PROVINCE OF NOVA SCOTIA

ARSENIC TASK FORCE

INTERIM REPORT

May 17, 1976

C O N T E N T S

1. Introduction

On February 13, 1976 a report to the Atlantic Health Unit by the Victoria General Hospital stated that a patient from the Waverley area had the symptoms of chronic arsenic intoxication. An investigation by Health Unit personnel assisted by the Environmental Chemistry Section of the Pathology Institute revealed that the water from the dug well at the patient's home contained arsenic in a concentration which far exceeded the Canadian Drinking Water Standards "maximum permissible limit".

A meeting of personnel from a number of Provincial departments and agencies and the patient's physician was called by C. E. Tupper, P. Eng., Administrator, Health Engineering Services. This meeting, held on February 24, 1976, resulted in the formation of a "task force" to devise and co-ordinate a program of investigation of the occurrence of arsenic in water wells in Nova Scotia. It was generally believed at that time by those involved, that the investigation would only be necessary in the "gold districts" of the Province.

Members of the Provincial Arsenic Task Force are:

Department of the Environment

Environmental Assessment Division—Creighton Brisco, Environmental Analyst
William A. Coulter, P. Eng., Staff Engineer

Water Planning and Management Division—John F. Jones, P. Eng., Acting Director

Department of Mines

A. Chatterjee, Ph.D., Geologist
Howard Donahoe, Geologist

Department of Public Health

Atlantic Health Unit—David A. Grantham, P. Eng., Public Health Engineer
(Co-ordinator of Task Force)

Pathology Institute

Division of Clinical Chemistry— J. T. Hindmarsh, M.D., Associate Pathologist
Environmental Chemistry Section—Ross McCurdy, Chief

The Task Force has been assisted greatly in its work by many individuals in the Environment, Mines, and Public Health Departments, the Pathology Institute, members of the public and news media. A more detailed listing of those who have been involved cannot be presented in this interim report. This will be included in the final report of the Task Force.

2. Method of Investigation

The main efforts of the investigation were initially directed at the sampling of wells in the most densely populated and most heavily mined gold districts, beginning with the Waverley area. Sampling was carried out by teams composed of Public Health Inspectors and Environment Department field personnel. All samples were analyzed at the Environmental Chemistry Laboratory.

Letters reporting the arsenic concentrations found were sent to the owners of the wells. Letters to owners of wells found to have arsenic concentrations greater than the maximum permissible limit were sent by registered mail. These letters informed the well owners that the water should not be used for drinking or cooking purposes. In addition, attempts were made to telephone as many of these individuals as possible. Copies of typical form letters for wells above the limit, below the limit, and at or near the limit are attached to this report.

All wells were sampled in Waverley, South Uniacke, and Oldham, the first three districts investigated. In other gold districts "spot sampling" of wells located in what were believed to be the most critical areas was carried out. More extensive sampling has been and will be used as dictated by results of the spot sampling program. In some instances, the results of samples of wells in areas somewhat removed from gold districts such as Silverside Subdivision on the Waverley Road indicated the need for further sampling.

Tabulated summaries of the results are listed in Section 3 of this report. Over 500 wells have been sampled to date at least once. Re-sampling of a representative number of wells in Waverley was carried out.

During the well sampling program, field personnel had well owners complete questionnaires covering details of well construction. These were used in themselves and as an aid to the looking up of well drilling logs which are on file with the

Environment Department.

The records of the Department of Mines have been used as an aid in locating old mine workings and details of mining operations.

Several members of the Task Force and support staff have been involved in an examination of available literature related to various aspects of arsenic in the environment and its effects on exposed persons. A number of technical papers were provided by the Health Protection Branch of Health and Welfare Canada. These have been a useful source of information.

Clinics have been held in Waverley and preliminary arrangements have been made to perform some similar investigations in Tangier and Oldham. Hair, nail, blood, and urine samples were obtained at the Waverley clinics. Three groups of persons were requested to attend the clinics: (1) all those using wells above the limit, (2) a number of those using wells at or near the limit, and (3) a number of those using wells considerably below the limit. Questionnaires regarding water usage and time of residence were completed.

A medical investigation has been started by staff of the Pathology Institute, particularly Dr. J. T. Hindmarsh and Dr. O. MacLetchie. Letters reporting the results of the hair sampling and analysis program have been sent to the persons involved.

Personnel of the Environment and Mines Departments have been engaged in researching well logs and mine records, mapping and tabulating data from the well surveys, collating geological and mineralogical information and generally attempting to relate the well sampling results to the following parameters: well construction, primary geochemistry and mineralogy of bedrock, mining operations--underground (shafts), and mining operations--surface (tailings and waste rock dumps).

