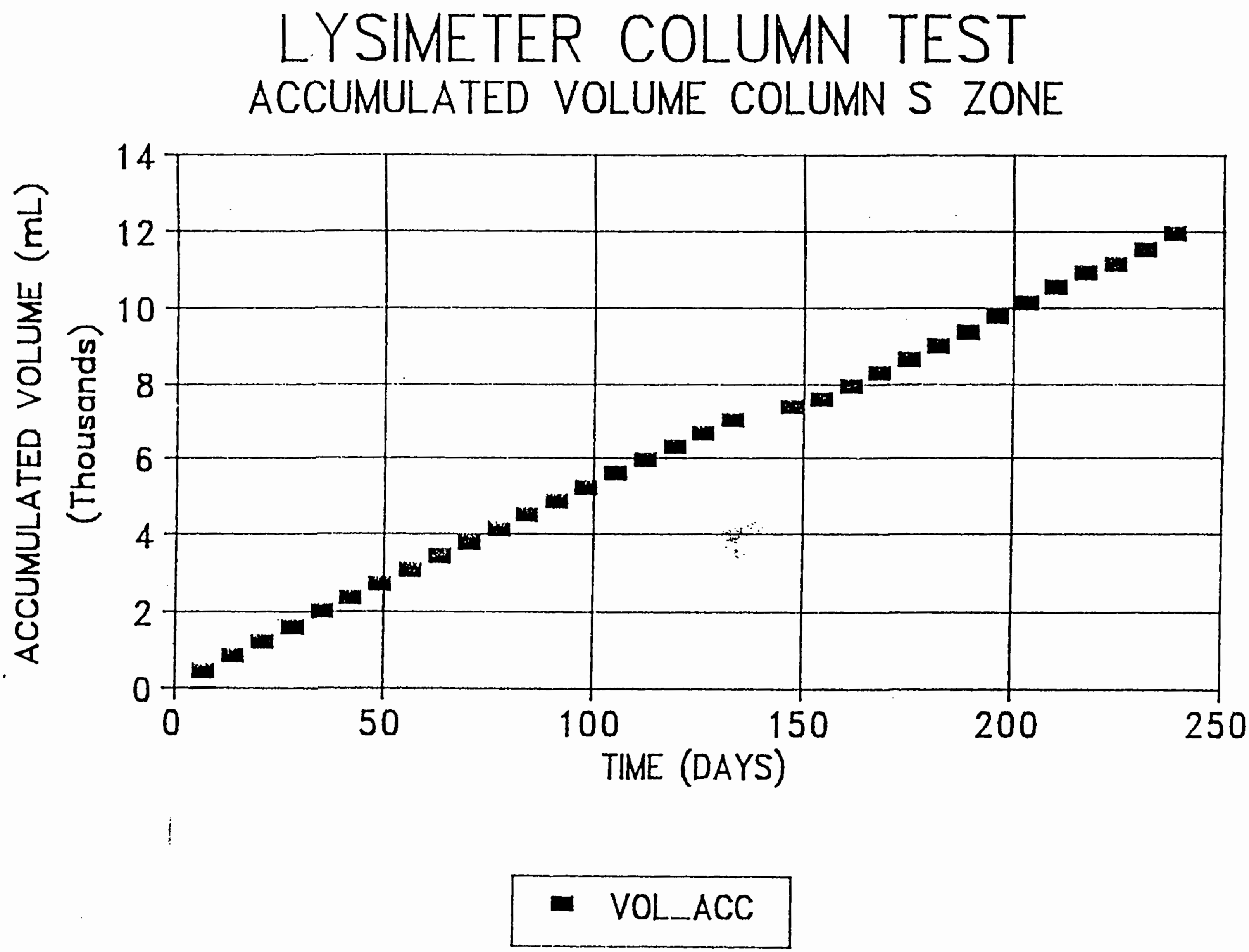


Fig. 24 - Total accumulated volume (average) per column for S Zone.

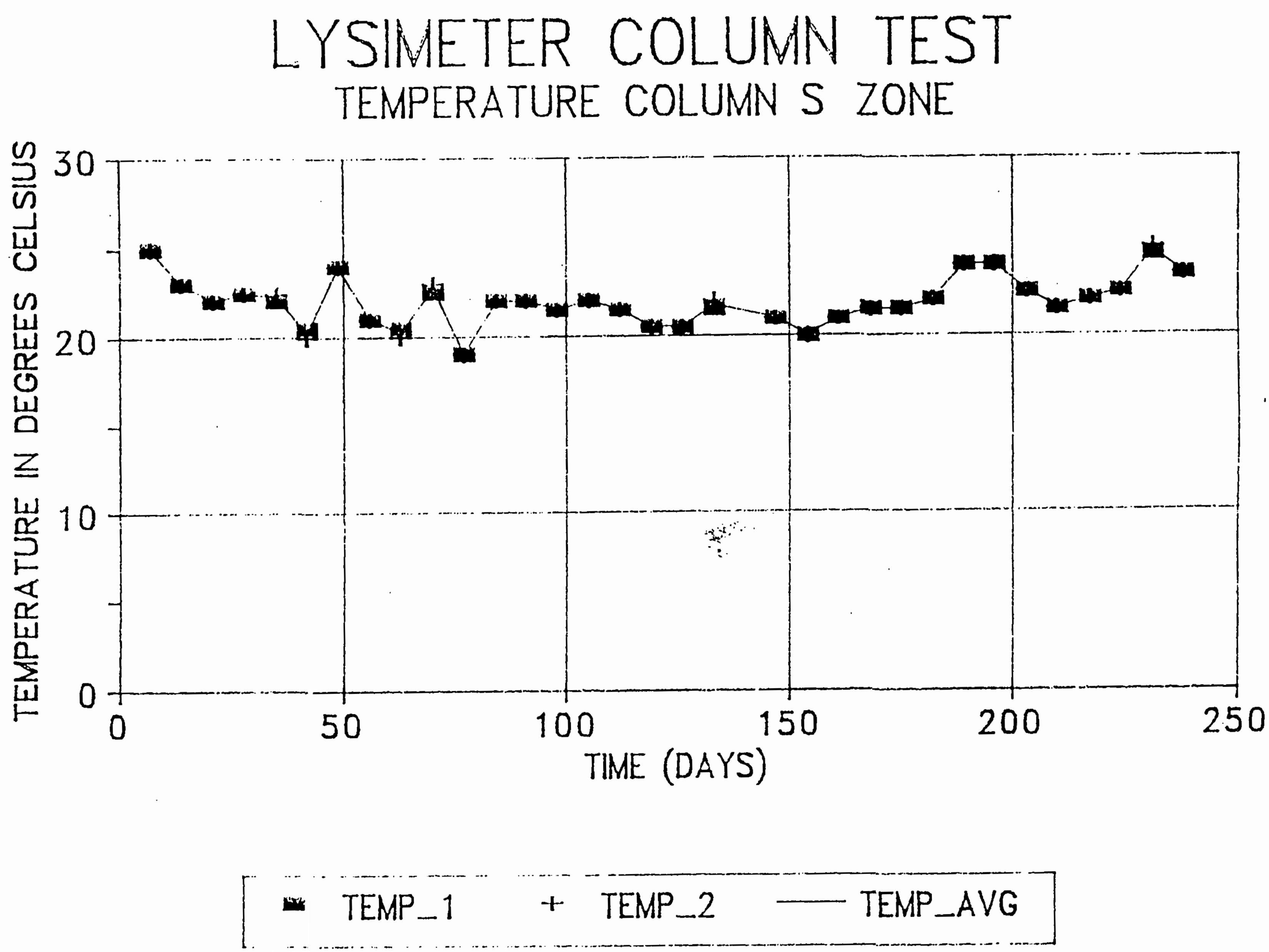


Fig. 25 - Effluent temperature for S Zone columns.

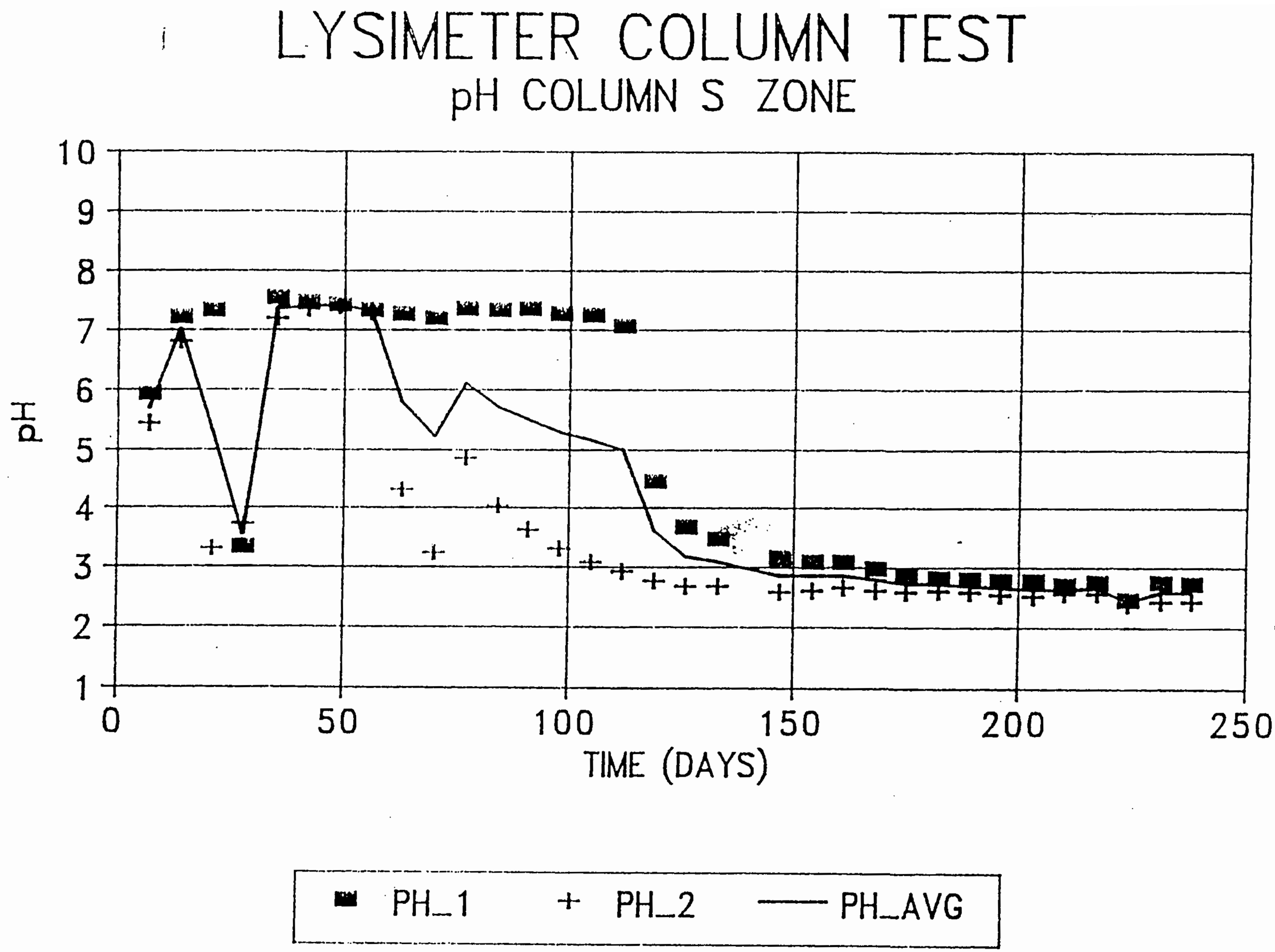


Fig. 26 - Effluent pH for S Zone columns.

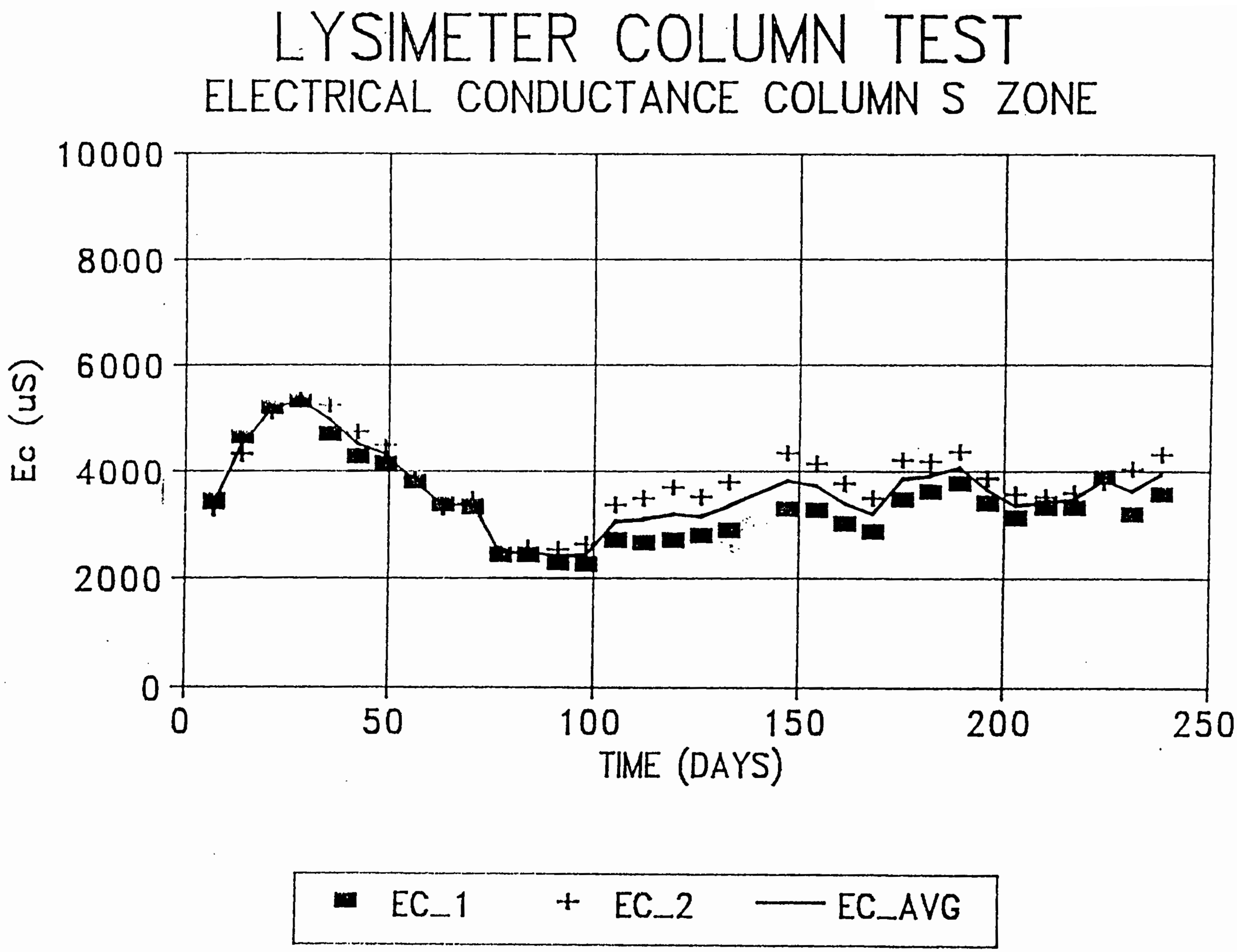


Fig. 27 - Effluent electrical conductance 'Ec' for S Zone columns.

