cc Rankin Inl. Mines

Environment Canada / Environnement Canada
Environmental Protection / Protection de l'Environnement
Box 2310
Yellowknife, N.W.T.
X0E 1H0

December 13, 1978

Your file *Votre référence*

Our file *Notre référence*
4221-70/y24

Mr. W. Moore
Mine Manager
Giant Yellowknife Mines Ltd.
Yellowknife, N.W.T.
X0E 1H0

Dear Mr. Moore:

Re: Yellowknife Snow Surveys. 1977, 1978

Pleased find enclosed a copy of the above surveys. We are pleased that there has been a substantial improvement in the arsenic values over the 1975 values.

Should you require any further information please do not hesitate to call.

Yours truly,

Tom Dafoe

RJK:bh

Encl.

c.c. Mr. C. Oelson
Mr. M. Hawes
Mr. M. Hewitt
Mr. M. Ballantyne

EP-1002

Government of Canada / Gouvernement du Canada

MEMORANDUM **NOTE DE SERVICE**

TO / À: File

FROM / DE: Asit K. Hazra
Snr. Project Eng.

SECURITY - CLASSIFICATION - *DE SÉCURITÉ*:

OUR FILE - *N/RÉFÉRENCE*: 4421-70/y24

YOUR FILE - *V/RÉFÉRENCE*:

DATE: November 15, 1978

SUBJECT / *OBJET*: SNOW SURVEYS - Yellowknife, NWT - 1977, 1978

The Environmental Protection Service, as part of its ongoing arsenic monitoring program in the Yellowknife area, collected core snow samples during March/April, 1977 and 1978. The 1977 snow survey was basically conducted to obtain samples for a quality assurance program on analytical arsenic techniques, whereas the prime objectives of the 1978 survey were firstly to quantify the concentration of arsenic in melted snow, and secondly, to assess the deposition rate of arsenic during the winter of 1977-78 and thirdly, to compare the results with a similar survey conducted in 1975. The results of the 1975 survey have been published in EPS report 5-NW-77-7 entitled "Chemical Characteristics of Snow in the Yellowknife Area, NWT - 1975."

All snow samples collected in 1977 and 1978 were core samples. The sampling procedure was identical to the procedure outlined in the above referenced report.

The 1977 samples were analyzed exclusively for arsenic utilizing different laboratories and both the graphite furnace (atomic absorption spectroscopy) as well as the vasak and sedivec colorimetry technique. The results of the quality assurance program were fairly consistent. Since only 12 samples were collected in 1977, the results are too sparce for an accurate comparison with either the 1975 or 1978 surveys. Nonetheless, such a comparison is undertaken.

The location of the sampling sites for the 1978, 1975, and 1977 surveys have been depicted in figures 1, 2, and 3 respectively. Further, average arsenic concentrations obtained at each site during the 1978, 1975 and 1977 surveys have been depicted in figures 4, 5 and 6 respectively.

During the 1978 snow survey, a total of 54 core samples were collected. The accuracy of the analytical results were checked as part of the quality.

assurance program and the results have been presented in Table 1 and is similar to Table 4 of the 1975 report. Analytical procedures were fairly similar, the only major differences being that Antimony and Beryllium were dropped whereas cyanide was added to the list of heavy metals analyzed; the method for mercury analysis was changed from atomic absorption spectroscopy to the pharmacia mercury monitor; the method for total arsenic analysis was changed from vasak and sedivec to atomic absorption spectroscopy and the amount of arsenic present in the trivalent state was determined in addition to the amount of total arsenic.