3. Results

Summaries of arsenic concentrations found in wells sampled in various parts of the Province are tabulated in Table 1, Page 5. The manner in which these results have been correlated with the parameters of well construction, primary bedrock geochemistry and mineralogy and mining operations and the conclusions reached on this basis are presented in Appendix B.

As shown in the table, well water arsenic concentrations above the limit have been found in eight areas out of a total of 21 areas sampled in five counties. The highest concentration found is that found in the first well which was sampled in Waverley.

The results of the first re-sampling of a representative number of Waverley wells showed that of the 30 wells re-sampled, 19 remained about the same in arsenic concentration; of the remaining 11, 8 wells had lower concentrations than in the first sample, and 3 had higher concentrations. The owners of 2 wells which went from slightly below to slightly above the limit were notified. A second re-sampling of Waverley wells is currently being done. Initially the Task Force advanced several possible explanations for the occurrence of high well water arsenic concentrations in gold mining areas. The results of the well sampling program to date strongly indicate that all of the explanations are valid to some degree depending on the area. In some areas only one or two of the causes seem to be involved; in other areas all of the causes seem involved. Perhaps the most significant fact which has emerged is that there are indications that above the limit arsenic concentrations can be encountered in drilled wells which are located some miles from known gold producing areas. At this time it appears that the natural bedrock conditions in some parts of the Province are the cause of this problem.

Samples taken from Lake William and Lake Thomas at the end of February by the Environment Department were all well below the maximum permissible limit for arsenic. Three samples taken during the second week of May from Lake William were slightly higher in arsenic than the February samples, but the concentrations are well below the limit. Two samples taken from Lake Thomas during the second week of May were also slightly higher in arsenic than the February samples, but the concentrations are well below the limit. Increased runoff at this time of year may be the reason for the increased lake water arsenic concentrations.

TABLE 1

SUMMARY OF ARSENIC CONCENTRATIONS IN WELLS SAMPLED

Place	No. of Wells Sampled	Above Limit >0.05 mg/l	Below Limit <0.04 mg/l	At or Near Limit 0.04 & 0.05 mg/l
Halifax County				
Caribou Gold Mines	7	0	5	2
Cow Bay	15	0	15	0
Lawrencetown	22	4	16	2
Mineville	17	0	16	1
Montague Mines	19	3	13	3
Moose River Gold Mines	13	0	12	1
Oldham	70	14	51	5
Silverside Subdivision	51	5	41	5
Tangier	49	8	37	4
Waverley	186	31	135	20
Guysborough County				
Drumhead Harbour	5	1	4	0
Goldboro	10	0	10	0
Goldenville	12	2	7	3
Isaac's Harbour	7	0	7	0
Seal Harbour	8	0	8	0
Wine Harbour	10	0	10	0
Lunenburg County				
Blockhouse	7	0	7	0
Gold River	5	0	5	0
Hants County				
South Uniacke	18	0	16	2
Queens County				
Brookfield (south)	1	0	1	0
Molega Lake	6	0	6	0
TOTALS*	538	68	422	48

* To May 14, 1976

4. Recommendations

At this time the Task Force makes the recommendations listed below. Time constraints have made it impossible to write into this interim report all of the information which has led to, and facts which support, the recommendations. Much of the background information on which the recommendations are based is contained in Appendices A to D which are attached to this report. The Task Force is certain that the recommendations are valid, necessary, and supportable. The recommendations are not listed in any particular order.

The Provincial Arsenic Task Force recommends:

1) That under no circumstances should water with an arsenic concentration in excess of 0.05 mg/l (ppm) be used for consumption or cooking. This recommendation has already been made to all owners of wells found to have such concentrations of arsenic.

2) That in the Waverley area groundwater cease to be used as a source of water for human consumption and for cooking purposes and that an alternate source of water be found by means of a detailed study which should begin immediately. The Task Force does not have the required resources to carry out this study, but would be most willing to assist in any way possible. The Task Force wishes to emphasize the urgency for immediate action in implementing this recommendation.

3) (a) That surface water bodies found to contain arsenic concentrations above 0.05 mg/l be posted as being contaminated and unsafe as sources of water supply and

(b) That surface water bodies found to contain very high arsenic concentratio be posted as being also unsafe for swimming.

Such closures should be widely publicized.

Muddy Pond in Waverley and the swimming pond in Moose River Gold Mines fall into category (b) and should be posted.

