REPORT #2

A Report on the CONTINUED INVESTIGATIONS INTO THE OCCURRENCE OF METALS AND ARSENIC IN PRIVATE DRINKING WATER SUPPLIES OF THE TRI-TOWN AREA

October 1977
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APPENDIXES

I PURPOSE

To determine the level of arsenic and heavy metals of all private water supplies in and adjacent to the designated areas of the Tri-town area (See Preliminary Report, April 1977), not sampled during the earlier survey.

To designate and monitor a number of private water supplies to determine the magnitude of any variations in water quality.

II SUMMARY

This report details the continuation of the study that began in the fall of 1976, investigating the occurrence of heavy metals and arsenic in private water supplies in the Tri-town area of Northern Ontario.

Initially during the fall of 1976 and early winter of 1977, 188 private water supplies were tested for the following elements; arsenic, cobalt, lead, zinc, cadmium, nickel, and silver. Investigators were primarily concerned with the levels of arsenic detected in the water supplies, due to the extensive arsenic-bearing mineralization throughout the area and the large quantities of arsenic bearing tailings from mining operations. In response to the recommendations of the initial report, further testing of private water supplies was conducted from May to August of 1977.

Part A Sampling Additional Supplies

In the preliminary study, 188 private water supplies were sampled. Since the beginning of May 1977, a further 187 supplies were tested. This further testing was done both in areas where sampling had previously been done, and areas not tested during the initial sampling. Approximately 15% of the wells tested since May 1977, were within the eight designated circles shown in the preliminary report. The remaining 85% occurred outside of the circles.

In the 1976 work, 12 of the 188 private water supplies had arsenic levels over the Ministry objective of 0.01 mg/litre. Of the 187 supplies tested in 1977, 2 wells were above the objective level. These 2 wells were both located in a circled area of previous sampling.

Part B Sampling to confirm variations in Water Quality

In the initial testing, 59 supplies were found to have a detectable level of arsenic present. To obtain further information on the possible fluctuations of the arsenic and heavy metal levels, staff attempted to sample these wells two more times during 1977. Between May 24, and June 9, 1977, forty-three of these suspect supplies

were resampled twice. At this time, 5 wells that had not previously shown the presence of arsenic were also resampled. In the second testing period (July 26 to August 25, 1977), 61 wells were tested.

The arsenic levels from these suspect supplies are generally less than 0.004 mg/l (MOE objective 0.010 mg/l). The results confirm that the amount of arsenic in these water supplies is subject to fluctuation.

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III BACKGROUND

As a result of work undertaken in 1975 and 1976, and reported on in the April 1977 Report entitled "A Report on the PRELIMINARY INVESTIGATIONS INTO THE OCCURRENCE OF METALS AND ARSENIC IN DRINKING WATER SUPPLIES OF THE TRI-TOWN AREA", Ministry staff set up a further sampling program to attempt to answer some of the questions raised by the preliminary investigations. The 1977 follow-up work was directed mainly at:

1) determining if there were additional wells where arsenic or metal levels were beyond the Provincial objectives;

2) determining if there were variations of arsenic levels in wells throughout the year;

3) determining if the probable source of the excessive arsenic can be accounted for during a detailed examination of selected supplies.

It should be stressed that this work merely supplements the first report and in no way examines environmental problems related to the mining industry activities or the natural geological formations. Experts in those fields have already, or will supply that information in other documents. This report deals exclusively with the status of 375 private and five communal water supplies in the Tri-town area, little more.

IV PROCEDURE

(a) Sampling of Remaining Private Water Supplies

Since the beginning of May 1977, one field staff member sampled 187 private water supplies which were not tested during the preliminary survey. This testing was done both in areas where sampling previously had been done (in an attempt to collect a sample from all supplies), and areas beyond those tested during the initial sampling period. Approximately 15% of the new supplies sampled in 1977 were in the designated "potential problem areas" shown in the preliminary report. The remaining 85% occurred outside of these 8 areas.

Undoubtedly, there are still a small number of supplies in the designated areas (perhaps as many as 10) which have not been sampled because no one was present during the three times a Ministry inspector visited the house.

Samples were taken from the point where residents obtained their drinking water, preserved with nitric acid, then shipped to the Ministry of the Environment laboratory in Toronto for analysis. When the analysis results were received in the North Bay District Office, staff notified the users of systems by telephone if any of the test parameters was at or near Provincial objectives, and confirmed the call with a letter (two supplies had Arsenic levels above the Ontario Drinking Water objectives, but less than the criteria for the rejection of the supply).

(b) Determining if there were variations in Arsenic Levels in Various Supplies

On the initial testing, 59 supplies were identified which had detectable levels of arsenic (12 of these had arsenic over the MOE objective). These supplies were resampled twice during the summer. The samples were handled in the same manner as outlined above.

(c) Determining Possible Source of Arsenic Contamination of Various Wells

District staff, accompanied by the Regional Ground Water Hydrogeologist undertook a detailed inspection of several water supplies in the surrounding area to determine if there was evidence of natural or man made features which might account for the measured arsenic levels. The findings are presented as appendix VI.

V SAMPLE RESULTS

(a) Parameters Evaluated

Most of the water samples were analysed for: Arsenic (As), cadmium (Cd), Cobalt (Co), Lead (Pb), Nickel (Ni), Silver (Ag), and Zinc (Zn) because geologic information indicated the presence of these materials in the area bedrock. Details on the Ministry of the Environment's drinking water objective levels and a brief summary of the health effects of ingesting these constituants are included as Appendix V.

In cases where levels of arsenic or other metals in the drinking water exceed maximum permissible limits, the people were notified immediately by telephone with confirmation by registered mail. A copy of each letter was mailed to the Timiskaming Health Unit. The residents were notified of the analysis results and advised to contact their physician or the Health Unit.

(b) Summary of New Private Water Supply Results

(i) Arsenic

The testing of the second group of private water supplies was conducted from June 9 to August 25, 1977. The location of the wells sampled during this period are shown on the enclosed map. They are denoted by a "J" and a following number. All of the Sample Results are presented as Appendix I.

Of the 187 supplies sampled, forty-five (45) showed a detectable level of arsenic. The detectable arsenic levels ranged from 0.001 mg/l to 0.08 mg/l. A further breakdown of the detectable arsenic levels found is shown in Table A.

TABLE A

1977 Tri-town Sampling Arsenic Levels (mg/l)	Number	Percent
No. of samples	187	-
No. < 0.001	141	75.40
No. from 0.001 to 0.004	41	21.93
No. from 0.005 to 0.009	3	1.61
No. from 0.01 to 0.05 (Above MOE objective)	1	0.53
No. > 0.05 (Above Rejection Limit)	1	0.53

As these results show, the majority of the detectable arsenic levels (88.9%) are below 0.005 mg/l and only one sample was above this Ministry's recommended rejection level of 0.05 mg/l. This water sample (0.08 mg/l as As) was from a drilled mine shaft, approximately 100 feet deep, which is not used as a drinking water supply. In addition, one supply contained an arsenic level less than the rejection limit, but equal to this Ministry's recommended objective of 0.01 mg/l.

The questionable water supplies, (those with an arsenic level of over 0.001 mg/l) can be grouped into several areas, as illustrated on the map.

In the residences tested in the Bass Lake area, south of Cobalt, all four private water supplies showed an arsenic level of 0.002 mg/l. The water was from the south end of Bass Lake in all four cases. The Kiwanis Beach at the north end of Bass Lake showed an arsenic level of 0.001 mg/l. At the municipal trailer park at Bass Lake, the arsenic level was 0.002 mg/l. The sample was taken from the 85 foot drilled well that serves the 50 mobile homes located there. A second sample taken later showed the same arsenic level of 0.002 mg/l.

Two samples were taken at Sharp Lake, west of Cobalt. An arsenic level of 0.001 mg/l was found in a water sample from a 10 foot dug well. A diamond drill hole 742 feet deep, was found to have a level of 0.003 mg/l.

A water sample was taken from a drilled well 50 feet deep on the

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Cobalt West Road, showing an arsenic content of 0.001 mg/l. Results from testing done in this area previously, have shown the presence of considerable arsenic in the other water supplies.

The Mileage 104 area, north of Cobalt, showed extensive contamination of the private water supplies with arsenic. Of the 17 wells sampled here, 13 had detectable arsenic levels, ranging from 0.001 mg/l to 0.01 mg/l. All the wells in this area were dug, varying from 9 to 30 feet deep. The Township of Coleman has two municipal wells in Mileage 104 that are used by a small number of families. While there was no detectable arsenic in one well, the other well had an arsenic level of 0.003 mg/l.

Just northeast of Mileage 104, detectable arsenic was found at a residence with two wells. A 15 foot dug well had a level of 0.001. A level of 0.08 mg/l was found in the mine shaft on the property, the highest level in a water supply not previously sampled. This site is located near the Bucke Township Park well that was found to have an arsenic level as high as 10.0 mg/l.

In Moore's Cove, just north of Haileybury, detectable arsenic was found in six of eighteen houses sampled. All of these were drilled wells, and had an arsenic level of 0.001 mg/l. Arsenic was not found in the seven dug wells. In June of 1977, resampling of a house in this area revealed an arsenic level of 0.62 mg/l. However, further testing of that well and other water supplies in the vicinity did not yield a level of more than 0.001.

Extensive sampling was done in Harris Township, but only four private water supplies showed detectable levels of arsenic. All four wells had 0.001 mg/l arsenic present.

In Uno Park, a farming area north of New Liskeard, there were five wells sampled that showed a detectable level of arsenic. All were 0.001 mg/l. Three of the wells were drilled, varying in depth from 160 feet to 400 feet. The remaining two wells were flowing surface wells.

One of the four wells tested in Milberta had an arsenic level of 0.001 mg/l. There was no arsenic detectable in the other three wells.

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In Lorrain Township, a diamond drill hole of unknown depth was tested and found to have an arsenic level of 0.004 mg/l. This is known to supply drinking water for some area residents.

(ii) Other Heavy Metals

Of the 187 private water supplies tested for the first time in the summer of 1977, only three showed an elevated level of a metal other than arsenic. They are listed below.

Name	Sample Number	Location	Element	Level
George Flint	J25	Hudson Twp.	lead	0.10
Gordon Love	J165	Hudson Twp.	zinc	10.0
Arnold Hawkins	J174	Hudson Twp.	lead	0.13

The levels of cadmium, cobalt, nickel and silver were usually below the level of detection, and were always well below the maximum allowable levels.

The three water supplies are in the Twin Lake area of Hudson Township and all are from sandpoint wells. Resampling of these three water supplies should be done to determine if these elevated levels are present in the water itself or are due to any reaction of the water with the pipes.