The results of the 1978 snow survey have been summarized in Table 2 in a format similar to Table 5 of the 1975 report. In addition, a frequency distribution of arsenic concentrations obtained in these samples is given in Table 3. Analyzing the data and comparing it with the specifications of the of the Canadian Drinking Water Standards (1968) indicates the following: the concentration of arsenic in 50% of these samples was greater than the maximum permissible level of 0.05 mg/l specified by the standards, and 1% of the values were at least an order of magnitude greater than the limit. Most samples (85%) did not fall within the range of pH specified by the standards. Elevated concentrations of lead were noted in a number of instances and 4% of the samples analyzed contained concentrations in excess of the value of 0.05 mg/l specified by the standards. Values for iron were also high, such that 17% of the samples exceeded the maximum of 0.3 mg/l indicated by the standards. A number of samples (6%) also contained manganese in excess of the limit of 0.05 mg/l specified by the standards. Concentrations of cadmium, copper, cyanide, mercury, sulphate and zinc, however, did not exceed the levels specified by the standards.

Core samples are representative of all deposition and precipitation events occurring since the first snow cover for the particular winter season. Isopleths of arsenic deposition rates for 1978 and 1975 have been presented in figures 7 and 8 respectively. As expected, the isopleths correlate well with wind rose information, since such samples are not strongly influenced by short term meteorological conditions.

A geometric mean value of 0.002 tons arsenic/sq. mile/month was obtained as the overall total deposition rate for the winter of 1977-78. These calculations reflect best estimates and hence prudence should be exercised in quoting these depostion rate figures.

For comparison purposes, frequency distributions of arsenic concentrations in melted snow samples for 1975, 1977 and 1978 have been presented in Table 4. These results indicate that the 1977 arsenic values are fairly similar to the 1975 values However, the 1978 arsenic results are a substantial improvement in comparison to 1975 values. Iron and lead concentrations as well as pH values also improved in 1978 in comparison to 1975 values.

-70.6%

The isopleths of arsenic deposition rates for 1978 and 1975 presented in figures 7 & 8 respectively, clearly indicate that Giant Yellowknife Mines Limited continues to be the most significant source of arsenic to the

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ambient air. They also visually demonstrate the substantial reduction in arsenic deposition rates observed in 1978 in comparison to 1975.

The geometric mean arsenic concentration in melted snow samples was 0.05 ug/ml as compared to 0.17 ug/ml in 1975. Further, a geometric mean value of 0.002 tons arsenic/sq. mile/month was obtained as the overall total deposition rate for the winter of 1977-78 as compared to a value of 0.0053 tons arsenic/sq. mile/month for the winter of 1974-75.

Finally, the summary section as well as most of the conclusions and recommendations of EPS report 5-NW-77-7 still apply.

Asit K. Hazra

AH/nb

cc: J. Parkinson
H. Veldhuizen
W. J. Bryant
W. A. Lemmon

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TABLE 1. ACCURACY OF ANALYTICAL RESULTS FOR CORE SAMPLES - 1978

Parameter	Quantity of Preservative per liter of Sample	Time Limit for Analysis (in days)	Method of Analysis	Actual Time of Analysis (in days)	Reproducibility (±)
pH	None	1	Hydrogen Ion Meter	1	2
Arsenic (Total)	1 ml conc. Nitric Acid	180	Atomic Absorption Spectroscopy	14	15
Arsenic (+3)	None	14	Modified Vasak & Sedivec Colorimetry	14	15
Sulphate	None	7	Turbidimetric Method	<14	10
Cadmium	1 ml conc. Nitric Acid	180	Atomic Absorption Spectroscopy	21	5
Copper	"	180	"	"	5
Cyanide	Sodium Hydroxide	14	Selective Ion Electrode	7	5
Iron	1 ml conc. Nitric Acid	180	Atomic Absorption Spectroscopy	21	3
Lead	"	180	"	"	6
Manganese	"	180	"	"	2
Mercury	Nitric Acid/$K_2Cr_2O_7$	60	Pharmacia Mercury Meter	7	10
Nickel	1 ml conc. Nitric Acid	180	Atomic Absorption Spectroscopy	21	5
Zinc	"	180	"	"	5