4) That arrangements be made to have M.S.I. accept blood arsenic, hair arsenic, and urine arsenic determinations as insured out-patient tests, to be performed only at the discretion of a pathologist.

5) That a long-term medical study be carried out in Waverley and possibly other areas. This would be a research project, the main aim of which would be to further medical knowledge in this regard. The Clinical

Trace Metals Research Group, Dalhousie University is interested in this matter and could carry out such a study if funds are made available.

6) That the Department of the Environment advise all well drillers in the Province to recommend to customers having wells drilled in slate and quartzite of the Meguma Group to submit samples of water from these wells to the Environmental Chemistry Laboratory, Pathology Institute for analysis for arsenic; the cost of the analysis to be charged to the customer.

7) (a) That the well survey in gold districts be continued to completion, with priority being given to residential areas situated near the remaining gold districts.

(b) That a well sampling program be carried out over an area or areas underlain by slate and quartzite of the Meguma Group, but outside any known gold producing region to help determine background arsenic concentration levels in wells situated in rocks belonging to the Meguma Group and to follow-up on the apparent possibility of above-the-limit arsenic concentrations occurring outside gold districts.

8) That consideration be given to the establishment of a program by the Environment and Mines Departments in consultation with the Public Health Department to locate possible problem areas in the Province where, because of geological conditions, other specific trace elements could reach harmful concentrations in soils and groundwater.

9) That the Department of the Environment or the Department of Mines, or both, impose an immediate ban on the removal or disruption of mining wastes, for any reason, without the written approval of the Minister(s) of the appropriate Departments(s) with the concurrence of the Minister of Public Health.

10) That waste materials from all present and future mining operations be subjected to chemical analyses for arsenic and other toxic substances and the disposal of all mining wastes be dependent upon the written approval of the Minister of the Environment or the Minister of Mines, or both, with the concurrence of the Minister of Public Health.

11) That the Department of the Environment inspect existing rock crushing operations to determine whether or not the source rock for these operations contains arsenic at a level which could give rise to problems with respect to groundwater contamination in areas in which the crushed rock is placed, such as road-beds, septic tank system disposal beds and dug wells. Consideration should

be given to establishing a permit system whereby the rock to be used in proposed rock crushing operations can be given prior examination.

12) That the Department of the Environment immediately begin an arsenic sampling program at specific points in Lake William and Lake Thomas with sampling to be carried out at least once per month. The Public Health Department should be kept informed of the results by regular reports and the program should continue for as long as these Lakes are used as water supply sources for subdivisions in Waverley.

13) That a study be carried out on various water treatment units to determine the suitability of each unit to remove arsenic from water and that research be carried out to develop a suitable arsenic removal process for use in individual houses if none of the units currently available is satisfactory. Probably the most suitable location for carrying out such a project would be the Environmental Chemistry Laboratory of the Pathology Institute.

5. Further Investigations

If Recommendation 2 above is implemented, the problem of arsenic contaminated wells in Waverley will be solved. There will remain many high arsenic wells in other parts of the Province, some clustered in small geographical areas, others scattered throughout the Province. Furthermore, persons will wish to dig or drill new wells as various forms of development are proposed in various areas.

The Task Force wishes to point out the need for alternatives and advice for both the owners of existing arsenic-contaminated wells and for those who will wish to build in areas which are not served with municipal water supplies. Some of the recommendations noted above will, if implemented, result in the obtaining of some of the information required to cope with this situation. In addition, the further analysis of data already in hand will result in further recommendations which will be made as soon as possible. For example, it appears that in some areas the only wells with high arsenic concentration are drilled wells. In such areas the use of dug wells as the source of drinking and cooking water may be the answer. As a further example, it may be possible to advise that wells not be located in specific areas because of the proximity of mine shafts or tailings dumps.

The Task Force will work towards providing a specific recommendation for the Oldham area where most of the problem wells are located in one part of the community. It appears that the solution for the owners of arsenic contaminated wells in all other areas will involve one or a combination of the following:

a) re-location of the well,
b) constructing a dug well to provide drinking and cooking water,
c) using a surface water body such as a stream or lake as a source of drinking and cooking water (such water may require treatment such as boiling to ensure safe bacterial quality), and
d) installation of treatment equipment in individual houses.

It is hoped that with regard to proposed developments, recommendations can be derived with respect to:

a) locations safe and those unsafe for construction or drilling of wells,
b) kind of well which should be used in certain areas (e.g. dug, drilled, deep, or shallow), and
c) use of surface water source instead of a well.

The Task Force may implement long-term monitoring of wells in some areas.