(c) Resampling Data (To establish degree of quality variation)

(i) Arsenic - General Results

In the 1976 testing, 61 of the sources sampled were found to have a detectable level of arsenic present. To obtain further information on the possible fluctuations of the arsenic and heavy metal levels, these wells were sampled two more times during 1977. Between May 24 and June 9, 1977, 43 of these designated sources were resampled, as well as 5 wells that had not previously shown the presence of arsenic. In a second testing period, from July 26 to August 25, 1977, 61 supplies were sampled. Appendix II presents the level of the elements for the 1976 testing period and the two sampling periods from summer 1977.

In Table B, the samples are grouped according to the level of arsenic detected in the water supply.

Table B

ARSENIC LEVEL IN RESAMPLED SELECTED WATER SUPPLIES

Arsenic Level (mg/l)	1976		May	%	1977 July	%
No. of samples	61	-	48	-	64	-
No. < 0.001	6	9.84	4	8.33	13	20.3
No. from 0.001 to 0.004	46	75.41	35	72.92	40	62.5
No. from 0.005 to 0.009	3	4.92	4	8.33	2	3.13
No. from 0.01 to 0.05	5	8.19	4	8.33	6	9.38
No. > 0.05 (above rejection limit)	1	1.64	1	2.09	3	4.69

The reader must be cautioned that while the data of Table B may appear to indicate a trend to increased levels of arsenic, the specific 1976 and resampling results set out in Appendix III show only that there have been variations in water quality for 49 of the 63 supplies sampled. From a review of the raw data, it appears that for the 43 instances where it was possible to collect samples during each testing period:

10 decreased during the 3 samples.
23 showed variation among the 3 samples.
7 remained constant for the 3 samples.
3 increased during the 3 samples.

(ii) Details of Significant Arsenic Variations

In actual numbers, there were five water samples collected during the 1976 sampling that exceeded the Ministry's objective level of 0.01 mg/l and one that exceeded the rejection limit of 0.05 mg/l. This level was 0.93 mg/l. The water supply from previous testing that was over the rejection limit had a decreased arsenic content of only 0.001 mg/l.

In May 1977, four samples had an arsenic concentration over the objective level and one was over the rejection limit. The latter private water supply had a level of 0.62 mg/l. When originally tested in 1976, there was 0.002 mg/l arsenic present.

In July 1977, six water supplies were above the Ministry objective and three had an arsenic content greater than the rejection

level of 0.05 mg/l. The Cobalt Refinery Water Works had an arsenic content of 0.06 mg/l, an increase from the 0.037 mg/l level that was observed in 1976. One private water supply with an arsenic content of 0.023 mg/l when tested in 1976, had a level of 0.13 mg/l. The third sample that exceeded the rejection limit contained 0.40 mg/l arsenic. A content of 0.001 mg/l had been observed in the May sampling. In the July sampling, all of the water supplies that were previously over the rejection limit were now below the 0.05 mg/l level. It is evident, there are large fluctuations in the arsenic levels observed in these identified "problem" supplies.

(iii) Heavy Metals - Resampling General Results

Appendix III details the levels of six heavy metals that were analyzed during the resampling of the 61 designated supplies. Table C below summarizes the results of this work.

Table C

SUMMARY OF RESAMPLING RESULTS (HEAVY METALS)

	Co	Pb	Zn	Cd	Ni	Ag
Results	No.	No.	No.	No.	No.	No.
detectable but not exceeding rejection limit	1	13	151	0	17	0
Exceeding rejection limit	0	0	3	0	0	0

Cadmium and silver were not present in any of the samples. Only one sample (1976 survey) contained a detectable level of cobalt, but cobalt was not detected in the two subsequent tests.

Lead was detected in thirteen water samples. In most of these cases, lead was found in the original water sample, but was not detectable in further testing during the summer of 1977. This is also true of the occurrence of nickel in the water supplies. The majority of the detectable levels of nickel were obtained during the original sampling period.

Detectable levels of zinc occurred in all of the water supplies sampled during at least one of the three sampling periods. While there were larger fluctuations in the level of zinc in a water supply, than nickel or lead, there was also a trend towards decreased levels of the metal in the more recent samples. Forty-two wells showed a decrease in the amount of zinc present from 1976 sampling to 1977 sampling, 15 wells had an increased zinc concentration, and six wells had a constant zinc level throughout the test period.

It is a possibility that the decrease in some of the concentrations of the heavy metals, such as zinc or lead, could be the result of letting the water run for a longer period of time before sampling, than was practised in the earlier sampling. This ensured that the water from the source rather than the water remaining in the pipes, was not sampled as it may possibly have reacted with the pipes.

(iv) Results of Sampling Municipal Systems

The operating authorities for the Latchford, Cobalt, Haileybury, and New Liskeard water works were requested to supplement their sampling program and submit additional samples, so that metals and arsenic levels could be determined. The results of these special samples are summarized in Appendix III. The water of the four supplies was safe.

(v) Results of Sampling Cobalt Refinery Water Works

After the initial analysis result, the water supply was monitored by the owner and this Ministry. The results are presented in Table D. Some of the samples were taken and analyzed at private laboratories by the owner to assure corporation officials that results from the Ministry of the Environment were valid. The results to date confirm that arsenic levels are consistently above this Ministry's objective (0.01 mg/l as As) and exceed the Rejection limit of 0.05 mg/l on 5 of the 12 dates the water was sampled.

TABLE D

Arsenic Results - Cobalt Refinery Townsite

Sample Date	Result	Lab
Nov. 3, 1976	0.037	MOE Lab
Feb. 3, 1977	0.03	Enviroclean
March 1, 1977	0.031(As)	Enviroclean
	0.041(As_2O_3)	Enviroclean
	0.03	MOE Lab
	0.022	Baringer Resources
	0.024	Baringer Resources
April 4, 1977	0.03	MOE Lab
	0.026	Enviroclean
	0.027	Enviroclean
May 13, 1977	0.03	MOE Lab
	0.02	MOE Lab
	0.023	Enviroclean
	0.024	Enviroclean
July 18, 1977	0.05	Enviroclean
	0.05	Enviroclean
July 26, 1977	0.034	MOE Lab
August 19, 1977	0.05	MOE Lab
Sept. 19, 1977	0.06	MOE Lab
	0.05	Enviroclean
Sept. 21, 1977	0.049	MOE Lab
	0.043	Enviroclean
Oct. 19, 1977	0.055	Enviroclean
Nov. 18, 1977	0.06	MOE Lab

VI INTERPRETATION

(a) Is There Evidence of Arsenic or Metals Contamination beyond that documented in the 1976-1977 report?

(i) In Municipal Water Supplies?

The samples from the Cobalt, Haileybury and New Liskeard water supplies continue to be free from undesirable levels of arsenic and heavy metals. To provide a final confirmation of the year round safety of these supplies, the present monitoring program should be stepped up to provide one sample per month from each system until January 1979.

(ii) In Private Communal Water Supplies?

Special attention has been focussed on the Cobalt Refinery Water Works system because sampling subsequent to the 1977 report produced sample results which indicated enormous fluctuations in Arsenic levels. All users of the system were notified by registered letter authorized by the Medical Officer of Health of the Timiskaming Health Unit, and the District Officer of the Ministry of the Environment, that the arsenic level was consistently above the Provincial objective, and might occasionally exceed the Provincial level for rejection of the water supply. Users were advised to consult medical authorities, for clarification of what injection of these levels of arsenic could mean to their health. The new owner of the system has been actively developing an alternate arsenic-free source, to ensure all consumers are supplied with safe water. It seems that this problem (which has probably gone on undetected for many years), will be corrected in 1978.

(iii) In Private Individual Water Supplies?

The total data confirms the arsenic contamination of a small number (14) of the 375 private water supplies sampled to date. Both supplies from the 1977 sampling with arsenic levels above the Provincial objective, were within the previously defined higher risk areas.

It appears the eight higher risk circles set out in the earlier report (and shown on Map 1), adequately define all of the areas where conditions may produce unsatisfactory water quality. Of course, within each of the circles, the majority of the supplies are producing safe water; only the chance of an elevated arsenic level is increased somewhat.

(b) What is the Significance of the Observed Variations in Water Quality of the Selected Supplies in the Area?

There was no consistent change in the water quality of these supplies from one sampling period to the next. Since supplies showed increases, decreases and no change during the same sampling period, it is clear there are not uniform changes in water quality throughout the year.

In the case of the Cobalt Refinery Water Works, the comprehensive sampling to date seems to indicate a seasonal trend for at least this specific supply. More sampling will be required to confirm the apparent trend for this supply. There is no data which suggests this trend is in effect in other supplies.

(c) Are there Areas in the Tri-Town Where Private Water Supplies Have a Significant Probability of Containing Arsenic or Metals Levels?

The evidence indicates that there are no areas where specific geological conditions produce a significant probability that all private water supplies will have elevated arsenic or metals levels. Even in situations where system characteristics appear similar (eg same type, same depth of well), there can be major differences in water quality between adjacent supplies.

On the other hand, it should be noted that safe but detectable levels (ie greater than 0.001 mg/l as As), Arsenic were found throughout the study area. Therefore, there is reasonable probability that any private water supplies in the Tri-Town will contain safe but detectable levels of arsenic.

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VII CONCLUSIONS

In the Tri-Town area there are a small number of private water supplies (14 of 375) which, because of local conditions, produced water with arsenic and/or metals levels above Ontario's Drinking Water Objective. The Re-sampling of specific supplies during the summer of 1977 demonstrated that there were significant variations in water quality from one period to the next; however, there was no evidence of any overall trend. An indepth examination of 10 of the supplies demonstrated that in each instance of an elevated arsenic level, it was possible to identify a probable source of the contaminant.

In order to protect consumers, the following steps have been undertaken:

1) Most private water supplies in the area have been sampled and the users apprised of the analyses results.

2) All licensed well drillers have been required to submit water samples of all new wells in the Tri-Town area so that metals and arsenic levels can be evaluated to ensure the water is safe to drink.

3) The accumulated information on the drinking water monitoring study in this area has been published and released to all the municipalities, libraries of the area and local media.

4) Ministry staff have set up a procedure which will permit water users to submit water samples to Ministry of the Environment Laboratories for arsenic determination.

These steps should be sufficient to ensure that residents are aware of the quality of water they are using (at the time of sampling) and alerted to the possibility that some supplies may occasionally contain arsenic at levels above the Provincial Objective.

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VIII RECOMMENDATIONS

It is recommended that:

1) A portion of the study be continued to provide more data on the nature and magnitude of water quality variations in the eight areas where there is some possibility of detectable arsenic in private water supplies, by resampling of a limited number of supplies, carried out every two weeks with the co-operation of the users;

2) Analytical data on new drilled wells in the area should be published by the Ministry every 5 years, so future private water supplies can be developed with the benefit of data on adjacent supplies;

3) All concerned water users should be informed of how they can take samples from their supply and have them analyzed.

