

REPORT NO. 60612

**1987 AND 1988 SEEP SURVEYS:
FARO PITS AND ROCK WASTE DUMPS**

for

CURRAGH RESOURCES INC.

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by

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SUMMARY

Six seep surveys were conducted at the Faro mine site in 1987 and 1988. These surveys were designed to characterize the water flow and water quality in the mine area. Seasonal variations and background water quality levels were also investigated.

The surveys established the seep characteristics of five distinct areas on the mine site. Comparisons between areas were thus possible, and the relative significance of each area to the overall contaminant load could be determined. Total water discharges and metal concentrations were used to calculate total metal loadings, and the relative impact of one area upon another could be determined.

Survey results indicate that the existing quality of water from the present pit area will require treatment, at least during that part of the year when creek flows are low and metal loading rates at a maximum. Currently, water from the mine area is routed through the tailings impoundment area where it mixes with the concentrator tailings discharge which has sufficient excess lime to reduce high metal concentrations.

Survey results indicate that zinc concentrations are a greater concern than copper concentrations. High zinc loadings were noted from the old Faro Creek channel (FC), the upper main pit wall area (MPA), Zone 2 pit (SP), and in the waste rock dump area (WMSW). These areas will continue to be sources of contaminated flows after abandonment and could not be discharged into North Fork Rose Creek during low creek flow periods without prior water treatment. Without treatment of these discharges, zinc concentrations in North Fork Rose Creek would be greater than 0.50 mg/L. The zinc concentration level of 0.50 mg/L is currently the zinc "effluent" discharge limit for the mine site. The Environment Canada zinc standard for receiving waters is 0.05 mg/L of zinc.

The results indicate that Zone MPA 6 of the upper main pit wall area (MP) is a major zinc loading source for the pit. The recharge to this zone flows through a waste rock dump which most probably contains waste with a high sulphide content. Water control or sulphide waste removal may reduce existing zinc loading rates to acceptable discharge levels. Yearly seep surveys are required to determine whether or not existing water levels are changing.

It is important to emphasize, however, that between 1988 and final pit abandonment, the physical dimensions and characteristics of the Faro pit will have changed. For example, active mining is currently changing the types of wall rock exposures in Zone MPA8 in the upper pit wall area. In the Faro Abandonment Plan, 1988, plans have been developed to reduce some of the problems identified with pit decommissioning. In the Zone 2 area, water controls are currently being implemented; in the Zone MPA6 area, water controls are planned. The seep surveys are intended to identify and quantify concerns identified within the Faro Abandonment Plan and to monitor the effects of

mitigation efforts. For complete details of the Faro pit decommissioning plans, the Faro Abandonment Plan, 1988, must be referenced.

The seep surveys to date have been successful in characterizing the current conditions in the Faro pit area. However, acid drainage conditions change with time and long term patterns must still be established, as must the relationships between peak loading rate sources. The large number of sample sites used in the 1987 and 1988 surveys, though, is no longer required.

Seep surveys should be continued until final Faro minesite abandonment. During this period the long term trend in water quality will become evident, and abandonment plans can be adjusted accordingly. Two surveys each year should be sufficient; with one survey being conducted in June and one in late August to early September. Emphasis should be placed on obtaining accurate water discharge volumes. The number of sample sites can be reduced. The following sites are recommended:

- Faro Creek (FC); site 25
- Faro Valley collector ditch (FVW); site 26
- Old Faro Creek channel (FCO); site 29
- Faro Creek diversion (at division between FDU and FDL)
- Upper pit wall area (MPA 6); site A30 including recharges and discharges
- Next Creek (WNW); site W8
- Upper pit wall area (MPA 8); at largest flow into pit
- Zone 2 area (SP); sites 3, 5, 6, 7, 8 and 2
- Toes of waste dumps WNE, WSP3, WIE, WISE, WMS, WMSW
- Waste dump (WMSW); site X23
- North Fork Rose Creek (NF)

In addition, a sampling of groundwater from wells in Zone 2, east of Zone 2, and south of the sulphide waste dump should be conducted. This information, in combination with the seep results, will provide a basis for the evaluation of the quality of groundwater in Faro mine area and allow a more effective definition and evaluation of the final mine abandonment plan.

SEEP SURVEYS: FARO PITS AND ROCK WASTE DUMPS

1.0 INTRODUCTION

The Faro Mine, owned and operated by Curragh Resources Inc. (CRI), is situated approximately 20 kilometres northwest of the town of Faro, Yukon.

The Faro open pit mining operation began in 1969 and, except for a temporary mine closure between 1982 to 1985, has continuously produced lead/ zinc ore to the present date. Ore production should continue until 1993, at which time the Faro pit reserves will be exhausted. Planning for the abandonment of the Faro pit and waste dump areas has therefore been started. The concentrator and tailings ponds will continue operations for a considerable period beyond 1983. The Vangorda and Grum open pit operations, located 14 kilometres from the concentrator, will be developed by 1993, and these pits together with other Vangorda Plateau area pits are expected to provide ore to maintain concentrator operations for another 20 to 25 years.

During 1988, Curragh Resources developed an abandonment plan for the Faro open pits and waste rock dump areas (Faro Mine Abandonment Plan, 1988. CRI). The objective of the plan is to abandon the Faro minesite with minimal long term maintenance requirements and in a manner which limits the minesite's impact on the quality of the water in Rose Creek. Present abandonment plans are to flood the Faro pits (Zone I/III and Zone II pits).

In preparation for Faro pit abandonment planning, Curragh Resources initiated the first in a series of seep surveys in 1987. In 1988, a monitoring and research program was incorporated into the Faro pit abandonment plan. This program, designed to assess the effectiveness of the plan, included the continuation of pit and waste rock seep surveys.

The seep surveys have been designed to assess the quality of waters discharging from the open pits and waste rock dumps. Both geographical distributions and the seasonal annual fluctuations and long term time rates of change were to be determined. The determination of existing metal loading in seeps, seasonal and long term variations will provide a framework from which future pit water quality can be predicted.

This report outlines the objectives of the surveys and summarizes available survey results. A preliminary evaluation of Acid Mine Drainage (AMD) potential from existing seeps is also presented.

SEEP SURVEY OBJECTIVES

The seep surveys were designed to assess both background water quality conditions around the Faro pit and waste dump areas, and the water quality of current seeps into and from pit walls and rock waste dumps.

The Faro ore deposit occurs in sulphide bearing rock. Ore is mined from the open pit and sent to the concentrator. To reach the ore, large quantities of sulphide bearing waste rock are removed to sulphide waste dumps. Some sulphide bearing rock is left exposed in the pit walls. Exposure of sulphide minerals to oxygen and water creates the potential for oxidation of the sulphide and the accompanying generation of acid mine drainage (AMD). Three major objectives of the seep surveys are:

- to determine current levels of AMD from the open pit wall rock and the waste rock dumps;
- to determine seasonal variations in levels of AMD from the open pit wall rock and the waste rock dumps; and,
- to determine the long term change in these seep water qualities and from this to predict the potential magnitude of AMD generation from the Faro pit and waste rock areas following abandonment.

3.0 FIELD SAMPLING

3.1 Field Sampling Methods

Six water quality seep surveys of the Faro pit and waste rock dumps were conducted from September, 1987, to October, 1988. The sampling periods for the surveys are shown in Table 3-1. The sampling periods were selected to cover the spring melt period with frequent surveys to determine when the peak concentration occurs.

Table 3-1
FARO SEEP SURVEYS - SAMPLING PERIODS

<u>Survey Designation</u>			<u>Sampling Period</u>	
I	September	1987	September	24 - 29, 1987
II	April	1988	April	14 - 16, 1988
III	May	1988	May	16 - 26, 1988
IV	June	1988	June	20 - 28, 1988
V	August	1988	August	2 - 11, 1988
VI	October	1988	October	20 - 24, 1988

During each survey, water samples were collected from the various creeks, ditches, ponds and seeps located in and around the Faro pits and waste rock dumps. Each collection site was designated by a number and assigned to a sampling area within the survey boundaries. Sampling sites and areas are shown on Figure 3-1.

At each sample site, measurements of pH, temperature, conductivity and flow rate were made in the field. The pH was determined using a Beckman 21 pH meter; temperature was measured by a mercury thermometer; and conductivity was determined with a Hanna HI8033 meter. Water flows were determined by a Marsh McBirney current meter or by timing flows into a measuring container or by visual estimation. Field trials were conducted to estimate the relative accuracy of the flow measurement methods used. The current meter and the measuring container methods are considered to have a ± 10 percent accuracy, and the visual estimation method a ± 30 percent accuracy. Flows which were too disperse or too small to measure were recorded as 0.01 L/s.

Grab samples were taken at each site for laboratory analysis. Sample collection and preservation was conducted following the procedures described in "Standard Methods for the Examination of Water and Wastewater, 1986." Each sample was analyzed for total and dissolved metals, sulphates, alkalinity and acidity as indicated in Table 3-2.

Table 3-2
SAMPLING AND ANALYSIS PROCEDURES

<u>Test Parameter</u>	<u>Sample Size</u>	<u>Preservation</u>	<u>Laboratory</u>
Alkalinity) Acidity)	250 mL)	None	Curragh Water Laboratory
Total copper) Total zinc) Total iron)	250 mL)	1 mL nitric acid Ltd.	Bondar-Clegg & Co.
Dissolved copper) Dissolved zinc) Dissolved iron)	Filtered (0.45 um) 250 mL)	1 mL nitric acid	Bondar-Clegg & Co. Ltd.
Total sulphate	250 mL*	1 mL nitric acid	Bondar-Clegg & Co.

* Note 1: Analysis uses same sample as for Total Cu/Zn/Fe.

Quality control and quality assurance was established by comparisons of metal and sulphate concentrations in samples taken weekly from the Faro pit dewatering discharge (X22) and from the waste dump seep (X23) located in the old Faro Valley south of the main Faro pit (Zone I pit).

3.2 Description of Sampling Areas and Sampling Sites

Figure 3-1 shows five distinct areas within the Faro pits and waste rock dumps which were characterized by rock type or other attributes. A description of each area is presented in Table 3-3. Specific areas were characterized chemically and the relative contribution of AMD from each area was determined by comparison of metal loading contributions. Water balances for individual areas and for the survey region were also estimated.

Table 3-3:
AREA LOCATIONS AND DESCRIPTIONS OF SURVEY AREAS

There are distinct areas, defined by location or attribute, within the Faro pits and waste rock dumps. Sample sites for creeks, ditches, ponds, pit walls, and waste rock dump toes have been grouped into five main areas. A geological map and cross sections of the Faro Pit at abandonment, a description of the geology of the Faro deposit and an explanation of the alpha-numeric unit designations are included in the Faro Mine Abandonment Plan (CRI 1988)

FCA: Faro Creek Area

FC:

Faro Creek (FC) is located northeast of the active Faro pit (Zone I/III) and encompasses Faro Creek and the Faro Creek catchment basin. This area ends at the point of diversion of Faro Creek into the upper Faro Creek diversion channel (FDU). The sampling site is #25. This area is unaffected by mining activities.

FCO:

The old Faro Creek channel (FCO) is located northeast of the main Faro pit, and is bounded to the northeast by the Faro Creek diversion dike(FDU), and to the south by the Faro Valley waste dump (WVW). The western boundary (FVW) is formed by the valley wall of the original Faro Creek. Sampling sites are: #27, #28, #29, and #30. This area is upstream from most mine activities but mine waste was used in construction of the Faro Creek Diversion dyke.

FVW:

This area is located on the western valley wall of the Faro Valley. A surface run-off interceptor ditch is the major feature of this area. This ditch (26-1-1) begins north of the Zone I pit crest, and runs east-northeasterly. A secondary ditch (26-1-2) originating higher up the valley slope to the west joins the main interceptor ditch, which then runs into the Faro division canal (FDU) immediately downstream of the diversion dike on Faro Creek. The major sampling site is #26. This area is mostly up hill from mine activity although light vehicle roads cross the area.

FCU:

The Upper Faro Creek diversion canal (FDU) is located on the eastern wall of the Faro Valley. This canal routes Faro Creek along the northeastern crest of the Zone I/III (MP) pit. The sampling site is 24-U. Most drainage is from areas unaffected by mining, the only opportunity for water to interact with mine waste is in the diversion dyke wall.

Table 3-3: (cont'd)

MP: Faro Main Pit (Zone I/III) AREA

The Faro Zone I/III open pit is approximately 1675 m long and 975 m wide. At abandonment, the lowest elevation within the pit will be 1006 m, which will be 335 m below the highest point of 1341 m located on the western pit wall.

The main pit has been divided into three survey areas: the upper wall area (MPA) which is located above 1194.8 m (3920 ft. bench); the lower wall area (MPB the approximate level of flooding of the abandoned pit.) which is located below 1194.8 m; and the water collection sump areas (MPC) located at or near the bottom of the pit. Each of these survey areas has been further subdivided to facilitate data analysis.

MPA: Main Pit Walls Above 1194.8 m (3920 Ft.) Bench

To monitor and analyze seepage from the upper pit wall (MPA) area, the pit circumference was divided into ten zones. The first zone (MPA1) begins to the east and below the pit dispatch tower. This zone is bounded to the south by a diorite dyke (10E). Zones and distances were then determined from this point in a clockwise direction. Zone boundaries, where possible, were defined by geological rock type or structural change, and sample sites were located on the 1228.3 m (4030 ft.) bench.

MPA1: Upper Pit Wall Area

Zone MPA1 is located in the southwestern corner of the pit, and the predominant rock type is a calc-silicate gneiss (3D). This rock type is considered a net acid consumer. No sample sites were located in this zone.

MPA2: Upper Pit Wall Area

Zone MPA2 on the upper pit walls is approximately 100 metres long and lies entirely within a fine biotite-muscovite-andalusite schist (1D0). This rock is considered to be a possible acid producer. Sample sites are: A23, A24, and A25.

MPA3: Upper Pit Wall Area

Zone MPA3 is approximately 80 metres wide, and the wall rock is predominantly altered quartz muscovite schist (1D4). This schist is considered to be a possible acid producer. Sample sites are: A26, A27, A28, and A29.

MPA4: Upper Pit Wall Area

Zone MPA4 is approximately 100 metres wide, and has within its boundaries three rock types. In order of areal coverage, these rock types are: an altered quartz muscovite schist (1D4) considered a

Table 3-3: (cont'd)

possible acid producer; an undifferentiated non-graphitic sulphide bearing quartzite (2BCD) considered a potential acid producer; and a barren massive pyrite which is also a potential acid producer. The sample sites are A88 and A88-1.

MPA5: Upper Pit Wall Area

Zone MPA5 is approximately 200 metres in width. The predominant rock type is hornblende quartz diorite (10E) which forms one of the two Anvil dyke suites. This rock is considered to be non-acid generating. The sample site is #89.

MPA6: Upper Pit Wall Area

Zone MPA6 is approximately 150 metres wide, and is distinct in that the upper pit walls are composed of fluvial gravels and silts derived from varying sequences by water erosion and sedimentation. The underlying bedrock is made up of various schist, the most predominant rock type being a biotite-muscovite schist (1CD-1D0). The schist classed as 1CD is considered a non-acid producer; the schist classed as 1D0 is a possible acid producer. Samples sites include: D1, D2, D3, D4, D5, D6, A30, A30-1, A30-2, A30-3, and A32.

MPA7: Upper Pit Wall Area

Zone MPA7 begins at the contact between the glacio-fluvial deposits of the Faro Creek Valley in the west and the biotite-muscovite-andalusite schist (1CD) in the west. The eastern boundary is formed by the contact between the schist material and the dioritic dyke (10E) located in the northeastern corner of the pit. The predominant rock type is the schist (1CD) which is considered a non-acid producer. The sample site is A13.

MPA8: Upper pit Wall Area

Zone MPA8 lies in the northeastern corner of the Faro pit, and much of the rock type is biotite-muscovite-andalusite schist (1CD) which is a non-acid producer. A dioritic dyke (10E) is also present in the western limits of this zone, and a quartz feldspar porphyry (10F) is located in the southern portion. Dyke rocks are considered to be non-acid generating although 10F can be a severley slaking rock. The Big Indian Fault, trending north - south, and dipping steeply west also intersects this zone. The fault is a complex structure characterized by a wide zone of sheering and gouge. Permability along the zone through broken rock is enhanced but across the zones where clay rick gouge is developed permeability may be reduced. The fault extends to the Faro Diversion ditch. Sample sites include: #13, #14, #15, #16, #17, #18, #19, #20, #21, #22, C1, C2, S1, S2, S3, S-P, A-DITCH, and B-DITCH.

Table 3-3: (cont'd)

MPA9: Upper Pit Wall Area

Zone MPA9 is located in the southern pit corner and is divided into two segments by the main haul road exiting the open pit. The southeastern segment is mostly biotite-muscovite-andalusite schist (1CD), with some altered quartz muscovite schist (1D4) and some massive pyrite (2E). The 1CD is considered a non-acid producer, the 1D4 is a possible acid producer, and the 2E is a potential acid producer. The Big Indian Fault intersects this zone in the vicinity of the haulroad; however, several subsets also intersect this eastern segment of zone nine. The southwestern segment of this zone is primarily composed of calc-silicate gneiss (3D), which is a net acid consumer. No sample sites were located in this area.

MPA10: Upper Pit Wall Area

Zone MPA10, located on the southwestern pit wall, is primarily made up of a calc-silicate gneiss (3D) which is a net acid consuming rock. A dioritic dyke (10E) penetrates the northwestern edge of this zone. No sample sites were located in this zone. This pit wall is cut off from any substantial recharge by the pit as is MPA9 and MPA1.

MPB: Main Pit Walls Below 1194.8 m (3920 ft.) Bench

To monitor and analyze seepage from the lower pit wall (MPB) area, the pit circumference was also divided into ten zones. These zones roughly correspond with the upper pit wall (MPA) zones. Wall rock composition is generally different from the upper wall area, and as the elevations of the ore zones are approached, the frequency of rock type changes increases. Wall rock compositions for the lower wall area are not detailed as flooding, on abandonment should reduce the AMD from this area. An exception is the horizontal band of wall rock in the vicinity of the projected 1194.8 m water level.

Sample sites include: A2, A3, A4, A5, A6, A9, A10, A11, A12, A14, A15, A17, A18, A19, A20, A21, A22, and JB2.

MPC: Faro Main Pit Water Sump Sub-Area

This area is located in the lower levels of the Faro pit, and is composed of a system of water collection sumps and ponds. Water entering the pit is collected in and pumped from these sumps.

At the time of writing there were two water collection and pumping areas in the main pit; the Zone I/III mining area (MPC1) and the JB phase area (MPC2). The majority of pit dewatering occurs from the Zone I/III mining area. The pumping system in the MPC1 zone consists of a sinking cut sump and pump (site A1) which ultimately will be situated at elevation 1005.8 m (3300 ft.), a collector sump and pump (site A7) situated at elevation 1033.3 m (3390 ft.), and a main sump with two pumps (site A8) situated at elevation 1100.3 m (3610 ft.). The pumping system of the MPC2 zone consists of a collector pond and one pump located at site JB1.

Table 3-3: (cont'd)

SP: Zone 2 Pit and Waste Dump Area

The Zone 2 pit was mined prior to 1982, and is presently being backfilled with non-acid generating rock. A waste rock dump (WSP1) north of the Zone 2 pit drains into either a ditch (WSP2) which follows the toe of the dump or into the pit directly. The drainage ditch discharges into the remaining open pit in its northwestern corner. The pit itself is divided into two areas: the remaining pit walls consisting of northeastern to southeastern upper wall faces (SPA1), and the pit pond (SPB1). The area immediately to the south of the pit (WSP3) consists of a rock dump as well as part of the flood plain of North Fork Rose Creek immediately south of the pit. The zone 2 pit is more completely described in the Zone 2 Pit dumping plan (CRI, 1987).

Sample sites include: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 23, and 31,

W: FARO WASTE ROCK DUMPS AREA

The Faro waste rock dumps are located along the eastern, southern and western boundaries of the Faro pit area. To conduct the seep surveys, the waste dumps were divided into zones. These zones, beginning in the northeastern quadrant, are:

- WE: East Waste Dump
- WSP3: South Zone 2 Waste Dump and Area
- WIE: East Intermediate Waste Dump
- WISE: Southeast Intermediate Waste Dump
(includes Sulphide Waste Dump).
- WMS: South Main Waste Dump
- WMSW: Southwest Main Waste Dump
- WW: West Waste Dump
- WNW: Northwest Waste Dump

Sample sites include: W1, W2, W3, W4, W5, W6, W7, W8, W9, W10, W11, SDUMP2, SDUMP3, SDUMP4, POND1, POND2, POND3, N/NE1, N/NE2, N/NE3, and X23.

The Faro Valley waste dump (WFV) and the Zone 2 pit waste dumps (WSP1, WSP2, and WSP3) are grouped in the main pit (MP) and Zone 2 pit (SP) areas. The composition of material in the dumps is not generally well known however the location of current sulphide dumping is well known. The Faro Valley dump (WFV) contains some sulphide rock from the upper benches of Zone 1 along with much altered schist and quartz diorite. The northwest dump, especially the upper portions, contain a similar assemblage; while the lower portions are dominantly schist, calcsilicate and till. The upper parts pests of WNS and to a lesser extent WMSW are dominantly calc-silicate with lesser schist. The current sulphide dump is in WISE; the remainder of the dump is mainly schist. Dumps in Zone 2 are

Table 3-3: (cont'd)

dominantly schist. The northeast dump (WNE) are mainly schist and lesser calc-silicate quartz diorite and till with some pockets of sulphides and altered schist. A more complete inventory of the dumps is scheduled for the summer of 1989

NF: North Fork Rose Creek Area

North Fork Rose Creek flows along the eastern boundary of the Faro minesite. Sample sites include NFU, NFL, and X2. The boundary between NFU and NFL is the Vangorda road rock drain consisting of calc silicate breccia with a capping of schist.

4.0 SURVEY RESULTS

4.1 Faro Creek Area (FCA)

4.1.1 Faro Creek Area: Location

The Faro Creek area is located northeast of the active Faro pit (Zone I/III) and encompasses Faro Creek and the Faro Creek catchment basin (FC), the old Faro Creek channel (FCO), the western valley wall of the old Faro Creek channel (FVW), and the upper section of the Faro Creek diversion canal (FDU). The Faro Creek area and its sub-areas are shown on Figure 3-1.

4.1.2 Faro Creek Area: Hydrology

The drainage in the Faro Creek area includes the remaining natural creek, the diversion canal, 1300 meters of abandoned creek channel and a drainage control ditching network. Flows are summarized for each component in Table 4-1, and shown graphically on Figure 4-1.

Faro Creek (FC) upstream of the diversion dike has an alpine catchment area of 14 km². Approximately 370 mm (Mean annual average) of precipitation falls on the area yearly, resulting in an estimated average annual flow rate in Faro Creek of 170 L/s. A continuous flow recorder is not used on Faro Creek; however, flows have been determined periodically using a Marsh McBirney current meter. Measured flow rates range from 80 L/s to 1650 L/s, with peak flows generally occurring during the month of June. The Mean Annual Flood (MAF) using the Janowicz (1986) analysis method is estimated at 2200 L/s.

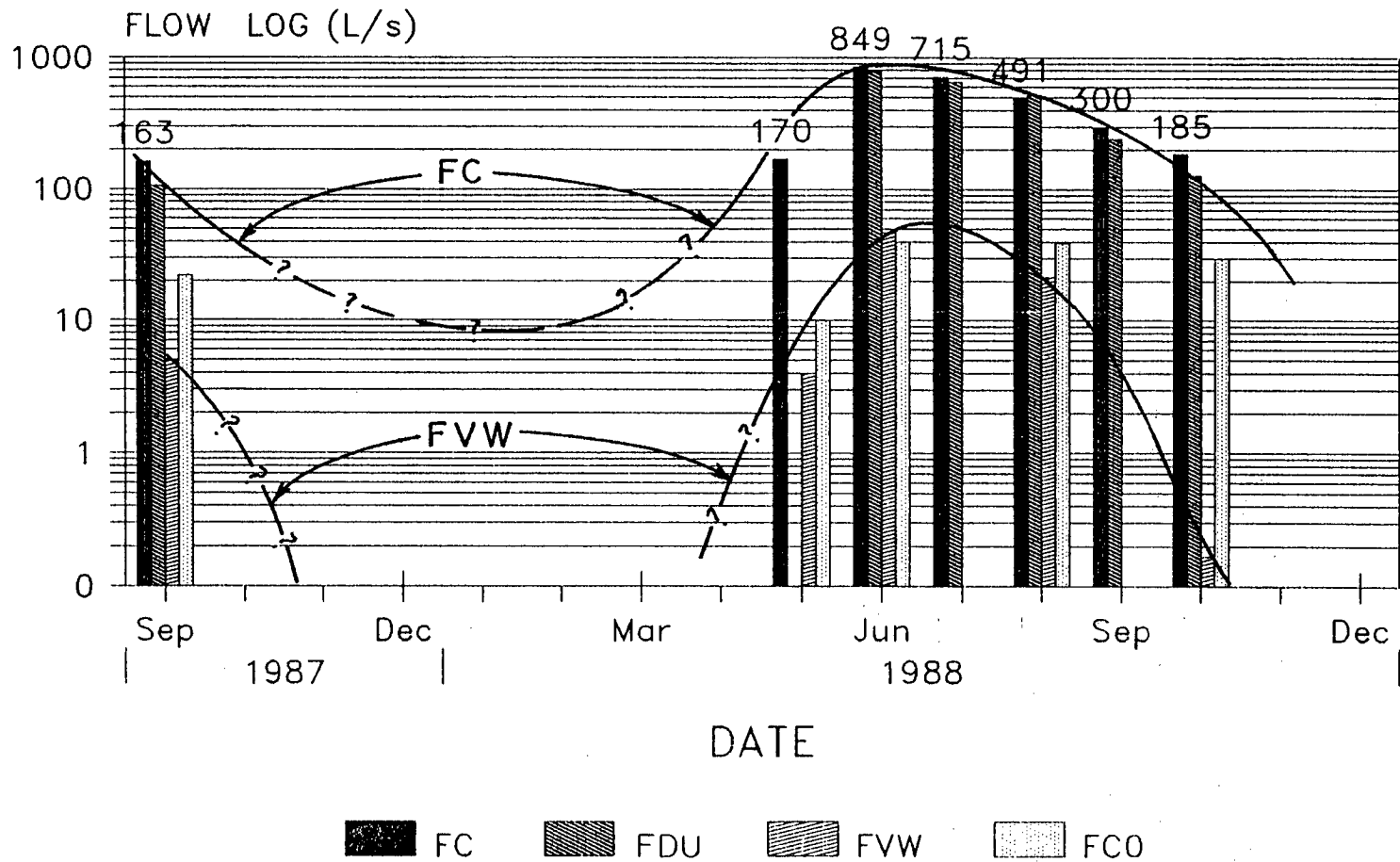
Faro Creek (FC) discharges into Faro Creek diversion (FDU) approximately 1300 meters north of the Faro pit. Immediately downstream of the diversion, a surface water collection ditch (FVW) also discharges in the diversion canal. This ditch network collects water from the western slope of Faro valley. Peak flows occur in the spring following snow melt. In June, a high of 47 L/s was estimated, while by August, 1988, flows had more than halved to 21 L/s. Flow data for the winter period is not available; efforts should be made to obtain flows during the 1989/90 winter period. This would alleviate an existing weakness in the seep survey data. Precipitation events were noted to have a large effect on the volume of ditch flow. By fall, the flow had almost stopped and estimates varied from 0.17 to 4.9 L/s. Flow data for the winter period is not available; efforts should be made to obtain flows during the 1989/90 winter period. This would alleviate an existing weakness in the seep survey data. During the winter, the ditch was completely frozen. The upper diversion canal (FDU) which receives flow from Faro Creek and from the surface water collector ditch flows towards the southwest for approximately 1000 metres. The lower section then swings southeast and parallels the northern Faro pit crest.

