DEPARTMENT OF THE ENVIRONMENT
ENVIRONMENTAL PROTECTION SERVICE
PACIFIC REGION

YAKOUN RIVER, TRIBUTARY STREAMS AND MAMIN RIVER DATA REPORT ON WATER QUALITY SAMPLES COLLECTED BY THE ENVIRONMENTAL PROTECTION SERVICE NOVEMBER 1983 AND FEBRUARY 1984

Regional Program Report No. 85-13

By

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ABSTRACT

Water quality samples were collected from seven streams in the area of a proposed gold mine development on Graham Island, Queen Charlotte Islands. Surveys were conducted in November 1983 and February 1984. Intragravel as well as surface water samples were collected at four of the stations.

RÉSUMÉ

Des échantillons de la qualité des eaux furent collectés dans sept rivières de la région d'un projet de dévelopment minier aurifère sun l'ile Graham dans les iles de la Reine Charlotte. Les études furent conduites en novembre 1983 et févier 1984. Les eaux intersticielles du granier et de surface furent collectées à quatre des stations.

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SUMMARY AND CONCLUSIONS

Surface water samples were collected in November 1983 and February, 1984 adjacent to the proposed Consolidated Cinola gold mine property on Graham Island. The results will serve as part of a data base developed by EPS to determine the background quality and sensitivity of these streams prior to any development.

Triplicate samples were collected to help assess spatial variability. Intragravel samples were collected to assess the quality of water within the substrate at four of the seven stations.

1 INTRODUCTION

As part of a pre-development monitoring program the Environmental Protection Service (EPS) of Environment Canada conducted water quality studies in streams adjacent to the proposed Consolidated Cinola gold mine property (Fanning and Griffing 1980). The mine site is located within the Yakoun River drainage on Graham Island (Queen Charlotte Islands).

Earlier water quality studies were conducted by EPS in 1981/82 (Derksen 1983). This report presents data collected during the November 2/3, 1983 and February 29, 1984 surveys. A method of obtaining intragravel water samples was tested at three stations in November and four stations in February.

2 DESCRIPTION OF STUDY AREA

The area surveyed included the Yakoun River and tributary streams associated with the proposed Cinola development as well as the Mamin River and Gold Creek (Figure 1).

The sample stations used by EPS in 1981/82 (Derksen 1983) and retained in 1983/84 included the Yakoun River (Station 2) downstream of Barbie Creek, Barbie Creek (Station 4), Canoe Creek (Station 5), and Florence Creek (Station 6). Additional stations sampled in 1983/84 included the Mamin River (Station 7), Gold Creek (Station 8) and an unnamed tributary (Station 9) draining the region of the proposed waste rock dump. The stations are described in Table 1.

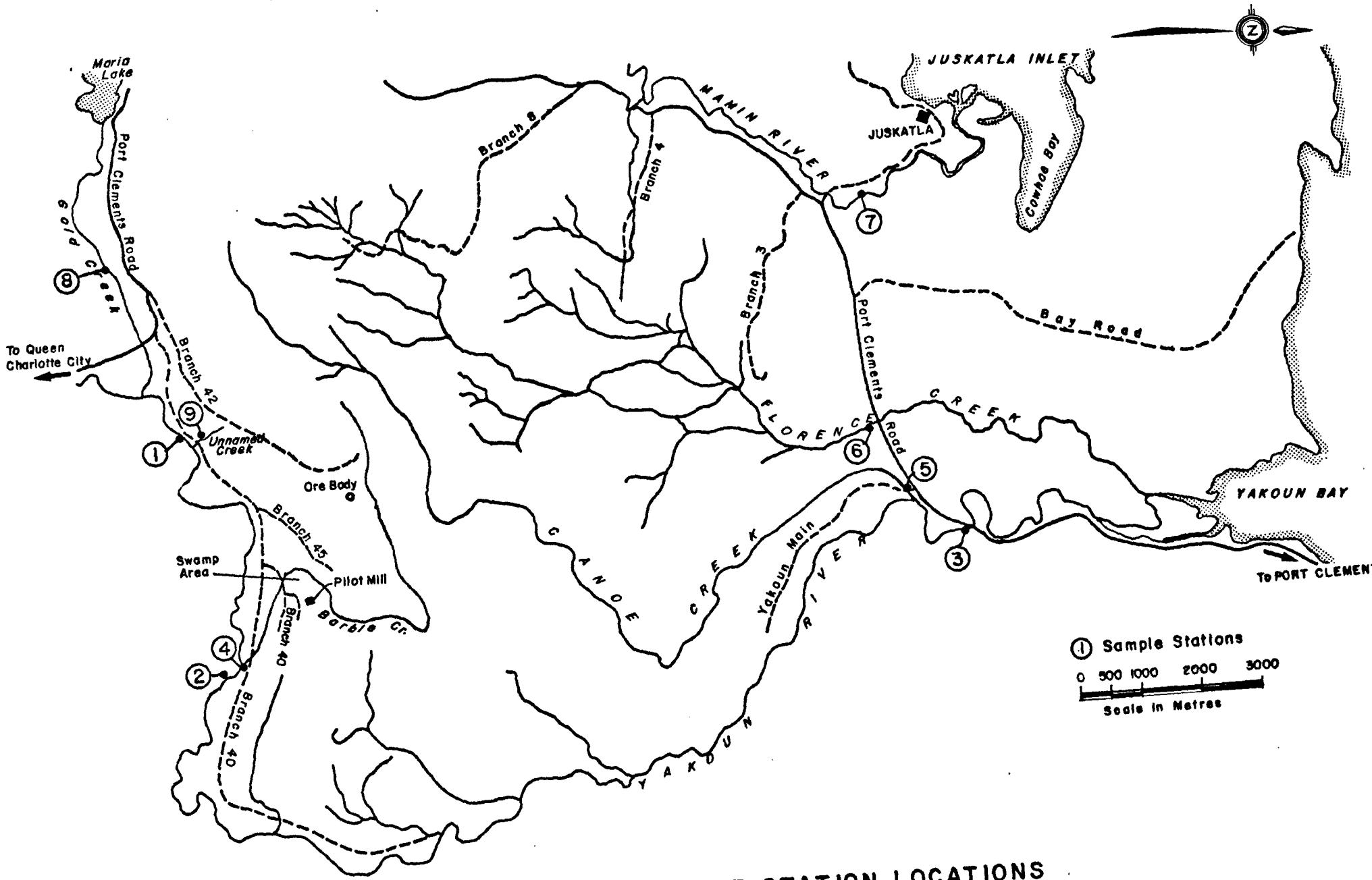

FIGURE 1 YAKOUN RIVER AND EPS SAMPLE STATION LOCATIONS

TABLE 1 DESCRIPTION OF SAMPLE STATIONS

RIVER/CREEK (year sampled)	STATION NUMBER*	DESCRIPTION
Yakoun River (1981/82)	1	Located approximately 1.3 km downstream of Gold Creek confluence on the north side. Access at a turnoff on Branch 40. The turnoff is located 1.2 km west of the Branch 40/Branch 47 junction.
(1981/82) (1983/84)	2	Located approximately 0.6 km downstream of Barbie Creek on the north side. Access at turnoff on Branch 40. The turnoff is located 0.5 km west of where Barbie Creek flows under Branch 40.
(1981/82)	3	Located approximately 40 m upstream of Main Line road bridge over lower Yakoun River. On west side downstream of logs chained across the river.
Barbie Creek (1981/82) (1983/84)	4	Located half-way between Branch 40 road and the Yakoun River confluence.
Canoe Creek (1981/82) (1983/84)	5	Located on upstream side of Yakoun logging road bridge crossing lower Canoe Creek.
Florence Creek (1981/82) (1983/84)	6	Located on upstream side of Main Line road bridge crossing Florence Creek.
Mamin River (1983/84)	7	Located at end of turnoff which was approximately 1.0 km from Juskatla turnoff.
Gold Creek (1983/84)	8	Located approximately 2.0 km upstream of Yakoun River confluence.
Unnamed Tributary (1983/84)	9	Tributary located just downstream of Yakoun Station 1. Sampled on upstream side of Branch 40 road.

*(See Figure 1)

3 MATERIALS AND METHODS

3.1 Water Samples

3.1.1 Surface Water. Triplicate water samples were collected sequentially at each station for: dissolved oxygen; pH (field and laboratory); total alkalinity, total acidity; conductivity; non-filterable residue (NFR); sulfate; chloride; nitrite plus nitrate and ammonia ($NH_3 + NH_4^+$). A single sample was collected for total phosphate and total dissolved phosphate. The total phosphate sample was collected in a clean 50 ml graduated cylinder and then poured into a 50 ml glass Sovril bottle. For total dissolved phosphate, a 50 ml sample was filtered through a distilled water rinsed 0.45 u cellulose acetate membrane filter. Dissolved oxygen samples were fixed with 2 ml each of manganese sulfate and alkali-iodide azide reagents. All samples were kept cool while in transit and where analyzed by methods used at the DOE/DFO laboratory in West Vancouver (Anon 1979, Appendix I).

Field pH was measured with a Metroholm Model E588 pH meter and temperature was determined with a pocket thermometer.

Triplicate samples were collected at each station for mercury and heavy metal analysis. Mercury samples were preserved with nitric- dichromate acid (5 ml acid per 100 ml sample). Metal samples were acidified with nitric acid to pH 1.5. Dissolved mercury and dissolved metal samples were filtered through 0.45 u cellulose nitrate membrane filters. Samples were analyzed at the DOE/DFO laboratory in West Vancouver (Appendix I).