Appendix I

ANALYSIS RESULTS FROM SUMMER 1977 SURVEY

(results from 187 private supplies)

SAMPLE RESULTS FROM 1977 SURVEY

NOTE:

1. Results are grouped by Township.

2. Sample number refers to the actual identification code used on the sample submission sheets.

3. These components are reported:

   As - arsenic
   Co - cobalt
   Pb - lead
   Zn - zinc
   Cd - cadmium
   Ni - nickel
   Ag - silver

4. All results are in milligrams per litre (mg/l).

Appendix I

TOWNSHIP OF BUCKE

TOWNSHIP OF BUCKE

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J123	Germaine Plouff 104	0.007	<0.01	<0.02	<0.01	<0.01	<0.02	<0.01
J124	David Fleming (house) 104	0.001	<0.01	<0.02	0.26	<0.01	<0.02	0.01
J125	David Fleming (garden) 104	0.001	<0.01	<0.02	0.06	<0.01	<0.02	0.01
J127	Ed Brown 104	0.01	<0.01	<0.02	0.74	<0.01	<0.02	0.01
J128	Christine Audet 104	0.005	<0.01	<0.02	1.9	<0.01	<0.02	<0.01
J129	Lawrence Tull 104	0.001	<0.01	<0.02	2.8	<0.01	<0.02	<0.01
J130	Viola Perrier 104	0.001	<0.01	<0.02	1.8	<0.01	<0.02	<0.01
J178	K. Fulson (mine shaft) 567	0.08	<0.02	<0.03	0.30	<0.005	<0.02	<0.01

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TOWNSHIP OF BUCKE

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J179	K. Fulson (dug well) 567	0.001	<0.02	<0.03	0.62	<0.005	<0.02	<0.01
J180	P. Huard	<0.001	<0.02	<0.03	0.04	<0.005	<0.02	<0.01
J181	J. Mills	0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
J182	J. Parcher	<0.001	<0.02	<0.03	0.10	<0.005	<0.02	<0.01
J183	J. MacDougall	<0.001	<0.02	<0.03	0.10	<0.005	<0.02	<0.01
J184	A. Proulx	<0.001	<0.02	<0.03	0.14	<0.005	<0.02	<0.01
J185	G. Paquette	<0.001	<0.02	<0.03	0.12	<0.005	<0.02	<0.01
J186	R. Roy	<0.001	<0.02	<0.03	0.10	<0.005	<0.02	<0.01

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TOWNSHIP OF BUCKE

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J187	L. Roy	<0.001	<0.02	<0.03	0.07	<0.005	<0.02	<0.01
J188	W. K. Hurst	0.001	<0.02	<0.03	0.07	<0.005	<0.02	<0.01
J189	O. Spangler	0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
J190	J. Conroy	<0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
J191	N. Carr	0.001	<0.02	<0.03	0.18	<0.005	<0.02	<0.01
J192	K. Rice	<0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
J202	K. Gorman	0.001	<0.02	<0.03	0.09	<0.005	<0.02	<0.01
J176	R. S. Cole	0.001	<0.02	<0.03	0.02	<0.005	<0.02	<0.01

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Appendix I

COLEMAN TOWNSHIP

COLEMAN TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J70	John Gore (cottage)	0.001	<0.01	0.02	0.34	<0.005	<0.02	<0.01
J71	Sharp Lake (diamond drill hole)	0.003	<0.01	0.02	0.25	<0.005	<0.02	<0.01
J126	Nelson Bigelow	0.001	<0.01	<0.02	0.17	<0.01	<0.02	0.01
J131	Mrs. Omer Morin	<0.001	<0.01	<0.02	0.65	<0.01	<0.02	<0.01
J132	Lilian Hyncak	<0.001	<0.01	<0.02	2.2	<0.01	<0.02	<0.01
J133	Mrs. Hearst	0.002	<0.01	<0.02	1.8	<0.01	<0.02	<0.01
J134	Lawrence Coe	0.005	<0.01	<0.02	0.07	<0.01	<0.02	0.01
J135	Pat Cooper	<0.001	<0.01	<0.02	0.04	<0.01	<0.02	0.01

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COLEMAN TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J136	Township of Coleman Municipal well - a	<0.001	<0.01	<0.02	4.2	<0.01	<0.02	0.01
J137	William Cull	< 0.001	<0.01	<0.01	0.04	<0.01	<0.02	<0.01
J138	Frank Clattenburg	0.003	< 0.01	<0.02	2.6	< 0.01	<0.02	<0.01
J139	Gatien Paquin	0.004	<0.01	<0.02	0.19	<0.005	<0.02	0.01
J140	Township of Coleman municipal well - b	0.003	<0.01	<0.02	0.24	<0.005	<0.02	0.01
J194	Mrs. O. McDermid	0.001	<0.02	<0.03	0.82	<0.005	<0.02	<0.01
J195	A. Cormier	<0.001	<0.02	<0.03	2.5	<0.005	<0.02	< 0.01
J196	W. Bridges	<0.001	< 0.02	<0.03	0.89	<0.005	<0.02	<0.01

COLEMAN TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J197	B. Beland	<0.001	<0.02	<0.03	1.0	<0.005	<0.02	<0.01
J203	V. Bigelow (hand pump)	0.001	<0.04	<0.06	0.41	<0.01	<0.04	<0.02

Appendix 1

DYMOND TOWNSHIP

DYMOND TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J87	Tom Haig	<0.001	<0.02	<0.02	0.21	< 0.01	<0.02	< 0.01
J88	Henri Benoit	<0.001	<0.02	<0.02	0.02	<0.01	<0.02	< 0.01
J89	Allan Bowes	<0.001	<0.02	<0.02	0.15	<0.01	<0.02	<0.01
J90	Etienne Falardae	<0.001	<0.02	<0.02	0.28	<0.01	<0.02	<0.01
J91	Don Maguire	<0.001	<0.02	<0.02	0.08	<0.01	< 0.02	<0.01
J92	Lloyd Burnett	<0.001	<0.02	<0.02	0.08	<0.01	<0.02	<0.01
J93	R. Hurtubise	<0.001	<0.02	<0.02	0.04	<0.01	<0.02	<0.01
J94	Richard Gauvreau	<0.001	<0.02	<0.02	<0.01	<0.01	<0.02	< 0.01

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DYMOND TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J113	Ernest Woods	< 0.001	<0.02	<0.02	0.04	<0.01	<0.02	<0.01
J114	Jim Robertson	0.001	<0.02	<0.02	0.12	<0.01	<0.02	<0.01
J115	Richard Smith	<0.001	<0.02	<0.02	0.08	<0.01	<0.02	<0.01
J117	George Miller	0.001	<0.02	<0.02	0.09	<0.01	<0.02	<0.01
J119	Wilfred Godmaire	0.001	<0.02	<0.02	0.03	<0.01	<0.02	<0.01
J121	Andre Godmaire	<0.001	<0.02	<0.02	0.16	<0.01	<0.02	<0.01

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GILLIES LIMIT

GILLIES LIMIT

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J16	Roger Chartrand	0.002	<0.01	<0.01	0.05	<0.005	<0.01	<0.01
J17	C. Belland	0.002	<0.01	<0.01	0.10	<0.005	<0.01	<0.01
J18	P. J. Lemon	0.002	<0.01	<0.01	0.16	<0.005	<0.01	<0.01
J19	J. L. MacMillan	0.002	<0.01	<0.01	0.20	<0.005	<0.01	<0.01
J20	Josephine Villa	<0.001	<0.01	<0.01	1.2	<0.005	<0.01	<0.01
J62	Bass Lake	0.002	<0.02	<0.02	0.22	<0.01	<0.02	<0.01
	Trailor Park	0.002	<0.02	<0.03	0.10	<0.005	<0.02	<0.01
J4	Kiwanis Beach (snack bar)	0.001	<0.02	<0.03	0.06	<0.005	<0.02	<0.01
J5	Kiwanis Beach (lake)	0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01

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HARLEY TOWNSHIP

HARLEY TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J116	Gerald Roy	<0.001	<0.02	<0.02	<0.01	<0.01	<0.02	<0.01
J118	F. Ballard	0.001	<0.02	<0.02	1.4	<0.01	<0.02	<0.01
J120	Omer Godmaire	0.001	<0.02	<0.02	0.16	<0.01	<0.02	<0.01

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HARRIS TOWNSHIP

HARRIS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J39	Brian McLean	0.001	< 0.02	< 0.02	0.15	< 0.01	< 0.02	< 0.01
J40	R. Howe	< 0.001	< 0.02	< 0.02	0.16	< 0.01	< 0.02	< 0.01
J41	Neil Munroe	< 0.001	< 0.02	< 0.02	0.27	< 0.01	< 0.02	0.01
J42	T. R. Jelly	< 0.001	< 0.02	< 0.02	0.77	< 0.01	< 0.02	0.01
J43	L. MacKewn	< 0.001	< 0.02	< 0.02	1.5	< 0.01	< 0.02	0.01
J44	Robert MacKewn	< 0.001	< 0.02	< 0.02	2.4	< 0.01	< 0.02	0.01
J45	Ed Collier	< 0.001	< 0.02	< 0.02	0.29	< 0.01	< 0.02	< 0.01
J46	Don Gibson	< 0.001	< 0.02	< 0.02	0.23	< 0.01	< 0.02	< 0.01

HARRIS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J47	Jack McVey	<0.001	<0.02	<0.02	1.1	<0.01	<0.02	0.01
J48	Robert Moore	<0.001	<0.02	<0.02	0.10	<0.01	<0.02	<0.01
J49	E. Geiger	<0.001	<0.02	<0.02	0.20	<0.01	<0.02	<0.01
J50	Peter Gibson	<0.001	<0.02	<0.02	0.29	<0.01	<0.02	<0.01
J51	Mrs. Jemett	<0.001	<0.02	<0.02	0.57	<0.01	<0.02	<0.01
J52	A. H. Brown	<0.001	<0.02	<0.02	0.06	<0.01	<0.02	<0.01
J53	J. L. Sheedy	<0.001	<0.02	<0.02	0.32	<0.01	<0.02	<0.01
J54	Lillian Alderdice	<0.001	<0.02	<0.02	0.42	<0.01	<0.02	<0.01

HARRIS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J54	John Rogers	<0.001	<0.01	<0.01	0.01	<0.005	<0.01	<0.01
J55	F. Waugh	<0.001	<0.01	<0.01	0.21	<0.005	<0.01	<0.01
J56	R. Deakos	<0.001	<0.01	<0.01	0.15	<0.005	<0.01	<0.01
J57	C. Monahan	<0.001	<0.01	<0.01	0.16	<0.005	<0.01	<0.01
J58	E. E. Sutton	<0.001	<0.01	<0.01	0.25	<0.005	<0.01	<0.01
J59	Arnold Peters	<0.001	<0.01	<0.01	0.02	<0.005	<0.01	<0.01
J60	J. L. Gauvreau	<0.001	<0.01	<0.01	0.34	<0.005	<0.01	<0.01
J61	Gordon Fisher	<0.001	<0.01	<0.01	0.03	<0.005	<0.01	<0.01

