THE UNIVERSITY OF ALBERTA

PERCEPTION AND MANAGEMENT OF WATER QUALITY IN THE NORTH SASKATCHEWAN RIVER AT EDMONTON, ALBERTA

by

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ABSTRACT

The purpose of this study was to determine whether or not the residents of Edmonton, Alberta think that the North Saskatchewan River, flowing through their city, is polluted; and if so, whether they feel any responsibility for this situation. In addition, it was hoped to determine if the residents' perception of water pollution has any impact on the decision-making process. Through the use of two separate questionnaires it was found that the residents did think that the river is polluted, but that over half of the residents felt no responsibility in the matter. The question of the influence of the residents in decision-making revealed that decision-makers claimed that private citizens do have influence, while the citizens interviewed were largely skeptical.

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CHAPTER I

INTRODUCTION

The deterioration of the quality of water in streams, lakes, and oceans is not a new phenomenon. For centuries, man has disposed of wastes in water bodies with little apparent concern for the consequences in terms of water quality. For many years now, man has been aware that he is damaging his waters. However, he has done little to prevent this damage. In the past, it has most often been only after a water body has become unfit for human consumption that he has made any attempt to restore and maintain the quality of its waters.

Currently, much attention is being given to environmental quality. The pollution of water bodies is a major part of this concern. The news media have focused, to a large extent, on the rivers and lakes of eastern Canada and the United States, where concentrations of population and industry over a period of many years have created a problem of water pollution that is already severe. In comparison, the rivers of the Prairies, flowing out of the Rocky Mountains, may seem relatively pure. This apparent lack of a problem could cause a complacency which might stall more water pollution control measures until the Prairie rivers

were as polluted as those of the highly industrialized part of Ontario.

Purpose

The purpose of this study is to investigate how the quality of water in a river is perceived by the residents of a particular Prairie city, Edmonton, Alberta. Under examination is whether or not the residents think that the North Saskatchewan River, flowing through their city, is polluted, and if so, to what extent. Also, an attempt will be made to determine how they define pollution. These questions will not be answered on the basis of any scientific knowledge on the part of the residents about the condition of the river. The intent is to determine what the residents think is the condition of the river. This may be based on actual contact with the river, on the appearance of the river from a distance, on hearsay, or any number of things.

In addition to this, there will be an attempt to determine the importance of perception of water pollution on decision-making in water quality management. More specifically, to find out whether it matters if the residents of Edmonton think that the North Saskatchewan River is polluted; whether or not they have any influence on decision-making in this matter.

The city chosen as a study area, Edmonton, Alberta, is situated on a river, the North Saskatchewan, which flows from the Rocky Mountains. There are no large concentrations

of population or industry upstream of Edmonton to grossly impair the quality of river water. Edmonton, itself, has both water treatment and sewage treatment facilities. The city and the river will be discussed in detail in Chapter IV.

As a background to the study, there will be a general discussion of water quality management, the level of technology, administrative bodies, and legislation, and a specific discussion of these factors as related to the city of Edmonton. This will provide some terms of reference for any possible conclusions that can be drawn from the study.

Definition of Pollution

Before proceeding to a discussion of water quality management, one should consider the problem of defining pollution. In order to legislate against pollution or set standards for water quality, pollution must be defined in a specific way. Ancient English common law stated that "the user of water was not entitled to diminish it in quality" (McGauhey, 1968, p. 1), but it did not define quality. The word quality is not very precise in legal terms, but it has been used repeatedly in defining water pollution. Today, in England, pollution is "legally definable as the addition of something to water which changes its natural qualities so that the riparian owner does not get the natural water of the stream transmitted to him" (Hynes, 1966, p. 1). The United States House of Representatives Committee on Public Works defines pollution as "an impairment of quality such

that it interferes with the intended usages" (Divorsky, 1967, p. 2). In Canada it is the "introduction of liquid or stable material into water whereby the natural quality of the water is changed" (Gisvold, 1967, p. 66). The Canada Water Act does not define the word pollution. Instead it defines waste as "any substance that, if added to any waters, would degrade or alter . . . the quality of those waters to an extent that is detrimental to their use by man" (Bill C-144, 1970, p. 3).

This problem of definition, along with the question of setting water quality standards, was recognized very early in the struggle against water pollution. However, there has been little success in devising a satisfactory and precise definition. On the contrary, definition has become even more difficult with increasing complexity of effluents and increasing knowledge of microorganisms, chemical and radioactive substances, and their effects.

Water Quality Management

The administration of programs for water quality management is a complex problem. It involves several levels of government. For example, the management of the North Saskatchewan River at Edmonton involves the city of Edmonton, which contributes municipal wastes to the river; the surrounding counties, which have jurisdiction over the industries outside of the city; the province, which has control of all of the waters within its boundaries; and the federal

government, which has certain nation-wide controls. In addition, there are special-purpose agencies such as the Prairie Provinces Water Board, which have regional or interprovincial interests. This complex of administrative bodies must be coordinated to deal with a problem which itself is very complex. Water pollution is not caused by one or two simple substances. There is a tremendous variety of effluents and sources of effluents which must be taken into account.

Many researchers in water quality management conclude that what is needed to effectively deal with the problem is one agency or governmental body with the authority and financial backing to administer comprehensive pollution control programs. Beecroft, in a Canadian study of municipalities and water management states, "One of the principal conclusions to emerge from this study is that effective measures of pollution control are dependent . . . on the design of institutions for planning and decision-making" (Beecroft, 1968, p. 39).

Kneese and Bower have investigated the problem of water quality management from the viewpoints of economics, technology, and the institutions involved. (Kneese and Bower, 1968) They strongly recommend regional water management agencies based on watersheds or river basins. These agencies should have the power to integrate water quality management with all other aspects of water resource development. They should have some communications with the managers of land

use in the area. They should study a wide range of possible choices in water quality programs, and should have the authority to implement their programs. In this respect, the authors suggest that a system of effluent charges to motivate industries and municipalities to reduce waste discharge would be most effective. And they recommend that the agencies should provide an opportunity for parties affected by their programs to have some voice in the decision-making.

Some river basin agencies already exist which carry on programs of water quality management. Perhaps the best example of this is in the Ruhr area in Germany. In this highly industrialized region there are eight water resource management agencies, each responsible for a river basin. The oldest of these agencies, in the Emscher area, has been in operation since 1904. These Genossenschaften, as they are called have designed, built and operated their own regional systems of waste disposal and water supply. The facilities for waste treatment have been paid for largely by effluent charges, based on a complicated analysis of the concentration, type, and amount of the waste that is discharged. The organization of the Genossenschaften is significant because it includes, in addition to political representatives of the area, owners of businesses and industries which make use of the river. It has been suggested that the reason for the success of these agencies and the cooperation of the public with their programs is the good relationships

between the Genossenschaften and their members. (Kneese and Bower, 1968, p. 262)

In England and Wales the former River Boards were replaced by River Authorities as a result of the Water Resources Act of 1963. These twenty-seven River Authorities have broad responsibilities of water management, but little specific power related to water quality management. However, they do have the authority to license all discharges of waste water. This power could be significant. For the most part, their function seems to be in regulating water withdrawals and carrying out development programs. The membership of the Authorities is made up of representatives of the central and the local governments. (Kneese and Bower, 1968)

France also has river basin agencies, which were created in 1964. These six agencies have broad powers of water quality, and make use of effluent charges. Local representatives, including representatives of industry, are members of the agencies along with representatives of the central government. However, the central government must give final approval of any water management program recommended by the agencies. (Kneese and Bower, 1968)

The United States does not have any national scheme of river basin agencies. However, several regional water management agencies have come into existence. An example of this is the Delaware River Basin Commission, an interstate-federal compact agency created in 1961 to administer a

comprehensive plan of water resource management for the basin. It has powers to construct and operate facilities for water quality management, and powers to enforce standards for waste discharges. The Commission is made up of representatives of the four states involved in the basin and the federal government, with no representation of local interests.

In Canada the river basin agencies proposed under the Canada Water Act should function as comprehensive water management agencies. These will however, be established only in certain specified areas. This matter will be discussed more fully in Chapter III.

Perception of the Environment

The study of perception of the environment is relatively new within the field of Geography. However, during the 1960's there was a surge of interest which created a proliferation of perception studies in various phases of the discipline. From Lynch's 1960 study of paths, edges and images within a city, to Saarinen's 1966 investigation of perception of the drought hazard in the Great Plains of the United States, to MacIver's 1970 study of perception and choice of city water supply alternatives in the Grand River basin in Ontario, perception studies in the last decade have dealt with many different aspects of the environment.

In order to study perception, one must understand the concept involved. Saarinen calls the type of perception

studies that geographers have been doing "social perception." In his words, "Social perception is generally concerned with the effects of social and cultural factors on man's cognitive structuring of his physical and social environment" (Saarinen, 1969, p. 5). Thus, an individual's background is an important factor affecting his perception of a given stimulus. Schiff makes a distinction between perception and attitudes. She defines social perception in the same way that Saarinen does, but states that "perception should be limited to those situations in which there is or was a physical stimulus or set of stimuli present" (Schiff, 1970, p. 5). For a situation in which the environmental stimulus is not or has not been present, she would use the term cognition or belief. An attitude, on the other hand, is defined as "an organized set of feelings and beliefs which will influence an individual's behavior" (Schiff, 1970, p. 6).

As geographers have always been interested in the relationships between man and the environment, so studies of perception of the environment are merely an extension of that interest. However, this extension is into the realm of the perceived environment, which differs from the "real" environment in that it is the environment as seen through the perceptual filter of an individual. (Sadler (a), 1971, p. 53) In this sense, it is very complex due to the wide range of factors which influence it from individual to individual and within the same individual through time.

One problem inherent in trying to measure perception through the use of a questionnaire is that in asking a question, one is automatically affecting the response, either in the way in which the question is asked, or by merely bringing up the topic. Another problem is that the respondent may not answer with his true opinion, but with the opinion that others have or the opinion that he thinks the interviewer is trying to elicit. (Sadler (b), 1971, p. 4). There is no way to insure against these problems. One can only endeavor to design the questionnaire and ask the questions in a manner least likely to lead the respondent. In this study two different types of questionnaires were used; one with short, multiple-choice answers, and a longer interviewing technique allowing for comments and explanations of answers. An attempt will be made to judge which is more effective in a study such as this.

The second part of this study is concerned with the value of studying perception of water pollution in the North Saskatchewan River. It will attempt to determine if the residents' perception of water pollution makes any difference in the decision-making process. Sewell, in his study on the attitudes of engineers, came to the conclusion that, "the expert often relies on his own judgement as to what people prefer rather than seeking their opinions" (Sewell, 1971, pp. 61-62). MacIver found a similar attitude among water supply decision-makers in the Grand River basin. (MacIver, 1970)

However, most researchers in the field of resource management agree that the public should take part in resource management decisions, and that basic to that is an awareness of the problems. Swanson states, "The study of public perceptions of, and attitudes to, resources can be seen as having a significant role to play in the realization of public participation in resource planning and management" (Swanson, 1970, p. 2). Kasperson complains that "in many natural resource conflicts . . . low levels of knowledge and participation result in an abdication to 'experts' of the responsibility for decision-making" (Kasperson, 1968, p. 10). He goes on to argue for a better information system to keep the public well informed. Kneese expresses a similar thought when discussing water quality management agencies. "Achieving a supporting constituency and making sure that all relevant values are reflected in the decision-making process require some means of communication with the parties affected by the decisions" (Kneese and Bower, 1968, p. 289). And, in a study on perception of water pollution in British Columbia, McMeiken and Rostron concluded that "without a program to satisfy general public viewpoints the potential effectiveness of public policy decisions will be in question" (McMeiken and Rostron, 1969, p. 26).

Methodology

The organization of the present study is given below. Chapter II contains a brief discussion of the history of water

pollution, man's awareness of it, and what he has done to control it. Chapters III and IV deal with the study area, Edmonton, Alberta. First is an examination of the institutional framework of water pollution control. This is followed by a discussion of the physical geography of Edmonton and a description of the water treatment and sewage treatment facilities that are in operation. Chapter V presents the methodology used for the first questionnaire in this study. Chapter VI presents the results of the first questionnaire. Chapter VII discusses the second questionnaire and its results, and Chapter VIII concludes the study with a summary of the findings and the possible implications that this might have on decision-making.

CHAPTER II

THE HISTORY OF WATER POLLUTION

If water pollution is defined in terms of man's alteration of the quality of water, then the history of water pollution is as old as the history of man. H. B. N. Hynes, a biologist, points out that "the middens of Stone Age man, like those of his present descendants, must have increased the amount of putrescent organic matter reaching the water" (Hynes, 1966, p. 1). The amount may have been insignificant at first, but as men began living together in groups and settling near a water supply--stream, lake, spring, pond--their wastes, accumulating over a period of time, must have significantly altered the quality of their source of water. It has been speculated that one reason for early nomadism was to move away from accumulated wastes and find a fresh source of water. (Bryan, 1965, p. 180)

The ancient civilizations in the Middle East, India, Greece, and Rome developed sewage control systems along with their water supply systems. These systems, at varying levels of advancement and efficiency, indicate an awareness of the necessity of controlling sewage in some way. Aristotle documented this awareness in noting "the white colour produced by foul mud and the small red threads that grow out

of it" (Hynes, 1966, p. 2).

The Romans developed a fairly sophisticated system for water supply and sewage control. They were aware of the problems involved in improper or inefficient disposal of wastes. Their first aqueduct, the Appia, was constructed in 313 B.C. because ground disposal of wastes for many generations had polluted the groundwater beyond tolerance. (McGauhey, 1968, p. 5) With the construction of later aqueducts, waters of differing degrees of purity were kept separate. The aqueduct Marcia was used for drinking water, while water from the aqueduct Anio Vetus was used for washing clothes and similar purposes. (Merdinger, 1955, p. 238) The Romans also used settling tanks at the ends of some of the aqueducts for water purification, and crude filters to eliminate pebbles and large impurities from the city's water pipes. (Merdinger, 1955, p. 238) These methods would remove only gross impurities; however, Pliny indicated that many private citizens boiled their water to make it wholesome. (Merdinger, 1955, p. 238)

Little progress was made in sanitary systems during the Middle Ages. Many new cities springing up throughout Europe had even less advanced techniques for quality control for city water supplies than the earlier Romans. Some of the monasteries of the Middle Ages, however, did use certain precautions to keep their drinking water pure. By 1160, the Benedictine Priory of Christ Church at Canterbury piped its

water into a circular conduit house, sent it through a perforated plate to filter out large impurities, then piped it to five settling tanks before distributing it. (Merdinger, 1955, p. 238)

Although little or nothing was done in most cities in the Middle Ages to keep sewage separate from drinking water or to purify it, the people of that time could not help being aware of the problem. As early as 1367, Edward III of England ordered the mayor and sheriffs of London to clean up the River Thames. The king had:

> beheld dung and laystalls and other filth accumulated in diverse places in the said city upon the bank of the said river . . . had perceived the fumes and other abominable stenches arising therefrom; from the corruption of which, if tolerated, great peril, as well to the persons dwelling within the said city as to the nobles and others passing along the river, will it is feared arise, unless indeed some fitting remedy be speedily provided for the same. (Dolman, 1967, p. 231)

Unfortunately, no fitting remedy was speedily provided.

