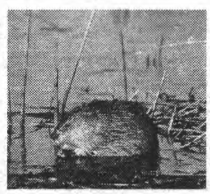
Canada Alberta Northwest Territories

Northern River Basins Study









NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 54

AN ANALYSIS OF ALBERTA HEALTH RECORDS FOR THE OCCURRENCE OF WATERBORNE DISEASE

FOR THE NORTHERN RIVER BASINS STUDY






Prepared for the
Northern River Basins Study
under Project 4421-C1

by

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PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

It is explicit in the objectives of the Study to report the results of technical work regularly to the public. This objective is served by distributing project reports to an extensive network of libraries, agencies, organizations and interested individuals and by granting universal permission to reproduce the material.

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Whereas the above publication is the result of a project conducted under the Northern River Basins Study and the terms of reference for that project are deemed to be fulfilled,
IT IS THEREFORE REQUESTED BY THE STUDY OFFICE THAT;
this publication be subjected to proper and responsible review and be considered for release to the public.

F. J. Wrona — 7-June 95

(Dr. F. J. Wrona, Ph.D., Science Director) (Date)

Whereas it is an explicit term of reference of the Science Advisory Committee "to review, for scientific content, material for publication by the Board",
IT IS HERE ADVISED BY THE SCIENCE ADVISORY COMMITTEE THAT;
this publication has been reviewed for scientific content and that the scientific practices represented in the report are acceptable given the specific purposes of the project and subject to the field conditions encountered.
SUPPLEMENTAL COMMENTARY HAS BEEN ADDED TO THIS PUBLICATION: [ ] Yes [✓] No

P. A. Larkin — 7 June 95

(Dr. P. A. Larkin, Ph.D., Chair) (Date)

Whereas the Study Board is satisfied that this publication has been reviewed for scientific content and for immediate health implications,
IT IS HERE APPROVED BY THE BOARD OF DIRECTORS THAT;
this publication be released to the public, and that this publication be designated for: **[✓] STANDARD AVAILABILITY [ ] EXPANDED AVAILABILITY**

Lucille Partington — June 8/95

(Lucille Partington, Co-chair) (Date)

Robert McLeod — June 12/95

(Robert McLeod, Co-chair) (Date)

AN ANALYSIS OF ALBERTA HEALTH RECORDS FOR THE OCCURRENCE OF WATERBORNE DISEASE FOR THE NORTHERN RIVER BASINS STUDY

STUDY PERSPECTIVE

Reliable and safe drinking water supplies are important issues to residents in the Northern River Basins Study area. The potential risks for people to drink microbial contaminated water can be much higher than those associated with chemical contaminants. The purpose of this project was to review provincial and territorial health records for prior documentation of waterborne diseases that could be attributed to drinking water. In the best of circumstances people suffering from certain diseases will be included in these records but the records are limited in that they rely on people to report occurrences. Some of these notifiable diseases can be used to give an indication of the historic microbial water quality. Since many of the waterborne microbes can also move by other means such as human-human or food-human contact, this information cannot be used as a direct measure of the relative microbial quality of the local drinking water. However, the reporting of these notifiable diseases may not accurately reflect the actual incidence since not all cases are reported for a variety of reasons. These records provide good insight into likely areas of concern.

> ***Related Study Questions***
>
> 2) *What is the current state of water quality in the Peace, Athabasca and Slave River basins, including the Peace-Athabasca Delta?*
>
> 8) *Recognizing that people drink water and eat fish from these river systems, what is the current concentration of contaminants in water and edible fish tissue and how are these levels changing through time and by location?*

Results of this project revealed a slight trend toward a higher incidence of giardiasis (beaver fever), salmonellosis and shigellosis in the Alberta portion of the study area, but all these diseases can also be transferred by food.

This project was the first step in assessing microbial contaminated drinking water within the Peace-Athabasca and Slave river basins. Because the Northwest Territories has a different reporting structure than Alberta, it was not possible to include territorial data in this report. This matter will be dealt with in the wrap-up report prepared by the Drinking Water Component. Future projects will focus on the effectiveness of treatment methods for dealing with contaminants and microbes as well as surveying for the presence of these undesirable elements.

REPORT SUMMARY

This report reviews the Alberta Health Records and the literature concerning the incidence of microbiological, viral and protozoan waterborne diseases in the Northern River Basins Study area. From this review the report concluded:

1. The potential risk from microbial contaminants can be high in comparison to the potential risk from chemical contaminants.

2. For many pathogenic microbes there are substantial non-human reservoirs. As a result, even complete elimination of human discharges will not eliminate the source for many pathogens.

3. Little data is available in the Northern River Basins Study area to assess microbial water quality. There appears to be a need to increase the baseline microbiological data on surface water quality in the study area for microorganisms other than those currently required by Alberta Environmental Protection.

4. Analysis of health records showed that there appeared to be a trend towards higher incidence of giardiasis, salmonellosis and shigellosis in some of the health units, but failed to indicate if this was due to foodborne, person to person or waterborne means of transmission.

5. Results also indicated that although incidence of some diseases were higher in many cases, the differences were not significant and residents do not appear to have substantially higher risk from waterborne disease in the study area compared to the rest of Alberta.

The analysis of health records is an essential first step in setting up a framework for assessing the risks to health from microbes in drinking water in the study area.

LIMITATIONS OF THE STUDY

This document was developed to determine the historical incidence of microbiological, viral and protozoan waterborne disease in the Northern River Basins area. No actual independent, microbiological testing was performed during the course of this study. Data was acquired primarily from health unit records from the study area and annual notifiable disease summaries provided by Alberta Health.

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Introduction

Drinking water is not pure or sterile, rather the goal of drinking water treatment is to lower concentrations of contaminants to a level for which the water is considered "safe" to drink. The definition of safe is set by the establishment of drinking water quality guidelines (CDWQG, 1993) for the protection of public health. In addition to the guidelines it is important to note that what might be "safe" for a normal healthy person may not be "safe" for a compromised individual. Normally the quality of drinking water is assessed by various physical, chemical, radiological and microbial parameters. Levels of these parameters are compared to regulations, guidelines and known health risks to assess the safety of water.

In the Northern River Basin Study area, Alberta Environmental Protection is responsible for municipal waterworks systems and monitors drinking water quality. Part of this monitoring is a treated water survey which is completed on a routine basis. The survey consists of analysis of drinking water supplies for 250 parameters of which all are for chemical contaminants or physical parameter. The treated water survey does not sample for microbial contaminants. Under their license to operate from Alberta Environmental Protection, treatment facilities are required to sample for two indicator organisms to assess microbial quality. The primary reasons for the limited analyses of microbial contaminants is: the traditional use of indicator organisms for assessment of drinking water quality; limitations in microbial detection technology which can be difficult, expensive and non-existent for determination of many microbial contaminants; and the number unknown microbial contaminants which may be pathogenic.

Traditionally, routine monitoring has used indicator organisms, rather than try and measure every single microorganism and/or pathogen type which may be present. Indicator organisms have been used as "indicators" of safety or the water quality and to measure the effectiveness of the water treatment process. The definition of indicator organisms allows for the supposition that the presence of the indicator shows some type of "pollution or contamination". However, the absence of the indicator organisms does not automatically assume a clean, "sterile" environment (Bonde, 1977). The normal use of coliform bacteria as indicator organisms has been questioned as monitoring for coliform bacteria has failed to prevent waterborne disease outbreaks (Batik, et al, 1984) and may not indicate community wide, endemic illness caused by drinking water (Payment et al. 1991). In addition, these indicators have been shown to be inadequate for protozoan cysts and enteric viruses, because these pathogens are more resistant to physiochemical treatment and disinfection (Sobsey, 1989).

Although the use of traditional indicator organisms has been found wanting, it is still not economically or technologically possible to measure all microorganisms and/or pathogens which may be present. Methods developed must be extremely sensitive as it has been shown through microbial risk assessment modeling that exposures to low concentrations of microorganisms (perhaps less than one infectious organism per 1,000 L) may result in significant risks of infection and illness in a community (Regli et al. 1992; Regli et al. 1991; and Rose et al. 1991). In addition, no reliable detection methods are available for many organisms. This is true for even well known waterborne pathogens such as Norwalk viruses and hepatitis A and E viruses (Sobsey, et al. 1993).