HARRIS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J73	Hugh Grant	<0.001	<0.01	0.02	0.35	<0.005	0.04	<0.01
J74	C. Jemmett	<0.001	<0.01	0.01	0.26	<0.005	0.09	<0.01
J75	J. Robertson	<0.001	<0.01	0.04	0.32	<0.005	0.11	<0.01
J76	Mrs. C. Belonotia	<0.001	<0.01	0.01	0.17	<0.005	0.07	<0.01
J77	Mrs. A. Walker	<0.001	<0.01	0.02	0.35	<0.005	0.05	<0.01
J78	W. K. Mason	<0.001	<0.01	0.03	0.49	<0.005	<0.02	<0.01
J79	D. Mason	<0.001	<0.01	0.01	0.11	<0.005	0.06	<0.01
J80	B. Scott	<0.001	<0.01	<0.01	0.12	<0.005	0.06	<0.01

HARRIS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J81	Garfield Scott	<0.001	<0.01	<0.01	0.02	<0.005	<0.01	<0.01
J82	D. Lacarte	<0.001	<0.01	<0.01	0.21	<0.005	<0.01	<0.01
J83	A. Licoup	0.001	<0.01	<0.01	0.09	<0.005	<0.01	<0.01
J84	R. Walker	<0.001	<0.01	<0.01	0.27	<0.005	<0.01	<0.01
J85	J. R. Licoup	<0.001	<0.01	0.04	0.15	<0.005	<0.02	<0.01
J86	R. Dobson	<0.001	<0.01	0.04	0.01	<0.005	<0.01	<0.01
J95	Z. Arheault	<0.001	<0.02	<0.02	0.28	<0.01	<0.02	<0.01
J96	T. J. Allard	<0.001	<0.02	0.03	3.0	<0.01	<0.02	<0.01

HARRIS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J97	R. Denyes	<0.001	<0.02	<0.02	0.13	<0.01	<0.02	<0.01
J98	W. Pettau	0.001	<0.02	<0.02	<0.02	<0.01	<0.02	<0.01
J99	L. Lariviere	<0.001	<0.02	0.02	0.17	<0.01	<0.02	<0.01
J100	C. Michelutti	<0.001	<0.02	0.02	<0.01	<0.01	<0.02	<0.01
J101	H. Guenther	<0.001	<0.02	<0.02	0.06	<0.01	<0.02	<0.01
J102	J. Willard	<0.001	<0.02	<0.02	0.03	<0.01	<0.02	<0.01
J103	O. Binkley	<0.001	<0.02	<0.02	0.17	<0.01	<0.02	<0.01
J104	B. Donaghue	<0.001	<0.02	<0.02	0.16	<0.01	<0.02	0.01

HARRIS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J105	F. L. Plumton	<0.001	<0.02	<0.02	<0.01	<0.01	<0.02	<0.01
J106	D. Aitchison	<0.001	<0.02	<0.02	0.18	<0.01	<0.02	<0.01
J107	G. Thrasher	<0.001	<0.02	<0.02	0.04	<0.01	<0.02	<0.01
J108	Mrs. V. Darragh	<0.001	<0.02	<0.02	0.04	<0.01	<0.02	<0.01
J109	B. R. Poulton	<0.001	<0.02	<0.02	0.82	<0.01	<0.02	<0.01
J110	W. Ackroyd	<0.001	<0.02	<0.02	0.22	<0.01	<0.02	<0.01
J111	J. Dent	<0.001	<0.02	<0.02	0.08	<0.01	<0.02	<0.01
J112	S. Hamilton	<0.001	<0.02	<0.02	0.04	<0.01	<0.02	<0.01

HARRIS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J122	Austin Clarabut	< 0.001	< 0.02	< 0.02	1.4	< 0.01	< 0.02	< 0.01
J141	G. Hughes	< 0.001	< 0.01	< 0.02	1.4	< 0.005	< 0.02	0.01
J142	W. Link	< 0.001	< 0.01	< 0.02	0.83	< 0.005	< 0.02	< 0.01
J143	C. Ball	< 0.001	< 0.01	< 0.02	0.35	< 0.005	< 0.02	< 0.01
J144	B. Pinkerton	< 0.001	< 0.01	< 0.02	4.3	< 0.005	< 0.02	0.01
J145	F. Carter	< 0.001	< 0.01	< 0.02	0.16	< 0.005	< 0.02	< 0.01
J146	W. Glassford	< 0.001	< 0.01	< 0.02	4.0	< 0.005	< 0.02	< 0.01
J146	R. D. Smylie	< 0.001	< 0.01	< 0.02	0.37	< 0.005	< 0.02	< 0.01

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HARRIS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J148	Twp. of Harris Office	<0.001	<0.01	<0.02	4.8	<0.005	<0.02	<0.01
J149	J. Deck	<0.001	<0.01	<0.02	0.04	<0.005	<0.02	<0.01
J150	H. Peddie	<0.001	<0.01	<0.02	0.26	<0.005	<0.02	<0.01
J151	D. Peddie	<0.001	<0.01	<0.02	0.04	<0.005	<0.02	<0.01
J152	L. Gervais	<0.001	<0.01	<0.02	0.32	<0.005	<0.02	<0.01
J153	R. Tobler	<0.001	<0.01	<0.02	0.06	<0.005	<0.02	0.01
J154	L. Donaldson	<0.005	<0.01	<0.02	0.42	<0.005	<0.02	0.01
J155	C. Labonte	<0.001	<0.01	<0.02	0.08	<0.005	<0.02	<0.01

HARRIS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J156	J. Rundle	<0.001	<0.01	<0.02	0.04	<0.005	<0.02	<0.01
J157	R. Loach	<0.001	<0.01	<0.02	0.70	<0.005	<0.02	<0.01
J158	F. Sowinski	<0.001	<0.01	<0.02	0.34	<0.005	<0.02	<0.01
J159	G. Loney	<0.001	<0.01	<0.02	0.05	<0.005	<0.02	<0.01
J160	K. Naef	<0.001	<0.01	<0.02	0.30	<0.005	<0.02	<0.01
J161	K. Johnston	<0.001	<0.01	<0.02	0.49	<0.005	<0.02	<0.01
J162	B. Bieder	<0.001	<0.01	<0.02	0.04	<0.005	<0.02	<0.01

Appendix I

HUDSON TOWNSHIP

HUDSON TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J23	George Gordon	0.002	< 0.01	< 0.01	0.44	< 0.005	< 0.01	< 0.01
J24	L. M. Madill	< 0.001	< 0.01	< 0.01	0.72	< 0.005	< 0.01	< 0.01
J25	George Flint	< 0.001	< 0.01	0.10	0.34	< 0.005	< 0.01	< 0.01
J26	Ossie Villeneff	< 0.001	< 0.01	< 0.01	0.84	< 0.005	< 0.0	< 0.01
J27	C. Villeneff	< 0.001	< 0.01	< 0.01	0.35	< 0.005	0.02	< 0.01
J28	Truman Musson	< 0.001	< 0.01	< 0.01	0.09	< 0.005	< 0.01	< 0.01
J29	H. H. Foley	< 0.001	< 0.01	< 0.01	0.12	< 0.005	< 0.01	< 0.01
J30	A. Beland	< 0.001	< 0.01	< 0.01	0.05	< 0.005	< 0.01	< 0.01

HUDSON TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J31	Ira Murphy	0.004	<0.01	<0.01	0.07	<0.005	<0.01	<0.01
J32	P. Grant	<0.001	<0.01	<0.01	0.46	<0.005	<0.01	<0.01
J33	A. Berthelette	<0.001	<0.01	<0.01	0.10	<0.005	<0.01	<0.01
J34	Matheus Van Leer	<0.001	<0.01	<0.01	0.01	<0.005	<0.01	<0.01
J35	Martin Willard	<0.001	<0.01	<0.01	0.04	<0.005	<0.01	<0.01
J36	Jack Willard	<0.001	<0.01	<0.01	0.17	<0.005	<0.01	<0.01
J37	Charles Reid	<0.001	<0.01	<0.01	2.6	<0.005	0.01	<0.01
J38	Peter Maru	<0.001	<0.01	<0.01	0.03	<0.005	<0.01	<0.01

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HUDSON TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J163	R. W. Fielder	<0.001	<0.01	<0.02	0.44	<0.005	<0.02	<0.01
J164	H. Moeltner	<0.001	<0.01	<0.02	0.06	<0.005	<0.02	<0.01
J165	Gordon Love	<0.001	<0.01	<0.02	10.0	<0.005	<0.02	<0.01
J166	J. Heikkila	<0.001	<0.01	<0.02	4.2	<0.005	<0.02	<0.01
J167	Alfred Spencer	<0.001	<0.01	<0.02	0.02	<0.005	<0.02	<0.01
J168	Jean White	<0.001	<0.01	<0.02	1.2	<0.005	<0.02	<0.01
J169	S. Durrell	<0.001	<0.01	<0.02	3.5	<0.005	<0.02	<0.01
J170	William Begg	<0.001	<0.01	<0.02	2.8	<0.005	<0.02	<0.01

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HUDSON TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J171	Ralph Taylor	<0.001	<0.01	<0.02	1.1	<0.01	<0.02	<0.01
J172	W. A. Bowman	<0.001	<0.01	<0.02	1.1	<0.01	<0.02	<0.01
J173	Bruce Hawkins	<0.001	<0.01	<0.02	2.6	<0.01	<0.02	<0.01
J174	Arnold Hawkins	<0.001	<0.01	0.13	4.8	<0.01	<0.02	<0.01
J9	C. E. Bond	<0.001	<0.02	<0.03	2.0	<0.005	<0.02	<0.01
J8	T. Cragg	<0.001	<0.02	<0.03	0.02	<0.005	<0.02	<0.01
J7	A. Dugas	0.001	<0.02	<0.03	0.12	<0.005	<0.02	<0.01
J6	L. Duval	<0.001	<0.02	<0.03	0.23	<0.005	<0.02	<0.01

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KERNS TOWNSHIP

KERNS TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J198	W. Willard	<0.001	<0.02	<0.03	0.14	<0.005	<0.02	<0.01
J199	R. Armstrong	0.001	<0.02	<0.03	0.16	<0.005	<0.02	<0.01
J200	K. Ingleton	<0.001	<0.02	<0.03	0.20	<0.005	<0.02	<0.01
J201	H. J. Jarvis	<0.001	<0.02	<0.03	0.02	<0.005	<0.02	<0.01

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LORRAIN TOWNSHIP

LORRAIN TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J1	Loon Lake (diamond drill hole)	0.004	<0.01	<0.01	0.02	<0.005	0.01	<0.01
J177	H. Jenson	<0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
J193	K. White	<0.001	<0.02	<0.03	0.15	<0.005	<0.02	<0.01
J194	Mrs. E. Vahey	<0.001	<0.02	<0.03	0.02	<0.005	<0.02	<0.01

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OLIVE TOWNSHIP

OLIVE TOWNSHIP

No.	Name	As	Co	Pb	Zn	Cd	Ni	Ag
J15	Hector Larente	<0.001	<0.01	0.02	0.16	<0.005	<0.01	<0.01

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Appendix II

ANALYSIS RESULTS FROM RESAMPLING

OF SELECTED WATER SUPPLIES IN THE TRI-TOWN AREA

May 24 - June 9, 1977
July 26 - August 25, 1977

Note:

1. Sample number refers to the identification code used on the original sample submission sheets.

2. For an individual sample, the first line of values are from 1976 and winter 1977 tests; the second line are test results from May 24, 1977 to June 9, 1977; the third line of values are results from July 26 to August 26, 1977. Any different sampling periods are indicated for the individual sample.