In spite of countless reports and complaints about the stench and obvious filth of the Thames, only crude methods of filtration were in practice as late as the early nineteenth century. "A grid in the river sufficed to keep out all the larger impurities such as dead dogs" (Dolman, 1967, p. 231). Sewage was washed directly into the river, with no attempt at purification. In 1829, the first slow sand filter, Simpson's filter, was introduced. This was a reservoir with layers of sand and gravel, through which the water passed. (Merdinger, 1955, p. 359) It was a great improvement

over the old grid filters.

It was not until the late 1840's that medical discoveries were made which specifically connected disease with public water supply. Dr. John Snow of London traced an outbreak of cholera to a water supply which had been contaminated with sewage from cholera victims. This discovery prompted the passage of an Act of Parliament requiring that by 1855 all water for domestic use in metropolitan London be sandfiltered. (Am. Water Works Assoc., 1940, p. 14) During the following twenty years, many more discoveries were made in the field of bacteriology by Pasteur, Koch, Eberth, Budd and others, which verified the connections between disease and sewage-contaminated water supply. In the 1880's it was first recognized that slow sand filtration of water was effective, not only in the mechanical removal of turbidity, but in the bacteriological activity taking place at the sand bed which consumed many pathogenic organisms. (Merdinger, 1955, p. 359)

Some of the early bacteriologists attempted to set standards of water quality according to the number of bacteria present. However there were differing opinions as to the exact number of bacteria that could be present in "pure" water. For example, one scientist felt that there should be less than ten bacteria per millliliter, while another suggested that there could be as many as one hundred bacteria per milliliter of water without considering it to be

contaminated. (Am. Water Works Assoc., 1940, p. 16)

In North America, progress in combating water pollution lagged behind that of Europe. In 1866, James Kirkwood was sent by the Saint Louis Board of Water Commissioners to Germany to study European methods of water purification. In 1869 he published *Report on the Filtration of River Waters for the Supply of Cities as Practiced in Europe*. (Merdinger, 1955, p. 359) Following the European example, the first sand filter for a municipal water supply in the United States was constructed in Poughkeepsie, New York in 1872. (Kazmann, 1965, p. 16) About this same time, public health agencies were being established which would be responsible for sanitary reform. In 1869, Massachusetts started its State Board of Health. The American Public Health Association was founded several years later in 1872. (Dolman, 1967, p. 239) In Canada, Ontario was the first to set up a Provincial Board of Health in 1882, followed by Quebec's Conseil de Santé in 1886. Not until 1919 did the federal government of Canada establish its Department of Pensions and National Health. (Dolman, 1967, p. 240) In 1894, a Canadian bacteriologist, Wyatt Johnston, encouraged the American uniform methods of water analysis. The result was *Standard Methods of Water Analysis*, first published in 1905 and now in its twelfth edition. (Dolman, 1967, p. 242)

In 1897, a study was done on typhoid-fever death rates in various European and North American cities. At

that time it was discovered that there was a definite reduction in death rates in cities which had filtration of the public water supply. (Fuertes, 1897, p. 46)

As mentioned previously, sterilization of water by boiling was recognized as effective by the early Romans. In 1877, it was discovered that ultra-violet light would kill bacteria. (Merdinger, 1955, p. 363) But both of these methods of water purification were impractical at the large scale needed for a city water supply. Chemical purification proved to be the most practical solution. In 1894, Traube first discovered that chlorine kills bacteria in water. (Merdinger, 1955, p. 363) Chlorine was first added to a water supply in Maidstone, England during a typhoid epidemic in 1897. The epidemic was quickly brought under control. (Dolman, 1967, p. 242) In North America, the first city to have a continuously chlorinated water supply was Jersey City, New Jersey in 1908. (Dolman, 1967, p. 243) Subsequently, chlorination of urban water supplies was widely accepted and recognized as effective in controlling bacteria in the water. The practice was adopted in most cities; however, some people remained skeptical about adding chemicals to their water. As recently as the 1940's, the local Water Board of Vancouver, the mayor, the city council, and many citizens struggled for several years to prevent their city's water from being "poisoned" by chlorine. (Dolman, 1967, p. 244).

Present Technology

Many advances in the technology of water purification and waste treatment have been made since Simpson's filter was first introduced. With industrialization and increasing urban growth, man has introduced a complex variety of chemicals, microorganisms, and other substances into his waters. At the same time he has developed new techniques to restore these polluted waters to a drinkable state.

There are several stages of waste treatment which are commonly in use. Primary treatment of wastes involves mechanical processes. These include screening and microstraining to remove much of the suspended matter. Sedimentation basins are widely used to allow suspended materials to settle. To get rid of very fine particles which will not settle, chemicals (usually alum) are added, which cause the particles to cluster. This process is known as flocculation. The floc formed by the clusters is then removed by sedimentation. These primary treatment processes can remove from fifty to sixty per cent of the suspended solids and from thirty to forty per cent of the B.O.D. B.O.D., biochemical oxygen demand, is a common measure used to describe the level of pollution. It represents the "amount of oxygen that is needed by any unit volume of sewage or polluted water to oxidize all organic material within it" (Grava, 1969, p. 37).

Secondary treatment involves biological treatment of wastes. In a trickling filter, waste water is passed

through a filter of rocks covered with a biologically active film. In the activated sludge method, the waste water is aerated to accelerate oxidation. Primary and secondary treatment together can eliminate from eighty to ninety per cent of the B.O.D. (Kneese and Bower, 1968, p. 53) Oxidation or stabilization ponds can be as effective as secondary treatment. (Kneese and Bower, 1968, p. 55)

Tertiary treatment involves chemical processes such as chemical oxidation, neutralization of acid or alkaline wastes, or sterilization with chlorine or ozone. This type of treatment, if used, is most often used only in times of crisis because of the cost. (Kneese and Bower, 1968, p. 55) There are also processes now developed which will remove radioactive wastes from water, provided the concentration of the contaminant is within the legal limits of radioactive waste disposal. (Overman, 1969, p. 175)

Techniques of water purification are now so advanced that a city's sewage can be treated and recirculated into the water supply, safe for consumption. This was practiced during a severe drought in Chanute, Kansas in 1956-57. For a period of five months, water from the sewage treatment plant was sent to a stabilization pond, then through the water treatment plant and distributed throughout the city. The only special techniques practiced were recirculation of treated sewage through the sewage treatment plant, increased chlorination, and intensive checking and bacteriological

testing. The water was found to be safe bacteriologically; however, public reaction was unfavorable because the treated water had a pale yellow color, an unpleasant smell and taste, and it tended to foam. (Metzler, 1958, pp. 1021-60)

Economic and Administrative Problems

Even though modern technology is capable of eliminating much of the pollution of our waters, there are many problems which still hinder pollution control. One problem mentioned earlier is in defining pollution and setting standards of water quality so that laws can be made to control it. This was demonstrated in the controversy over the Canada Water Act, introduced by the Minister of Energy, Mines and Resources, J. J. Greene in 1969. Opponents of the act complained that it did not set any standards of water quality. Greene held that there should not be one set of standards for all of Canada, because if the standards were too low, it would be a license to pollute some of the cleaner western streams down to that level. On the other hand, if standards were too high, it would be impossible for certain eastern streams to be made clean enough to comply with the law. This position is supported in a study on the establishment of water quality standards done in the state of Washington. (Sylvester and Rambow, 1968, pp. 110-22) The authors conclude that to solve this problem, one must establish regional standards which are realistically attainable, and

also goals which would represent the ultimate desired quality of water.

Another problem related to the passage of laws to control pollution is the influence of special interest groups. Even in Massachusetts, a leader in pollution control legislation, this has been a problem. In 1886, Massachusetts passed a strict water pollution control law. At that time, the Merrimack River was one of the most polluted rivers in the United States due to the presence of many industries. Nevertheless, in 1887, the industrial interests in the region were successful in influencing passage of a law which exempted the Merrimack from pollution control. (Goldman, 1967, p. 22)

Another major difficulty in effective water pollution control, as previously mentioned, is the complex of administrative levels and agencies responsible for various elements in the society. The problem of water pollution is not simply related to water. It is also related to industrial wastes, city sewage, consumer practices, pesticides, health, recreation. Jurisdictions are not clear cut. And although water is a matter of provincial control in Canada, many streams pass through more than one province. Krueger recognized this in 1963, in writing about water pollution.

> Although the need for a firm attack on this problem has been recognized in the various provinces, substantial difficulties have been encountered in dealing with the matter, especially difficulties resulting from the diffusion of responsibilities among a large number of agencies. (Kristjanson and Sewell, 1963, p. 22)

The federal government came up against this problem in trying to pass the Canada Water Act to control water pollution at a national level. Several of the provincial governments expressed resentment of this policy, saying that matters dealing with water are the responsibility of the provinces. This sort of lack of cooperation is a great obstacle to any meaningful legislation.

Even with the passage of legislation for water pollution control, a lack of financing often postpones action. Any new or improved treatment facilities cost a great deal of money, whether it is municipal sewage treatment or industrial waste treatment. Without money for these projects, little can be accomplished.

This leads to the problem of enforcement of water pollution control legislation. The city of Rochester, New York faced this problem in 1966. A state law was passed which stated that raw drinking water should not have a coliform count of more than 5,000 per 100 milliliters of water. Health officials were then faced with the question of what action to take if the water was not up to standards. Should they ignore the law, or should they close down the city's water supply? (Van Buren and Jolidon, 1966) Or should a polluter, city or industry, be fined for the offense and then be allowed to continue polluting? The answer is unresolved.

Considering the long history of water pollution and

of man's awareness of the problem, relatively little has been done to solve it. Only recently have the techniques been developed to effectively combat it. And even today self-interest and lack of cooperation hinder progress in the matter, so that it is probably a more serious problem now than it has ever been.

CHAPTER III

ADMINISTRATION OF POLLUTION CONTROL

Responsibility for water resources in Canada lies basically with the provinces. However, both the federal and municipal governments are involved in water matters to some extent. The federal government has jurisdiction over boundary waters and navigable waters. In addition, the Canada Water Act gives the federal government certain powers over polluted waters. Municipal governments are responsible for treating their public water supply and treating their wastes before discharging them into a water body. They also have control over land use adjacent to a water body within their jurisdiction, and they may restrict use of the water itself. Following is an examination of the jurisdiction over water quality in the North Saskatchewan River, particularly at Edmonton, Alberta.

Canada Water Act

Bill C-144, called the Canada Water Act, was passed by the House of Commons on June 4, 1970. Its purpose is "to provide for the management of the water resources of Canada including research and the planning and implementation of programs relating to the conservation, development and

utilization of water resources" (Bill C-144). It is particularly concerned with water quality management.

Briefly, the Canada Water Act provides a framework for the establishment of river-basin agencies to plan and implement programs and policies related to water quality and development. The provinces are to take part in the work of these agencies. The act provides for a fine of $5000 per day for municipalities or industries which discharge pollutants into a water body in violation of standards set by one of these agencies.

This legislation could be effective, but the process for establishing river-basin agencies is cumbersome and limiting. It depends largely on the cooperation of the provinces. In the past, the provinces have not been eager to share their authority over provincial waters. One cannot foresee any change in this attitude. J. D. Henderson, as Alberta's Minister of Health, addressed the Alberta Advisory Committee on Pollution Control in 1969, expressing reservations about the Canada Water Act.

> It is the view of the Government of Alberta that the responsibility of the Federal government should include the setting of effective standards and penalties to cover offenses. However, the manner in which these standards are policed must remain primarily within the Provincial jurisdiction. (Alberta Advisory Committee on Pollution Control, 1969, p. 20)

If the provinces do not wish to cooperate in establishing a river-basin agency, the federal government may proceed on its own. However, the Act specifies that this will

be done only in cases of "urgent national concern." With limited funds, and national attention focused on pollution problems in the East, Alberta is unlikely to be affected by the Canada Water Act for many years to come.

Provincial Authority

The provinces, as mentioned above, have authority over waters within their boundaries. This authority includes pollution control. In Alberta, a program of water pollution control was started in 1950. The Public Health Act gave the Division of Environmental Health Services within the Provincial Department of Health responsibility for carrying out water pollution control programs. The Division of Environmental Health Services carried out this function until it was replaced by new legislation in 1971. It drafted and periodically revised surface water quality criteria for the province. These criteria can be found in Appendix A. The division also monitored the water quality of rivers and lakes throughout the province. The results of these monitoring surveys were published in annual reports. In addition, Environmental Health Services received and investigated complaints of pollution, periodically inspected certain municipal and industrial effluent outfalls, and maintained contact with other governmental bodies whose jurisdiction may touch on the problem of water pollution.

