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PRELIMINARY WATER-QUALITY SAMPLING FOR THE FAIRBANKS INTERNATIONAL AIRPORT BIOREMEDIATION PROJECT: NOVEMBER 1990 THROUGH OCTOBER 1991

By

Scott R. Ray and Jim Vohden
Alaska Division of Water

Alaska Division of
Geological and Geophysical Surveys

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794 University Avenue, Suite 200
Fairbanks, Alaska 99709-3645

INTRODUCTION

The Fairbanks International Airport Bioremediation Project is a multi-agency effort to remediate a contaminated site at the airport using innovative engineering designs and enhanced biological remediation. The major agencies involved include the Alaska Department of Transportation and Public Facilities (ADOTPF), the US Army Corp of Engineers Cold Region Research Engineering Laboratory (CRREL), the US Geological Survey (USGS), the Alaska Division of Water (DOW), and the University of Alaska Fairbanks Water Research Center (WRC). This report will not discuss the details of the project, but will present the water chemistry data collected from November 1990 to September 1991.

Eleven wells were sampled during the period, although not all wells were sampled each sampling event are were all parameters measured for each well. Figure 1 shows the well locations and the bioremediation site. One well upgradient and off-site was used as a control (P-Tan). Three wells on site not directly associated with the infiltration gallery were monitored (B-l, B-2, and B-4). These wells were either up- or parallel-gradient of the infiltration gallery. The remaining wells are associated with the infiltration gallery (B-3, IG-1, IG-2, IG-3, IG-WW, DEC-1, DEC-2). At the start of the project, only wells P-Tan, B-l, B-2, and B-4 were monitored. Well B-3 was added during the spring 1991, with the remaining wells added late in the summer of 1991.

METHODS

Field

All sampling was done in accordance with U.S. Environmental Protection Agency (1982) methods. Standardization of all field meters was done on a daily basis. For each well sampled there was a dedicated Teflon bailer to minimize cross-contamination of the organic constituents. Each well was fitted with a length of 3/8" Teflon tubing which remained in the well between sampling periods. Wells were purged with a peristaltic pump at approximately one gpm. Pumping was stopped when consistent conductivity and pH

measurements were recorded. At this point, the Teflon tubing was removed from the well and inserted into an appropriate length of 4" diameter polyethylene bag. Teflon bailers with controlled flow bottoms were used to sample each well. The first aliquot sampled was used to measure dissolved oxygen, pH, and conductivity. Subsequently, appropriate sample bottles were filled. The Teflon tubing was reinserted into the well and the polyethylene bag was disposed of.

Analytical

All samples were analyzed by the Alaska Division of Water, Water Quality Laboratory in Fairbanks Alaska, with the exception of volatile organic samples. Northern Testing Laboratories of Fairbanks Alaska was contracted to provide sample containers and analysis for BTEX (benzene, toluene, ethylbenzene, and xylene) by EPA method 602 . Analytical methods are listed in Table 1. General data reduction procedures are described in Standard Methods (API-IA, 1989).

Table 1. Analytical methods.

Parameter	EPA method	Description	Detection Limit
pH	150.1	meter	
Conductivity	120.1	meter	----
Dissolved Oxygen	360.1	meter	0.10 mg/l
Chloride	300.0	ion chromatograph	0.01 mg/l
Nitrate	300.0	ion chromatograph	0.02 mg/l
Phosphate	300.0	ion chromatograph	0.10 mg/l
Total Petroleum Hydrocarbons (TPH)	418.1	infrared spectrophotometer	2.0 mg/l
Iron	AES 0029	DCP	0.03 mg/l
Lead	AES 0029	DCP	0.05 mg/l

Table 1 (cont). Analytical methods.