3. The components reported are:

   As - arsenic
   Co - cobalt
   Pb - lead
   Zn - zinc
   Cd - cadmium
   Ni - nickel
   Ag - silver

4. All results are in milligrams per litre (mg/l).

	As	Co	Pb	Zn	Cd	Ni	Ag
F 12 R. Mercier (Firstbrook line)	0.001	<0.01	<0.01	<0.01	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.06	<0.005	<0.01	<0.02
	0.001	<0.03	<0.03	0.03	<0.005	<0.02	<0.01
F 50 D. Waugh (Hwy 65E)	0.037	<0.01	<0.01	0.86	<0.005	<0.01	<0.02
	0.02	<0.01	<0.01	0.15	<0.005	<0.01	<0.02
	0.02	<0.03	<0.03	1.0	<0.005	<0.02	<0.01
L 58 V. Teskey (North Cobalt	0.001	<0.01	<0.01	0.20	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.002	<0.03	<0.03	0.03	<0.005	<0.02	<0.01
F 10 B. Jenkins (Firstbrook line)	0.001	<0.01	<0.01	<0.01	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
L 15 J. Farrow (Moore's Cove)	0.001	<0.01	<0.01	0.40	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	<0.001	<0.002	<0.03	0.22	<0.005	<0.01	<0.02
F 44 D. Stewart (Cobalt West Road) Aug. 24, 1976	0.93	<0.01	<0.01	0.14	<0.005	<0.01	<0.02
	0.001	<0.01	<0.01	0.07	<0.005	<0.01	<0.02
	0.02	<0.03	<0.02	0.18	<0.005	<0.02	<0.01
	0.03	<0.01	<0.02	0.29	<0.005	0.02	<0.01

	As	Co	Pb	Zn	Cd	Ni	Ag
L 26 June	0.002	<0.01	<0.01	0.09	<0.005	0.01	<0.02
W. Polenz 6	0.62	<0.01	<0.01	0.16	<0.005	0.15	<0.02
(Moore's 11 Jul	0.001	<0.03	<0.02	0.04	<0.005	<0.02	<0.01
Cove) Aug. 9	0.001	<0.02	<0.03	0.12	<0.005	<0.02	<0.01
Aug. 18	0.001	<0.02	<0.03	0.19	<0.005	<0.02	<0.01
Aug.24	0.001	<0.02	<0.03	0.20	<0.005	<0.02	<0.01
N 37	0.001	<0.01	<0.01	0.19	<0.005	<0.01	<0.02
E. Welch (Hwy. 65W)	0.001	<0.01	<0.01	0.06	<0.005	<0.01	<0.02
	<0.001	<0.02	<0.03	0.05	<0.005	<0.02	<0.01
N 49	0.002	<0.01	<0.01	0.04	<0.005	<0.01	<0.02
H. Edwards (Hwy 65W)	0.001	<0.01	<0.01	0.18	<0.005	<0.01	<0.02
	0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
F 53	0.020	<0.01	<0.01	0.23	<0.005	<0.01	<0.02
L. Laferriere (Hwy 65)	0.003	<0.01	<0.01	0.08	<0.005	<0.01	<0.02
	0.03		<0.03	0.16	<0.005	<0.02	<0.01
F 42	<0.002	<0.01	<0.01	0.46	<0.005	0.01	<0.02
V. Bigelow (West Cobalt)	0.003	<0.01	<0.01	0.35	<0.005	<0.01	<0.02
	0.01	<0.03	<0.03	0.12	<0.005	<0.02	<0.01
F 46	0.001	<0.01	<0.01	0.40	<0.005	<0.01	<0.02
E. Montgomery (West Cobalt)	0.002	<0.01	<0.01	0.18	<0.005	<0.01	<0.02
	0.002	<0.03	<0.03	0.12	<0.005	<0.02	<0.01

	As	Co	Pb	Zn	Cd	Ni	Ag
F 32 L. Hamilton (Gilles Lake)	0.002	<0.01	<0.01	0.04	<0.005	<0.01	<0.02
	0.003	<0.01	<0.01	0.05	<0.005	<0.01	<0.02
	0.001	<0.03	<0.03	<0.02	<0.005	<0.02	<0.01
N 13 R. Sturgeon (Hwy. 65W)	<0.001	<0.01	<0.01	0.04	<0.005	<0.01	<0.02
	0.005	<0.01	<0.01	0.09	<0.005	<0.01	<0.02
	0.001	<0.02	<0.03	0.02	<0.005	<0.02	<0.01
F 33 A. Carrierre (Gilles Lake)	0.001	0.01	0.02	0.26	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.11	<0.005	<0.01	<0.01
	0.001	<0.02	<0.03	0.28	<0.005	<0.02	<0.01
F 18 R. McNickle (11 & 11B Junction)	0.002	<0.01	<0.01	0.27	<0.005	<0.01	<0.02
	0.003	<0.01	<0.01	0.12	<0.005	<0.01	<0.01
	0.001	<0.03	<0.03	0.36	<0.005	<0.02	<0.01
F 17 A. Caron (11 & 11B Junction)	0.001	<0.01	<0.02	0.07	<0.005	<0.01	<0.02
	0.001	<0.01	<0.01	0.04	<0.005	<0.01	<0.01
	0.001	<0.03	<0.03	<0.02	<0.005	<0.02	<0.01
L 38 New Ontario Dynamics (well near office)	0.001	<0.01	<0.01	0.02	<0.005	0.01	<0.01
	0.001	<0.01	<0.01	0.05	<0.005	<0.01	<0.01
	0.001	<0.03	<0.03	<0.02	<0.005	<0.02	<0.01

	As	Co	Pb	Zn	Cd	Ni	Ag
L 39 N.O.D. (lab well)	0.001	<0.01	0.02	1.3	<0.005	<0.01	<0.02
	0.001	<0.01	<0.01	1.6	<0.005	0.02	<0.01
	<0.001	<0.03	<0.03	1.2	<0.005	<0.02	<0.01
F 3 R. Haddow (Hwy. 558W)	0.002	<0.001	0.01	1.4	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.14	<0.005	<0.01	<0.01
	0.001	<0.03	<0.03	0.06	<0.005	<0.02	<0.01
F 7 O. Lafluer (Hwy. 558W)	0.002	<0.01	<0.01	1.5	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.47	<0.005	<0.01	<0.01
	0.001	<0.03	<0.03	2.0	<0.005	<0.02	<0.01
F 6 W. Glinker (Hwy 558 W)	0.001	<0.01	<0.01	0.08	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.04	<0.005	<0.01	<0.01
	0.001	<0.03	<0.03	0.08	<0.005	<0.02	<0.01
F 5 S. Wright (Hwy. 558W)	0.001	<0.01	<0.01	0.06	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.06	<0.005	0.02	<0.01
	0.001	<0.02	<0.03	0.02	<0.005	<0.02	<0.01
L 42 P. Beneke (11 &558 junction)	<0.001	<0.01	<0.01	0.16	<0.005	0.01	<0.02
	0.001	<0.01	<0.01	0.18	<0.005	0.01	<0.01
	<0.001	<0.03	<0.03	0.07	<0.005	<0.02	<0.01

	As	Co	Pb	Zn	Cd	Ni	Aq
F 31 T. Dwer (Gilles Lake)	0.001	<0.01	<0.01	0.37	<0.005	0.01	<0.02
	0.002	<0.01	<0.01	0.12	<0.005	0.01	<0.01
	0.001	<0.03	<0.03	0.90	<0.005	<0.02	<0.01
L 23 P. Hopkings (Dutton St.)	0.002	<0.01	<0.01	0.38	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.40	<0.005	<0.01	<0.01
	0.002	<0.03	<0.03	0.66	<0.005	<0.02	<0.01
L 31 B. Cousins (Hwy 558W)	0.001	<0.01	<0.01	0.72	<0.005	0.02	<0.02
	0.002	<0.01	<0.01	0.67	<0.005	0.02	<0.01
	<0.001	<0.02	<0.03	0.13	<0.005	<0.02	<0.01
N11 G. Quene (Hwy 65W)	0.001	<0.01	0.01	0.21	<0.005	<0.01	<0.02
	0.03	<0.01	0.01	0.18	<0.005	<0.01	<0.02
	0.001	<0.02	<0.03	0.04	<0.005	<0.02	<0.01
N 6 E. Morrow (Hwy 65W)	0.002	<0.01	<0.01	0.07	<0.005	<0.01	<0.02
	0.001	<0.01	<0.01	0.15	<0.005	<0.01	<0.02
	0.002	<0.03	<0.03	0.02	<0.005	<0.02	<0.01
N 7 P. Beland (Hwy 65W)	0.006	<0.01	<0.01	0.05	<0.005	<0.01	<0.02
	0.005	<0.01	<0.01	0.12	<0.005	<0.01	<0.02
	0.003	<0.03	<0.03	0.02	<0.005	<0.02	<0.01

	As	Co	Pb	Zn	Cd	Ni	Aq
N 8 V. Foley (Hwy 65W)	0.004	<0.01	0.01	0.02	<0.005	<0.01	<0.02
	<0.001	<0.01	<0.01	0.08	<0.005	<0.01	<0.02
	0.003	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
N 25 L. Huff (Hwy 65W)	0.001	<0.01	<0.01	0.07	<0.005	<0.01	<0.02
	0.004	<0.01	<0.01	0.11	<0.005	<0.01	<0.02
	<0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
N 2 J. Carl (Hwy 65W)	0.001	<0.01	<0.01	0.21	<0.005	<0.01	<0.02
	0.009	<0.01	<0.01	0.52	<0.005	<0.01	<0.02
	0.001	<0.02	<0.03	0.19	<0.005	<0.02	<0.01
N 33 P. Auger (Hwy 65W)	0.001	<0.01	<0.01	4.7	<0.005	<0.01	<0.02
	0.002	<0.01	0.02	0.07	<0.005	<0.01	<0.02
	<0.001	<0.02	<0.03	1.7	0.005	<0.02	<0.01
N 29 D. Pauls (Hwy 65W)	0.004	<0.01	<0.01	0.03	<0.005	<0.01	<0.02
	0.03	<0.01	0.01	1.0	<0.005	<0.01	<0.02
	0.001	<0.02	<0.03	0.82	<0.005	<0.02	<0.01
N 35 A. Greenwood (Hwy 65W house)	0.001	<0.01	<0.01	0.06	0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.24	<0.005	<0.01	<0.02
	0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01