TYPICAL FORM LETTERS FOR REPORTING WELL SAMPLE RESULTS

DEPARTMENT OF PUBLIC HEALTH
NOVA SCOTIA

5182 Prince Street
Halifax, Nova Scotia
B3J 1L5

TANGIER SURVEY

Following a case of illness arising from the presence of arsenic in water from a well in the Waverley area, a survey involving the sampling of wells in your area is being carried out by personnel of the Provincial Department of Public Health and the Department of the Environment.

Your well is among those sampled to date.

The sample of your well water taken on contained an arsenic concentration of mg/l (milligrams per liter or parts per million).

This concentration is higher than the maximum permissible limit of 0.05 mg/l set down in the Canadian Drinking Water Standards.

We, therefore, regretfully advise that, based on the sample results, the water in your well is unsafe and unfit for human consumption. We strongly urge that this water NOT be used for drinking or cooking purposes. The well water could still be used for washing and for toilet flushing.

We suggest that, as an immediate measure, you carry drinking and cooking water from an approved source or purchase bottled water from a company engaged in that business. To our knowledge, to date the only type of treatment unit which will reliably remove arsenic from water is a distillation unit. Regardless of what some manufacturers may claim, the various filters, water softeners, and ion exchange units which are available will not remove arsenic on a continuing and reliable basis.

The two main disadvantages of the distillation unit mentioned above, aside from initial cost to purchase, are the limited amount of water which can be treated daily and the fact that the units are electrically powered and may be costly to operate. At present, we can only advise that we will be looking into this aspect of the matter further. Our advice is that you not purchase any type of treatment equipment before checking with David A. Grantham, P. Eng., Public Health Engineer, (424-3954).

It appears that the arsenic is coming from the natural rock formations in the area and from deposits of "tailings" or broken rock which was discarded during the gold mining and production period which ended in the early part of this century. It seems likely that the arsenic has been in the groundwater for a very long period. The concentrations found to date are not high enough to be harmful for a very short period, but they would cause illness if taken into the body over a period of months and years.

Once again, we express our regret that you are faced with this problem, but we must urge that in your own interest, you immediately stop using your well water for drinking and cooking purposes.

Further tests will be carried out as soon as time permits.

Sincerely yours,

J. R. Cameron, M.D., D.P.H.,
Director, Atlantic Health Unit.

/fmi

c.c: Mr. H. G. Benstead, Secretary, County Board of Health.

The sample of your water taken for bacteriological analysis was found to contain ___coliform bacteria per 100 ml. This indicates that your water is/is not satisfactory with respect to bacteriological quality. If there is a bacteria count in your water you may receive assistance in correcting the problem from the public health inspector for your area who can be contacted at the Department of Public Health office nearest to you.

DEPARTMENT OF PUBLIC HEALTH
NOVA SCOTIA

5182 Prince Street
Halifax, Nova Scotia
B3J 1L5

TANGIER SURVEY

Following a case of illness arising from the presence of arsenic in water from a well in the Waverley area a survey involving the sampling of wells is being carried out by personnel of the Provincial Department of Public Health and the Department of the Environment.

Your well is among those sampled to date.

The sample of your well water taken on contained an arsenic concentration of mg/l (milligrams per liter or parts per million).

We are pleased to advise that this concentration is lower than the maximum permissible limit of 0.05 mg/l set down in the Canadian Drinking Water Standards.

We, therefore, advise that based on the sample results, it appears that the water in your well is safe for human consumption.

If you have any reason to suspect that the sample result may not be representative and that you may have physical symptoms indicating that a problem exists, please contact your family physician or this office.

Yours sincerely,

J.R. Cameron, M.D., D.P.H.
Director
Atlantic Health Unit

/lms
cc: Mr. H. G. Bensted

The sample of your water taken for bacteriological analysis was found to contain ___coliform bacteria per 100 ml. This indicates that your water is/is not satisfactory with respect to bacteriological quality. If there is a bacteria count in your water you may receive assistance in correcting the problem from the public health inspector for your area who can be contacted at the Department of Public Health office nearest to you.

CORRELATION OF WELL SAMPLE RESULTS AND CAUSES OF ARSENIC CONTAMINATION

PRELIMINARY REPORT ON ARSENIC CONTAMINATION IN NINE GOLD DISTRICTS

by

Creighton Brisco, Howard Donohoe,
John Gibb, and Theresa Woodlock

INTRODUCTION

Information on well construction and well location with respect to proximity to underground workings, rock dumps, tailings flats, and mill concentrates was reviewed in conjunction with data on arsenic concentration levels, in nine Gold Districts.