TABLE 4-1: FCA - FARO CREEK AREAS: WATER FLOW and WATER QUALITY
SUMMARIES

CALCULATED LOADINGS

AREA	DATE	SITE FLOW (L/s)	pH	ALK (mg/L) CaCO3	CU TOTAL (mg/L)	ZN TOTAL (mg/L)	TOTAL CU (mg/s)	DISS CU (mg/s)	TOTAL ZN (mg/s)	DISS ZN (mg/s)	TOTAL FE (mg/s)	DISS FE (mg/s)	SO4 (mg/s)
FC	Sep-87	25	163.20			0.002	0.33	0.00	0.33	0.00	0.00	0.00	1306
FC	Apr-88	25											
FC	May-88	25	170.00	7.70	5.25	0.01	0.32	1.02	1.36	5.95	14.11	9.86	510
FC	Jun-88	25	849.00	7.22	5.95	0.01	1.61	1.61	5.07	6.79	59.43	8.49	1358
FC	Jul-88	25	715.00	7.20	12.21	0.01	0.68		4.03				2145
FC	Aug-88	25	490.50	8.05	13.65	0.01	0.96	1.16	2.63	4.07	92.96	37.77	1672
FC	Sep-88	25	300.00	7.70	14.00	0.01	0.57	0.00	1.50	0.00	0.00	0.00	270
FC	Oct-88	25	185.00	7.08	14.50	0.01	0.36	0.34	1.04	14.11	18.00	9.35	185
FC	AVERAGE		410.39		10.93	0.01	0.69		2.28		30.75		1064
FCO	Sep-87	29	22.10	6.94		0.17	4.85	3.69	0.00	107.19	0.00	0.00	995
FCO	May-88	29	10.00	7.08	14.18	0.05	2.07	0.45	0.34	20.70	20.20	1.43	330
FCO	Jun-88	29	40.00	7.25	12.60	0.10	2.55	4.12	1.64	102.00	94.00	12.80	2920
FCO	Aug-88	29	39.30	7.10	7.88	0.40	6.90	15.72	4.21	271.17	220.08	129.69	1965
FCO	Oct-88	29	30.00	7.87	18.00	0.07	2.45	2.04	1.38	73.50	69.00	10.05	630
FCO	AVERAGE		28.28	7.25	13.17	0.16	3.76	5.20	1.51	114.91	80.66	30.79	1368
FVW	Sep-87	26	4.90	7.75		0.004	0.02	0.02	0.00	0.12	0.00	0.00	44
FVW	May-88	26	4.00	7.32	11.02	0.004	0.02	0.02	0.03	0.06	0.15	2.16	24
FVW	Jun-88	26	47.20	7.41	12.60	0.002	0.00	0.09	0.09	0.19	1.18	6.61	47
FVW	Aug-88	26	21.40	7.75	23.10	0.150	0.47	3.21	0.15	10.06	0.54	599.20	364
FVW	Oct-88	26	0.17	7.69	43.00	0.003	0.02	0.00	0.00	0.00	0.01	0.09	1
FVW	AVERAGE		15.53		22.43	0.033	0.11	0.67	0.05	2.09	0.37	121.61	96
FDU	Sep-87	24U	106.30										
FDU	Jun-88	24U	792.00	7.05									
FDU	Jul-88	24U	658.00	7.23									
FDU	Aug-88	24U	524.00	8.16	15.80	0.002	0.01	1.05	0.00	4.19	0.00	0.00	472
FDU	Sep-88	24U	243.00	7.80	14.50	0.002	0.02	0.49	0.00	3.65	0.00	0.00	219
FDU	Oct-88	24U	128.00	8.00	23.00	0.014	0.05	1.63	0.00	5.51	0.00	70.09	129
FDU	AVERAGE		408.55		17.77	0.006	0.02	1.05	0.00	4.45	0.00	23.36	273

FIGURE 4-1: FARO CREEK AREA FLOWS



The old Faro Creek channel (FCO) lies to the west and below the upper section of the Faro Creek diversion canal (FDU). This abandoned channel receives seepage passing through the diversion dike as well as groundwater emerging at the toe of the east and west valley walls. Over the survey period, flows estimated in the old Faro Creek channel (Site 29) varied from 10 to 40 L/s. In September, 1987, an estimated flow loss calculation was conducted on the first kilometre of the Faro diversion canal. Loss was estimated at 57 L/s, while flow in the old Faro Creek channel (Site 29) was estimated at 22 L/s. This 22 L/s correlates well with the 15 to 30 L/s of estimated seepage flow (MPA6) that discharges into the main pit immediately southwest and below the Faro Valley waste dump. Water flowing into the old Faro Creek channel ponds behind the Faro Valley rock waste dump (FVD) but ultimately seeps into the Zone I pit.

4.1.3 Faro Creek Area: Water Quality

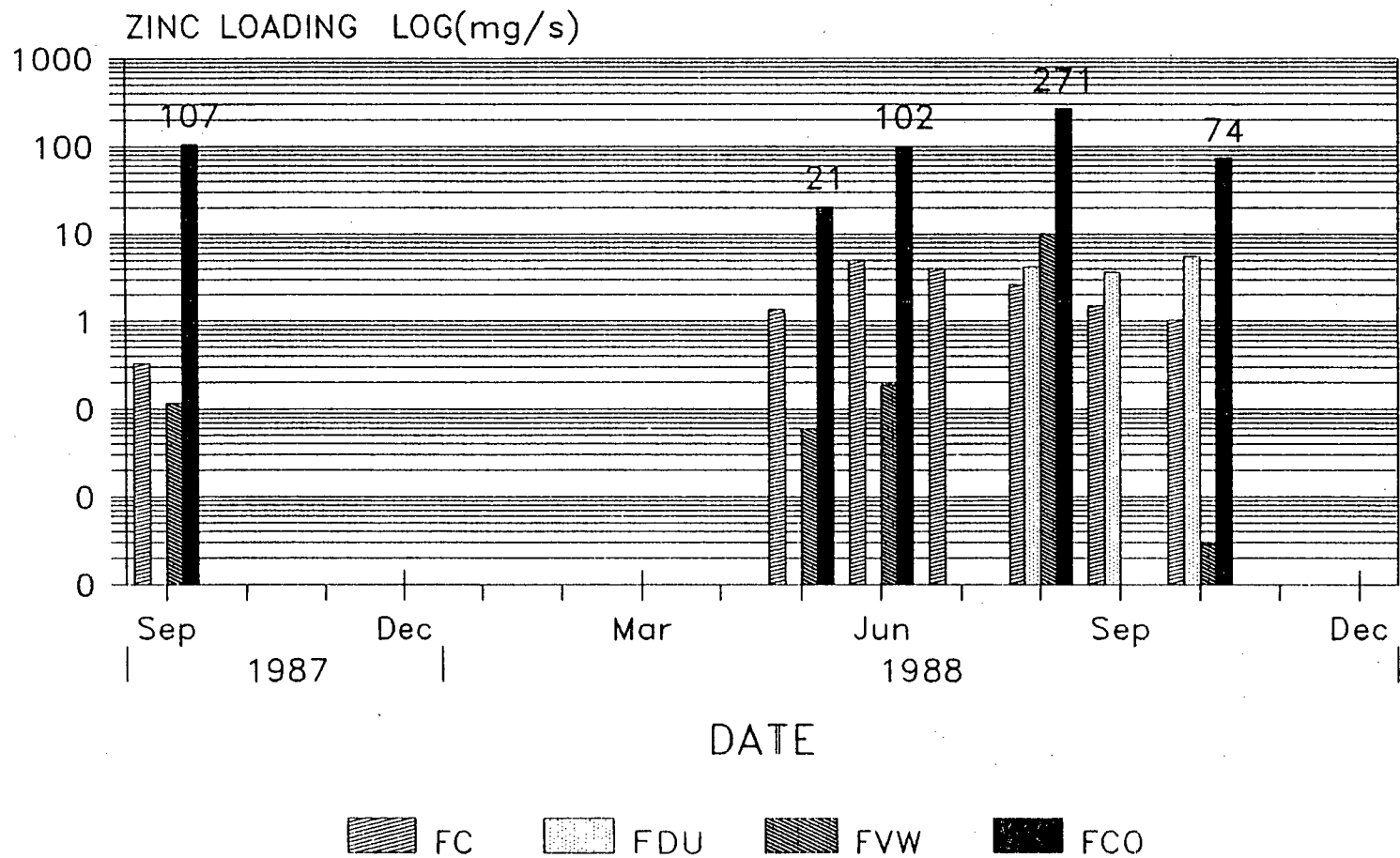
Water quality results for the Faro Creek area are summarized in Table 4-1. Zinc loadings are shown graphically in Figure 4-2. The water quality of Faro Creek (FC) upstream of the diversion canal is of particular importance as this water has not been affected by mining activity and can therefore be used as a back-ground or reference quality in interpreting the mine's influence on downstream water quality. This water is also available for diution to reduce downstream impact. The water quality of the Faro Creek area is reviewed below with reference to selected water quality parameters.

In this report, concentrations and metal loadings determined for waters within specific areas, sub-areas and zones have been averaged. Metal loading is the numeric product of concentration and flow rate and provides a means to compare the relative significance of concentrations in water. Averages are useful in determining the current mass loading attributable to specific areas and for monitoring long term loading changes from these sources. Averages, however, can also be deceptive. For example, very high metal concentrations may be present over a relatively short period during the year, but may be sufficient to produce lethal or sub-lethal conditions for aquatic life. Averages tend to reduce the apparant concentrations during such events, and mask the relationships between concentrations, pH, temperature and flow rates. Ranges of concentrations provide a more accurate view of overall water quality and where possible have been included.

pH: (FCA)

During the survey, the pH in Faro Creek (FC) upstream of the diversion ranged from 6.38 to 8.49. In the old Faro Creek channel (FCO), pH ranged from 6.94 to 7.87. The collector ditch (FVW) discharge had a pH range of 7.72 to 7.75, while water in the upper Faro diversion canal (FDU) had an average pH range of 7.05 to 8.00. None of these pH values are indicative of AMD, although as noted, the area below the old Faro Creek channel is affected by acid generation products.

FIGURE 4-2: FARO CREEK AREA ZINC LOADINGS



Alkalinity: (FCA)

The alkalinity of water from the sub-areas within the Faro Creek area ranged from 10.9 to 22.4 mg/L expressed as CaCO₃. The average Faro Creek area alkalinity was 16.08 mg/L expressed as CaCO₃. On a relative scale, this average natural alkalinity is low.

Zinc: (FCA)

The average total zinc concentration in Faro Creek (FC) upstream of the diversion was 0.005 mg/L and did not exceed 0.010 mg/L during sampling. The average zinc concentration in the collector ditch (FVW) discharge was 0.106 mg/L. Zinc concentrations in ditch discharge ranged from 0.001 to 0.470 mg/L. The average zinc concentration in upper Faro diversion (FDU) discharge, being a combination of creek and ditch discharge, was 0.024 mg/L. On the basis of these results, average background zinc concentrations range from less than 0.01 to 0.11 mg/L.

In contrast, water in the old Faro Creek channel (FCO) had zinc concentrations ranging from 2.07 mg/L in May to 6.90 mg/L in August, 1988, with an average concentration of 3.76 mg/L. As mentioned previously, some of the recharge to this channel is by seepage through the Faro Creek diversion dike. The elevated zinc concentrations are due to the presence of sulphide waste within the dike.

Dissolved zinc and copper concentration determinations were also made for all samples. These analysis were intended to provide a measure of quality control on total metals analysis and to provide insight into the differences in total and dissolved metals content in the water samples.

Of particular note are the zinc determinations for Faro Creek. The average dissolved zinc concentration in Faro Creek (FC) was 0.033 mg/L with a range of 0.007 to 0.083 mg/L. A disparity between total and dissolved zinc is evident in that the dissolved concentration in four out of five individual samples exceeded the corresponding total zinc concentrations. The values for dissolved zinc are suspect because the standard deviation for 12 total zinc determinations was 0.002 mg/L, whereas the standard deviation for 5 dissolved zinc determinations was 0.031 mg/L. Sampling on laboratory analysis error is indicated. Sampling procedures will be reviewed for future surveys. This disparity was not noted between total and dissolved copper determinations.

Zinc loading, which is the numeric product of concentration and flow rate, provides a means to compare the relative significance of zinc concentrations in water. The average zinc loading in Faro Creek (FC) water was 2.28 mg/s. Peak loading was observed in mid-June at 5.07 mg/s. A loading low of 0.33 mg/s was recorded in May, 1988. Discharge from the collector ditch network (FVW) had an average zinc loading of 2.09 mg/s and an August peak load of 10.06 mg/s. (It should be noted that zinc concentrations in both Faro Creek (FC) and the collector ditch (FVW) were at or below the limits of detection. Loading rates, in these cases, are therefore, primarily a function of flow rate).

The upper Faro diversion channel (FDU) had an average zinc loading of 4.45 mg/s. This average loading theoretically should equal the sum of source loads to the diversion channel. Zinc loading sources are: Faro Creek (FC) and the collector ditch (FVW). For comparison, the sum of the average loadings from these two zinc sources for the survey period was 4.37 mg/s. The average zinc loadings correlate well; however, the zinc peak loads during August, 1988, do not. The upper Faro diversion channel (FDU) determination was 4.19 mg/s of zinc, while the sum of its source zinc loads was 12.69 mg/s. These results indicate that a relatively small discharge such as the collector ditch (FVW) can be a major influence to a larger stream's water quality and zinc concentrations ranging from 0.01 to 0.05 mg/L can be expected to occur naturally in the Faro area.

In the old Faro Creek channel (FCO), the average zinc loading was 114.9 mg/s. A peak of 271.2 mg/s was observed in August, 1988, and a low of 20.20 mg/s was observed in May, 1988. Relative to Faro Creek (FC), the collector ditch (FVW) and the upper Faro Creek diversion canal, this average loading is 25 to 50 times greater in magnitude.

Copper: (FCA)

The average total copper concentration in Faro Creek (FC) upstream of the diversion was 0.002 mg/L and did not exceed 0.010 mg/L during sampling. The average copper concentration in the collector ditch (FVW) discharge was slightly higher at 0.033 mg/L. Copper concentrations in ditch discharge ranged from 0.003 to 0.150 mg/L. The average copper concentration in upper Faro diversion (FDU) discharge, being a combination of creek and ditch discharge, was 0.006 mg/L. On the basis of these results, average background copper concentrations range from less than 0.01 to 0.04 mg/L.

In contrast to water in Faro Creek, Faro diversion canal, and the collector ditch, water in the old Faro Creek channel (FCO) had copper concentrations ranging from 0.050 to 0.400 mg/L with an average concentration of 0.160 mg/L. A major recharge source to this channel is seepage through the Faro Creek diversion dike. The presence of sulphide waste within the dike is therefore considered probable. The highest copper concentration was noted in August, 1988.

The average copper loading in Faro Creek (FC) water was 0.69 mg/s corresponding to an average concentration of less than 0.01 mg/L of zinc. Peak loading was observed in mid-June at 1.61 mg/s (less than 0.01 mg/L). A loading low of 0.32 mg/s was recorded in May, 1988. Discharge from the collector ditch network (FVW) had an average copper loading of 0.67 mg/s (0.03 mg/L) and an August peak load of 3.21 mg/s (0.150 mg/L).

The upper Faro diversion channel (FDU) had an average copper loading of 1.05 mg/s. This average loading theoretically should equal the sum of source loads to the diversion channel. Copper loading sources are: Faro Creek (FC) and the collector ditch (FVW). For comparison, the sum of the average loadings from these two copper sources for the survey period was 1.36 mg/s. The average copper

loadings correlate well; however, as with zinc the peak loads during August, 1988, do not. The upper Faro diversion channel (FDU) determination was 1.05 mg/s of copper, while the sum of its source copper loads was 4.17 mg/s.

In the old Faro Creek channel (FCO), the average copper loading was 5.20 mg/s. A peak of 15.72 mg/s was observed in August, 1988, and a low of 0.45 mg/s was observed in May, 1988. This variation may be due to the relative contribution of surface snow melt (less contaminated) to groundwater seepage (more contaminated) flows during these periods. Relative to Faro Creek (FC), the collector ditch (FVW) and the upper Faro Creek diversion canal, this average loading is five to eight times greater in magnitude.

Iron and Sulphate: (FCA)

The total Faro Creek (FC) iron concentration averaged 0.102 mg/L and ranged from 0.070 to 0.160 mg/L. Average sulphate concentration was 3 mg/L with a range of 1 to 8 mg/L. Iron in the collector ditch (FVW) averaged 7.31 mg/L and had an August, 1988, peak value of 28.0 mg/L. Sulphate averaged 7.8 mg/L. In the upper diversion canal (FDU), iron averaged 0.548 mg/L and a peak of 1.00 mg/L was recorded in October, 1988. Sulphate averaged 1 mg/L. In comparison, iron averaged 1.03 mg/L in water sampled in the old Faro Creek channel (FCO). Sulphate concentrations averaged 44 mg/L for the survey sampling in this area, and peaked in June, 1988, at 73 mg/L. In conclusion, iron and sulphate concentrations provide further evidence of deteriorated water quality in the old Faro Creek channel.

4.2 MP: Faro Main Pit (Zone I/III) Area

Curragh Resources is currently mining the Faro Zone I/III open pit. In 1993, the ore reserves in this pit will be exhausted. At this time, the Zone I/III pit will be approximately 1675 m long and 975 m wide. The lowest elevation in the pit will be at 1006 m. This elevation is 335 m below the highest point of 1341 m located on the western pit wall.

The main pit has been divided into three survey sub-areas: the upper wall area (MPA) which is located above 1194.8 m (3920 ft. bench); the lower wall area (MPB) which is located below 1194.8 m; and the water collection sump areas (MPC) located at or near the bottom of the pit. Each of these survey areas has been further subdivided as indicated in Table 3-3 to facilitate data analysis. Areas are indicated on Figure 3-1.

Each sub-area of the main pit (MP) is reviewed individually below. Thus, the relative importance of each sub-area after abandonment can be assessed. Following the sub-area reviews, the main pit (MP) as a whole is reviewed.

4.2.1 MPA Sub-Area: Main Pit Walls Above 1194.8 m (3920 ft.) Bench

At mine abandonment the Faro main pit, which includes Zone I and Zone III, will be flooded. The water level after abandonment will be at the 1194.8 m (3920 ft.) elevation. The water cover should effectively stop further oxidation of wall rock below this elevation; however, metal loading from seeps exiting above 1194.8 m will continue. This seepage has the potential of affecting the water quality of the Faro pit discharge after abandonment. The delineation of the upper pit wall (MPA) metal loading potential is therefore required to assess the feasibility of the Faro pit abandonment plan.

4.2.1.1 MPA Sub-Area: Location

The MPA Sub-Area is defined as Faro main pit wall extending from elevation 1194.6 m (3920 ft.) to the pit crest. The pit circumference is approximately 3300 meters and wall height varies from 30 to 150 meters.

To monitor seepage the pit circumference was further divided into ten zones. The first zone begins to the east and below the pit dispatch tower and is bounded to the south by a diorite dyke (10E). Zones and distances were then determined from this point in a clockwise direction as defined in Table 3-3. Zone boundaries, where possible, were defined by geological rock type or structural change, and sample sites were located on the 1228.3 m (4030 ft.) bench. A listing of the zones, together with a description of the predominant wall rock types at the time of pit abandonment, is given in Figure 4-3. Sample sites for each area are defined in Table 3-3.

4.2.1.2 MPA Sub-Area: Hydrology

In the upper pit wall area (MPA), individual seep flows and drainage ditch discharges were measured during each survey period. A total flow for each zone of the MPA sub-area was then calculated from the results. Table 4-2A, 4-2B and Figure 4-4 present the summary flow data for each zone of the upper pit wall area (MPA).

From the seep surveys, the average discharge to the main Faro pit from the upper wall area (MPA) was 33.91 L/s. Total inflows ranged from 17.17 L/s in April, 1988 to 54.75 L/s in June, 1988. Zone MPA6 immediately below the Faro valley waste dump (WFV) contributed the majority of this pit inflow water, during the period of the seep surveys. Of the average inflow of 33.91 L/s, 27.27 L/s or 80 percent originated from Zone MPA6.

The inflow contribution of Zone MPA6 relative to the upper pit wall area did, however, vary considerably throughout the year. In April, at the initiation of spring melt, Zone MPA6 contributed 15.0 L/s or 87 percent of the seepage flow attributable to the upper pit wall area. During May, 96

FIGURE 4-3: PREDOMINANT ROCK TYPES OF ZONES WITHIN FARO MAIN PIT
(Abandoned Pit Wall Rocks)

UPPER PIT WALL SUB-AREA (MPA)

ZONE MPA1: Calc-silicate gneiss (3D).

ZONE MPA2: Biotite-muscovite-andalusite schist (1DO).

ZONE MPA3: Quartz muscovite schist (1D4).
Some sulphide bearing quartzite (2BCD) and barren massive pyrite (2EO).

ZONE MPA4: In order of wall area exposure:
- altered quartz muscovite schist (1D4);
- undifferentiated non-graphitic sulphide bearing quartzite (2BCD);
- barren massive pyrite (2EO).

ZONE MPA5: Hornblende and quartz diorite (10E).

ZONE MPA6: Fluvial deposits underlain by biotite-muscovite schist (1CD, 1DO).

ZONE MPA7: Biotite-muscovite-andalusite schist (1CD).

ZONE MPA8: Biotite-muscovite-andalusite schist (1CD).
Dioritic dyke (10E) on western boundary.
Quartz feldspar porphyry (10F) in southern section.
Big Indian Fault, trending north-south, runs through this zone.

ZONE MPA9: Biotite-muscovite-andalusite schist (1CD) pre-dominates north of pit haul road, with some quartz muscovite schist (1D4) and massive pyrite (2E).

Calc-silicate gneiss (3D) south of pit haulroad.

ZONE MPA10: Calc-silicate gneiss. Western zone boundary composed of dioritic dyke (10E).

percent of pit inflow from the upper wall came from Zone MPA6. By June, though, this percent had dropped to 81 percent and remained relatively constant through to August when 79 percent of the discharge from the upper pit wall came from Zone MPA6. In the fall, the percent of flow from MPA6 dropped to 69 percent of the total inflow from the upper pit wall. The fall percentage was the same in September, 1987 and October, 1988.

Zone MPA8 recorded the second largest discharge from the upper wall area into the main pit. Of the total average inflow of 33.91 L/s, an estimated 5.12 L/s or 15 percent originated from this zone. Contributions from this zone varied from a low of one percent of the upper wall seepage in May to a high of 22 to 28 percent of total discharge in the autumn.

Zone MPA6 and MPA8 have several features in common: these two zones together contribute the majority of seepage water originating from the upper pit wall area (MPA); both zones have peak discharges during June, and both zones have minimum discharges in the fall. These trends reflect the source of recharge which is predominately Faro Creek Water. More importantly, the upper sections of both of these zones are permeable. The upper section of MPA6 is composed of fluvial deposits and waste rock (WFV). The upper section of MPA8 is composed of faulted, highly fractured rock with foliations dipping approximately 20 degrees southwest towards the main pit. Both MPA6 and MPA8 receive seepage originating from the Faro diversion canal.

By comparison, peak flows for the remaining zones of the upper pit wall occur in the early spring due to snow melt. Low or constant discharges occur during summer and autumn months. Peak flows are not large and are not related to nearby runoff streams since these areas are not recharged by them.. Zone MPA3 displayed one of the larger flows from this group of upper wall zones. The flow was 1.40 L/s during April, 1988. These other eight zones also differ from zones MPA6 and MPA8 in that they do not have a Faro diversion canal immediately above them to act as a recharge source. Structural geology, especially in the southern and western zones of the upper pit walls, is also not favourable to seepage flow into the main pit. In these zones the rock foliations dip southwesterly at approximately 20 degrees, in a direction away from the open pit.