TABLE 2. SUMMARY OF RESULTS FOR CORE SNOW SAMPLES - 1978

Parameter	Sample Analysis Range	Reproducibility (±)	Canadian Recommended Allowable Limit for Potable Water	Samples Not Within Recommended Canadian Allowable Limit		EPA (1973) Recommended Maximum Limit
				Number	%	
pH	4.3 - 7.7	2	6.5 - 8.3	46	85	5 - 9
Arsenic	<0.01 - 1.7 ug/ml	15	<0.05 ug/ml	27	50	<0.10 ug/ml
Sulphate	<5 - 14.5 ug/ml	10	<500 ug/ml	0	0	<250 ug/ml
Cadmium	<0.001 - 0.002	5	<0.01 ug/ml	0	0	<0.01 ug/ml
Copper	<0.001 - 0.01 ug/ml	5	<1 ug/ml	0	0	<1 ug/ml
Cyanide	<10 ng/ml	5	<10 ng/ml	0	0	=
Iron	<0.01 - 3.9 ug/ml	3	<0.3 ug/ml	9	17	<0.3 ug/ml
Lead	<0.01 - 0.14 ug/ml	6	<0.05 ug/ml	2	4	<0.05 ug/ml
Manganese	<0.01 - 0.10 ug/ml	2	<0.05 ug/ml	3	6	<0.05 ug/ml
Mercury	<0.10 - 1.7 ng/ml	10	<2 ng/ml	0	0	<2 ng/ml
Nickel	<0.02 ug/ml	5	-	-	-	<0.1 ug/ml
Zinc	<0.003 - 0.066 ug/ml	5	<5 ug/ml	0	0	<5 ug/ml

TABLE 3. FREQUENCY DISTRIBUTION OF ARSENIC CONCENTRATIONS IN MELTED CORE SNOW SAMPLES - 1978

Range of Arsenic Concentrations (ug/ml)	Frequency distribution of Snow Samples Analyzed	
	Number of Samples	% of Samples
<0.05	27	50
0.05 - 0.25	25	46
0.25 - 0.50	1	2
<0.5	1	2

Geometric Mean (Arsenic Concentration) 0.05 ug/ml.

TABLE 4. COMPARISON OF FREQUENCY DISTRIBUTION OF ARSENIC CONCENTRATIONS IN MELTED SNOW SAMPLES - 1975/77/78

Range of Arsenic Concentrations (ug/ml)	Frequency Distribution of Snow Samples Analyzed					
	1975 Samples		1977 Samples		1978 Samples	
	No.	%	No.	%	No.	%
<0.05	9	17	3	25	27	50
0.05 - 0.25	27	53	6	50	25	46
0.25 - 0.50	8	15	1	8	1	2
<0.5	8	15	2	17	1	2
TOTALS	52	100	12	100	54	100
Geometric Mean (Arsenic Concentration)	0.17 ug/ml		0.16 ug/ml		0.05 ug/ml	

70.6% reduction.