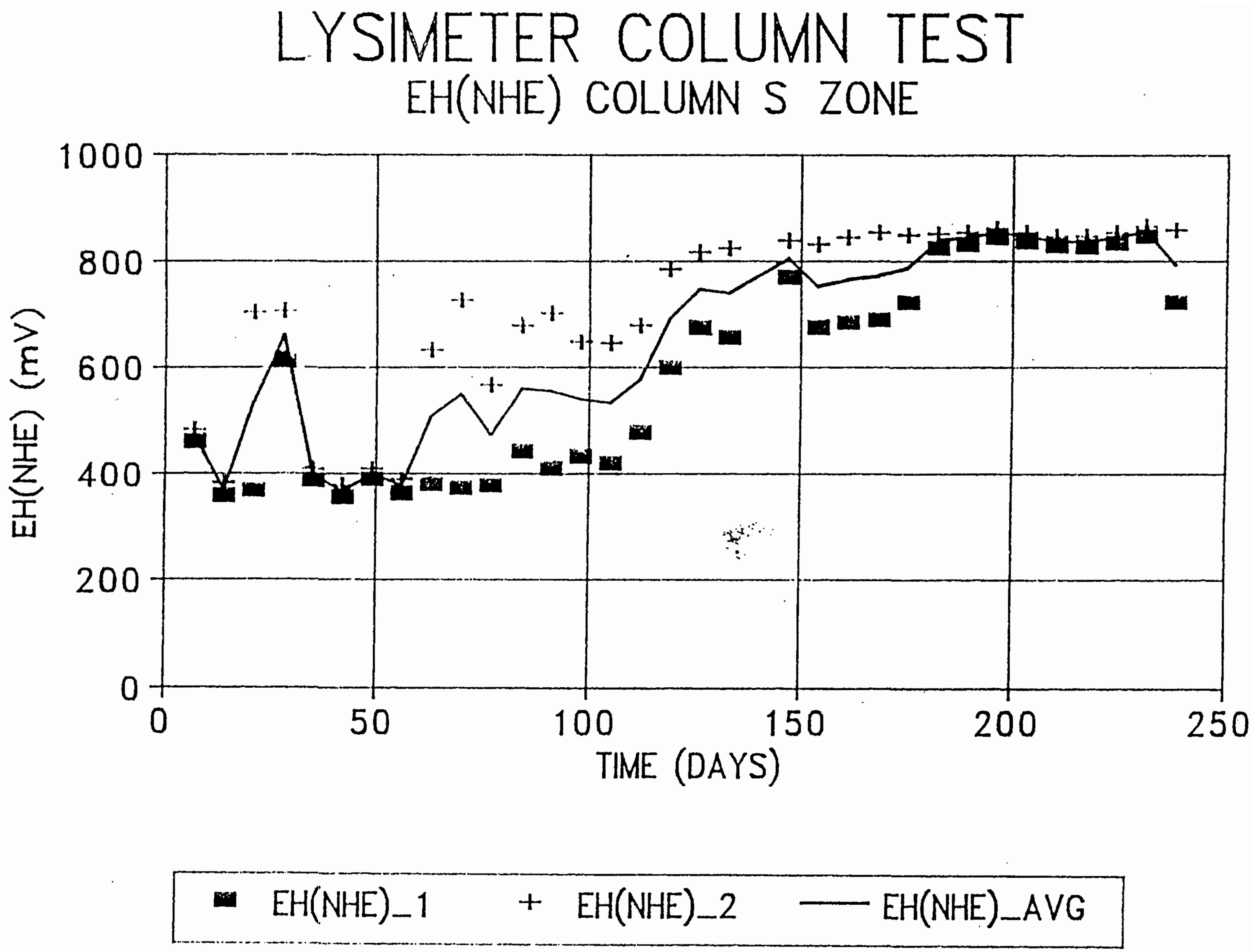


Fig. 28 - Effluent redox potential 'Eh' (absolute) for S Zone columns.

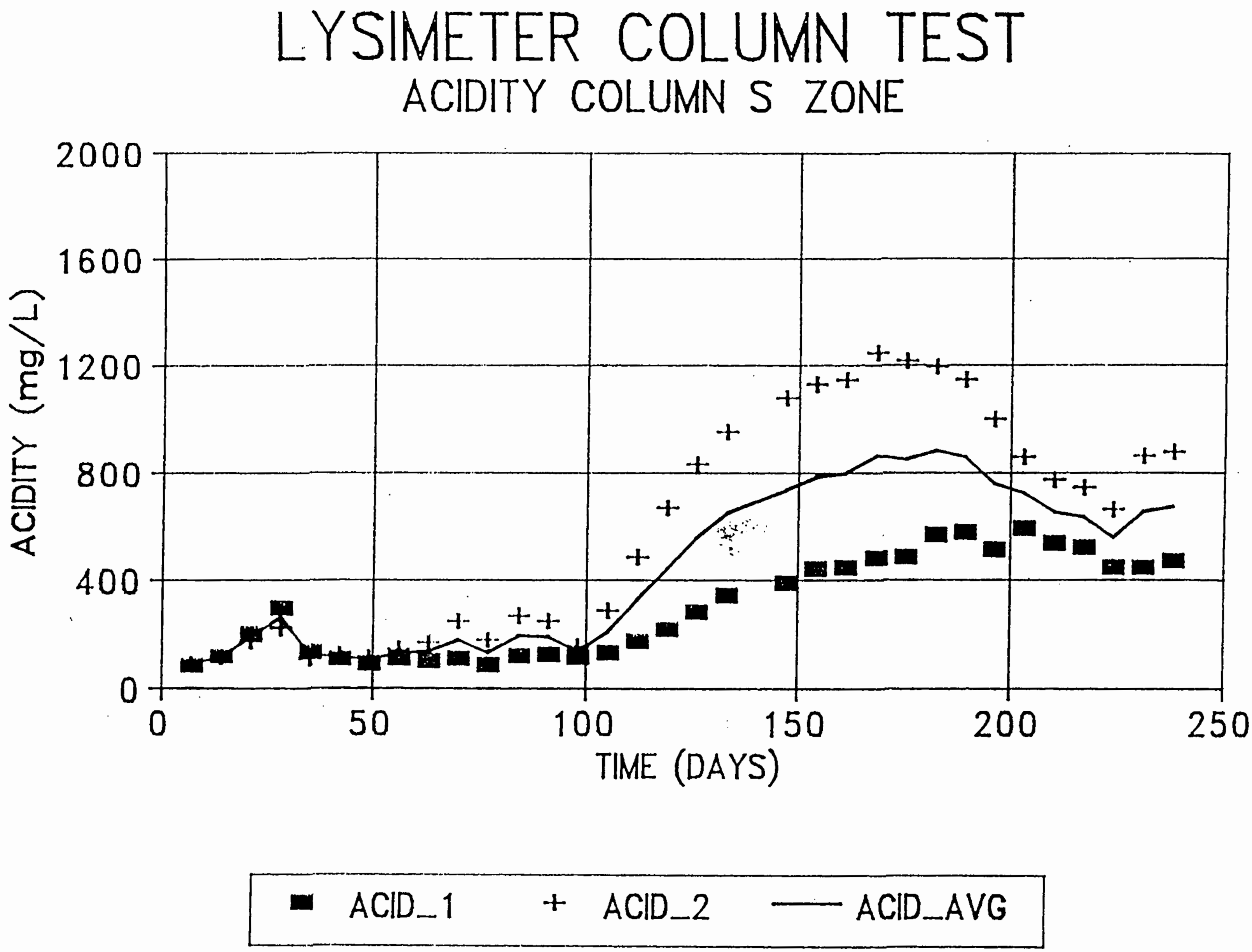


Fig. 29 - Effluent acidity for S Zone columns.

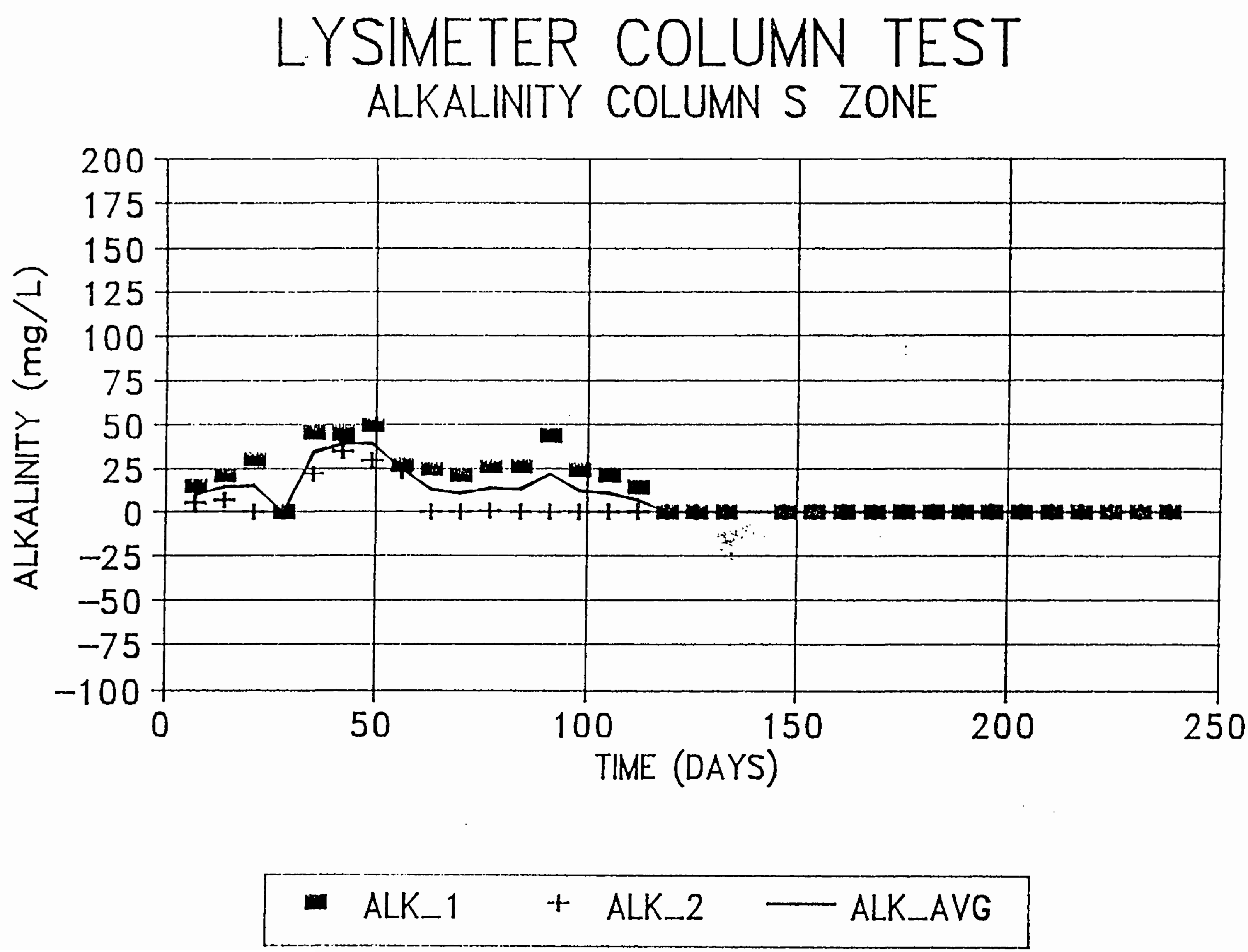


Fig. 30 - Effluent alkalinity for S Zone columns.

Photo 4. Composite View of Mill Site Showing Mill Service Buildings, Mill and Crusher Unit.

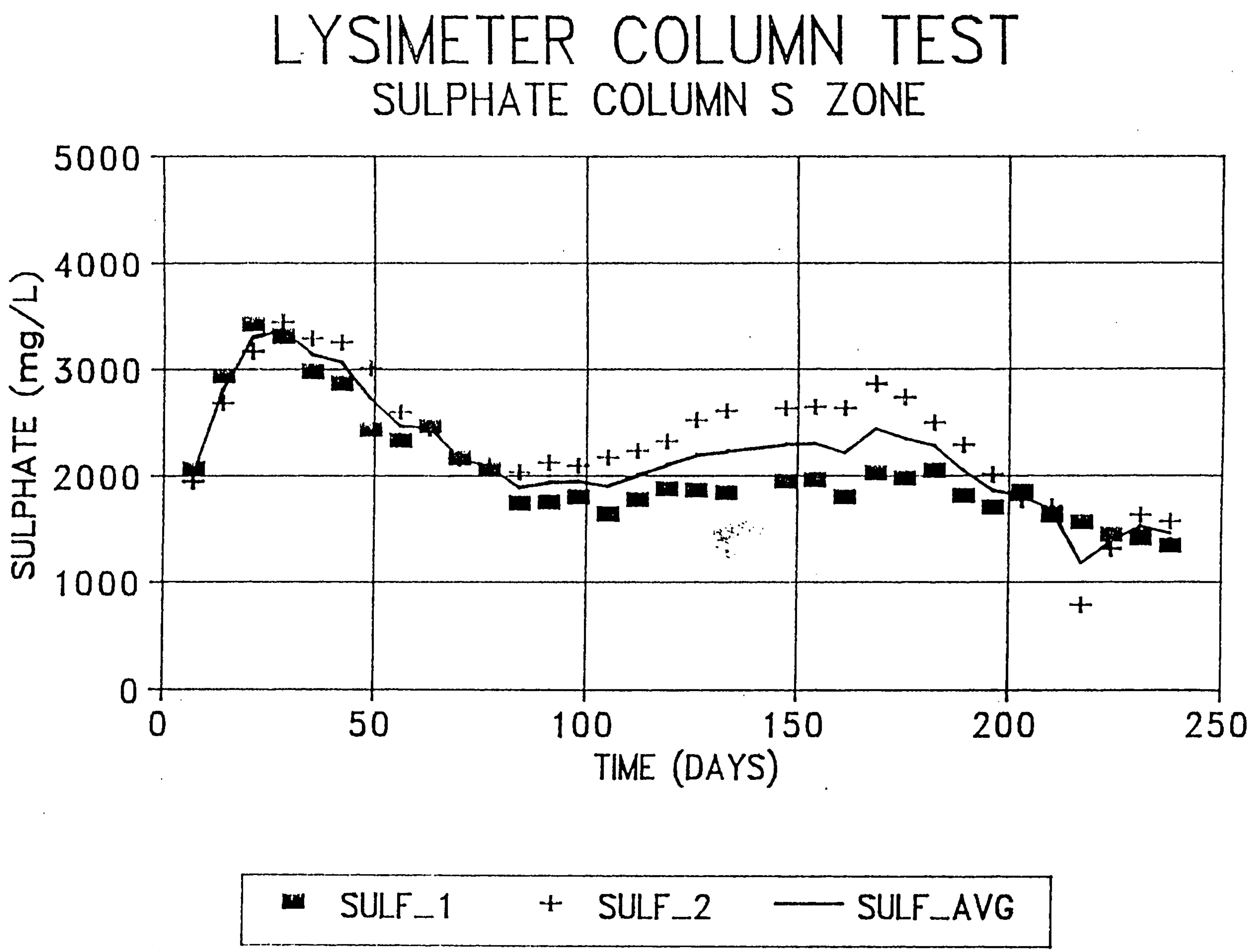


Fig. 31 - Effluent total sulphate (SO_4^{-2}) concentration for S Zone columns.