Four possible sources of arsenic contamination were defined:

(a) the use of waste rock and tailings (rich in arsenopyrite) in well construction;
(b) surface water filtering through tailings and mill concentrates then into wells;
(c) groundwater circulating through underground workings;
(d) the minerology and chemistry of the Meguma Group.

The first three may be considered to result directly from the gold mining activity carried out near the turn of the century, while the fourth possible source, stems from the primary geochemistry and mineralogy of the underlying bedrock.

While an attempt is made to define the role played by each of these sources in each of the Districts, it is likely that the contamination is frequently a consequence of all four factors; the relative importance of each one as a contributor of arsenic, varies according to the well sampled.

DESCRIPTION OF POSSIBLE SOURCES

Well Construction

In Nova Scotia's gold producing areas broken waste rock was frequently used in dug well construction. Slate which contains much of the arsenopyrite mineralization was preferentially selected because of its smooth flat surfaces, for lining wells. The influence of arsenopyrite-bearing rock used as well lining remains uncertain; however, two wells with high arsenic concentrations were lined with dump rock rich in arsenopyrite. While it is suspected that backfilling was often done with sand-size tailings, this can only be confirmed by the excavation of dug wells.

Surface Debris

Generally waste rock produced as a result of mining operations is widespread over each district with occasional large dumps located downslope from the deeper shafts and adjacent to stamp mill sites. Because of the widespread occurence of this material and significant variations in the amount of arsenopyrite mineralization, it was not possible to assess the relative importance of waste rock as a source of arsenic.

Tailings, the waste material or crushed rock from stamp mills were always washed downslope from the mill site. This sand size material was generally deposited in flat lying, swampy areas where the streams' carrying capacity was reduced. This produced the tailings flats.

The significance of tailings flats as possible sources of arsenic contamination is revealed by one sample obtained in the Waverly area which contained 6610 ppm arsenic. Two samples taken of standing water over the tailings flat in the same area showed arsenic concentrations of, .02, .03, .12, .04 and .05 ppm.

Primary Geology

Studies by R. W. Boyle (1966, Can. Min. V.8, p 662) have revealed values of arsenic as high as 2% in greywacke beds that are outside of the former gold districts. Thorpe and Thomas (1976, Geol. Surv. Can. paper 76-1 A, p. 319-326) suggest a primary sedimentary origin for gold in greywackes and slates in the Oldham district. They advance the notion that gold precipitated with or on pyrite and arsenopyrite in the sedimentary environment. These studies suggest a possible explanation based upon primary geology, for high arsenic values in wells situated outside gold districts. A well sampling program currently being conducted outside any known gold district may serve to establish the significance of bedrock minerology in producing high arsenic concentration levels in groundwater.

Underground Workings

In two areas, Oldham and Waverley preliminary information on groundwater movement indicated a general pattern of high concentrations in wells where groundwater had likely moved through extensive subsurface workings. Frequently, underground workings were backfilled with waste rock, this practice has

undoubtedly increased the amount of arsenopyrite mineralization available for leaching.

Only a limited number of shafts have been sampled in gold districts with arsenic concentrations ranging from <.005 (Blockhouse) to .14 ppm (Lupsigate). The relatively low values may be due to the fact that all samples were taken within a few feet of the water surface; stratification of arsenic has been noted in a number of wells.

The influence that rate of flow and a fluctuating water table, has on concentration levels is not known.

ASSESSMENT OF SELECTED GOLD DISTRICTS

1. WAVERLEY

Well Construction:

The wells affected by As contamination are both dug and drilled. The method of construction may be contributing in some cases because some old dug wells appear to be rocked up with what may be waste rock. Arsenopyrite has been found in rocks lining some of the wells.

Primary Geology:

There is some indication that this factor may be affecting drilled wells. A few high values have been found in drilled wells in Silversides Sub-division, 1.7 km south of Waverley where there has been no mining activity.

Underground Mining Operations:

Some drilled wells in the core area of Waverley may be affected by waters moving through underground workings; one well is reported to have penetrated an old drift.

Surface Debris

Some dug wells either in or down-flow from tailings deposits are affected. It is not known if Leachate from tailings dumps may contaminate drilled wells since it is possible for this leachate to enter bedrock through joints, faults, and bedding planes.

Another source of contamination could be road-beds constructed with tailings material.

Conclusions:

(1) All drilled wells and most dug wells are contaminated with arsenic (> 0.05 ml./l) in the core area of Waverley.
(2) The dug wells on the perimeter of the village have moderate or low values while the deeper drilled wells have moderate values.
(3) Dug wells outside the core area provide suitable water but deep drilled wells may still be contaminated by water moving from old workings or tailings flats through the bedrock.
(4) It appears unlikely that a satisfactory groundwater supply could be developed by relocating wells in the core area; however, in order to test the above a detailed testing program must be implemented.