Another difficulty facing the assessment of the microbial quality of drinking water is that the total number of possibly pathogenic microorganisms is many and appears to be increasing. For example, *Cryptospordium parvum* was not generally recognized as a human pathogen until about 1976 and it was not incriminated in waterborne disease until 1985 (Rose, 1988). This protozoan which causes cryptosporidiosis which symptoms include diarrhea, abdominal cramps, nausea, occasional vomiting and low-grade fever, was implicated in a disease outbreak in Milwaukee in which 370,000 residences were stricken (Bolden and Farrel, 1994). Many pathogens are still unknown as about half of all reported waterborne disease outbreaks in the United States have no identified etiology (Craun, 1988: Herwaldt et al. 1992). Endemic, community wide gastrointestinal illness has been attributed to drinking water in the absence of pathogen detection, despite extensive microbial analysis using modern detection techniques (Payment et al. 1991).

The above discussion indicates some of the difficulties in assessing the microbial quality of water. As a result some innovative techniques have been proposed to help to assess microbial quality of drinking water. One method that has been employed to assess drinking water is the study of the health of the community to assess the occurrence of diseases which could be waterborne. This has found to be effective as the response to microbial contaminants in drinking water is often sudden and acute, compared to long-term chronic response to many chemical contaminants. These studies have shown that compared with the potential or predicted risks associated with exposure to chemicals in water, the actual or documented health risks associated with microbes are high. For many of them, the risk of infection over a lifetime is a certainty (probability = 1). For example, virtually everyone experiences rotavirus infection by age 5, and the majority of Americans are still likely to experience hepatitis A infection during their lifetime (Blacklow and Greenberg, 1991: Hadler and Margolis, 1989). Virtually all people experience one to two episodes of gastrointestinal illness each year and much of this is caused by enteric microbes (Blacklow and Greenberg, 1991: Guerrant and Bobak, 1991). Because of the risk associated with microbial contamination and difficulties in determining these risks any information on the microbial quality of water is extremely valuable.

This report presents the results of the analysis of health records for the Northern River Basins Study area. The Alberta Public Health Act has designated certain diseases as notifiable to the local medical officer of health within the health unit or to Communicable Disease Control, Alberta Health. A number of these notifiable diseases could be transferred by the water route, and as a result can be used as an indication of microbial water quality within the study area. The results can not be used as a direct measure of microbial water quality as many of the microbes can also be transfer by other routes such as human-human and food-human. Nevertheless valuable information about the occurrence of the notifiable waterborne disease in the study area can be obtained. Sobsey et al. (1993) states that analysis of health records is an essential first step in setting up a conceptual framework for assessing risks to health from microbes in drinking water.

Waterborne Disease Transmission

The microbial risks in drinking water stem from a broad range of waterborne microbial, viral, fungal or protozoan disease agents. Sources of these waterborne organisms to a watershed include discharges from humans, domestic animals, wildlife, industrial discharges and storm water runoff over the watershed (Geldreich, 1991). Geldreich (1972) estimated that the overall infection rate of any population (human or warm-blooded animal) ranged from less than 1 percent to 25 percent of the total population in the area. Contributions by wildlife in remote areas tend to be significant and more noticeable than in areas more colonized by humans (Geldreich, 1972). Table 1 summarizes certain zoonoses, whose causative agents could be waterborne and possibly survive for a certain period of time in northern Alberta rivers.

It is important to note that many potentially pathogenic organisms may have significant reservoirs in wild/domestic animals. Consequently the control of human discharges will not result in the elimination of some of these sources. In recognition that human control measures are not totally effective against pathogens which have non-human reservoirs, the International Task Force for Disease Eradication (C.D.C., 1993) identified a number of disease conditions examined in this study which will not be able to be eradicated, but rather where control is dependent on proper potable water and wastewater treatment, health education, disinfection and hygiene. These are listed in Table 2.

For disease transmission through drinking water to occur the microbes must be transported from the source to the raw drinking water supply (normally a lake or river), where the microbes must be able to survive in the raw water, through the treatment process and distribution system to reach the consumer. With respect to microbiological discharges to river and lakes, there are a number of natural, "ill-defined", self-purification processes that include dilution, hydrological mixing, adsorption to sediments, dilution, predation, effect of water temperature and ultraviolet radiation. These

Table 1 : Examples of Certain Zoonoses Whose Agents Can Also be Waterborne (Emde, 1991)

Organism	Disease	Incubation Period (for animals)	Animal Vector(s)
Brucella species	Brucellosis	Variable	Cattle, Dogs, Pigs, Sheep, Wild Animals
Campylobacter species	Campylobacteriosis	Unknown	Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals
Clostridium perfringens	Clostridial myositis, Gas Gangrene, Enterotoxaemia, etc	Variable	Birds, Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals
Corynebacterium species (*C. ulcerans, C. equi, C. pseudotuberculosis, C. pyogenes*)	Pharyngitis, Wound Infection, Pneumonia	Variable	Birds, Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals
Cryptosporidium species	Cryptosporidiosis	1 - 10 days	Birds, Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals,
Erysipelothrix rhusiopathiae.	Erysipeloid	2 - 7 days	Birds, Cattle, Cats, Dogs, Fish, Pigs, Sheep, Wild Animals
Escherichia coli; 0157:H7	Haemorrhagic colitis	Variable	Birds, Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals
Histoplasma capsulatum	Histoplasmosis	Unknown	Birds, Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals
Listeria monocytogenes	Listeriosis	Variable	Birds, Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals
Mycobacterium species (*M. avium, M. marinum*)	Mycobacterial infection	Variable	Birds, Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals
Pasteurella multocida	Pasteurellosis	Variable	Birds, Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals
Salmonella species	Salmonellosis	1 - 5 days	Birds, Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals
Yersinia enterocolitica	Yersinosis	Uncertain	Birds, Cattle, Cats, Dogs, Pigs, Sheep, Wild Animals

Table 2: Selected Disease Conditions Found Not Suitable for Potential Eradication by the International Task Force for Disease Eradication (after CDC, 1993)

Disease/ Condition	Extent of Problem	Epidemiologic Vulnerability	Possible Interventions
Balantaidiasis	Worldwide; low incidence	Reservoir in swine, feces, others; resistant to chlorination	Sanitation; water supply; chemotherapy
Cryptosporidiosis	Worldwide	Reservoir in cattle, other domestic and wild animals; fecal-oral route of transmission	Disinfection, sanitation; water supply; personal hygiene
Campylobacter diarrhea	Responsible for 5 to 14 % all cases of diarrhea	Reservoir in many animals	Sanitation; water supply; oral rehydration, antibiotic therapy
Giardiasis	Worldwide	Reservoir in beavers and wild/domestic animals	Sanitation, water supply, hygiene, chemotherapy
Legionellosis	Worldwide; cause of acute pneumonia, Pontiac fever	Reservoir in water systems	Disinfection, water treatment; antibiotic treatment
Leptospirosis	Worldwide, zoonosis	Extensive reservoirs in wild/domestic animals	Avoidance of contaminated water, sanitation; personal protective devices
Salmonellosis	Worldwide; cause of diarrhea and certain other, severe infection	Reservoir in wild and domestic animals, water	Water treatment, sanitation, health education; proper cooking; antibiotic therapy
Shigellosis	Worldwide; cause of severe dysentery and death	Humans are main reservoir	Water treatment, sanitation, health education, hygiene, antibiotics
Typhoid fever	Worldwide, approximately 10% fatality rate	Human asymptomatic carrier state, some drug resistant strains	Water treatment, sanitation, hygiene, antibiotic therapy

processes have varying degrees of effectiveness and should not be relied upon solely for protection. The efficacy of self-purification can require hours to days, with the length of time increasing substantially with decreases in water temperature and under ice cover (Geldreich, 1991). For example, it was found that under conditions of high biological oxygen demand and low water temperatures, potential pathogens such as *Salmonella* species could be detected 73 miles downstream (4 days flow time) from the nearest point discharge source (Geldreich, 1991). In ice covered rivers (Gordon 1972; Davenport et al. 1976; Putz et al. 1984) have found increased microorganism survival. The cold water retards respiration and predation, while the ice sheet eliminates the lethal effects of sunlight (Putz et al. 1984). Table 3 summarizes survival times in water for selected pathogens. Also included in the table are infective doses for some of these organisms. It should be noted that the infective doses reported in this table will vary depending on the health of the individual consuming, inhaling, or contacting the water source.

When pathogenic organisms enter low nutrient environments, such as rivers, there are a number of fates possible. These include: death immediately or soon after entering that environment; adaptation to the new environment, entering into some state of dormancy or; finding alternate, non-human hosts in the new environment. Failure to consider these possibilities may results in substantial underestimation of the actual numbers and types of organisms present in the environment. These limitations are acknowledged in the current analytical protocols available for water analysis (Standard Methods, 1992).