3.1.2 Intragravel Water. Triplicate water samples were collected at Stations 2, 4, and 8 in November and February and as well at Station 6 in February. A stainless steel standpipe (59 cm long, 2.6 cm ID) and Maruyama model HP-06WE syphon hand pump were used (Plates 1 and 2).

A large plastic garbage bag 76 cm by 1.22 m was weighted down with rocks to isolate a section of substrate. The standpipe was then

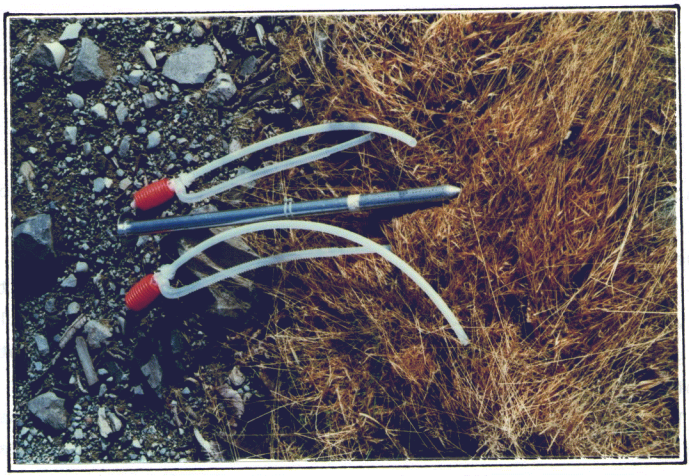

PLATE 1 - STAINLESS STEEL STANDPIPE AND SYPHON PUMP

PLATE 2 - SAMPLING
BARBIE CREEK

pushed through the middle of the bag into the substrate to a depth of 20-25 cm (depth of salmon egg deposition). The standpipe was pumped until a clear sample was obtained and then the sample bottles were filled and treated per the surface samples. Samples were not collected for phosphate analysis and only dissolved metal samples were collected.

A new precleaned pump was used at each station. The pump was cleaned by dismantling it and removing any loose plastic material with a Kimwipe tissue. The pump was then rinsed with 0.5% nitirc acid followed by four rinses with distilled water. A 78 cm long piece of polyethylene tubing (15 mm ID) was attached to the pump to reach the bottom of the standpipe. The tubing was cleaned per the pump. The pumps and tubing were stored in large clean polyethylene bags until used.

4 RESULTS AND DISCUSSION

4.1 Inorganics (excluding metals) and Temperature

The results for the surface and intragravel samples are reported in Appendix II (a to n) and summarized in Tables 2 to 4.

The reader can refer to Appendix III to compare results with values recommended for salmonid hatchery water supplies. The reader is referred to Sigma 1983 for a complete discussion on the use and development of the recommended levels.

4.2 Total and Dissolved Metals

The results for the surface and intragravel samples are reported alphabetically in Appendix IV (a-f) and Al, As, Cd, Cu, Fe, Pb, Mn, Hg, and Zn are summarized in Tables 5 to 9. The reader can refer to Appendix III and V to compare results with values recommended for hatchery water supplies (Sigma 1983) and values recommended by Environment Canada (Inland Waters Directorate) as surface water quality objectives for aquatic life (Reeder 1979).

4.3 Unusual Results

Some level of variability in water quality parameters is to be expected. However, in some cases individual values occur that are unexplainably high and are considered to be outliers. Results that seem to fall into this category are the dissolved copper concentation of 10 ug/l when total and other dissolved copper values were < 1 ug/l (Appendix IV(i), Station 2) and possibly the dissolved copper concentration of 3 ug/l when total and other dissolved copper values were < 1 ug/l (Appendix IV(i), Station 9). Those single high values account for the higher mean values reported for dissolved copper at those stations in Table 6. Other unusual results are the detectable levels of dissolved copper (2-3 ug/l) but below detectable levels of total copper at Station 8 in November (Appendix IV (i)). For Barbie Creek (Station 4), in both November and February the dissolved zinc fraction was either as high or higher than the total values (Appendix IV(t)).

TABLE 2 SUMMARY TABLE FOR TEMPERATURE, DISSOLVED OXYGEN, PERCENT SATURATION AND pH

PARAMETER	NOVEMBER 1983		FEBRUARY 1984	
	SURFACE	INTRAGRAVEL	SURFACE	INTRAGRAVEL
	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)
Temperature* (°C)				
Yakoun River (Station 2)	6.5	6.5	4.0	4.0
Barbie Creek (Station 4)	6.9	6.9	4.0	4.0
Canoe Creek (Station 5)	6.0		4.0	
Florence Creek (Station 6)	6.0	-	4.0	4.0
Mamin River (Station 7)	6.0		4.0	
Gold Creek (Station 8)	6.2	6.5	4.0	4.0
Unnamed Tributary (Station 9)	6.2		4.5	
Dissolved Oxygen (mg/l)				
Yakoun River (Station 2)	10.4 (.1)	8.6 (.1)	11.4 (.1)	11.0 (.3)
Barbie Creek (Station 4)	8.9 (.2)	8.7 (.4)	10.2 (.1)	9.8 (.4)
Canoe Creek (Station 5)	10.1 (.3)		11.1 (.2)	
Florence Creek (Station 6)	9.7 (0)	-	10.9 (.2)	10.1 (.1)
Mamin River (Station 7)	10.7 (.1)		11.5 (.1)	
Gold Creek (Station 8)	10.4 (.1)	10.4 (.2)	11.2 (.3)	11.2 (.2)
Unnamed Tributary (Station 9)	10.6 (.1)		11.3 (.2)	
% Saturation (%)				
Yakoun River (Station 2)	87.0 (1.0)	72.5 (.5)	90.0 (.4)	86.3 (2.3)
Barbie Creek (Station 4)	75.1 (1.8)	74.0 (3.5)	80.0 (.5)	77.2 (2.8)
Canoe Creek (Station 5)	84.0 (2.6)		87.1 (1.2)	
Florence Creek (Station 6)	80.4 (0)	-	85.8 (1.6)	79.2 (.5)
Mamin River (Station 7)	89.0 (.9)		90.8 (.5)	
Gold Creek (Station 8)	86.4 (1)	87.2 (1.4)	88.2 (2.8)	88.5 (1.2)
Unnamed Tributary (Station 9)	88.0 (.5)		90.2 (1.3)	

* single value

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TABLE 2 SUMMARY TABLE FOR TEMPERATURE, DISSOLVED OXYGEN, PERCENT SATURATION AND pH (Continued)

PARAMETER	NOVEMBER 1983		FEBRUARY 1984	
	SURFACE	INTRAGRAVEL	SURFACE	INTRAGRAVEL
	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)
pH** (field)				
Yakoun River (Station 2)	6.5	6.4	6.0	5.9 - 6.1
Barbie Creek (Station 4)	5.1	5.1	5.0 - 5.1	5.0 - 5.1
Canoe Creek (Station 5)	4.9		4.5 - 4.6	
Florence Creek (Station 6)	5.3 - 5.4	-	5.1	5.1
Mamin River (Station 7)	6.4		5.9 - 6.0	
Gold Creek (Station 8)	6.5 - 6.6	6.5 - 6.6	5.7	5.8 - 5.9
Unnamed Tributary (Station 9)	5.9		5.9	
pH** (lab)				
Yakoun River (Station 2)	6.3 - 6.4	6.3 - 6.4	6.3	6.3
Barbie Creek (Station 4)	4.8 - 4.9	4.8 - 4.9	5.2 - 5.3	5.3
Canoe Creek (Station 5)	4.5 - 4.6		4.8 - 4.9	
Florence Creek (Station 6)	5.0 - 5.1	-	5.4 - 5.5	5.5
Mamin River (Station 7)	6.1 - 6.2		6.2	
Gold Creek (Station 8)	6.4	6.4	6.3 - 6.4	6.3
Unnamed Tributary (Station 9)	5.6		5.9 - 6.0	

** range of values

TABLE 3 SUMMARY TABLE FOR TOTAL HARDNESS, TOTAL ALKALINITY, TOTAL ACIDITY, CONDUCTIVITY, AND NON-FILTERABLE RESIDUE

PARAMETER	NOVEMBER 1983		FEBRUARY 1984	
	SURFACE	INTRAGRAVEL	SURFACE	INTRAGRAVEL
	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)
Hardness (as mg/l $CaCO_3$)				
Yakoun River (Station 2)	12.7 (.2)	15.4 (.4)	10.5 (0)	10.2 (.2)
Barbie Creek (Station 4)	14.0 (.2)	13.7 (.1)	11.5 (.1)	11.7 (.1)
Canoe Creek (Station 5)	9.49 (.03)		7.51 (.21)	
Florence Creek (Station 6)	10.8 (.1)	-	9.04 (.10)	9.23 (.22)
Mamin River (Station 7)	10.3 (.1)		8.10 (.10)	
Gold Creek (Station 8)	12.1 (.1)	12.1 (.2)	10.7 (.1)	10.4 (.1)
Unnamed Tributary (Station 9)	10.6 (.1)		9.65 (.14)	
Total Alkalinity (as mg/l $CaCO_3$)				
Yakoun River (Station 2)	7 (1)	10 (0)	6.3 (.3)	6 (0)
Barbie Creek (Station 4)	nil (0)	nil (0)	< 1 (0)	< 1 (0)
Canoe Creek (Station 5)	nil (0)		nil (0)	
Florence Creek (Station 6)	nil (0)	-	1 (0)	1 (0)
Mamin River (Station 7)	5 (0)		4.3 (.3)	
Gold Creek (Station 8)	6 (1)	7 (1)	6 (0)	5 (0)
Unnamed Tributary (Station 9)	1.5 (0)		2 (0)	
Total Acidity (as mg/l $CaCO_3$)				
Yakoun River (Station 2)	4 (1)	6 (2)	3.8 (.3)	5 (1)
Barbie Creek (Station 4)	13 (0)	14 (4)	9 (1)	10 (0)
Canoe Creek (Station 5)	12 (1)		8 (1)	
Florence Creek (Station 6)	11 (0)	-	6 (1)	9 (1)
Mamin River (Station 7)	4 (1)		4 (0)	
Gold Creek (Station 8)	4 (1)	4 (1)	4 (2)	5 (1)
Unnamed Tributary (Station 9)	6 (0)		4 (0)	