Recommendations:

(1) An alternate water supply should be investigated for at least the core area of Waverley.

2. SOUTH UNIACKE

Well Construction:

One drilled and one dug well have moderate values of arsenic (0.04 ppm). All other wells (mostly dug) are low. The dug well with the moderate value consists of a punctured metal drum which could be sitting on mining debris containing arsenopyrite.

Primary Geology:

There is insufficient information to assess this factor.

Surface Debris:

It appears unlikely that leachate from tailings or waste rock dumps could reach the affected wells.

Conclusions:

(1) Dug wells, with one exception, are low in arsenic. It appears unlikely that any of these wells could be affected by mining operations.
(2) There is insufficient data to indicate the susceptibility of drilled wells to arsenic contamination from bedrock geology.

Recommendations:

(1) An investigation to determine the source of arsenic in the affected dug well should be conducted.

3. MONTAGUE MINES

Well Construction:

Both dug and drilled wells are affected by arsenic contamination. There is insufficient information to determine if well construction is a factor.

Primary Geology:

This may be affecting some of the drilled wells.

Underground Mining Workings:

This factor may be affecting some of the drilled wells located over known workings.

Surface Debris:

Leachate from tailings dumps may be affecting two dug wells in the west end of the area of investigation because wells are located near dumps.

Conclusions:

(1) Some dug and drilled wells may be affected by mine workings and some dug wells away from workings have moderate values of arsenic.

(2) Drilled wells well away from underground workings and shallow dug wells away from drainage through surface mining debris are low in arsenic.

4. ISAACS HARBOUR AND GOLDBORO

Well Construction:

All wells are dug wells and only one (in Isaacs Harbour) is high in arsenic (0.08 ppm). This is an unused, overflowing well in a basement. One well in Goldboro with 0.01 mg/l arsenic is constructed with crocks. The nature of the backfill material is unknown but could consist of gravel from tailings dumps.

Primary Geology:

There is insufficient information to assess this factor. Possibly the well in the basement has been completed in bedrock.

Underground Mining Workings:

These appear to be too far away to influence the affected wells.

Surface Debris:

It appears that leachate from tailings and rock dumps would flow away from the wells.

Conclusions:

(1) Only two dug wells appear affected by arsenic: one in Goldboro at 0.01 ppm and one in Isaac's Harbour at 0.08 ppm. It appears unlikely that any wells are affected by mining operations.

Recommendation:

(1) An investigation to determine the source of arsenic in the two dug wells should be conducted.

5. GOLDENVILLE

Well Construction:

All wells are dug wells and some may have been rocked with mine waste rock. One of the three contaminated wells is poorly constructed.

Primary Geology:

It is unlikely that this is affecting wells in the area because all wells are shallow dug wells.

Underground Mining Workings:

There is insufficient information.

Surface Debris:

Two of the three contaminated wells are located downstream from the tailings dumps.

Conclusion:

(1) Shallow dug wells, even those wells located directly over the old workings, are safe water sources unless they are constructed with mining debris or downslope from tailings.

Recommendation:

(1) Further study should be conducted in this area to determine the source of arsenic in the affected wells and to locate better dug well sites.

6. WINE HARBOUR

Well Construction:

All wells in Wine Harbour were very low in arsenic (<0.005 ppm.). All are shallow dug wells; it is not known if the rock or backfill material contains arsenopyrite.

Primary Geology:

This factor has not produced contamination here.

Underground Mining Workings:

There is no effect from this factor because underground mining operations are downslope.

Surface Debris:

There appears to be no effect of this on dug wells, because the wells are upslope from major concentrations of mining debris.

Conclusions:

(1) Although wells sampled in the Wine Harbour gold district were situated directly over an area of extensive sub-surface workings, all exhibited concentration levels well below the maximum acceptable limit of 0.05 ppm.

Recommendations:

(1) No further work is necessary in this area at present.

7. MOLEGA LAKE

Well Construction:

Five relatively deep (6-11 m.) dug wells were sampled and all were < 0.005 ppm arsenic . All wells were rocked with granite although one had cement crocks on top of granite rocks.

Primary Geology:

It appears unlikely that this factor affects the well water.

Underground Mining Workings:

It is unlikely that this is affecting the wells.

Surface Debris:

It is unlikely that this is affecting the wells.

Conclusions:

(1) All wells are dug and are low in arsenic. None appears to be affected by mining operations.