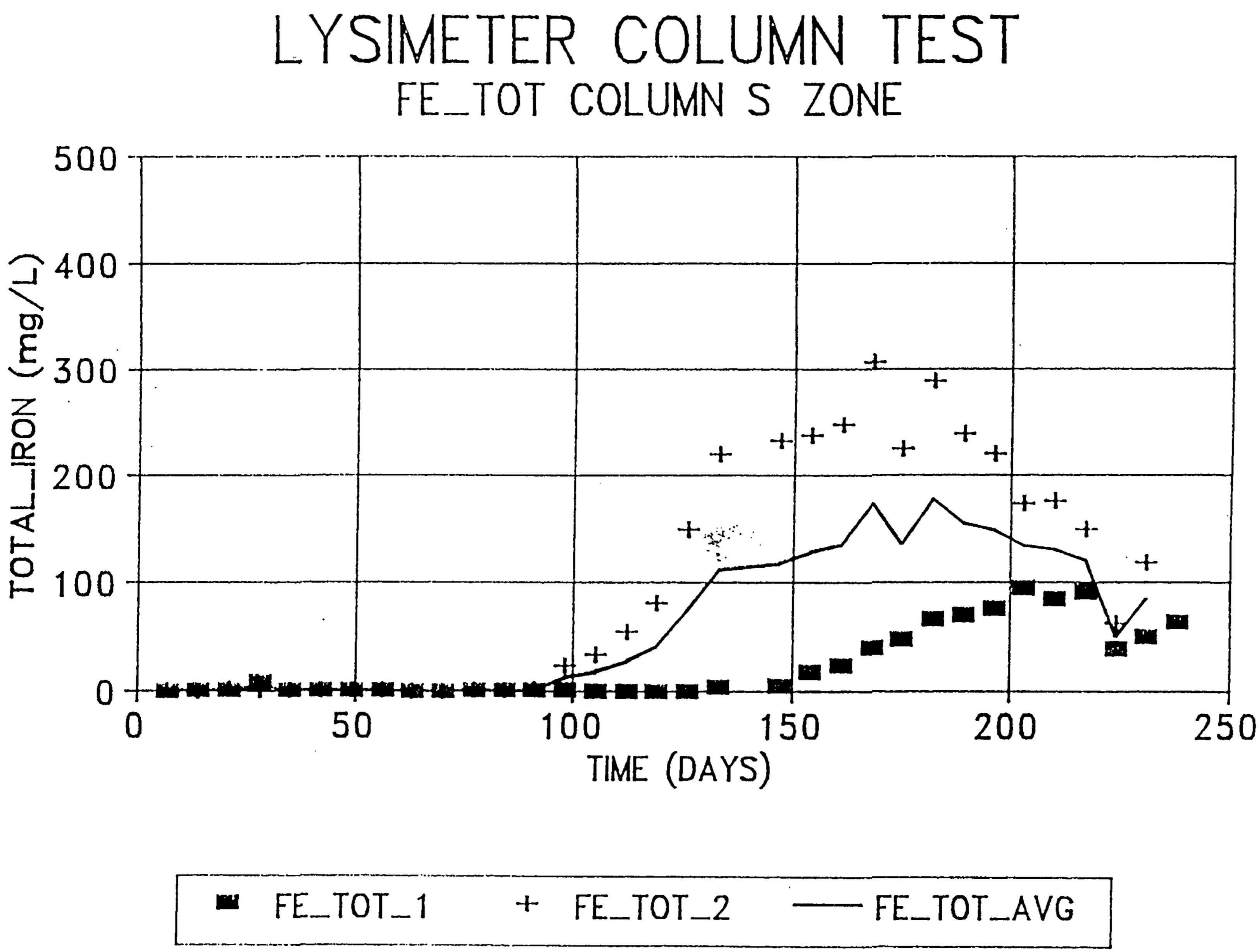


Fig. 32 - Effluent total iron (Fe) concentration for S Zone columns.

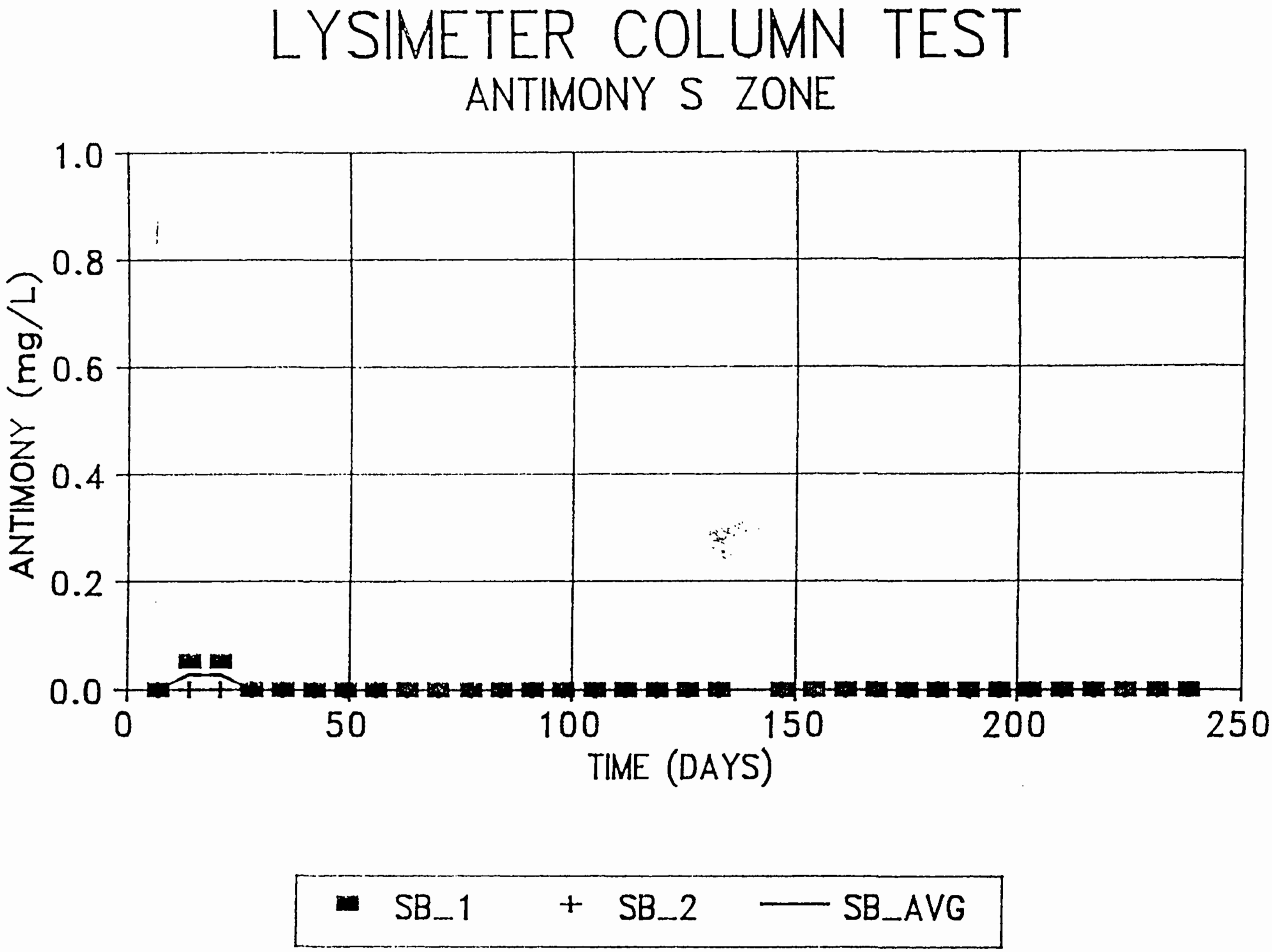


Fig. 33 - Effluent total antimony (Sb) concentration for S Zone columns.

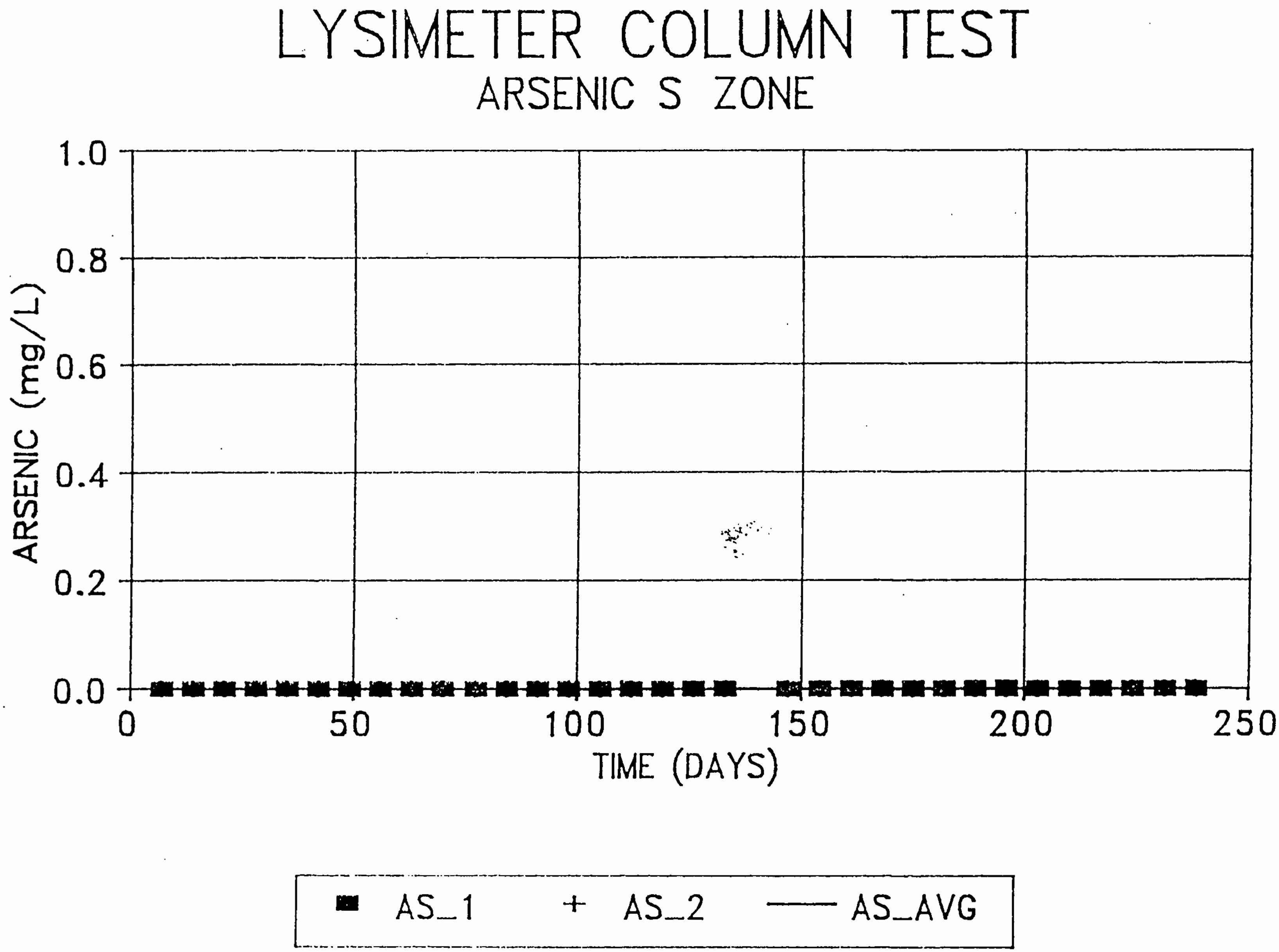


Fig. 34 - Effluent total arsenic (As) concentration for S Zone columns.

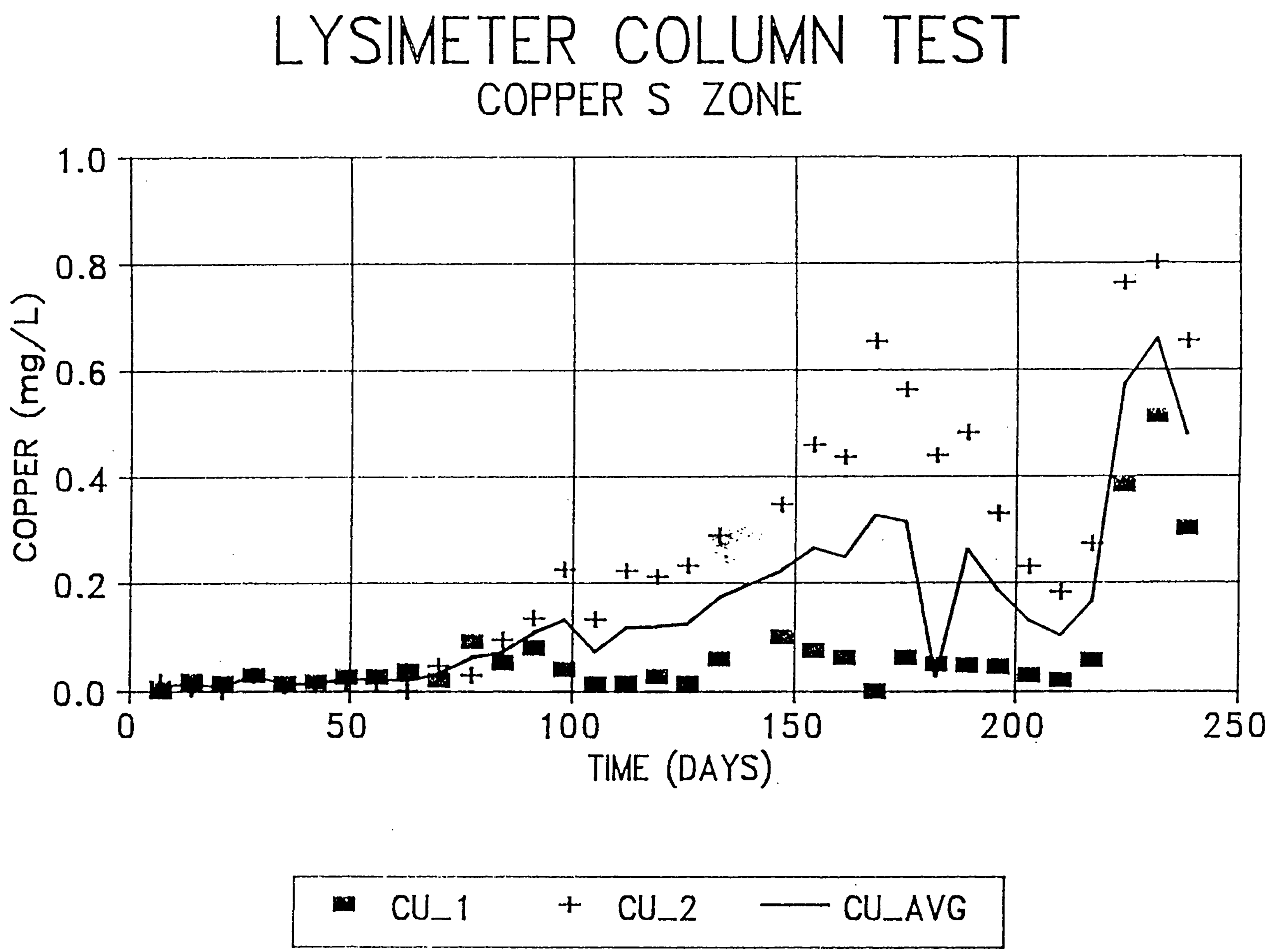


Fig. 35 - Effluent total copper (Cu) concentration for S Zone columns.

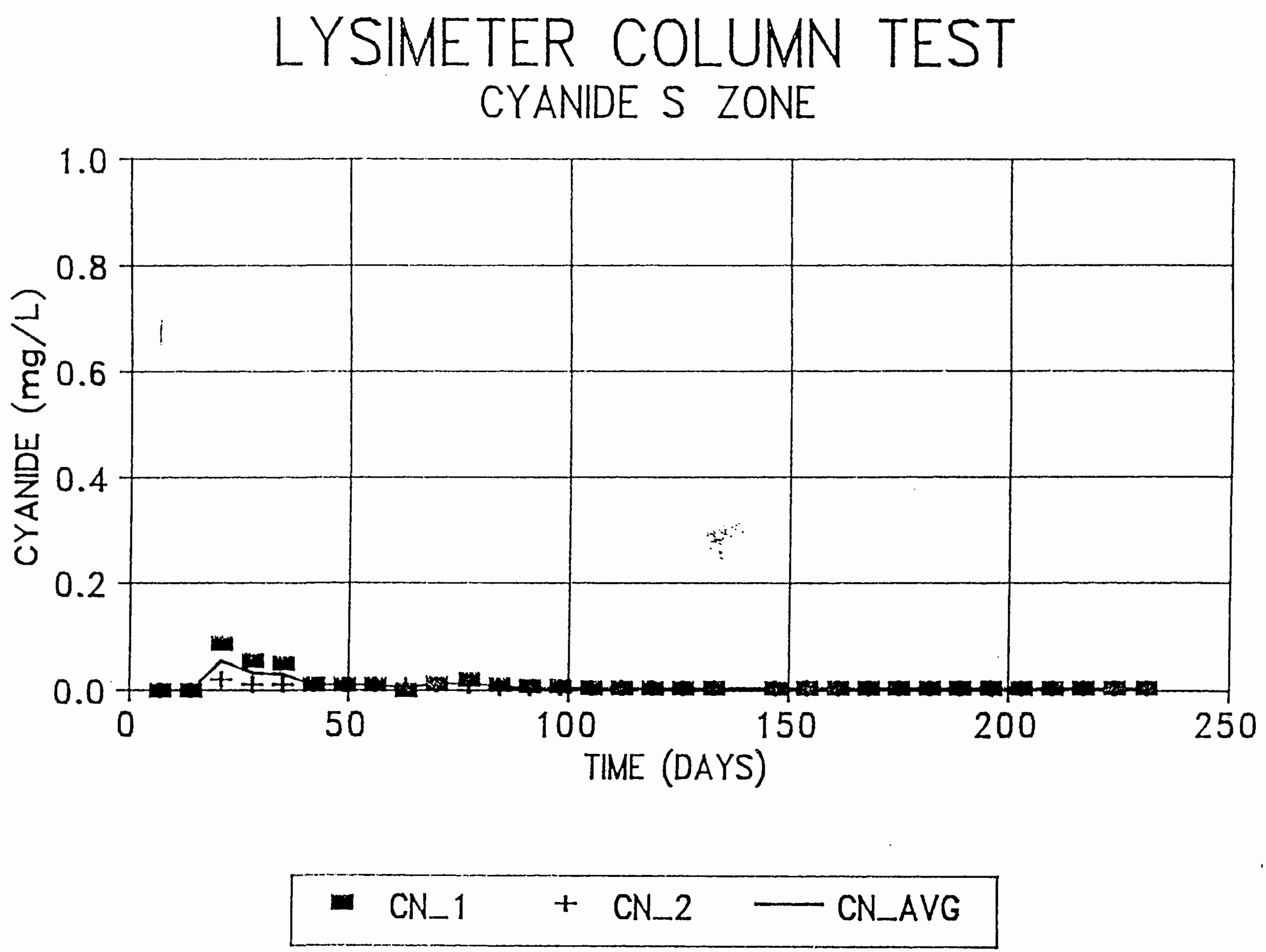


Fig. 36 - Effluent total cyanide (CN^-) concentration for S Zone columns.