Microorganisms tend to adapt quickly to new environments, if they are to survive. This includes a reduction in cell size to minimize cellular osmotic stress, changes in metabolism, formation of symbiotic or communal associations with other organisms in the new environment and attachment to solid surfaces such as particulates, submerged pipes, and others (Rozak and Colewell, 1987; Delattre et al, 1991). Organisms that attach to sediments or rocks in surface waters may only be temporarily removed until events that disturb the river bottom (floods, storms, spring run-off, human activities) cause these organisms to re-enter the water column.

This ability to attach, or formation of biofilms, allows the microorganism to take advantage of higher nutrient levels at the solid-liquid or, solid-air interface (Costerton et al, 1987). This process occurs in surface waters, groundwater wells, surfaces in the water treatment facility (pipes, filter media), storage reservoirs and the distribution systems. The implications for public health include an increased resistance of attached organisms to disinfectants and chemical agents (Costerton et al, 1987), potential harboring and shearing off of pathogens in treated water systems (Emde and Smith, 1992), infrastructure deterioration (Emde and Smith, 1992) and, changes in water quality due to addition or removal of chemicals and microorganisms from the bulk water phase (Emde and Smith, 1992).

The vast majority of pathogenic organisms entering a water treatment facility are inactivated through various physiochemical and disinfection processes. However, the treatment system can not remove all microorganisms. As mentioned protozoan cysts and enteric viruses are more resistant to physiochemical treatment and disinfection (Sobsey, 1989). If a number of pathogenic organisms breaks through the treatment process they could infect the consumer through both primary or secondary routes as outlined in Figure 1. The primary route is through direct consumption or inhalation of the water containing the pathogenic organism. Secondary routes can be through food that is washed by the water or by contact with persons who have already been infected by the pathogen.

Pathogens in drinking water can be generally classed as direct or opportunistic pathogens. Direct pathogen can cause disease in normal healthy individuals. However, many organisms have the ability to act as opportunistic pathogens, given the proper conditions and presence of a suitable host. Opportunistic organisms generally form part of the normal micro-flora of the body, but under certain, specific conditions, may be capable of causing infections in compromised persons (Geldreich, 1991b). Table 4 is a summary of characteristics of selected waterborne opportunistic and direct pathogens, which could be found in northern Alberta rivers, depending on the nature and quantity of discharge to the river.

Table 3: Pathway of Pathogens from Wastewater to Contaminated Drinking Water (after Geldreich, 1991)

Pathogen	Amount Excreted by Infected Individual per Gram Feces	Maximum Survival in Water (days)[1]	Infective Dose (no. of organisms)[2]	United States Contaminated Water Supply Outbreaks[3]
Bacteria				
Toxigenic *E. coli*	10^8	90	10^9	5
Salmonella species	10^6	60 to 90	10^{6-7}	37
Shigella species	10^6	30	10^2	52
Campylobacter	10^7	7	10^6	5
Vibrio species	10^6	30	10^8	1
Yersinia enterocolitica	10^5	90	10^9	1
Aeromonas species	-	90	10^8	-
Viruses				
Enterovirus	10^7	90	100	-
Hepatitis A	10^6	5 to 27	-	51
Rotavirus	10^6	5 to 27	-	1
Norwalk virus	-	5 to 27	-	16
Protozoans and Amoebae				
Entamoeba	10^7	25	10 to 100	3
Giardia	10^5	25	5 to 100	84
Cryptosporidium	-	-	-	2
Balantidium coli	-	20	25 to 100	0
Parasites				
Ascaris	10^3	365	2 to 5	-
Taenia	10^3	-	-	-
Unknown Agents	?	?	?	266

1 This is an average survival time. This may be increased/decreased by factors such as water temperature, ice cover, BOD, hydraulic flow and others
2 Infectious dose found to cause clinical symptoms in 50% of individuals tested
3 Waterborne outbreaks in the U.S. between 1961 to 1983.

PRIMARY ROUTES OF INFECTION

SECONDARY ROUTES OF INFECTION

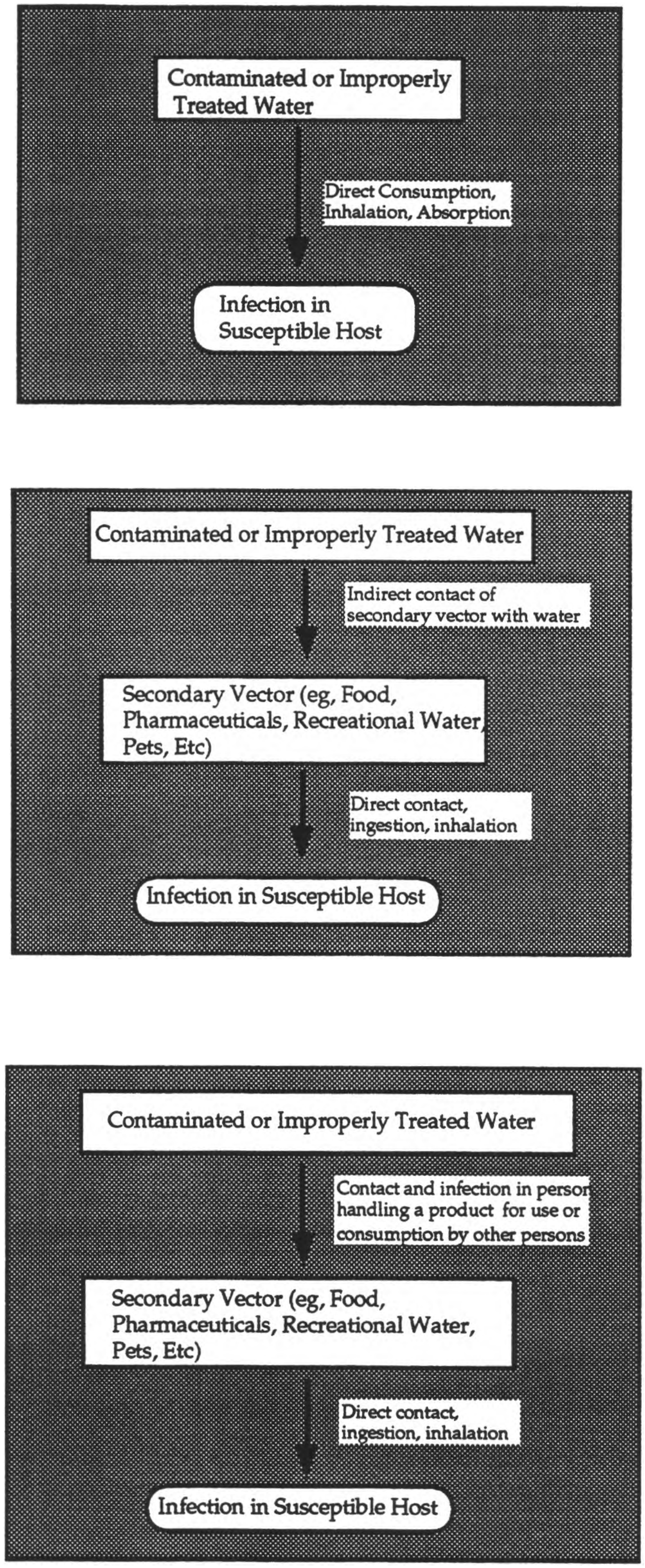

Figure 1: Routes of Disease Transmission

Table 4 Characteristics of Selected Waterborne Opportunistic and Direct Pathogens (Emde, 1991, Emde and Smith, 1992)