4.2.1.3 MPA Sub-Area: Water Quality

Water quality results for the upper main pit wall sub-area (MPA) are summarized in Table 4-2. Figures 4-5 and 4-6, respectively, show zinc and copper loadings from the upper pit wall area (MPA), and the relative contributions from the individual zones. The water quality of the upper main pit wall sub-area (MPA) is reviewed below with reference to selected water quality parameters.

TABLE 4-2A: MPA - FARO UPPER WALL SUB-AREA :

WATER QUALITY SUMMARIES

COPPER

AREA	TOTAL CU CONCENTRATION RANGE	PEAK TOTAL Cu CONCENTRATION SITE/DATE	DISSOLVED Cu CONCENTRATION RANGE	PEAK DISSOLVED Cu CONCENTRATION SITE/DATE
Area MPA	<0.002 - 13.8	MPA2/April	0.002 - 0.940	MPA8/June
Zone MPA2	0.003 - 13.8	A25/April	0.002 - 0.165	A25/April
MPA3	0.002 - 0.031	A29-1/May	0.002 - 0.003	
MPA4	0.002 - 0.350	A88-1/April	0.002 - 0.003	
MPA5	0 - 0.148	89/May	0 - 0.002	
MPA6	0.002 - 1.10	A30-3-2-MID/May	0.002 - 0.920	1930-3-2-Mid/May
MPA8	0.003 - 1.03	S-P/June	0.003 - 0.940	SP/June

ZINC

	TOTAL Zn CONCENTRATION RANGE	PEAK TOTAL Zn CONCENTRATION SITE/DATE	DISSOLVED Zn CONCENTRATION RANGE	PEAK DISSOLVED Zn CONCENTRATION SITE/DATE
Area MPA	<0.01 - 240	MPA2/April	<0.01 - 1.46	MPA2/April
Zone MPA2	5.06 - 240	A25/April	5.20 - 146	A25/April
MPA3	0.006 - 3.74	A29/April	0.004 - 0.285	A28/April
MPA4	0.124 - 0.620	A88-GRP/June	0.045 - 0.580	A88-GRP/June
MPA5	0 - 1.81	89/May	0 - 0.017	89/May
MPA6	0.028 - 61.0	A30-3-2-Mid May	0.005 - 50.0	A30-3-3-Sou/May
MPA8	0.041 - 61.5	S-P/June	0.052 - 50.0	S-P/June

TABLE 4-2B: FARD UPPER PIT WALL SUB-AREA
WATER FLOW and WATER QUALITY SUMMARIES

(E): Estimate
(A): Average

AREA	DATE	SITE	FLOW (L/s)	pH	ALK. (mg/l CaCO3)	TOTAL CU (mg/L)	TOTAL ZN (mg/L)	TOTAL CU (mg/s)	DISS CU (mg/s)	TOTAL ZN (mg/s)	DISS ZN (mg/s)	TOTAL FE (mg/s)	DISS FE (mg/s)	SO4 (mg/s)
MPA2	SEP-87	SUMMARY	0.05	7.99		0.003	5.060	0.00		0.25				6
MPA2	APR-88	SUMMARY	0.32	6.02	3.0	13.800	240.000	4.42	0.05	76.80	46.72	216.00	4.38	281
MPA2	MAY-88	SUMMARY	0.01	7.60	167.0	0.024	9.400	0.00	0.00	0.07	0.04	0.11	0.00	2
MPA2	JUN-88	SUMMARY	0.03	7.81	172.2	0.003	5.500	0.00	0.00	0.16	0.15	0.00	0.00	5
MPA2	AUG-88	SUMMARY	0.03	7.90	166.4	0.044	11.300	0.00	0.00	0.28	0.14	0.75	0.00	4
MPA2	OCT-88	SUMMARY(E)	0.03											
MPA2	AVERAGE	AVERAGE	0.09	7.46	127.2	2.775	54.252	0.88	0.01	15.51	11.76	54.22	1.10	59
MPA3	SEP-87	SUMMARY	2.05	8.12		0.001	0.097	0.00		0.20				60
MPA3	APR-88	SUMMARY	1.40	8.05	205.3	0.106	1.512	0.15	0.00	2.12	0.19	330.54	0.04	85
MPA3	MAY-88	SUMMARY	1.21	8.20	239.5	0.010	0.181	0.01	0.00	0.22	0.04	25.36	0.01	87
MPA3	JUN-88	SUMMARY	0.96	8.17	257.1	0.002	0.034	0.00	0.00	0.03	0.03	0.85	0.01	40
MPA3	AUG-88	SUMMARY	0.91	8.18	258.8	0.002	0.032	0.00	0.00	0.03	0.03	0.84	0.07	48
MPA3	OCT-88	SUMMARY	0.40	7.85	265.3	0.010	0.430	0.00	0.00	0.17	0.09	2.76	0.00	18
MPA3	AVERAGE	AVERAGE	1.16	8.09	245.2	0.022	0.381	0.03	0.00	0.46	0.08	72.07	0.03	56
MPA4	SEP-87	SUMMARY(E)	0.01											
MPA4	APR-88	SUMMARY(E)	0.0	8.30	75.0									
MPA4	MAY-88	SUMMARY	0.17	7.69	314.3	0.002	0.051	0.00	0.00	0.01	0.21	1.21	0.00	68
MPA4	JUN-88	SUMMARY	0.05	8.32	361.2	0.002	0.620	0.00	0.00	0.03	0.03	0.01	0.00	7
MPA4	AUG-88	SUMMARY	0.05	8.00	360.2	0.014	0.580	0.00	0.00	0.03	0.01	0.36	0.00	7
MPA4	OCT-88	SUMMARY	0.01		172.0	0.004	0.430	0.00	0.00	0.00	0.00	0.01	0.00	0
MPA4	AVERAGE	AVERAGE	0.07	8.08	256.5	0.006	0.420	0.00	0.00	0.02	0.06	0.39	0.00	21
MPA5	16-May-88	89	0.20	8.36	211.0	0.148	1.810	0.03	0.00	0.36	0.00	42.00	0.00	38
MPA6	SEP-87	SUMMARY	15.90	7.47		0.003	5.231	0.05		83.17				3037
MPA6	APR-88	SUMMARY	15.00	7.83	79.0	0.150	8.500	2.25	0.11	127.50	75.00	2025.00	0.53	3345
MPA6	MAY-88	SUMMARY	40.60	6.56	90.0	0.254	22.291	10.30	1.01	905.00	585.84	424.62	0.62	10101
MPA6	JUN-88	SUMMARY	44.51	6.93	75.4	0.049	12.071	2.18	0.36	537.26	475.10	86.99	1.15	30
MPA6	AUG-88	SUMMARY	32.50	7.19	70.5	0.072	14.909	2.33	0.61	484.55	397.37	87.73	4.39	7281
MPA6	OCT-88	SUMMARY	15.10	6.31	91.6	0.018	9.042	0.27	0.14	136.52	130.52	19.65	0.39	3280
MPA6	AVERAGE	AVERAGE	27.27	7.05	81.3	0.091	12.007	2.90	0.44	379.00	332.77	528.80	1.41	4513
MPA7	27-Sep-87	A13						0.00	0.00	0.00	0.00	0.00	0.00	0
MPA8	SEP-87	SUMMARY	5.13	8.13		0.008	0.369	0.04		1.89				153
MPA8	APR-88	SUMMARY(E)	0.24											
MPA8	MAY-88	SUMMARY	0.24	6.76	50.4	0.049	1.126	0.01	0.00	0.27	0.25	1.41	0.00	24
MPA8	JUN-88	SUMMARY	9.00	6.66	25.8	0.038	0.682	0.34	0.24	6.15	4.37	20.84	0.75	579
MPA8	AUG-88	SUMMARY(A)	7.56											
MPA8	OCT-88	SUMMARY	6.11	6.82	71.8	0.492	7.423	3.01	1.75	45.35	42.93	139.06	57.15	2004
MPA8	AVERAGE	AVERAGE	5.12	7.09	49.3	0.147	2.400	0.85	0.66	13.42	15.85	53.77	19.30	690

FIGURE 4-4: MPA – UPPER PIT WALL
MPA: FLOWS BY ZONE

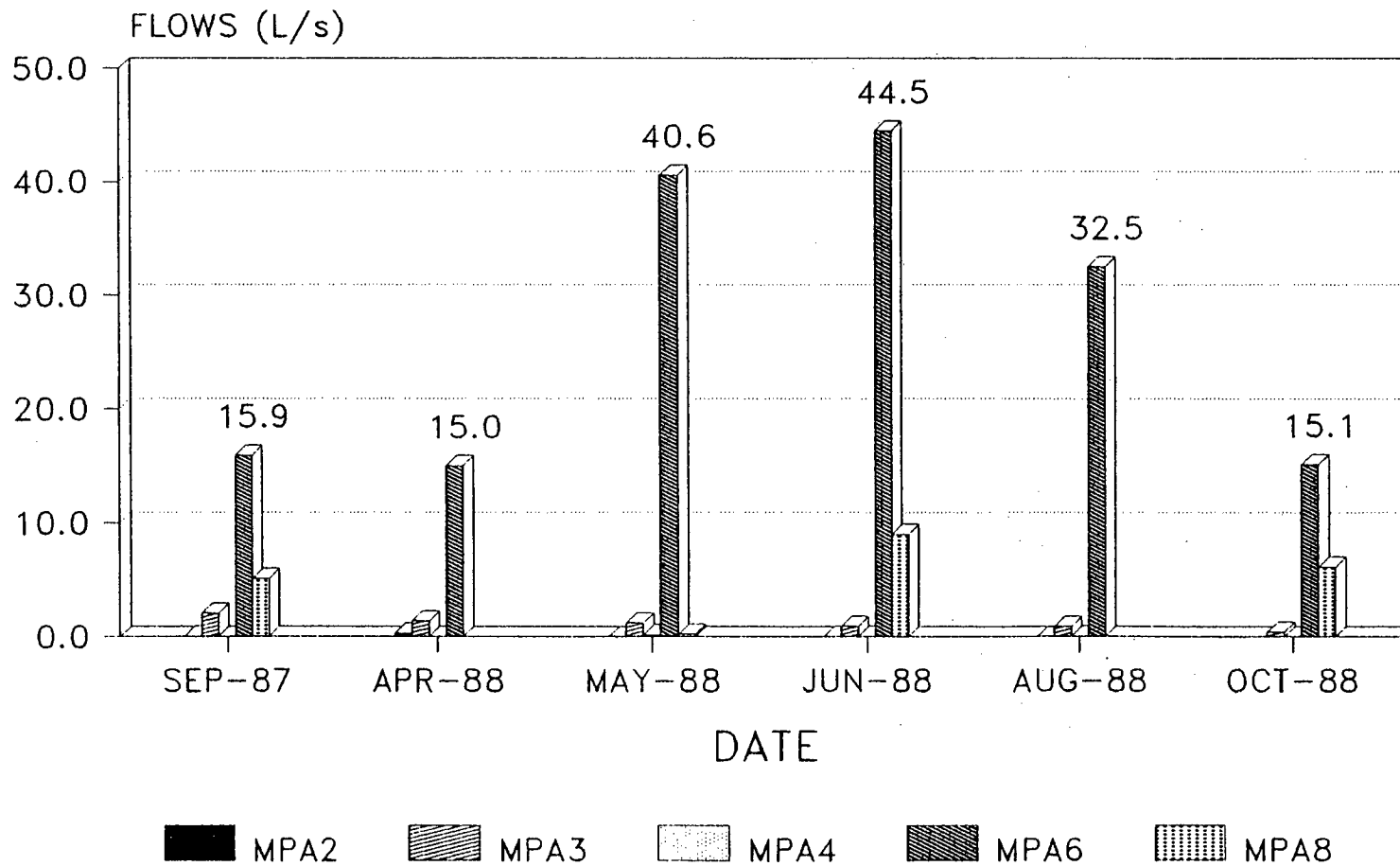


FIGURE 4-5A: MPA: UPPER PIT WALL
ZINC LOADING CONTRIBUTIONS
PER MPA ZONE

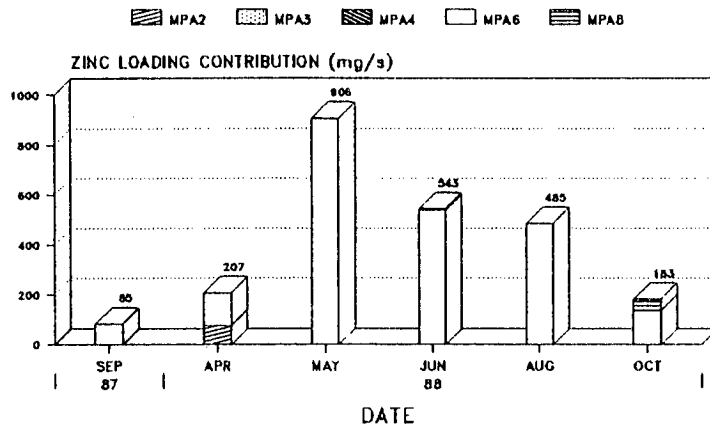


FIGURE 4-5B: MPA - UPPER PIT WALL
ZINC LOADING CONTRIBUTIONS
PER MPA ZONE

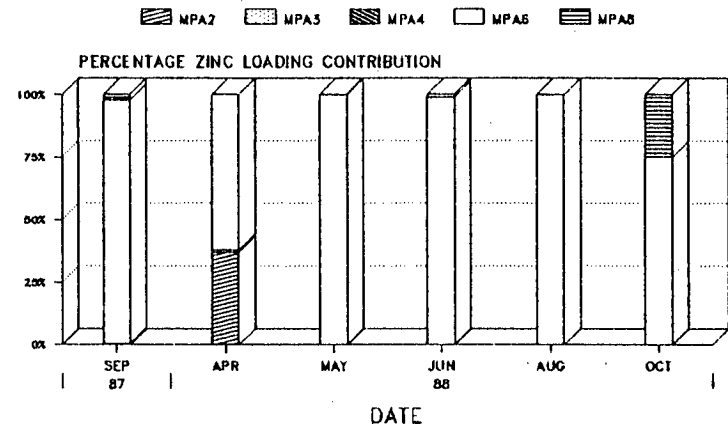


FIGURE 4-6A: UPPER PIT WALL
COPPER LOADING CONTRIBUTIONS
PER MPA ZONE

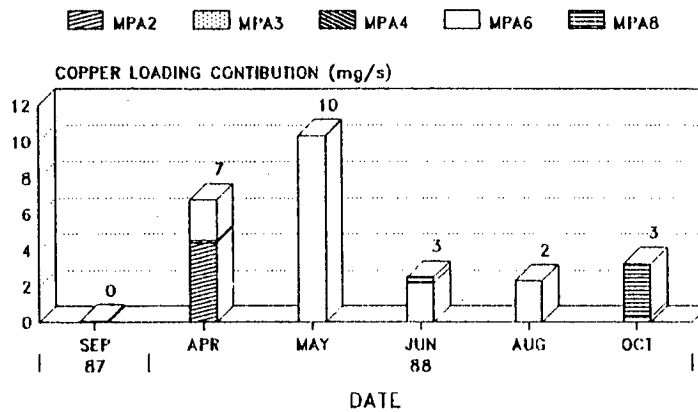
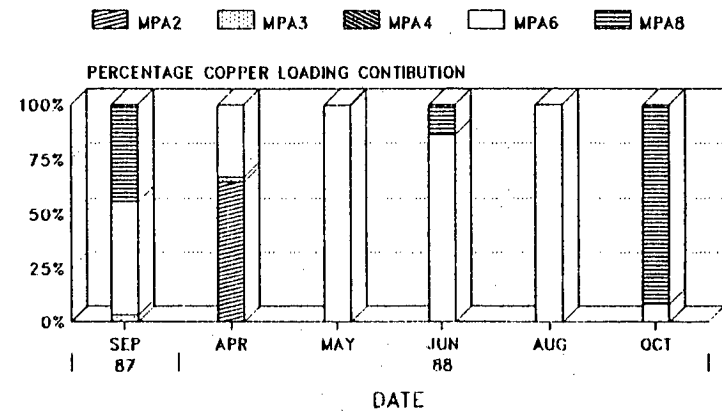


FIGURE 4-6B: MPA: UPPER PIT WALL
COPPER LOADING CONTRIBUTIONS
PER MPA ZONE



pH: (MPA)

A summary average pH respective to an individual survey was calculated for each zone within the upper pit wall area (MPA). A characteristic average pH was then calculated from the summary averages for each zone. (The pH averages in this report are numeric, rather than log averages. Numeric pH averages are lower than log pH averages. Example: MPA2; Numeric pH = 7.46; log pH = 7.64). The characteristic average pH of the zones within the upper pit wall area (MPA) ranged from 7.05 to 8.09. The lowest average of 7.05 was recorded for Zone MPA6. The summary averages of Zone MPA6 ranged from 6.31 to 7.83, with the high being recorded in April, 1988, and the low being recorded in October, 1988.

Zone MPA2 had a characteristic average pH of 7.46; however, the lowest summary average for an individual survey was recorded for this zone. In April, a summary average pH of 6.02 was determined for Zone MPA2. Summary averages for the individual surveys taken in Zone MPA2 ranged from 6.02 to 7.99.

The summary pH values for all zones, and for each of the six surveys, were greater than 6.0. Summary pH averages between 6.0 and 7.0 were generally isolated to spring months and were most noticeable in Zone MPA2, MPA6 and MPA8. The exception was recorded for Zone MPA6. In October, 1988, this zone recorded a summary average pH of 6.31. In conclusion, the pH of water seeping from the upper pit wall (MPA) to date has been neutral to slightly alkaline. The recorded pH values from this area are not indicative of acidic drainage.

Alkalinity: (MPA)

Alkalinity, expressed as CaCO₃, ranged from a low of 3.0 mg/L in Zone MPA2 during April, 1988 to a high of 361.2 mg/L in Zone MPA4 during June, 1988. The alkalinity of water discharging from Zone MPA6 and MPA8 during all six surveys was less than 100 mg/L, expressed as CaCO₃ which is consistent with the low alkalinity of Faro Creek waters. Zone MPA3, in comparison, recorded alkalinites consistently greater than 200 mg/L, expressed as CaCO₃. Zone MPA4 and MPA3 both drain altered hornblende diorite suggesting this rock is a source of alkalinity in groundwater.

Zinc: (MPA)

The total zinc concentrations in seepage water discharging from the upper pit wall area (MPA) ranged from less than 0.002 mg/L to 240 mg/L. The concentration peak of 240 mg/L was determined for a seep (A25) within Zone MPA2 during April, 1988. MPA2 contains exposed sulphide in the final pit wall.

Table 4-2A shows total zinc concentration ranges for the zones within the upper pit wall area (MPA). The highest zinc concentration range was recorded for Zone MPA2 discharge. Total zinc ranged from 5.06 to 240 mg/L. Seepage water from zones MPA6 and MPA8 was also elevated with respect to total zinc concentration; Zone MPA6 concentrations ranged from 0.028 to 61.0 mg/L and Zone MPA8 ranged

from 0.041 to 61.5 mg/L. The elevated lower concentration in the above ranges should also be noted and will be discussed below in terms of zinc loading. Peak concentrations were recorded in May and June, 1988, respectively.

Dissolved zinc concentrations ranges are also shown in Table 4-2A. Total and dissolved zinc concentration ranges for each zone in the upper pit wall area (MPA) tend to follow similar patterns. High dissolved zinc concentration ranges were recorded for discharges from zones MPA2, MPA6, and MPA8.

Zinc loading, which is the numeric product of concentration and flow rate, provides a means to compare the relative significance of zinc concentrations in water. Table 4-2B summarizes zinc loadings from the upper pit wall area. The average total zinc loading from all areas, for the survey period was 408 mg/s. Figure 4-5A shows zinc loading contributions from each area of upper pit wall for each sample period. Total zinc loadings ranged from 85 to 906 mg/s. Peak loading occurred during May, 1988. For comparison, Faro Creek (FC) above the diversion had an average zinc loading of 2.3 mg/s.

Figure 4-5A indicates a seasonal zinc loading pattern from the upper pit wall area. During the start of spring melt in April, 1988, a zinc loading rate of 207 mg/s was determined for the upper pit wall area (MPA). By May, 1988, this rate had increased to 906 mg/s. Over the summer, zinc loading rates slowly decreased until by October, the loading rate had decreased to 182 mg/s. This fall rate can be considered approximately equal to the April initial zinc loading rate.

There are three zones within the upper pit wall area which contribute the majority of the zinc loading. As shown in Figure 4-5A and Figure 4-5B, Zone MPA6 is the largest zinc loading source. Over the survey period, zinc loads ranged from 87.2 to 905 mg/s. Peak zinc loading from this zone occurred during May, 1988. This peak coincided with the upper wall area peak loading period. Approximately 99 percent of the upper wall area zinc loading originated from seeps located in Zone MPA6. Zone MPA6 was the majority zinc contributor in all of the survey periods. Final abandonment must be considered, though, when interpreting these results. As described in the Faro Pit Abandonment Plan, 1988, water flow controls will be implemented on Faro Creek diversion. Thus, present zinc loadings from Zone MPA6 may be larger than loadings after pit decommissioning.

Zone MPA2 was the second largest zinc contributor of the upper wall area. In April, 1988, the zinc loading rate from this zone was 76.8 mg/s. Flows were low but the zinc concentration in the seeps was high. During other surveys, zinc loading from Zone MPA2 ranged from 0.1 to 0.3 mg/s.

Zone MPA8 is the third largest zinc contributor in the upper pit wall area. The loading rates in Zone MPA8 varied from less than 0.3 to 45.4 mg/s. The highest loading rate of 45.4 mg/s occurred during the October, 1988 survey. All other survey periods recorded zinc loading rates ranging from 0.3 to 1.9 mg/s. An explanation for the elevated rate during the fall is not evident from existing data.

However, as indicated in Figure 4-5A, there was a significant difference between 1987 and 1988 fall loading rates. In September, 1987, the zinc loading rate was 85.5 mg/s, of which 1.9 mg/s was attributable to Zone MPA8. In October, 1988, the zinc loading rate was 182 mg/s, of which 45.4 mg/s was attributable to Zone MPA8. There is not as yet enough data to state whether this change represents an increase in the zinc loading rate from this zone in the upper pit wall area, or whether the difference can be attributable to natural variations in flow channels and zinc leachability rates. Long term trends are unknown at present. This area of the pit is currently being mined and differences may be caused by this activity.

Copper: (MPA)

The total copper concentrations in seepage water discharging from the upper pit wall area (MPA) ranged from less than 0.002 mg/L to 13.8 mg/L. The concentration peak was determined for a seep (A25) within Zone MPA2 during April, 1988.

Table 4-2A shows total copper concentration ranges for the zones within the upper pit wall area (MPA). The largest range of 0.002 mg/L to 13.8 mg/L was recorded for Zone MPA2. The ranges for Zone MPA6 and MPA8 are within the next lowest grouping, varying between 0.002 mg/L to 1.10 mg/L. Ranges for zones MPA3, MPA4 and MPA5 are the lowest, varying between 0.002 mg/L to 0.350 mg/L of total copper. Peaks in all zones occurred during the April to May period.

Dissolved copper concentrations ranges are also shown in Table 4-2A. The largest dissolved copper concentration ranges were found in zones MPA6 and MPA8. This is a variation from total copper ranges, where the highest range was found in Zone MPA2. The dissolved copper range for zones MPA6 and MPA8 was 0.002 to 0.940 mg/L. The dissolved copper range for Zone MPA2 was 0.002 mg/L to 0.165 mg/L.

Table 4-2B summarizes copper loadings from the upper pit wall area. The average copper loading for the survey period was 4.7 mg/s. Figure 4-6A shows copper loadings from the various areas of the upper pit wall for each sample period. Total copper loadings ranged from less than 0.1 to 10.3 mg/s. Peak loading occurred during May, 1988. For comparison, Faro Creek above the diversion had a yearly average of 0.7 mg/s.

Figure 4-6A indicates a seasonal copper loading pattern for the upper pit wall area (MPA). In April, 1988, a relatively high copper loading rate of 6.8 mg/s was determined. By May, 1988, this rate had increased to 10.3 mg/s. Rates then decreased to the relatively constant range of 2.3 to 3.3 mg/s for the summer and fall periods. This pattern is different from that indicated for zinc loading. The zinc rates tended to decrease gradually over the summer months; copper rates tended to decrease rapidly. The highest flow period occurred in June, 1988.

There are three zones within the upper pit wall area which contribute the majority of the copper loading. As shown in Figure 4-6A and Figure 4-6B, Zone MPA6 is the largest copper loading source. Over the survey, copper loads ranged from 0.05 to 10.3 mg/s. Peak copper loading occurred during May, 1988, and 99 percent of the copper load originate from seeps located in Zone MPA6. Zone MPA6 was a major copper contributor during the May through August, 1988, surveys.

Zone MPA2 was the second largest copper contributor of the upper wall area. In April, 1988, the copper loading rate from this zone was 4.42 mg/s. Flows were low but the copper concentration in the seeps, as noted above, was high. During other surveys, copper loading from Zone MPA2 was less than 0.01 mg/s. After spring melt, flow from this zone drop to less than 0.03 L/s. The resultant low copper loading rates during low flow periods are not considered significant relevant to the total copper loading from the upper pit wall area (MPA).

Zone MPA8 is the third largest copper contributor in the upper pit wall area. The loading rates in Zone MPA8 varied from less than 0.1 to 3.1 mg/s. The highest loading rate of 3.1 mg/s occurred during the October, 1988 survey. Other than a loading rate of 0.3 mg/s calculated for June, 1988, all other survey periods recorded copper loading rates of less than 0.1 mg/s. An explanation for the elevated rate during the fall is not evident from existing data.