With regard to the North Saskatchewan River, Environmental Health Services maintained ten monitoring stations

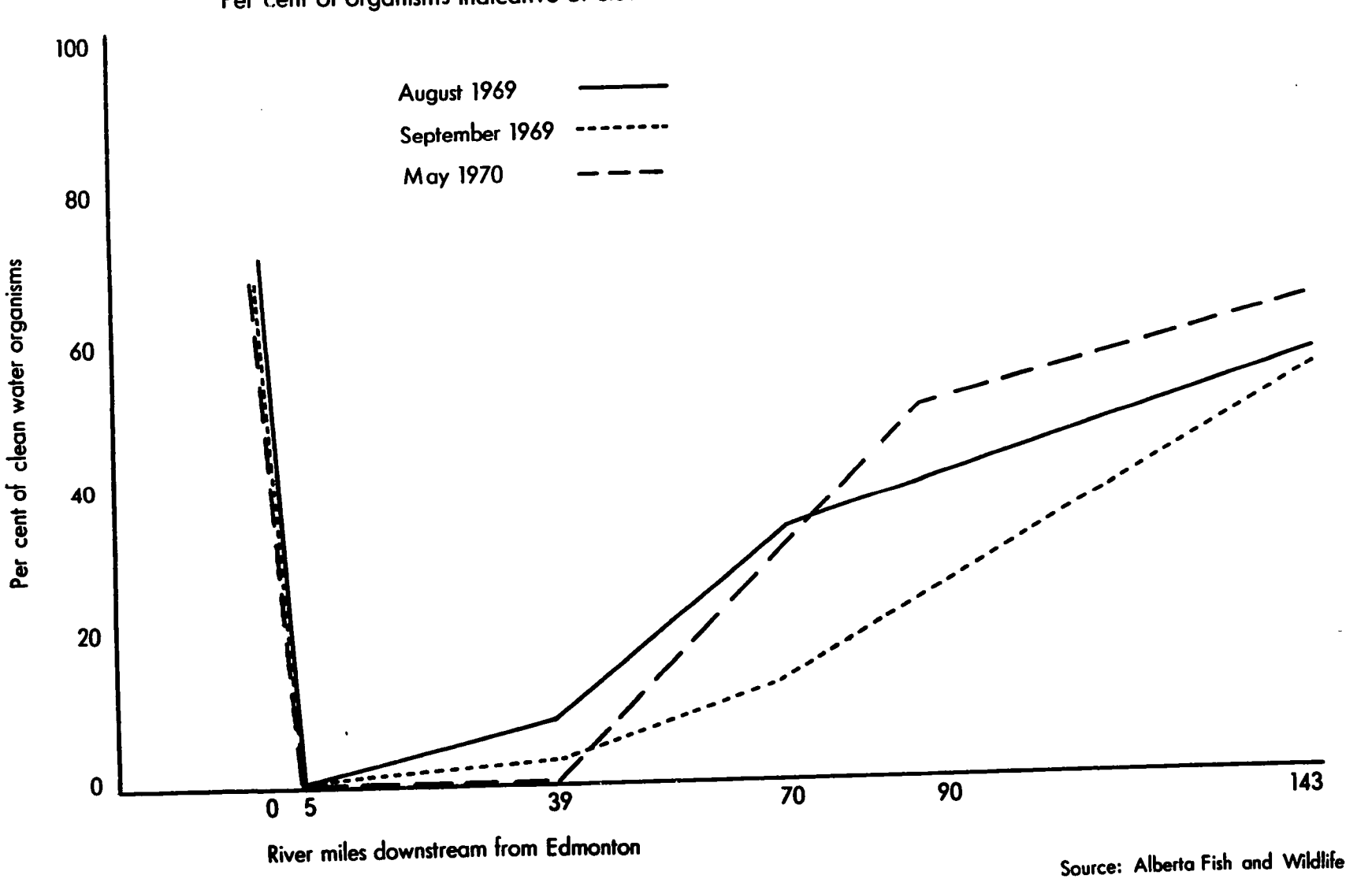
on the river. Three of these were upstream from Edmonton, one was at the 105 Street Bridge in Edmonton, and six were downstream from Edmonton. Upstream sampling was done once a month. Downstream and at Edmonton sampling was done bi-weekly. The only exception to this was at Fort Saskatchewan, the first station downstream from Edmonton, where sampling was done weekly. Features monitored included dissolved oxygen, B.O.D., Ammonia-nitrogen, Nitrate-nitrogen, phenolics, oils and grease, coliforms and other bacteriological constituents, pesticides, and mercury. The results of this monitoring will be discussed in Chapter IV.

If the Division of Environmental Health Services found that a party was polluting the river in violation of the provincial standards there was, unfortunately, very little that could be done. The party would be asked to stop polluting, but there was no strong mechanism of enforcement if the offender failed to comply.

Within the Department of Lands and Forests, the Division of Fish and Wildlife is interested in water pollution inasmuch as it relates to fish and wildlife. In 1970, this division prepared the first annual summary report of biological pollution in four of Alberta's rivers--the Oldman River, the Bow River, the Red Deer River, and the North Saskatchewan River. This survey was done on the basis of the presence of clean water organisms and pollution tolerant organisms. Figure I gives the results of this survey for the North Saskatchewan River.

Figure I

North Saskatchewan River Biological Pollution Survey



Source: Alberta Fish and Wildlife Pollution Survey 1969-1970

Fish and Wildlife officers have occasionally been asked by the Division of Environmental Health Services to assist in the enforcement of water pollution control regulations, since Environmental Health was not able to perform this function.

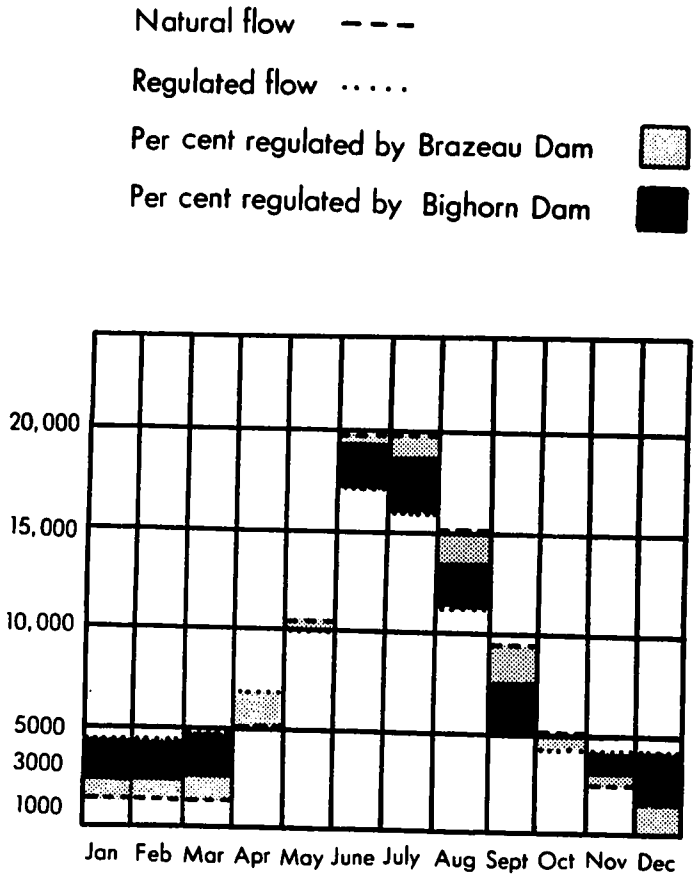
The Alberta Oil and Gas Conservation Board is not directly involved with water pollution control. However, industries which use deep wells for the disposal of wastes rather than using the river, must have the approval of the Board. The wells are required to be at least 2000 feet deep, to end between two impervious layers, and to have a double casing to prevent leakage.

The Government of Alberta has made agreements with Calgary Power Ltd. for joint construction and operation of two dams on the North Saskatchewan River. The Brazeau Dam, completed in the early 1960's and the Big Horn Dam, to be completed in the early 1970's, are to provide both power and pollution dilution. These two dams will prevent the very low flows which are normal for the winter months on the North Saskatchewan River. Figure II illustrates the projected flows compared with the natural flow of the river.

In the spring of 1971, the Government of Alberta presented two bills to the legislature dealing with water pollution. Bill thirty-two, the Department of the Environment Act, proposed the establishment of a Department of the Environment presided over by a Minister of the Environment. This

Figure II

North Saskatchewan River at Edmonton



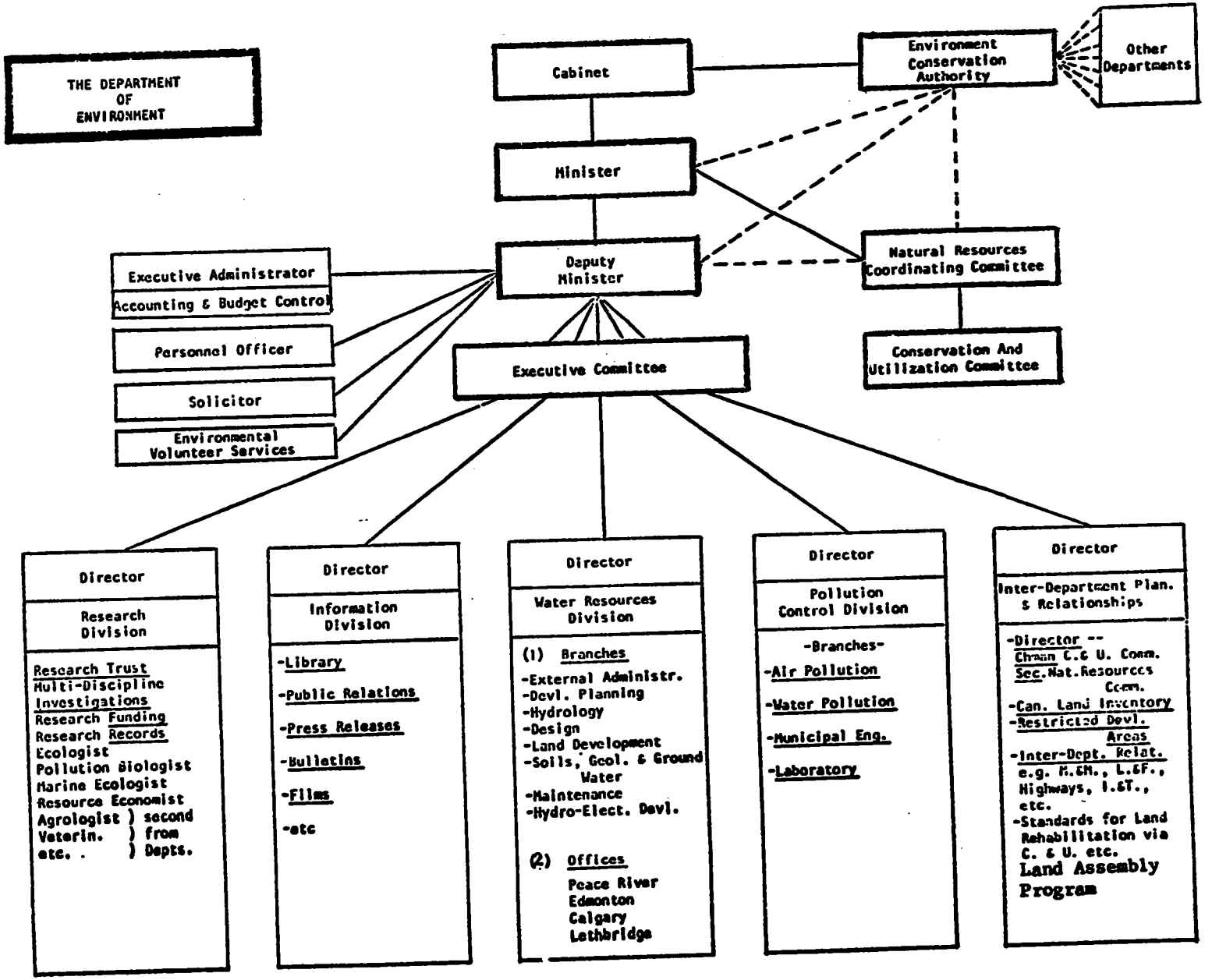
Source: Calgary Power

department would deal with conservation and management of land, air, plant and animal life, as well as water. Bill forty, the Clean Water Act, would enable the Minister of the Environment to prescribe levels of water contaminants or water temperatures that are more stringent than present regulations, to approve plans for structures which may be sources of water pollution, and to issue stop orders to parties guilty of an offense. This act would also provide for a fine or imprisonment, or both for proven offenders. These two bills were passed early in 1971.

The Province of Alberta officially established the Department of the Environment on April 1, 1971 to deal with all matters concerning the environment and resource management. This new department consists of what was formerly the Division of Water Resources in the Department of Agriculture and the Division of Environmental Health Services in the Department of Health. In addition, the Department of the Environment has three new sections devoted to interdepartmental relations, research, and information. The organization of the department is illustrated in Figure III.

In the fall of 1971, the new government of Alberta reorganized the Department of the Environment by splitting the Division of Pollution Control into two separate divisions; the Standards and Approval Division for setting standards and granting approval for industry, and the Pollution Control Division, for enforcement.

Figure III


THE DEPARTMENT OF ENVIRONMENT
Cabinet
Environment Conservation Authority
Other Departments
Minister
Deputy Minister
Natural Resources Coordinating Committee
Executive Administrator
Accounting & Budget Control
Personnel Officer
Solicitor
Environmental Volunteer Services
Executive Committee
Conservation And Utilization Committee
Director
Research Division
Research Trust
Multi-Discipline Investigations
Research Funding
Research Records
Ecologist
Pollution Biologist
Marine Ecologist
Resource Economist
Agrologist) second
Veterin.) from
etc. .) Depts.
Director
Information Division
-Library
-Public Relations
-Press Releases
-Bulletins
-Films
-etc
Director
Water Resources Division
(1) Branches
-External Administr.
-Devl. Planning
-Hydrology
-Design
-Land Development
-Soils, Geol. & Ground Water
-Maintenance
-Hydro-Elect. Devl.
(2) Offices
Peace River
Edmonton
Calgary
Lethbridge
Director
Pollution Control Division
-Branches-
-Air Pollution
-Water Pollution
-Municipal Eng.
-Laboratory
Director
Inter-Department Plan. & Relationships
-Director -- Chmn C.& U. Comm. Sec. Nat. Resources Comm.
-Can. Land Inventory
-Restricted Devl. Areas
-Inter-Dept. Relat. e.g. M.&M., L.&F., Highways, I.&T., etc.
-Standards for Land Rehabilitation via C. & U. etc.
Land Assembly Program

The City of Edmonton

The City of Edmonton maintains and operates facilities for treatment of the public water supply and treatment of sewage and other wastes. These facilities will be discussed in detail in Chapter IV. In addition, the city carries out periodic sampling of industrial sewer outlets to assure that the wastes do not exceed the formula set out in the city by-law number 2458 (see Appendix B), regulating the use of public and private sewers. Samples are analysed and a surcharge for the waste is determined.

Alberta Advisory Committee

In 1967 the Alberta Advisory Committee on Pollution Control was established for the purpose of involving people from many sectors of the community in pollution control. The members include representatives from provincial departments, federal departments, the news media, the cities of Edmonton, Calgary and Lethbridge, the universities of Alberta and Calgary, and several professional organizations. The committee meets once a year, with various subcommittees meeting during the year to discuss specific pollution problems and programs, and to make recommendations to be presented to the committee. Recommendations approved by the committee are to be taken directly to the Provincial Cabinet. With regard to the North Saskatchewan River, the committee has heard reports and engaged in discussions, but has not as yet made

any specific recommendations to the Cabinet. However, the Alberta Advisory Committee on Pollution Control has the potential for being very effective in the future.