ORGANISM	PATHOGENICITY			VEHICLES		INFECTIOUS DOSE		RANGE OF SYMPTOMS	POTENTIAL RISK GROUPS	REFERENCES
	None (*)	Opportunist	Direct	Water	Food	Normal	Compromised or Sensitive			
BACTERIA										
Acinetobacter species	+	+		+		U	N, ND	2, 4	E, H, IS	Finegold, Henderson, Lenette
Aeromonas hydrophila		+		+		U	N, ND	3, 4, 5, 6, 7,	CI, E., D., H., IC., ID, IS, S, O	Craun, Cubitt, Finegold ICMSF, Janda, Khardori et al, Lenette, Millership, Pitlik
Alcaligenes species	+	+		+		U	N, ND	2	IC, IS, ID	Finegold, Lenette
Bacillus cereus			+	+	+	~10^5/gm food or water	ND	5	CI, E, H, IC, IS, ID, O, S	Finegold, Lenette
Campylobacter jejuni		+	+	+	+	≤500 cfu to >1000cfu	ND	5, 9 (in special cases)	CI, E, H, IC, IS, ID, O, S	Craun, Finegold, LCDC, Lenette, Lighton, Park et al, Pitlik, Stelzer,
Campylobacter coli		+	+	+	+	≤500 cfu	ND	5, 9 (in special cases)	CI, E, H, IC, IS, ID, O, S	Craun, Finegold, LCDC, Lenette, Lighton, Park et al, Pitlik, Stelzer,
Citrobacter freundii		+	+	+	+	U	N, ND	3, 4, 5, 6,	CI, E, H, IC, ID, IS, O, S,	Craun, Finegold, LCDC, Lenette, Pitlik
Clostridium perfringens		+	+	+	+	~10 cfu/g food or water	N, ND	1 (gas gangrene), 2, 5, 6	CI, E, H, IC, ID, IS, O, S	Craun, Finegold, LCDC, Lenette, Pitlik
Enterobacter aerogenes	+	+		+	+	U	N, ND	3, 4, 5, 6, 7	CI, E, H, IC, ID, IS, O, S	Craun, Finegold, LCDC, Lenette, Pitlik
Enterobacter agglomerans	+	+		+	+	U	N, ND	3, 4, 5, 6, 7	CI, E, H, IC, ID, IS, O, S	Craun, Finegold, LCDC, Lenette, Pitlik
Enterobacter cloacae		+		+	+	U	N, ND	3, 4, 5, 6, 7	CI, E, H, IC, ID, IS, O, S	Craun, Finegold, LCDC, Lenette, Pitlik
Escherichia coli		+	+	+	+	? to ≤ 10^8cfu by ingestion	N, ND	2, 3, 4, 5, 6, 7, 8	CI, E, H, IC, ID, IS, O, S	Craun, Finegold, LCDC, Lenette, Pitlik
Flavobacterium species	+	+		+		U	N, ND	1, 2, 3, 4	CI, E, IC, IS, ID, S	Craun, Finegold, LCDC, Lenette, Pitlik
Hafnia alvei	+	+		?	?	U	N, ND	3, 4, 5, 6, 7	CI, E, IC, ID, IS, S	Craun, Finegold, LCDC, Lenette, Pitlik
Klebsiella oxytoca	+	+		+		U	N, ND	3, 4, ,6	CI, E, H, IC, ID, IS, S	Craun, Finegold, LCDC, Lenette, Pitlik
Klebsiella ozonae	+	+		+		U	N, ND	3, 4, 6	CI, E, H, IC, ID, IS, S	Craun, Finegold, LCDC, Lenette, Pitlik

Table 4: Continued

ORGANISM	PATHOGENICITY			VECTORS		INFECTIOUS DOSE		RANGE OF SYMPTOMS	POTENTIAL RISK GROUPS	REFERENCES
	None (*)	Opportunist	Direct	Water	Food	Normal	Compromised or Sensitive			
Klebsiella pneumophila		+	+	+	+	U	N, ND	3, 4, 6	CI, E, H, IC, ID, IS, S	Craun, Finegold, LCDC, Lenette, Pitlik
Legionella pneumophila		+	+	+		U	N, ND	4	CI, E, H, IC, ID, IS, S	Best, Botzenhat, Breiman, Craun, Emde, Finegold Hanrahan, Johnston, LCDC, Lee, Lenette, Norman, Parry, Phair, Pitlik, Sullivan, T, US EPA, Wadowsky,
Legionella species		+	+	+		U	N, ND	4	CI, E, H, IC, ID, IS, S	Best, Botzenhat, Breiman, Craun, Emde, Finegold Hanrahan, Johnston, LCDC, Lee, Lenette, Norman, Parry, Phair, Pitlik, Sullivan, US EPA, Wadowsky,
Mycobacterium avium-intracellulare		+		+		U	N, ND	4, 8, 9	E, IC, ID, IS, S	Botzenhat, Cason, Chapman, Craun, Finegold Hyder, Jacobson, Jenkins, LCDC, Lenette, Norman, Pitlik
Mycobacterium chelonae	+	+		+		U	N, ND	4, 8, 9	E, IC, ID, IS, S	Botzenhat, Cason, Chapman, Craun, Finegold Hyder, Jacobson, Jenkins, LCDC, Lenette, Norman, Pitlik
Mycobacterium fortuitum	+	+		+		U	N, ND	4, 8, 9	E, IC, ID, IS, S	Botzenhat, Cason, Chapman, Craun, Finegold Hyder, Jacobson, Jenkins, LCDC, Lenette, Norman, Pitlik
Mycobacterium gordonae	+	+		+		U	N, ND	4, 8, 9	E, IC, ID, IS, S	Botzenhat, Cason, Chapman, Craun, Finegold Hyder, Jacobson, Jenkins, LCDC, Lenette, Norman, Pitlik
Moraxella species	+	+		+		U	N, ND	2	CI, E, H, IC, ID, IS	Craun, Finegold, LCDC, Lenette, Pitlik
Proteus species	+	+		+		U	N, ND	3, 6, 7	IC, ID, IS, S	Craun, Finegold, LCDC, Lenette, Pitlik
Pasteurella multicida	+	+		+		U	N, ND	3, 4, 5, 6,	IC, ID, IS ,S	Craun, Finegold, LCDC, Lenette, Pitlik
Pseudomonas aeruginosa		+	+	+	+	U	N, ND	1, 2, 3, 4, 5, 6, 7	CI, E, H, IC, IS, ID, O, S	Barrow, Benson, Botzenhat, Colwell, Craun, Cubitt, Emde, Finegold Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik

Table 4: Continued

ORGANISM	PATHOGENICITY			VECTORS		INFECTIOUS DOSE		RANGE OF SYMPTOMS	POTENTIAL RISK GROUPS	REFERENCES
	None (*)	Opportunist	Direct	Water	Food	Normal	Compromised or Sensitive			
Pseudomonas cepecia	+	+		+		U	N, ND	1, 2, 3, 4, 5, 6, 7	CI, E, H, IC, IS, ID, O, S	Barrow, Benson, Botzenhat, Colwell, Craun, Cubitt, Emde, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Pseudomonas fluorescens	+	+		+	+	U	N, ND	1, 2, 3, 4, 5, 6, 7	CI, E, H, IC, IS, ID, O, S	Barrow, Benson, Botzenhat, Colwell, Craun, Cubitt, Emde, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Salmonella species		+	+	+	+	100 - 1000 cfu by ingestion	N, ND	5, 8 (in special cases)	CI, E, H, IC, IS, ID, O, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Serratia species	+	+		+		U	N, ND	1, 2, 3, 4, 7	CI, E, H, IC, IS, ID, O, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Shigella species		+	+	+	+	180 by ingestion	N, ND	5	CI, E, H, IC, IS, ID, O, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Staphylococcua aureus	+	+	+	+	+	U	N, ND	1, 2, 3, 4, 5, 6, 7,	CI, E, H, IC, IS, ID, O, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Staphylococcus epidermidis	+	+		+		U	N, ND	1, 2	IC, ID, IS	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Streptococcus faecalis	+	+		+	+	U	N, ND	5, 6	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Streptococcus fecium	+	+		+	+	U	N, ND	5, 6	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Vibrio fluvalis		+		+		U	N, ND	2, 5, 7	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Vibrio alginolyticus		+		+		U	N, ND	2	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Yersinia enterocolitica		+	+	+	+	U	N, ND	5	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
AMOEBA *Acanthamoeba species*		+	+	+	?	U	N, ND	2, 8 (eg meningitis)	CI, E, H, IC, ID, IS, S	Craun, DeJohckhere, Finegold, Fowler, Geldich, ICSM, LCDC, Lenette, McFeters, Mergehan, Pitlik, Wilhelmus