Parameter	EPA method	Description	Detection Limit
Benzene	602	gas chromatograph	0.2 ug/l
Toluene	602	gas chromatograph	0.3 ug/l
Ethyl Benzene	602	gas chromatograph	0.2 ug/l
Xylene	602	gas chromatograph	0.6 ug/l

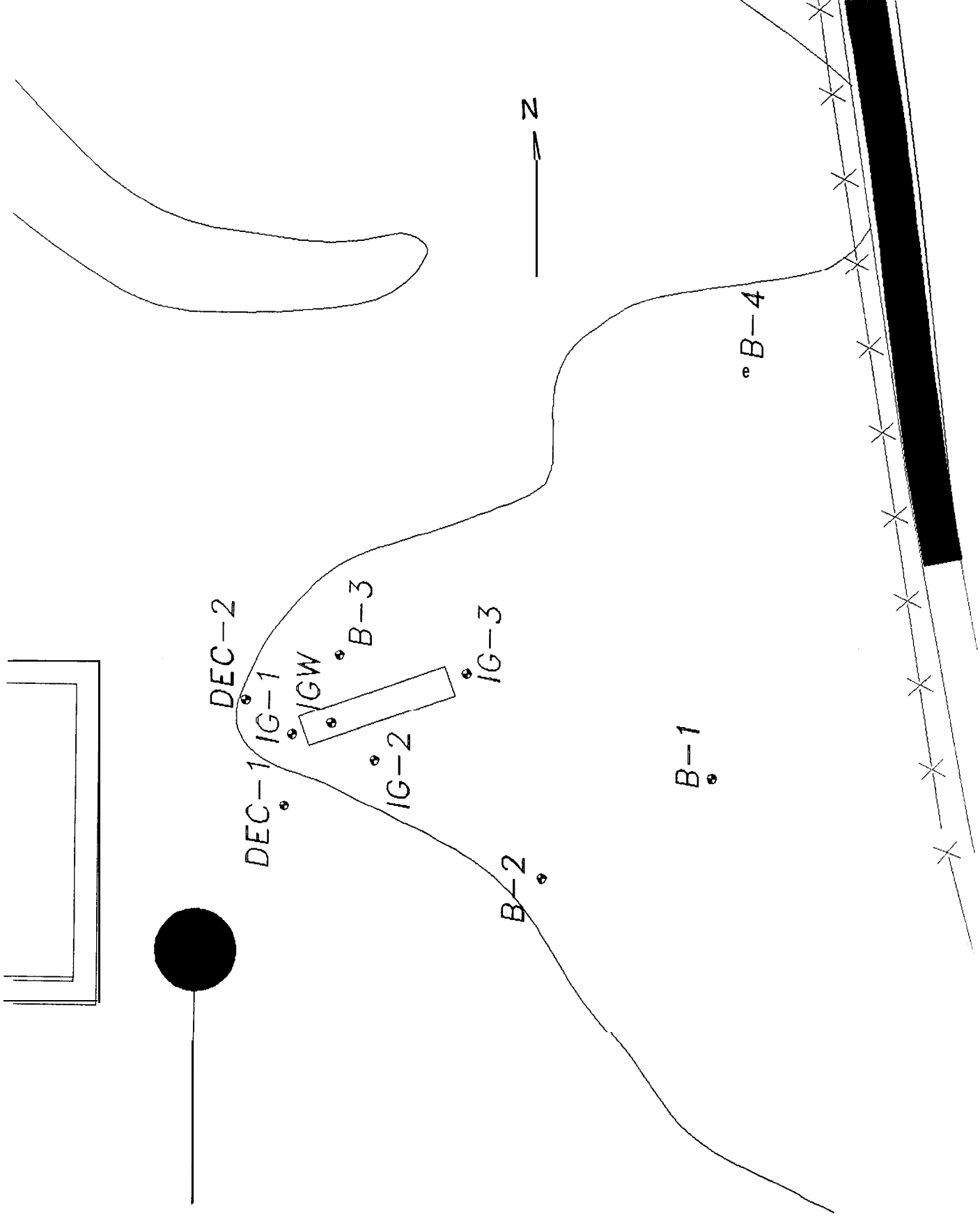

Figure 1. Well locations for the Fairbanks International Airport Bioremediation Project.

RESULTS

INORGANIC

The results from the wells are divided into three sections: wells off-site and upgradient (P-Tan); wells on-site not associated with the infiltration gallery (B-l, B-2, and B-4); and wells associated with the infiltration gallery (B-3, IG-1, IG-2, IG-3, IG-WW, DEC-1, DEC-2). Appendix A gives the results of the field parameters and inorganic analyses. Appendix B gives the results of the organic analyses.