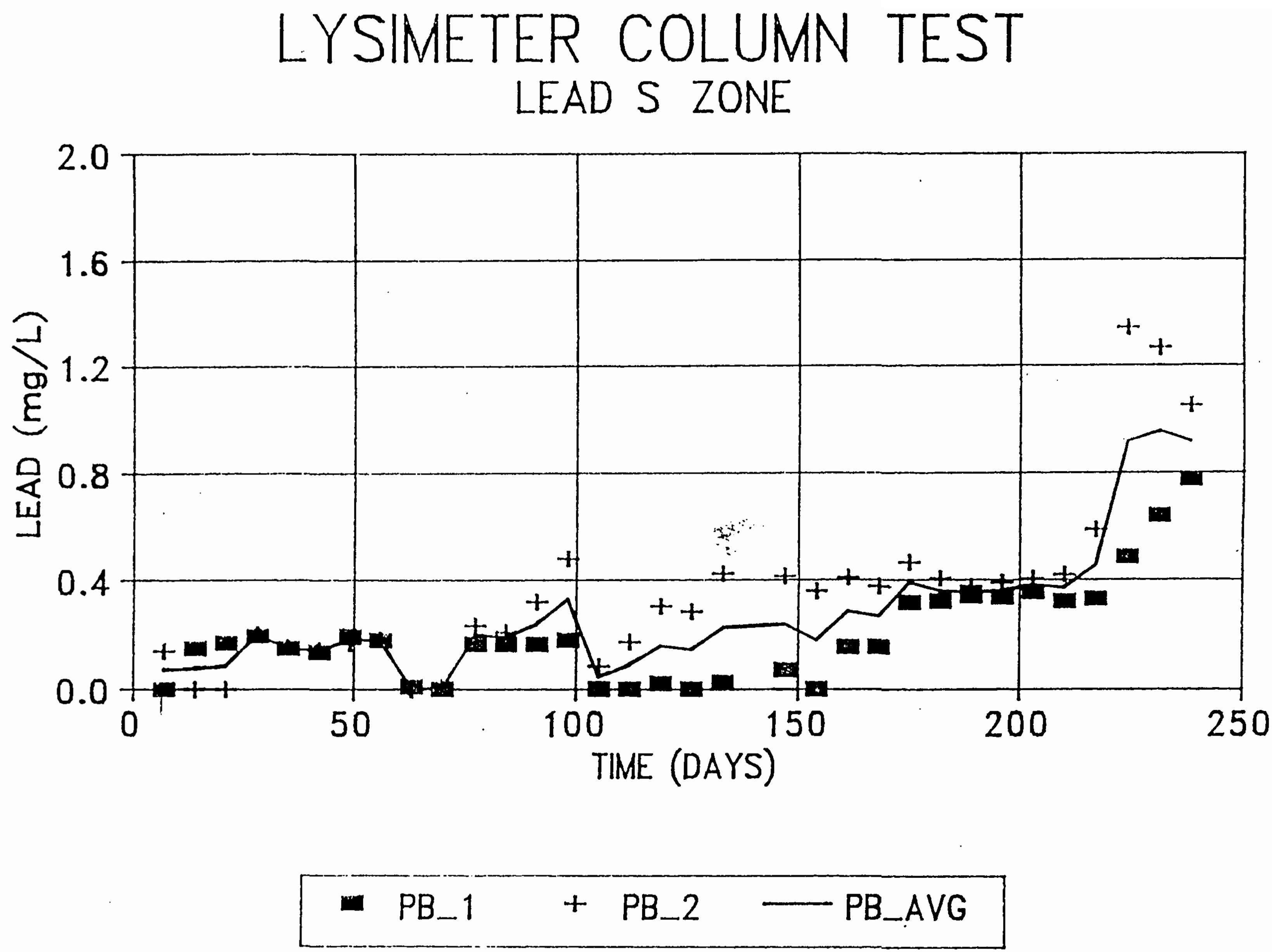


Fig. 37 - Effluent total lead (Pb) concentration for S Zone columns.

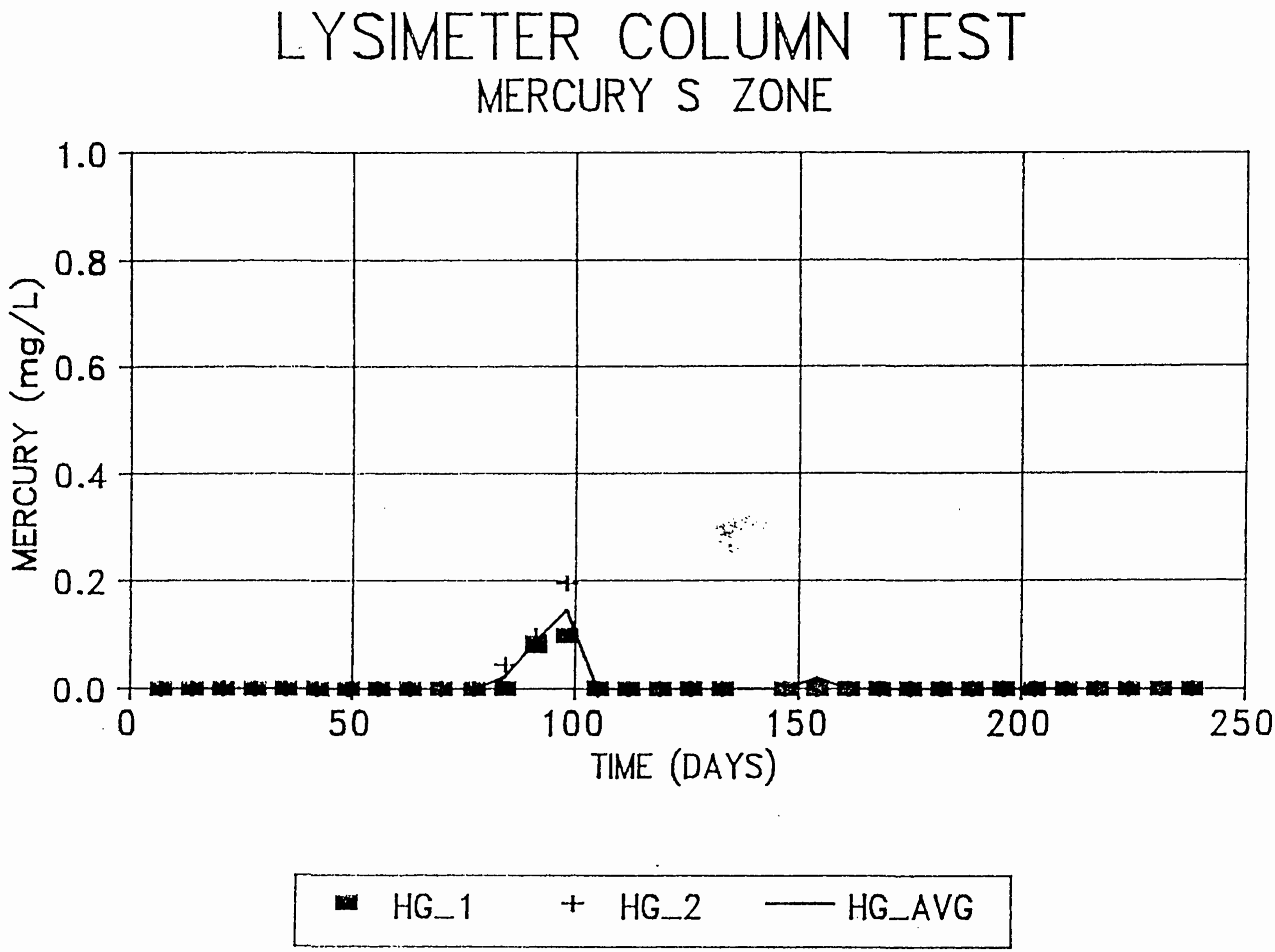


Fig. 38 - Effluent total mercury (Hg) concentration for S Zone columns.

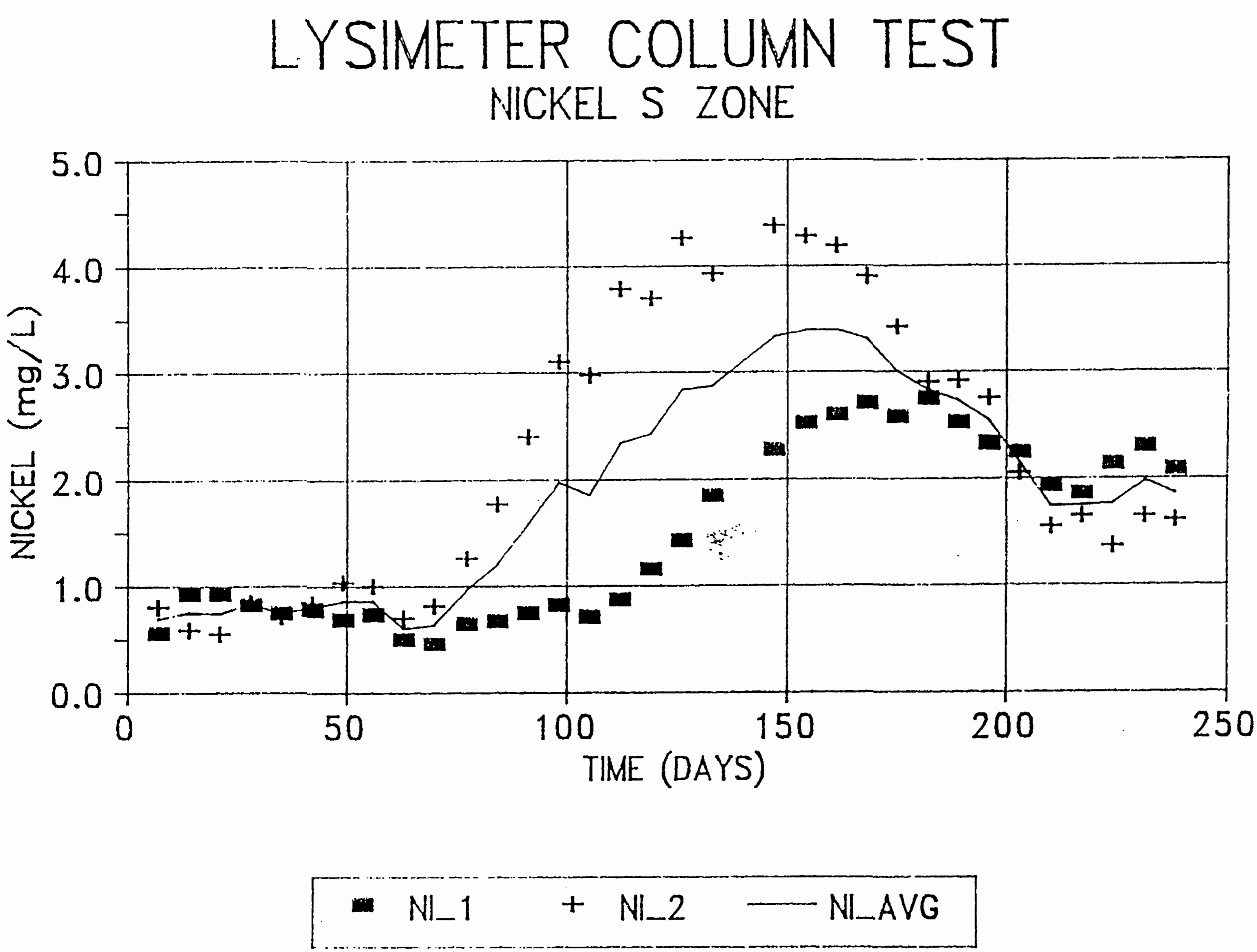


Fig. 39 - Effluent total nickel (Ni) concentration for S Zone columns.

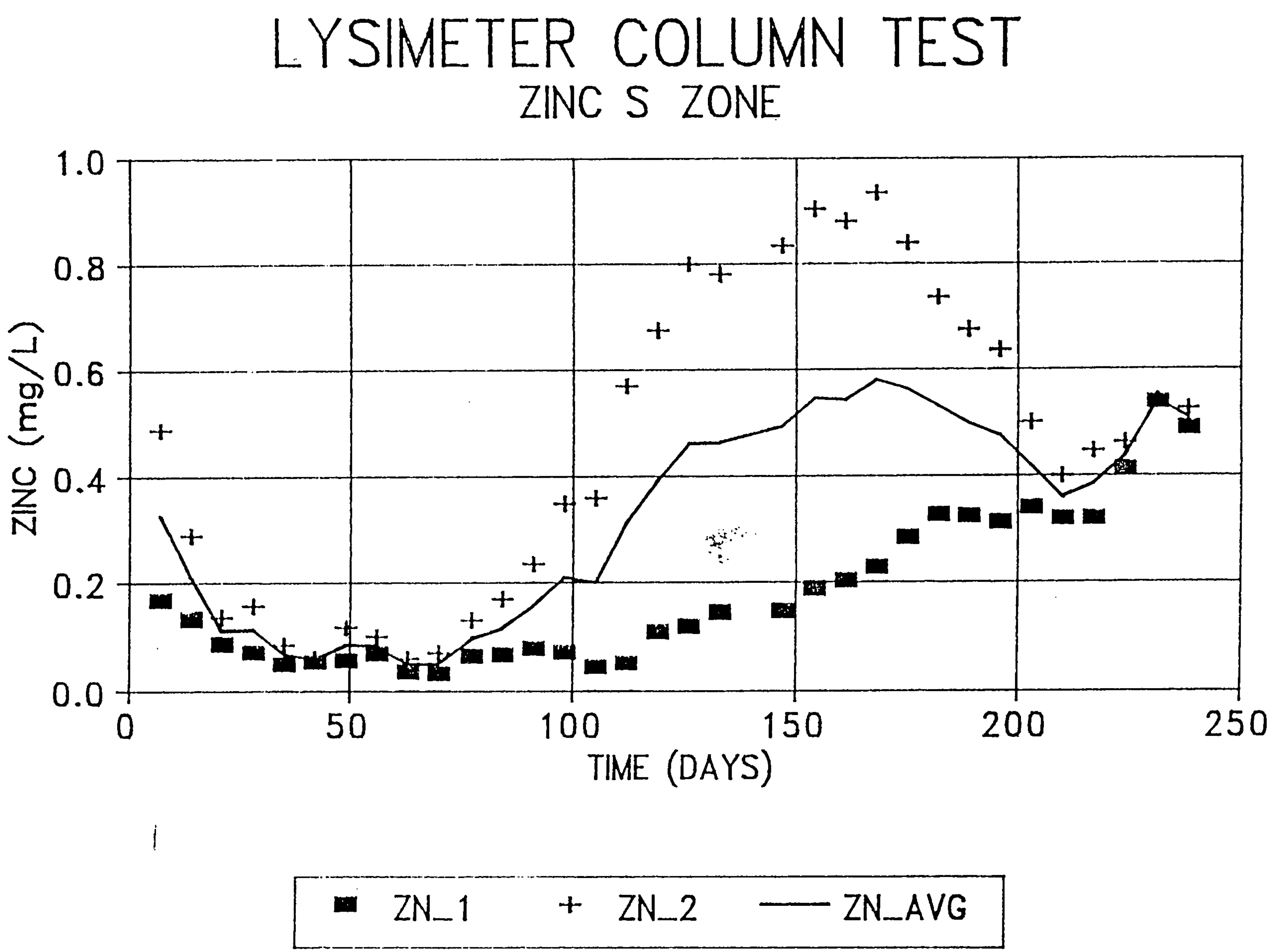


Fig. 40 - Effluent total zinc (Zn) concentration for S Zone columns.