Table 4: Continued

ORGANISM	PATHOGENICITY			VECTORS		INFECTIOUS DOSE		RANGE OF SYMPTOMS	POTENTIAL RISK GROUPS	REFERENCES
	None (*)	Opportunist	Direct	Water	Food	Normal	Compromised or Sensitive			
Naegleria fowlerii		+	+	+	?	U	N, ND	8 (eg. meningitis)	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters. Pitlik
FUNGI *Aspergillus* species	+	+		+	+	U	N, ND	1, 4, 8, 9(eg allergic response)	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Cephalosporium species	+	+		+		U	N, ND	1, 4, 8, 9(eg allergic response)	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Fusarium species	+	+		+		U	N, ND	1, 4, 8, 9(eg allergic response)	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters. Pitlik
Penicillium species	+	+		+		U	N, ND	1, 4, 8, 9(eg allergic response)	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
Rhizopus species				+		U	N, ND	1, 4, 8, 9(eg allergic response)	CI, E, H, IC, ID, IS, S	Craun, Finegold, Geldich, ICSM, LCDC, Lenette, McFeters, Pitlik
VIRUSES Adenovirus		+		+		U	N, ND	2, 4, 5	CI, E, H, IC, ID, IS, S, O	Berkow et al, 1987, Lenette
Coxsackie virus		+		+		U	N, ND	2, 4, 5, 8 , 9(diabetes?)	CI, E, H, IC, ID, IS, S, O	Berkow et al, 1987, Lenette
Enterovirus		+		+		U	N, ND	2, 4, 5, 8	CI, E, H, IC, ID, IS, S, O	Berkow et al, 1987, Lenette
Hepatitis		+		+	+	U	N, ND	5, 8	CI, E, H, IC, ID, IS, S, O	Berkow et al, 1987, Lenette
Norwalk virus		+		+		U	N, ND	5	CI, E, H, IC, ID, IS, S, O	Berkow et al, 1987, Lenette
Reovirus		+		+		U	N, ND	4,5 (?)	CI, E, H, IC, ID, IS, S, O	Berkow et al, 1987, Lenette
Rotavirus		+		+		U	N, ND	5	CI, E, H, IC, ID, IS, S, O	Berkow et al, 1987, Lenette
PROTOZOA *Cryptosporidium*			+	+	?	1 cyst	1 cyst	5	CI, E, H, IC, ID, IS, S, O	Casemore, Craun, Finegold Geldich, Hyde, ICSM, LCDC, Lenette, McFeters, Pitlik, Poulton, Sallon, Tzipori. USEPA West
Entamoeba histolytica			+	+	?	1 cyst	1 cyst	5	CI, E, H, IC, ID, IS, S, O	Craun, Finegold, Geldich, Gimason, Hyde, ICSM, LCDC, Lenette, McFeters, Pitlik

Table 4: Continued

ORGANISM	PATHOGENICITY			VECTORS		INFECTIOUS DOSE		RANGE OF SYMPTOMS	POTENTIAL RISK GROUPS	REFERENCES
	None (*)	Opportunist	Direct	Water	Food	Normal	Compromised or Sensitive			
Giardia lamblia			+	+	?	1 cyst	1 cyst	5, 9 (eg arthritis)	CI, E, H, IC, ID, IS, S, O	Chute, Craun, Emde, Finegold, Geldich, Gilmour, Hater, Hoff, Hopkins, Hyder, ICSM, Jakubowski, Keystone, Logdson, LCDC, Lenette, McFeters, Pacha, Pitlik, Shaw, US EPA, West, Woo,

1. *: No Documented pathogenicity for "normally healthy" persons
2. **Summery of Risk Group Codes**

CI Children and infants
E Elderly
H Healthy individual receiving an infectious dose
IC Immunocompromised individual
ID Immunodeficient individual
IS Immunosuppressed individual
S Surgery
O Other (e.g. recent illness, pregnancy, etc)

3. **Pathogenicity Code:**

U: Infectious dose for "normally healthy" persons unknown
ND: Infectious dose for compromised persons not yet determined. In some cases the infectious dose may be as low as one organism.
N: Nosocomial Infections documented

4. **Range of Symptoms Codes**

1. Skin/Hair Infection;
2: Eye/Ear Infection;
3. Bacteremia/Septecemia;
4. Pneumonia/Respiratory Illness;
5. Gastrointestinal Infection;
6. Genitourinary Infection;
7. Wound infections;
8. Other types of infection (menengitis,);
9. Chronic infection (eg. asthma, arthritis, etc)

Health Records

The Northern River Basins study area contains a number of health units: Jasper, Alberta West Central, Sturgeon (a small sector), Athabasca, Fort McMurray, South Peace, Peace River and High Level - Fort Vermilion. This is illustrated in Figure 2. It is recognized that disease incidence, as reported by a certain health unit, may in fact include municipalities, towns, villages and hamlets that do not derive their primary drinking water supply from the basins of the Peace, Athabasca and Slave Rivers. However, the scope of this particular study did not allow for a more detailed examination of health records for areas served solely by the study area water supplies.

Each Alberta health unit is responsible to the Minister of Health, but is administered by a local board of health (prior to creation of the Regional Health Authorities). With respect to water quality, health units become involved when there is a potential for a public health problem, with private water supplies, or at the request of other regulatory agencies.

The Alberta Public Health Act, Sections 33 and 34, as well as, Alberta Regulation 238/85 has designated certain diseases as notifiable to the local medical officer of health within the health unit or to Communicable Disease Control, Alberta Health. Table 5 summarizes notifiable diseases in the Province of Alberta. This list may not be exactly the same from province to province to territory. Notification is required of medical laboratories, physicians, health practitioners, teachers or persons in charge of an institution. For the purposes of this study, a selection of diseases, whose agents could be waterborne, as well as, transmitted by many other vehicles were chosen. This includes amebiasis, giardiasis, salmonellosis, shigellosis, cryptosporidiosis, typhoid, legionellosis, hepatitis A and unspecified diarrhea. Disease incidence, as reported in the health unit records or in Alberta Health Communicable disease statistics, was calculated as a rate per 100,000 population for the health units in the Northern River Basins study area.

The actual incidence of waterborne disease may not always reflect the reported incidence. This is due to a number of factors that include:

- the individual(s) may have exposure from more than one environmental source (food, water, other) and may not associate water consumption, inhalation, or contact with the symptoms experienced;
- the individual(s) may have self-limiting symptoms and not seek medical attention;
- the individual(s) may have other health conditions that mask or overshadow the waterborne exposure;
- medical facilities, especially in remote areas, may not always allow for timely investigation or treatment, especially if the condition is self-limiting;
- the individual(s) may not be sampled by medical personnel, thus the causative agent(s) may not be established;
- the medical condition may not be considered within the definition of notifiable diseases, as specified by the Public Health Act, and consequently not be reported;
- the epidemiological investigation may not detect the causative agent from the water source, especially if the agent was a transient member of the water flora, rather than a resident member;
- laboratory detection may fail to detect the actual causative agent, fail to detect injured microorganisms or, not be sufficiently sensitive for low populations of the suspected microorganism.