Off-site/upgradient

P-Tan is the only well that is off-site and upgradient. The average values of some selected field and inorganic parameters are summarized in Table 2. It is assumed that since this site is upgradient, it is not influenced by the bioremediation project and will serve as a control.

On-site/not associated with the infiltration gallery

Wells B-l, B-2 and B-4 comprise this group. The average values of some selected field and inorganic parameters for these wells are summarized in Table 2. The pH and conductivity for these wells are similar, though there are slight differences. The dissolved oxygen in well B-4 appears to be higher than the others. This may be a result of the sampling procedure at that well. This was the only well which would draw-down to the bottom of the well and would require much longer purging times than the other wells. This might of had some influence on the dissolved oxygen.

The nitrate value at well B-2 was higher than the other wells (1.72 mg/l). The high average was caused by two high values (> 5 mg/l) in August and September. The source of the nitrates were from a failed pit upgradient of the well. This pit (another part of the bioremediation project) was filled with nitrate-enriched water. The average nitrate value without including those two samples was 0.65 mg/l. This is still higher than the other wells. The low iron concentration at this well reflects the nitrate concentrations. The nitrates oxidize the iron, causing it to precipitate out of solution. This is especially evident when the nitrate values were high. Although the nitrate value was low, well B-l shows the same effect from the leaking pit on August 20 when the iron value dropped below detection.

Well B-l was the only well with detectable phosphate concentrations. The average value was 0.10 mg/l, with values up to 0.31 mg/l in September.

Table 2. Average values for field and inorganic constituents for wells not associated with the infiltration gallery.

Well	pH	Conductivity (uS/cm)	Dissolved Oxygen (mg/l)	NO_3 (mg/l as N)	Cl (mg/l)	Fe (mg/l)
P-Tan	7.06	611	2.2	0.02	1.25	22.8
B-l	7.04	744	2.4	0.14	4.06	23.6
B-2	6.92	805	2.6	1.72	1.96	9.3
B-4	7.15	608	3.2	0.06	2.09	32.5

Infiltration gallery

The August 20 sampling of the infiltration gallery wells was just prior to the start-up of the installation. By the September 3 sampling, nitrate values were going up and iron concentrations were falling (Figures 2 and 3). This continued until the project was shut-down for winter. The chloride value for these wells remained very constant over the period of August 20 to October 1. The wells B-3 and IG-3 had average chloride values of 1.09 and 1.16 mg/l, respectively. The remaining wells had average chloride values ranging from 1.36 mg/l at well DEC-1 to 1.53 mg/l at well IG-1. This may provide some information as to the flow direction.

ORGANICS

Analyses for BTEX were conducted on a regular basis on samples from wells IG-1, IG-WW, DEC-1, and DEC-2. A one-time sampling of wells B-l, B-2, and B-4 was conducted during March. The results of all the analyses are given in Appendix B. Total petroleum hydrocarbon (TPH) analyses were also