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TABLE 3 SUMMARY TABLE FOR TOTAL HARDNESS, TOTAL ALKALINITY, TOTAL ACIDITY, CONDUCTIVITY, AND NON-FILTERABLE RESIDUE

(Continued)

PARAMETER	NOVEMBER 1983		FEBRUARY 1984	
	SURFACE	INTRAGRAVEL	SURFACE	INTRAGRAVEL
	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)
Conductivity (umhos/cm)				
Yakoun River (Station 2)	39.6 (.1)	48.1 (.1)	32.8 (0)	35.6 (.2)
Barbie Creek (Station 4)	46.5 (.3)	46.1 (.1)	41.1 (0)	45.4 (.1)
Canoe Creek (Station 5)	36.6 (.1)		31.9 (.1)	
Florence Creek (Station 6)	34.4 (0)	-	33.0 (1.9)	34.6 (.1)
Mamin River (Station 7)	34.1 (.1)		31.1 (.1)	
Gold Creek (Station 8)	37.9 (.1)	38.2 (.5)	36.0 (0)	35.9 (.3)
Unnamed Tributary (Station 9)	37.0 (.2)		39.1 (.2)	
Non-Filterable Residue (mg/l)				
Yakoun River (Station 2)	≤ 5 (0)	-	< 5 (0)	-
Barbie Creek (Station 4)	5 (1)	-	< 5 (0)	-
Canoe Creek (Station 5)	6 (1)		< 5 (0)	
Florence Creek (Station 6)	6 (1)	-	< 5 (0)	-
Mamin River (Station 7)	6 (1)		6 (1)	
Gold Creek (Station 8)	≤ 5 (0)	-	< 5 (0)	-
Unnamed Tributary (Station 9)	≤ 5 (0)		5 (1)	

TABLE 4 SUMMARY TABLE FOR SULFATE, CHLORIDE, NITRITE PLUS NITRATE, AMMONIA, TOTAL PHOSPHATE AND TOTAL DISSOLVED PHOSPHATE

PARAMETER	NOVEMBER 1983		FEBRUARY 1984	
	SURFACE	INTRAGRAVEL	SURFACE	INTRAGRAVEL
	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)
Sulfate (mg/l)				
Yakoun River (Station 2)	5.8 (.8)	5.2 (.2)	2.7 (.1)	3.2 (.2)
Barbie Creek (Station 4)	10.2 (.5)	10.3 (1.2)	6.1 (.1)	7.9 (.3)
Canoe Creek (Station 5)	7.5 (.6)		3.8 (.1)	
Florence Creek (Station 6)	7.4 (.8)	-	3.8 (.1)	5.5 (.2)
Mamin River (Station 7)	5.2 (.5)		2.2 (.1)	
Gold Creek (Station 8)	5.7 (1.2)	5.8 (.3)	2.5 (.1)	3.4 (.1)
Unnamed Tributary (Station 9)	7.2 (.6)		4.0 (.2)	
Chloride (mg/l)				
Yakoun River (Station 2)	5.1 (.1)	5.9 (.1)	4.2 (.1)	4.3 (.1)
Barbie Creek (Station 4)	7.0 (.1)	7.4 (.1)	7.1 (.1)	7.5 (.1)
Canoe Creek (Station 5)	7.1 (0)		6.8 (0)	
Florence Creek (Station 6)	6.7 (.1)	-	4.7 (1.5)	6.6 (.1)
Mamin River (Station 7)	5.7 (0)		2.2 (.1)	
Gold Creek (Station 8)	5.4 (.1)	5.5 (.1)	2.5 (.1)	4.4 (.2)
Unnamed Tributary (Station 9)	6.8 (.1)		4.0 (.2)	
Nitrite plus Nitrate (ug/l)				
Yakoun River (Station 2)	23 (6)	50 (0)	37 (12)	43 (6)
Barbie Creek (Station 4)	< 10 (0)	10 (0)	30 (26)	40 (10)
Canoe Creek (Station 5)	< 10 (0)		20 (10)	
Florence Creek (Station 6)	< 10 (0)	-	10 (0)	37 (6)
Mamin River (Station 7)	10 (0)		30 (10)	
Gold Creek (Station 8)	30 (0)	30 (0)	60 (0)	60 (0)
Unnamed Tributary (Station 9)	< 10 (0)		13 (15)	

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TABLE 4 SUMMARY TABLE FOR SULFATE, CHLORIDE, NITRITE PLUS NITRATE, AMMONIA, TOTAL PHOSPHATE AND TOTAL DISSOLVED PHOSPHATE

(Continued)

PARAMETER	NOVEMBER 1983				FEBRUARY 1984			
	SURFACE		INTRAGRAVEL		SURFACE		INTRAGRAVEL	
	$\bar{x}$	(S.D.)	$\bar{x}$	(S.D.)	$\bar{x}$	(S.D.)	$\bar{x}$	(S.D.)
Ammonia ($NH_3 + NH_4^+$) (ug/l)								
Yakoun River (Station 2)	7	(0)	14	(2)	< 5	(0)	< 5	(0)
Barbie Creek (Station 4)	15	(0)	16	(0)	10	(2)	11	(2)
Canoe Creek (Station 5)	18	(0)			12	(1)		
Florence Creek (Station 6)	17	(1)	-		10	(1)	15	(2)
Mamin River (Station 7)	8	(0)			≤ 5	(0)		
Gold Creek (Station 8)	9	(0)	11	(1)	6	(1)	5	(1)
Unnamed Tributary (Station 9)	12	(0)			7	(0)		
Total Phosphate* (ug/l)								
Yakoun River (Station 2)	12				-			
Barbie Creek (Station 4)	23				13			
Canoe Creek (Station 5)	22				14			
Florence Creek (Station 6)	24				14			
Mamin River (Station 7)	16				14			
Gold Creek (Station 8)	11				11			
Unnamed Tributary (Station 9)	15				11			
Total Dissolved Phosphate* (ug/l)								
Yakoun River (Station 2)	12				-			
Barbie Creek (Station 4)	19				11			
Canoe Creek (Station 5)	17				-			
Florence Creek (Station 6)	19				12			
Mamin River (Station 7)	11				-			
Gold Creek (Station 8)	9				7			
Unnamed Tributary (Station 9)	12				-			

* single value

TABLE 5 SUMMARY TABLE FOR TOTAL AND DISSOLVED ALUMINIUM AND ARSENIC

PARAMETER	NOVEMBER 1983		FEBRUARY 1984	
	SURFACE	INTRAGRAVEL	SURFACE	INTRAGRAVEL
	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)
Total Aluminium (mg/l)				
Yakoun River (Station 2)	.42 (.03)		.28 (.04)	
Barbie Creek (Station 4)	.63 (.05)		.32 (.01)	
Canoe Creek (Station 5)	.67 (0)		.44 (.02)	
Florence Creek (Station 6)	.61 (.01)		.43 (.01)	
Mamin River (Station 7)	.39 (0)		.25 (.01)	
Gold Creek (Station 8)	.28 (.02)		.31 (.01)	
Unnamed Tributary (Station 9)	.47 (.01)		.37 (.04)	
Dissolved Aluminum (mg/l)				
Yakoun River (Station 2)	.16 (.01)	.15 (0)	.12 (.01)	.13 (.01)
Barbie Creek (Station 4)	.54 (.03)	.52 (.01)	.32 (.01)	.32 (.01)
Canoe Creek (Station 5)	.51 (.01)		.34 (.01)	
Florence Creek (Station 6)	.49 (.01)	-	.34 (.01)	.36 (.01)
Mamin River (Station 7)	.25 (.01)		.16 (0)	
Gold Creek (Station 8)	.19 (.01)	.20 (.01)	.16 (.01)	.15 (.01)
Unnamed Tributary (Station 9)	.40 (.01)		.25 (.01)	
Total Arsenic (ug/l)				
Yakoun River (Station 2)	< .5 (0)		< .5 (0)	
Barbie Creek (Station 4)	1.2 (.06)		1.1 (.1)	
Canoe Creek (Station 5)	< .5 (0)		< .5 (0)	
Florence Creek (Station 6)	< .5 (0)		< .5 (0)	
Mamin River (Station 7)	< .5 (0)		< .5 (0)	
Gold Creek (Station 8)	< .5 (0)		< .5 (0)	
Unnamed Tributary (Station 9)	< .5 (0)		< .5 (0)	
Dissolved Arsenic (ug/l)				
Yakoun River (Station 2)	< .5 (0)	< .5 (0)	< .5 (0)	< .5 (0)
Barbie Creek (Station 4)	.9 (0)	.8 (.2)	.7 (.1)	.7 (.1)
Canoe Creek (Station 5)	< .5 (0)		< .5 (0)	
Florence Creek (Station 6)	< .5 (0)	-	< .5 (0)	< .5 (0)
Mamin River (Station 7)	< .5 (0)		< .5 (0)	
Gold Creek (Station 8)	< .5 (0)	< .5 (0)	< .5 (0)	< .5 (0)
Unnamed Tributary (Station 9)	< .5 (0)		< .5 (0)	