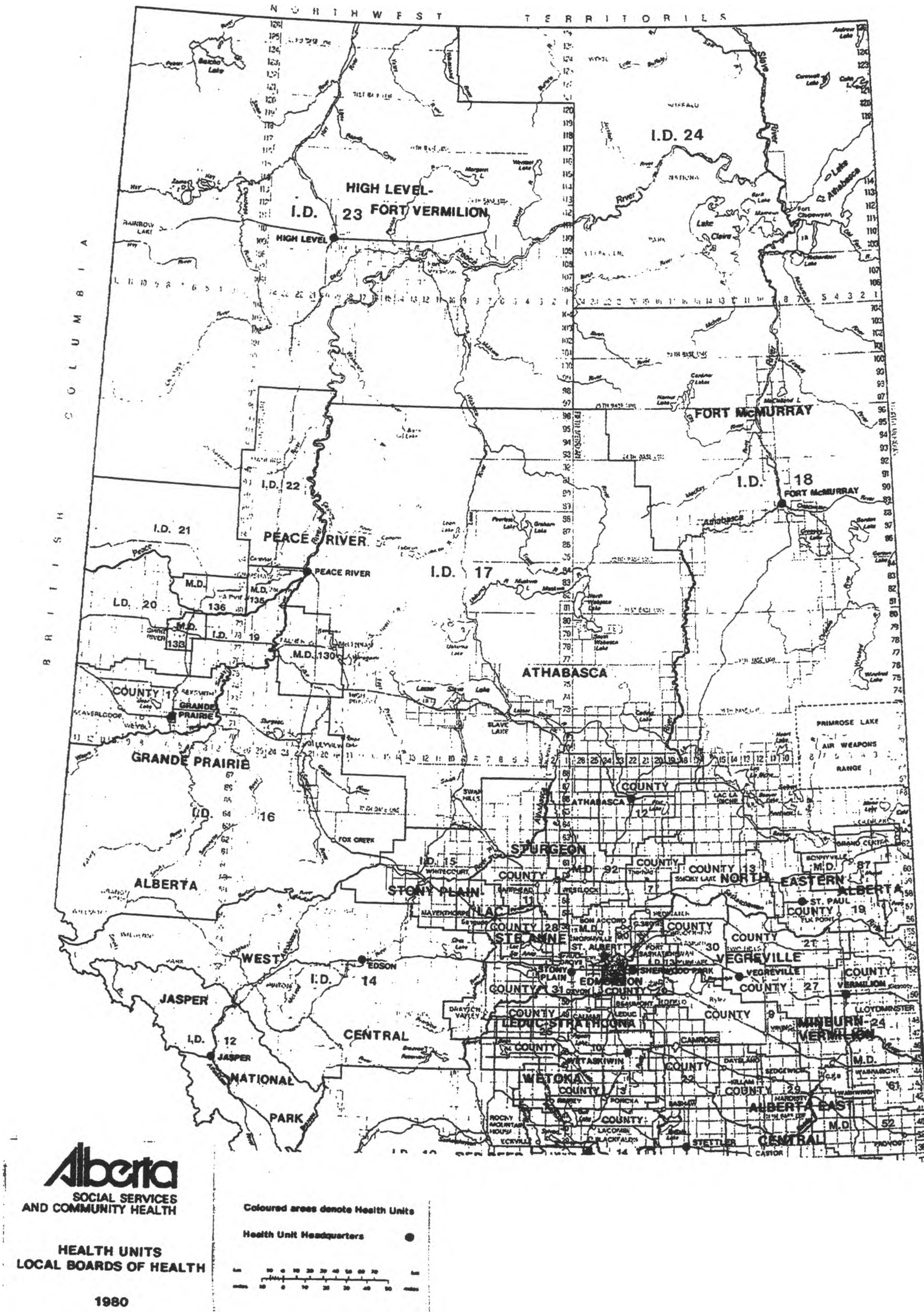

Figure 2: Health Units in the Northern River Basins Study Area

Table 5: Alberta Notifiable Disease Summary

AIDS	Meningococcal infection
Amebiasis	Mucopurulent cervicitis (STD)
Anthrax	Mumps
Arboviral infections	Neonatal herpes
Botulism	Nongonococcal urethritis (STD)
Brucellosis	Ophthalmia neonatorum (STD)
Campylobacter infections	Paratyphoid
Chancroid (STD)	Pertussis
Chickenpox	Plague
Chlamydial infections (STD)	Poliomyelitis
Cholera	Psittacosis
Congenital infections	Q Fever
Dengue	Rabies
Diphtheria	Reye Syndrome
Encephalitis	Rickettsial infections
Enteric Pathogens[1]	Rocky Mountain Spotted Fever
E. coli 0157:H7	Rubella
Foodborne outbreaks[1]	Rubeola
Gastroenteritis, epidemic[1]	*Salmonella* infections
Giardiasis	*Shigella* infections
Gonorrhea (STD)	Smallpox
Hemolytic uremic syndrome	Stool Pathogens[1]
Hemophilis influenzae infections	Syphilis (STD)
Hepatitis A, B, non A, non B	Tetanus
Kawasaki disease	Toxic Shock Syndrome
Lassa fever	Toxoplasmosis (congenital)
Legionella infections	Trichinosis
Leprosy	Tuberculosis
Leptospirosis	Tularemia
Listeriosis	Typhoid
Lymphogranuloma venereum (STD)	Typhus
Malaria	Varicella
Measles	Verotoxigenic *E. coli*
Meningitis	Viral hemorrhagic fevers
	Waterborne illness
	Yellow Fever
	Zoster

1. Includes the following and any other identified or unidentified cause: *Aeromonas, Bacillus cereus, Campylobacter, Clostridium botulinum, Clostridium perfringens, E. coli* (enteropathogenic, verotoxogenic, enterotoxogenic), *Giardia, Salmonella, Shigella, Staphylococcus,* Viruses, *Yersinia.*

As a result the actual numbers reported in health records are probably small compared to the total number which occur.

Results

The results of the review of the health records are presented in Appendix 1. The actual disease incidence in each health unit was calculated in terms of an incidence per 100,000 population and compared to a province-wide disease incidence, expressed in terms of incidence per 100,000 population. For a number of the disease categories chosen, the incidence per individual health unit was not available. This may reflect the low provincial number of cases in the reporting period examined. Also, the records examined did not distinguish between food borne and waterborne possibilities of transmission. The data may also be influenced by the relatively low population in northern Alberta relative to southern Alberta. If medical treatment was sought in outside of the health unit (e.g. City of Edmonton, Calgary), reporting of the case could be included in the health unit of treatment, rather than occurrence.

In general, for giardiasis, salmonellosis and shigellosis, there appeared to be a trend of higher incidence of cases in some of the health units relative to the provincial averages, however health unit records and provincial communicable disease summaries were not sufficiently detailed to determine whether water was the vehicle of transmission. However, a recent epidemiological-microbiological study estimated that conventionally treated water produced from a contaminated source but meeting existing quality standards was responsible for a large portion (perhaps one fourth to one third) of endemic community wide gastroenteritis (Payment et al. 1991). The microorganism responsible for most known waterborne disease outbreaks in the United States is *Giardia. lamblia*. Figure 3 compares the incidence of giardiasis in the Northern River Basins Study area with the Alberta average.

As indicated by the figure, generally rates are somewhat higher in the northern health units than the Alberta average. It should be noted that the high value for Jasper may not be truly representative, given the number of tourists that may be included in the disease reports, but not included in the population estimates. Other waterborne disease data had similar results. These results are presented in Appendix 1.

Although the waterborne rates tend to somewhat higher in the Northern River Basins area, in many cases the differences were not significant. Based on the data it can not be said that substantially higher risk from waterborne disease exists in the study area as compared with the rest of Alberta. However, the data does show, as has been found in other locations in North America, the occurrence of diseases which may be waterborne, is of concern.

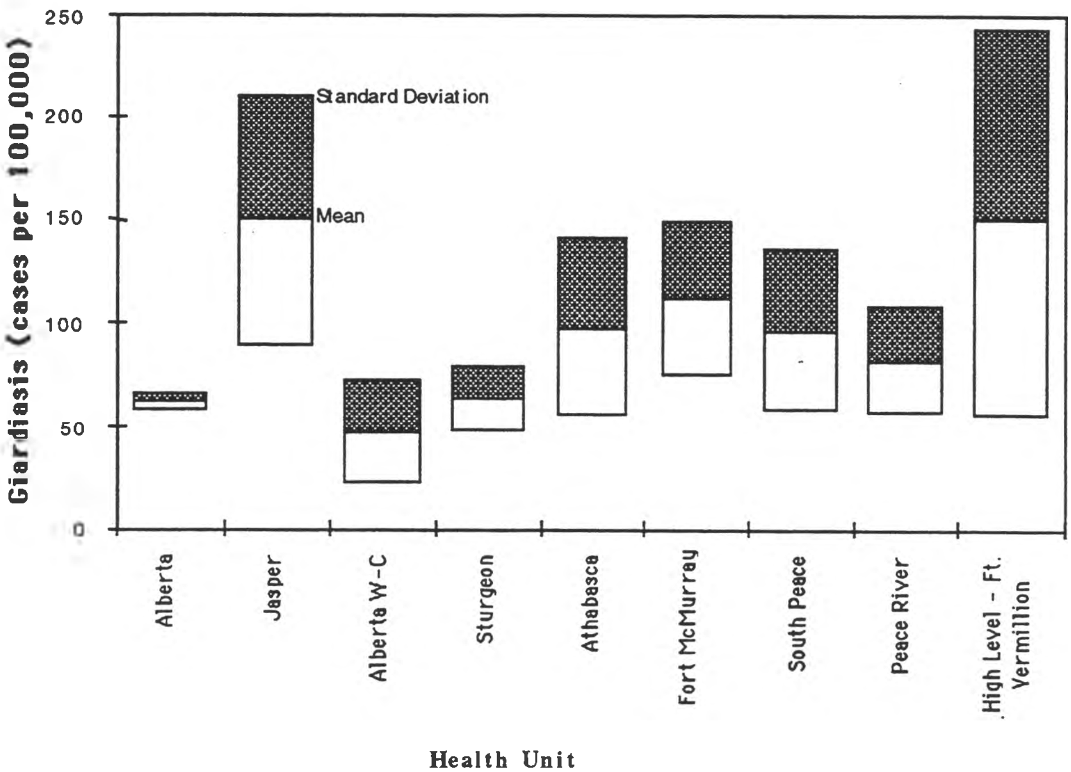

Figure 3. Cases of Giardiasis in the Northern River Basins Study Area (1985 to 1990)

In a study of this nature it would be ideal to determine the exact cause of the diseases reported. Under the current method of medical reporting this is difficult, if not impossible, as found by a recent study in Edmonton (TOXCON, 1992) which attempted to use the Alberta Health Care Insurance Plan (AHCIP) database to determine the incidence of waterborne disease in the City of Edmonton. A number of problems were identified in that study related to the analytical protocol. This includes: physician billing codes may not have identified the cause of disease, the quality and completeness of the database was not constant over time and the costs of extensive analysis of the database were prohibitive. This type of analysis was not within the scope of this particular study. A complicating factor in the Northern River Basins Study area would be the relative lack of postal codes to precisely define various regions in the study area.