As shown in Figure 4-6A, there was a significant difference between 1987 and 1988 fall copper loading rates. This pattern is similar to that noted for zinc loading. In September, 1987, the copper loading rate was less than 0.1 mg/s. In October, 1988, the copper loading rate was 3.3 mg/s, of which 3.0 mg/s was attributable to Zone MPA8.

Sulphate: (MPA)

Sulphate concentrations in water seeping from the upper pit wall area (MPA) ranged from less than one to 879 mg/L. The peak concentration was recorded in April, 1988 for Zone MPA2. High sulphate concentrations generally correspond to elevated zinc concentrations. The sulphate concentration of 879 mg/L corresponds to a zinc concentration of 240 mg/L; the sulphate concentration of 423 corresponds to a zinc concentration of 61.0 mg/L; the sulphate concentration of 421 mg/L corresponds to a zinc concentration of 17.4 mg/L; and the sulphate concentration of 415 mg/L corresponds to a zinc concentration of 55.8 mg/L. A correlation does not exist beyond the generalization that high sulphate concentrations indicate elevated zinc concentrations. A relationship between sulphate and copper concentrations is not evident.

4.2.2 MPB Sub-Area: Main Pit Walls Below 1194.8 m (3920 ft.) Bench

At abandonment, the pit wall area below 1194.8 m (3920 ft.) will be under water. The water cover is intended to restrict oxygen availability, and thereby effectively stop further oxidation of the

submerged wall rock. Determination of present metal loadings from the lower pit walls (MPB) allows the adjustment of, current total metal loadings to estimate conditions which will develop after mine flooding.

Caution should be exercised, however, in applying the above procedure. The band of wall rock immediately above and below the flooded water level (1194.8 m) could be subject to fluctuating water levels. These water level fluctuations may act like an oxygen pump as well as encourage leaching and consequently increase rates of acid generation and metal loading from this band of rock. The band of wall rock will be predominantly (greater than 90 percent) schist, though, and schist is not acid generating.

4.2.2.1 MPB Sub-Area: Location

The MPB Sub-Area (MPB) is defined as Faro main pit wall extending from elevation 1194.8 m (3920 ft.) to the pit bottom. To monitor and analyze seepage from this wall area, the pit circumference was also divided into ten zones. These zones roughly correspond with the upper pit wall zones (MPA).

A schematic representation of zone locations and sample sites is shown on Figure 3-1. Unlike the upper pit wall area, rock composition is not defined in detail. Wall rock composition is generally different from the upper wall area, and as the elevations of the former ore zones are approached, the frequency of rock type changes increases. Wall rock composition for the lower wall area is not detailed as abandonment flooding should reduce the significance of this area as a source of AMD. An exception, as previously noted, is the horizontal band of wall rock in the vicinity of the projected 1194.8 m water level.

4.2.2.2 MPB Sub-Area: Hydrology

In the lower pit wall area (MPB), individual seeps and drainage ditch discharges were measured during each survey period. A total flow for each zone of the MPB sub-area was then calculated from the results. Table 4-3A, 4-3B and Figure 4-7 present the summary flow data for each zone of the lower pit wall area (MPB).

From the seep surveys, the average discharge to the main Faro pit from the lower wall area (MPB) was 11.46 L/s. Total inflows ranged from 1.45 L/s in October, 1988 to 22.59 L/s in August, 1988. Zone MPB6 immediately below the Faro valley waste dump (WFV) contributed the majority of this pit inflow water during the seep surveys. Of the average inflow of 11.46 L/s, 8.61 L/s or 75 percent originated from Zone MPB6. The second largest flow of 15.11 L/s was recorded in April, 1988. Of this flow 15.0 L/s or 99 percent originated from Zone MPB6.

TABLE 4-3A: MPB - FARO LOWER WALL SUB-AREA :

WATER QUALITY SUMMARIES

COPPER

AREA	TOTAL CU CONCENTRATION RANGE	PEAK TOTAL Cu CONCENTRATION SITE/DATE	DISSOLVED Cu CONCENTRATION RANGE	PEAK DISSOLVED Cu CONCENTRATION SITE/DATE
Area MPB	0.002 - 2.59	MPB3/April	0.002 - 1.10	MPB3/August
Zone MPB2	0.004	A22/June	0.003	A22/June
MPB3	0.003 - 2.59	A19/April	0.002 - 1.10	A20/August
MPB6	0.008 - 0.420	A9/April	0.002 - 0.007	A10/August
MPB7	0.002 - 0.950	A14-1/August	0.002 - 0.010	A14-2/August
MPB9	0.002 - 0.022	JB2/October	0.003 - 0.006	JB2/October

ZINC

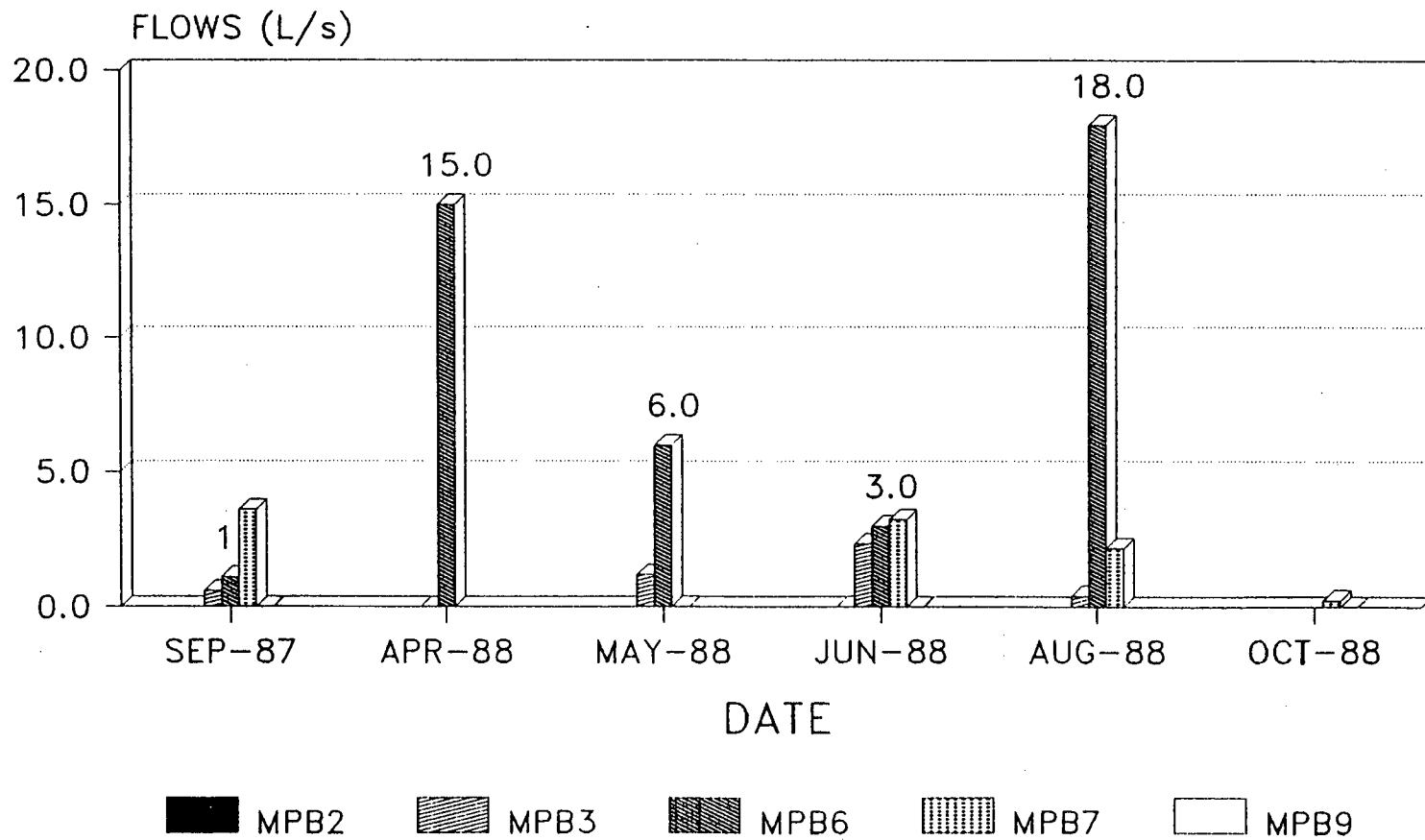
	TOTAL Zn CONCENTRATION RANGE	PEAK TOTAL Zn CONCENTRATION SITE/DATE	DISSOLVED Zn CONCENTRATION RANGE	PEAK DISSOLVED Zn CONCENTRATION SITE/DATE
Area MPB	0.103 - 745	MPB3/August	0.080 - 540	MPB3/August
Zone MPB2	66.5	A20/June	64.5	A22/June
MPB3	0.410 - 745	A20/August	0.080 - 540	A20/August
MPB6	0.455 - 19.5	A9/August	0.310 - 13.6	A10/August
MPB7	0.103 - 445	A6/May	0.055 - 435	A6/May
MPB9	6.48 - 9.90	JB2/June	6.20 - 10.10	JB2/June

TABLE 4-3B: FARD LOWER PIT WALL SUB-AREA
WATER FLOW and WATER QUALITY SUMMARIES

(E): Estimate
(A): Average

AREA	DATE	SITE	FLOW (L/s)	pH	ALK. (mg/l CaCO3)	TOTAL CU (mg/L)	TOTAL ZN (mg/L)	TOTAL CU (mg/s)	DISS CU (mg/s)	TOTAL ZN (mg/s)	DISS ZN (mg/s)	TOTAL FE (mg/s)	DISS FE (mg/s)	SO4 (mg/s)
MPB1	SEP-87	SUMMARY	0.05	7.59		0.002	62.500	0.0001		3.125				52
MPB1	APR-88	SUMMARY												
MPB1	MAY-88	SUMMARY												
MPB1	JUN-88	SUMMARY												
MPB1	AUG-88	SUMMARY												
MPB1	OCT-88	SUMMARY												
MPB1	AVERAGE	AVERAGE				0.002	62.500							
MPB2	SEP-87	SUMMARY												
MPB2	APR-88	SUMMARY												
MPB2	MAY-88	SUMMARY												
MPB2	JUN-88	SUMMARY	0.03	7.42	113.4	0.004	66.500	0.00		1.66	1.61			22
MPB2	AUG-88	SUMMARY												
MPB2	OCT-88	SUMMARY												
MPB2	AVERAGE	AVERAGE				0.004	66.500							
MPB3	SEP-87	SUMMARY	0.60	7.87		0.009	32.533	0.01		19.52				223
MPB3	APR-88	SUMMARY	0.00	7.75	111.0			0.00	0.00	0.00	0.00	0.00	0.00	0
MPB3	MAY-88	SUMMARY	1.18	6.47	200.8	0.350	12.000	0.41	0.00	14.16	2.28	289.10	0.21	184
MPB3	JUN-88	SUMMARY	2.35	8.04	229.7	0.003	3.650	0.01	0.00	8.57	6.34	3.29	0.04	256
MPB3	AUG-88	SUMMARY	0.41	6.23	253.5	0.081	35.066	0.03	0.02	14.51	9.80	9.61	3.85	81
MPB3	OCT-88	SUMMARY												
MPB3	AVERAGE	AVERAGE	0.91	7.27	198.8	0.111	20.812	0.09	0.01	11.35	4.60	75.50	1.02	149
MPB6	SEP-87	SUMMARY	1.10	8.10		0.003	5.476	0.00		6.02				206
MPB6	APR-88	SUMMARY	15.00	7.81	79.0	0.420	19.500	6.30	0.05	292.50	108.00	1545.00	0.08	1125
MPB6	MAY-88	SUMMARY	6.00	7.57	100.3	0.049	3.575	0.29	0.01	21.45	12.95	72.55	0.10	627
MPB6	JUN-88	SUMMARY	3.00	7.93	149.4	0.058	8.593	0.18	0.02	25.78	20.17	107.30	0.09	663
MPB6	AUG-88	SUMMARY	17.97	7.30	153.8	0.008	0.687	0.15	0.04	12.35	9.96	54.89	0.45	3947
MPB6	OCT-88	SUMMARY(E)	1.10											
MPB6	AVERAGE	AVERAGE	8.61	7.74	120.6	0.108	7.566	1.38	0.03	71.62	37.77	444.93	0.18	1314
MPB7	SEP-87	SUMMARY	3.60	7.90		0.002	21.957	0.01		79.04				599
MPB7	APR-88	SUMMARY												
MPB7	MAY-88	SUMMARY	0.01	7.24	87.0	0.006	222.785	0.00	0.00	2.67	2.61	0.26	0.21	9
MPB7	JUN-88	SUMMARY	3.24	7.75	167.6	0.028	19.634	0.09	0.01	63.55	61.31	114.52	6.63	1473
MPB7	AUG-88	SUMMARY	2.18	7.36	207.5	0.457	74.384	1.00	0.01	161.91	106.41	318.71	8.61	906
MPB7	OCT-88	SUMMARY	0.25	7.32	195.0	0.064	83.919	0.02	0.00	20.73	19.31	4.90	0.72	130
MPB7	AVERAGE	AVERAGE	1.85	7.51	164.3	0.111	84.536	0.22	0.00	65.58	47.41	109.60	4.04	624
MPB9	SEP-87	SUMMARY	0.01	7.32	0.0	0.002	6.480	0.00		0.06				2
MPB9	APR-88	SUMMARY												
MPB9	MAY-88	SUMMARY												
MPB9	JUN-88	SUMMARY	0.01	6.47	147.5	0.005	9.900	0.00	0.00	0.10	0.10	0.02	0.00	4
MPB9	AUG-88	SUMMARY												
MPB9	OCT-88	SUMMARY	0.01	6.10	126.5	0.022	7.100	0.00	0.00	0.07	0.06	0.12	0.00	2
MPB9	AVERAGE	AVERAGE	0.01	6.63	91.3	0.010	7.827	0.00	0.00	0.08	0.08	0.07	0.00	3

FIGURE 4-7: MPB: LOWER PIT WA
 MPB: FLOWS BY ZONE



During May and June, 1988, flows ranged from 7.28 L/s to 8.68 L/s. In May, Zone MPB6 contributed 82 percent of this flow. In June, however, Zone MPB7 contributed 3.24 L/s or 37 percent of the flow; Zone MPB6 contributed 3.00 L/s or 35 percent of the flow; and Zone MPB3 contributed 2.35 L/s or 27 percent of the flow. Autumn discharge from the lower pit walls (MPB) ranged from 5.39 L/s in September, 1987 to 1.45 L/s in October, 1988. In September, 1987, Zone MPB7 contributed 3.60 or 67 percent of the discharge from the lower pit wall. In October, 1988, Zone MPB6 again predominated, discharging 76 percent of the total lower wall flow. During the survey, recorded flows from other zones in the lower pit wall area (MPB) were less than 0.10 L/s.

4.2.2.3 MPB Sub-Area: Water Quality

Water quality results for the lower main pit wall sub- area (MPB) are summarized in Table 4-3A or 4-3B. Figures 4-8 and 4-9, respectively, show zinc and copper loadings from the lower pit wall area (MPB), as well as the relative contributions from the individual zones. The water quality of the lower main pit wall sub-area (MPB) is reviewed below with reference to selected water quality parameters.

pH: (MPB)

A summary average of values for each survey period was calculated for each zone within the lower pit wall area (MPB). A characteristic average pH was then calculated from the summary averages for each zone. The characteristic average pH of the zones within the lower pit wall area (MPB) ranged from 6.63 to 7.74. The lowest average of 6.63 was recorded for Zone MPB9. The summary averages of Zone MPB9 ranged from 6.10 to 7.32, with the high being recorded in September, 1987, and the low being recorded in October, 1988.

The summary pH values for all zones in the lower pit wall area (MPB), and for each of the six surveys, were greater than 6.0. Summary pH averages that were less than 7.0 were recorded in May and August in Zone MPB3 and in June and October in Zone MPB9. A pattern is not evident from existing data.

On an individual seep basis, seep A20 located in Zone MPB3 is of note. The pH of this seepage water in August, 1988, was 3.10. As discussed below, high metal concentrations were also found in this discharge. The flow however was very small, being 0.02 L/s. This was the only acidic seep recorded in the lower pit wall area (MPB) during the six seep surveys.

Alkalinity: (MPB)

Alkalinity ranged from a low of less than 0.1 mg/L in Zone MPB9 during September, 1987 to a high of 253.5 mg/L in Zone MPB3 during August, 1988. In general, the alkalinity of water discharging from all zones during all six surveys was greater than 100 mg/L and less than 300 mg/L. Exceptions

FIGURE 4-8A: MPB - LOWER PIT WALL
ZINC LOADING CONTRIBUTIONS
PER MPB ZONE

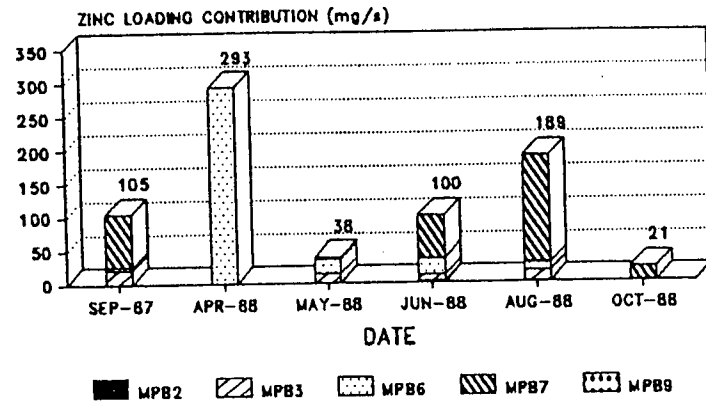


FIGURE 4-8B: MPB - LOWER PIT WALL
ZINC LOADING CONTRIBUTIONS
PER MPB ZONE

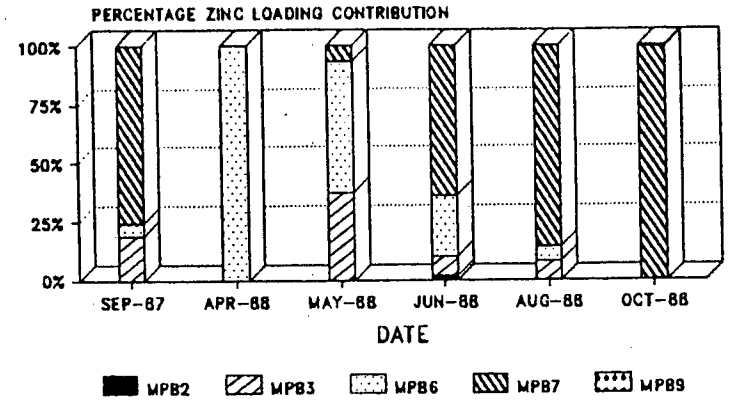


FIGURE 4-9A: MPB - LOWER PIT WALL
COPPER LOADING CONTRIBUTIONS
PER MPB ZONE

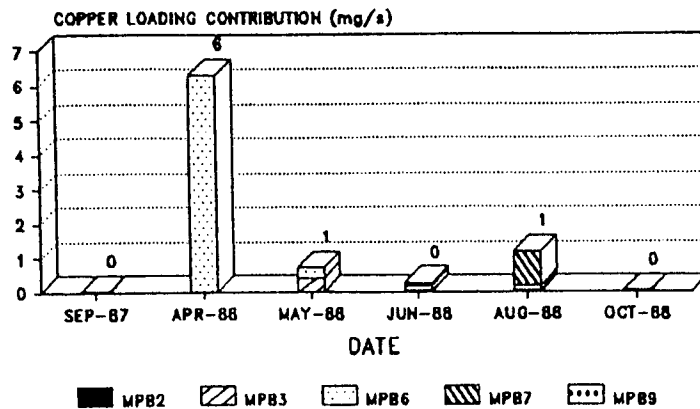
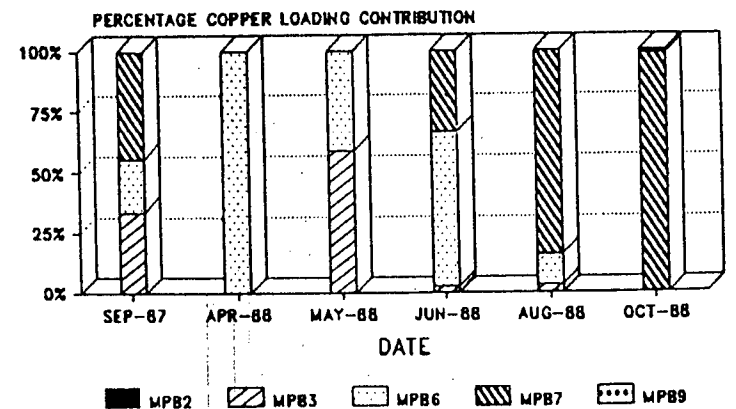


FIGURE 4-9B: MPB - LOWER PIT WALL
COPPER LOADING CONTRIBUTIONS
PER MPB ZONE



were: 79.0 mg/L recorded for Zone MPB6 in April, 1988; 87.0 mg/L recorded for Zone MPB7 in May, 1988, and as previously mentioned, less than 0.1 mg/L recorded for Zone MPB9 in September, 1987. All alkalinities are expressed as CaCO₃ equivalent.

Zinc: (MPB)

The total zinc concentrations in seepage water discharging from the lower pit wall area (MPB) ranged from less than 0.002 mg/L to 745 mg/L. The concentration peak of 745 mg/L was determined for a seep (A20) within Zone MPB3 during August, 1988. This seep, as noted above, had a pH of 3.10 and a flow of 0.02 L/s.

Table 4-3A shows total zinc concentration ranges for the zones within the lower pit wall area (MPB). The highest zinc loading range was recorded for Zone MPB3 discharge. Total zinc ranged from 0.410 to 745 mg/L. Seepage water from zones MPB7 was also elevated. Zone MPB7 zinc concentrations ranged from 0.103 to 445 mg/L. The peak was recorded at seep A6 in May, 1988.

Dissolved zinc concentrations ranges are also shown in Table 4-3A. Total and dissolved zinc concentration ranges for each zone in the lower pit wall area (MPB) tend to follow similar patterns. High dissolved zinc concentration ranges were recorded for discharges from Zone MPB3 and Zone MPB7.

Table 4-3B summarizes zinc loadings from the lower pit wall area (MPB). The average zinc loading for the survey period was 153 mg/s. Figure 4-8A shows zinc loadings from lower pit wall seepage relative to each sample period. Total zinc loadings ranged from 21 to 293 mg/s. Peak loading occurred during April, 1988. For comparison, Faro Creek (FC) above the diversion had an average zinc loading of 2.3 mg/s and the upper pit wall area (MPA) had an average zinc loading of 408 mg/s.

There are two zones within the lower pit wall area which contribute the majority of the zinc loading. As shown in Figure 4-8A and Figure 4-8B, Zone MPB6 is the largest zinc loading source. Over the survey, zinc loads ranged from 6.02 to 293 mg/s. Peak zinc loading from this zone occurred during April, 1988. This peak coincided with the lower wall area peak loading period. Approximately 99 percent of the lower wall area zinc loading originated from seeps located in Zone MPB6. Zone MPB6 was the majority zinc contributor in May, 1988 also.

Zone MPB7 was the second largest zinc contributor of the lower wall area. MPB7 was the dominant zinc contributor in September, 1987 and in June, August, and October of 1988. The zinc loading rates from this zone ranged from 2.67 mg/s in May, 1988 to 162 mg/s in August, 1988. A secondary zinc loading peak occurred in August and was attributable to the zinc loading originating from Zone MPB7.

Copper: (MPB)

The total copper concentrations in seepage water discharging from the lower pit wall area (MPB) ranged from less than 0.002 mg/L to 2.59 mg/L. The concentration peak was determined for a seep (A19) within Zone MPB3 during April, 1988.

Table 4-3A shows total copper concentration ranges for the zones within the lower pit wall area (MPB). The largest range of 0.002 mg/L to 2.59 mg/L was recorded for Zone MPB3. The ranges for Zone MPB7 and MPB6 are within the next lowest grouping, varying between 0.002 mg/L to 0.950 mg/L.

Table 4-3B summarizes copper loadings from the lower pit wall area. The average copper loading for the survey period was 1.7 mg/s. Figure 4-9A shows copper loadings from lower pit wall seepage relative to each sample period. Total copper loadings ranged from less than 0.10 to 6.3 mg/s. Peak loading occurred during April, 1988. For comparison, Faro Creek (FC) above the diversion had a yearly average of 0.70 mg/s and the upper pit wall area (MPA) had an average copper loading rate of 4.7 mg/s.

The major copper loading zones in the lower wall area, in order of magnitude, were Zone MPB6, MPB7 and MPB3. Zone MPB6 rates ranged from less than 0.10 mg/s to 6.30 mg/s. Peak loading from this zone occurred in April, 1988. Approximately 99 percent of all the copper loading from the lower pit wall area (MPB) during April originated from Zone MPB6. Zone MPB7 was the major copper loading source for the remaining survey periods, excepting May, 1988. The copper loading rates from Zone MPB7 ranged from less than 0.10 mg/s to 1.0 mg/s. The peak was recorded in August, 1988. Zone MPB3 dominated during May, 1988. Copper loading rates ranged from less than 0.10 mg/s to 0.41 mg/s. The peak was recorded in May, 1988.

Sulphate: (MPB)

Sulphate concentrations in water seeping from the lower pit wall area (MPB) ranged from nine to 1920 mg/L. The peak concentration was recorded in August, 1988 for Zone MPB7. Elevated sulphate generally corresponds to elevated total zinc, although a strong correlative relationship is not apparent. Four examples follow: the sulphate peak of 1920 mg/L corresponded with a zinc concentration of 165 mg/L; the second highest sulphate concentration of 1785 mg/L corresponded with a zinc concentration of 540 mg/L; the third highest sulphate concentration of 1640 mg/L corresponded to a zinc concentration of 180 mg/ and the fourth highest sulphate concentration of 1480 corresponded to a zinc concentration of 445 mg/L. Not even a general relationship is indicated between sulphate and copper.