TABLE 6 SUMMARY TABLE FOR TOTAL AND DISSOLVED CADMIUM AND COPPER

PARAMETER	NOVEMBER 1983		FEBRUARY 1984	
	SURFACE	INTRAGRAVEL	SURFACE	INTRAGRAVEL
	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)
Total Cadmium (ug/l)				
Yakoun River (Station 2)	< .5 (0)		< .5 (0)	
Barbie Creek (Station 4)	< .5 (0)		< .5 (0)	
Canoe Creek (Station 5)	< .5 (0)		< .5 (0)	
Florence Creek (Station 6)	< .5 (0)		< .5 (0)	
Mamin River (Station 7)	< .5 (0)		< .5 (0)	
Gold Creek (Station 8)	< .5 (0)		< .5 (0)	
Unnamed Tributary (Station 9)	< .5 (0)		< .5 (0)	
Dissolved Cadmium (ug/l)				
Yakoun River (Station 2)	< .5 (0)	< .5 (0)	< .5 (0)	< .5 (0)
Barbie Creek (Station 4)	< .5 (0)	< .5 (0)	< .5 (0)	< .5 (0)
Canoe Creek (Station 5)	< .5 (0)		< .5 (0)	
Florence Creek (Station 6)	< .5 (0)	-	< .5 (0)	< .5 (0)
Mamin River (Station 7)	< .5 (0)		< .5 (0)	
Gold Creek (Station 8)	< .5 (0)	< .5 (0)	< .5 (0)	< .5 (0)
Unnamed Tributary (Station 9)	< .5 (0)		< .5 (0)	
Total Copper (ug/l)				
Yakoun River (Station 2)	< 1 (0)		< 1 (0)	
Barbie Creek (Station 4)	< 1 (0)		< 1 (0)	
Canoe Creek (Station 5)	< 1 (0)		< 1 (0)	
Florence Creek (Station 6)	< 1 (0)		< 1 (0)	
Mamin River (Station 7)	< 1 (0)		< 1 (0)	
Gold Creek (Station 8)	< 1 (0)		1 (1)	
Unnamed Tributary (Station 9)	< 1 (0)		< 1 (0)	
Dissolved Copper (ug/l)				
Yakoun River (Station 2)	4 (5)	< 1 (0)	< 1 (0)	< 1 (0)
Barbie Creek (Station 4)	< 1 (0)	1 (1)	< 1 (0)	< 1 (0)
Canoe Creek (Station 5)	< 1 (0)		< 1 (0)	
Florence Creek (Station 6)	< 1 (0)	-	< 1 (0)	< 1 (0)
Mamin River (Station 7)	< 1 (0)		< 1 (0)	
Gold Creek (Station 8)	2 (1)	< 1 (0)	< 1 (0)	< 1 (0)
Unnamed Tributary (Station 9)	2 (1)		< 1 (0)	

TABLE 7 SUMMARY TABLE FOR TOTAL AND DISSOLVED IRON AND LEAD

PARAMETER	NOVEMBER 1983		FEBRUARY 1984	
	SURFACE	INTRAGRAVEL	SURFACE	INTRAGRAVEL
	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)
Total Iron (ug/l)				
Yakoun River (Station 2)	505 (11)		283 (91)	
Barbie Creek (Station 4)	1270 (21)		938 (8)	
Canoe Creek (Station 5)	1150 (21)		719 (1)	
Florence Creek (Station 6)	1060 (15)		708 (2)	
Mamin River (Station 7)	502 (8)		242 (10)	
Gold Creek (Station 8)	330 (2)		282 (7)	
Unnamed Tributary (Station 9)	615 (5)		449 (26)	
Dissolved Iron (ug/l)				
Yakoun River (Station 2)	262 (3)	210 (9)	138 (1)	112 (4)
Barbie Creek (Station 4)	1070 (6)	1050 (21)	737 (13)	728 (6)
Canoe Creek (Station 5)	996 (12)		599 (9)	
Florence Creek (Station 6)	904 (12)	-	581 (4)	616 (58)
Mamin River (Station 7)	349 (3)		153 (3)	
Gold Creek (Station 8)	225 (3)	191 (7)	129 (2)	125 (3)
Unnamed Tributary (Station 9)	522 (1)		306 (6)	
Total Lead (ug/l)				
Yakoun River (Station 2)	< 1 (0)		< 1 (0)	
Barbie Creek (Station 4)	< 1 (0)		< 1 (0)	
Canoe Creek (Station 5)	< 1 (0)		< 1 (0)	
Florence Creek (Station 6)	< 1 (0)		< 1 (0)	
Mamin River (Station 7)	< 1 (0)		< 1 (0)	
Gold Creek (Station 8)	< 1 (0)		2 (2)	
Unnamed Tributary (Station 9)	< 1 (0)		< 1 (0)	
Dissolved Lead (ug/l)				
Yakoun River (Station 2)	< 1 (0)	2 (1)	< 1 (0)	< 1 (0)
Barbie Creek (Station 4)	< 1 (0)	2 (1)	< 1 (0)	< 1 (0)
Canoe Creek (Station 5)	< 1 (0)		< 1 (0)	
Florence Creek (Station 6)	< 1 (0)	-	< 1 (0)	< 1 (0)
Mamin River (Station 7)	< 1 (0)		< 1 (0)	
Gold Creek (Station 8)	< 1 (0)	≤ 1 (0)	< 1 (0)	< 1 (0)
Unnamed Tributary (Station 9)	< 1 (0)		< 1 (0)	

TABLE 8 SUMMARY TABLE FOR TOTAL AND DISSOLVED MANGANESE AND MERCURY

PARAMETER	NOVEMBER 1983		FEBRUARY 1984	
	SURFACE	INTRAGRAVEL	SURFACE	INTRAGRAVEL
	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)
Total Manganese (ug/l)				
Yakoun River (Station 2)	26 (2)		21 (7)	
Barbie Creek (Station 4)	127 (3)		174 (2)	
Canoe Creek (Station 5)	42 (1)		51 (0)	
Florence Creek (Station 6)	35 (1)		32 (0)	
Mamin River (Station 7)	23 (0)		19 (1)	
Gold Creek (Station 8)	20 (1)		30 (1)	
Unnamed Tributary (Station 9)	28 (1)		49 (9)	
Dissolved Manganese (ug/l)				
Yakoun River (Station 2)	16 (1)	16 (1)	9 (0)	6 (1)
Barbie Creek (Station 4)	123 (1)	124 (4)	104 (1)	72 (2)
Canoe Creek (Station 5)	38 (1)		30 (0)	
Florence Creek (Station 6)	30 (1)	-	17 (1)	21 (4)
Mamin River (Station 7)	17 (0)		9 (0)	
Gold Creek (Station 8)	14 (0)	13 (1)	11 (1)	5 (1)
Unnamed Tributary (Station 9)	24 (0)		12 (1)	
Total Mercury (ug/l)				
Yakoun River (Station 2)	< .05 (0)		< .05 (0)	
Barbie Creek (Station 4)	< .05 (0)		< .05 (0)	
Canoe Creek (Station 5)	.05 (.01)		< .05 (0)	
Florence Creek (Station 6)	< .05 (0)		< .05 (0)	
Mamin River (Station 7)	< .05 (0)		< .05 (0)	
Gold Creek (Station 8)	< .05 (0)		< .05 (0)	
Unnamed Tributary (Station 9)	< .05 (0)		< .05 (0)	
Dissolved Mercury (ug/l)				
Yakoun River (Station 2)	< .05 (0)	.06 (.01)	< .05 (0)	< .05 (0)
Barbie Creek (Station 4)	< .05 (0)	.06 (.01)	< .05 (0)	< .05 (0)
Canoe Creek (Station 5)	< .05 (0)		< .05 (0)	
Florence Creek (Station 6)	< .05 (0)	-	< .05 (0)	< .05 (0)
Mamin River (Station 7)	< .05 (0)		< .05 (0)	
Gold Creek (Station 8)	< .05 (0)	.08 (.02)	< .05 (0)	< .05 (0)
Unnamed Tributary (Station 9)	< .05 (0)		< .05 (0)	

TABLE 9 SUMMARY TABLE FOR TOTAL AND DISSOLVED ZINC

PARAMETER	NOVEMBER 1983		FEBRUARY 1984	
	SURFACE	INTRAGRAVEL	SURFACE	INTRAGRAVEL
	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)	$\bar{x}$ (S.D.)
Total Zinc (ug/l)				
Yakoun River (Station 2)	2 (1)		< 2 (0)	
Barbie Creek (Station 4)	10 (2)		4 (1)	
Canoe Creek (Station 5)	< 2 (0)		< 2 (0)	
Florence Creek (Station 6)	< 2 (0)		< 2 (0)	
Mamin River (Station 7)	< 2 (0)		< 2 (0)	
Gold Creek (Station 8)	< 2 (0)		< 2 (0)	
Unnamed Tributary (Station 9)	3 (0)		3 (1)	
Dissolved Zinc (ug/l)				
Yakoun River (Station 2)	< 2 (0)	< 2 (0)	< 2 (0)	< 2 (0)
Barbie Creek (Station 4)	12 (4)	< 2 (0)	6 (1)	6 (1)
Canoe Creek (Station 5)	2 (1)		< 2 (0)	
Florence Creek (Station 6)	≤ 2 (0)	-	< 2 (0)	< 2 (0)
Mamin River (Station 7)	< 2 (0)		< 2 (0)	
Gold Creek (Station 8)	< 2 (0)	< 2 (0)	< 2 (0)	2 (1)
Unnamed Tributary (Station 9)	3 (0)		< 2 (0)	