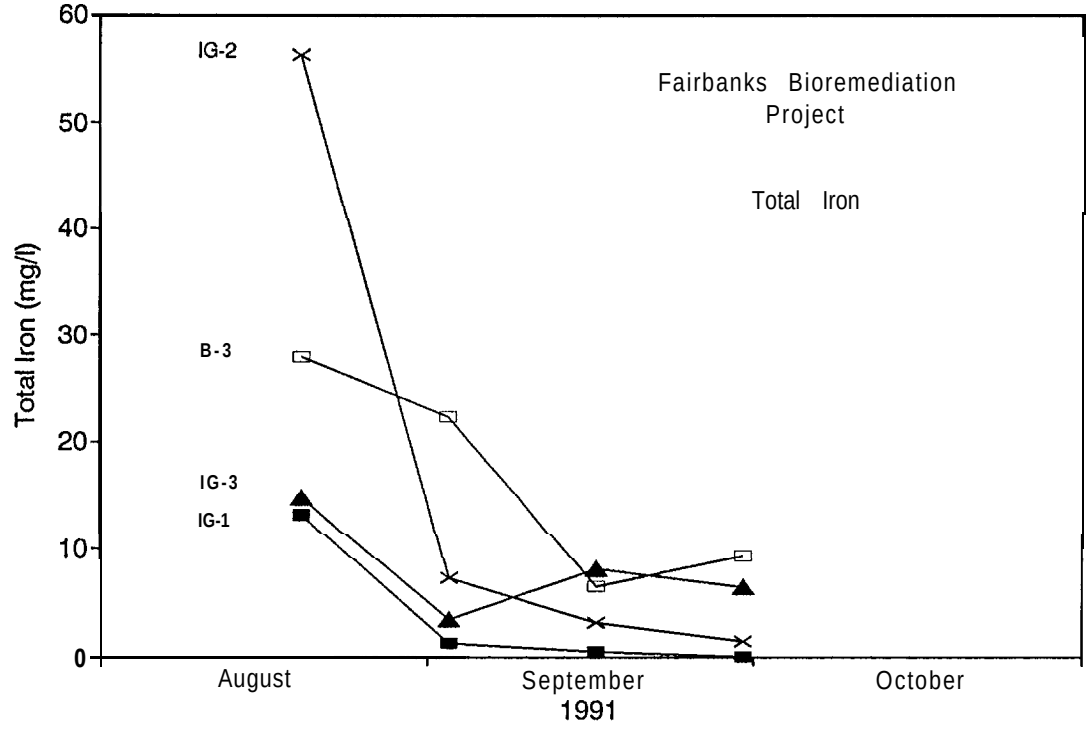

*Figure 2. Plot **of** total iron values **for** infiltration gallery wells, August through October, 1991.*

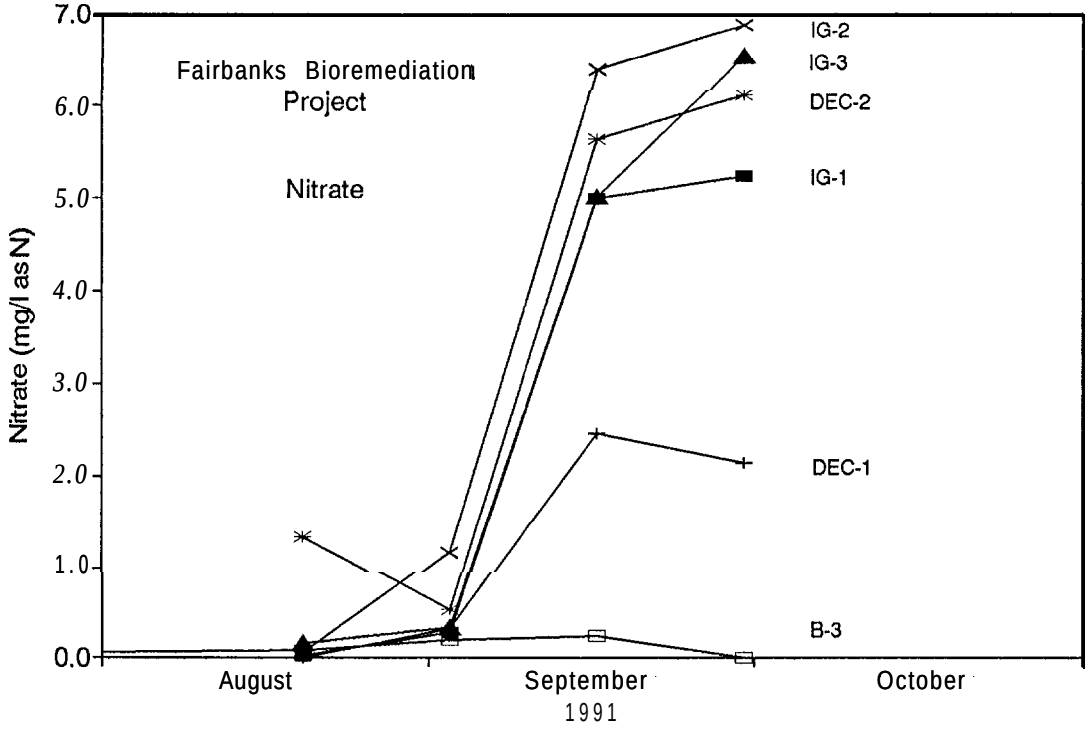

*Figure 3. Plot **of** nitrate values **for** infiltration gallery wells, August through October, 1991.*

conducted on the wells. With the exception of the initial sample at well B-2, well B-4 was the only well to have measurable TPH values. However by August, TPH was no longer detected at well B-4.