4.2.3 MPC: Faro Main Pit Water Sump Sub-Area

4.2.3.1 MPC Sub-Area: Location

This area is located in the lower levels of the Faro pit, and is composed of a system of water collection sumps and ponds. Water entering the pit is collected into and pumped from these sumps. The location of this sub-area which includes two zones, is shown on Figure 3-1.

There are two water collection and pumping zones in the main pit; the Zone I/III mining area (MPC1) and the JB phase area (MPC2). The majority of pit dewatering occurs from the Zone I/III mining area. The pumping system in the MPC1 zone consists of a sinking cut sump and pump (site A1) which ultimately will be situated at elevation 1005.8 m (3300 ft.), a collector sump and pump (site A7) situated at elevation 1033.3 m (3390 ft.), and a main sump with two pumps (site A8) situated at elevation 1100.3 m (3610 ft.). The pumping system of the MPC2 zone consists of a collector pond and one pump located at site JB1. (Modifications to the above pumping scheme will occur as mining progresses).

4.2.3.2 MPC Sub-Area: Hydrology

In zone MPC1, water is pumped from the sinking cut (site A1) to the collector sump (site A7) at rates varying from 0 to 19 L/s. The collector sump water, which is a combination of sinking cut water and lower pit wall seepage water, is pumped to the main sump (site A8) at rates varying from 19 to 25 L/s. The main sump water (site A8), which is a combination of collector sump water and pit wall seepage water, is then pumped to the southwestern pit crest (site X22) at rates varying from 31 to 76 L/s. A summary of flow data for the main sump (site A8) is presented in Table 4-4, and graphically shown in Figure 4-10. Flow rates were estimated from pumping records, and do not include upper wall seepage from zone MPA6. During active mining, zone MPA6 seepage is collected in a sump located on the 1228.3 m (4030 ft.) bench, and pumped around the pit to site X22. This seepage, however, is part of the recharge to the main pit (MP).

In zone MPC2, water is pumped from the JB pond (site JB1) to the southwestern pit crest (site X22). Discharge rates are seasonal. During the first four to six weeks following spring melt, the pumping rate is estimated to be 31 L/s. For the remainder of the summer, and the autumn period, the rate decreases to 13 L/s. The JB pond is not pumped during the winter. Estimated flow rates are shown in Table 4-4 and graphically presented on Figure 4-10.

Zinc loading from the MPC1 sump zone is expected to be high; zone MPC1 water is a combination of pit wall seepage water and water collected from the sinking cut in the active mining area. Sinking cut water runs over and through exposed ore grade sulphides.

TABLE 4-4: FARD PIT SUMP SUB-AREA
WATER FLOW and WATER QUALITY SUMMARIES

(E): Estimate
(A): Average

AREA	DATE	SITE	FLOW (L/s)	pH	ALK. (mg/l CaCO3)	TOTAL CU (mg/L)	TOTAL ZN (mg/L)	TOTAL CU (mg/s)	DISS CU (mg/s)	TOTAL ZN (mg/s)	DISS ZN (mg/s)	TOTAL FE (mg/s)	DISS FE (mg/s)	SO4 (mg/s)
MPC1	SEP-87	SUMMARY	31.54	7.10		0.005	38.000	0.16		1198.52				16905
MPC1	APR-88	SUMMARY	31.54	6.93	145.0	0.044	40.500	1.39	0.32	1277.37	1245.83	305.94	33.12	10629
MPC1	MAY-88	SUMMARY	31.54	6.54	107.8	0.042	130.363	1.31	0.11	4111.64	3851.78	306.52	64.07	28346
MPC1	JUN-88	SUMMARY	44.16	6.79	232.2	0.014	49.084	0.62	0.40	2167.56	2055.17	166.28	23.13	26072
MPC1	AUG-88	SUMMARY	44.16	6.67	140.6	0.026	97.672	1.15	0.22	4313.21	3235.51	423.12	125.43	37045
MPC1	OCT-88	SUMMARY	31.54	6.53	177.4	0.012	51.042	0.37	0.21	1609.87	1435.05	99.16	25.49	23270
MPC1	AVERAGE	AVERAGE	35.75	6.76	160.6	0.024	67.777	0.83	0.25	2446.36	2364.67	260.20	54.25	23711
MPC2	SEP-87	JB1	12.62	7.85		0.002	19.900	0.03		251.14				5793
	APR-88													
	MAY-88													
MPC2	JUN-88	JB1	31.54	7.28	105.0	0.005	21.000	0.16	0.09	662.34	646.57	9.78	0.47	14950
	AUG-88													
MPC2	OCT-88	JB1	12.62	6.40	120.0	0.038	13.300	0.48	0.18	167.85	152.70	39.75	0.19	4291
	AVERAGE		18.93	7.18	112.50	0.015	18.067	0.22	0.14	360.44	399.64	24.77	0.33	8344.45

FIGURE 4-10: MPC: FARO PIT SUMP AREA FLOWS

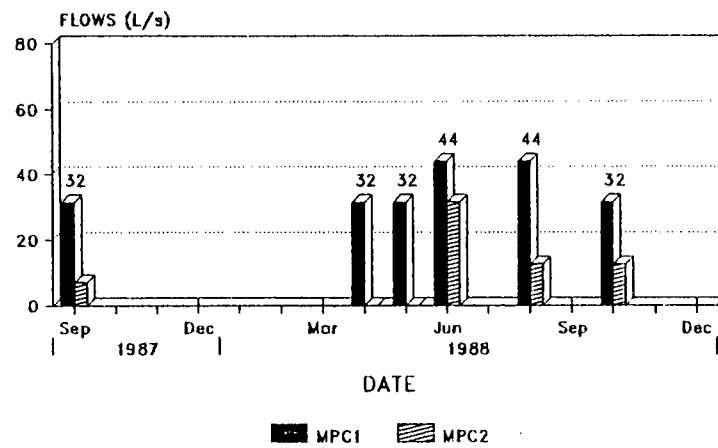


FIGURE 4-11: MPC: FARO PIT SUMP AREA ZINC LOADINGS

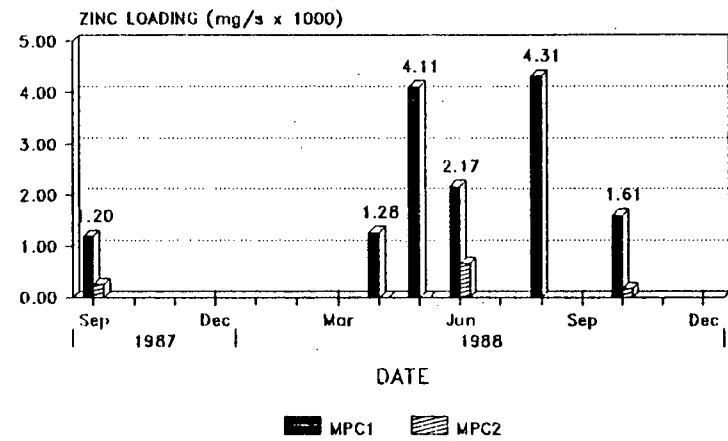
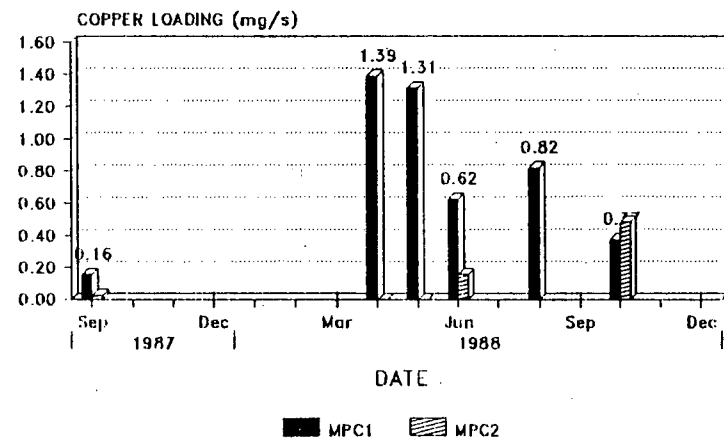


FIGURE 4-12: MPC: FARO PIT SUMP AREA COPPER LOADINGS



4.2.3.3 MPC Sub-Area: Water Quality

Water quality results are summarized in Table 4-4. Figures 4-11 and 4-12, respectively, show zinc and copper loadings from the main pit sump area (MPC).

pH: (MPC)

The pH from the main pit sump ranged from 6.40 to 7.85. However, in six out of eight summary pH measurements, the pH ranged from 6.40 to 6.93.

Alkalinity: (MPC)

Alkalinity ranged from 105 mg/L to 232 mg/L, expressed as CaCO₃.

Zinc: (MPC)

Zone MPC1 (as sampled at sump site A8) showed very high zinc loading rates during the six seep surveys. Rates ranged from 1198 to 4313 mg/s. Zinc loadings were the highest during the August, 1988, survey; however, an almost equal loading rate of 4112 mg/s was recorded during the May, 1988, survey.

Zone MPC2 (as sampled from sump site JB1) also displays a significant zinc loading; however, these zinc loadings are 10 to 30 percent lower than loadings recorded for zone MPC1. A zinc loading high of 662 mg/s was recorded in June, 1988, and a low of 168 mg/s was recorded in October, 1988. Zone MPC2 differs from zone MPC1 in two respects; the MPC2 pond collects seepage from a wall area less than one-twentieth of the area for MPC1, and the MPC2 pond covers 90 percent of the pit bottom area of the JB zone. The sumps in the MPC1 zone covers less than an five percent of the Zone I/III bottom area.

Copper: (MPC)

Copper loading rates from Zone MPC1 (as sampled at sump site A8) ranged from 0.16 to 1.39 mg/s. Copper loadings were the highest during the April, 1988, survey. The May, 1988 results were also elevated; the copper loading rate was 1.31 mg/s.

Zone MPC2 (as sampled from sump site JB1) ranged from 0.03 mg/s to 0.48 mg/s. The peak loading was recorded in October, 1988.

Sulphate: (MPC)

Sulphate concentrations were extremely high in the discharges from both Zone MPC1 and Zone MPC2. Average sulphate summary concentrations ranged from 4290 mg/L to 28350 mg/L. The peak was recorded in May, 1988 and corresponded with a zinc peak loading rate of 4112 mg/s and a copper loading rate of 1.39 mg/s.

4.2.4 MP: Summary of Faro Main Pit Results

A summary of water quality and flow rates for the main pit areas is presented in Table 4-5A. Table 4-5B provides comparison data of pit discharge water (site X22). Figure 4-13 illustrates main pit recharge (from zone MPA6 and area MPC) and discharge (from site X22) flow rates. Figure 4-14 presents zinc loading rates for the main pit; Figure 4-15 presents copper loading rates for the main pit.

4.2.4.1 MP: Hydrology

As previously stated, three areas (MPA, MPB, and MPC) contribute to the total water inflow to the main pit. Under present mining conditions, zone MPA6 and MPC2 water is intercepted and pumped around or from the pit area by separate facilities. All pit water is eventually discharged at site X22, from which point a ditch carries the discharge to the tailings impoundment area some 1,500 meters to the southwest. Figure 16 shows a schematic of the pumping systems of the Faro pits.

As illustrated in Figure 16, all water inflows can be represented by the combination of pump discharges from sumps located at sites A30 (Zone MPA6), A8 (Zone MPC1) and JB1 (Zone MPC2). Discharge from sump A30 represents total seepage from upper wall zone MPA6; discharge from sump JB1 represents seepage from upper wall zones MPA9 and MPB9; and discharge from A8 represents seepage from the remaining upper and lower wall zones, and from the sinking cut sump vicinity. Figures 4-13 through 4-15 display combined flows and metal loadings as recorded from these three sumps. Water flow and quality for site X22 is also shown to provide a comparison to pit inflow water and to show typical pit discharge water quality during 1987 and 1988.

As indicated in Figure 4-13, the highest seepage flow estimates were recorded for June, 1988. The estimated inflow during this period was 120 L/s (1900 USGM) [A30 = 1 pump: Max. 37.9 L/s (600 USGM); A8 = 2 pumps: Max. 75.7 L/s (1200 USGM); JB1 = 1 pump: Max. 37.9 L/s]. Of significance is the proportion of total flow originating from the upper pit wall zone MPA6. During the seep surveys, MPA6 contributed from 25 to 57 percent of total main pit inflows. Highest percentages were recorded in the spring period of 1988.

Total estimated flows from the rest of the upper and lower pit wall areas (MPA - MPA6 and MPB) are also shown on Figure 4-13. Seeps from these wall areas collect in the sumps of zone MPC1. These flows, as recorded, make up less than 50 percent of any MPC1 discharge.

TABLE 4-5A: FARD MAIN PIT AREA (MP): SUMMARY OF AREAS MPA, MPB, and MPC

AREA	DATE	SITE	FLOW (L/s)	pH	ALK. (mg/l CaCO3)	TOTAL CU (mg/L)	TOTAL ZN (mg/L)	TOTAL CU (mg/s)	DISS CU (mg/s)	TOTAL ZN (mg/s)	DISS ZN (mg/s)	TOTAL FE (mg/s)	DISS FE (mg/s)	SO4 (mg/s)
MPA	Sep-87		23.33			0.005	3.681	0.12		85.88		42.00		3293
	Apr-88		16.92			0.404	12.221	6.84	0.16	206.78	121.92	2613.54	4.95	3749
	May-88		42.43			0.244	21.352	10.36	1.02	905.93	586.38	494.71	0.64	10320
	Jun-88		54.75			0.047	9.936	2.55	0.60	543.99	479.68	150.68	1.91	699
	Aug-88		33.69			0.070	14.404	2.36	0.62	485.26	397.55	131.68	4.47	7377
	Oct-88		21.81			0.152	8.363	3.31	1.89	182.41	173.55	203.48	57.54	5340
MPA	AVERAGE		32.16			0.154	11.659	4.26	0.86	401.71	351.82	606.02	13.90	5130
MPA6 (*)	SEP-87		15.90	7.47		0.003	5.231	0.05		83.17				3037
	APR-88		15.00	7.83	79.0	0.150	8.500	2.25	0.11	127.50	75.00	2025.00	0.53	3345
	MAY-88		40.60	6.56	90.0	0.254	22.291	10.30	1.01	905.00	585.84	424.62	0.62	10101
	JUN-88		44.51	6.93	75.4	0.049	12.071	2.18	0.36	537.26	475.10	86.99	1.15	30
	AUG-88		32.50	7.19	70.5	0.072	14.909	2.33	0.61	484.55	397.37	87.73	4.39	7281
	OCT-88		15.10	6.31	91.6	0.018	9.042	0.27	0.14	136.52	130.52	19.65	0.39	3280
MPA6	AVERAGE		27.27	7.05	81.3	0.091	12.007	2.90	0.44	379.00	332.77	528.80	1.41	4513
MPA-MPA6	Sep-87		7.43			0.010	0.365	0.07		2.71		42.00		256
	Apr-88		1.92			2.393	41.291	4.59	0.06	79.28	46.92	588.54	4.42	404
	May-88		1.83			0.030	0.508	0.05	0.00	0.93	0.54	70.09	0.02	219
	Jun-88		10.24			0.037	0.657	0.38	0.24	6.73	4.58	63.70	0.76	668
	Aug-88		1.19			0.028	0.591	0.03	0.00	0.70	0.18	43.95	0.08	96
	Oct-88		6.72			0.453	6.834	3.04	1.76	45.89	43.03	183.82	57.15	2060
MPA-MPA6	AVERAGE		4.89			0.492	8.374	1.36	0.41	22.71	19.05	77.22	12.49	617
MPB	Sep-87		5.36			0.003	20.108	0.02		107.78				1082
	Apr-88		15.00			0.420	19.500	6.30	0.05	292.50	108.00	1545.00	0.08	1125
	May-88		7.19			0.098	5.323	0.71	0.01	38.28	17.84	361.91	0.52	820
	Jun-88		8.62			0.032	11.561	0.27	0.03	99.67	89.53	225.13	6.75	2419
	Aug-88		20.56			0.057	9.181	1.18	0.07	188.77	126.17	383.21	12.90	4934
	Oct-88		0.26			0.062	80.930	0.02	0.00	20.80	19.37	5.01	0.72	133
MPB	AVERAGE		9.50			0.112	24.434	1.41	0.03	124.63	72.18	504.05	4.19	1752
MPC1 (*)	SEP-87		31.54	7.10		0.005	38.000	0.16		1198.52				16905
	APR-88		31.54	6.93	145.0	0.044	40.500	1.39	0.32	1277.37	1245.83	305.94	33.12	10629
	MAY-88		31.54	6.54	107.8	0.042	130.363	1.31	0.11	4111.64	3851.78	306.52	64.07	28346
	JUN-88		44.16	6.79	232.2	0.014	49.084	0.62	0.40	2167.56	2055.17	166.28	23.13	26072
	AUG-88		44.16	6.67	140.6	0.026	97.672	1.15	0.22	4313.21	3235.51	423.12	125.43	37045
	OCT-88		31.54	6.53	177.4	0.012	51.042	0.37	0.21	1609.87	1435.05	99.16	25.49	23270
MPC1	AVERAGE	AVERAGE	35.75	6.76	160.6	0.024	67.777	0.83	0.25	2446.36	2364.67	260.20	54.25	23711

TABLE 4-5A: FARO MAIN PIT AREA (MP): SUMMARY OF AREAS MPA, MPB, and MPC

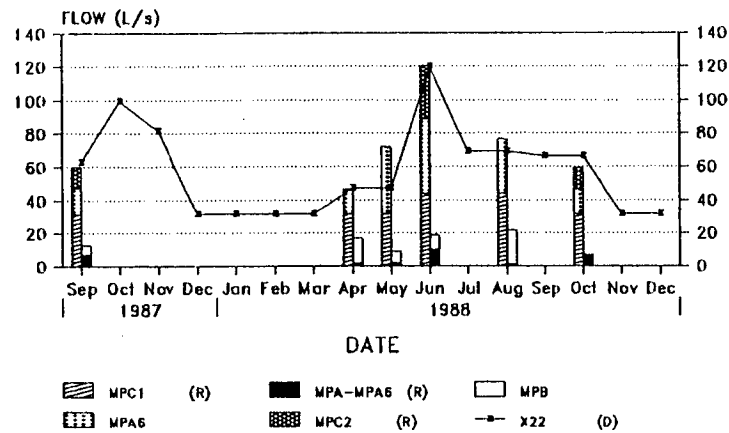
AREA	DATE	SITE	FLOW (L/s)	pH	ALK. (mg/l CaCO3)	TOTAL CU (mg/L)	TOTAL ZN (mg/L)	TOTAL CU (mg/s)	DISS CU (mg/s)	TOTAL ZN (mg/s)	DISS ZN (mg/s)	TOTAL FE (mg/s)	DISS FE (mg/s)	SO4 (mg/s)
MPC2 (*)	SEP-87		12.62	7.85		0.002	19.900	0.03		251.14				5793
	APR-88													
	MAY-88													
	JUN-88		31.54	7.28	105.0	0.005	21.000	0.16	0.09	662.34	646.57	9.78	0.47	14950
	AUG-88													
	OCT-88		12.62	6.40	120.0	0.038	13.300	0.48	0.18	167.85	152.70	39.75	0.19	4291
MPC2	AVERAGE		18.93	7.18	112.50	0.015	18.067	0.22	0.14	360.44	399.64	24.77	0.33	8344
MP (*)	SEP-87	TOTAL	60.06			0.004	25.522	0.23		1532.83				25735
	APR-88	of	46.54			0.078	30.186	3.64	0.42	1404.87	1320.83	2330.94	33.64	13974
	MAY-88	MPA6(*)	72.14			0.161	69.540	11.62	1.12	5016.64	4437.62	731.15	64.68	38447
	JUN-88	MPC1(*)	120.21			0.025	28.011	2.96	0.85	3367.16	3176.84	263.04	24.76	41052
	AUG-88	and	76.66			0.045	62.585	3.48	0.84	4797.76	3632.87	510.85	129.82	44326
	OCT-88	MPC2(*)	59.26			0.019	32.303	1.12	0.52	1914.24	1718.28	158.57	26.07	30840
MP (*)	AVERAGE		72.48			0.055	41.358	3.84	0.75	3005.58	2857.29	798.91	55.79	32396

(*) Denotes zones included in MP Summary

TABLE 4-5B: FARD MAIN PIT AREA (MP): SUMMARY OF MP DISCHARGE (X22)

SMPL SITE	SMPL DATE	FLOW RATE (L/s)	pH	ALKAL. (mg/L)	COPPER (mg/L)	ZINC (mg/L)	LOAD CU (mg/s)	LOAD ZN (mg/s)	LOAD FE (mg/s)	LOAD PB (mg/s)	LOAD SO4 (mg/s)
X22	Oct-86	66.2			0.017	37.433	1.10	2479.58		8.83	43431
X22	Nov-86	31.5			0.010	53.900	0.32	1700.01		0.47	27866
X22	Dec-86	120.8			0.030	40.900	3.62	4940.72		53.15	68252
X22	Jan-87	128.8			0.005	34.400	0.63	4430.72		3.22	65624
X22	Feb-87	60.7			0.005	17.167	0.30	1041.44		3.44	23094
X22	Mar-87	45.5			0.005	3.765	0.22	171.31		7.51	12240
X22	Apr-87	45.5			0.015	18.350	0.68	834.93		13.42	17040
X22	May-87	45.5			0.068	53.865	3.07	2450.86		6.83	29393
X22	Jun-87	94.6			0.192	46.100	18.16	4360.14		14.00	57429
X22	Jul-87	71.7			0.006	17.410	0.44	1247.43		7.52	23573
X22	Aug-87	91.3			0.005	20.528	0.45	1874.67		5.48	35571
X22	Sep-87	63.0			0.005	13.487	0.31	850.05		1.41	18529
X22	Oct-87	99.5			0.007	35.196	0.69	3503.18		13.34	51061
X22	Nov-87	81.8			0.009	25.875	0.71	2116.58		6.34	26790
X22	Dec-87	31.5			0.034	27.660	1.07	872.40		5.87	19725
X22	Jan-88	31.5	7.17	81.0	0.009	15.780	0.28	497.70		2.02	8005
X22	Feb-88	31.5	6.95		0.007	11.975	0.21	377.69		1.29	7294
X22	Mar-88	31.5	6.89		0.010	13.520	0.33	426.42		2.11	7563
X22	Apr-88	47.3	6.77	50.0	0.121	60.925	5.70	2882.36		4.22	20036
X22	May-88	47.3	7.13	127.6	0.028	102.125	1.32	4831.53		4.53	35861
X22	Jun-88	119.9	7.20	161.3	0.022	60.800	2.64	7287.49		14.93	72635
X22	Jul-88	69.4	6.63	173.6	0.021	61.250	1.46	4250.14		12.56	51054
X22	Aug-88	69.4	6.73	191.2	0.029	62.520	2.04	4338.26		16.56	51779
X22	Sep-88	66.2	6.94	206.8	0.018	55.250	1.21	3659.76		8.81	47776
X22	Oct-88	66.2	7.08	213.2	0.011	46.875	0.73	3105.00	174.43	5.23	44215
X22	Nov-88	31.5	6.65	190.9	0.010	40.160	0.30	1266.65	64.66	7.57	17934
X22	Dec-88	31.5	6.73	117.3	0.005	37.700	0.16	1189.06	67.50	1.68	13310
YEARLY AVERAGE		63.76	6.90	151.30	0.03	37.59	1.78	2480.97	102.19	8.61	33225
STD. DEVIATION		29.13	0.20	52.53	0.04	21.62	3.45	1777.37	51.09	9.84	19243
COUNT		27	12	10	27	27	27	27	3	27	27

FIGURE 4-13: MP: FARO MAIN PIT FLOWS



Recharge (R) vs. Discharge (D)