	As	Co	Pb	Zn	Cd	Ni	Ag
N 36 A. Greenwood (barn)	0.001	<0.01	<0.01	0.02	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.06	<0.005	<0.01	<0.02
	0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
N 44 J. Scott (Hwy 65W)	0.001	<0.01	<0.01	0.08	<0.005	0.02	<0.02
	0.001	<0.01	<0.01	0.14	<0.005	<0.01	<0.02
	0.001	<0.02	<0.03	<0.02	<0.005	<0.02	<0.01
N 27 M. Bonney (Hwy 65W)	0.001	<0.01	<0.01	0.08	<0.005	<0.01	<0.02
	0.001	<0.01	<0.01	0.07	<0.005	<0.01	<0.02
	0.001	<0.02	<0.03	0.04	<0.005	<0.02	<0.01
L 3 J. Price (east Cobalt)	0.002	<0.01	<0.01	0.27	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.21	<0.005	<0.01	<0.02
	0.002	<0.03	<0.03	0.06	<0.005	<0.02	<0.01
N 58 R. Larocque (hwy 588W)	0.001	<0.01	<0.01	0.48	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.04	<0.005	<0.01	<0.02
	0.001	<0.03	<0.03	0.08	<0.005	<0.02	<0.01
L 9 J. Boucher (mileage 104)	0.002	<0.01	<0.01	0.18	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	1.2	<0.005	<0.01	<0.02
	0.002	<0.03	<0.03	0.30	<0.005	<0.02	<0.01

	As	Co	Pb	Zn	Cd	Ni	Aq
L 15 G. Evans (north cobalt)	0.004	<0.01	<0.01	0.10	<0.005	<0.01	<0.02
	0.002	<0.01	<0.01	0.03	<0.005	<0.01	<0.02
	0.002	<0.03	<0.03	<0.02	<0.005	<0.02	<0.01
L 14 D. Evans (North Cobalt	<0.001	<0.01	<0.01	<0.01	<0.005	<0.01	<0.02
	0.001	<0.01	<0.01	0.16	<0.005	<0.01	<0.02
	<0.001	<0.03	<0.03	<0.02	<0.005	<0.02	<0.01
L 59 N. Hermistan (North Cobalt)	0.002	<0.01	<0.01	0.24	<0.005	<0.01	<0.02
	0.003	<0.01	0.04	0.04	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
L 5 M. Leishmand (East Cobalt)	<0.008	<0.01	<0.01	2.5	<0.005	<0.01	<0.02
	0.02	<0.01	<0.01	0.27	<0.005	<0.01	<0.02
	0.006	<0.03	<0.03	0.78	<0.005	<0.02	<0.01
F 25 S Lopley (Cobalt Refinery WW)	0.037	<0.01	0.01	0.16	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.04	<0.03	<0.03	0.16	<0.005	<0.02	<0.01
J 21 R. Nobes (North Cobalt)	-	-	-	-	-	-	-
	<0.001	<0.01	0.05	8.0	<0.005	<0.01	<0.01
	<0.001	<0.02	<0.03	4.2	<0.005	<0.02	<0.01

	As	Co	Pb	Zn	Cd	Ni	Aq
J22(L63) L. Millard (North Cobalt) ✓	<0.001	<0.01	0.04	7.1	<0.005	<0.01	<0.02
	<0.001	<0.01	0.01	6.2	<0.005	<0.01	<0.01
	<0.001	<0.02	<0.03	3.2	<0.005	<0.02	<0.01
1 H Cobalt Castings Ltd. (Refinery Road)	0.037	<0.01	0.01	0.16	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.06	<0.02	<0.03	<0.01	<0.005	<0.02	<0.01
N 59 Robert Bowers (Lorrain Valley)	0.004	<0.01	<0.01	0.10	<0.005	0.01	<0.02
	-	-	-	-	-	-	-
	0.008	<0.02	<0.03	0.01	<0.005	<0.02	<0.01
L 60 ✓ J. Hacquard (Lorrain Valley)	0.023	<0.01	<0.01	0.06	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.03	<0.02	<0.03	0.04	<0.005	<0.02	<0.01
L16 Mervin Neill (North Cobalt) ✓	0.001	<0.01	<0.01	1.6	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.001	<0.02	<0.03	0.89	<0.005	<0.02	<0.01
L 43 P. Beneke (11& 588 junction)	0.001	<0.01	<0.01	0.38	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.001	<0.02	<0.03	0.80	<0.005	<0.02	<0.01

	As	Co	Pb	Zn	Cd	Ni	Ag
F 58 R. DeBernardi (Casey Twp)	0.002	<0.01	<0.01	<0.01	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.004	<0.02	<0.03	0.08	<0.005	<0.02	<0.01
F 61 R. LeGros (Dymond Twp)	0.001	<0.01	<0.01	0.65	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.001	<0.02	<0.03	1.2	<0.005	<0.02	<0.01
N14 D. Fowler (Hudson Twp)	0.001	<0.01	<0.01	0.13	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.001	<0.02	<0.03	0.02	<0.005	<0.02	<0.01
N 12 J. Bumstead (Hudson Twp.)	0.001	<0.01	<0.01	0.04	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	<0.001	<0.02	<0.03	<0.01	<0.005	<0.02	<0.01
N 16 Roy Taylor (Hudson Twp)	0.001	<0.01	<0.01	0.06	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.001	<0.02	<0.03	0.06	<0.004	<0.02	<0.01
N 17 Paul Field (Hudson Twp)	0.001	<0.01	<0.01	0.16	<0.005	<0.01	<0.02
	-	-	-	-	-	-	-
	0.002	<0.02	<0.03	0.16	<0.005	0.02	<0.01

	As	Co	Pb	Zn	Cd	Ni	Ag
L 24 N. Cleroux (Moore's Cove)	0.001	<0.01	<0.01	2.2	<0.005	<0.01	<0.01
	-	-	-	-	-	-	-
	0.001	<0.02	<0.03	0.02	<0.005	<0.02	<0.01
J 3 W. Poscoe (east Cobalt)	-	-	-	-	-	-	-
	0.001	<0.01	<0.01	2.6	<0.005	<0.01	<0.02
	0.40	<0.02	<0.03	0.08	<0.005	<0.01	<0.02
N 34 C. Smith (hwy. 65W)	0.001	<0.01	<0.01	0.01	<0.005	<0.01	<0.02
	0.006	<0.01	<0.01	0.04	<0.005	<0.01	<0.02

Appendix III

HEAVY METALS AND ARSENIC SAMPLE RESULTS - 1977

MUNICIPAL WATER SUPPLY SYSTEMS - TRITOWN AREA

COBALT
HAILEYBURY
NEW LISKEARD
LATCHFORD

Note:

1. The components reported are:

   As - Arsenic
   Hg - Mercury
   Pb - Lead
   Zn - Zinc
   Ni - Nickel

2. All results are in milligrams per litre (mg/l), except mercury which is in nanograms per millilitre.

Date of Sample	As	*Hg	Pb	Zn	Ni
Cobalt					
Jan 5/77 Raw	0.004				
Treated	0.004				
Jan 25/77 Raw	0.003	0.16	<0.01	<0.01	<0.01
Feb 4/77		0.31			
Feb 23/77 Raw	0.002	0.23	0.02	0.06	0.05
Mar 10/77	0.004	0.04	<0.01	0.02	0.01
Haileybury					
Feb 2/77 Raw	0.001	<0.02			
April 3/77 Raw	<0.001	<0.03			
Treated	<0.001	<0.03			
May 31/77 Raw	0.005	<0.02			
Treated	0.001	<0.02			
July 26/77 Raw	0.001	<0.02			
Treated	<0.001	<0.02			
Sept. 9/77 Raw	0.002	0.10			
Treated	0.001	<0.02			
New Liskeard					
Feb 23/77	<0.001		<0.01	0.03	
Aug 10/77 Raw	<0.001		<0.03	0.06	
Nov 2/77 Treated	0.001		<0.01	<0.01	<0.01
Latchford					
Feb 18/77		<0.02			

*Note: equivalent to parts per billion

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Appendix IV

LIST OF QUESTIONABLE PRIVATE WATER SUPPLIES FROM 1977 SAMPLING

(Arsenic at or over 0.001 mg/l)

NOTE:

1. Results are grouped by Township.

2. Sample number refers to the actual identification code used on the sample submission sheets.

3. All results are in milligrams per litre (mg/l).

4. Note: The Ministry of the Environment objective is 0.01 mg/l with a rejection limit of 0.05 mg/l.

Occupant	No. People Served	Arsenic level (ppm)	Type of Supply	Sample No.
Bucke Township				
Germaine Plouff	(6)	0.007	20' dug well	J123
David Fleming	(4)	0.001	25-30' dug well	J124
D. Fleming (Garden)		0.001	dug well	J125
Ed Brown	(1)	0.010	dug well	J127
Cristine Audet	(2)	0.005	20' dug well	J128
Lawrence Tull	(5)	0.001	25' dug well	J129
Viola Perrier	(2)	0.001	15' dug well	J130
K. Fulson (mine shaft)		0.08	100' drilled well	J178
K. Fulson (garden)	(4)	0.001	15' dug well	J179
J. Mills	(2)	0.001	127' drilled well	J181
W. Hurst	(2)	0.001	drilled well	J188
O. Spangler	(3)	0.001	148' drilled well	J189
N. Carr	(3)	0.001	drilled well	J191
K. Gorman	(5)	0.001	201' drilled well	J202
R. Cole	(4)	0.001	120' drilled well	J176
Coleman Township				
John Gore (cottage)	(2)	0.001	10' dug well	J70
John Gore (drill hole)		0.003	742' drill hole	J71
Nelson Bigelow	(4)	0.001	9' dug well	J126
Mrs. Hearst	(1)	0.002	19-20' dug well	J133
Lawrence Coe	(2)	0.005	15' dug well	J134
Frank Clattenburg	(2)	0.003	13-14' dug well	J138
Gatien Paquin	(3)	0.004	25' dug well	J139
Township of Coleman municipal well b		0.003	dug well	J140