CHAPTER IV

THE STUDY AREA

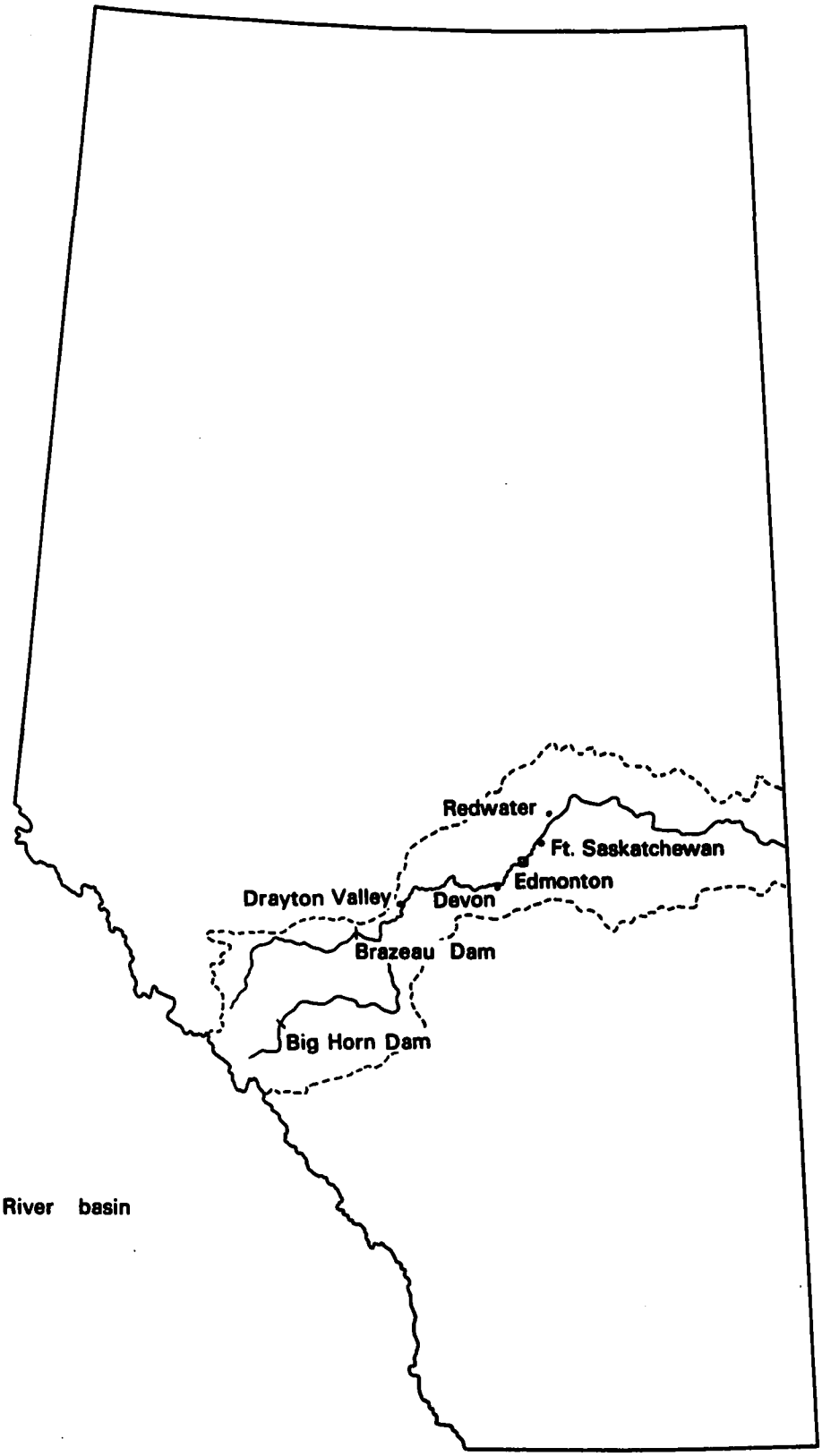
The North Saskatchewan River

The North Saskatchewan River flows from the Rocky Mountains in Alberta eastward across the Prairies. It joins the South Saskatchewan River in the province of Saskatchewan and flows on to Lake Winnipeg. From there the waters join the Nelson River and drain into Hudson Bay. Within the province of Alberta, the North Saskatchewan River and its tributaries drain approximately 36,050 square miles, or 14.1 per cent of the province. (Paterson, 1966, p. 2) (See Figure IV)

There is a great seasonal fluctuation in flow in the North Saskatchewan River. Over a thirty-three year period, the average monthly flow for February was 1120 c.f.s. For July the average was 20,510 c.f.s. (Wonders, 1959, p. 9) Since the construction of the Brazeau Dam in the early 1960's (see Figure IV) the effects of this seasonal variation on settlements downstream of the dam have been reduced. As was illustrated graphically in Figure II, the completion of the Big Horn Dam (see Figure IV) should insure a minimum flow of no less than 3000 c.f.s.

The river carries a great load of silt, particularly

Figure IV



North Saskatchewan River basin

in the summer when there is no snow cover to impede runoff. It has been estimated that it carries a load of approximately 13,125,000 pounds of silt per day during the high-flow period. (Wonders, 1959, p.9) The depth and width of the North Saskatchewan River vary widely with the variation in flow. Because of these variations and the speed of the current, aquatic vegetation has been unable to establish itself in the river. (Paterson, 1966, p. 13)

The North Saskatchewan River does contain at least twenty-one different species of fish, even within the limits of the City of Edmonton. (Paterson, 1966, p. 104) There are also numerous varieties of bottom organisms. The distribution of the fish and the smaller organisms within the city varies according to the location of effluent outfalls. There are more outfalls on the south bank of the river, and consequently there is a greater concentration and variety of fish on the north side of the river. (Paterson, 1966, p. 106) In winter, the fish seem to prefer the warm effluents from the city power plant and some industrial outfalls. (Paterson, 1966, p. 108) However, certain effluents, even in low concentrations, are toxic to river organisms. (Paterson, 1966, p. 103)

To determine the quality of the water in any river, B.O.D. is often used as a criterion. Table I simplifies the task by assigning subjective descriptions of pollution to values of B.O.D. Using this as a basis, one can examine

TABLE I

B.O.D.
(Parts per million dissolved oxygen absorbed in five days)

Very clean	1 p.p.m.*
Clean	2
Fairly clean	3
Doubtful	5
Bad	10

*Parts per million is the same as milligrams per liter (mg/l)

Source: Hynes, 1966.

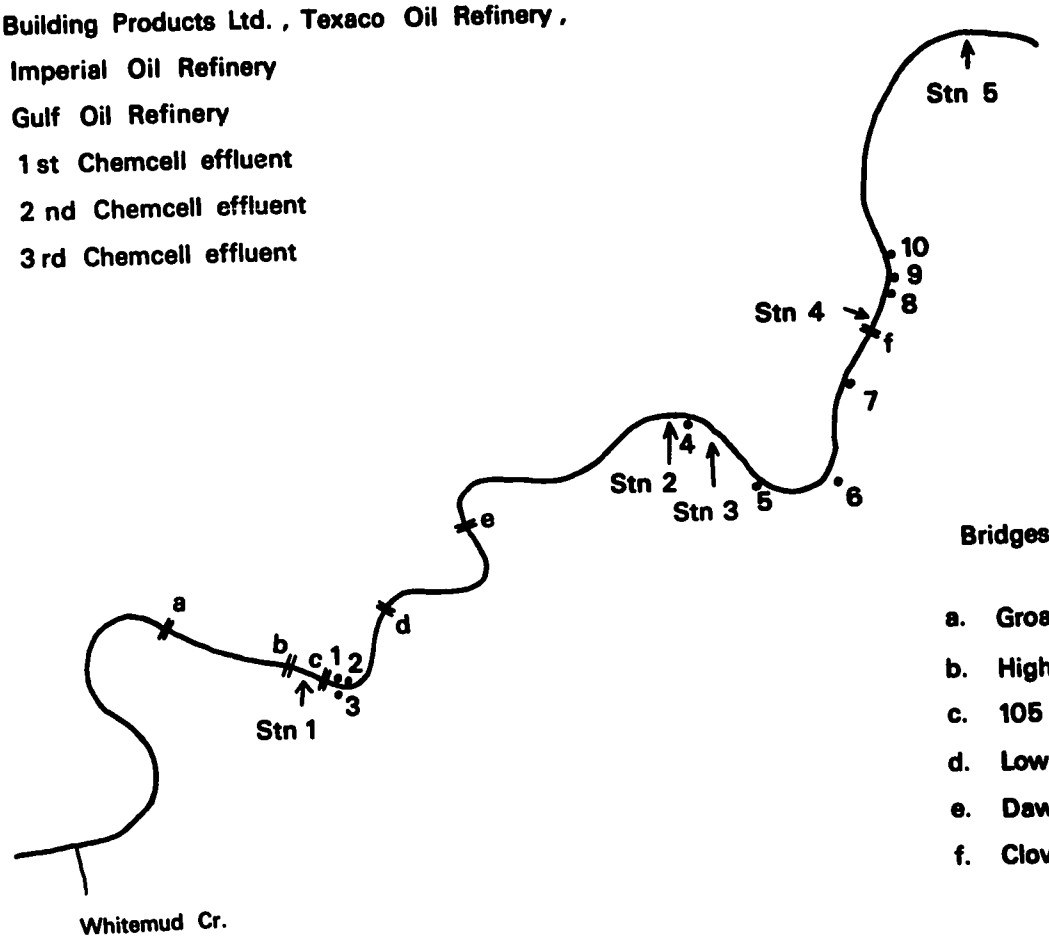
figures for B.O.D. in the North Saskatchewan River. Paterson took readings at five stations in Edmonton during the period 1964-65 (see Figure V). Table II gives the figures that he found for the highest B.O.D. reading at each station during that period. At station I, just upstream from the 105th Street bridge, the highest B.O.D. value recorded was 3.20 p.p.m. This is within the "fairly clean" category of Table I. At station II, 7.88 p.p.m. was the highest B.O.D. value. This is well into the "doubtful" category. At station III, the 9.92 p.p.m. B.O.D. value recorded is only slightly better than "bad". Station IV showed a decline to 4.27 p.p.m. as the highest. This represents a recovery to the "fairly clean"

North Saskatchewan River Effluent Outfalls

Figure V

Effluents

1. City power plant
2. Water treatment plant
3. 105 st. sewage treatment plant
4. Main sewage treatment plant
5. Building Products Ltd., Texaco Oil Refinery,
6. Imperial Oil Refinery
7. Gulf Oil Refinery
8. 1 st Chemcell effluent
9. 2 nd Chemcell effluent
10. 3 rd Chemcell effluent



Bridges

a. Groat
b. High Level
c. 105 St.
d. Low Level
e. Dawson
f. Clover Bar

from Paterson

TABLE II

B.O.D. IN THE NORTH SASKATCHEWAN RIVER

Station	Highest B.O.D. Sampled
Station I	3.20 p.p.m.
Station II	7.88 p.p.m.
Station III	9.92 p.p.m.
Station IV	4.27 p.p.m.
Station V	17.00 p.p.m.

Source: Paterson, 1966

category. But station V showed a highest reading of 17.00 p.p.m. This is well above the 10.00 p.p.m. which Hynes uses to define a badly polluted water body. This high figure was recorded only on one occasion; however it indicates what can happen. "Average values mean little in attempting to interpret the effect of pollutants on living matter . . . The extreme conditions are the important conditions" (Alberta Fish and Wildlife Division, Pollution Report No. 1, 1970, p. 4).

The situation is more complicated when one considers dissolved oxygen. The Province of Alberta Surface Water Quality Criteria, included in Appendix A, define the permissible amount of B.O.D. in terms of dissolved oxygen. "Dependent on the assimilative capacity of the receiving water

the B.O.D. must not exceed a limit which would create a dissolved oxygen content of less than five mg./l." (Div. of Environmental Health, Surface Water Quality Criteria, 1970, p. 5). This is not easily determined, since under an ice cover a B.O.D. of five mg./l. would consume a dissolved oxygen of five mg./l. However, if the water is not covered by ice some reoxygenation occurs at the surface.

Considering this, one must compare B.O.D. values with dissolved oxygen values, taking into account the time of the year. Referring again to Paterson's study, Table III gives the D.O., dissolved oxygen, figures taken at the same time as the highest B.O.D. reading. Included is the month in which these readings were taken. The reading of 17 p.p.m.

TABLE III

DISSOLVED OXYGEN IN THE NORTH SASKATCHEWAN RIVER

Station	Month	D.O. p.p.m.	B.O.D. p.p.m.
I	July	11.5	3.20
II	April	11.7	7.88
III	July	10.2	9.92
IV	May	9.7	4.27
V	November	7.9	17.00

Source: Paterson, 1966

at station V was taken when the D.O. was 7.9 p.p.m. This was in the month of November, when there was probably at least a partial ice cover on the river. Under these conditions, surface reoxygenation was probably not adequate to prevent

the dissolved oxygen level from falling below five p.p.m. The reading at station III of 9.92 p.p.m. B.O.D. was taken in July with a dissolved oxygen of 10.2 p.p.m. In this instance, it is difficult to say how much of the required oxygen was received from the surface at that locality.

The Department of the Environment's pollution survey of the North Saskatchewan River includes only one sampling station within the city of Edmonton. From that it is impossible to determine the quality of water in the river as it passes through various parts of the city. One can only examine the figures for the stations at the 105 Street bridge and at Fort Saskatchewan, twenty-two river miles downstream. All of the factors sampled in 1969-70 indicated a marked change between these two stations, with the exception of phenolics, which showed an increase thirty miles upstream from Edmonton. (Div. of Environmental Health Services, Summary Report, 1970) Showing the greatest increase in this distance were bacteriological constituents and B.O.D.

The 1970-71 pollution survey recorded that "lower dissolved oxygen and generally higher concentrations of B.O.D., alkalinity, total residue, chlorides, nutrients and phenolics were noted as compared to data obtained in the previous year" (Dept. of the Environment, Pollution Survey Summary, 1971, p. 20). It also reported excessive levels of ammonia nitrogen, total phosphorous, bacteriological constituents, chromium and mercury.