The results of the one-time BTEX sampling of wells B-l, B-2, and B-4 are summarized in Table 3. Both wells B-l and B-4 are near known spill sites.

Table 3. Results of the one-time BTEX sampling. All values are in ug/l.

Well	Benzene	Toluene	Ethyl Benzene	Xylene
B-l	71	9.0	14	15
B-2	<DL	<DL	<DL	<DL
B-4	130	0.8	4.4	13

The only infiltration gallery area well which consistently had measurable BTEX was IG-WW (except both DEC wells about 1 ug/l benzene on the initial sampling; IG-1 had small amounts on the initial sampling and on September 23). Initial samples at IG-WW were low, however the remaining were higher and consistent. Table 4 gives the average BTEX values for IG-WW. Values below detection were assumed zero for the calculation.

Table 4. Average values of BTEX at IG-WW. All values are in ug/l.

Well	Benzene	Toluene	Ethyl Benzene	Xylene
IG-WW	11	9.5	1.4	4.6

REFERENCES CITED

U.S. Environmental Protection Agency, 1982, Handbook For Sampling And Sample Preservation Of Water And Wastewater: U.S. Environmental Protection Agency, EPA-600/4-82-029 September 1982.

American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1989, Standard Methods for the Examination of Water and Wastewater, 17th edition: APHA, AWWA, WPCF, Washington, D.C.

APPENDIX A

Inorganic and field parameters

Date	pH	Cond	Dis Oxy	TPH	NO_3	PO_4	Cl	Fe	Pb
Well P-TAN									
15-Nov-90	7.10	653	0.9	<DL	<DL	<DL	---	24.8	<DL
13-Dec-90	7.19	564	2.7	<DL	0.10	<DL	---	22.2	<DL
13-Feb-91	6.84	519	---	<DL	0.01	<DL	1.91	16.1	---
21-Mar-91	6.97	486	2.8	<DL	<DL	<DL	1.58	28.1	---
24-Apr-91	7.00	515	1.6	<DL	0.04	<DL	1.58	21.2	---
B-May-91	7.00	805	2.2	<DL	<DL	<DL	2.01	30.4	---
25-Jun-91	7.07	744	3.0	<DL	<DL	<DL	0.65	23.1	---
20-Aug-91	7.26	597	2.2	<DL	<DL	<DL	0.80	17.2	---
17-Sep-91	7.14	619	2.1	<DL	<DL	<DL	0.21	21.8	---
Well B-l									
15-Nov-90	7.04	870	1.9	2.3	0.22	<DL	---	29.2	<DL
13-Dec-90	7.07	665	2.2	<DL	0.07	<DL	---	19.3	<DL
13-Feb-91	7.03	695	---	<DL	0.14	<DL	5.66	22.2	---
21-Mar-91	7.11	792	2.7	<DL	0.37	0.1	5.22	25.6	---
24-Apr-91	7.23	710	1.7	<DL	0.06	<DL	4.71	30.1	---
B-May-91	7.03	848	2.8	<DL	0.05	<DL	4.51	24.6	---
25-Jun-91	6.95	720	3.5	<DL	0.09	0.26	2.36	31.8	---
20-Aug-91	6.90	670	2.3	<DL	0.15	0.25	2.70	<DL	---
17-Sep-91	7.03	724	1.7	<DL	0.11	0.31	3.28	29.2	---
Well B-2									
15-Nov-90	7.02	807	4.2	<DL	0.05	<DL	---	14.9	<DL
13-Dec-90	6.93	721	2.5	<DL	0.13	<DL	---	10.5	<DL
13-Feb-91	6.90	815	---	<DL	1.57	<DL	2.10	6.2	---
21-Mar-91	6.89	857	1.6	<DL	1.55	<DL	2.22	6.5	---
24-Apr-91	7.05	870	1.9	<DL	0.40	<DL	0.70	19.6	---
28-May-91	6.98	888	2.3	<DL	0.35	<DL	4.48	10.4	---
25-Jun-91	6.82	800	4.2	<DL	0.45	<DL	1.51	12.4	---
20-Aug-91	6.92	755	1.9	<DL	5.39	<DL	1.39	1.3	---
17-Sep-91	6.81	730	2.3	<DL	5.55	<DL	1.30	1.9	---