Conclusions

Through a review of literature and health records in the Northern River Basins area the following can be concluded:

1. Potential risk from microbial contaminants can be high in comparison to potential risk from chemical contaminants.
2. For many pathogenic microbes there are substantial non-human reservoirs. As a result even complete elimination of human discharges will not eliminate the source for many pathogens.
3. Little data is available in the Northern River Basins Study area to assess microbial water quality. There appears to be a need to increase the baseline microbiological data on surface water quality in the study area for microorganisms other than those currently required by the Alberta Environmental Protection.
4. Analysis of health records showed that there appeared to be a trend towards higher incidence of giardiasis, salmonellosis and shigellosis in some of the health units, but failed to indicate if this was due to food borne, person to person or waterborne means of transmission.
5. Results also indicated that although incidence of some disease were higher, in many cases the differences were not significant and residence generally do not appear to have substantially higher risk from waterborne disease in the study area compared to the rest of Alberta.

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APPENDIX I

NOTIFIABLE DISEASE STATISTICS FOR POTENTIALLY WATERBORNE AND/OR FOODBORNE DISEASES: 1985 TO 1990

Notifiable Disease Statistics for Potentially Waterborne and/or Foodborne Diseases: 1985

Disease	Alberta Total	Jasper	Alberta West Central	Sturgeon	Athabasca	Fort McMurray	South Peace	Peace River	High Level - Fort Vermilion
Amebiasis	4.8	NA	NA	NA	NA	NA	NA	NA	NA
Giardiasis	64.5	205.4	20.7	89.7	170.4	141.6	117.3	117.3	307.3
Salmonellosis	31.4	NR	23.3	14.2	39.3	24.5	29.8	29.8	19.8
Shigellosis	8.3	205.4	NR	9.8	144.1	NR	10.5	10.5	-
Cryptosporidiosis	4.5	NA	NA	NA	NA	NA	NA	NA	NA
Typhoid	0.4	NA	NA	NA	NA	NA	NA	NA	NA
Legionellosis	0.2	NA	NA	NA	NA	NA	NA	NA	NA
Unspecified Diarrhea	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hepatitis A	1.8	NR	NR	NR	NA	NR	NA	NA	NA

Reported as incidence per 100,000 population

NA: Information not available in databases examined
NR: No cases reported for that reporting period

Notifiable Disease Statistics for Potentially Waterborne and/or Foodborne Diseases: 1986

Disease	Alberta Total	Jasper	Alberta West Central	Sturgeon	Athabasca	Fort McMurray	South Peace	Peace River	High Level - Fort Vermilion
Amebiasis	4.8	NA	NA	NA	NA	NA	NA	NA	NA
Giardiasis	68.5	231.1	36.2	50.1	95.0	133.5	148.8	102.3	119.0
Salmonellosis	32.2	25.7	12.8	33.9	36.0	19.1	36.8	12.2	9.9
Shigellosis	6.3	NR	NR	2.2	19.7	13.6	1.8	7.3	19.8
Cryptosporidiosis	2.9	NA	NA	NA	NA	NA	NA	NA	NA
Typhoid	4.7	NA	NA	NA	NA	NA	NA	NA	NA
Legionellosis	0.3	NA	NA	NA	NA	NA	NA	NA	NA
Unspecified Diarrhea	17.5	NA	NA	NA	NA	NA	NA	NA	NA
Hepatitis A	13.1	NR	15.5	8.8	108.1	2.7	21.0	14.7	NR

Reported as incidence per 100,000 population

NA: Information not available in databases examined
NR: No cases reported for that reporting period

Notifiable Disease Statistics for Potentially Waterborne and/or Foodborne Diseases: 1987

Disease	Alberta Total	Jasper	Alberta West Central	Sturgeon	Athabasca	Fort McMurray	South Peace	Peace River	High Level - Fort Vermilion
Amebiasis	4.7	NA	NA	NA	NA	NA	NA	NA	NA
Giardiasis	63.3	102.7	46.6	46.0	85.2	152.5	120.8	85.6	99.1
Salmonellosis	40.0	NR	15.5	17.5	45.9	46.3	50.8	51.3	NR
Shigellosis	8.7	NR	NR	6.6	16.4	5.4	17.5	NR	NR
Cryptosporidiosis	4.7	NA	NA	NA	NA	NA	NA	NA	NA
Typhoid	4.7	NA	NA	NA	NA	NA	NA	NA	NA
Legionellosis	0.6	NA	NA	NA	NA	NA	NA	NA	NA
Unspecified Diarrhea	17.4	NA	NA	NA	NA	NA	NA	NA	NA
Hepatitis A	6.0	25.7	2.6	5.5	6.6	NR	5.3	NR	19.8

Reported as incidence per 100,000 population

NA: Information not available in databases examined
NR: No cases reported for that reporting period

Notifiable Disease Statistics for Potentially Waterborne and/or Foodborne Diseases: 1988

Disease	Alberta Total	Jasper	Alberta West Central	Sturgeon	Athabasca	Fort McMurray	South Peace	Peace River	High Level - Fort Vermilion
Amebiasis	6.0	NA	NA	NA	NA	NA	NA	NA	NA
Giardiasis	62.3	77.0	31.1	67.8	104.8	79.0	75.3	83.1	218.1
Salmonellosis	40.3	NR	33.6	40.5	59.0	27.2	42.0	34.2	29.7
Shigellosis	11.1	NR	10.4	3.3	NR	16.4	14.0	NR	NR
Cryptosporidiosis	6.0	NA	NA	NA	NA	NA	NA	NA	NA
Typhoid	0.3	NA	NA	NA	NA	NA	NA	NA	NA
Legionellosis	0.3	NA	NA	NA	NA	NA	NA	NA	NA
Unspecified Diarrhea	16.3	NA	NA	NA	NA	NA	NA	NA	NA
Hepatitis A	8.8	NR	7.8	3.3	26.2	10.9	3.5	NR	NR

Reported as incidence per 100,000 population

NA: Information not available in databases examined
NR: No cases reported for that reporting period

Notifiable Disease Statistics for Potentially Waterborne and/or Foodborne Diseases: 1989

Disease	Alberta Total	Jasper	Alberta West Central	Sturgeon	Athabasca	Fort McMurray	South Peace	Peace River	High Level - Fort Vermilion
Amebiasis	5.5	NA	NA	NA	NA	NA	NA	NA	NA
Giardiasis	58.4	128.4	72.5	64.6	98.3	103.5	49.0	53.8	89.2
Salmonellosis	41.3	NR	33.5	39.4	55.7	30.0	36.8	44.0	49.6
Shigellosis	6.6	25.7	13.1	3.3	NR	NR	NR	2.4	NR
Cryptosporidiosis	1.4	NA	NA	NA	NA	NA	NA	NA	NA
Typhoid	0.3	NA	NA	NA	NA	NA	NA	NA	NA
Legionellosis	0.2	NA	NA	NA	NA	NA	NA	NA	NA
Unspecified Diarrhea	18.3	NA	NA	NA	NA	NA	NA	NA	NA
Hepatitis A	8.7	25.7	5.2	3.3	26.2	5.4	12.3	NR	NR

Reported as incidence per 100,000 population

NA: Information not available in databases examined
NR: No cases reported for that reporting period

Notifiable Disease Statistics for Potentially Waterborne and/or Foodborne Diseases: 1990