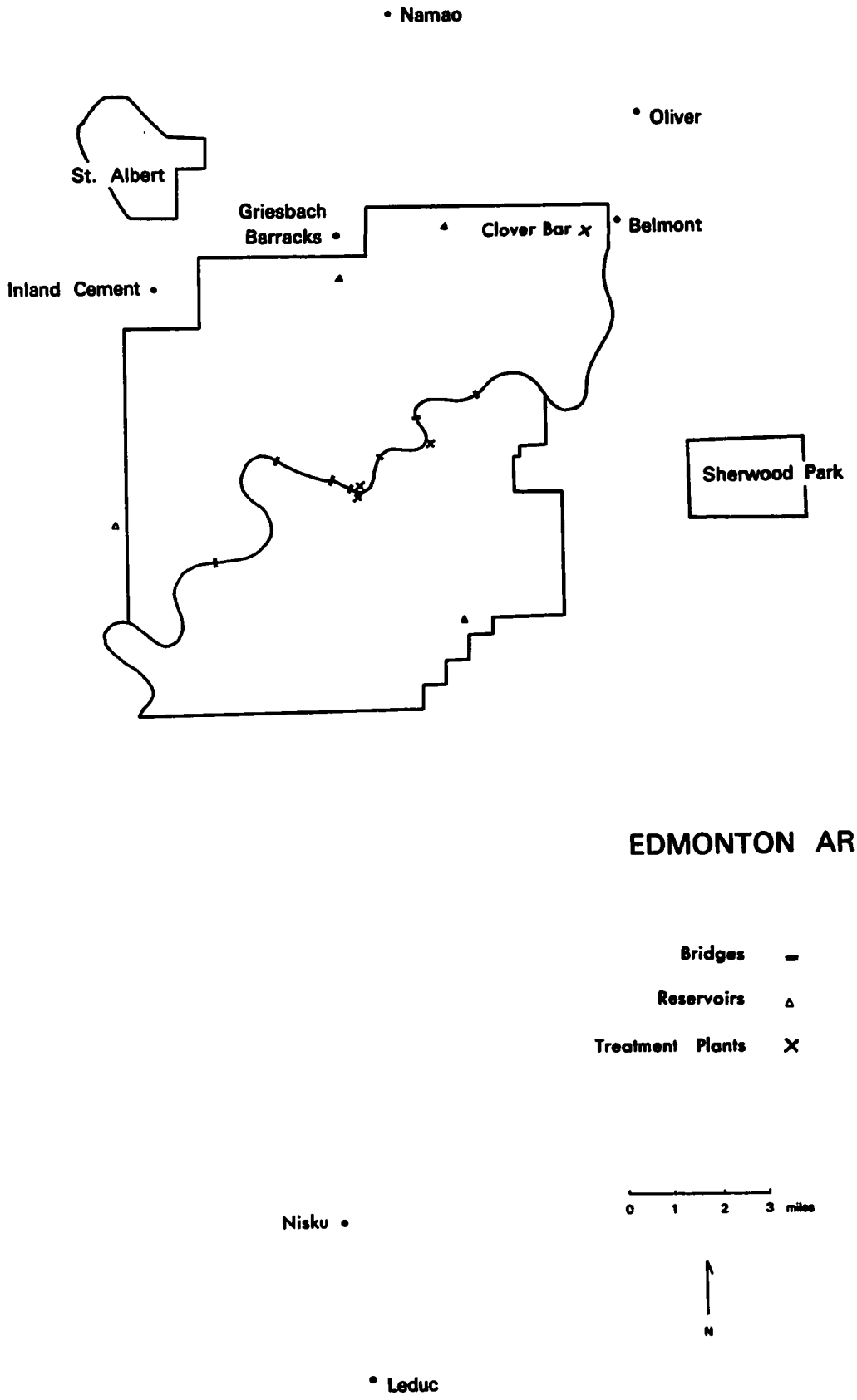
The Edmonton Anti-Pollution Group carried out a study on water pollution in the North Saskatchewan River. The resulting report was very critical of the condition of the river and expressed dissatisfaction with the current water pollution programs. It stated specifically that there has been a steady deterioration in water quality in the North Saskatchewan, "notably in the content of nitrogen, phosphates, phenols, coliform bacteria, and fecal bacteria. All of these consistently exceed the standards set in the Surface Water Quality Criteria" (Edmonton Anti-Pollution Group, 1971). The report also pointed out that all of the major effluent outfalls are on the south bank, while all monitoring of water quality by the province is done in the center or toward the north shore. The researchers maintain that the assumption that complete mixing takes place is incorrect, and therefore the monitoring is missing a "pollution stream" along the south bank.

The City of Edmonton

Edmonton, Alberta is located in the central part of the province, (see FigureIV) astride the North Saskatchewan River. The river valley, about 160 to 200 feet deep and one-half to one mile wide, winds through the city from southwest to northeast (see Figure VI)(Wonders, 1957, p. 17)

The population of the City of Edmonton according to the 1970 census was 435,503. This shows an increase of 3.1 per cent over 1969, a fairly rapid rate of increase.

Figure VI


• Namao
• Oliver
St. Albert
Griesbach Barracks •
Clover Bar
• Belmont
Inland Cement •
Sherwood Park
EDMONTON AREA
Bridges
Reservoirs
Treatment Plants
0 1 2 3 miles
N
Nisku •
• Leduc
DJW

The population for the metropolitan area, which includes St. Albert and Sherwood Park, was 449,000. (*Edmonton Journal*, February 2, 1971)

Edmonton's industry is dominated by petrochemical and refinery operations and by meat processing and packaging. (Edmonton General Plan, 1967, p. 63) Figure VII illustrates the relative economic importance of the various industries in the Edmonton metropolitan area.

The North Saskatchewan River freezes over from approximately November through April. However, the power plant at 105 Street (see Figure VI) discharges warm water into the river, which breaks up the ice for about eleven and one-half miles downstream. (Paterson, 1966, p. 7)

Edmonton Waterworks

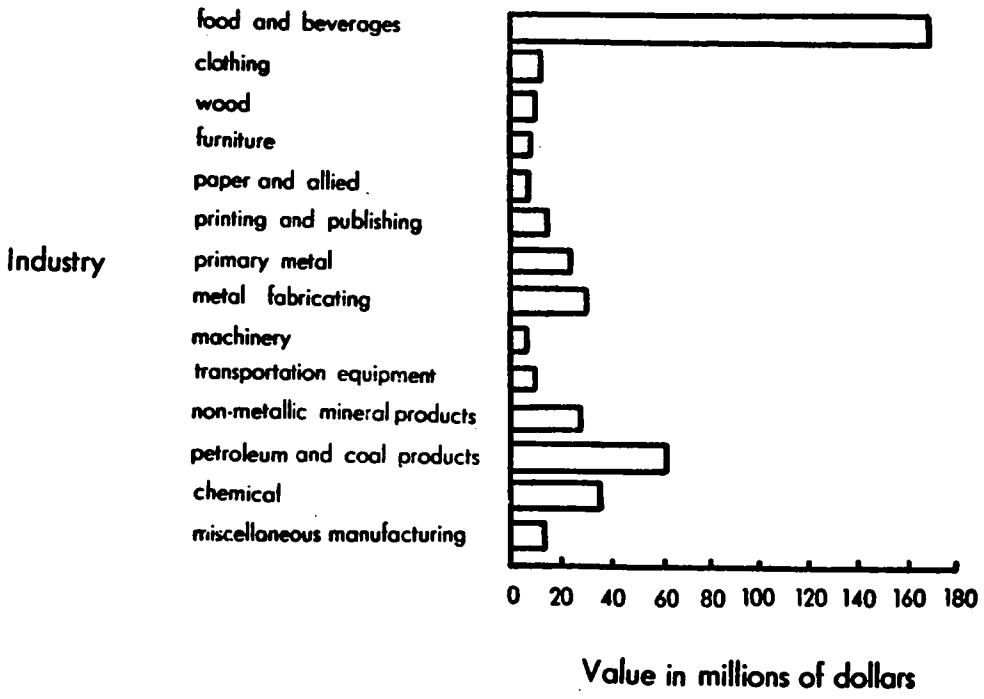
When the Town of Edmonton was incorporated in 1892, the citizens were getting their water supply either from private wells or from the North Saskatchewan River. The river water was distributed by horsedrawn water wagons. (Dale, 1969, p. 66) These methods could not keep up with the growing population, so in 1902 the Town of Edmonton approved by-law number 220 for the construction of a water-works system. (Dale, 1969, p. 67) Completed in 1903, the system had six miles of water mains and five miles of sewer mains. (Dale, 1969, p. 67)

Strathcona, on the south side of the North Saskatchewan River had been depending solely on private wells for

Figure VII

Gross Value of Manufacturing Production

Metropolitan Edmonton 1961



Source: Edmonton General Plan 1967.

its water supply. In 1906, construction was completed on a waterworks system for Strathcona, which consisted of about four miles of water mains. (Christophers, 1970, p. 2) Neither Edmonton nor Strathcona chlorinated its water at that time, and there was only inadequate filtration. (Christophers, 1970, p. 4) Edmonton and Strathcona amalgamated on February 1, 1912, and the waterworks systems were combined. At that time there was a total of nearly ninety-seven miles of water mains in the combined system. (Christophers, 1970, p. 4).

The Edmonton waterworks system served just the City of Edmonton until 1926. At that time, the system began to supply water to the Provincial Mental Institute at Oliver. (Christophers, 1970, p. 5) During the 1950's agreements were made for the Edmonton system to supply water to Leduc, Jasper Place, Beverly, St. Albert and Nisku (see Figure VI). (Christophers, 1970, p. 6) Since then, Jasper Place and Beverly have become part of the City of Edmonton. Presently Edmonton Water services, in addition to the above, parts of Strathcona County, Sherwood Park, Namao, Griesbach Barracks, Inland Cement, Belmont Rehabilitation Institute, Canada Creosoting, Fort Saskatchewan, and Redwater (see Figure VI). Water users outside the city are charged the city rate plus a thirty-five per cent surcharge. These parties have agreements with the city to receive water of the same quality that is supplied within the city. This water is treated and

fluoridated. If non-fluoridated water is desired, the communities or industries must filter out the fluorides themselves. (Edmonton District Planning Commission, 1960, p. 15) There is a public tap at the city water service plant where residents can draw water with most of the fluorides filtered out. About 3,000 gallons per month are drawn from this tap. This amount has remained fairly constant since fluoridation of city water began at noon on August 30, 1967. (*Edmonton Journal*, October 22, 1970)

Edmonton Water Treatment

Edmonton has three water treatment plants, all located just east of the 105 Street bridge on the north bank of the river (see Figure VI). Plant number one, built in 1947, has a capacity of 22.5 million Imperial gallons per day. Plant number two, built in 1956, has a capacity of 37.5 million Imperial gallons per day, and plant number three, built in 1965, has a capacity of 20 million gallons per day. This third plant is used only in the summer for peaking.

Summer peaking is necessary, as the demand for water is much greater in the summer. For example, in 1969 the day of greatest water consumption was June 17, when 74.6 million gallons were pumped. This equals a demand of 165.9 gallons/capita/day compared with the average for that year of 90.8 gallons/capita/day. (Edmonton Water, Annual Report 1969, p. 16)

Water is pumped raw from the river and mixed with heated raw water from the power plant adjacent to the water treatment plant. Beginning the treatment with this warmed water allows for less costly treatment, since the chemical processes take place faster in water of this temperature.

In the treatment process, lime is used for softening in the summer. A lime-soda process is used for softening in the winter. Aluminum sulphate is added for coagulation and clarification. Activated carbon and chlorine dioxide are used to remove objectionable tastes and odors. Ammonia and chlorine sterilize the water. Fluoride is added in the form of hydrofluosilicic acid. These chemicals are added at various points in the treatment process (see Figure VIII). After flocculation, clarification, and carbonation, the water passes through a rapid sand filter and is then sent either to storage or through the distribution system. Table IV gives an average water analysis for raw water entering the plant and for treated water.

The City of Edmonton has four reservoirs to store treated water. These are at Rosslyn, Londonderry, Thorncliff, and in the southeast (see Figure VI). They have a combined total of 55 million gallons of storage

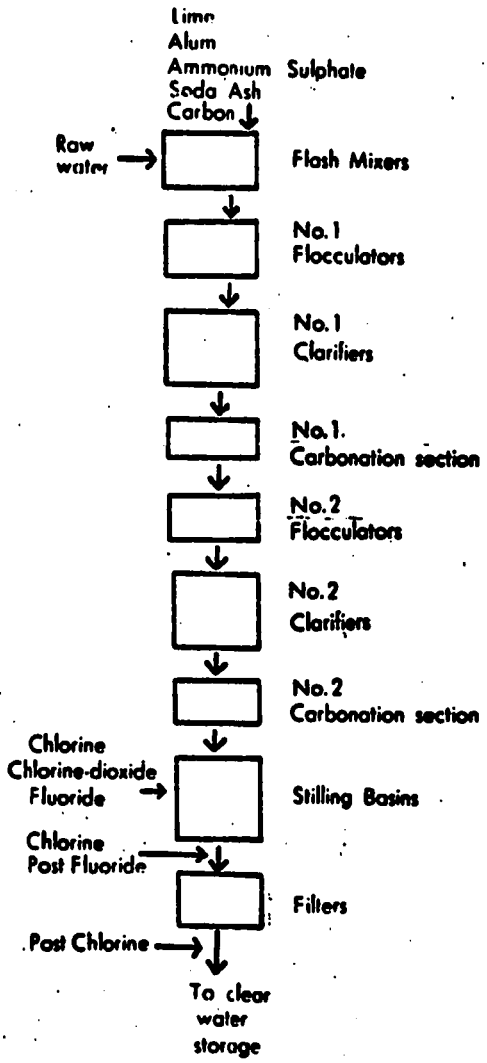
Edmonton Sewage Treatment

The sewage treatment system for the City of Edmonton includes the main plant east of the Capilano bridge, (see Figure VI) a smaller plant at Queen Elizabeth Park, and a

Figure VIII

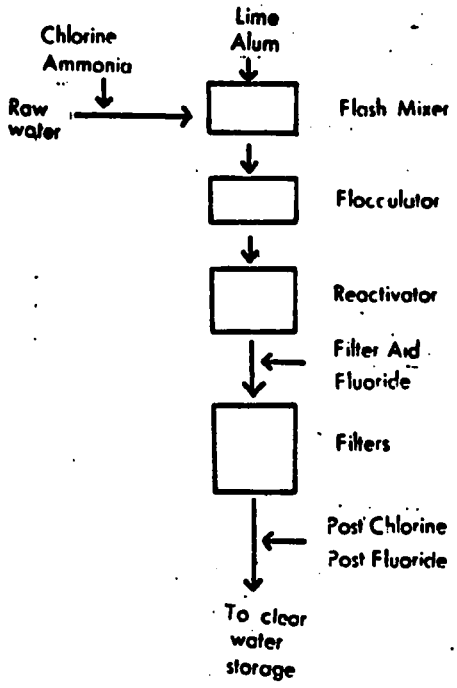
Water Treatment Plants

No. 1 and No. 2



Water Treatment

Plant No. 3



Source: City of Edmonton
Generation and Water Treatment, 1968

TABLE IV

AVERAGE WATER ANALYSIS

Mineral	October - April		May - September	
	Raw Water	Treated Water	Raw Water	Treated Water
Calcium Carbonate	142 ppm	36 ppm	98 ppm	38 ppm
Calcium Sulphate	26 ppm	12 ppm	-	20 ppm
Magnesium Sulphate	86 ppm	33 ppm	50 ppm	23 ppm
Magnesium Carbonate	-	2 ppm	-	-
Sodium Sulphate	-	47 ppm	-	17 ppm
Sodium Chloride	5 ppm	5 ppm	5 ppm	5 ppm
Aluminum & Iron Oxides	trace	trace	trace	trace
Silica	5 ppm	5 ppm	3 ppm	3 ppm
Fluoride	0.2 ppm	1.0 ppm	0.2 ppm	1.0 ppm
Organic Matter	8 ppm	7 ppm	14 ppm	4 ppm
Total Solids	270 ppm	146 ppm	170 ppm	111 ppm
Total Hardness	254 ppm	83 ppm	148 ppm	81 ppm
pH Value	7.9	8.7	8.1	8.7

Source: City of Edmonton
Edmonton Generation and Water Treatment, 1968

series of lagoons at Clover Bar.