FIGURE 4-14: MP: FARO MAIN PIT ZINC LOADING

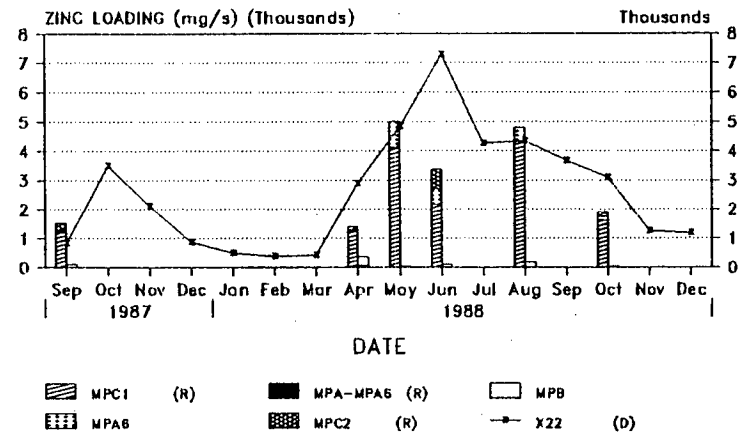


FIGURE 4-15: MP - FARO MAIN PIT COPPER LOADING

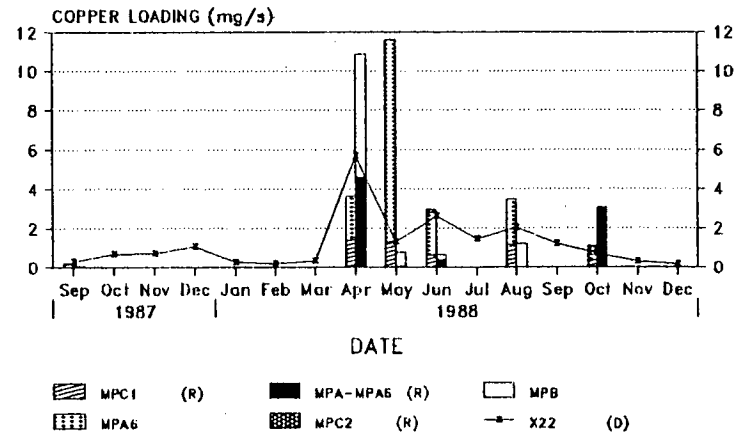
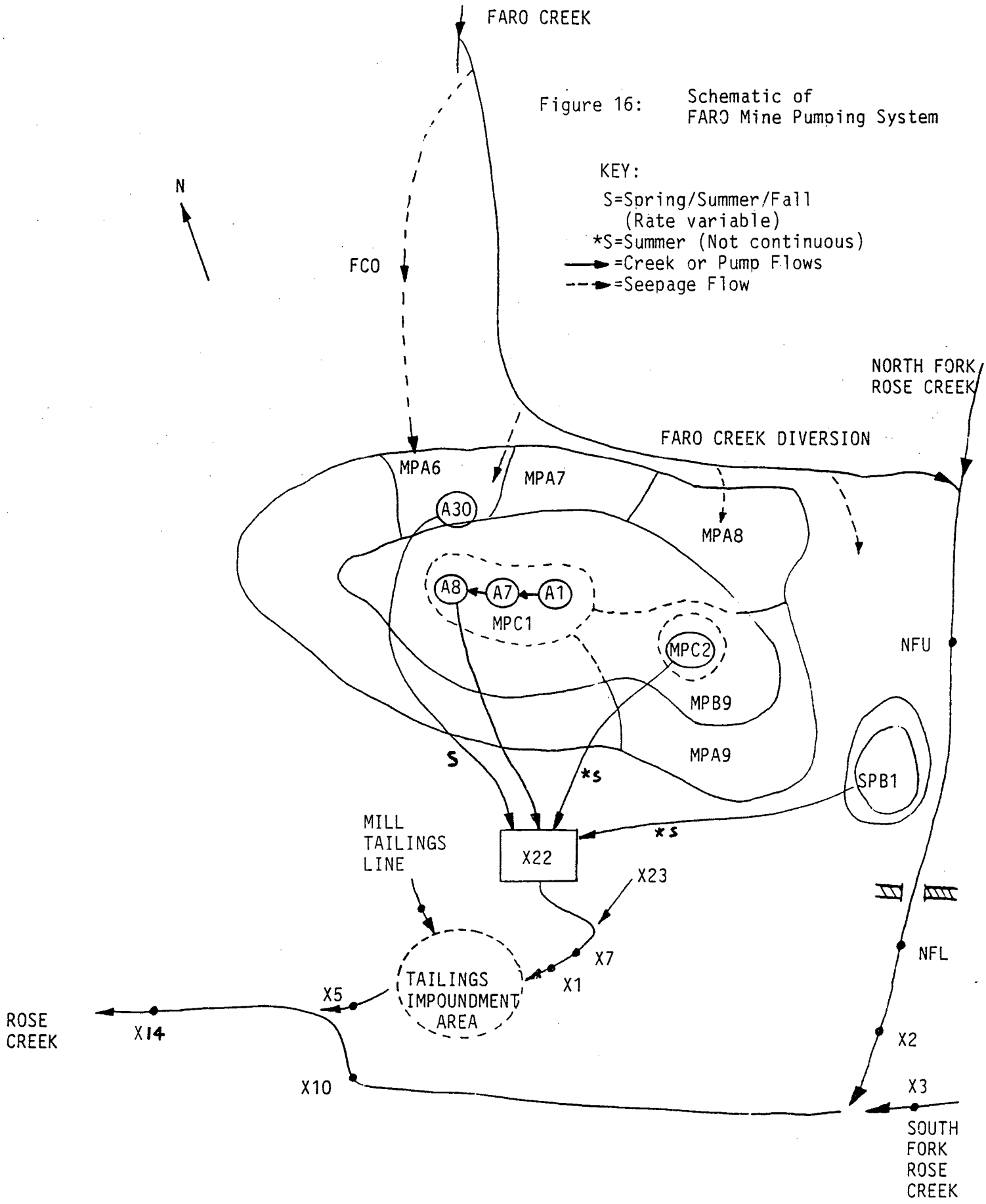


Figure 16: Schematic of FARO Mine Pumping System



4.2.4.2 MP: Water Quality

Water quality results for the Faro Main Pit area (MP) are summarized in Table 4-5. Zinc and copper loadings are shown, respectively, in Figure 4-14 and Figure 4-15. Most of this metal loading will be eliminated by loading of the pit at abandonment.

pH: (MP)

The pH, as summarized at site X22 during 1988, ranged from 6.63 to 7.20. The pH of Faro Creek, in comparison, ranged from 6.38 to 8.49. The 1988 average pH was 6.90 with a standard deviation of 0.20. These results are based on weekly measurements.

Alkalinity: (MP)

The alkalinity of main pit discharge (MP) as summarized at site X22 during 1988 ranged from 50.0 to 213 mg/L, expressed as CaCO₃. The 1988 average was 151 mg/L with a standard deviation of 52.3 mg/L, expressed as CaCO₃.

Zinc: (MP)

Zinc loading rates, as shown on Figure 4-14, peaked during the spring of 1988. A combined high of 5016 mg/s was recorded in May, 1988. A similar rate of 4800 mg/s was also recorded in August, 1988. The main sump (MPC1) located near the pit bottom appeared to be the major loading source, with zone MPA6 and MPC2 contributing less than 20 percent in any survey.

Copper: (MP)

Copper loading rates, as shown on Figure 4-15, were greatest during the May, 1988, survey. A rate of 11.62 mg/s was recorded. Copper loading rates for pit recharge (MPA6, MPC1 and MPC2) are considerably higher than discharge rates (X22). The discrepancy could be a result of sampling error, or changes in the amounts of copper remaining in solution with time. Dissolved copper loadings are provided in Table 4-5A, and average less than 20 percent of the total copper loading rates. Dissolved copper was not analyzed at site X22.

Sulphate: (MP)

Sulphate concentrations ranged from 300 mg/L to 578 mg/L. The average sulphate concentration for the main pit discharge was 450 mg/L. The peak sulphate concentration was recorded in August, 1988. The peak zinc and copper concentrations and loadings did not correspond with the sulphate peak. A relationship between metal concentrations or metal loadings and sulphate concentrations was not evident.

4.3 **SP: Zone 2 Pit and Waste Dump Areas**

4.3.1 **SP: Location**

The Zone 2 pit and waste dump areas are shown on Figure 3-1. This pit was mined out prior to 1982 and is presently being backfilled with non-acid generating rock. Seepage from a waste rock dump (WSP1) north of the Zone 2 pit drains into either a ditch (WSP2) which follows the toe of the dump or into the pit directly. The drainage ditch discharges into the remaining open pit in its northwestern corner. The pit itself is divided into two sub-areas: the remaining pit walls consisting of northeastern to southeastern upper wall faces (SPA1), and the pit pond (SPB1). The area immediately to the south of the pit (WSP3) consists of a rock dump as well as part of the flood plain of North Fork Rose Creek.

4.3.2 **SP: Hydrology**

The areas north and northeast of the pit (WSP1 and WSP2) have undergone considerable change since the first seep survey in September, 1987. The upper section of the lined drainage ditch was located immediately to the south of the Faro diversion canal in 1987. In 1988, drainage from this vicinity was redirected to the main pit through zone MPA8; thus the recharge area of the ditch discharging into the Zone 2 pit was reduced.

The effects of this change in drainage pattern was noticeable at sample site 3, as is shown in Table 4-6 and Figure 4-17. Site 3 is located upstream of seeps emerging from the rock dump (WSP1) immediately to the northeast of the Zone 2 pit. Flow decreased from the 8.4 L/s recorded in September, 1987, to less than 1.0 L/s in the 1988 surveys.

Moving downstream of Site 3 in the drainage ditch, two sets of seeps emerge from the toe of the waste dump located on the northeast edge of the ditch. These seeps, labelled 7-8 and 5-6 flow either into the lined ditch or under the ditch into stream bed gravel. Regardless, the discharge goes to the Zone 2 pit. Flows in seeps 7-8 ranged from 1.88 L/s to 12.1 L/s. Peak flow was recorded in June, 1988. Flows in seeps 5-6 ranged from 1.13 to 7.49 L/s and peaked in August, 1988.

In September, 1987, the seepage flows from sites 7-8 and 5-6 were small in comparison to ditch flow at site 3. In 1988, flow from these seeps became the predominate recharge to the drainage ditch and zone 2 pit. Flow from site 7-8 was recorded at 2.83 L/s in the spring of 1988, which was similar to the fall, 1987 flow estimate. By June, the flow had increased to a survey peak of 12.13 L/s, followed by an August flow estimate of 7.15 L/s. Relatively small flows were recorded at site 5-6 during the spring and summer; however, in August a survey peak of 7.49 L/s was estimated.

The fall and spring combined flows from seeps 7-8 and 5-6 are approximately equal, being 6.1 and 5.3 L/s respectively. This flow may be attributable to a relatively steady-state groundwater flow

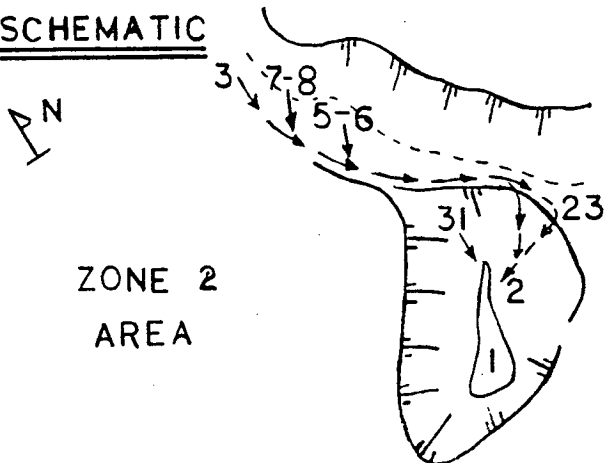
TABLE 4-6A: SP: ZONE 2 AREA
WATER FLOW AND WATER QUALITY SUMMARIES

FLOW (L/s)	SITE 3	SITE 7-8	SITE 5-6	SITE 3+(7-8) +(5-6)	SITE 23	SITE 2	SITE 31
Sep-87	8.40	1.88	4.20	14.48	9.20	9.40	0.01
Apr-88						5.00	0.10
May-88	1.00	2.83	1.45	5.28			0.03
Jun-88	0.80	12.13	1.13	14.06	4.95	17.68	0.09
Aug-88	0.80	7.15	7.49	15.44	0.80	23.60	
Oct-88						9.45	

ZINC LOADING (mg/s)	SITE 3	SITE 7-8	SITE 5-6	SITE 3+(7-8) +(5-6)	SITE 23	SITE 2	SITE 31
Sep-87	22.26	4.87	23.70	50.83	36.06	37.60	9.35
Apr-88				28.57		25.25	32.00
May-88	3.25	14.25	5.41	22.91			3.99
Jun-88	2.20	35.37	3.14	40.71	13.12	42.43	4.85
Aug-88	5.16	39.17	36.44	80.77	3.96	103.84	
Oct-88						16.54	

COPPER LOADING (mg/s)	SITE 3	SITE 7-8	SITE 5-6	SITE 3+(7-8) +(5-6)	SITE 23	SITE 2	SITE 31
Sep-87	1.22	0.03	0.17	1.42	0.77	0.71	0.93
Apr-88						0.10	0.36
May-88	0.01	0.05	0.02	0.08			0.37
Jun-88	0.01	0.18	0.01	0.20	0.04	0.21	0.32
Aug-88	0.02	0.11	0.12	0.25	0.01	0.38	
Oct-88						0.19	

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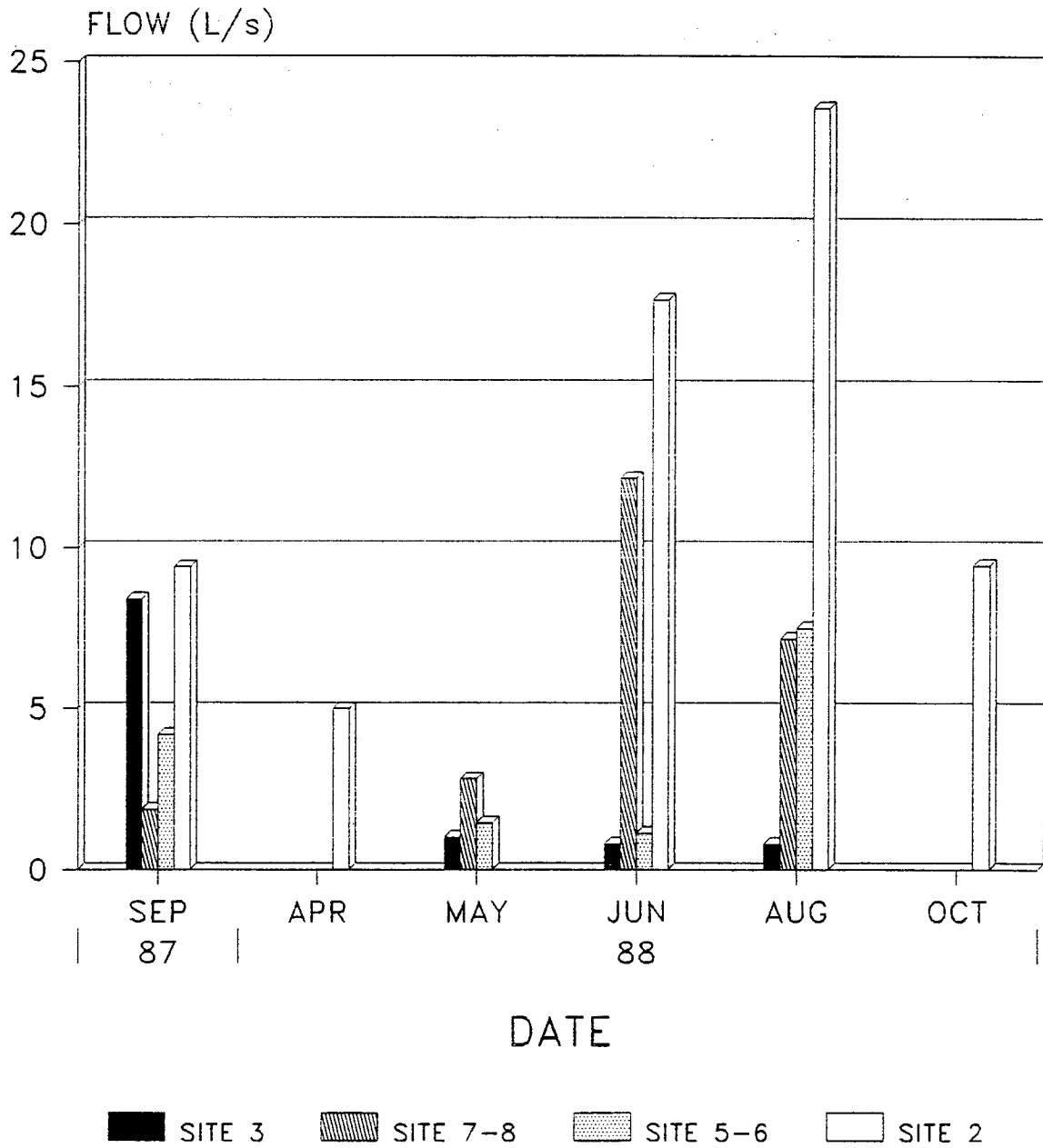


ZONE 2
AREA

TABLE 4-6B: SP: ZONE 2 AREA

AREA	DATE	SITE	WATER FLOW AND WATER QUALITY SUMMARIES				CONCENTRATIONS				CALCULATED LOADINGS				
			FLOW	pH	ALKAL	TOTAL	TOTAL	TOTAL	SO4	TOTAL DISS	TOTAL	DISS	TOTAL	DISS	
			(L/s)		CaCO3 (mg/L)	Cu (mg/L)	Zn (mg/L)	Fe (mg/L)	(mg/L)	CU (mg/s)	CU (mg/s)	ZN (mg/s)	ZN (mg/s)	FE (mg/s)	FE (mg/s)
SPA1	24-Sep-87	2	9.40	7.27		0.076	4.000		202.0	0.71		37.60			
SPA1	26-Sep-87	23	9.20	7.43		0.084	3.920		180.0	0.77		36.06			
SPA1	29-Sep-87	31	0.10	3.06		9.300	93.500		860.0	0.93		9.35			
SPA1	14-Apr-88	31	0.10	3.65		3.640	320.000	220.000	1570.0	0.36	0.33	32.00	31.00	22.00	15.00
SPA1	16-Apr-88	2	5.00	7.06	54.0	0.019	5.050	0.805	299.0	0.10	0.06	25.25	22.15	4.03	0.43
SPA1	20-May-88	2		7.70	193.5	0.029	2.400	5.600	244.0						
SPA1	20-May-88	23		7.56	214.0	0.012	3.250	1.100	316.0						
SPA1	20-May-88	31	0.03	2.87		11.100	121.000	225.000	1460.0	0.37	0.37	3.99	4.06	7.43	7.43
SPA1	23-Jun-88	2	17.68	8.02	162.8	0.012	2.400	0.530	215.0	0.21	0.12	42.43	37.13	9.37	0.44
SPA1	23-Jun-88	23	4.95	7.39	16.6	0.008	2.650	0.095	213.0	0.04	0.04	13.12	10.64	0.47	0.07
SPA1	23-Jun-88	31	0.09	2.65		3.650	54.500	60.500	620.0	0.32	0.35	4.85	4.72	5.38	5.47
SPA1	02-Aug-88	2	23.60	8.20	136.5	0.016	4.400	1.200	262.0	0.38	1.65	103.84	80.24	28.32	1.77
SPA1	02-Aug-88	23	0.80	7.70	163.8	0.014	4.950	0.390	264.0	0.01	0.01	3.96	3.00	0.31	0.03
SPA1	24-Oct-88	2	9.45	5.90	162.0	0.020	1.750	4.400	275.0	0.19	0.05	16.54	11.34	41.58	0.80
SPB1	24-Sep-87	1	6.30	7.06		0.028	20.100		444.0	0.18		126.63			
SPB1	24-May-88	1		7.10	87.7	0.006	35.000	2.800	490.0						
SPB1	23-Jun-88	1	18.90	7.18	137.6	0.014	11.400	0.295	324.0	0.26	0.19	215.46	179.55	5.58	0.19
SPB1	02-Aug-88	1	6.30	7.60	135.4	0.017	13.200	0.490	374.0	0.11	0.46	83.16	76.23	3.09	3.09
SPB1	24-Oct-88	1	6.30		190.0	0.044	126.000	43.500	1525.0	0.28	0.14	793.80	806.40	274.05	233.10
WSP1	24-Sep-87	4	0.40	7.71		0.002	1.150		139.0	0.00	0.00	0.46	0.00	0.00	0.00
WSP1	24-Sep-87	5	0.70	7.49		0.048	5.860		315.0	0.03	0.00	4.10	0.00	0.00	0.00
WSP1	24-Sep-87	6	3.50	7.00		0.040	5.600		278.0	0.14	0.00	19.60	0.00	0.00	0.00
WSP1	24-Sep-87	7	1.40	7.06		0.011	2.610		139.0	0.02	0.00	3.65	0.00	0.00	0.00
WSP1	24-Sep-87	8	0.48	6.91		0.013	2.550		134.0	0.01	0.00	1.22	0.00	0.00	0.00
WSP1	16-Apr-88	6		7.18	255.0	0.041	3.110	0.980	509.0						
WSP1	19-May-88	7	2.57	6.53	107.5	0.017	5.050	0.095	257.0	0.04	0.04	12.98	11.74	0.24	0.01
WSP1	19-May-88	8	0.26	6.60	206.5	0.020	4.870	0.185	262.0	0.01	0.00	1.27	1.25	0.05	0.00
WSP1	20-May-88	5	0.70	7.29	198.0	0.010	4.250	0.120	318.0	0.01	0.00	2.97	2.94	0.08	0.01
WSP1	20-May-88	6	0.75	6.94	228.0	0.012	3.250	0.220	360.0	0.01	0.01	2.44	2.55	0.17	0.01
WSP1	22-Jun-88	5	0.25	7.41	155.9	0.009	2.900	0.080	226.0	0.00	0.00	0.73	0.69	0.02	0.01
WSP1	22-Jun-88	6	0.88	6.31	181.7	0.014	2.750	0.270	221.0	0.01	0.01	2.41	2.28	0.24	0.03
WSP1	22-Jun-88	7	7.08	6.54	153.8	0.016	3.000	0.025	155.0	0.11	0.10	21.23	19.46	0.18	0.11
WSP1	22-Jun-88	8	5.05	6.45	152.3	0.014	2.800	0.025	151.0	0.07	0.07	14.14	11.87	0.13	0.05
WSP1	02-Aug-88	5	0.10	7.50	116.6	0.010	5.950	0.095	313.0	0.00	0.00	0.60	0.54	0.01	0.00
WSP1	02-Aug-88	6	7.39		168.0	0.016	4.850	0.215	272.0	0.12	0.10	35.84	27.71	1.59	0.33
WSP1	02-Aug-88	7	3.85	6.90	146.0	0.016	5.500	0.125	195.0	0.06	0.04	21.18	16.75	0.43	0.15
WSP1	02-Aug-88	8	3.30	7.10	146.0	0.016	5.450	0.025	204.0	0.05	0.05	17.99	14.52	0.08	0.07
WSP1	27-Oct-88	5-6		7.00	173.5	0.011	2.200	0.550	257.0						
WSP1	27-Oct-88	7-8		7.50	168.5	0.011	2.300	1.250	158.0						
WSP2	24-Sep-87	3	8.40	7.54		0.145	2.650		93.0	1.22	0.00	22.26	0.00	0.00	0.00
WSP2	24-Sep-87	9	2.90	7.20		0.215	2.790		63.0	0.62	0.00	8.09	0.00	0.00	0.00
WSP2	25-Sep-87	10	4.00	7.14		0.235	2.860		64.0	0.94	0.00	11.44	0.00	0.00	0.00
WSP2	25-Sep-87	11	0.10	3.30		8.980	99.000		1290.0	0.90	0.00	9.90	0.00	0.00	0.00
WSP2	25-Sep-87	12	3.70	6.70		0.018	0.515		32.0	0.07	0.00	1.91	0.00	0.00	0.00
WSP2	16-Apr-88	11	0.50	3.53		6.080	71.000	33.500	525.0	3.04	3.04	35.50	35.00	16.75	15.00
WSP2	20-May-88	3	1.00	7.31	202.0	0.014	3.250	0.950	347.0	0.01	0.01	3.25	3.10	0.95	0.01
WSP2	22-Jun-88	3	0.80	7.27	154.4	0.014	2.750	0.400	157.0	0.01	0.01	2.20	2.00	0.32	0.05
WSP2	02-Aug-88	3	0.80	7.50	144.9	0.021	6.450	2.500	210.0	0.02	0.01	5.16	3.36	2.00	0.22

FIGURE 4-17: SP-ZONE 2 AREA FLOWS



component. The combined flow during the summer months is approximately three times the fall and spring flow rates. In June, 1988, 14.1 L/s was estimated and in August, 1988, 15.4 L/s was estimated. The increased flow rate may be attributable to interflow recharged from dump surface infiltration.

The dump seeps (7-8 and 5-6), as previously stated, flow into either the drainage ditch or seep directly into the Zone 2 pit. Sites 23 and 2 are located towards the terminus of the drainage ditch as it flows into the pit. (In September, 1987, site 23 was immediately upstream of site 2. In 1988, the drainage ditch eroded through its embankment and began to flow into the Zone 2 pit through two channels. Site 23 is located on the eastern channel and, as flow data indicates, no longer receives all the ditch flow. Flow at site 2 ranged from 5.00 L/s in April, 1988, to 23.6 L/s in August, 1988. (All ditch flow passes site 2 as it did in September, 1987). Site 31 monitors a wall seep. Flows were less than 0.10 L/s during all survey periods. All three of these sites are located in the northeastern wall section (SPA1) of the Zone 2 pit.

The final indicator of water discharge quality of the Zone 2 pit is the pit pond water (site 1) which is designated SPB1. This pond area is now a rock dump for non-acid generating rock (ZONE 2 Report, Curragh Resources Inc., 1987). During 1988, the pond area was noticeably reduced by active rock backfilling. Before the completion of pit backfilling, Curragh Resources Inc. will ensure that a rock drain and water collector system is in place. Should pit overflow discharge not meet acceptable regulatory standards, the pit discharge water can be recovered for appropriate treatment.

During the seep survey period, Zone 2 pit dewatering rates were variable. During the summer months, pumping rates varied from 6.3 to 18.9 L/s.

4.3.3 SP: Water Quality

Water quality results for the Zone 2 pit area are summarized in Table 4-6A or 4-6B and in Figures 4-18 and 4-19.

pH: (SP)

In the Zone 2 pit area, the pH ranged from 2.65 to 8.40. The low was recorded at site 31 in Zone SPA1. Whenever this pit wall seep was monitored, pH values of less than 4.0 were recorded. The lowest pH values on the mine site were recorded at site 31. For comparison, seeps in the Faro pit and waste dump areas recorded pH values ranging from 5.2 to 8.4.

Except for seep 31, seeps and drainage ditches in the Zone 2 pit area had pH values ranging from 5.90 to 8.40. The low of 5.90 was recorded at site 2 in Zone SPA1 in October, 1988.