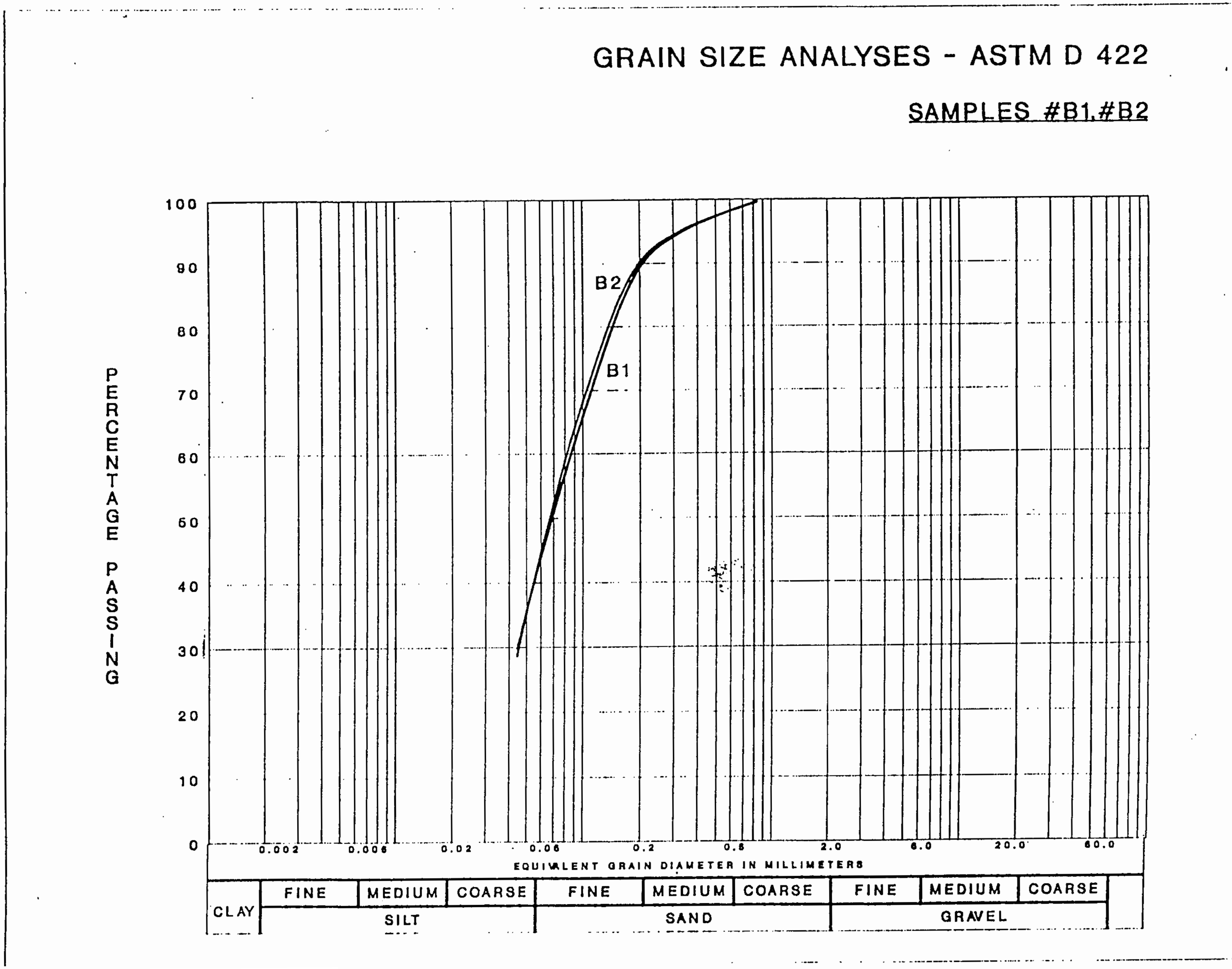


Fig. 41 - Grain size distribution of B Zone tailings.

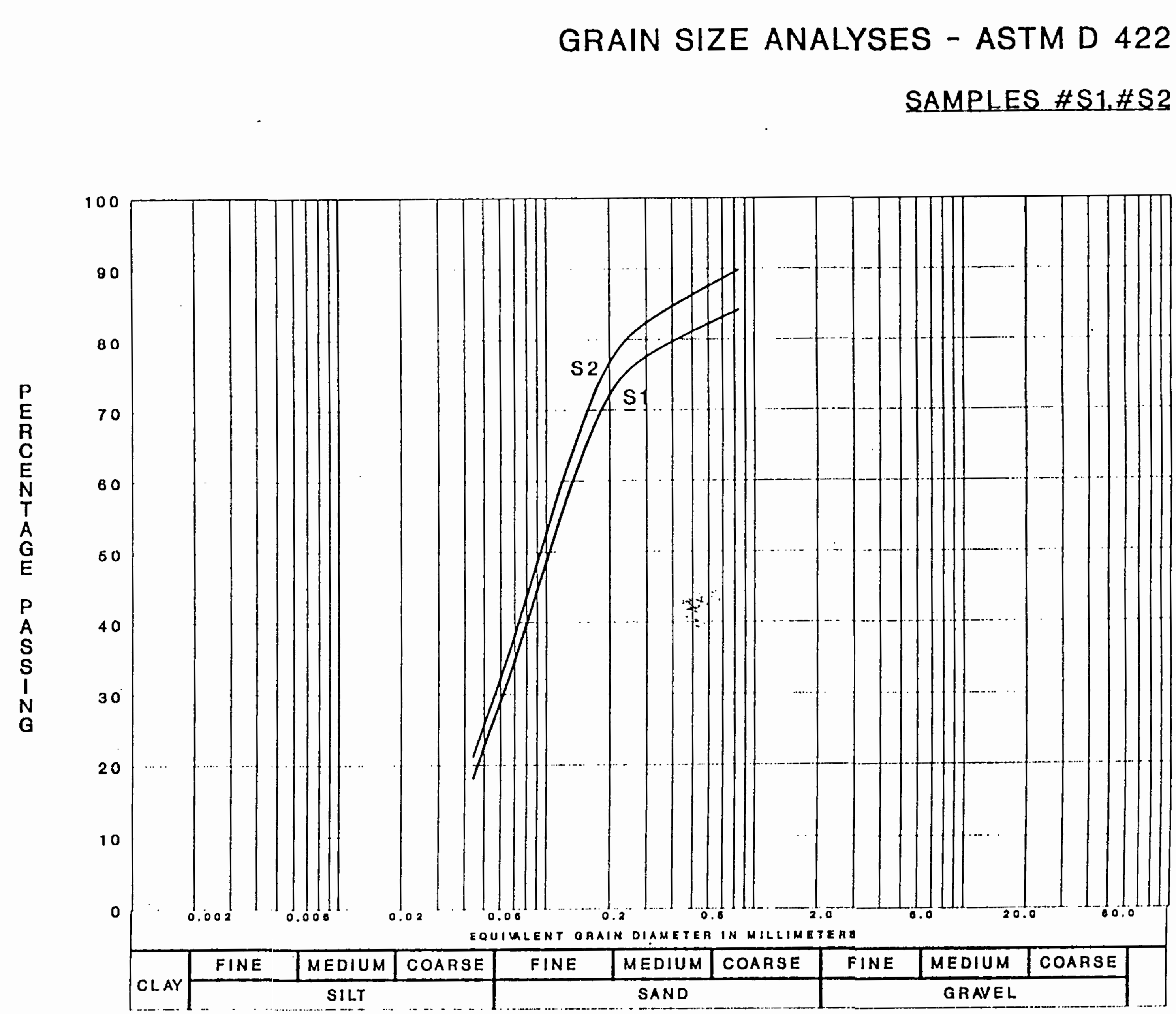


Fig. 42 - Grain size distribution of S Zone tailings.

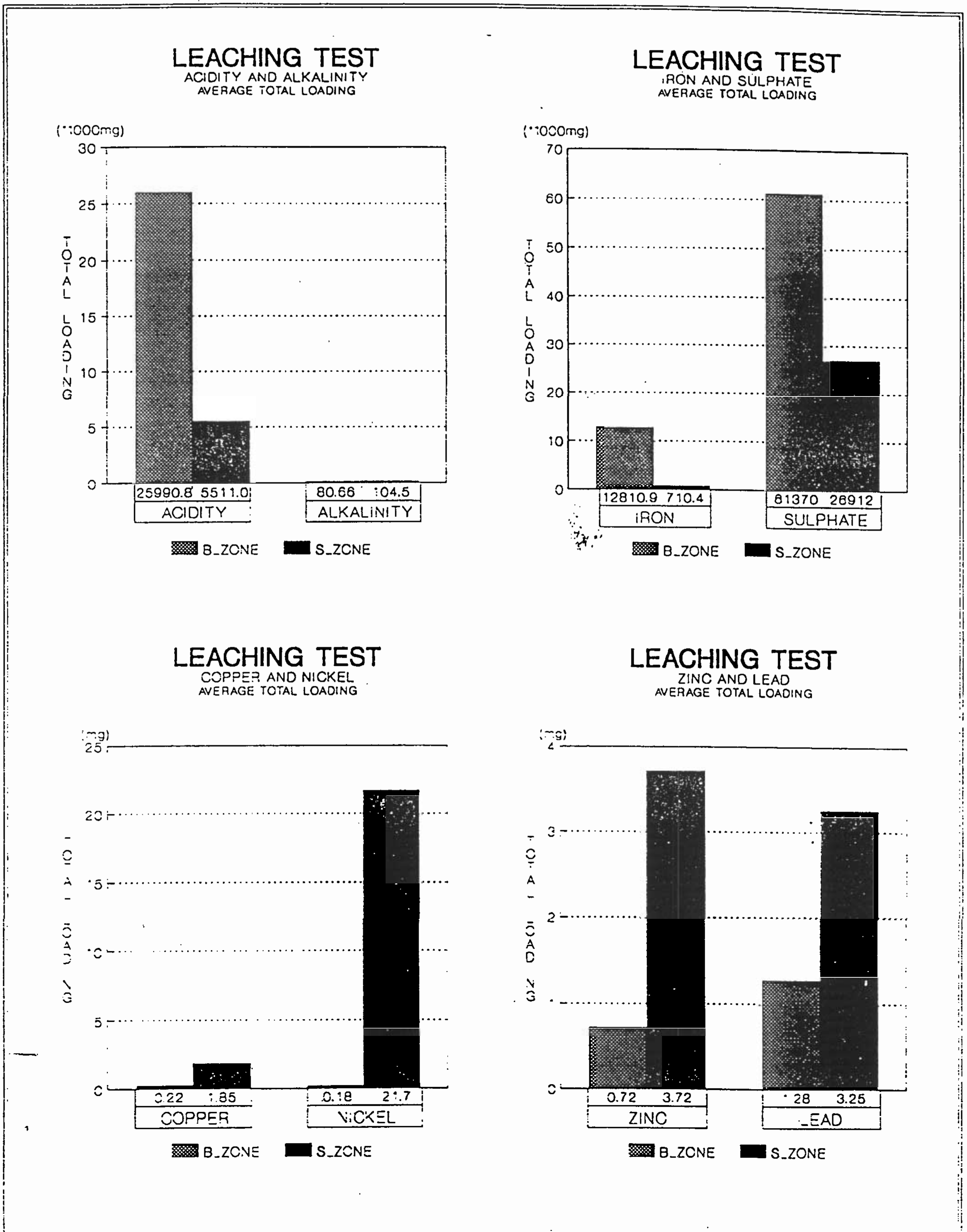


Fig. 43 - Total loading for acidity, alkalinity, iron, sulphate, copper, nickel, zinc and lead for B and S Zone tailings.

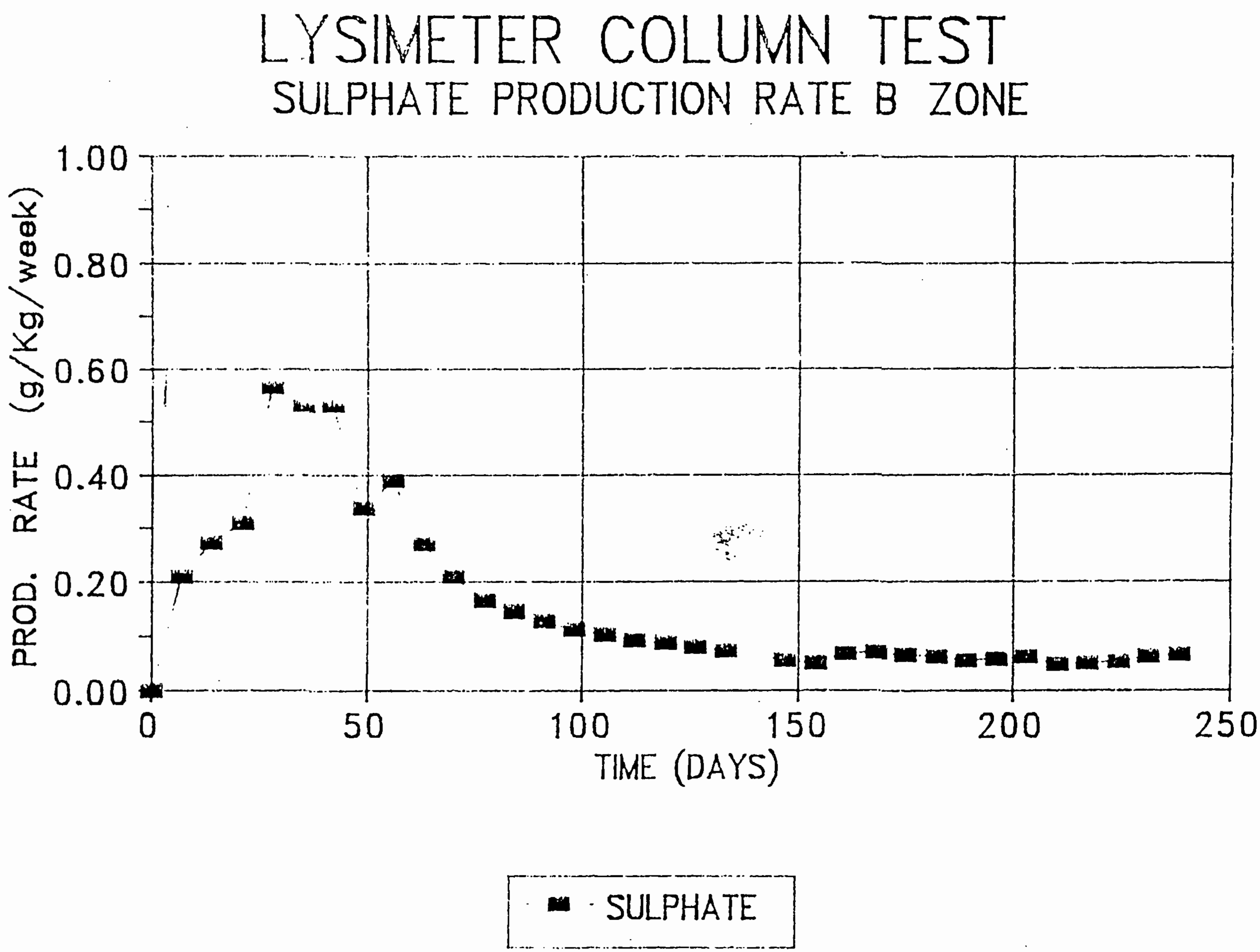


Fig. 44 - Rate of sulphate production per kg of tailings (dry weight) for B Zone tailings.