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Occupant	No. People Served	Arsenic level (ppm)	Type of Supply	Sample No.
Mrs. O. McDermid	(2)	0.001	20' dug well	J194 (b)
V. Bigelow		0.001	drilled well	J203
Dymond Township				
Jim Robertson	(6)	0.001	400'+	J114
George Miller	(4)	0.001	flowing well (surface)	J117
Wilfred Godmaire	(4)	0.001	400' drilled well	J119
Gillies Limit				
Roger Chartrand	(4)	0.002	lakewater supply	J16
C. Belland		0.002	lakewater supply	J17
P. J. Lemon	(1)	0.002	lakewater supply	J18
J. L. MacMillan	(1)	0.002	lakewater supply	J19
Bass Lake Trailer Park		0.002	85' drilled well	J62
Kiwanis Beach (snack bar)		0.001	lakewater supply	J4
Kiwanis Beach (lake)		0.001	lakewater supply	J5
Harley Township				
F. Ballard	(5)	0.001	160' drilled well	J118
Omer Godmaire	(4)	0.001	flowing well	J120
Harris Township				
Brian McLean		0.001	unknown	J39
J. L. Sheedy	(2)	0.001	60' drilled well	J53
A. Licoup	(4)	0.001	60' drilled well	J83
W. Pettau	(6)	0.001	unknown	J98

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Occupant	No. People Served	Arsenic level (ppm)	Type of Supply	Sample No.
Hudson Township				
George Gordon	(2)	0.002	25' sandpoint well	J23
Ira Murphy	(2)	0.004	sandpoint well	J31
A. Dugas	(2)	0.001	35' sandpoint well	J7
Kerns Township				
R. Armstrong	(2)	0.001	85' drilled well	J199
Lorrain Township				
Loon Lake		0.004	diamond drill hole	J1

APPENDIX V

DRINKING WATER OBJECTIVE LEVELS AND SIGNIFICANCE OF VARIOUS METALS AND ARSENIC

Arsenic - MOE Drinking Water Rejection Level 0.05 mg/l

Arsenic is commonly found in nature as various minerals. It may be present in natural waters by the dissolution of these minerals, industrial discharges and pesticide application. The element in its inorganic salts is highly toxic to humans, and is known to exhibit carcinogenic properties especially in the arsenic form. Since arsenic is eliminated from the body very slowly, it tends to accumulate, becoming concentrated in the nails, hair and skin. Hence the prolonged intake of water containing only minute quantities of arsenic may be a health hazard. For this reason, the maximum permissible concentration in domestic water supplies has been established at 0.05 mg/l with an objective of less than 0.01 mg/l.

Cadmium - MOE Drinking Water Objective Level 0.01 mg/l

All forms of cadmium are highly toxic and once ingested are likely to remain in the body for a long time, becoming concentrated in the liver, kidneys and other organs. The maximum acceptable concentration of cadmium in domestic water supplies is 0.01 mg/l.

Cobalt - No maximum acceptable level

Cobalt is an essential element at trace levels for both animal and plant nutrition. Cobalt deficiency in man and animals results in a type of anaemia which may be corrected by administering small doses of cobalt chloride orally. Adverse effects due to cobalt are very slight, even at high concentrations. No limits have been set on the maximum acceptable concentration for cobalt in domestic water supplies.

Lead - MOE Drinking Water Objective Level 0.05 mg/l

Lead is a very toxic element which tends to exchange with calcium and accumulate in bone marrow. Organic lead exerts its toxic effect on the nervous system within a very short time causing mental confusion, delirium, nausea, hallucinations, insomnia and convulsions. The maximum acceptable concentration of lead in domestic water is 0.05 mg/l.

Nickel - No Maximum Acceptable Level

Nickel is more abundant in Ontario than anywhere else in the world. Nickel and its salts have generally proven to be non-toxic to man even at very high levels. Nickel sulphate and nickel bromide have even been used therapeutically as nervous sedatives for headaches, neuralgia and insomnia. No maximum acceptable concentration in domestic water supplies has been specified.

Silver - MOE Drinking Water Objective Level 0.05 mg/l

Silver is found in nature as the native metal. Exposure in industry is usually manifested as a condition referred to as agryria, with common symptoms including a permanent blue-gray discoloration of the skin and eyes. Although excessive exposure to silver may result in kidney, liver or spleen damage, no recognizable disturbances of health need accompany this condition. The maximum acceptable concentration of silver in domestic water supplies is 0.05 mg/l.

Zinc - MOE Drinking Water Objective Level 5.0 mg/l

Zinc and its compounds are relatively non-toxic when orally taken. Even at high concentrations, nausea and diarrhea are the only adverse effects likely to be encountered. The limiting factors which determine the acceptable maximum concentration in a water supply are taste and appearance. Zinc, in excess of 5.0 mg/l imparts a bitter astringent taste, a milky appearance in alkaline waters, and may cause a greasy film when the water is boiled. The maximum acceptable limit for domestic water supplies in Ontario is therefore 5.0 mg/l.

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APPENDIX VI

PROBABLE SOURCE OF SOME HIGH ARSENIC LEVELS IN TRI-TOWN AREA WELLS

- Table I General Chemical Water Quality Analysis Results
- Significance of Sample Results
- Table II Heavy Metals (Powder Spectograph) Analysis Results ugm/gm

Report PROBABLE SOURCE OF SOME HIGH ARSENIC LEVELS IN TRI-TOWN AREA

The writer, in the company of North Bay District Municipal & Private Abatement Staff, conducted field investigations on 10 wells in the Tri-Town area on August 24, 1977.

The following well supplies were included in this investigation:

	NAME	LOCATION (as per District Maps)
1)	Cobalt Castings Ltd. Supply	Township of Gillies Limit
2)	Bass Lake Trailer Park	Coleman Twp. #J-62
3)	D. Stewart Residence	Coleman Twp. #F-44
4)	V. Bigelow (adjacent to Stewart Residence)	Coleman Twp. #J-203 or #F-45
5)	Mileage 104, public well	Bucke Twp. #J-104
6)	Ed Brown Residence (near mileage 104 public well)	Bucke Twp. #J-127
7)	W. Polenz (Moores Cove)	Bucke Twp. #L-26
8)	J. Farrow Residence (adjacent to W. Polenz)	Bucke Twp. #L-25
9)	G. Gordon Residence (Burtle Lake)	Hudson Twp. #J-23
10)	I. Murphy Residence (Frere Lake)	Hudson Twp. #J-31

At each well site, general observations of the geological setting were noted. Soil samples from strategic locations were collected for heavy metals analysis (see Table II). Water samples were collected from the study wells for heavy metals and general chemistry analyses (see Table I).

The field observations and soil sample locations follow:

1) Cobalt Castings Limited Area Wells

Generally, the area is situated in a low relief fine sand plain. Reportedly there are prevailing west winds in this area (soil sample collected about 200' east of the office building). The property was previously owned by the Cobalt Refinery and reportedly there have been no stack emissions since that time. An old tailings area was noted west of the Cobalt Castings Limited in Westbay on the Montreal River.

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The Cobalt Castings Limited drilled well is 3" in diameter and 25' deep. The Water Well Record indicates the following soils stratigraphy: blue clay 0 to 18', hard pan 18 to 23' and coarse gravel 23 to 25'.

2) Bass Lake Trailer Park

The trailer park is located on a fine sand bluff adjacent to the east shore of Bass Lake, approximately 2 miles east of Cobalt Castings Limited. The trailer park is reportedly serviced by two overburden drilled wells at 85' to 110' (Water Well Records not available). Soil samples were collected approximately 200' west of the trailer park where the soil was undisturbed.

3) V. Bigelow Residence

The area was noted to be sparse and overburden with many bedrock outcrops and a swamp to the west of the residence. It was noted that much of the fill material consisted of imported gravel and mine rock (see Table II). The water supply is reportedly obtained from a drilled well which intercepts a black slate deposit. In addition, the Bigelow residence has a hand pump (not used as domestic supply) which is reported to be constructed over a 50' deep exploration pit (see Table I).

4) D. Stewart Residence

This supply is located directly across the street from the V. Bigelow Residence and most of the same observations apply. Their water supply is reportedly obtained from a drilled well which intersects black slate.

5) Mileage 104 Public Well

This dug well had a water level about 12' below the ground surface. Extensive mining activity was noted southwest and northwest in the area with tailings disposal southeast and east of the well. Mine rock fill material, with erythrite staining (see Table II) was noted on the surface surrounding the well.

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6) Ed Brown Residence

This dug well was located several hundred yards north of the mileage 104 well and many of the same observations apply. This well also appeared to be surrounded by mine rock material (see Table II).

7) W. Polenz Residence

This well is reportedly 120' drilled well which intersected bluish-black slate over limestone. The overburden was noted in this area. The driveway and fill material appeared to be mine rock (see Table II). The rail bed ballast material ¼ mile upgradient appeared to be mine rock high in sulphide mineralization (see Table II). A water Well Record was not available for this well.

8) J. Farrow Residence

This 12' deep dug well was located adjacent to the W. Polenz property and the same observations apply.

9) G. Gordon Residence

This residence was situated on a fine sand bluff adjacent to Bartle Lake. The water supply is obtained from a 23' sand point. Fill was obtained from the Grant Pit for the driveway and septic system (see Table II).

10) Murphy Residence

This residence was located on a sand bluff adjacent to Frere Lake. A dug well of unknown depth supplies the potable water. The driveway fill appeared to be similar in nature to the fill at the G. Gordon Residence (see Table II).

The following is a summary of the Arsenic levels of water samples collected from the study wells.

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LOCATION	DATE OR SOURCE	As level (mg/l)
Cobalt Castings Ltd.	April 1977 Report	0.037**
	August 24, 1977	0.06*
Bass Lake Trailer Park	August 24, 1977	0.002
D. Stewart Residence	April 1977 Report	.93*
	May 24 to June 9, 1977 sampling	0.001
	July 26 to August 26, 1977 sampling	0.02**
	August 24, 1977	0.03**
V. Bigelow	April 1977 (Report)	.001 (drilled well)
	August 24, 1977	0.001 (hand pump)
Mileage 104 public well	April 1977 Report	0.004
	August 24, 1977	0.004
E. Brown Residence	August 24, 1977	0.01**
W. Polenz Residence	April 1977 Report	.002
	June 6, 1977	0.62*
	June 14, 1977	0.001
	August 9, 1977	0.001
	August 18, 1977	0.001
	August 24, 1977	0.001
J. Farrow Residence	April 1977 Report	.001
	July 26 to August 26, 1977	0.001
G. Gordon Residence	April 1977 Report	0.002
	August 24, 1977	0.001
I. Murphy Residence	April 1977 Report	0.004
	August 24, 1977	0.001

* denotes Arsenic level in excess of maximum acceptable level of 0.05 mg/l

** denotes wells containing 0.01 mg/l Arsenic level or above.

In summary, the following well water supplies have exhibited elevated arsenic levels:

(a) in excess of 0.05 mg/l As:

Cobalt Castings Limited
D. Stewart Residence
W. Polenz

(b) 0.01 mg/l or more As (in addition to (a):

E. Brown Residence

Water samples were collected from 8 of the available study wells for a general chemical analysis (see Table I). The primary ob-

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jective of this analysis was to determine if there were any obvious correlations between chemical variables and high arsenic levels in the well water supplies. No consistent correlation was noted. It is possible that long term extensive chemical water quality monitoring could reveal more consistent correlations which were not obvious from these sample results.