FIGURE 4-18: SP - ZONE 2 AREA
ZINC LOADINGS

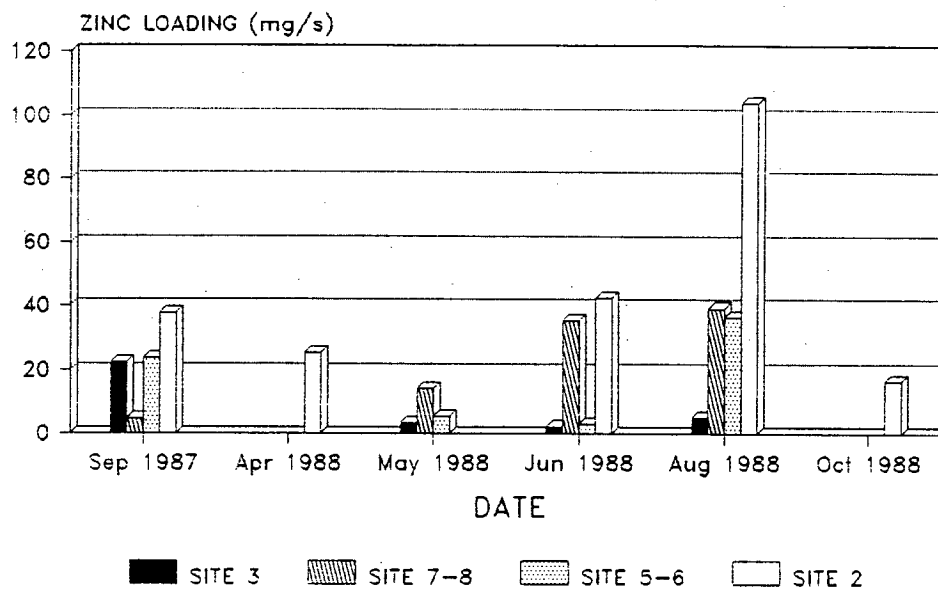
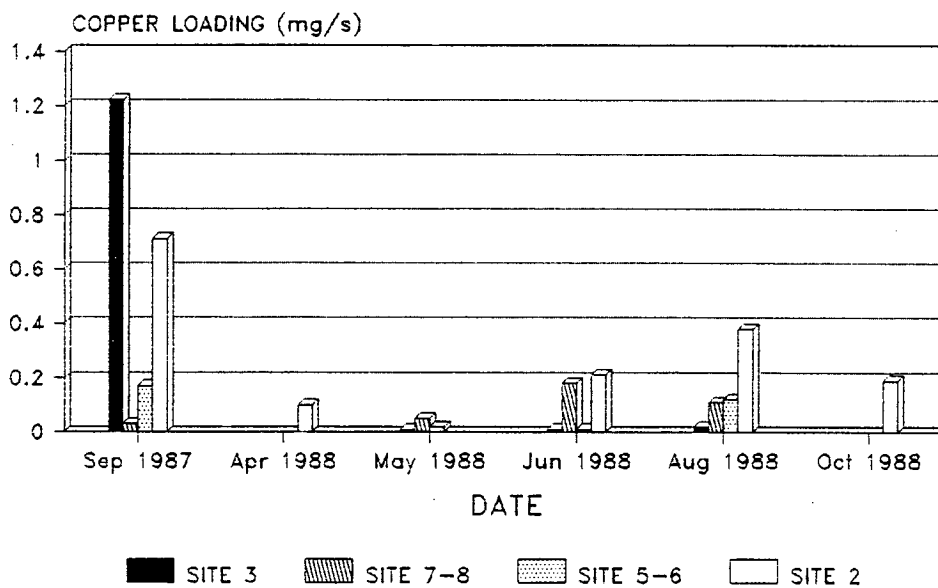


FIGURE 4-19: SP - ZONE 2 AREA
COPPER LOADINGS



Alkalinity: (SP)

Alkalinity ranged from 16.6 mg/L to 255 mg/L, expressed as CaCO₃. The low was recorded in June, 1988 at site 23 and the high was recorded in April, 1988 at site 6.

Zinc: (SP)

Table 4-6 and Figure 4-18 summarize zinc concentrations and loading rates from seeps and drainage ditches in the Zone 2 pit area (SP). In September, 1987, a major zinc loading source was the lined ditch treated in the northeastern section of MPA8. During this first seep survey, a zinc loading rate of 22.3 mg/s was determined at site 3 in sub-area WSP2. Subsequently, flows decreased at this site due to re-alignment of the drainage control system. The 1988 surveys recorded zinc loading rates ranging from 2.20 to 5.16 mg/s.

Two sets of seeps (seeps 7-8 and 5-6) in sub-area WSP1 flow into or under the lined ditch (WSP2); however, these seeps eventually recharge the Zone 2 pit. Zinc loading rates from these seeps ranged, respectively, from 4.87 to 39.2 mg/s and 3.14 to 36.4 mg/s.

The combined zinc loading rates from these dump seeps (seeps 7-8 and 5-6) ranged from 22.9 to 80.8 mg/s. Loading peaked by late summer, 1988 at 80.8 mg/s. Flows and zinc concentrations were then at maximum recorded values. The lowest loading rates were recorded in the spring when average zinc concentrations were moderately high at 4.34 mg/L but flow rates were relatively low. Loading rate increases during the 1988 summer period paralleled increases in flow rates. In September, 1987, a zinc loading rate of 28.6 mg/s was recorded, and although flows were not estimated during the October, 1988 survey, field notes indicate that seepage flows were much reduced from late summer flows. Zinc concentrations for this period were the lowest recorded from these seeps, being 2.25 mg/L. With inferred low flow rates, the zinc loading is assumed to be considerably less than the peak recorded during the August survey.

The majority of flow from the lined ditch(WSP2) and the waste rock dump seeps(WSP1) flows past site 2 located in sub-area SPA1. Zinc loading rates at site 2 ranged from 16.5 to 103 mg/s. The zinc loading at this location trends with site 7-8 and 5-6 loadings, and peaked in August, 1988.

Seep 31 is also located in this sub-area and although seepage flow never exceeded 0.1 L/s, zinc loadings ranging from 4.0 to 32.0 mg/s were recorded. This seep is an example of a truly acidic seep. A zinc loading peak of 32.00 mg/s corresponding with a zinc concentration high of 320.00 mg/L was recorded in early spring, 1988. Summer loadings ranged from 4.0 to 5.0 mg/s. Seep 31, despite its relatively insignificant flow rate, is a significant zinc loading source.

As stated above, the final indicator of the Zone 2 pit area water quality is the pit pond water (site 1) located in sub-area SPB1. A zinc concentration high of 135 mg/L was recorded in the pit water in October, 1988. This concentration is almost a four fold increase over any previously recorded zinc

concentration in the pit water, and may be an indicator of deteriorating pit water quality. During the survey, zinc concentrations ranged from 11.40 to 126 mg/L; however, four out of five concentrations ranged from 11.40 to 35.00 mg/L.

Copper: (SP)

Copper loading rates, shown on Figure 4-19, at in sub-area SPA1 (site 2) ranged from 0.10 mg/s to 0.38 mg/s. The peak loading occurred in August, 1988. Loadings from sub-area WSP2 (site 3) ranged from 1.22 in September, 1987 to less than 0.02 mg/s during the 1988 surveys. Copper loadings from the 7-8 and 5-6 seeps located in sub-area WSP1, in comparison, were relatively constant throughout the seep surveys. Combined, these seeps averaged 0.18 mg/s and ranging from 0.08 to 0.25 mg/s. Seeps 7-8 peaked in June, 1988 at 0.18 mg/s and seeps 5-6 peaked in September, 1987 at 0.17 mg/s.

Copper concentrations in the pit pond (SPB1, site 1) were relatively low and averaged 0.022 mg/s. Copper concentrations ranged from 0.006 to 0.044 mg/L. The copper high, like zinc, was recorded in October, 1988.

4.4 W: Faro Waste Rock Dumps

The Faro waste rock dumps are located along the eastern, southern and western boundaries of the Faro pit area. Dump locations are shown in Figure 3-1. The Zone 2 Pit dump (SPB1) and seeps from dumps immediately north of the Zone 2 Pit (WSP1 and WSP2) are reviewed in section 4.3.

By the time the mine is prepared for abandonment, a total of 92 million cubic meters of waste rock will have been removed from the Faro pits. Waste dump capacities and estimates of the volumes of different types of wastes contained are shown in Table 4-7. (p.48; Faro Abandonment Rpt., 1988). Table 4-8 shows the seven major waste rock types (greater than one percent by volume of all waste) produced during mining at Faro. (p.45; Faro Abandonment Rpt., 1988). Curragh Resources Inc. is currently conducting a drill core sampling and analysis program to classify the acid generating potential of the different waste rock materials.

The exact composition of many of the waste dumps is unknown. This is especially true for the older dumps for which dumping records are not available. Thus, assessment of the dumps cannot be made based on rock composition alone. The seep surveys, however, can be used to determine metal loadings resulting from the currently existing acid generation. These surveys can also provide insight into the future acid generating potential of the waste dumps.

TABLE 4-7: FARO MINESITE - CHARACTERISTICS OF MAJOR WASTE DUMPS

DUMP SITE LOCATION and DESCRIPTION	FINAL DUMP VOLUME Cubic Meters (x 1,000,000)	CALC- SILICATE GNEISS 3D	BIOTITE MUSCOVITE ANDALUSITE SCHIST 100	BIOTITE MUSCOVITE SCHIST 100	GRANO- DIORITE &DIORITE 10E	POTENTIALLY ACID GENERATING WASTE ROCK
FARO MAIN DUMPS SITES Includes: Main Dump, Intermediate Dump, "B" Stockpile & Oxide Ore Stockpile, Pad Locations, Encapsulated Sulphides	56.0	33%	29%	19%	9%	10% 5.6 Million Cubic Meters
UPPER NORTH WEST DUMP SITES Includes: Terraced Dump Levels North of Haulroad from Crusher to Lube shop	5.0	35%	30%	20%	10%	5% 0.3 Million Cubic Meters
EAST SIDE DUMP SITES Includes: Faro Valley, Zone 2, and S.E. Rock and till dump sites	23.0	35%	30%	20%	10%	5% 1.2 Million Cubic Meters
OPEN PIT DUMPS	3.0	20%	18%	12%	6%	44% 1.3 Million Cubic Meters
VANGORDA HAUL ROAD	5.0	40%	30%	20%	10%	0%
TOTALS	92.0 Million Cubic meters					12.1 Million Cubic Meters

*** NOTE: Approx. 1 tonne of rock = 0.79 cubic meter of rock.

TABLE 4-8: FARO MINE - DESCRIPTION OF ROCK TYPES

ANVIL DYKE SUITE	10E	HORNEBLENDE DIORITE and QUARTZ FELDSPAR PORPHYRY
Cretaceous	10F	QUARTZ FELDSPAR PORPHYRY
VANGORDA FORMATION	3D	CALC-SILICATE GNEISS
Cambrian to	3A	BASAL UNIT OF VANGORDA FORMATION CARBONACEOUS SCHIST, SCHIST, CHLORITE SCHIST, CALC-SILICATE
FARO DEPOSIT	2A	RIBBON BANDED GRAPHITIC PYRITIC QUARTZITE
	2BCD	UNDIFFERENTIATED NON-GRAPHITIC SULPHIDE BEARING QUARTZITE
	2E0	BARREN MASSIVE PYRITE
	2EF	MASSIVE PYRITIC SULPHIDES
MT. MYE FORMATION	1D0	FINE BIOTITE-MUSCOVITE-ANDALUSITE SCHIST
Lower Cambrian	1D2	DARK GREY CARBONACEOUS SCHIST
	1D4	ALTERED QUARTZ MUSCOVITE SCHIST
	1H0	CHLORITE SCHIST
	1H4	ALTERED META BASIC INTRUSIVE
	1CD	BIOTITE-MUSCOVITE-GARNET-STAUROLITE-ANDALUSITE SCHIST
WASTE	1CD	QUARTZO-FELDSPATHIC, BIOTITE-MUSCOVITE SCHIST Non-acid producer.
	3D	CALC-SILICATE GNEISS Net acid consumer.
		CALC-SILICATE BRECCIA Heavily silicified calc-silicates. Silicification has removed much of carbonate; thus, generally net acid consumer but highly variable.
	1D0	BIOTITE-MUSCOVITE-ANDALUSITE SCHIST TO PHYLLITE Possible acid producer.
	1D4	ALTERED SCHIST, QUARTZ MUSCOVITE SCHIST Possible acid producer.
	2E0	SULPHIDE WASTE
	2EF	Potential acid producer.
	10E	DYKE ROCKS, MAINLY ALTERED SCHIST
	10F	Non-acid generating.

To conduct the seep surveys, the waste dumps were divided into zones. These zones, beginning in the northeastern quadrant, are:

- WNE: East Waste Dump
- WSP3: South Zone 2 Waste Dump and Area
- WIE: East Intermediate Waste Dump
- WISE: Southeast Intermediate Waste Dump
(includes Sulphide Waste Dump).
- WMS: South Main Waste Dump
- WMSW: Southwest Main Waste Dump
- WW: West Waste Dump
- WNW: Northwest Waste Dump

4.4.1 W: Hydrology

During each survey, a walking inspection of the toes and faces of the waste dumps was conducted. In general, active seeps were not found on dump faces, although staining in areas of the east waste dump (WNE) indicated that intermittent flows had occurred in the past. Most active seeps had low flow rates, or were evident only by the presence of ponded surface water. Table 4-9A, Table 4-9B and Figure 4-20 show the flows from the dump seeps.

Only one major seep was located along the toe of the eastern dump (WE). This seep, at site W5, emerged from the toe of the dump along a 20 meter length as a diffuse stream flowing through the grass and moss. Surface flow ceased approximately 30 meters from the toe of the dump, only to emerge again about 100 meters to the east. Flow at this site was seasonal. In June, 1988, a flow of 22.50 L/s was recorded; in August, 1988, a flow of 0.17 L/s was estimated. The only other active seep from this dump was located at site W2. Flows here did not exceed 0.05 L/s, and by August the seep was dry. The existence of small gullies and channels provided evidence of three other seeps; however, neither flows nor ponded water was observed during any of the surveys.

No active seeps were found along the toes of the south Zone 2 dump (WSP3), the east intermediate dump (WIE), the southeast intermediate dump (WMSE) or the south main dump (WMS). Eight small ponds containing standing water were located.

One of the most significant waste dump seeps noted in all of the surveys emerges from the toe of the southwest main dump zone (WMSW) at site X23. This site, located in the southern portion of the old Faro Creek channel, flows throughout the year and is monitored weekly. Flow rate estimates are shown in Table 4-9B and Figure 4-20B. The estimated average yearly flow of this seep was 3.19 L/s. June had the highest flow rate at 8.0 L/s.

TABLE 4-9: W: WASTE ROCK DUMP AREAS

WATER FLOWS AND WATER QUALITY SUMMARIES

CALCULATED LOADINGS

AREA	DATE	SITE FLOW (L/s)	pH	ALKAL (mg/L)	TOTAL	TOTAL	TOTAL	SO4 (mg/L)	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	
					Cu (mg/L)	Zn (mg/L)	Fe (mg/L)		CU (mg/s)	CU (mg/s)	ZN (mg/s)	ZN (mg/s)	FE (mg/s)	FE (mg/s)	
WNE	28-Sep-87	W1	0.00												
WNE	28-Sep-87	W2	0.05						0.00	0.00	0.00	0.00	0.00	0.00	
WNE	28-Sep-87	W3	0.00												
WNE	28-Sep-87	W4	0.00												
WNE	28-Sep-87	W5	1.00	7.85	0.003	0.750		306.0	0.00	0.00	0.75	0.00	0.00	0.00	
WNE	19-May-88	W2	0.05	8.24	127.5	0.003	0.024	0.355	67.0	0.00	0.00	0.00	0.00	0.02	0.00
WNE	19-May-88	W5		7.80	325.5	0.007	1.600	0.097	830.0						
WNE	23-Jun-88	W2	0.03	7.81	74.6	0.003	0.018	0.390	21.0	0.00	0.00	0.00	0.00	0.01	0.00
WNE	23-Jun-88	W5		7.29	233.1	0.005	0.855	0.260	277.0						
WNE	23-Jun-88	W5-1	22.50	7.12	206.9	0.003	0.008	0.005	299.0	0.07	0.05	0.18	0.32	0.11	0.23
WNE	02-Aug-88	W2		7.70	131.2	0.019	0.205	12.000	49.0						
WNE	02-Aug-88	W5	0.17	7.70	209.0	0.006	0.640	0.485	255.0	0.00	0.00	0.11	0.10	0.08	0.01
WSP3	18-May-88	N/NE1		7.5	0.002	0.011	0.130	3.0							
WSP3	18-May-88	N/NE2		6.0	0.002	0.015	0.170	3.0							
WSP3	18-May-88	N/NE3		6.0	0.002	0.015	0.170	3.0							
WSP3	23-Jun-88	POND1	7.00	75.6	0.055	0.305	28.000	63.0							
WIE	19-May-88	POND1	6.87	45.0	0.081	0.460	39.000	84.0							
WIE	19-May-88	POND2	3.25		0.760	115.000	43.500	517.0							
WIE	19-May-88	POND3	7.11	18.5	0.004	2.050	1.080	120.0							
WISE	18-May-88	SDUMP3	7.46	127.5	0.012	22.000	0.330	1740.0							
WISE	18-May-88	SDUMP4	7.46	24.5	0.006	0.033	0.455	10.0							
WMS	30-Sep-87	W11	0.10	7.55	0.004	0.665		335.0	0.00	0.00	0.07	0.00	0.00	0.00	0.00
WMS	18-May-88	SDUMP2	6.32	25.5	0.010	3.550	1.790	324.0							
WMS	18-May-88	W11	6.57	9.0	0.019	0.980	1.190	25.0							
WMSW	28-Sep-87	X23	3.10	6.92	0.015	26.500		1500.0	0.05	0.00	82.15	0.00	0.00	0.00	0.00
WMSW	15-Apr-88	X23	1.90	6.83	554.0	0.012	23.500	0.525	1385.0	0.02	0.02	44.65	40.85	1.00	0.08
WMSW	28-Jun-88	MILL-PIT	6.73	86.1	0.032	18.200	3.600	282.0							
WMSW	28-Jun-88	S-D-DITCH	6.73	592.2	0.006	22.000	0.160	1525.0							
WNW	29-Sep-87	W10	20.00	7.54	-0.002	0.004		4.0	0.04	0.00	0.08	0.00	0.00	0.00	0.00
WNW	29-Sep-87	W6	0.50	7.58	0.004	0.325		76.0	0.00	0.00	0.16	0.00	0.00	0.00	0.00
WNW	29-Sep-87	W7	0.00												
WNW	29-Sep-87	W8	0.10	7.40	0.003	0.100		20.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00
WNW	29-Sep-87	W9	20.00	7.72	0.002	0.028		5.0	0.04	0.00	0.56	0.00	0.00	0.00	0.00
WNW	26-May-88	W10		8.29	36.8	0.002	0.002	0.025	1.9						
WNW	26-May-88	W8	0.17	7.47	41.0	0.003	0.019	0.074	3.0	0.00	0.00	0.00	0.00	0.01	0.00
WNW	26-May-88	W9		7.09	34.7	0.003	0.215	0.071	19.0						
WNW	29-Jun-88	W10		7.54	53.6	0.002	0.005	0.040	0.9						
WNW	29-Jun-88	W8	19.90	7.31	52.5	0.002	0.050	0.105	5.0	0.04	0.06	1.00	1.05	2.09	0.50
WNW	29-Jun-88	W9		6.70	45.7	0.003	0.134	0.145	0.9						
WNW	09-Aug-88	W10	1.60	6.99	52.5	0.002	0.008	0.060	3.0	0.00	0.00	0.01	0.01	0.10	0.02
WNW	09-Aug-88	W10-	0.33	6.91	54.6	0.003	0.017	0.405	2.0	0.00	0.00	0.01	0.01	0.13	0.06
WNW	09-Aug-88	W8	1.30	7.05	55.6	0.002	0.027	0.115	2.0	0.00	0.01	0.04	0.04	0.15	0.08
WNW	09-Aug-88	W9	0.17	7.08	45.7	0.002	0.040	0.040	1.0	0.00	0.00	0.01	0.01	0.01	0.01
WNW	27-Oct-88	W10		6.50	52.0	0.002	0.004	0.105	3.0						
WNW	27-Oct-88	W8		6.70	68.5	0.006	0.125	0.495	15.0						

TABLE 4-9: W: WASTE ROCK DUMP AREAS (Continued)
 WATER FLOWS AND WATER QUALITY SUMMARIES

CALCULATED LOADINGS

AREA	DATE	SITE	FLOW (L/s)	pH	ALKAL (mg/L)	TOTAL	TOTAL	TOTAL	SO4	TOTAL	TOTAL	TOTAL
						CU (mg/L)	ZN (mg/L)	IRON (mg/L)	(mg/L)	CU (mg/s)	ZN (mg/s)	FE (mg/s)
WNSW	Oct-86	I23	2.0			0.015	32.350			0.03		64.70
WNSW	Nov-86	I23	2.0			0.010	35.775			0.02		71.55
WNSW	Dec-86	I23	2.0			0.012	36.667			0.02		73.33
WNSW	Jan-87	I23	2.0			0.020	31.575			0.04		63.15
WNSW	Feb-87	I23	2.0			0.007	19.425			0.01		38.85
WNSW	Mar-87	I23	2.0			0.029	12.300			0.06		24.60
WNSW	Apr-87	I23	2.0			0.030	15.250			0.06		30.50
WNSW	May-87	I23	5.0			0.020	39.900			0.10		199.50
WNSW	Jun-87	I23	8.0			0.012	29.180			0.10		233.44
WNSW	Jul-87	I23	5.0			0.007	28.225			0.04		141.13
WNSW	Aug-87	I23	5.0			0.006	26.500			0.03		132.50
WNSW	Sep-87	I23	3.0			0.005	27.000			0.01		81.00
WNSW	Oct-87	I23	2.0			0.005	24.940			0.01		49.88
WNSW	Nov-87	I23	2.0			0.005	22.925			0.01		45.85
WNSW	Dec-87	I23	2.0			0.034	26.620			0.07		53.24
WNSW	Jan-88	I23	2.0	7.54	535.0	0.009	23.760	1553		0.02		47.52
WNSW	Feb-88	I23	2.0	7.35		0.039	20.025	1481		0.08		40.05
WNSW	Mar-88	I23	2.0	6.99		0.011	20.880	1450		0.02		41.76
WNSW	Apr-88	I23	2.0	6.95	494.1	0.011	20.125	1416		0.02		40.25
WNSW	May-88	I23	5.0	6.90	544.5	0.011	22.925	1468		0.05		114.63
WNSW	Jun-88	I23	8.0	6.95	589.4	0.007	18.280	1510		0.06		146.24
WNSW	Jul-88	I23	5.0	6.58	513.5	0.008	21.950	1495		0.04		109.75
WNSW	Aug-88	I23	5.0	6.72	409.5	0.008	23.020	1347		0.04		115.10
WNSW	Sep-88	I23	3.0	6.72	398.3	0.013	20.675	1413		0.04		62.03
WNSW	Oct-88	I23	2.0	7.13	410.2	0.014	22.625	0.473	1625	0.03		45.25
WNSW	Nov-88	I23	2.0	6.89	435.2	0.048	20.200	16.500	1494	0.10		40.40
WNSW	Dec-88	I23	2.0	7.19	510.0	0.023	19.767	2.005	618	0.05		39.53
YEARLY AVERAGE			3.19	6.99	483.96	0.02	24.55	6.33	1406	0.04		79.47
STD. DEVIATION			1.83	0.26	63.03	0.01	6.38	7.22	247	0.03		52.03
COUNT			27	12	10	27	27	3	12	27		27

Seep W5 in the east dump (WNE) had a flow rate of 22.5 L/s during June, 1988; however, very low flow rates, ranging from 0.10 to 1.0 L/s, were recorded for the rest of the year.

In the northwest waste dump (WNW), two small seeps were recorded during the September, 1987 survey. These flows, at sites W6 and W8, were 0.50 and 0.10 L/s respectively. Next Creek flows through the western perimeter of the northwest dump and was monitored both upstream and downstream of the dump. Flow estimates ranged from 20.0 L/s in September, 1987 to 1.3 L/s in August, 1988.

4.4.2 W: WATER QUALITY

The water quality of seepage from the waste dumps is summarized in Table 4-9. Zinc loading is shown on Figure 4-21.

pH: (W)

The pH of all the seeps and ponded water ranged from 6.32 to 8.29 with the exception of pond 2 located along the eastern perimeter of the intermediate waste dump (WIE). Pond 2, which was stagnant, had a pH of 3.25 in May, 1988.

Zinc: (W)

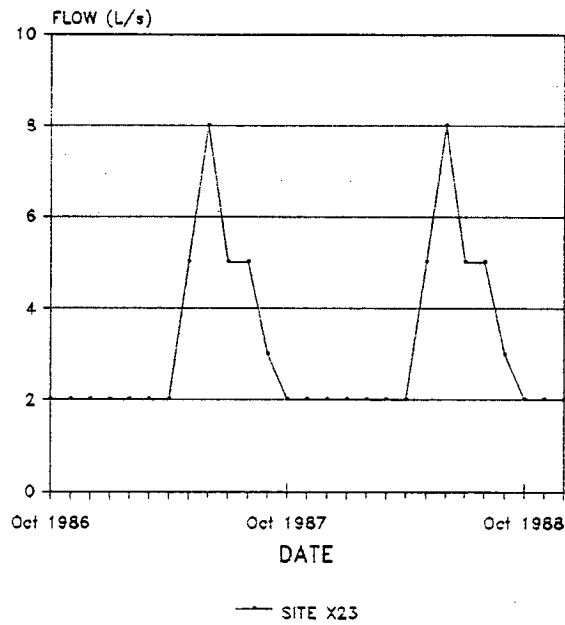
Zinc loading rates did not exceed 1.0 mg/s for any of the seeps except for the seep located at site X23. At this site, zinc loading rates ranged from 24.6 mg/s to 233 mg/s. The average loading since October, 1986, at site X23 was 79.5 mg/s with a standard deviation of 52.0 mg/s.