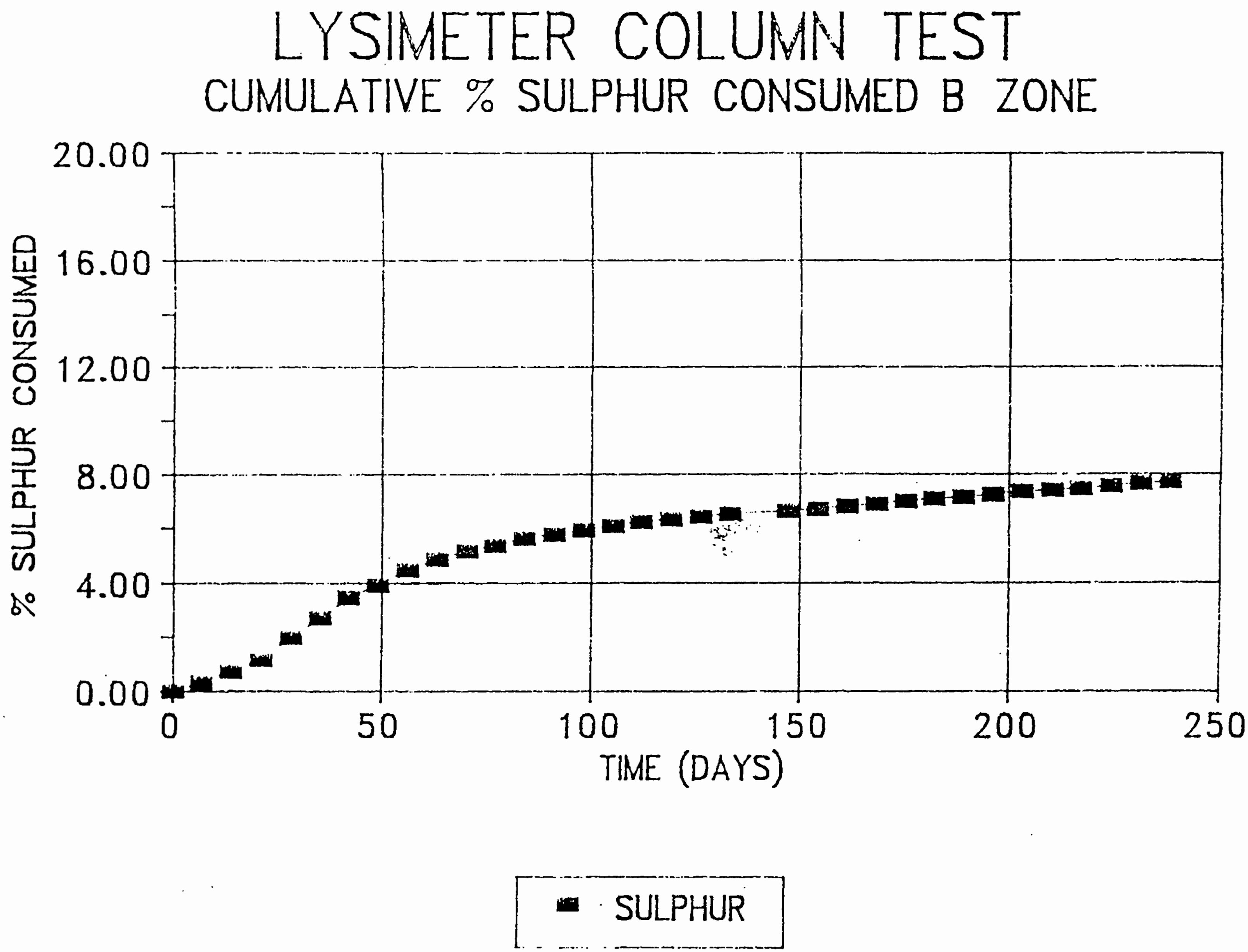


Fig. 45 - Cumulative rate of sulphur consumption (percent) for B Zone tailings.

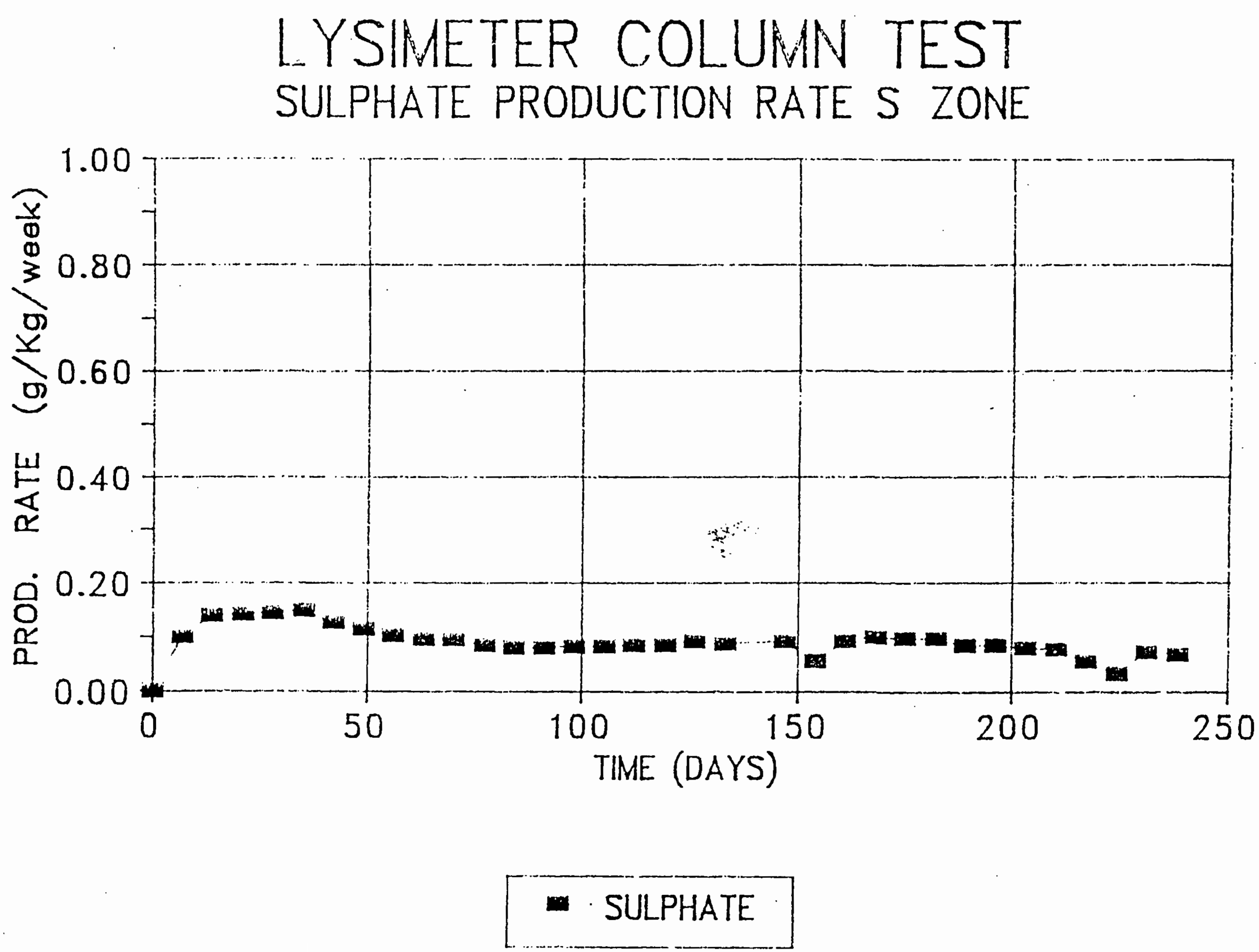


Fig. 46 - Rate of sulphate production per kg of tailings (dry weight) for S Zone tailings.

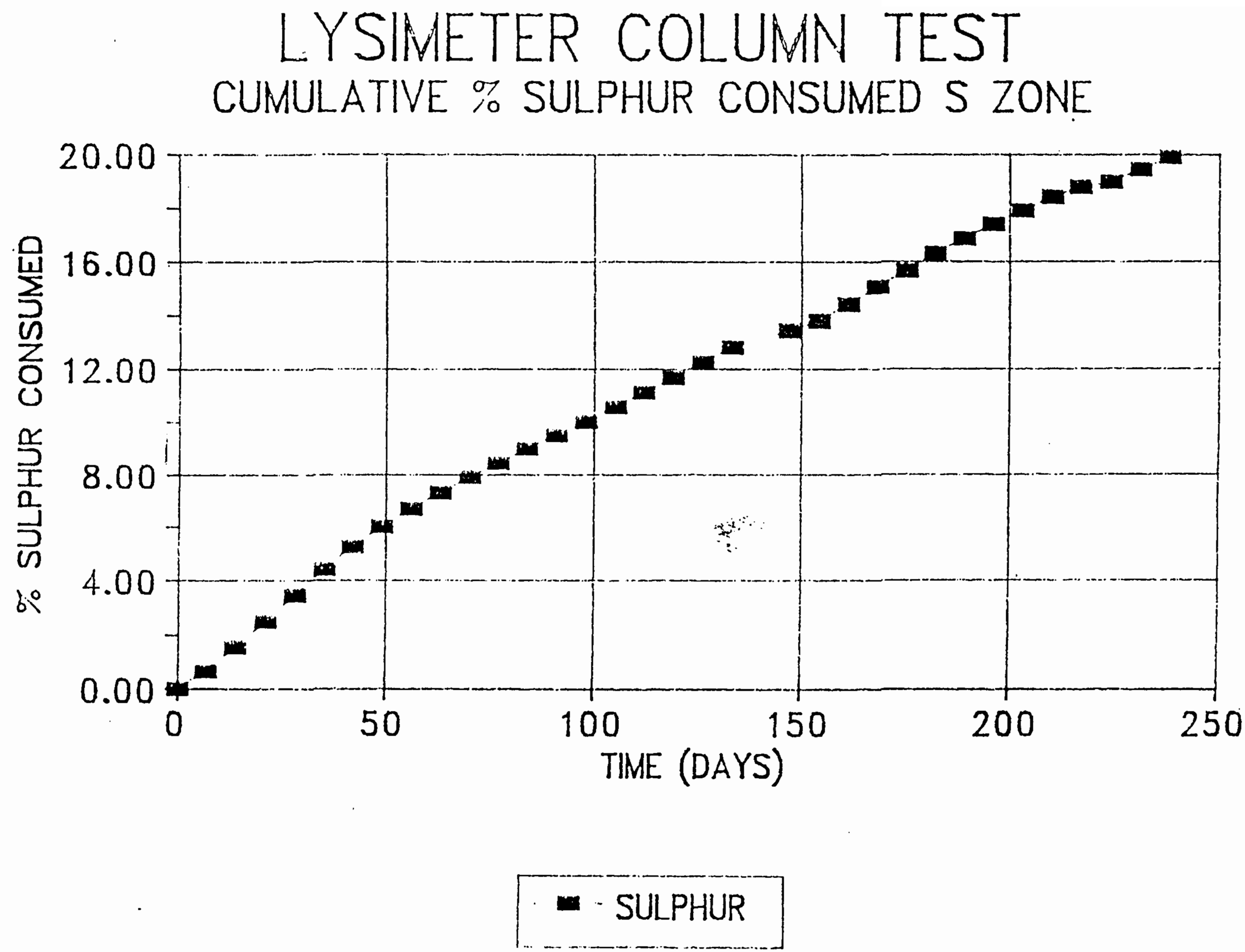


Fig. 47 - Cumulative rate of sulphur consumption (percent) for S Zone tailings.

CORONA CORPORATION

666 Burrard Street
Suite 2500
Vancouver, Canada
V6C 2X8

Fax (604) 669-7177
Telephone (604) 669-1011

October 16, 1990

Dr. N. Davé
Research Scientist
Energy Mines and Resources
CANMET
Elliot Lake Laboratory
P.O. Box 100, 99 Spine Rd.
Elliot Lake Ontario
P5A 2J6

Dear Dr. Davé,

Re: Contract work for Corona Corporation

Further to your discussions with Mr. W. Napier, we are prepared to contract the following work to your laboratory:

1. Cullaton Lake: Column Leaching Study

Two samples of Cullaton Lake Tailings have been sent to the CANMET laboratory. The purpose of the testwork is to acquire the necessary information to develop a Final Abandonment and Restoration Plan. If the tailings are non-acid generating, then covering the exposed beaches with overburden will be proposed. If the tailings are acid generating, then other decommissioning strategies will be considered. To satisfy our objective, a number of tests could be done, including humidity cell tests. We concur, however, with your view that leaching test columns should be adequate to provide us with the desired information.

(i) Prior to starting the column study the tailings samples will be analysed for sulphide speciation and a paste pH will be determined;

(ii) Four Schedule 80 PVC, 15 cm diameter, 2.4 m columns will be set up containing samples of tailings (one for each zone plus replicates);

(iii) The columns will be filled with tailings and underlain with a sand and gravel filter bed;

(iv) The columns will be innoculated with *Thiobacilli ferro oxidans* and will be leached using untreated natural lake water;

(v) The columns will be operated under trickle leach conditions with the water level at the sand and gravel interface;

(vi) The leachate will be collected and analysed weekly for a thirty week period.

Parameters to be analysed are pH, Eh, Ec, CN_{tot}, acidity alkalinity, sulphate, and dissolved metals such as iron, lead, copper, nickel, zinc, arsenic, mercury and antimony.

(vii) CANMET will prepare a summary report presenting and interpreting the data. The report shall be submitted no later than two months after the thirty week sampling period is completed.

2. Renabie Mine: Muskeg Bog Treatment

Renabie Mine is interested in demonstrating bog treatment for a portion of our supernatant discharge. Although the absorption/adsorption behaviour of bog plants is not well understood, experience shows that some plants have a natural affinity for certain types of metals and compounds. Next spring we would like to set up a pilot test along the south east corner of our tailings area. We would like to sprinkle approximately 300 to 5000 gpm of decant water into a spagnum moss bog and monitor any changes in effluent.

CANMET will be contracted to undertake the following work:

(i) provide a summary report on relevant studies applicable to our investigation;

(ii) analyze six soil samples for background concentrations of nickel, lead, zinc, copper, lead, sulphate, acidity, alkalinity and cyanide;

(iii) analyze another set of soil samples once the test work is completed;

(iv) during the test period {up to eight weeks} analyze water samples collected at the inflow and outflow of the bog; and

(v) prepare a report describing the results of the test work and speculate on the absorption/ adsorption characteristics of plants.

The cost for the above mentioned work, excluding travel arrangements, is estimated to be the following:

the cost for the Cullaton Lake Column tests is	$16,000
the cost for bog treatment at Renabie Mine is	$ 5,000

Should you wish further clarification or to discuss this matter further, please do not hesitate to contact the undersigned or Mr. W. Napier.

Yours truly

R. A. McCallum

R. A. McCallum, P. Eng.
Vice-President
Operations

Shear Lake De-watering and Fish Removal

SHEAR LAKE DE-WATERING AND FISH REMOVAL[5]
Summary of Report

The Northwest Territories Water Board approved the Company's request in Summer of 1984 to de-water Shear Lake because test mining on mineralized zones located beneath the lake was planned. The removal of the water was not expected to have any adverse effect on the environment due to the Lake being a minor component of the drainage system.

Prior to de-watering, the Company conducted a fish removal program whereby fish would be transported to Cullaton Lake in order to protect the fish resource. On June 21, 1984, Brian Wong, writing for Don Dowler, sent Merdy Armstrong [mine manager] a permit to remove fish from Shear Lake and release them alive into Cullaton Lake.

Fish removal commenced July 24, 1984. Fishery Officer Jerry Hordal from Yellowknife was present to supervise and assist the program. A seine net with one quarter inch mesh was used to collect fish. Fish populations included: spine sticklebacks, lake chubs, and minnows. The fish were collected and placed in a forty-five gallon drum previously filled with water from Cullaton Lake. They were then transported by helicopter to Cullaton Lake and released alive.

Because of the low capture success, reflecting a low fish density, and the absence of any potential commercial fish (such as Arctic grayling or Lake trout common to the area), the fish removal was declared finished by the fisheries officer shortly after the exercise was begun.

Cullaton Lake Gold Mines began pumping water on June 23, 1984, once the permit for de-watering Shear Lake and removing the fish was received. The natural drainage was diverted around the lake in order to avoid a potential in-rush into the underground workings. The water flow was directed towards the Kognak River system, downstream of the normal, natural drainage from Shear Lake.

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[5]Robinson, Renee. Submission to the Northwest Territories Water Board for the Renewal of Water Licence N6L3-0940. Presented August 28, 1984 at the Water Board Public hearing, Eskimo Point, N.W.T.