Yellowknife Bay Area

★ GIANT MINE SITE

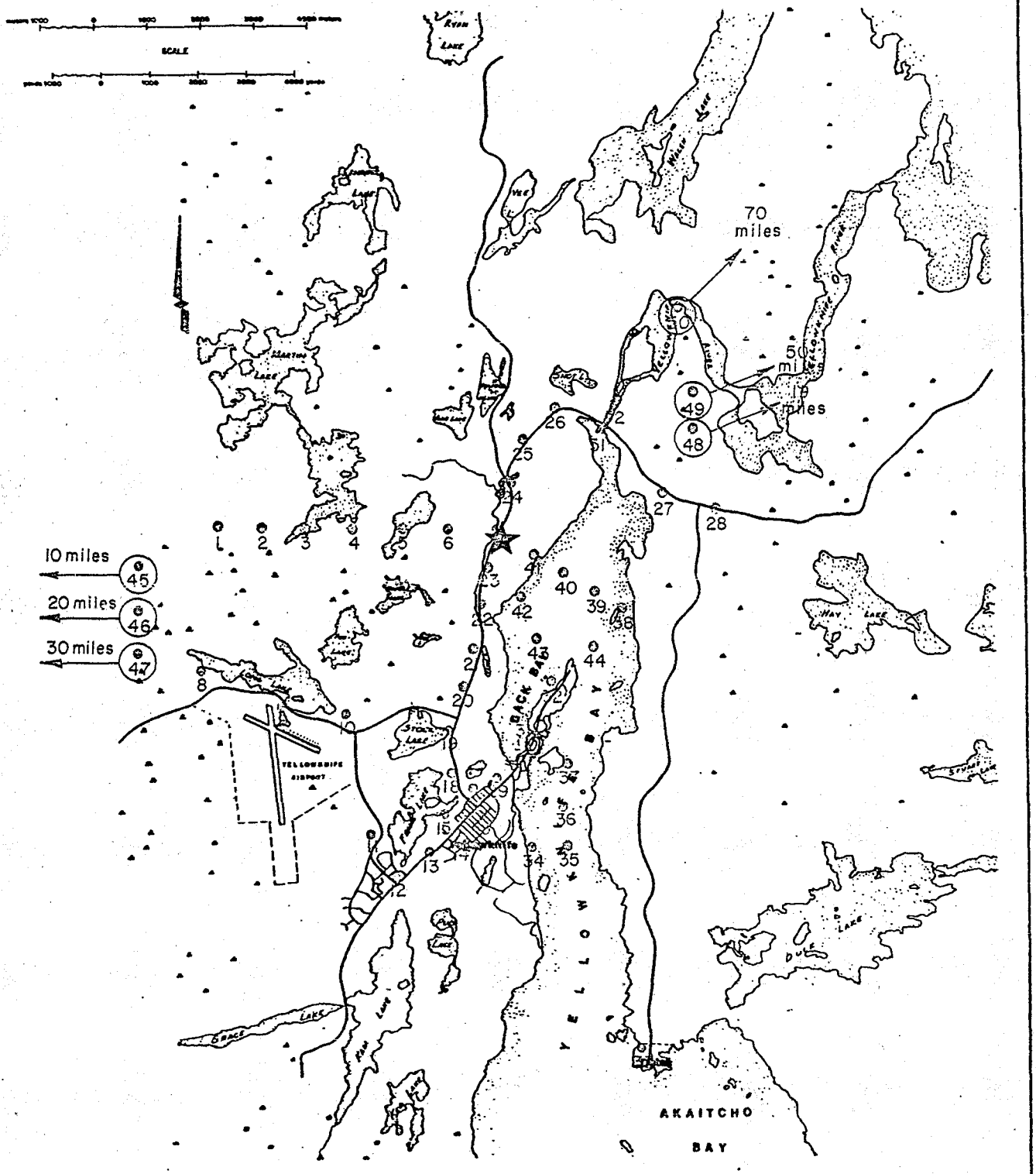

FIGURE 2. LOCATION OF CORE SNOW SAMPLE SITES – MARCH/APRIL 1975