As previously noted, ponded water was found along the toes of the dumps. Loading rates could not be determined. However, some ponds did contain relatively high concentrations of zinc. In particular, Pond 2 below the east intermediate dump (WIE) with the pH of 3.25 had a zinc concentration of 115.0 mg/L in May, 1988. Pond 3, below the same dump, had a zinc concentration of 2.05 mg/L, while pond SDUMP 4, below the southeast intermediate dump, had a zinc concentration of 22.0 mg/L. Sites W5 and W11 also displayed elevated zinc concentrations. At site W5, zinc ranged from 0.64 to 1.60 mg/L. At site W11, zinc ranged from 0.67 to 3.55 mg/L. At all other sites, excepting site X23, the zinc concentrations were less than 0.50 mg/L.

Copper: (W)

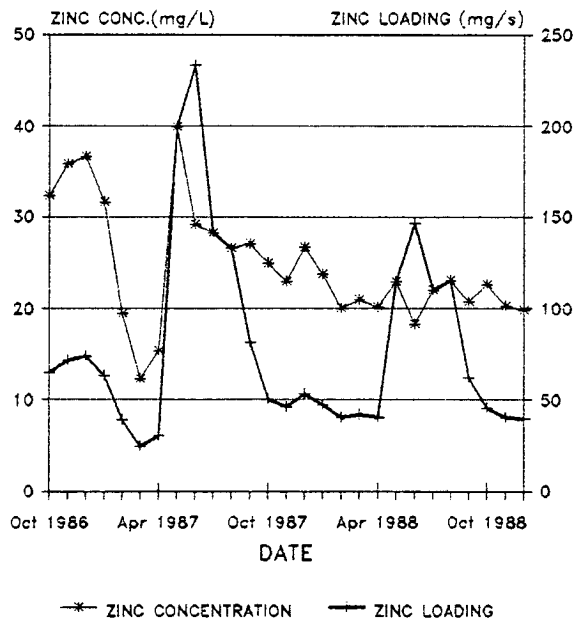
Copper loading rates were very low and did not exceed 0.07 mg/s except at site X23 where 0.10 mg/s was recorded during May and June, 1987. Copper averaged 0.04 mg/s with a standard deviation of 0.03 since October, 1986.

FIGURE 4-20: FLOWS
WASTE ROCK DUMP AREAS (X23)



*Flow pattern derived. 5 measurements.

FIGURE 4-21: ZINC
W: WASTE ROCK DUMPS (X23)



As previously noted, ponded water was found along the toes of the dumps and some of these ponds had elevated concentrations of copper. In particular, Pond 2 below the east intermediate dump (WIE) with the pH of 3.25 had a copper concentration of 0.760 mg/L. At all other sites, excepting site X23, the copper concentrations were less than 0.10 mg/L.

4.5 NF: North Fork Rose Creek

4.5.1 NF: Hydrology

The North Fork Rose Creek is monitored monthly at site X2 and is a receiving water for the Faro Mine. Table 4-10 summarizes flow and water quality for three sites on this creek. During the seep surveys, site NFL located below the rock drain causeway and site NFU located upstream of the causeway were also sampled.

An automatic water flow recorder is being installed on North Fork Rose Creek during 1989. During the survey period, flows were periodically determined using a Marsh-McBirney current meter. However, for the purposes of calculating metal loading rates an average flow rate of 1400 L/s has been used. This average rate is based on an average rainfall of 370 mm per year and a watershed of 118 km.

4.5.2 NF: Water Quality

pH: (NF)

North Fork water had a pH ranging from 6.60 to 8.21.

Alkalinity: (NF)

The alkalinity of North Fork Rose Creek ranged from 34.7 mg/L to 765 mg/L, expressed as CaCO₃.

Zinc: (NF)

As shown in Table 4-10 and Figure 4-22, the average zinc loading was 58 mg/s with a range from 21 to 115 mg/s since August, 1987. Zinc concentrations during this period only exceeded 0.050 mg/L in October, 1987, April, 1988, and October, 1988. The concentrations, respectively, were 0.060 mg/L, 0.150 mg/L and 0.082 mg/L. With these three exceptions, zinc concentrations ranged from 0.013 to 0.050 mg/L.

Zinc concentrations in the North Fork are also available from 1980 to 1984. During this period, zinc concentrations ranged between 0.05 to 0.25 mg/L with three exceptions. In April, 1981, a zinc concentration of 0.6 mg/L was recorded; in November, 1983, a zinc concentration of 0.38 mg/L was recorded, and in November, 1984 a concentration of 1.2 mg/L was recorded. These elevated zinc concentrations correlates to zone 2 overflows.

Copper: (NF)

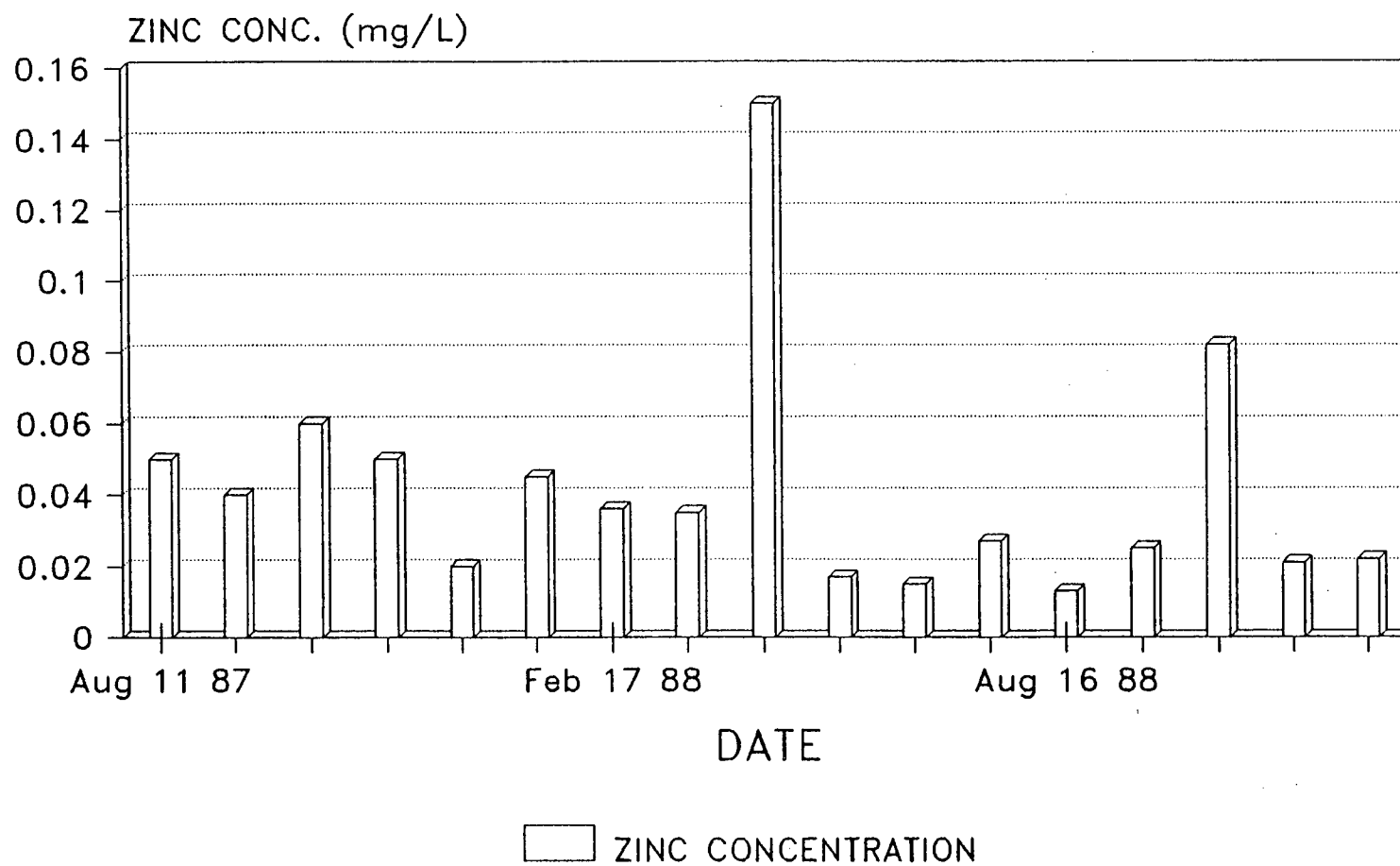
Copper concentrations remained below 0.007 mg/L and the maximum copper loading rate was 8.4 mg/s in for April, 1988.

TABLE 4-10: NF - NORTH FORK ROSE CREEK
WATER FLOWS AND WATER QUALITY SUMMARIES

CALCULATED LOADINGS

AREA	DATE	SITE	FLOW (L/s)	pH	ALKAL (ng/L)	TOTAL	TOTAL	TOTAL	SO4	TOTAL	TOTAL	TOTAL		
						CU (ng/L)	ZN (ng/L)	IRON (ng/L)	(ng/L)	CU (ng/s)	ZN (ng/s)	FE (ng/s)		
NFU	29-Sep-87	NF1	1400	6.65		0.002	0.057		4.0	2.80		79.80		
NFU	23-Jun-88	NF1	1400	7.23	56.7	0.002	0.010	0.130	1.0	2.66	2.56	14.00	9.80	182.00
NFU	24-Oct-88	NF1	1400		82.0	0.002	0.006	0.105	4.0	2.80	2.80	8.40	39.20	147.00
NFL	29-Sep-87	NF2	1400	7.65		0.002	0.042		8.0	2.80		58.80		
NFL	28-Jun-88	NF2	1400	7.24	63.0	0.002	0.022	0.125	4.0	2.66	2.80	30.80	131.60	175.00
NFL	27-Oct-88	NF2	1400	6.30	86.5	0.002	0.021	0.180	9.0	2.80	2.80	29.40	53.20	252.00
NFL	11-Aug-87	X2	1400	7.74		0.005	0.050		11	6.86		70		
NFL	08-Sep-87	X2	1400	7.61		0.005	0.040		7	6.86		56		
NFL	06-Oct-87	X2	1400	8.21		0.005	0.060		14	6.86		84		
NFL	10-Nov-87	X2	1400	7.39		0.005	0.050		15	6.86		70		
NFL	09-Dec-87	X2	1400	7.30		0.005	0.020		19	6.86		28		
NFL	27-Jan-88	X2	1400	7.08		0.003	0.045		9	4.2		63		
NFL	17-Feb-88	X2	1400	7.08		0.004	0.036		16	5.6		50.4		
NFL	24-Mar-88	X2	1400	7.11		0.002	0.035		12	2.66		49		
NFL	25-Apr-88	X2	1400	7.10	98.6	0.006	0.150		18	8.4		210		
NFL	25-May-88	X2	1400	7.51	46.2	0.003	0.017		6	4.2		23.8		
NFL	07-Jun-88	X2	1400	7.50	34.7	0.002	0.015		374	2.8		21		
NFL	11-Jul-88	X2	1400	7.84	55.1	0.002	0.027		3	2.8		37.8		
NFL	16-Aug-88	X2	1400	7.58	75.6	0.002	0.013		6	2.66		18.2		
NFL	13-Sep-88	X2	1400	7.70	72.3	0.002	0.025		10	2.8		35		
NFL	06-Oct-88	X2	1400	6.60	765.0	0.003	0.082	0.730	3	4.2		114.8		1022
NFL	01-Nov-88	X2	1400	7.10	87.0	0.002	0.021		7	2.66		29.4		
NFL	30-Nov-88	X2	1400	6.74	99.0	0.002	0.022	0.145	7	2.66		30.8		203

FIGURE 4-22: NF-NORTH FORK
SITE X2: ZINC CONCENTRATION



The six seep surveys conducted in 1987 and 1988 were designed to characterize the Faro mine site in terms of water flow and water quality. Seasonal water quality variations, and background water quality levels were investigated in this process. Section 4.0 details the survey results. Figure 5-1 provides a summary or overview of the metal loading in major flows for the mine site.

Five separate areas of the mine site were characterized by the seep surveys. Results of the Faro Creek area (FCA) and the North Fork area (NF) indicate background water quality representative of the pre-mining water quality in the Faro area. Results of the two pit areas (MP and SP) and the waste rock dump areas (W) represent the current water quality of the mining area. Existing mine water quality can be evaluated by a comparison with background water and with existing water quality standards. The water quality data base also provides a basis for identifying and evaluating changes in mine discharge water quality.

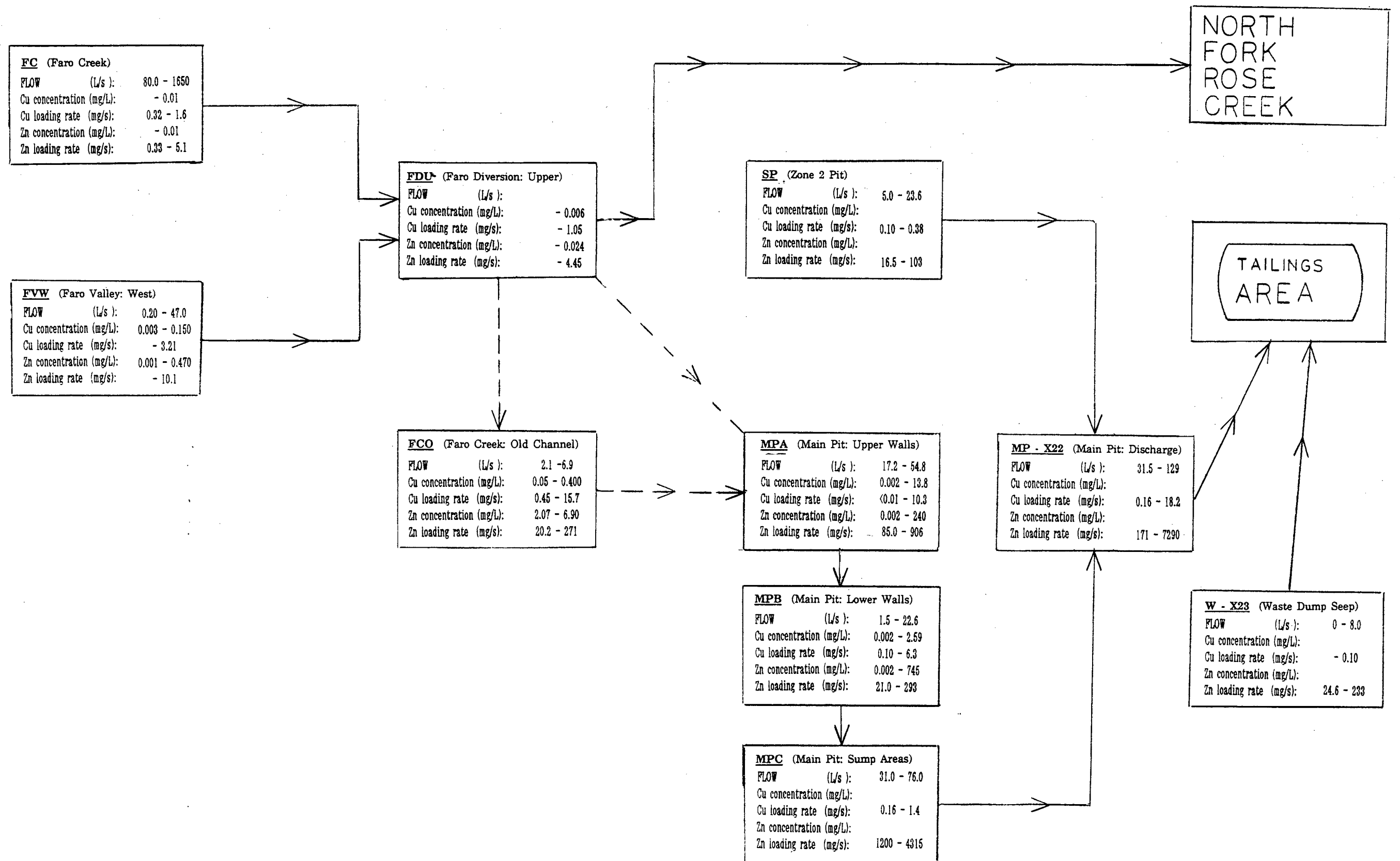
Background water quality levels in the Faro area are well within existing environmental effluent standards for the mine site. The effluent standard for zinc is 0.50 mg/L and for copper is 0.20 mg/L. The zinc standard for receiving waters is 0.05 mg/L of zinc. The background water flow and water quality, as summarized in Figure 5-1, can be characterized as follows:

- peak discharges occur in late May to early June;
- the pH ranges from 6.30 to 8.05;
- the total copper concentration ranges from <0.001 to 0.014 mg/L;
- the total zinc concentration ranges from 0.002 to 0.150 mg/L.

The quality of discharge from the mining areas (MP, SP, and W) is summarized in Figure 5-1. As discussed in Section 4.0, the pH of water within these areas generally ranged from 5.9 to 8.2. This range, similar to the background pH range, is not indicative of acid mine drainage. Several exceptions were noted, though. Seep A20 located in the lower pit wall zone MPB3, seep 11 and seep 31 in the Zone 2 pit area (SP), and pond 2 located at the toe of waste dump WIE had pH values ranging from 2.65 to 3.65. Relative to the number of sites sampled during the surveys, the sites with low pH values were not numerous and probably indicate localized areas of acid generation.

Should future surveys indicate an increase in the number of sites with depressed pH values, this would be indicative of increasing acid generation and the potential for deteriorating discharge water quality in the Faro mining area.

FIGURE 5-1: FLOW AND METAL LOADING SCHEMATIC - FARO MINE SITE



Metal concentrations and metal loading rates in the mining areas, as noted in Figure 5-1, are higher than background levels. Table 5-1, below, presents a summary of effect on water quality that the discharge from the various mine areas could have on concentrations in the adjacent creeks if they were allowed to discharge directly into these creeks. This procedure provides a basis to compare the water quality of the mining areas to background water quality, and to evaluate the effects that mining might have on water quality in the Faro area if remedial actions were not taken as part of the reclamation and abandonment plan.

Table 5-1: EFFECTS OF MINE DISCHARGE ON BACKGROUND WATER QUALITY

AREA	FLOW	EQUIVALENT ZINC CONCENTRATION IN FARO CRK. (mg/L)	EQUIVALENT ZINC CONCENTRATION IN NF ROSE CRK. (mg/L)	EQUIVALENT COPPER CONCENTRATION IN FARO CRK. (mg/L)	EQUIVALENT COPPER CONCENTRATION IN NF ROSE CRK. (mg/L)
FCO	LOW	0.25 - 3.4	0.01 - 0.19	<0.01 - 0.20	<0.01 - 0.01
	HIGH	0.01 - 0.16	0.01 - 0.04	<0.01 - 0.01	<0.01 - < 0.01
MPA	LOW	1.1 - 11	0.06 - 0.65	<0.01 - 0.13	<0.01 - <0.01
	HIGH	0.05 - 0.55	0.01 - 0.13	<0.01 - <0.01	<0.01 - <0.01
MPB	LOW	0.26 - 3.7	0.02 - 0.21	<0.01 - 0.08	<0.01 - 0.01
	HIGH	0.01 - 0.18	<0.01 - 0.04	<0.01 - <0.01	<0.01 - <0.01
MPC1	LOW	15.0 - 53.9	0.86 - 3.1	<0.01 - <0.01	<0.01 - <0.01
	HIGH	0.73 - 2.6	0.17 - 0.61	<0.01 - <0.01	<0.01 - <0.01
SP	LOW	0.21 - 1.3	0.01 - 0.07	<0.01 - 0.01	<0.01 - <0.01
	HIGH	0.01 - 0.06	<0.01 - 0.02	<0.01 - <0.01	<0.01 - <0.01
W(X23)	LOW	0.31 - 2.9	0.02 - 0.17	<0.01 - <0.01	<0.01 - <0.01
	HIGH	0.02 - 0.14	<0.01 - 0.03	<0.01 - <0.01	<0.01 - <0.01
*LOW	Low flow for Faro Creek = 80 L/s. Low flow for North Fork Rose Creek = 1400 L/s.				
**HIGH	High flow for Faro Creek = 1650 L/s. High flow for North Fork Rose Creek = 7000 L/s.				

Several conclusions can be drawn from the results presented in Table 5-1. Zinc concentration of Faro Creek diversion (FDU) would exceed the effluent limit of 0.50 mg/L of zinc where one or more of the following conditions occurred:

- old Faro Creek (FCO) water was discharged into the diversion during periods of low diversion flow; and zinc loading rates in old Faro Creek water were in the upper portion of its range of 20.2 to 271 mg/s. (Low flows occur in early spring, late fall and winter).

- upper main pit wall water (MPA) was discharged into the diversion during periods of low diversion flow.
- upper main pit wall water (MPA) was discharged into the diversion during periods of high diversion flow; and zinc loading rates in the upper pit wall water were in the upper portion of its range of 85 to 906 mg/s.
- lower pit wall water (MPB) was discharged into the diversion during periods of low diversion flow; and zinc loading rates in lower pit wall water were in the upper portion of its range from 21 to 293 mg/s.
- at any time sump water (MPC) was discharged into the diversion.
- Zone 2 (SP) water was discharged into the diversion during periods of low diversion flow; and zinc loading rates were in the upper portion of its range of 17 to 103 mg/s.

The zinc concentrations of North Fork Rose Creek (NF) would exceed the effluent limit of 0.50 mg/L of zinc where the following conditions are satisfied:

- upper pit wall water (MPA) was discharged into the creek during periods of low creek flow; and zinc loading rates in upper pit wall water were in the upper portion of its range from 85 to 906 mg/s.
- pit sump water (MPC) was discharged into the creek during periods of low creek flow.
- pit sump water (MPC) was discharged into the creek during periods of high creek flow; and zinc loading rates were in the upper portion of its range from 1198 to 4313 mg/s.

The seep survey results, as concluded above, indicate that water from the main pit could not be discharged into a creek the size of North Fork Rose Creek without increasing the creek zinc levels above the effluent standard of 0.50 mg/L. Currently, pit water is discharged to the tailings impoundment area and excess lime in the concentrator tailings discharge is sufficient to depress the elevated zinc concentrations.

At abandonment, the water cover should effectively stop the significant zinc loading presently occurring in the pit bottom and sump area (MPC). Loadings from the upper pit wall and part of the lower pit wall will continue, but water controls should reduce present loading rates. Conclusions drawn from Table 5-1, indicate that under current zinc loading conditions in these areas, this water could not be discharged into North Fork Rose Creek throughout the year. Water treatment would be necessary at least during those periods of low flow in the creek and during periods when zinc

loading rates in the upper pit wall area (MPA) were in the upper portion of its range of 85 to 906 mg/s.

Results also indicate that discharge from the Zone 2 pit (SP) and the waste rock dumps (W:X23) must be treated periodically throughout the year. At present, these discharges also go to the tailings area where excess lime is available for depression of zinc concentrations.

The timing between peak zinc loading rates and low flow rates is critical. The survey results indicate that ditch and creek flows peak in late May to early June, and low flows are common in early spring, late fall and winter. Peak zinc loading was evident in rock wall seeps during early April to May; peak loading occurred later in the season for discharges originating from rock waste dumps or from fluvial deposits. For example, Zone MPA 2 displayed peak zinc loading in April, 1988; Zone MPA6 displayed peak zinc loading in May, 1988, and Zone MPA8 displayed peak loading in October, 1988. MPA2 is a rock wall area; MPA6 is a rock wall area overlain by fluvial deposits and a waste rock dump; and MPA8 is a rock wall area recharged from the Faro Creek diversion canal. Peak zinc loadings in Zone 2 (SP:WSP1) occurred in August. The recharge area for these seeps is a waste rock dump. Without other mitigation or control measures, the combinations of high zinc loading rates and low creek discharges could dictate water treatment on abandonment. The alternative of storing zinc contaminated water during low creek flow periods and increasing releases during high creek flow periods have not been fully evaluated to determine if such discharge management will avoid the need for treatment.






Further, results indicate that Zone MPA6 is the major zinc loading source within the upper wall area. Zinc loading rates range from 85 to 906 mg/s, and this zone contributed over 50 percent of the upper pit wall zinc loading for all survey periods. The source of this zinc is considered to originate from the waste rock dump (WFV) immediately above this zone. Water seeping through the diversion dike enters the rock dump, and emerges downslope in Zone MPA6. The need for a water control system is indicated and will be implemented at abandonment. Such a system may reduce zinc loading levels from the upper pit walls sufficiently to facilitate discharge to North Fork Rose Creek without water treatment. This would assume that present loadings from all the areas of the pit remain relatively constant in the future.

The seep surveys, to date, have provided sufficient information to characterize the background water and mine water in the Faro area. Results have indicated seasonal variations in metal loading rates and have indicated the relative water quality of the pit and waste dump areas relative to background quality. Of further note is the observation that total metal loading sources during peak periods do not appear to be additive. An example was provided in section 4.0. with Faro Creek, the collector ditch (FVW) recharge the Faro Creek diversion (FDU). Average source loadings equal the Faro Creek diversion (FDU) loading rate. However, at peak loading rates, the Faro Creek diversion rate was much lower than the sum of its source loadings. This process could be critical in evaluating and

predicting water quality in the Faro area. The relationship should be investigated further as more seep survey data becomes available. A clear relationship is not evident from existing data.

FIGURE 3-1: SAMPLE AREAS and SAMPLE SITES

LEGEND

-  F... : FARO CREEK AREA
-  MP.. : MAIN PIT (Zone I/III)
-  SP.. : SECOND PIT (Zone II)
-  W... : WASTE DUMPS
-  NF.. : NORTH FORK ROSE CREEK