Tailings Assessment Report

Trow

Thunder Bay Branch

Trow Consulting Engineers Ltd.
807 Harold Crescent, Thunder Bay
Ontario, Canada. P7C 5H8
Telephone: (807) 623-9495
Facsimile: (807) 623-8070

February 1, 1995

Homestake Canada Ltd.
1000 – 700 West Pender Street
Vancouver, B.C.
V6C 1G8

Attention: Mr. Bill Napier, Manager Environmental Affairs

RE: Cullaton Lake Gold Mine
Our Reference No. F-90132-B/E

Dear Mr. Napier,

1.0 INTRODUCTION

The undersigned visited the Cullaton Lake Gold Mine during the period of June 25 to June 28, 1994 to examine the Tailings Containment Area and to conduct a topographic survey of this area.

2.0 SURVEY

A topographic survey was conducted to accurately establish the water elevations in the Tailings Pond and Polishing Pond, the size of the tailings pond, the depth of cover material, typical cross sections of the dams, locations of the thermistors and monitoring wells and locations of the mill buildings and shops. The elevations of these features are referenced to a temporary bench mark established on a concrete slab at the northeast corner of the mill building and given an assumed elevation of 100.00 m. Details are shown on Drawing No. 1. Typical sections of the tailings dams are shown on Drawing No.s 2 and 3.

3.0 THERMISTORS

Readings of the previously installed thermistors were recorded by Mr. Rodney McKay of McKay Environmental Industries Ltd. The results are given in the following table and are shown graphically on Drawings, No.s 4 through 7 along with readings from previous years.

Thermistor No.	Readings (June 27, 1994) 0	1	2	3	4	5
1	7.67 15.51	9.37 11.26	12.68 5.03	16.51 −0.21	18.17 −2.07	19.40 (kilohms) −3.33 (°C)
2	7.71 15.40	7.76 15.26	10.31 9.27	14.49 2.35	17.31 −1.13	19.04 (kilohms) −2.97 (°C)
3	7.71 15.40	8.52 13.27	11.67 6.72	16.47 −0.16	18.05 −1.94	19.20 (kilohms) −3.13 (°C)
4	7.74 15.32	8.37 13.65	11.53 6.97	16.24 0.10	17.87 −1.74	19.40 (kilohms) −3.33 (°C)

The comparative results from the four thermistor installations indicate that there is an upward trend in the level of permafrost. The average depth of frost was approximately 400 mm below the tailings ground surface during the time of this study. This compares to a frost level of a 800 mm below the ground surface during a similar time period in 1992 (July 6, 1992). It should be noted, however, that the greatest depth of thaw occurs at the end of the summer season which will lower the level of frost to the greatest seasonal depth. To obtain the level of maximum thaw, thermistor readings should be taken sometime in the month of September. A more accurate level of permafrost can then be recorded. At the current rate of rise in frost levels, it is expected that the covered tailings area will be in a permanently frozen state (permafrost) in 2 to 3 more years.

4.0 TAILINGS AREAS

A visual examination was conducted on the dams for Tailing Area No.s 1 and 2. The average water elevations measured on Dam No.s 1 and 2 are approximately 94.0 m and 89.4 m, respectively. There was no evidence of any seepage on the downstream side of each of the dams.

A visual examination of Tailings Dam No. 1 indicates that the dam is stable under current conditions. A stability analysis was carried out on this dam in Trow's, "Abandonment and Restoration Plan", dated May 7, 1991 prior to closure. The dams have since been lowered and the face flattened which increases the stability (see Trow report of July 19, 1993). The current water elevation of 94.0 m is controlled by the spillway constructed on the east side of the dam.

The spillways at each of the two dams appear to be in good condition. However, some levelling of some small rock piles immediately adjacent to the spillway in Dam No. 2 would provide a better appearance and provide better control of surface runoff. A slight trickle of water was noted through the rock fill in the spillway on Dam No. 1. Photographs, No.s 1 and 2 show the conditions of the two spillways.

Attempts were made to determine the profile of the bottom of Tailings Pond No. 1 by depth soundings using a canoe. Unfortunately, strong wind conditions during this field study proved to be too dangerous to take soundings with a canoe. Topographic information from a 1990 survey by H I W Surveys Ltd. was used in combination with our survey to provide a profile of Tailings Pond No. 1. Based on this combined survey information, there is a maximum water depth of approximately 3.0 m (10 ft.) in Tailings Pond No. 1.

There was no evidence of any exposed tailings in Tailings Area No. 1. Field measurements from a September 1990 site visit indicate that the maximum depth of seasonal thawing (active zone) is estimated to be 1.4 m. Measurements from a subsequent field visit of August 11, 1992 show that the cover material over the tailings is approximately 1.2 m thick. Photographs, No.s 3 and 4 show the covered tailings area.

A small section of the dam in the northwest corner of Tailings Dam No. 2 is not well defined. It is assumed that this section was disturbed when material was being used to cover the exposed tailings in Tailings Area No. 1. A stockpile of waste rock immediately adjacent to this area could be used to shape the dam to the conditions similar to the rest of the dam. Mr. Rodney McKay stated that this would be done during this site visit.

Based on our examination, the structures associated with the former tailings disposal system are stable. A visual inspection of Tailings Dam No. 1 shows that the dam is stable under current conditions. There is no evidence of seepage from the dams in Tailings Pond No. 1. The water level in Tailings Pond No. 1 is remaining stable at the level of the invert of the spillway (El 94.1 m). The permafrost level is rising in the covered tailings as predicated.

If there are any questions or comments regarding this information, please contact us at your convenience.

Yours truly,
TROW CONSULTING ENGINEERS LTD.

REGISTERED PROFESSIONAL ENGINEER
Jan. 2/95
R. B. DODDS
LICENSEE
N.W.T.

Donald E. Kaluza, P. Eng.

Robert B. Dodds, Ph.D., P.Eng.
Thunder Bay Branch Manager

THE ASSOCIATION OF
PROFESSIONAL ENGINEERS,
GEOLOGISTS and GEOPHYSICISTS
OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
P 184
TROW CONSULTING
ENGINEERS

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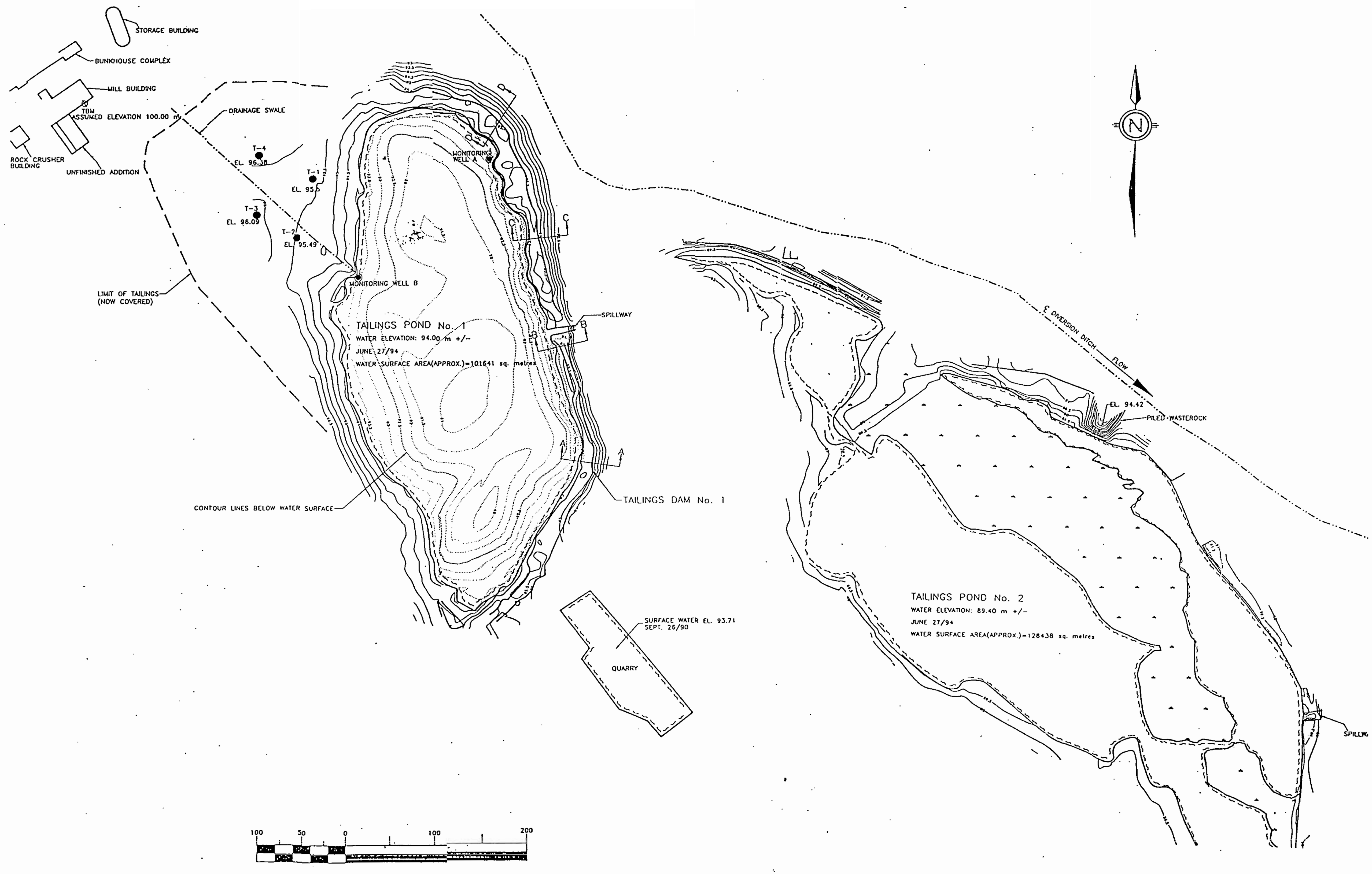


LEGEND

- MONITORING WELL
- BENCHMARK
- THERMOSTERS

NOTES:

1. DATA INTERPRETED FROM TROW ENGINEERING SURVEY(JUNE 27/94) AND SURVEY BY H.I.W. SURVEYS LTD.(NOV. 10/90)
2. BENCH MARK IS LOCATED ON CONCRETE SLAB AT NORTH EAST CORNER OF MILL BUILDING. ASSUMED ELEVATION: 100.00m
3. ALL ELEVATIONS ARE SHOWN IN METRES.

REVISIONS

No:	Date:	Revision

Client: HOMESTAKE CANADA

Project: CULLATON LAKE MINE CLOSURE

Title: TAILINGS POND SURVEY CULLATON LAKE, N.W.T.

Project No. F-90132-A/G

Dwg. No.: 1

TROW CONSULTING ENGINEERS LTD.
Thunder Bay, Ontario, Canada

Client: HOMESTAKE CANADA

Project: CULLATON LAKE MINE CLOSURE

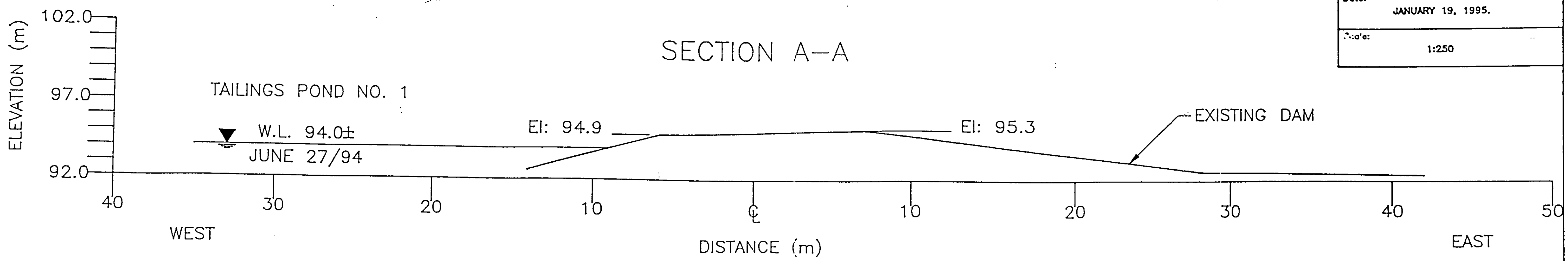
Title: CROSS SECTIONS
TAILINGS DAM NO. 1

Project No.: F-90132-A/E
Dwg. No.: 2

Drawn By: D.T.
Reviewed By: D.K.

Date: JANUARY 19, 1995.

Scale: 1:250



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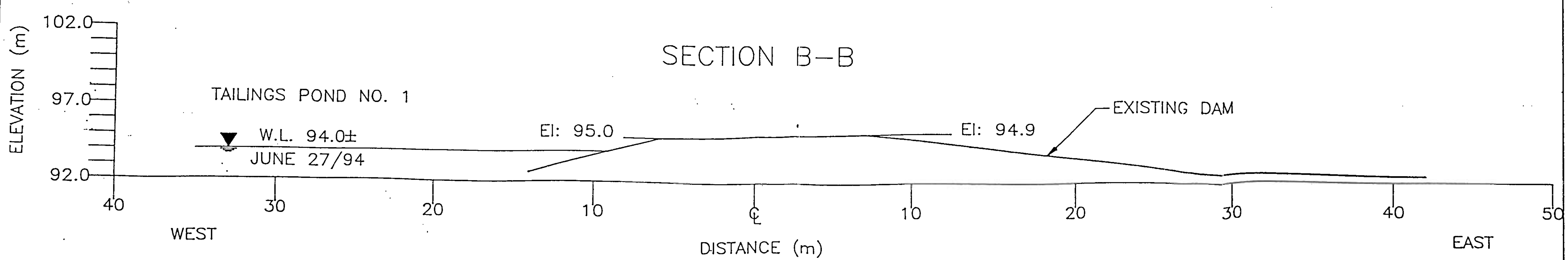
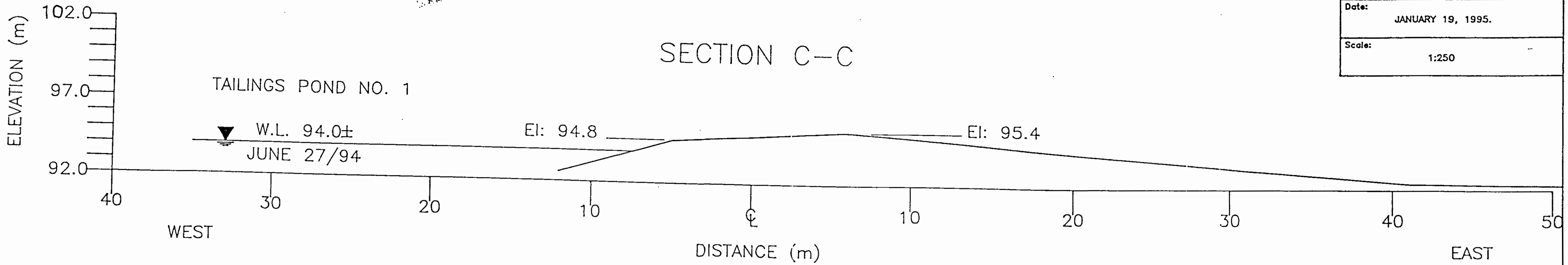
VERTICAL SCALE: 1:250



TROW CONSULTING ENGINEERS LTD. Thunder Bay, Ontario, Canada	
Client: HOMESTAKE CANADA	
Project: CULLATON LAKE MINE CLOSURE	
Title: CROSS SECTIONS TAILINGS DAM NO. 1	
Project No. F-90132-A/E	Dwg. No.: 3
Drawn By: D.T.	Reviewed By: D.K.
Date: JANUARY 19, 1995.	
Scale: 1:250	