All units are mg/l except:

pH - pH units
Conductivity - uS/cm

APPENDIX A **(cont)**

Date	pH	Cond	Dis Oxy	TPH	NO_3	PO_4	Cl	Fe	Pb
Well B-3									
15-Nov-90	---	---	---	---	---	---	---	---	---
13-Dec-90	---	---	---	---	---	---	---	---	---
13-Feb-91	---	---	---	---	---	---	---	---	---
21-Mar-91	6.85	1161	2.0	<DL	0.05	<DL	0.96	62.1	---
24-Apr-91	7.05	1095	1.1	<DL	0.07	<DL	0.85	85.9	---
B-May-91	6.85	1058	2.4	<DL	0.05	<DL	0.87	48.6	---
25-Jun-91	6.91	810	4.1	<DL	0.04	<DL	4.78	56.5	---
20-Aug-91	7.00	826	2.2	<DL	0.07	<DL	1.10	28.0	---
03-Sep-91	---	---	---	<DL	0.18	<DL	0.84	22.4	---
17-Sep-91	7.07	483	2.4	<DL	0.23	<DL	1.49	6.6	---
01-Oct-91	---	---	---	<DL	<DL	<DL	0.91	9.4	---
Well B-4									
15-Nov-90	6.95	828	2.3	17	<DL	<DL	---	36.2	<DL
13-Dec-90	7.05	681	2.8	7.6	0.14	<DL	---	38.4	<DL
13-Feb-91	7.02	673	---	6.6	<DL	<DL	4.04	68.4	---
21-Mar-91	6.88	619	2.4	2.0	<DL	<DL	3.61	33.3	---
24-Apr-91	7.50	319	2.6	2.2	0.05	<DL	1.07	15.8	---
B-May-91	7.15	599	3.7	2.3	<DL	<DL	1.60	22.8	---
25-Jun-91	7.02	538	5.2	2.4	<DL	<DL	0.98	18.5	---
20-Aug-91	7.35	622	3.9	<DL	0.15	<DL	1.59	31.7	---
17-Sep-91	7.39	597	2.4	<DL	0.16	<DL	1.77	27.3	---
Well IG-1									
20-Aug-91	7.24	511	2.1	<DL	0.02	<DL	1.64	13.3	---
26-Aug-91	---	---	---	---	---	---	---	---	---
03-Sep-91	---	---	---	<DL	0.26	<DL	1.69	1.3	---
10-Sep-91	---	---	---	---	---	---	---	---	---
17-Sep-91	---	---	---	<DL	5.00	<DL	1.70	0.53	---
23-Sep-91	---	---	---	---	---	---	---	---	---
Ol-act-91	---	---	---	<DL	5.24	<DL	1.08	0.02	---
07-Oct-91	---	---	---	---	---	---	---	---	---

All units are mg/l except:

pH - pH units
Conductivity - uS/cm

APPENDIX A (cont)

Date	pH	Cond	Dis Oxy	TPH	NO_3	PO_4	Cl	Fe	Pb
Well IG-2									
20-Aug-91	7.00	839	3.0	<DL	0.05	<DL	1.13	56.2	---
03-Sep-91	---	---	---	<DL	1.17	<DL	1.60	7.3	---
17-Sep-91	7.31	483	4.8	<DL	6.40	<DL	1.91	3.2	---
01-Oct-91	---	---	---	<DL	6.88	<DL	0.96	1.5	---
Well IG-3									
20-Aug-91	6.84	851	2.2	<DL	0.15	<DL	0.65	14.8	---
03-Sep-91	---	---	---	<DL	0.32	<DL	1.63	3.5	---
17-Sep-91	7.12	479	2.5	<DL	5.01	<DL	1.41	8.2	---
01-Oct-91	---	---	---	<DL	6.55	<DL	0.95	6.5	---
Well IG-WW									
20-Aug-91	---	---	---	---	---	---	---	---	---
26-Aug-91	---	---	---	---	---	---	---	---	---
03-Sep-91	---	---	---	---	---	---	---	---	---
10-Sep-91	---	---	---	---	---	---	---	---	---
17-Sep-91	---	---	---	---	---	---	---	---	---
23-Sep-91	---	---	---	---	---	---	---	---	---
01-Oct-91	---	---	---	---	---	---	---	---	---