Yellowknife Bay Area

N – New site

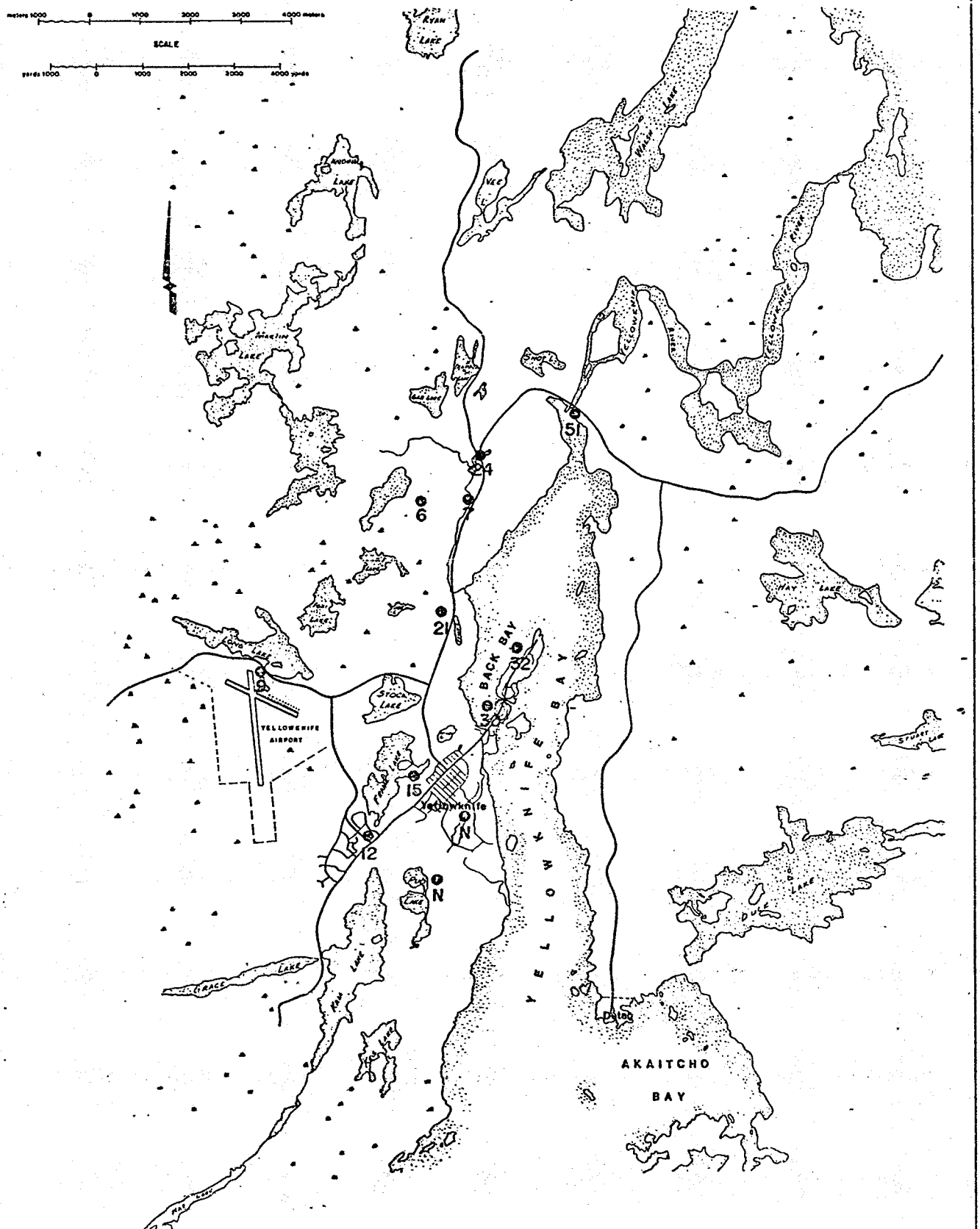

FIGURE 3. LOCATION OF CORE SNOW SAMPLE SITES - MARCH/APRIL 1977

Yellowknife Bay Area