Disease	Alberta Total	Jasper	Alberta West Central	Sturgeon	Athabasca	Fort McMurray	South Peace	Peace River	High Level - Fort Vermilion
Amebiasis	5.8	NA	NA	NA	NA	NA	NA	NA	NA
Giardiasis	59.8	154.0	82.8	68.9	39.3	62.2	69.7	56.2	69.4
Salmonellosis	35.1	77.0	20.7	23.0	19.7	38.1	8.3	9.8	19.8
Shigellosis	5.1	26.7	2.6	4.4	NR	2.7	NR	NR	9.9
Cryptosporidiosis	0.7	NA	NA	NA	NA	NA	NA	NA	NA
Typhoid	0.3	NA	NA	NA	NA	NA	NA	NA	NA
Legionellosis	0.4	NA	NA	NA	NA	NA	NA	NA	NA
Unspecified Diarrhea	23.9	NA	NA	NA	NA	NA	NA	NA	NA
Hepatitis A	12.1	25.7	10.4	14.2	29.5	5.4	5.0	NR	NR

Reported as incidence per 100,000 population

NA: Information not available in databases examined
NR: No cases reported for that reporting period

APPENDIX II

SUMMARY OF INFRASTRUCTURE OF MAJOR COMMUNITIES IN NORTHERN RIVER BASINS AREA

Summary of Infrastructure of Major Communities in Northern River Basins Area

Community	Health Unit	Population	Drinking Water Supply	Drainage Basin	Water Treatment	Sewage Treatment
Anzac	Fort McMurray	250	Gregoire Lake	Athabasca	No Treatment	None
Athabasca	Athabasca	1,975	Athabasca River	Athabasca	Complete, Piped	Piped, Aeration Ponds
Atikameg (Woodland Cree)	Athabasca	699	Utikuma Lake	Peace	Partial, Trucked	Septic Tanks, Privies
Calling Lake	Athabasca	391	Calling Lake	Athabasca	Piped, Complete	Piped, Detention Ponds, Septic Tanks, Lagoons
Canyon Creek	Athabasca	164	Lesser Slave Lake	Athabasca	Piped, Complete	Septic Tanks
Donnelly	Peace River	404	Wingami Lake	Athabasca	Piped, Coagulation, Filtration, Chlorination	Piped, Detention Ponds
Driftpile Band	Athabasca	515	Lesser Slave Lake	Athabasca	Complete, Iron Control	Piped, Trucks, Septic Tanks, Lagoons
Falher	Peace River	1172	Winagami Lake	Athabasca	Piped, Complete, Fluoridation	Piped, Lagoons
Faust	Athabasca	379	Lesser Slave Lake	Athabasca	Piped, Trucked, Filtration, Chlorination	Piped,Detention Ponds, LagoonsFort Chipewyn
Fort Chipewyan	Fort McMurray	1,100	Lake Athabasca	Athabasca	Piped, Filtration, Chlorination	Piped, Lagoons
Fort MacKay	Fort McMurray	285	Athabasca River	Athabasca	Piped, complete	Piped, Detention Ponds, Lagoons
Fort MacKay Band*	Fort McMurray	275	Athabasca River	Athabasca	Piped, Chlorination, Iron Control	Piped, Lagoons
Fort McMurray	Fort McMurray	33,698	Athabasca River	Athabasca	Piped, Fluoridation	Piped, Detention Ponds, Aerated Lagoons
Fort McMurray Band*	Fort McMurray	193	Athabasca River	Athabasca	Trucked, Complete	Trucked, No Treatment
Fort Vermilion	High Level/Fort Vermilion	831	Peace River	Peace	Piped, Complete	Piped, Lagoons
Garden Creek*	High Level - Fort Vermilion	164	Peace River	Peace	None	Septic Tank, Privies
Girouxville	Peace River	367	Winagami Lake	Athabasca	Piped, Filtration, Chlorination	Piped, Lagoons

Community	Health Unit	Population	Drinking Water Supply	Drainage Basin	Water Treatment	Sewage Treatment
Grande Cache	Alberta West Central	3,654	Victor and Grande Cache Lakes	Smoky River, then into Peace River	Piped,Filtration, Chlorination	Piped, Aeration Ponds, Secondary Treatment
Grouard	Athabasca	372	Lesser Slave Lake	Athabasca	Piped, Truck, Coagulation, Filtration, Chlorination	Piped, Detention Ponds, Lagoons
Grouard Band	Athabasca	162	Lesser Slave Lake	Athabasca	Piped, Truck, Coagulation, Filtration, Chlorination	Piped, Lagoon
Janvier Band*	Fort McMurray	450	Christina River	Athabasca River	Piped, Truck, Complete	Truck, Septic Tanks, Lagoons
Joussard	Athabasca	277	Lesser Slave Lake	Athabasca	Piped, Truck, Filtraton, Chlorination	Piped, Detention Pond, Lagoon
Lac La Biche	Athabasca	2553	Lac La Biche	Athabasca	Piped, Complete, Fluoridation	Piped, Detention Pond, Aerated Lagoons
McLennan	Peace River	1047	Winagami Lake	Athabasca	Piped, Complete, Fluoridation	Piped, Lagoons
Peace River	Peace River	6644	Peace River	Peace	Piped, Complete, Fluoridation	Piped, Detention Pond
Peerless Lake	Athabasca	252	Peerless Lake	Peace	Truck, Complete	Septic Tanks, Privies
Slave Lake	Athabasca	5611	Lesser Slave Lake	Athabasca	Piped, Complete, Fluoridation	Piped, Aeration Ponds, Lagoons
Smith	Athabasca	251	Athabasca River	Athabasca	Piped, Filtration, Chlorination	Piped, Lagoons
Whitecourt	Sturgeon	6,692	McLeod River	Athabasca	Piped, Complete, Fluoridation	Piped, Treatment Plant
Whitefish Lake Band*	Athabasca	799	Utikuma Lake	Athabasca	Piped, Truck, No treatment	Septic Tank, Privies

Complete water treatment means coagulation, sedimentation,filtration and chlorination
*Reserve

APPENDIX III

TERMS OF REFERENCE

NORTHERN RIVER BASINS STUDY

TERMS OF REFERENCE

Project 4421-C1: Analysis of Health Records for the Occurrence of Waterborne Disease

I. Introduction

The analysis of drinking water samples for all possible pathogenic microorganisms would be very time consuming, expensive and would only be representative of the time the sample was taken. A very efficient method of determining the microbiological quality of a drinking water supply is to analyze health records. Each health unit keeps records for many waterborne diseases, and analysis of these records can provide a great deal of information on the microbiological quality of the drinking water of that community. It should be emphasized that the analysis of this data is not to determine the health risk from drinking water, which is outside the cope of the NRBS, but to assess microbiological quality of the drinking water supply. As these records have been kept for some time another benefit to this type of study is that trends in the microbiological quality of drinking water can also be found.

II. Requirements

1. Provincial and Territorial Health Unit Records in the Northern River Basins will be identified and waterborne disease data from each of these units will be collected and analyzed. If appropriate enter waterborne disease data in a geo-referenced (latitude and longitude), electronic database (dBASE IV format. The data entry format of such a database is to be determined in consultation with the component coordinator.

2. Based on the results from Project 4401-C1, the water treatment facilities located in each Health Unit will be identified.

3. In all portions of this study any deficiencies in available data or information will be determined to define additional needs for future studies.

4. Synthesis of results in a concise and usable manner.

III. Reporting Requirements

1. The contractor is to prepare a synthesis report of all the information compiled under this project. The report is to include an acknowledgements section, table of contents, list of tables, list of figures and an appendix containing the Terms of Reference for this project. The draft report is to be submitted to the component coordinator by February 28th, 1994. A final report is to be submitted to the component coordinator three weeks after the receipt of review comments on the

draft report. Five cerlox bound copies and two unbound, camera-ready copies of the final report are to be submitted to the component coordinator. An electronic copy of the final report (Word Perfect format) is to be submitted to the component coordinator along with the final report. Pertinent data contained in figures, tables and/or appendices of the report are to be placed in electronic spreadsheets (Quattro Pro preferred) and submitted to the component coordinator along with the final report.

2. If it is appropriate to do so, the contract will also submit a geo-referenced, electronic database (dBASE IV) of waterborne disease data to the component coordinator at the same time the final report is submitted.

IV. Project Administration

The component coordinator for this project will be:

Greg Wagner
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690 Standard Life Centre
10405 Jasper Avenue
Edmonton, Alberta T5J 3N4
phone: (403) 427-1742 fax: (403) 422-3055