The main plant provides primary treatment alone for approximately four and one-half months of summer, and both primary and secondary treatment for the rest of the year. The higher river flows in the summer months provide more water for dilution. Therefore, secondary treatment is not deemed necessary for that season. This plant has a capacity of 50 million gallons per day for primary treatment and 25 million gallons of that flow for secondary treatment. Sewage entering the plant goes through grit removal tanks and then Barminutor units which cut up rags, paper, and large articles of waste. From there it goes to preliminary settling tanks with a detention time of one and one-half hours. The sludge and skimmings from this primary treatment are sent to digestors. Methane gas produced from the digestive process is used for heating the plant.

The secondary treatment used is the activated sludge process in aeration tanks. From there, the waste water goes to the final settling tanks for a detention period of approximately 2.4 hours. The final effluent is sent into the river. Table V gives some data on the flow characteristics for the main sewage treatment plant.

The smaller plant at Queen Elizabeth Park provides primary treatment only for approximately four million gallons per day. The treatment consists of primary settling tanks. The sludge is digested, as in the main plant.

TABLE V

SUMMARY OF FLOW CHARACTERISTICS
MAIN SEWAGE TREATMENT PLAN

	Influent	Effluent	Percentage Removed
Lbs. suspended solids-*total 1969	46,075,000	16,999,496	63.1
Lbs. B.O.D. *total 1969	30,133,841	15,312,291	49.2

*total includes primary treatment for summer months and both primary and secondary for winter

Source: City of Edmonton
Sewage Treatment Plants
1969 Annual Report

The Clover Bar Industrial Lagoons handle approximately four million gallons per day. Of this, about three million gallons come from three major packing houses. The rest comes from the residential areas of Beverly and Sherwood Park. The wastes flow through three anaerobic lagoons and then, during the summer months, into the river. When the river is frozen over, the effluent is stored in two large storage lagoons until breakup. Effluent which has been stored in this way has only slightly more B.O.D. and suspended solids than effluent which has had secondary treatment.

CHAPTER V

METHODOLOGY

The first perception study was undertaken in an effort to determine the extent of public awareness about the quality of water in the North Saskatchewan River at Edmonton. Relating to this, it was also intended to discover whether or not proximity to the river was related to one's perception of the quality of river water.

The pollution surveys discussed in Chapters III and IV indicate that the North Saskatchewan River is polluted to some extent, and that the City of Edmonton and nearby industries are major contributors to this pollution. It is difficult to make a definitive statement about the degree of pollution present in the North Saskatchewan River at Edmonton, since the condition of the river water varies from season to season and from place to place, even within the Edmonton area. It is affected by rainfall, ice cover, dumping of snow and sand, accidental spillage, and many other factors.

The results of this perception study should at least indicate the general level of awareness of river pollution of the Edmonton public. The original hypothesis for the study was that, in spite of the publicity that is currently

being given to water pollution in many cities in North America, the people of Edmonton are not aware of any water pollution in the North Saskatchewan River. This hypothesis was based on the fact that public attention had been focused on the extreme water pollution problems in the East. By comparison, the North Saskatchewan River, flowing from the Rocky Mountains to Edmonton without passing through any other major concentrations of population, might seem relatively pure.

Between the time the original hypothesis was drawn up and the time of the interviews, the amount of coverage given to pollution problems by all levels of the news media greatly increased. During January and February 1970 several special programs devoted to water pollution were televized in Edmonton. *Newsweek*, *Time*, *Fortune* and *Look* magazines all published special issues on environmental pollution during the same period. In addition to this, in Edmonton in February 1970, an organization called STOP, standing for Save Tomorrow - Oppose Pollution, was formed. The STOP organizers began a highly publicized campaign to get Edmonton residents to sign post cards to the Prime Minister of Canada, the Premier of Alberta, members of Parliament, and members of the Legislative Assembly demanding legislation to control pollution. This kind of public attention focussed on pollution is bound to have influenced responses to the perception questionnaire on water pollution, which was administered

between February 18 and March 9, 1970.

Procedure

The questionnaire was given to a group of Edmonton residents, selected in a manner to be discussed subsequently. The interviewers asked the questions and wrote down the answers, rather than giving the questionnaire to the individual to fill out. It was felt than an oral interview would stimulate more interest than a written questionnaire. The interviewing was done by approximately 400 students of Geography 201 at the University of Alberta. It is recognized that there may be problems involved in having a large number of people asking the questions. The students were briefed beforehand as to how they were to conduct the interview. However, admittedly there may have been differences in the way in which certain questions were asked which might have influenced the responses. Ideally, interviewing should be done by one person to insure that the questioning is uniform. It is hoped that this problem can be compensated for by having a larger number of responses than could easily be handled by one interviewer.

The questionnaire, consisting of five questions, was designed in an effort to determine whether Edmonton residents think that the North Saskatchewan River is polluted, to what degree, and what criteria they use to judge pollution. It was also hoped to determine if residential location or proximity to the river would relate in any way to

whether or not the respondent considered the river to be polluted.

The original questionnaire was given to a group of twenty as a pilot study. This group was an extension class in Urban Studies at the University of Alberta, including housewives and people with a variety of occupations. The pilot study revealed certain ambiguities in the phrasing which had to be reworked. A couple of questions were reworded for clarity. One question was changed completely because the responses showed that it did not convey the intended meaning. After the revisions, the questionnaire consisted of the following questions.

1. Is the North Saskatchewan River polluted upstream before it gets to Edmonton? a) no b) a little c) a lot

2. Is it polluted when it leaves the city?
   a) no b) a little c) a lot

3. If it is polluted, who should be required to pay to clean it up and maintain it?
   a) taxpayer b) industry c) both d) other

4. Do you ever get close to the river?
   a) no, not at all b) only driving over bridges
   c) get within 10 to 20 feet of the water

5. What would you use as a standard for judging whether or not water is polluted?
   (If more than one factor, underline which is most important)

Also to be noted by the interviewer were the date, sex and approximate age of the interviewer (less than thirty, thirty to fifty, over fifty) and location within the city.

The purpose of the first two questions was to

determine specifically whether the residents of Edmonton think that the North Saskatchewan River is polluted, and if so, to what general degree. Two questions were asked, one for upstream and one for downstream, because it was felt this would define more clearly whether the residents think that the City of Edmonton and the nearby industries pollute the river if it is polluted. The third question, asking who should pay to clean up pollution if it exists, was asked to determine the degree of responsibility felt by the residents for water pollution. Do they feel that they contribute to water pollution and should share the responsibility? Or do they feel that pollution generally is the fault of industry or some other group, and that the residents should not have to even share the cost?

The fourth question, asking how close the residents get to the river, was meant to determine whether someone who gets very close to the river would tend to think that it is more polluted, less polluted, or whether there is no relation between these two factors. One's residential location may also influence whether or not one thinks the river is polluted. For example, someone living half a mile from the river may tend to think it is more polluted than someone living five miles away. However, the person who lives half a mile from the river may never actually be within sight of the river. And the person living five miles from the river may go on frequent canoe trips which bring

him in direct contact with the river. For this reason, question four would define more specifically whether the residents ever see the river.

Question five was asked in an effort to determine what criteria the general Edmonton resident uses in deciding whether or not the river is polluted. It might be through personal observation. It might be through information transmitted to them in some way. Or they may in fact not really know how they judge pollution. The question was intentionally open-ended, in the hope that the person interviewed would answer with his own original response, rather than responding to suggested answers. Unfortunately, this presented some difficulties which will be discussed later.

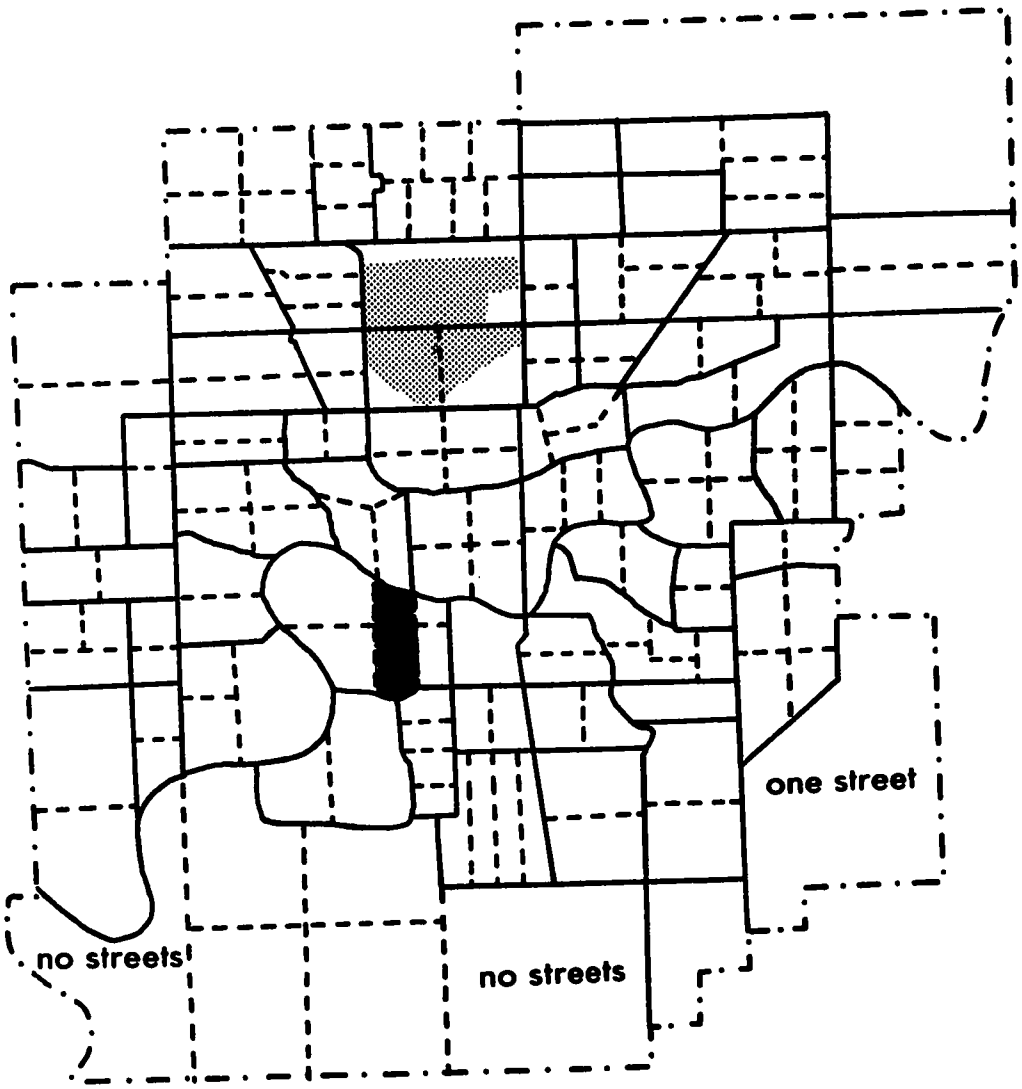
Sampling

The selection of Edmonton residents to be interviewed was done on the basis of stratified random sampling using blocks within census tracts. This method was chosen, rather than pure random sampling, in order to get responses from all parts of the city and at various distances from the river.

The method followed was to divide the census tracts for the City of Edmonton in 1966 into blocks of approximately 2,500 population (see Figure IX). The divisions were based on population distribution within the census tracts. Therefore, the blocks are irregular in size.

Figure IX

Edmonton Census Tracts and Blocks



Industrial Airport

University of Alberta

city boundary

census tract

population block

Several areas were left blank, where there were few or no residents. These are the University of Alberta campus, two areas in census tract forty-five which have no streets, and census tract forty-six which has one street and only 360 residents. The industrial airport spreads into more than one census tract, and those tracts also include residential areas. Therefore, the industrial airport does not show up as a blank area.

In this way, the sixty-three census tracts of Edmonton were divided into 160 blocks. The interviewers were assigned population blocks, so that each would be covered. Within each of the population blocks, intersections were selected randomly. The interviewers were instructed to proceed north from the intersection, and to approach the first residence on the east side of the street. If the resident was not at home, refused to answer the questionnaire, or did not speak English, the interviewers were to go on to the next residence. Following this procedure, 385 Edmonton residents were interviewed.

CHAPTER VI

RESULTS OF THE FIRST QUESTIONNAIRE

The 385 Edmonton residents who answered the first questionnaire represent slightly less than .1 per cent of the total population of the city. Because of their number and their selection by stratified random sampling, their answers should be fairly representative of the population as a whole.

The results of questions one through four are summarized in Table VI. Question five will be discussed separately.

Questions One and Two

Looking in detail at the answers to questions one and two, it was hoped to determine whether residential location would influence one's perception of pollution. This is taking into account only the distance of one's residence from the river. To see this relationship most clearly, the answers to questions one and two were each plotted on separate maps to show the residential location of each individual in relation to the river (see Figures X and XI). Upon examination of these maps, one can see that there is no clear relationship between a respondent's residential

TABLE VI

SUMMARY OF RESULTS OF FIRST QUESTIONNAIRE
QUESTIONS 1 - 4

Question	Percentage A	B	C	D	No Answer
1	16	60	22		2
2	4	26	69		1
3	4	43	43	9 (govt.,city)	1
4	5	52	43		0

location and whether or not he thought the North Saskatchewan River was polluted. Some people living adjacent to the river said that it was very polluted, and some said that it was not polluted at all. Some people living in the northern-most part of the city said that the river was very polluted, and some said that it was not polluted at all. This is true of the answers for both question one and question two. The responses for each possible answer seem to be scattered randomly throughout the city.

Knowing that most of the effluent outfalls in Edmonton are located in the eastern half of the city and on the south bank, one might expect people from those areas to think that the river is very polluted. This does not appear to be so. Some of the people in these areas think that the North Saskatchewan River is not polluted at all. There are no clear patterns of relationship between residential proximity to the river and whether or not one thinks it is polluted.