★ GIANT MINE SITE

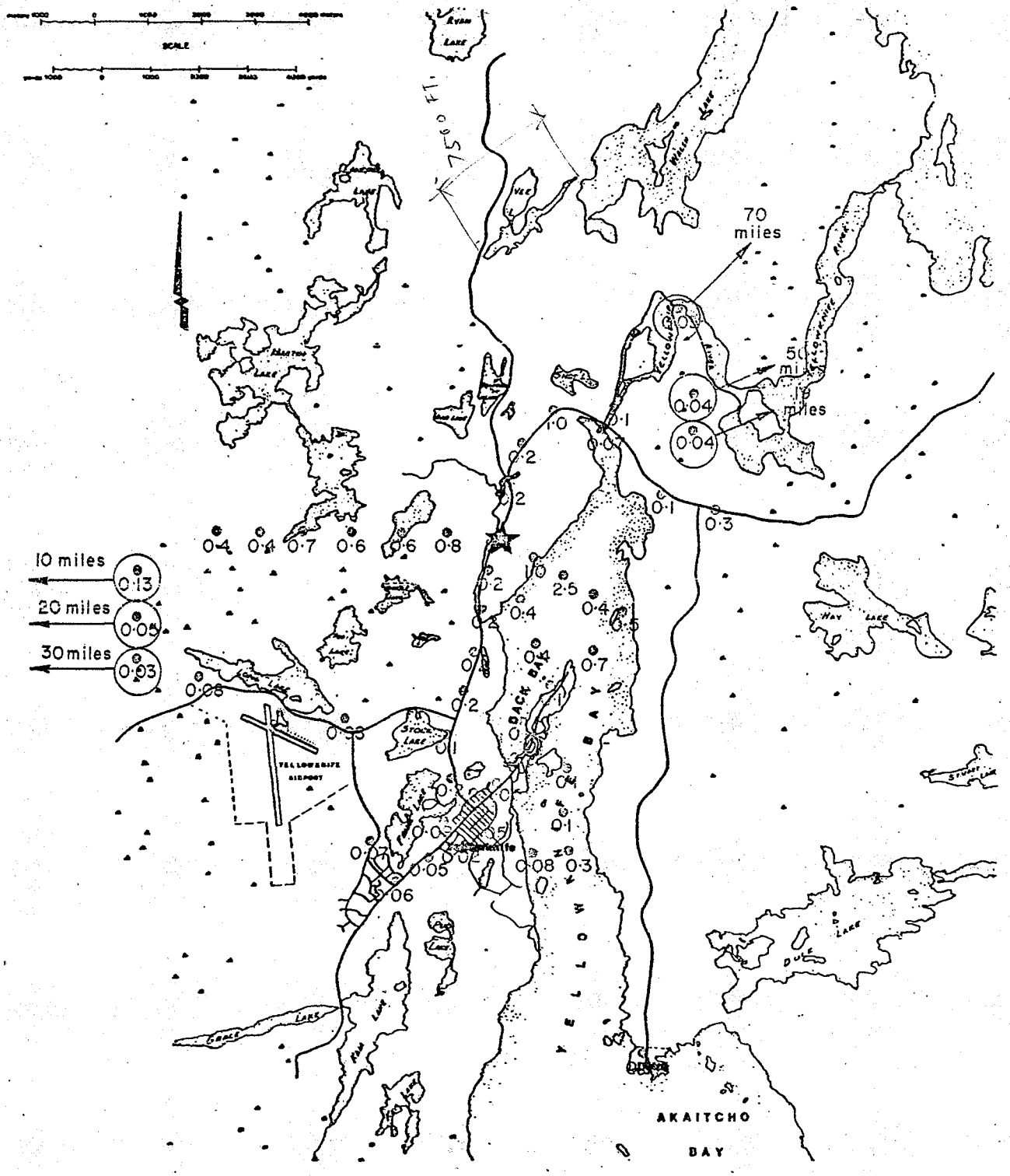

FIGURE 5. ARSENIC CONCENTRATIONS IN CORE SNOW SAMPLES MARCH/APRIL 1975

Yellowknife Bay Area