All units are mg/l except:

pH - pH units
Conductivity - uS/cm

APPENDIX A (cont)

Date	pH	Cond	Dis Oxy	TPH	NO_3	PO_4	Cl	Fe	NO_3-NTL
Well DEC.1									
20-Aug-91	6.83	695	---	<DL	<DL	<DL	1.13	---	<DL
26-Aug-91	- - -	---	---	...	---	---	---	---	0.05
03-Sep-91	---	---	---	<DL	0.31	<DL	1.53	---	0.43
10-Sep-91	- - -		---	...	...	...	...	---	2.10
17-Sep-91	7.09	422	---	<DL	2.46	<DL	1.65	---	3.83
23-Sep-91	---	---	---	---	---	---	---	---	7.30
01-Oct-91	- - -		---	<DL	2.15	<DL	1.14	2.1	2.10
07-Oct-91	- - -		---	---	---	---	---	---	0.80
Well DEC.2									
20-Aug-91	6.90	635	---	<DL	1.34	<DL	1.36	---	1.38
26-Aug-91	- - -	---	---	...	---	---	---	---	0.28
03-Sep-91	- - -		---	<DL	0.51	<DL	1.69	---	0.45
10-Sep-91	- - -		---	---	---	---	---	---	4.10
17-Sep-91	---	---	---	<DL	5.64	<DL	1.75	---	7.08
23-Sep-91	---	---	---	---	---	---	---	---	7.85
01-Oct-91	- - -		---	<DL	6.11	<DL	1.13	0.03	6.78
07-Oct-91	- - -		---	---	---	---	---	---	6.50

All units are mg/l except:

pH - pH units
Conductivity - uS/cm

NO_3-NTL: Nitrate sample analyzed by Northern Testing Laboratory - Fairbanks, Alaska

APPENDIX B

Organic parameters

all values in ug/l

Date	Benzene	Toluene	Ethylbenzene	Xylene
Well B-l				
21-Mar-91	71	9.0	14	1.5
Well B-2				
21-Mar-91	<DL	<DL	<DL	<DL
Well B-4				
21-Mar-91	130	0.8	4.4	13
Well IG-1				
20-Aug-91	0.8	0.5	0.3	2.1
26-Aug-91	<DL	<DL	<DL	<DL
03-Sep-91	<DL	<DL	<DL	<DL
10-Sep-91	<DL	<DL	<DL	<DL
17-Sep-91	<DL	<DL	<DL	<DL
23-Sep-91	<DL	0.3	0.3	1.7
Ol-act-91	<DL	<DL	<DL	<DL
07-Oct-91	<DL	<DL	<DL	<DL
Well IG-WW				
26-Aug-91	12	<DL	<DL	<DL
03-Sep-91	6.7	1.5	<DL	0.7
10-Sep-91	15	15	1.5	5.7
17-Sep-91	10	17	2.0	6.5
23-Sep-91	13	15	2.4	8.3
01-Oct-91	9.8	8.2	2.2	6.5
Well DEC-1				
20-Aug-91	1.0	<DL	<DL	<DL
03-Sep-91	<DL	<DL	<DL	<DL
17-Sep-91	<DL	<DL	<DL	<DL
01-Oct-91	<DL	<DL	<DL	<DL

Organic parameters

all values in ug/l

Date	Benzene	Toluene	Ethylbenzene	Xylene
Well DEC-2				
20-Aug-91	0.9	<DL	<DL	<DL
03-Sep-91	<DL	<DL	<DL	<DL
17-Sep-91	<DL	<DL	<DL	<DL
01-Oct-91	<DL	<DL	<DL	<DL