It may be noted that several chemical variables from several of the supplies sampled were higher than the acceptable limits for potable water, i.e. Chloride, Sodium, Iron and Manganese. Where these levels might constitute a health hazard the water users were notified by Ministry Staff.

In addition, the result for lead in the V. Bigelow Residence supply was reported as 0.06 mg/l Pb, this result is inappropriate since something had interfered with level of detection (the maximum acceptable limit for Pb is 0.05 mg/l). This chemical variable should be double checked during the next sampling of the well. With the exception of this result and the Cobalt Castings Limited arsenic result, all the heavy metals were within acceptable limits for the August 24 sampling.

The contaminated water supplies bear no distinct relationship with geographic distribution. The contaminated water supplies are widely distributed throughout the Tri-Town area. Variability in past sample results may be due to the following:

1) lack of standardized sampling procedure;
2) water use prior to sample collection;
3) contamination of sample bottles;
4) flushing and dilution due to natural groundwater level fluctuations.

The significance of the soil sample results (see Table II) is as follows:

SURFICAL SOIL SAMPLES WHICH HAD ARSENIC LEVELS ABOVE 500 ugm/gm

V. Bigelow (mine rock driveway fill)
Mileage 104, public well (mine rock fill surrounding top of well)

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Ed Brown (mine rock fill around top of well)
W. Polenz (mine rock driveway fill)
Railway Ballast Material (¼ mile upgradient from Polenz Residence)
G. Gordon (driveway and septic tile field fill from Grant's Pit)

The following contaminated well supplies may have elevated arsenic levels associated with arsenic leaching out of the soil and into the well via an inadequate well seal:

Owner of Supply	Associated Contaminated Surface Soil Sample Result (See Table II)
D. Stewart	V. Bigelow (neighbour) mine rock driveway fill contained high arsenic levels.
W. Polenz	W. Polenz mine rock driveway fill contained high arsenic levels and railway ballast upgradient.
E. Brown	Mine rock fill around top of the Ed Brown residence's well.

A surface soil sample collected near the Cobalt Castings contaminated supply was not excessively high in arsenic.

The following well supplies did not contain elevated arsenic levels associated with contaminated surface soil samples:

Owner of Supply	Contaminated Surface Soil Sample Near Well
Mileage 104 Public Well	Mine rock fill surrounding top of well.
V. Bigelow	Mine rock driveway fill.
J. Farrow	W. Polenz (neighbour) mine rock driveway fill and railway ballast upgradient.
G. Gordon	Driveway and septic tile field fill from Grant's Pit.

It is possible that these wells were sufficiently sealed to minimize access of arsenic to them via surface-runoff.

Two of the study well supplies did not contain elevated arsenic

levels and no contaminated surface soil was detected near them. These wells are as follows: Bass Lake Trailer Park, and I. Murphy Residence.

Two of the four well supplies elevated in arsenic were drilled into black-slate. In addition, the V. Bigelow well was drilled into black-slate, but this supply has not displayed elevated arsenic levels. It may be that the black-slate intersected by the V. Bigelow well was not mineralized sufficiently to produce high arsenic levels. This is consistent with the available literature which indicates that the highest arsenic levels in the Tri-Town area are to be found within mineralization in the black-slate deposits (see reference, Geological Survey of Canada, paper 66-46 Geochemistry in the Cobalt Area by R. W. Boyle).

In summary the most consistent relationship appears to be with wells associated with black-slate. Three of the four wells with elevated arsenic levels i.e. D. Stewart, W. Polenz and E. Brown are associated with black-slate, either drilled through it or surrounded at the surface by it. The Cobalt Castings well is a notable exception to this trend. The source of high arsenic in this well is not defined by available information.

All of the rock and soil samples collected except the I. Murphy residence (see Table II) which contained black-slate were high in arsenic levels. Variability in arsenic levels may be due to degree of mineralization. The adequacy of the well seal may be the determining factor whether the arsenic gains access to the well water or not.

As a result of this possible relationship of the black-slate material to high arsenic levels, we are asking Water Well Drillers operating in the Tri-Town area to collect water samples for chemical and heavy metals analyses and to specifically identify wells drilled in black-slate bedrock. The Regional Well Inspector is instructing the appropriate Water Well Drillers on sampling procedures, technique and identification of black-slate. It is anticipated that some interesting correlations may eventually be derived.

Results are pending on the analysis of soluble arsenic levels

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on the soil samples. If this information sheds any additional light on the matter, it will be elaborated upon in a later report.

More work would be required to resolve some of the inconsistencies evident from this investigation.

Clyde Hammond,
Groundwater Evaluator,
Northeastern Region.

TABLE I

GENERAL CHEMICAL WATER QUALITY ANALYSES RESULTS

(most in mg/l)

Sample	Hardness	Alkalinity	pH	Conductivity	ANIONS			
					Total Phosphorus	Chloride	Sulphate	Nitrate
Cobalt Castings Ltd. (office).	163	119	7.8	366	.03	33	21	.6
Bass Lake Trailer Park.	125	100	7.7	235	<.02	7	20	.2
D. Stewart (adjacent Bigelow Res.).	458	298	7.1	1400	<.02	253**	69	<.1
V. Bigelow Res. (hand pump).	534	306	7.1	1340	<.02	223	87	<.1
Mileage 104 public well.	479	325	7.9	1520	<.02	305**	44	<.1
W. Polenz (Moore's Cove).	218	258	7.8	505	<.02	17	6	<.1
G. Gordon (Bartle Lake).	181	160	8.0	335	<.02	12	7	<.1
Z. Murphy (Frere Lake).	112	59	6.8	260	<.02	29	23	.8
E. Brown Res.	N.A.							
J. Farrow	N.A.							

* see attached for parameters in excess of limits
** above limit
N.A. -Not Available

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TABLE I Continued

GENERAL CHEMICAL WATER QUALITY ANALYSES RESULTS

(most in mg/l)

CATIONS

Sample	Iron	Sodium	Potassium	Calcium	Magnesium	Manganese
Cobalt Castings Ltd. (office).	< .05	13	.6	46	12	.005
Bass Lake Trailer Park.	0.10	2	.2	42	5	.006
D. Stewart (adjacent Bigelow Res.).	4.7**	115**	4.8	144	24	4.00**
V. Bigelow Res. (hand pump).	3.9**	82**	2.6	168	28	1.40**
Mileage 104 public well.	.55**	130**	3.5	124	41	.032
W. Polenz (Moore's Cove).	.35**	29	2.6	42	27	.036
G. Gordon (Bartle Lake).	1.0**	3	.3	47	15	.008
Z. Murphy (Frere Lake).	.40**	6	1.0	29	10	.007
E. Brown Res.	N.A.					
J. Farrow	N.A.					

* see attached for parameters in excess of limits
** above limit
N.A. - Not Available

Significance of Sample Results

Hardness: The hardness content of water in Ontario ranges from less than 10 mg/l (milligrams/litre) to more than 1800 mg/l. Any water that has a hardness above 500 mg/l may cause problems when used for domestic purposes.

Alkalinity: There is no set standard for alkalinity as it is only used as an indicator of the presence of salts in the water. When the hardness exceeds the alkalinity, it is an indication that there usually are salts of Calcium and Magnesium present in association with sulphates, chlorides or nitrates.

Iron: The limit set for iron is 0.3 mg/l. Above this problems with the discolouring of plumbing fixtures and laundered goods can occur. Excessive iron can also cause a taste and odour problem in water. While excessive iron in the water is objectionable, it is not considered to be a danger to health.

Chlorides: The upper limit for chlorides has been set as 250 mg/l, above this limit a salty taste develops.

pH: The pH measurement is a scale that refers to the acidity or alkalinity of the substance, in this case water. The neutral range is a pH 7.0.

Conductivity: This is a measure of the ability of the water to conduct an electrical current and is used as a measure of the dissolved solids in the water. The result is not directly related to the quality of the water and therefore not to any problems with the water.

Nitrates: A limit of 10 mg/l has been set as the permissible level for nitrates. Above this the nitrates can affect the oxygen carrying capacity of the blood in babies causing a "blue-baby" condition to result.

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Manganese: A level of 0.05 mg/l has been designated as a permissible level for manganese in the water. A level of manganese above this level can cause the same problems as iron.

Sulphate: The maximum sulphate concentration permissible for domestic supplies in Ontario is 250 mg/l. Concentrations above these levels are non-toxic, but may produce a laxative effect on the gastro-intestional tract.

Sodium: Sodium is an important element for all life forms and is generally considered non-toxic. However, patients with high blood pressure are usually warned to avoid consumption of water containing more than 50 mg/l of Sodium.

Potassium: It is non-toxic and presents no known health hazard. No limits have been specified for the maximum acceptable concentration of potassium in domestic water supplies.

Calcium: Aqueous calcium compounds are generally non-toxic and represent no known health hazard.

Magnesium: Ingestion of magnesium produces no adverse effects at levels normally encountered in domestic water supplies.

TABLE II

HEAVY METALS (POWDER SPECTROGRAPH) ANALYSES RESULTS ugm/gm

Approximate Sample Location	Lead (Pb)	Copper (Cu)	Nickel (Ni)	Arsenic (As)	Cobalt (Co)	Materials Description
Cobalt Castings Ltd.	10	16	42	<300	trace	fine sand, west of office
Bass Lake Trailer Park	<10	17	19	<300	trace	fine sand, 200 ft. west of park
V. Bigelow Res.	~4000	~1500	>>1000	>>1000	>>300	gravel and mine rock (some black slate)
Mileage 104, public well	~3000	~10	>>1000	>>1000	>>300	mine rock fill (some black slate)
Mileage 104, Ed Brown Res.	~2500	1100	>>1000	>>1000	>>300	mine rock fill (some black slate)
W. Polenz Res. (Moore's Cove)	275	300	300	>>1000	>>300	mine rock fill (some black slate)
Railway Ballast (Moore's Cove)	19	1200	70	600	trace	mine rock fill, highly mineralized
G. Gordon Res. (Bartle Lake)	86	160	110	~1000	trace	crushed stone (some black slate)
I. Murphy Res. (Frere Lake)	33	220	68	<300	trace	crushed stone, similar to Gordon Residence

< - less than
> - greater than
>> - much greater than
~ - approximately