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APPENDIX I

ANALYTICAL METHODS

APPENDIX I ANALYTICAL METHODS

PARAMETER	SAMPLE BOTTLE	MANUAL TEST NUMBER*
Inorganics (Excluding Metals)		
Dissolved Oxygen (Winkler)	300 ml glass	(048)
pH (field)	200 ml polyethylene	Metroholm E588 pH meter
pH (laboratory)	2.5 l polyethylene	(080)
total alkalinity	2.5 l polyethylene	(006)
total acidity	2.5 l polyethylene	(002)
conductivity	2.5 l polyethylene	(044)
non-filterable residue	2.5 l polyethylene	(104)
sulfate	2.5 l polyethylene	(122)
chloride	2.5 l polyethylene	(024)
nitrite plus nitrate	2.5 l polyethylene	(072)
ammonia	2.5 l polyethylene	(058)
phosphate	50 ml glass	(082, 086)
Total and Dissolved Metals and Hardness*		
Arsenic	200 ml acid washed polyethylene	Inductively Coupled Argon Plasma (ICAP) Atomic Emission Spectroscopy-hydride method
Cadmium	200 ml acid washed polyethylene	Atomic Absorption Spectroscopy (AAS) flameless
Copper	200 ml acid washed polyethylene	(AAS) flameless
Lead	200 ml acid washed polyethylene	(AAS) flameless
Mercury	200 ml acid washed polyethylene	Pharmacia Mercury Monitor Model 100
Others	200 ml acid washed polyethylene	(ICAP)
Hardness	200 ml acid washed polyethylene	Calculated from dissolved metal sample

*Anon, 1979

APPENDIX II

RECEIVING WATER QUALITY DATA-INORGANICS
(Excluding Metals)

APPENDIX II (a) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Dissolved Oxygen - mg/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	10.3	10.5	10.3	8.6	8.7	8.6	11.5	11.4	11.4	11.3	10.8	10.8
Barbie Creek* Station 4	8.7	8.8	9.1	9.2	8.5	8.5	10.1	10.2	10.2	9.5	9.7	10.2
Canoe Creek Station 5	9.9	10.5	10.0	-	-	-	11.1	11.2	10.9	-	-	-
Florence Creek Station 6	9.7	9.7	9.7	-	-	-	10.7	11.1	10.9	10.1	10.1	10.0
Mamin River Station 7	10.8	10.6	10.8	-	-	-	11.5	11.6	11.5	-	-	-
Gold Creek Station 8	10.5	10.3	10.3	10.3	10.6	10.3	11.4	11.4	10.8	11.4	11.1	11.2
Tributary W.R. Station 9	10.6	10.5	10.6	-	-	-	11.2	11.2	11.5	-	-	-

APPENDIX II (b) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Percent Oxygen Saturation - %

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	86.4	88.1	86.4	72.2	73.0	72.2	90.5	89.8	89.8	89.0	85.0	85.0
Barbie Creek* Station 4	73.7	74.6	77.1	78.0	72.0	72.0	79.5	80.3	80.3	74.8	76.4	80.3
Canoe Creek Station 5	82.1	87.0	82.9	-	-	-	87.4	88.2	85.8	-	-	-
Florence Creek Station 6	80.4	80.4	80.4	-	-	-	84.2	87.4	85.8	79.5	79.5	78.7
Mamin River Station 7	89.5	87.9	89.5	-	-	-	90.5	91.3	90.5	-	-	-
Gold Creek Station 8	87.5	85.8	85.8	86.4	88.9	86.4	89.8	89.8	85.0	89.8	87.4	88.2
Tributary W.R. Station 9	88.3	87.5	88.3	-	-	-	89.4	89.4	91.7	-	-	-

APPENDIX II (c) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

pH (field)

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	6.5	6.5	6.5	6.4	6.4	6.4	6.0	6.0	6.0	6.0	6.1	5.9
Barbie Creek* Station 4	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.0	5.1	5.1	5.0	5.1
Canoe Creek Station 5	4.9	4.9	4.9	-	-	-	4.6	4.5	4.5	-	-	-
Florence Creek Station 6	5.4	5.4	5.3	-	-	-	5.1	5.1	5.2	5.1	5.1	5.1
Mamin River Station 7	6.4	6.4	6.4	-	-	-	5.9	5.9	6.0	-	-	-
Gold Creek Station 8	6.6	6.5	6.6	6.5	6.6	6.6	5.7	5.7	5.7	5.8	5.9	5.9
Tributary W.R. Station 9	5.9	5.9	5.9	-	-	-	5.9	5.9	5.9	-	-	-

APPENDIX II (d) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

pH (laboratory)

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	6.3	6.4	6.4	6.4	6.3	6.4	6.3	6.3	6.3	6.3	6.3	6.3
Barbie Creek* Station 4	4.8	4.9	4.8	4.9	4.8	4.9	5.2	5.2	5.3	5.3	5.3	5.3
Canoe Creek Station 5	4.5	4.6	4.6	-	-	-	4.8	4.9	4.8	-	-	-
Florence Creek Station 6	5.0	5.0	5.1	-	-	-	5.4	5.5	5.4	5.5	5.5	5.5
Mamin River Station 7	6.1	6.2	6.2	-	-	-	6.2	6.2	6.2	-	-	-
Gold Creek Station 8	6.4	6.4	6.4	6.4	6.4	6.4	6.3	6.4	6.4	6.3	6.3	6.3
Tributary W.R. Station 9	5.6	5.6	5.6	-	-	-	6.0	5.9	5.9	-	-	-

APPENDIX II (e) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Total Hardness - as mg/l $CaCO_3$

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	12.6	12.7	12.9	15.6	15.7	15.0	10.5	10.5	10.5	10.3	9.99	10.2
Barbie Creek* Station 4	14.1	13.8	14.1	13.8	13.7	13.7	11.4	11.5	11.5	11.7	11.7	11.6
Canoe Creek Station 5	9.52	9.49	9.46	-	-	-	7.74	7.46	7.33	-	-	-
Florence Creek Station 6	10.8	10.7	10.8	-	-	-	8.98	9.15	8.98	9.03	9.46	9.2
Mamin River Station 7	10.3	10.3	10.4	-	-	-	8.21	8.04	8.05	-	-	-
Gold Creek Station 8	12.0	12.2	12.1	12.1	12.3	12.0	10.7	10.8	10.7	10.4	10.4	10.3
Tributary W.R. Station 9	10.7	10.6	10.6	-	-	-	9.81	9.54	9.6	-	-	-

APPENDIX II (f) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Total Alkalinity - as mg/l $CaCO_3$

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	6.0	7.0	7.0	10.0	10.0	10.0	6.5	6.5	6.0	6.0	6.0	6.0
Barbie Creek* Station 4	nil	nil	nil	nil	nil	nil	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Canoe Creek Station 5	nil	nil	nil	-	-	-	nil	nil	nil	-	-	-
Florence Creek Station 6	nil	nil	nil	-	-	-	1.0	1.0	1.0	1.0	1.0	1.0
Mamin River Station 7	5.0	5.0	5.0	-	-	-	4.5	4.5	4.0	-	-	-
Gold Creek Station 8	7.0	6.0	6.0	7.0	6.0	7.0	6.0	6.0	6.0	5.0	5.0	5.0
Tributary W.R. Station 9	1.5	1.5	1.5	-	-	-	2.0	2.0	2.0	-	-	-

APPENDIX II (g) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Total Acidity - as mg/l $CaCO_3$

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	4.0	5.0	4.0	4.0	8.0	6.0	4.0	3.5	4.0	5.0	5.0	4.0
Barbie Creek* Station 4	13.0	13.0	13.0	18.0	13.0	11.0	9.0	8.0	9.0	10.0	10.0	10.0
Canoe Creek Station 5	12.0	13.0	12.0	-	-	-	8.0	8.0	9.0	-	-	-
Florence Creek Station 6	11.0	11.0	11.0	-	-	-	5.0	6.0	6.0	-	-	-
Mamin River Station 7	5.0	4.0	4.0	-	-	-	4.0	4.0	4.0	-	-	-
Gold Creek Station 8	4.0	4.0	5.0	3.0	5.0	3.0	3.0	3.0	6.0	4.0	5.0	5.0
Tributary W.R. Station 9	6.0	6.0	6.0	-	-	-	4.0	4.0	4.0	-	-	-

APPENDIX II (h) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Conductivity - umhos/cm

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	39.5	39.6	39.6	48.2	48.0	48.2	32.8	32.8	32.8	35.9	35.5	35.5
Barbie Creek* Station 4	46.3	46.3	46.8	46.2	46.1	46.0	41.1	41.1	41.1	45.3	45.3	45.5
Canoe Creek Station 5	36.7	36.5	36.7	-	-	-	32.0	32.0	31.8	-	-	-
Florence Creek Station 6	34.4	34.4	34.4	-	-	-	30.8	34.3	33.8	34.7	34.7	34.5
Mamin River Station 7	34.0	34.0	34.2	-	-	-	31.1	31.0	31.1	-	-	-
Gold Creek Station 8	37.9	37.8	37.9	37.7	38.7	38.3	36.0	36.0	36.0	35.7	36.3	35.7
Tributary W.R. Station 9	36.9	36.9	37.2	-	-	-	39.3	39.0	39.0	-	-	-