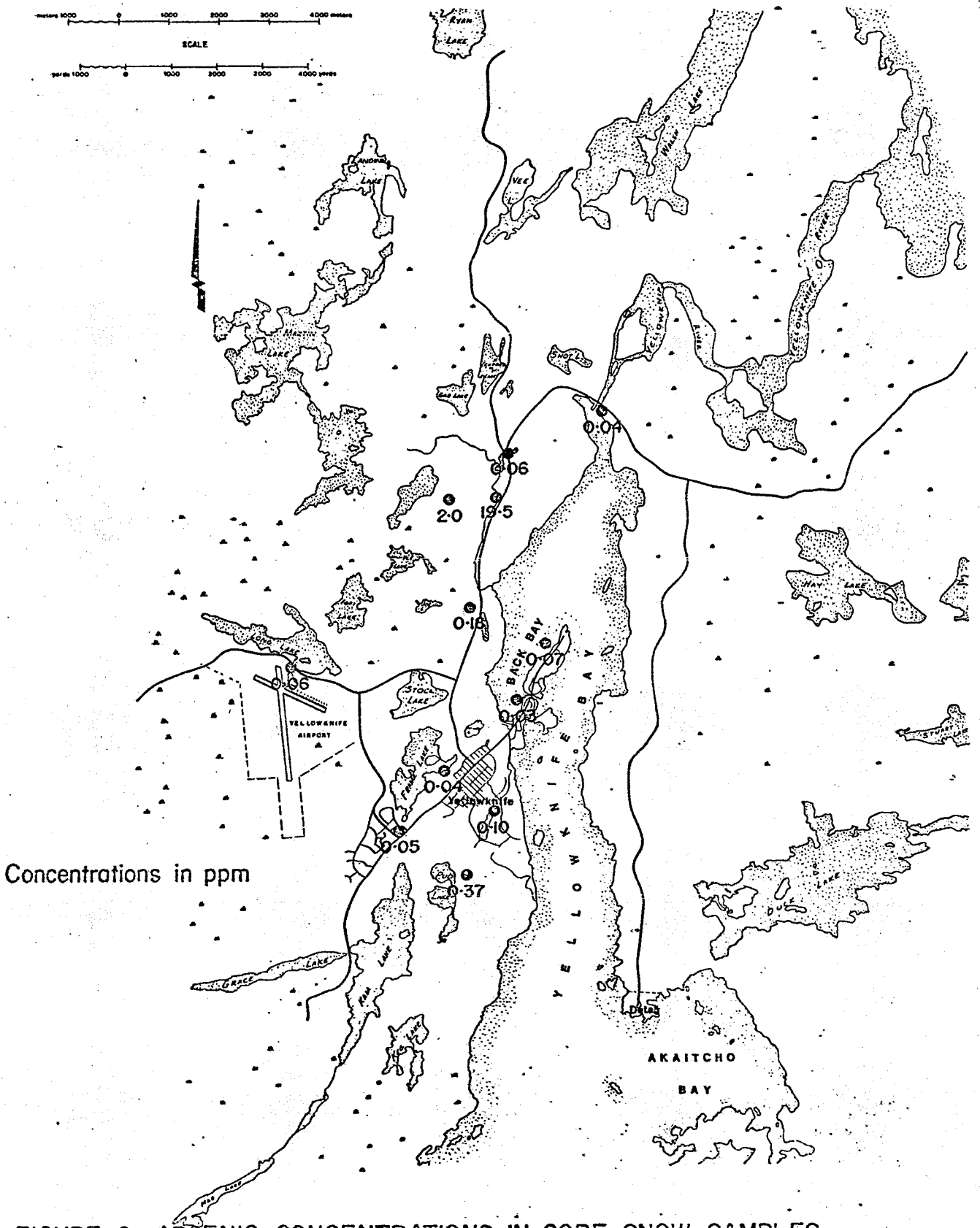

FIGURE 6. ARSENIC CONCENTRATIONS IN CORE SNOW SAMPLES MARCH/APRIL 1977

Yellowknife Bay Area

★ GIANT MINE SITE