8. GOLD RIVER

Well Construction:

One drilled well tested at 0.02 ppm of arsenic; all other wells were very low. It is unlikely that procedures in the construction of the well are responsible for the arsenic.

Primary Geology:

It is not known if this is a factor; a drilled well in the area tested less than 0.005 mg/l.

Underground Mining Workings:

It appears unlikely that this is a factor because the well is away from known workings.

Surface Debris:

It appears unlikely that this is a factor because no tailings or rock dumps are known in the area of the well.

Conclusions:

(1) The source of arsenic in the drilled well is unknown.

(2) Shallow dug wells provide water low in arsenic.

Recommendations:

(1) The drilled well should be investigated to determine the source of the arsenic.

9. OLDHAM

Well Construction:

Both dug and drilled wells are affected by arsenic contamination. Many of the dug wells are rocked and it is possible that mine waste rock was used. It is also possible that tailings were used as back-fill for some of the dug wells.

Primary Geology:

There is insufficient information to determine whether or not this factor is affecting wells in the area; however core from a 600 m. bore hole drilled by the Department of Mines contains abundant disseminated arsenopyrite.

Underground Mining Workings:

Preliminary information on groundwater flow indicates that all contaminated wells and springs in the Oldham area, are in a position to receive groundwater which has circulated through subsurface workings. All 16 wells which are at or above the 0.05 ppm. concentration levels are situated at the eastern end of the village of Oldham, in the immediate vicinity of the most extensively worked portion of the gold district.

Surface Debris:

Tailings flats are all situated downslope of the wells sampled, however one contaminated well (0.18 ppm.) is situated in a stream which originates in an area covered by extensive deposits of waste rock.

Conclusions:

There is a high probability that any well (shallow dug or deep drilled) placed in the eastern half of the village of Oldham will be susceptible to arsenic contamination.

The exact extent of contaminated area has yet to be determined however shallow dug and drilled wells one mile west of the right angle turn in the highway in Oldham exhibit concentration levels well below the .05 ppm limit.

CONCLUSIONS:

(1) Within the immediate vicinity of underground workings the incidence of arsenic contamination is significantly lower in shallow dug wells than in drilled wells.

(2) There is a significantly higher incidence of arsenic contamination in dug wells located close to and downslope from tailings flats or rock dumps. Wells located upslope or away from tailings flats or rock dumps have a low incidence of arsenic contamination.

(3) No information is available on seasonal or other time variations in arsenic content in wells.

RECOMMENDATIONS:

(1) In gold districts, where possible, well construction should be limited to shallow dug wells located upslope from tailings flats or rock dumps.

(2) Mine waste material should not be used in the construction of dug wells.

(3) Periodic monitoring of representative wells in selected gold districts should be conducted.

APPENDIX C

SUMMARY OF MEDICAL RESULTS OF CLINICAL SAMPLING PROGRAM

Findings to Date

Four clinics have been held; these results summarize the findings of the first 2 clinics where largely people with high arsenic wells (>0.05 mg/l) were seen. A total of 86 people using high arsenic wells were seen. Of these, 43 people (50%) had high hair arsenic levels (>100 μg/100g). Of these 43 people, 25 (29% of the total) had mild clinical symptoms and signs that could possibly be related to chronic arsenic poisoning.

Of the 33 people using wells with arsenic contents >0.10 mg/l, 31 had high hair arsenic levels (94%). Of these, 23 (70% of total) had mild symptoms and signs possibly attributable to arsenic poisoning.

Conclusions

Water with an arsenic content of >0.05 mg/l is toxic. The toxicity becomes more marked when the well arsenic >0.10 mg/l.

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MEMORANDUM

May 17, 1976

TO: David A. Grantham, P. Eng; Task Force Chairman
FROM: Ross F. McCurdy, M.S.,MPH, Task Force Member

RE: INVOLVEMENT OF THE ENVIRONMENTAL CHEMISTRY LABORATORY

All of the water samples collected by members of the Provincial Arsenic Task Force were analyzed for Arsenic using a slight modification of the Silver Diethyldithiocarbanate Method as outlined in the Analytical Methods Manual, Environment Canada. The Arsenic distillation apparatus was the Kingsley-Schaffert type described in the June, 1951 edition of Analytical Chemistry. It was found necessary to prepare the silver diethyl dithocarbanate according to the procedure described by Vogel in the text, A Text Book of Quantitative Inorganic Analysis.

To ensure accuracy and precision of the Arsenic Analysis, several of the water samples were also sent to nearby labs for Arsenic determination by either Graphite Furnace Atomic Absorbtion or Polarographic Techniques. A comparison of the data showed that there was no significant difference among the various procedures.