APPENDIX II (i) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Non-Filterable Residue - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	< 5	5	< 5	-	-	-	< 5	< 5	< 5	-	-	-
Barbie Creek* Station 4	< 5	6	< 5	-	-	-	< 5	< 5	< 5	-	-	-
Canoe Creek Station 5	7	5	6	-	-	-	< 5	< 5	< 5	-	-	-
Florence Creek Station 6	5	6	7	-	-	-	< 5	< 5	< 5	-	-	-
Mamin River Station 7	7	6	6	-	-	-	< 5	< 5	7	-	-	-
Gold Creek Station 8	< 5	< 5	< 5	-	-	-	< 5	< 5	< 5	-	-	-
Tributary W.R. Station 9	5	< 5	5	-	-	-	< 5	< 5	6	-	-	-

APPENDIX II (j) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Sulfate - mg/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	6.8	5.4	5.3	5.5	5.1	5.1	2.7	2.6	2.7	3.4	3.1	3.1
Barbie Creek* Station 4	9.8	10.2	10.7	10.0	11.6	9.3	6.2	6.1	6.1	8.2	7.9	7.6
Canoe Creek Station 5	8.0	6.9	7.5	-	-	-	3.7	3.7	3.9	-	-	-
Florence Creek Station 6	6.7	7.2	8.2	-	-	-	3.8	3.7	3.9	5.6	5.2	5.6
Mamin River Station 7	5.6	5.3	4.7	-	-	-	2.3	2.1	2.1	-	-	-
Gold Creek Station 8	4.4	6.6	6.2	5.5	5.7	6.1	2.4	2.4	2.6	3.3	3.5	3.5
Tributary W.R. Station 9	6.8	7.9	7.0	-	-	-	4.0	3.9	4.2	-	-	-

APPENDIX II (k) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Chloride - mg/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	5.1	5.0	5.1	6.0	5.9	5.9	4.2	4.2	4.1	4.3	4.4	4.3
Barbie Creek* Station 4	7.0	7.1	7.0	7.5	7.4	7.4	7.0	7.2	7.2	7.6	7.5	7.5
Canoe Creek Station 5	7.1	7.1	7.1	-	-	-	6.8	6.8	6.8	-	-	-
Florence Creek Station 6	6.7	6.7	6.8	-	-	-	6.4	3.7	3.9	6.6	6.6	6.7
Mamin River Station 7	5.7	5.7	5.7	-	-	-	2.3	2.1	2.1	-	-	-
Gold Creek Station 8	5.4	5.4	5.5	5.4	5.5	5.6	2.4	2.4	2.6	4.4	4.6	4.3
Tributary W.R. Station 9	6.8	6.8	6.9	-	-	-	4.0	3.9	4.2	-	-	-

APPENDIX II (1) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Nitrite plus Nitrate - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	30	20	20	50	50	50	30	30	50	40	50	40
Barbie Creek* Station 4	< 10	< 10	< 10	< 10	< 10	< 10	10	60	20	40	50	30
Canoe Creek Station 5	< 10	< 10	< 10	-	-	-	30	20	10	-	-	-
Florence Creek Station 6	< 10	< 10	< 10	-	-	-	10	10	10	30	40	40
Mamin River Station 7	10	10	10	-	-	-	20	40	30	-	-	-
Gold Creek Station 8	30	30	30	30	30	30	60	60	60	60	60	60
Tributary W.R. Station 9	< 10	< 10	< 10	-	-	-	10	10	30	-	-	-

APPENDIX II (m) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Total Ammonia** - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	SURFACE			INTRAGRAVEL			SURFACE			INTRAGRAVEL		
Yakoun River Station 2	7	7	7	16	12	14	< 5	< 5	< 5	< 5	< 5	< 5
Barbie Creek* Station 4	15	15	15	16	16	16	9	12	10	13	10	9
Canoe Creek Station 5	18	18	18	-	-	-	13	12	11	-	-	-
Florence Creek Station 6	18	17	17	-	-	-	10	10	11	13	17	14
Mamin River Station 7	8	8	8	-	-	-	< 5	5	5	-	-	-
Gold Creek Station 8	9	9	9	10	11	11	7	5	5	< 5	< 5	6
Tributary W.R. Station 9	12	12	12	-	-	-	7	7	7	-	-	-

**$NH_3 + NH_4^+$

APPENDIX II (n) RECEIVING WATER QUALITY DATA - INORGANICS (Excluding Metals)

Phosphate - ug/l

STATION	NOVEMBER 2*/3, 1983		FEBRUARY 29, 1984	
	TOTAL	DISSOLVED	TOTAL	DISSOLVED
Yakoun River Station 2	12	12	-	-
Barbie Creek* Station 4	23	19	13	11
Canoe Creek Station 5	22	17	14	-
Florence Creek Station 6	24	19	14	12
Mamin River Station 7	16	11	14	-
Gold Creek Station 8	11	9	11	7
Tributary W.R. Station 9	15	12	11	-

APPENDIX III

WATER QUALITY PARAMETER SCREENING TABLE FOR SALMONID HATCHERIES

APPENDIX III WATER QUALITY PARAMETER SCREENING TABLE FOR SALMONID HATCHERIES*

FISH CULTURE PARAMETERS	RECOMMENDED SCREENING LEVELS
Alkalinity[1]	> 15 mg/L as $CaCO_3$
Hardness[2]	> 20 mg/L as $CaCO_3$
pH[3]	7.2 to 8.5
Suspended Solids[4]	< 3 mg/L
$NH_3 + NH_4^+$ (total)	< 50 ug/L
Dissolved Oxygen	> 11.2 mg/L and > 95% saturation

METALS	MAXIMUM ACCEPTABLE LEVELS (ug/L)	HARDNESS (mg/L $CaCO_3$)
Aluminum (total)[5]	100	
Cadmium (dissolved)	0.3	- 10
	0.4	- 50
	0.5	- 100
	0.75	- 300
Chromium (total)	40	
Copper (dissolved)	2	- 10
	5	- 25
	11	- 50
	22	- 120
	64	- 300
Iron (total)[5]	300	
Mercury (total)	0.2	
Manganese (total)[5]	100	
Nickel (total)	45	- < 150
	250	- > 150
Lead (total)	4	0 - 35
	19	35 - 75
	25	75 - 150
	50	150 - 300
	100	300

CONTINUED...

APPENDIX III WATER QUALITY PARAMETER SCREENING TABLE FOR SALMONID HATCHERIES*

(Continued)

METALS	MAXIMUM ACCEPTABLE LEVELS (ug/L)	HARDNESS (mg/L $CaCO_3$)
Selenium (total)	50	
Silver (dissolved)	0.1	0 - 150
	0.15	150 - 300
Zinc (dissolved)	15	- 10
	35	- 25
	66	- 50
	121	- 100
	311	- 300

*Format modified from Sigma, 1983

[1]This is a suggested minimum level of alkalinity to buffer pH changes in rearing ponds.

[2]This is a suggested minimum level of hardness to reduce risks of toxic effects of metals, low pH and poor fish health. Although insufficient data are available to establish specific criteria for hardness, the importance of hardness (the divalent metallic cations Ca^{2+}, Mg^{2+} and others) in reducing the toxic effects of metals, low pH, total gas pressure, and nitrite has been documented.

[3]A minimum inflow pH of 7.2 makes some allowance for the pH reduction due to CO_2 respiration in a rearing pond. Inflow pH criteria should be evaluated on site-specific basis with consideration of alkalinity, free CO_2 and fish loading density.

[4]The characteristics of the suspended solids should be carefully considered. For example, some materials (i.e. iron hydroxide precipitates) are toxic at lower concentrations than 3 mg/L.

[5]Analyses for total aluminum, iron, and manganese frequently result in high metal concentrations (exceeding the screening levels) if the water sample contains a significant quantity of suspended silt or clay. These mineral forms of the metal are essentially non-toxic. However, aluminum, iron and manganese precipitates are toxic. Their presence should be investigated if the total metal levels are high and the inert mineral fraction of the suspended solids appears to be relatively low.

APPENDIX IV

TOTAL AND DISSOLVED METALS

APPENDIX IV (a) TOTAL AND DISSOLVED METALS - SURFACE

Arsenic - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	< .5	< .5	< .5	< .5	< .5	< .5	.5	< .5	< .5	< .5	< .5	< .5
Barbie Creek* Station 4	1.2	1.2	1.3	.9	.9	.9	1.0	1.1	1.2	.7	.6	.7
Canoe Creek Station 5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5
Florence Creek Station 6	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5
Mamin River Station 7	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5
Gold Creek Station 8	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	-
Tributary W.R. Station 9	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5

APPENDIX IV (a) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Arsenic - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	< .5	< .5	< .5	< .5	< .5	< .5
Barbie Creek* Station 4	.7	.8	1.0	.7	.6	.8
Florence Creek Station 6	-	-	-	< .5	< .5	< .5
Gold Creek Station 8	< .5	< .5	< .5	< .5	< .5	< .5

APPENDIX IV (b) TOTAL AND DISSOLVED METALS - SURFACE

Aluminum - mg/l)

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	.45	.41	.40	.16	.16	.17	.25	.32	.26	.11	.13	.12
Barbie Creek* Station 4	.69	.61	.60	.52	.57	.53	.32	.33	.32	.32	.31	.32
Canoe Creek Station 5	.67	.67	.67	.52	.51	.51	.43	.46	.43	.35	.34	.33
Florence Creek Station 6	.62	.60	.60	.49	.49	.50	.43	.44	.43	.34	.34	.33
Mamin River Station 7	.39	.39	.39	.26	.25	.25	.24	.26	.25	.16	.16	.16
Gold Creek Station 8	.29	.28	.26	.19	.20	.19	.31	.32	.30	.15	.16	.16
Tributary W.R. Station 9	.46	.48	.47	.40	.40	.39	.41	.34	.36	.26	.24	.25