NOTE:
0·032 TONS As/mi.^{2}/min
EQUIVALENT TO 1ug As/ml

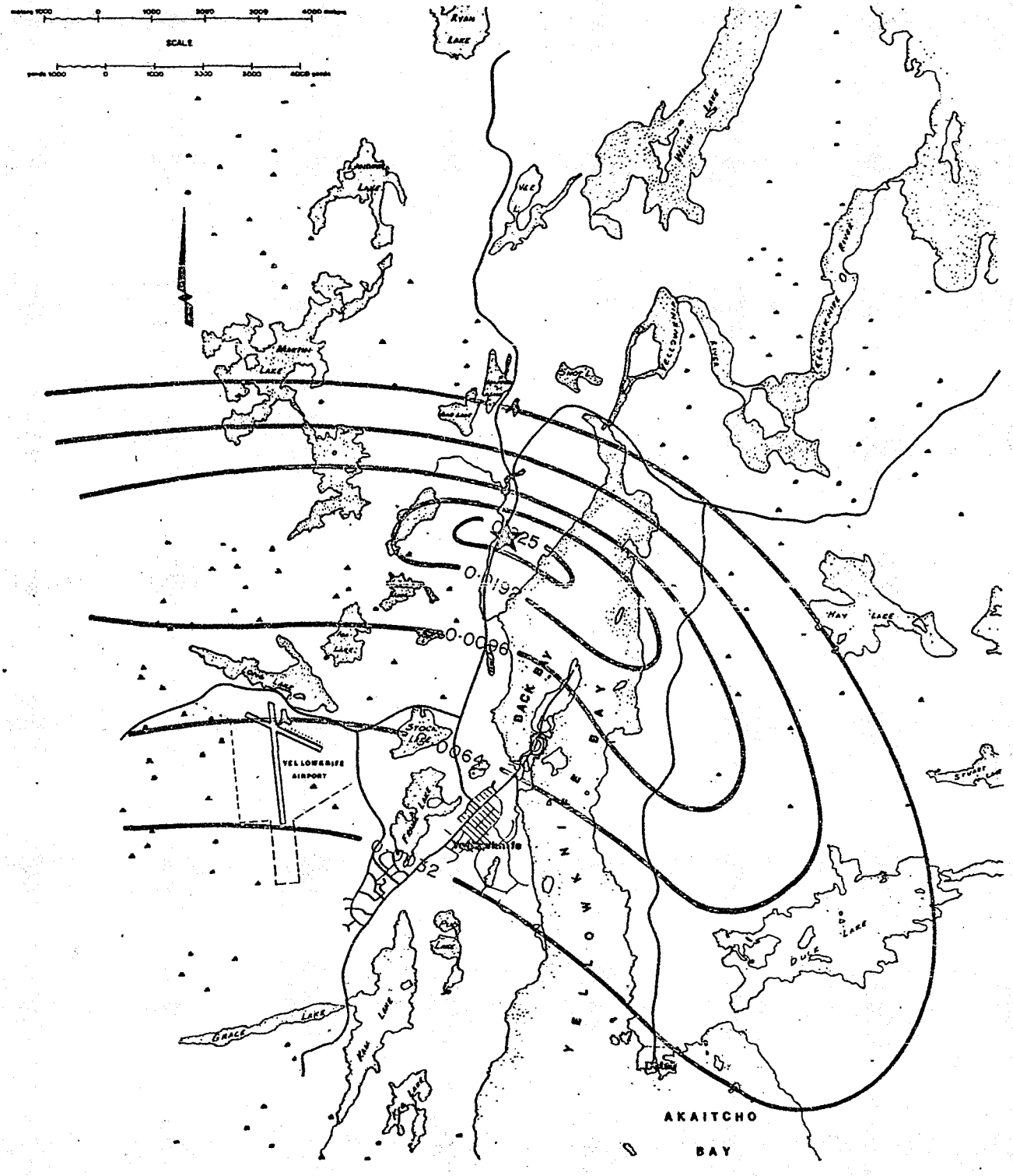

FIGURE 8. ARSENIC ISOPLETHS FOR SNOW SURVEY - 1975