To date, very little work has been done to determine which form the Arsenic exists in water. The Fisheries Research Lab in Halifax examined one of the samples for Arsenic (III) and (V) using the polarographic technique and found the Arsenic primarily in the trivalent form. This lab used a wet chemical oxidation technique to convert any organic arsenic to inorganic arsenic and then used the standard procedure to analyze the arsenic. There was no significant change in the arsenic levels before and after chemical oxidation. Further work is planned in the near future to examine the various forms of arsenic in well water. This lab also examined several of the water samples for insoluble arsenic by filtering the water sample with a 0.45 micron millipore filter prior to arsenic analysis. All of the arsenic was found to be present as water soluble arsenic.

As well as being analyzed for arsenic, all water samples were analyzed for major ions, a variety of heavy metals and cyanide. Although other water quality problems were found in many of the examined wells, these problems were usually related to a particular well. Preliminary observation showed that there was no significant relationship when arsenic was compared to the other ions analyzed.

RFMc/sgj

ADDITIONAL WELL SAMPLING IN AREAS REMOTE FROM GOLD DISTRICTS

NOVA SCOTIA
DEPARTMENT
OF THE
ENVIRONMENT

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M E M O R A N D U M

TO: David Grantham, P.Eng., Department of Public Health

FROM: Howard Donohoe and Creighton Brisco

DATE: May 3, 1976

SUBJECT: Additional Water Supply Sampling

Problem

Arsenic contamination in water supply was first noticed in Waverley through the symptons of arsenic intoxication in Mr. Hartlen. Additional water supply sampling in Waverley has demonstrated a widespread contamination by arsenic. The study of other gold districts has shown varying degrees of arsenic contamination. Until the results were available from water supply samples of Silverside Subdivision (Lake William) on the Waverley Road and the Lawrencetown area, arsenic contamination was only thought to be present in the former gold districts. The results demonstrated arsenic values above the 0.05 ppm safe point; these high values cannot be explained by simple proximity to the former mining operations. The Silverside Subdivision is 1.7 km. southwest of the south limit of the Waverley gold district and the contaminated wells along Route 207 are about 4.8 km. west of the Lawrencetown gold district.

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We suspect that another control on the arsenic contamination may be affecting the water supplies: the mineralogy and chemistry of the Meguma Group. Studies by R.W. Boyle (1966, Can. Min. V. 8, p. 662) have shown values of arsenic as high as 2% in greywacke beds that are outside of the former gold districts. Thorpe and Thomas (1976, Geol. Surv. Can. Paper 76-1A, p. 319-326) suggest a primary sedimentary origin for gold in greywackes and slates in the Oldham district. They advance the notion that gold precipated with or on pyrite and arsenopyrite (op. cit., p. 325) in the sedimentary environment. The data presented here suggest that the primary mineralogy and geochemistry may be responsible for arsenic contamination outside former mining areas.

Proposal

We propose a means of evaluating the above hypothesis by sampling water supplies in two areas: Waverley Road and Hammonds Plains area (see attached map). We believe this will accomplish two objectives:

1) the possible establishment of background values for arsenic from non-gold districts areas, and 2) the testing of the previously described hypothesis for abnormally high arsenic values outside gold districts.

Waverley Road and Hammonds Plains areas were chosen be-

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cause both are some distance from the known gold districts of Waverley and Montague. The Hammonds Plains area is about 10 km. southeast of the Waverley area; sampling of water supplies here will provide information on arsenic values along the southwestward continuation of the Waverley anticline. Samples from the Waverley Road will provide continuous arsenic values over 13 km. from Waverley to Montague mining areas. Further, we may be able to understand the abnormally high arsenic values present in Silverside.

The importance of this study cannot be understated. If the hypothesis of primary arsenic being responsible in some areas for contamination, is valid, then there may be no regular pattern to water supply contamination. We should test the hypothesis. The procedure follows.

Sampling Procedure

Only households using private dug or drilled wells should be sampled, those obtaining water from a central water supply or lake may be ignored. Since it is essential that the areas receive thorough coverage, it is suggested that a close sampling interval be used along both of the routes outlined below. Where possible samples should be taken directly from the well.

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Sampling areas: (See accompanying map)

1 Hammonds Plains: Lucasville Rd. from Webber Lake south to Hammonds Plains, then along Highway 213 east to Mill Cove.

2 Waverley Road: That section along Waverley Road between the Village of Waverley and Lake Charles in the vicinity of the turn-off to Montague Mines.

cc: J. Jones

HD:CB/pm