APPENDIX IV (b) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Aluminium - mg/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	.15	.15	.15	.13	.12	.13
Barbie Creek* Station 4	.53	.51	.51	.32	.32	.31
Florence Creek Station 6	-	-	-	.35	.37	.36
Gold Creek Station 8	.20	.20	.19	.15	.16	.14

APPENDIX IV (c) TOTAL AND DISSOLVED METALS - SURFACE

Barium - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	7	7	7	6	6	6	3	7	6	5	5	5
Barbie Creek* Station 4	11	10	10	10	10	10	8	8	8	7	7	7
Canoe Creek Station 5	7	7	7	6	6	6	5	5	5	5	4	4
Florence Creek Station 6	6	5	6	5	5	5	4	5	4	4	4	4
Mamin River Station 7	4	4	4	3	3	3	3	3	3	2	2	2
Gold Creek Station 8	4	4	4	3	3	3	3	4	4	3	3	3
Tributary W.R. Station 9	6	6	6	6	5	6	5	5	5	4	4	5

APPENDIX IV (c) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Barium - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	7	7	7	5	5	5
Barbie Creek* Station 4	10	10	10	8	8	8
Florence Creek Station 6	-	-	-	4	4	4
Gold Creek Station 8	4	4	4	3	3	3

APPENDIX IV (d) TOTAL AND DISSOLVED METALS - SURFACE

Beryllium - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Barbie Creek* Station 4	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Canoe Creek Station 5	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Florence Creek Station 6	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Mamin River Station 7	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Gold Creek Station 8	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Tributary W.R. Station 9	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1

APPENDIX IV (d) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Beryllium - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	< 1	< 1	< 1	< 1	< 1	< 1
Barbie Creek* Station 4	< 1	< 1	< 1	< 1	< 1	< 1
Florence Creek Station 6	-	-	-	< 1	< 1	< 1
Gold Creek Station 8	< 1	< 1	< 1	< 1	< 1	< 1

APPENDIX IV (e) TOTAL AND DISSOLVED METALS - SURFACE

Cadmium - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5
Barbie Creek* Station 4	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5
Canoe Creek Station 5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5
Florence Creek Station 6	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5
Mamin River Station 7	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5
Gold Creek Station 8	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5
Tributary W.R. Station 9	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5	< .5

APPENDIX IV (e) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Cadmium - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	< .5	< .5	< .5	< .5	< .5	< .5
Barbie Creek* Station 4	< .5	< .5	< .5	< .5	< .5	< .5
Florence Creek Station 6	-	-	-	< .5	< .5	< .5
Gold Creek Station 8	< .5	< .5	< .5	< .5	< .5	< .5

APPENDIX IV (f) TOTAL AND DISSOLVED METALS - SURFACE

Calcium - mg/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	3.5	3.5	3.4	3.4	3.4	3.4	2.8	5.2	4.6	2.9	2.9	2.9
Barbie Creek* Station 4	2.0	2.0	2.0	2.1	2.0	2.0	2.9	2.9	2.9	1.9	1.9	1.9
Canoe Creek Station 5	0.9	1.0	1.0	0.9	0.9	0.9	1.5	1.5	1.5	0.9	0.9	0.9
Florence Creek Station 6	1.2	1.2	1.2	1.3	1.3	1.3	2.1	2.0	2.1	1.2	1.3	1.2
Mamin River Station 7	2.2	2.2	2.2	2.1	2.1	2.1	3.1	3.1	3.1	1.8	1.8	1.8
Gold Creek Station 8	3.2	3.3	3.2	3.1	3.1	3.1	4.9	4.9	4.8	2.8	2.8	2.8
Tributary W.R. Station 9	1.9	1.9	1.9	1.8	1.8	1.8	3.2	3.1	3.1	1.9	1.8	1.8

APPENDIX IV (f) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Calcium - mg/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	4.3	4.4	4.2	2.8	2.8	2.8
Barbie Creek* Station 4	2.0	2.0	2.1	1.9	1.9	1.9
Florence Creek Station 6	-	-	-	1.2	1.2	1.2
Gold Creek Station 8	3.2	3.2	3.2	2.8	2.7	2.8

APPENDIX IV (g) TOTAL AND DISSOLVED METALS - SURFACE

Chromium - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Barbie Creek* Station 4	< 5	< 5	< 5	7	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Canoe Creek Station 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Florence Creek Station 6	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Mamin River Station 7	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Gold Creek Station 8	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Tributary W.R. Station 9	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5

APPENDIX IV (g) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Chromium - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	< 5	< 5	< 5	< 5	< 5	< 5
Barbie Creek* Station 4	< 5	< 5	< 5	< 5	< 5	< 5
Florence Creek Station 6	-	-	-	< 5	< 5	< 5
Gold Creek Station 8	< 5	< 5	< 5	< 5	< 5	< 5

APPENDIX IV (h) TOTAL AND DISSOLVED METALS - SURFACE

Cobalt - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Barbie Creek* Station 4	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Canoe Creek Station 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Florence Creek Station 6	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Mamin River Station 7	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Gold Creek Station 8	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Tributary W.R. Station 9	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5

APPENDIX IV (h) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Cobalt - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	< 5	< 5	< 5	< 5	< 5	< 5
Barbie Creek* Station 4	< 5	< 5	< 5	< 5	< 5	< 5
Florence Creek Station 6	-	-	-	< 5	< 5	< 5
Gold Creek Station 8	< 5	< 5	< 5	< 5	< 5	< 5

APPENDIX IV (i) TOTAL AND DISSOLVED METALS - SURFACE

Copper - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	< 1	< 1	< 1	< 1	10	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Barbie Creek* Station 4	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Canoe Creek Station 5	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Florence Creek Station 6	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Mamin River Station 7	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Gold Creek Station 8	< 1	< 1	< 1	2	3	2	2	1	< 1	< 1	< 1	< 1
Tributary W.R. Station 9	< 1	< 1	< 1	< 1	< 1	3	< 1	< 1	< 1	< 1	< 1	< 1

APPENDIX IV (i) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Copper - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	< 1	< 1	< 1	< 1	< 1	< 1
Barbie Creek* Station 4	< 1	< 1	2	< 1	< 1	< 1
Florence Creek Station 6	-	-	-	< 1	< 1	< 1
Gold Creek Station 8	< 1	< 1	< 1	< 1	< 1	< 1

APPENDIX IV (j) TOTAL AND DISSOLVED METALS - SURFACE

Iron - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	516	506	494	260	266	260	181	358	309	138	137	138
Barbie Creek* Station 4	1290	1250	1260	1070	1070	1080	930	938	945	747	722	741
Canoe Creek Station 5	1170	1130	1160	993	986	1010	719	720	718	607	600	590
Florence Creek Station 6	1070	1040	1060	917	898	896	710	706	708	576	583	583
Mamin River Station 7	501	495	511	351	345	351	240	252	233	155	150	155
Gold Creek Station 8	331	331	327	227	222	225	283	288	274	129	130	127
Tributary W.R. Station 9	609	618	617	522	523	522	479	440	429	309	300	310

APPENDIX IV (j) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Iron - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	220	207	204	116	112	109
Barbie Creek* Station 4	1070	1040	1030	731	732	722
Florence Creek Station 6	-	-	-	568	681	600
Gold Creek Station 8	186	199	189	125	128	122

APPENDIX IV (k) TOTAL AND DISSOLVED METALS - SURFACE

Lead - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Barbie Creek* Station 4	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Canoe Creek Station 5	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Florence Creek Station 6	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Mamin River Station 7	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Gold Creek Station 8	< 1	< 1	< 1	< 1	< 1	< 1	< 1	4	2	< 1	< 1	< 1
Tributary W.R. Station 9	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1

APPENDIX IV (k) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Lead - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	< 1	3	< 1	< 1	< 1	< 1
Barbie Creek* Station 4	< 1	2	2	< 1	< 1	< 1
Florence Creek Station 6	-	-	-	< 1	< 1	< 1
Gold Creek Station 8	1	< 1	< 1	< 1	< 1	< 1

APPENDIX IV (1) TOTAL AND DISSOLVED METALS - SURFACE

Magnesium - mg/l)

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	.8	.7	.7	.7	.7	.7	.5	.6	.5	.6	.6	.6
Barbie Creek* Station 4	1.0	1.0	.9	.9	.9	.9	.7	.8	.8	.8	.8	.9
Canoe Creek Station 5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6.	.6	.5
Florence Creek Station 6	.8	.8	.8	.7	.7	.7	.8	.7	.7	.7	.7	.7
Mamin River Station 7	.8	.8	.8	.7	.7	.7	.6	.6	.6	.6	.6	.6
Gold Creek Station 8	.7	.7	.7	.7	.7	.7	.6	.6	.6	.6	.6	.6
Tributary W.R. Station 9	.8	.8	.8	.7	.7	.7	.9	.8	.8	.8	.7	.7

APPENDIX IV (1) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Magnesium - mg/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	.9	.9	.9	.5	.5	.6
Barbie Creek* Station 4	.9	.9	.9	.9	.9	.9
Florence Creek Station 6	-	-	-	.7	.7	.7
Gold Creek Station 8	.7	.7	.7	.6	.6	.6