Figure X

Question One

Is the North Saskatchewan River polluted upstream

A

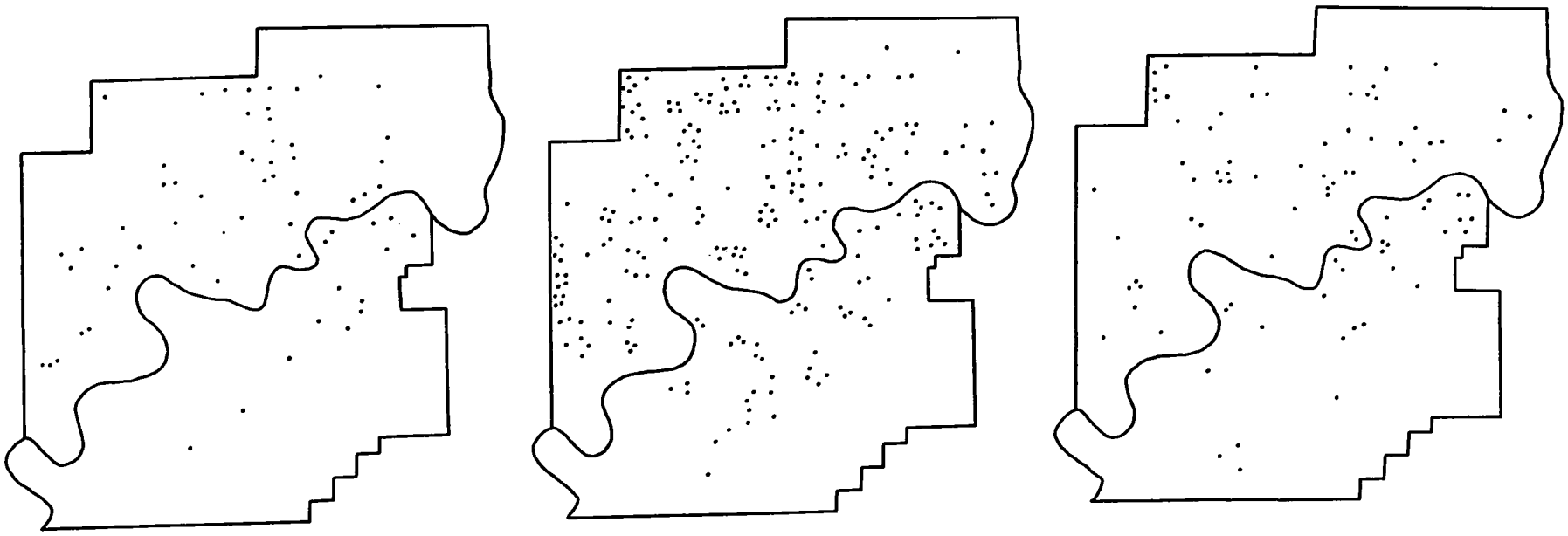
no

B

a little

C

a lot



DJW

Figure XI

Question Two

Is the North Saskatchewan River polluted downstream

A

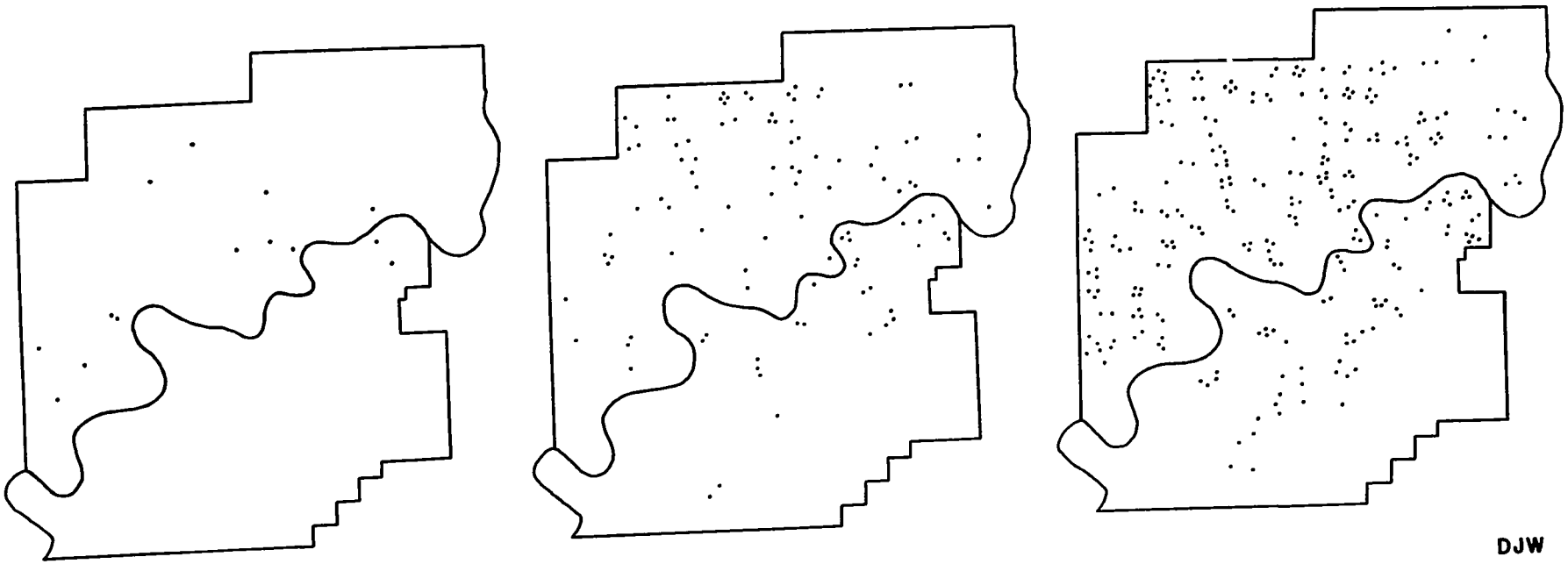
no

B

a little

C

a lot



DJW

The relationship between the answers for questions one and two merits special attention. The expected responses would be that the river is more polluted downstream than upstream, since the City of Edmonton and various industries contribute effluents to the river. Or one might say that it is the same downstream as upstream, particularly if one says that it is polluted upstream. However, this pattern is not always followed. Table VII illustrates the relationship between the answers to questions one and two. The general trend followed the expected pattern, but with notable exceptions.

TABLE VII

RELATIONSHIP BETWEEN QUESTIONS ONE AND TWO

Question 1 - polluted upstream				
	C a lot	1	12	72
	B a little	6	66	157
	A No	7	23	31
		A	B	C
		No	a little	a lot
		Question 2 - polluted downstream		

On examination of Table VII, one can see that nineteen people said that they thought that the North Saskatchewan River was less polluted downstream from Edmonton than upstream. There are several possible explanations for this. Unfortunately, one explanation may be that

they did not take the questionnaire seriously, and were trying to give a false impression. Another possibility is that some of the people interviewed may have been confused about the concepts of upstream and downstream. A third explanation is that, knowing that the City of Edmonton has water and sewage treatment facilities, some people may actually believe that the river water is cleaner when it leaves the city than it was when it entered. It is impossible to say with any certainty what factor or factors influenced these nineteen anomalous responses.

Question Three

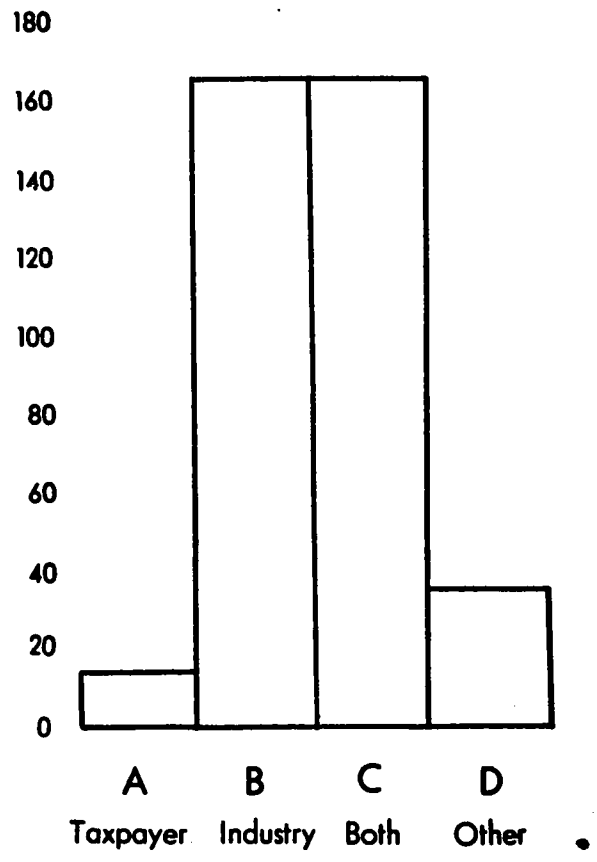
Turning to question three, asking who should be required to pay to clean up and maintain the river, it was hoped to get some idea of the amount of responsibility that is felt by the general public about water pollution. Figure XII shows the relative strength of the answers given for question three.

Most of the nine per cent who answered "other" did not offer a specific alternative. The only specific answers given were "government" and "the city." Realistically, the government and the city are both supported by the taxpayer. The fact that these people mentioned these in a separate category would indicate that they do not feel that they, the taxpayers, should be responsible for the cost of cleaning up pollution. Instead, they would pass the responsibility on to a remote entity called the government, with which they

Figure XII

Question Three

Who should be required to pay?



may feel no connection.

One could conclude from the answers to question three that forty-seven per cent of the people interviewed (those who answered "taxpayer" or "both") felt that they were at least partially responsible for cleaning up pollution. On the other hand, fifty-two per cent of the people (those who answered "industry" or "other") felt no responsibility, say that they should not be required to pay the cost. They put the blame and the responsibility on someone else. Forty-three per cent specifically blamed industry.

These findings have important implications in terms of pollution abatement. In spite of the intensive publicity that has been given to pollution in general, and in spite of the fact that ninety-five per cent of the people interviewed said that the North Saskatchewan River is polluted at least to some degree, still well over half of the people interviewed felt no personal responsibility toward the problem. This is important because the attitude of the general public on this question can influence just how hard the government is going to try to control or eliminate water pollution. If the public does not feel responsible and does not want to pay the price for pollution control, the governmental decision-makers might tend to give the problem less emphasis than they would if most of the people felt responsible and were willing to pay. This was substantiated in the interviewing done for the second questionnaire. There was no

specific question on this point, nevertheless a number of different government officials brought up the matter, saying that pollution control costs money and the public must be willing to pay.

Question Four

The main purpose of question four was to determine how close the person interviewed actually gets to the river. One's residence does not accurately reflect this. But the answer to question four should indicate whether or not the person gets close enough to see the water. This factor may influence whether or not he thinks the water is polluted. Admittedly, of those who just drive over the bridges, some may never really look at the water, particularly if they are doing the driving. A passenger in the same car may look at it fairly closely. This difference can not be detected from the answer given. In addition, seeing the water might influence one person's perception of the condition of the river and not influence another's.

The answers for question four were plotted with the answers for question two, indicating whether or not the respondent thought the North Saskatchewan River was polluted downstream (see Table VIII). Five people did not answer question two, therefore their answers to question four were not included in this analysis.

Examination of Table VIII indicates that there might be some positive relationship between thinking the

TABLE VIII

RELATIONSHIP BETWEEN QUESTIONS TWO AND FOUR

Nearness to River				
	C - 10 ft.	7	34	123
	B - bridges	4	60	133
	A - no	3	6	10
		no	a little	a lot
		A	B	C
			pollution	

river is polluted and getting close to the water. In other words, from this data there seems to be a tendency for people who get very close to the river to think that it is more polluted than those who do not get close to the river.

In an attempt to determine statistically whether this relationship exists and to what extent, the contingency coefficient test was applied to the data for questions two and four. In order to test the significance of the relationship between these sets of data, one must test the null hypothesis that no relationship exists and that the distribution could have occurred by chance. The procedure for this test is described in Siegel, (Siegel, 1956, pp. 196-202). Following this procedure, chi square was found to be 65.11. Using this figure, the contingency coefficient, C, was calculated to be .144.

The significance of this contingency coefficient can

be ascertained by testing the significance of the chi square. By referring to a Table of Critical Values of Chi Square, one finds that a value of 65.11 for chi square with a degrees of freedom value of four has a probability of occurring under the null hypothesis of less than .001. Therefore, the null hypothesis can be rejected at the .001 level of significance, and it can be assumed that there is a positive statistical relationship between the two sets of data under discussion. However, the degree of relationship is not very strong. No relationship would be indicated by a contingency coefficient of 0. The upper limit of C for data with a 3 x 3 matrix is .816. Therefore, the C of .144 for this case indicates a weak relationship.

This slight tendency for people who go near the North Saskatchewan River to think that it is polluted may be because they have seen the water at close range and it looks polluted. On the other hand, their responses may also be attributed to the fact that they enjoy recreational activities on or near the river and are therefore more interested in whether or not it is polluted.

Question Five

Turning to question five, the data gathered from this question is difficult to assess. One inherent difficulty is in the nature of the question. The question is, "What would you use as a standard for judging whether or not water is polluted?" There are no choices. The answer must

be supplied. Many of the people interviewed did not seem to know how to answer this question and asked for further explanation. If any answers were given as suggestions of the type of response wanted, this would heavily influence the response given. As the questionnaire was carried out by many different interviewers, it is impossible to say which answers were spontaneous and which were the result of suggested answers. Therefore, the validity of the answers as perception responses is questionable, and they should not be weighed too heavily.

Forty-two people did not answer question five. Of the answers that were given, some answers occurred frequently. Table IX shows a breakdown of the responses given. Similar answers were put together in order to reduce the number of categories. For example, the answers, "by looking at it" and "vision" were joined with "sight", and "odor" with "smell". The most popular answers, sight and smell, may have been most often suggested by the interviewers in explaining the question.

Even with the problem mentioned above, there was still a fairly wide range of answers given for question five. It should be pointed out that while most of the answers were related to direct observation (for example, sight, smell, taste), some of the people indicated that they judge whether or not water is polluted by inference. Four people said that they can tell that water is polluted if there is industry

TABLE IX

QUESTION FIVE - FREQUENCY OF ANSWERS

Sight - 97
Smell - 73
Testing - 31
Color - 28
Taste - 22
Dirty Water - 13
Dead Fish - 12
Garbage (debris) - 12
Plant or Animal Life - 12
News Media - 7
Industry Nearby - 4
Palatable - 4

Three or Less
No Swimming
Warning Signs
Logical Assumption
Texture
Foam
Scum
Sight of Sewage
Rumor
Government Standards
Effluent
Chemicals
Detergents
Dumping
Inference

nearby. They seem to be certain that either nothing can be done or not enough is being done about treating the industrial wastes to prevent pollution. One respondent even answered that he could tell that the river was polluted by "logical assumption", and another answered "by inference". These answers would indicate that for one reason or another, these people feel that the river is polluted even if they do not actually know about the chemical and biological constituents in the water. They feel that the river must be polluted, perhaps because of the size of the city, the presence of industry, an awareness of the evergrowing problem of pollution generally, or a number of other reasons.