SECTION C–C



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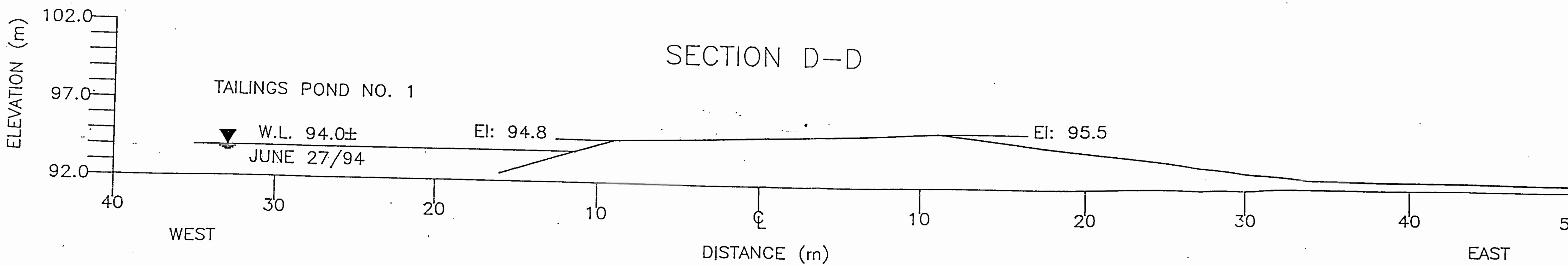
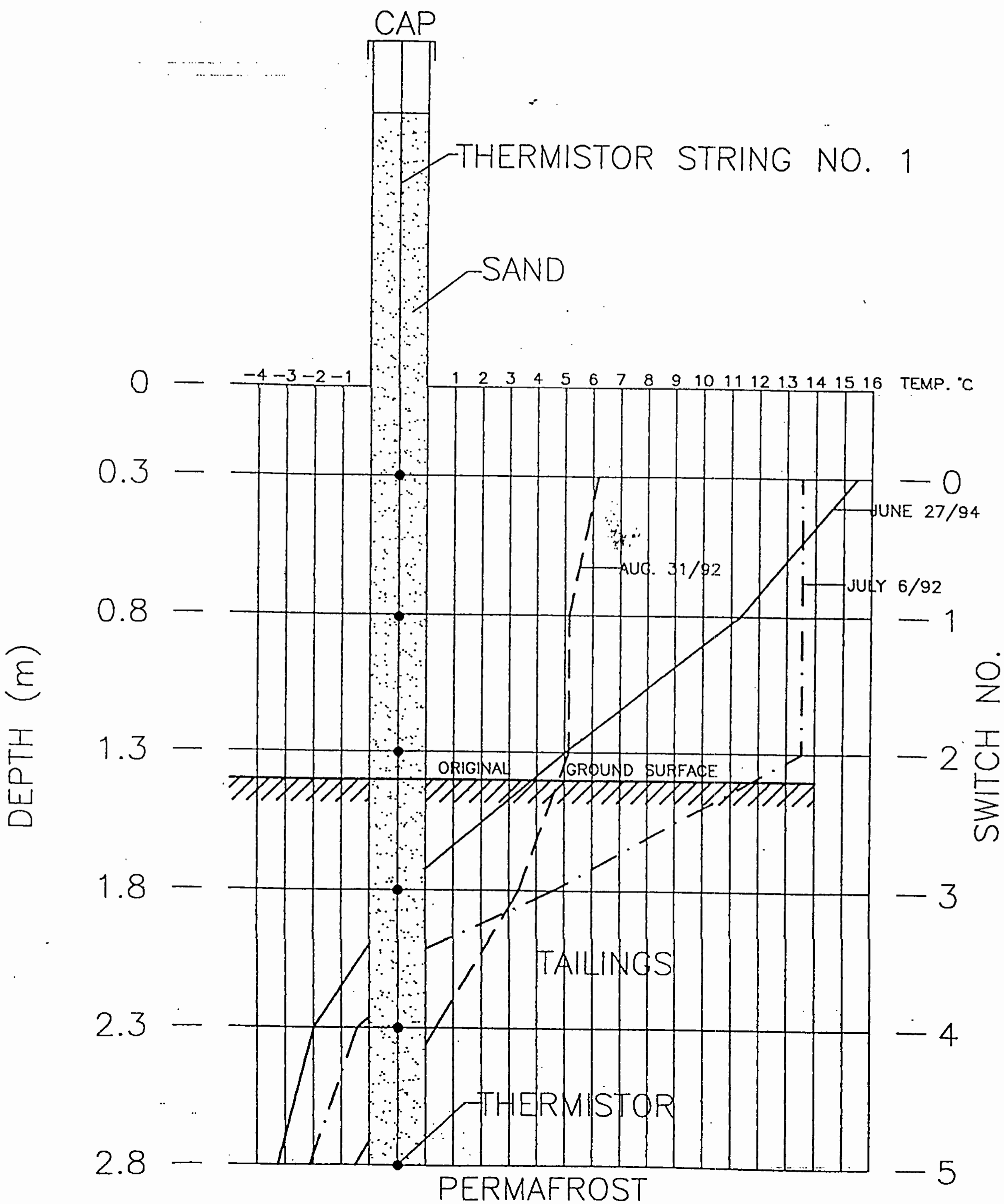
SECTION D–D



REF. NO. F-90132-A/E

DRAWING NO. 4

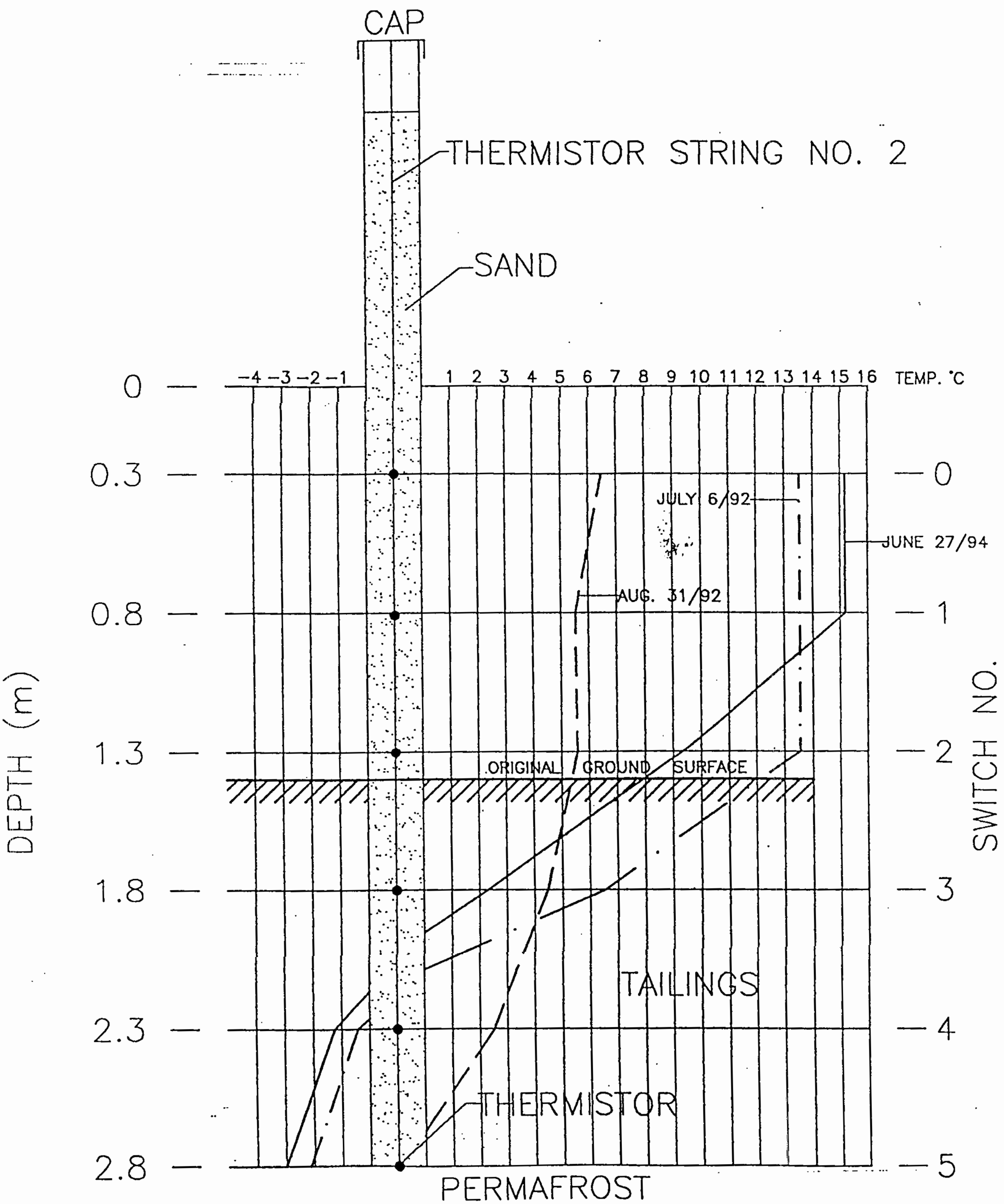


THERMISTOR STRING CONFIGURATION

INSTALLED AUGUST 23, 1991

REF. NO. F-90132-A/E

DRAWING NO. 5



THERMISTOR STRING CONFIGURATION

INSTALLED AUGUST 23, 1991

REF. NO. F-90132-A/E

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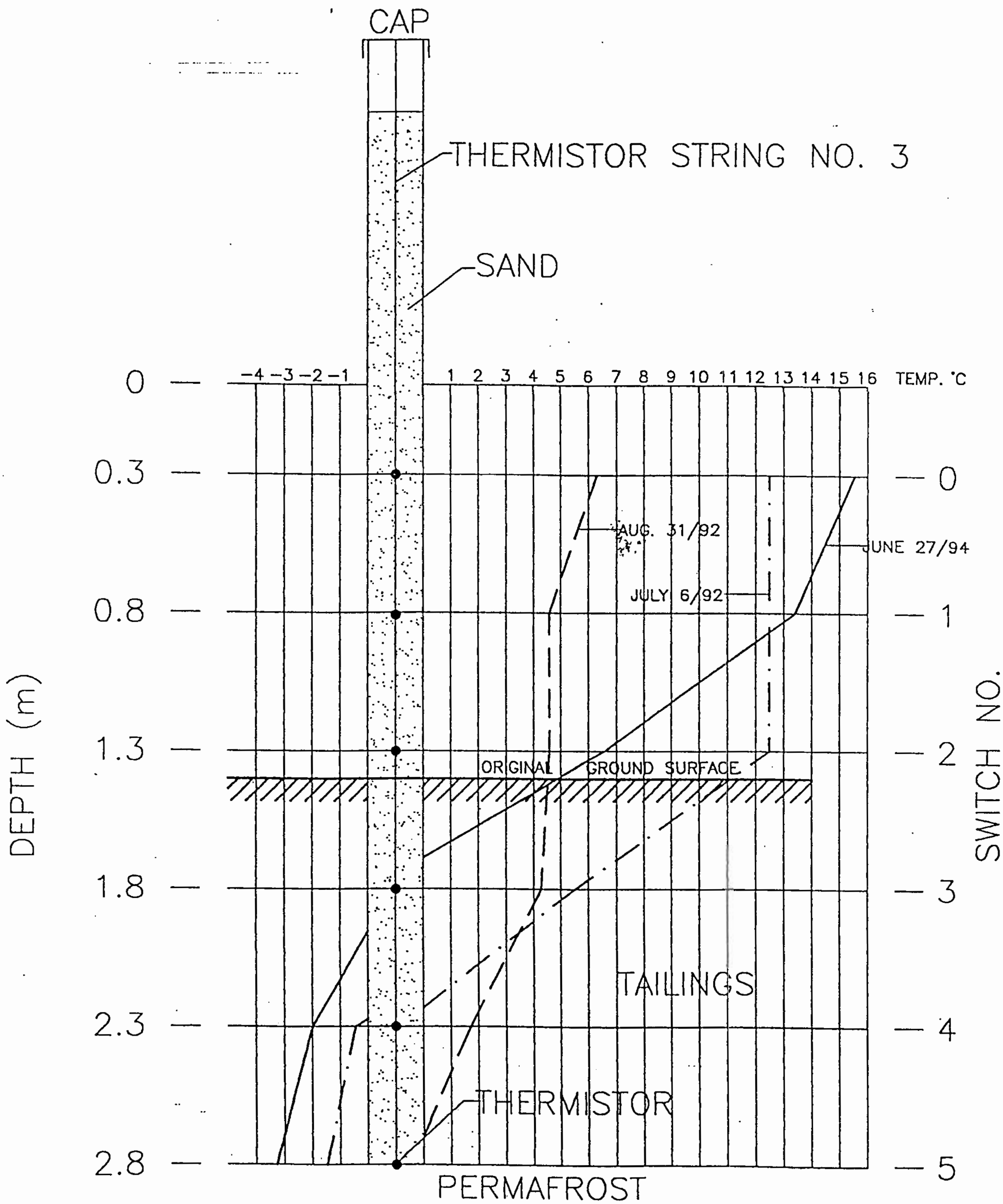

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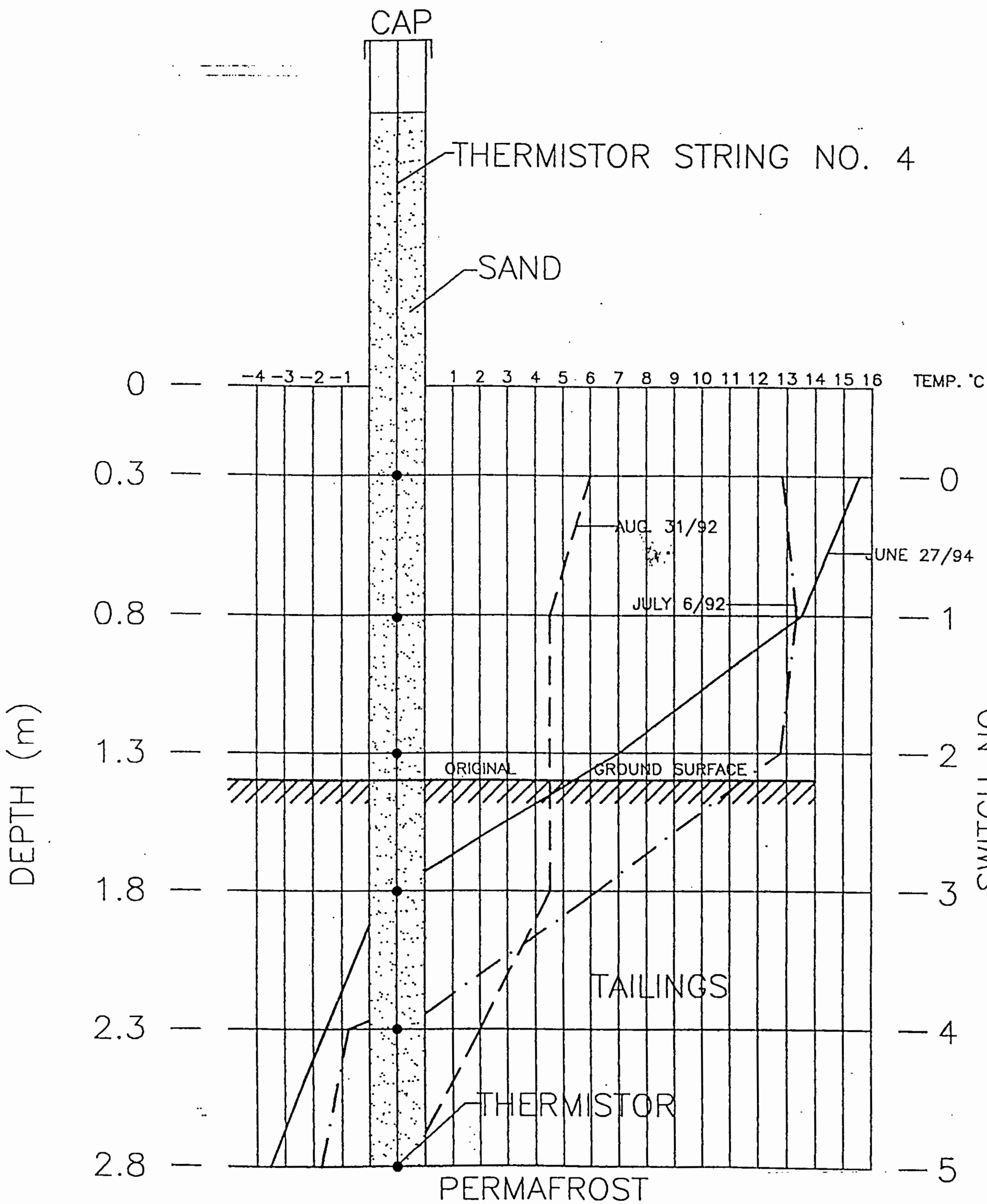
INSTALLED AUGUST 23, 1991

REF. NO. F-90132-A/E

DRAWING NO. 7



THERMISTOR STRING CONFIGURATION

INSTALLED AUGUST 23, 1991