APPENDIX IV (m) TOTAL AND DISSOLVED METALS - SURFACE

Manganese - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	29	25	25	15	16	17	13	26	24	9	9	9
Barbie Creek* Station 4	130	123	127	123	122	123	173	173	176	104	105	104
Canoe Creek Station 5	42	41	42	38	38	39	51	51	51	30	30	30
Florence Creek Station 6	36	35	35	31	30	30	32	32	32	17	17	18
Mamin River Station 7	23	23	23	17	17	17	19	18	19	9	9	9
Gold Creek Station 8	21	20	20	14	14	14	31	30	29	11	11	10
Tributary W.R. Station 9	28	29	28	24	24	24	59	45	42	12	12	13

APPENDIX IV (m) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Manganese - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	16	16	15	6	7	6
Barbie Creek* Station 4	121	128	122	74	72	70
Florence Creek Station 6	-	-	-	18	25	21
Gold Creek Station 8	13	13	14	4	6	4

APPENDIX IV (n) TOTAL AND DISSOLVED METALS - SURFACE

Mercury - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05
Barbie Creek* Station 4	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05
Canoe Creek Station 5	.06	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05
Florence Creek Station 6	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05
Mamin River Station 7	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05
Gold Creek Station 8	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05
Tributary W.R. Station 9	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05

APPENDIX IV (n) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Mercury - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	.05	.07	.06	< .05	< .05	< .05
Barbie Creek* Station 4	.07	.06	.06	< .05	< .05	< .05
Florence Creek Station 6	-	-	-	< .05	< .05	< .05
Gold Creek Station 8	.09	.09	.06	< .05	< .05	< .05

APPENDIX IV (o) TOTAL AND DISSOLVED METALS - SURFACE

Molybdenum - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Barbie Creek* Station 4	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Canoe Creek Station 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Florence Creek Station 6	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Mamin River Station 7	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Gold Creek Station 8	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Tributary W.R. Station 9	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5

APPENDIX IV (o) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Molybdenum - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	< 5	< 5	< 5	< 5	< 5	< 5
Barbie Creek* Station 4	< 5	< 5	< 5	< 5	< 5	< 5
Florence Creek Station 6	-	-	-	< 5	< 5	< 5
Gold Creek Station 8	< 5	< 5	< 5	< 5	< 5	< 5

APPENDIX IV (p) TOTAL AND DISSOLVED METALS - SURFACE

Silica - mg/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	2.3	2.4	2.3	2.0	2.0	2.0	1.1	2.1	1.8	1.7	1.7	1.7
Barbie Creek* Station 4	2.1	2.0	2.0	2.0	2.0	2.0	1.8	1.8	1.8	1.9	1.9	1.9
Canoe Creek Station 5	2.0	2.0	2.0	1.9	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.1
Florence Creek Station 6	2.8	2.7	2.7	2.8	2.7	2.7	2.9	2.9	2.9	3.0	3.0	3.0
Mamin River Station 7	2.9	2.9	3.0	2.8	2.8	2.8	2.2	2.2	2.1	2.1	2.1	2.1
Gold Creek Station 8	1.8	1.8	1.8	1.8	1.8	1.8	1.6	1.6	1.6	1.5	1.5	1.5
Tributary W.R. Station 9	1.9	1.9	1.9	1.9	1.9	1.9	2.1	2.1	2.1	2.1	2.1	2.1

APPENDIX IV (p) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Silica - mg/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	2.3	2.3	2.2	1.7	1.7	1.7
Barbie Creek* Station 4	2.0	2.0	2.0	1.9	1.9	1.9
Florence Creek Station 6	-	-	-	3.0	3.0	3.0
Gold Creek Station 8	1.8	1.8	1.8	1.5	1.5	1.5

APPENDIX IV (q) TOTAL AND DISSOLVED METALS - SURFACE

Sodium - mg/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	3.3	3.5	3.4	3.2	3.2	3.2	2.7	5.1	4.6	2.9	2.9	2.9
Barbie Creek* Station 4	4.5	4.5	4.6	4.3	4.2	4.4	7.1	7.2	7.2	4.4	4.4	4.4
Canoe Creek Station 5	4.4	4.2	4.4	4.0	4.1	4.1	6.5	6.6	6.6	4.0	4.0	3.9
Florence Creek Station 6	4.1	3.9	4.1	3.9	3.9	3.8	6.4	6.3	6.4	3.8	3.9	3.9
Mamin River Station 7	3.7	3.6	3.8	3.5	3.6	3.6	5.2	5.0	5.0	3.1	3.0	3.0
Gold Creek Station 8	3.4	3.4	3.3	3.2	3.2	3.3	4.9	5.0	4.8	3.0	2.9	2.9
Tributary W.R. Station 9	4.3	4.3	4.3	4.5	4.1	4.2	6.7	6.8	6.7	4.1	4.1	4.1

APPENDIX IV (q) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Sodium - mg/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	2.6	2.6	2.5	2.9	2.9	2.9
Barbie Creek* Station 4	3.4	3.3	3.4	4.4	4.4	4.2
Florence Creek Station 6	-	-	-	3.8	3.8	3.8
Gold Creek Station 8	2.5	2.5	2.4	2.9	2.9	2.9

APPENDIX IV (r) TOTAL AND DISSOLVED METALS - SURFACE

Strontium - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	18	20	19	18	18	17	8	17	16	15	14	14
Barbie Creek* Station 4	16	15	16	16	15	15	13	13	14	12	12	13
Canoe Creek Station 5	11	11	11	9	9	9	8	9	8	8	8	8
Florence Creek Station 6	12	12	12	11	11	11	11	12	12	10	10	11
Mamin River Station 7	14	14	15	14	14	14	12	12	12	11	11	11
Gold Creek Station 8	16	16	16	15	15	15	14	15	14	12	13	12
Tributary W.R. Station 9	13	13	14	12	12	12	12	12	12	12	12	12

APPENDIX IV (r) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Strontium - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	23	25	22	14	14	14
Barbie Creek* Station 4	15	15	15	12	12	12
Florence Creek Station 6	-	-	-	10	10	10
Gold Creek Station 8	16	17	16	12	12	12

APPENDIX IV (s) TOTAL AND DISSOLVED METALS - SURFACE

Titanium - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	9	10	12	< 2	< 2	< 2	< 2	7	10	< 2	< 2	< 2
Barbie Creek* Station 4	10	10	9	4	4	3	8	8	9	< 2	2	2
Canoe Creek Station 5	15	11	13	5	4	6	8	8	7	3	2	3
Florence Creek Station 6	12	12	14	6	3	4	7	8	8	2	2	2
Mamin River Station 7	11	7	8	< 2	< 2	< 2	5	6	5	< 2	< 2	< 2
Gold Creek Station 8	5	< 2	4	< 2	< 2	< 2	6	6	8	< 2	< 2	< 2
Tributary W.R. Station 9	6	6	7	3	3	3	5	5	5	< 2	< 2	< 2

APPENDIX IV (s) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Titanium - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	3	< 2	< 2	< 2	< 2	< 2
Barbie Creek* Station 4	5	5	4	2	3	3
Florence Creek Station 6	-	-	-	3	4	3
Gold Creek Station 8	< 2	< 2	< 2	< 2	< 2	< 2

APPENDIX IV (t) TOTAL AND DISSOLVED METALS - SURFACE

Zinc - ug/l

STATION	NOVEMBER 2*/3, 1983						FEBRUARY 29, 1984					
	TOTAL			DISSOLVED			TOTAL			DISSOLVED		
Yakoun River Station 2	3	2	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Barbie Creek* Station 4	10	8	11	16	9	10	4	4	5	7	6	6
Canoe Creek Station 5	< 2	< 2	< 2	< 2	2	3	< 2	< 2	< 2	< 2	< 2	< 2
Florence Creek Station 6	< 2	< 2	< 2	< 2	< 2	2	< 2	< 2	< 2	< 2	< 2	< 2
Mamin River Station 7	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Gold Creek Station 8	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2	< 2	< 2	< 2	< 2
Tributary W.R. Station 9	3	3	3	3	3	3	4	< 2	< 2	< 2	2	2

APPENDIX IV (t) TOTAL AND DISSOLVED METALS - INTRAGRAVEL

Zinc - ug/l

STATION	NOVEMBER 2*/3, 1983			FEBRUARY 29, 1984		
	DISSOLVED			DISSOLVED		
Yakoun River Station 2	< 2	< 2	< 2	< 2	< 2	< 2
Barbie Creek* Station 4	< 2	< 2	< 2	5	6	6
Florence Creek Station 6	-	-	-	< 2	< 2	< 2
Gold Creek Station 8	< 2	< 2	< 2	< 2	< 2	3

APPENDIX V

RECOMMENDED SURFACE FRESHWATER QUALITY OBJECTIVES FOR AQUATIC LIFE

APPENDIX V RECOMMENDED SURFACE FRESHWATER QUALITY OBJECTIVES* FOR AQUATIC LIFE

CONSTITUENT	OBJECTIVE CONCENTRATION (ug/L) (as Total)
Arsenic	50
Cadmium	0.2
Chromium	40
Copper	2
Lead	5 (hardness < 95 mg/L as $CaCO_3$) 10 (hardness > 95 mg/L as $CaCO_3$; waters with sensitive species of fish 30 (hardness > 95 mg/L as $CaCO_3$; sensitive species of fish absent)
Mercury	0.1 (to protect consumers of fish) 0.2 (where fish not eaten)
Nickel	25 (soft water) 250 (hardness > 95 mg/L as $CaCO_3$)
Selenium	10
Silver	0.1
Zinc	50 (hardness 0-120 mg/L as $CaCO_3$) 100 (hardness 120-180 mg/L as $CaCO_3$) 200 (hardness 180-300 mg/L as $CaCO_3$) 300 (hardness > 300 mg/L as $CaCO_3$)

*Format modified after Reeder, 1979