In order to avoid the problems encountered in question five, the question should have been redesigned to make it more specific. One possible way would be to attach it to questions one and two, which asked if the river is polluted. The question might be, "if yes, how do you know that?" This would at least be less likely to be misunderstood.

CHAPTER VII

SECOND QUESTIONNAIRE

After completion of the first questionnaire and analysis, a second questionnaire was devised as a follow up. The latter was designed primarily to discover whether the respondents think that an individual has any influence on decision-making in the field of water quality management. To determine, in effect, if it matters whether the residents of Edmonton think that the North Saskatchewan River is polluted. This second questionnaire consisted of twenty-one questions, and took anywhere from fifteen to ninety minutes, depending on the interest of the person being interviewed. This set of interviews was conducted by the writer, who attempted to ask the questions in the same manner each time.

The subjects for this questionnaire were chosen from two groups. The first group was made up of government officials, both civil servants and elected officials, whose responsibilities involve water in some way. These included Members of the Legislative Assembly, City Aldermen, employees of the Department of the Environment who were formerly employed by either Public Health or Water Resources, an employee of Edmonton Water, and an employee of Fish and Wildlife. The second group consisted of members of the

local anti-pollution groups, STOP and the Edmonton Anti-Pollution Group, including housewives, students, professors, teachers and businessmen. Ten of the government officials and ten of the anti-pollutionists were interviewed. It was assumed that the individuals from both of these groups would have more than the average knowledge of water pollution and decision-making, and would have a definite interest in the subject. The interviews were conducted during June and July 1971.

The questionnaire can be found in Appendix C. Generally, the first part of the questionnaire was designed to determine how the people in these groups perceive pollution in the North Saskatchewan River, who they feel is responsible for the pollution if it does exist, and whether they feel the Provincial government has been effective in controlling it. Questions eleven through eighteen were meant to determine the respondent's perception of just how much influence an individual or a group has in the decision-making process. The last three questions were meant to elicit some statements about the implications of water pollution and expectations for the future.

The responses to the questionnaire are included in Appendix C. In some cases the individual did not want to give a simple yes or no answer. He would elaborate with comments and qualifications, without saying yes or no. For this reason, the number of short answers is not always ten.

In these cases, the answer was recorded under comments. Most of the people interviewed had comments to offer even when they had given a yes or no answer. These were recorded in as much detail as possible in order to get a complete answer. Generally, the comments were more revealing than a simple tabulation of the short answers.

In many cases, the comments revealed significant differences between the groups which would not have been evident from the simple yes or no responses. This is seen in question three, asking if the previous Division of Environmental Health was adequate to control water pollution. In the government group, fifty per cent answered no. In the anti-pollution group, eighty per cent answered no. However, the comments of the government group included statements such as; "They could not handle the volume of the problem," "They didn't have control at the source," and "There were not enough staff and facilities." While the anti-pollutionists made such statements as; "The monitoring system was inappropriate," "They didn't enforce," and "They didn't care as long as no one was bothered." Thus, the responses of the governmental group tend to defend their own position, which would be expected. The anti-pollutionists, on the other hand, seem to blame the public officials.

This defensive position on the part of the governmental group is seen again in the answers to the question of whether or not the North Saskatchewan River is polluted.

enough interest." Comments from the anti-pollution group were: "The information is too technical," and "The government should give out information, but they withhold it." In this case, both groups seem to be blaming each other for a lack of communication. An exception to this is one anti-pollutionist who said that the public does not care to know.

There was a variety of opinions as to what should be the source of information about the condition of the river. Within the anti-pollution group, some said that information should come from the government; while one anti-pollutionist said that it should not come from the government, but rather from some private group. The rest of both groups were split between the government as a source of information, and the news media.

Question thirteen, asking whether the public has much influence on decision-making, revealed a great deal of difference between the two groups. The government group were unanimous in answering yes. They suggested ways in which one could have influence; by contacting the Department of the Environment, the Members of the Legislative Assembly, the City Council, and the news media. The members of the anti-pollution group were split on this question. Only one individual answered with a definite yes. Others were doubtful, and three people answered with a definite no. Some of the comments they gave were: "An individual doesn't have a chance against big business," "They could have influence

but have not been aroused enough," and "They have some influence but they must show the politicians that they are willing to go halfway." This would indicate that, if they are doubtful as to an individual citizen's influence on decision-making, some would blame the decision-makers, while others blame the citizens themselves either for apathy or ignorance.

One further comment should be made on the affirmative answers of all of the public officials. One would expect them to say that private citizens do have influence on decision-making. Considering their positions, it is unlikely that any one of them would say that they ignore citizen complaints about environmental pollution. It is impossible to determine the sincerity of these responses.

Question fifteen, asking if anti-pollution groups are a help or a hindrance to decision-makers, was asked only of the governmental group, for obvious reasons. Four individuals answered a help, two answered a hindrance, and one answered both. However, most of the comments were negative. "They don't state their case clearly, logically and concisely. They overdramatize and have no clear solutions." "They make noise but don't always listen to reason." "They are more emotional than realistic." Only one comment was positive. "Pressure groups bring attention to an issue." Thus, while some of the public officials felt that anti-pollution groups were helpful, others felt that the groups' methods and their emotionalism made them ineffective if not

harmful to their cause. In other words, some members of the anti-pollution groups, by their zealousness and their emotional appeals, seem to be turning some of the decision-makers against their cause.

Both of the groups interviewed agreed, in the majority, that a group can have more influence than an individual citizen in the decision-making process. Strength in numbers, organization and communication were given as reasons for this, although comments were made from both groups that in order to have influence, an anti-pollution group must be well organized and well informed. Only three individuals in the governmental group said that a group does not have more influence than an individual. These people said that complaints from an individual citizen would be given as much or more attention than those of a group. One anti-pollutionist concurred with this, saying that a handwritten letter from an individual would mean more than a printed postcard from a group member, in reference to the campaign of the STOP group mentioned earlier.

In answer to the question of whether or not the public overreacts to pollution scares, both groups were split. In the governmental group, sixty per cent said yes, the public does overreact. However, these answers were accompanied by such comments as: "But that is not necessarily bad," "A sector of the public overreacts," "It is a necessary thing," and "The news media overreact." In addition,

one individual in this group said that the public probably underreacts. So while generally agreeing that the public overreacts to pollution scares, they were not necessarily condemning the public for such a reaction. Members of the anti-pollution group generally agreed that the public does not overreact. Two anti-pollutionists said that the public can not overreact, indicating how serious they feel the pollution scares are. However, two individuals in the anti-pollution group stated that the public may have an inappropriate reaction, or may be misinformed.

Question eighteen was asked to determine the respondent's attitude toward industry and its role in the water pollution situation. In the governmental group, sixty per cent answered that industry is eager to cooperate with the government. Twenty per cent said that some industries are and some are not. Only one individual in this group said that industries try to get away with what they can. Within the anti-pollution group, sixty per cent said that industries try to get away with what they can, while again twenty per cent said that some industries cooperate and others do not. Only one individual in this group said that industry is eager to cooperate with government regulations concerning water pollution.

With the last three questions it was hoped to bring out the general attitude toward the question of water pollution in Edmonton, as well as its implications for the

future. Generally, the governmental group was optimistic. Eighty per cent of them said that the condition of the river will be the same or better in ten years. The remaining twenty per cent said they did not know what its condition would be. Several pointed out that tertiary sewage treatment will be necessary, but that this will control pollution in the North Saskatchewan River in the future. Several individuals in this group also mentioned that tertiary treatment will cost more than present treatment, and the public must be willing to pay.

The general attitude of the anti-pollution group was less optimistic. Forty per cent of this group said that the river will be in worse condition in ten years. Two people said that the population of Edmonton should be limited, and one said that there is not enough water for growth of the city. It was also mentioned by this group that tertiary treatment would be needed, and that it would be more expensive.

In answer to the question of whether or not water pollution will ever be eliminated in the North Saskatchewan River, one hundred per cent of the governmental group and seventy per cent of the anti-pollution group said that it would only be controlled. No one said that it would ever be eliminated. Within both groups there were individuals who thought that it could be eliminated, but that it would cost too much. Others said that water pollution could never

be eliminated as long as there are people living near the river.

Comparison between the general public interviewed in the first questionnaire and the "experts" interviewed in the second would be meaningless due to the differences in the questionnaires. The only questions asked of both groups were whether or not the North Saskatchewan River is polluted upstream and downstream. Even with these questions, the individuals given the second questionnaire were able to give comments to explain their answers, whereas those given the first questionnaire had to select from the three choices without comment. For this reason, no comparison will be made.

The material gathered in the second questionnaire indicates that there are several differences between the governmental and the anti-pollution groups which could be significant in terms of decision-making. The governmental group generally agreed that tertiary sewage treatment will be necessary in the future, and that the public should have some influence in the decision-making process. However, many of their answers were defensive of their positions, and some of these individuals reacted against the anti-pollution groups because of the emotionalism of their appeal.

The anti-pollution group generally seemed to have a negative attitude toward the decision-makers, and felt that the public could not influence these decision-makers. These

two viewpoints present a line of communication that is closed at both ends. It would seem that both groups need to make an effort to open this line of communication in order to allow the public to have an active role in the decision-making process. The anti-pollutionists, on the one hand, should endeavor to be well informed, well organized, and less emotional in their presentations to governmental groups. One of the anti-pollution groups in Edmonton has already taken this approach to a certain extent. The decision-makers, on the other hand, should be more open-minded and responsive, and less defensive of past policies.

The vehicles of communication between these two groups are already set up. The anti-pollution groups themselves, the Alberta Advisory Committee on Pollution Control, the periodic open hearings held by the government on specific topics, the information and public relations sections of the Department of the Environment all offer possible ways of getting together and working together on a mutual problem if they are used effectively. It might be naïve to suggest that the government and the public will work hand in hand in making decisions on water pollution control. However, if the public has the desire to take part in the political process, and if they do so in a rational, well-informed manner, perhaps the government will respond more positively in working with and communicating with the public.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

The Questionnaires

The two questionnaires just discussed made use of two different interviewing techniques. The first questionnaire, disregarding the fifth question which proved unsatisfactory, consisted of multiple-choice questions. There was no way that the person being interviewed could expand or explain any of his answers. He could only choose from one of the answers given. For the second questionnaire a longer interviewing technique was used in which the respondent was invited to comment and expand his answers. The comments were recorded as well as the short answers to the questions.

Comparing the two techniques used, it is apparent that the second technique provided much more information. This would have been true even if the questionnaires had been the same length. The problem that presents itself is how to analyze the material gathered. With a wide range of comments and explanations, the material does not lend itself to statistical analysis. It can only be interpreted subjectively, with the hope that the broader range of material will reveal more in terms of perception and attitudes than could be obtained from multiple-choice questions.

A questionnaire such as the first one with multiple-choice questions does lend itself to statistical analysis. However, there is a risk of distorting the answers through oversimplification. Given the highly complex and subjective nature of perception, one should be wary of the temptation to place too much statistical significance on answers which have been given a numerical value for convenience of format. It is the opinion of this writer that the longer, open interviewing technique is more valuable in a perception study.

Summary and Conclusions

This study has been an attempt to examine perception of water pollution in the North Saskatchewan River and the relationship of this perception to decision-making in water quality management. To summarize briefly some of the more important points established by the first questionnaire, ninety-five per cent of the people interviewed said that the North Saskatchewan River is polluted. This finding is contrary to the original hypothesis, which was that the residents of Edmonton do not think that the river is polluted. In addition, fifty-five per cent of those interviewed think that the river is more polluted downstream than upstream, indicating that they think that Edmonton and nearby industries cause or significantly contribute to this pollution. Whether or not the people interviewed thought that the North

Saskatchewan River was polluted did not seem to be related to the location of their residence. There was only a very slight relationship indicated between thinking the river was polluted and getting close to the river.

In spite of the general agreement that the North Saskatchewan River is polluted, over half of those interviewed did not feel in any way responsible, and were unwilling to pay even some of the cost of cleaning up and maintaining the river. As mentioned earlier, this fact is very significant to the decision-makers. They are unlikely to put much effort into programs which they know the taxpayers are unwilling to support, particularly when the programs are very expensive, which water quality control programs tend to be.

Turning to the second questionnaire, it was found that there are significant differences between the attitudes of government officials and the attitudes of members of the anti-pollution groups in Edmonton regarding water pollution and decision-making. The government officials tended to be defensive in answering many of the questions and seemed to be trying to justify their own positions. On the other hand, many members of the anti-pollution groups tended to be negative and highly skeptical about what the government is doing about water pollution and whether they themselves have any influence on the decision-making. It is significant that all of the government officials said that an individual

has influence in the decision-making process, while only one of the anti-pollutionists said that an individual has influence. One would hope that this negative attitude on the part of the anti-pollution group members would not cause them to stop trying to influence the decision-makers. On the contrary, what is needed is an opening of minds from all quarters in order to keep open the lines of communication. As mentioned earlier, there are ways already established for these two groups to get together and communicate. What is needed is for them to be used effectively.

Another point that should be mentioned is that all twenty of the people interviewed agreed that the public is not well informed about the condition of the river. If one feels that the public should have an active role in decision-making and should endeavor to influence policy making, then this lack of information is alarming. The question remains, what should be the source of such information? The Department of Environment has a section for making information available to the public. However, with the possibility of bias in terms of what material is being presented and how it is presented, this should not be the only source of information on the topic. The anti-pollution groups have carried out studies on water pollution, which are available to the public. It was suggested by one of the elected government officials that the local newspaper should carry a regular column on environmental problems in the local

area. This would reach more people than the reports just mentioned, although the coverage of the topic would most likely be shallow. Here again there is the problem of the source of the information used. Perhaps a column of this sort could use materials from both government and anti-pollution groups, stating the sources that had been used. A newspaper column of this sort could supply at least some degree of information to many people who would not take the time and effort to obtain and read the studies and reports prepared by the government and private groups. It might also help to convince some of the general public that they are indeed responsible for supporting programs for controlling pollution in the river that flows through their city.

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APPENDIX A

SURFACE WATER QUALITY CRITERIA

These criteria have been prepared in co-operation with the Provinces of Saskatchewan and Manitoba and represent water quality suitable for most uses either through direct use or prepared for use by an economically practical degree of treatment.

Parameter	Criteria
1. Bacteriology (Coliform Group)	(a) In waters to be withdrawn for treatment and distribution as a potable supply or used for outdoor recreation other than direct contact, at least 90 per cent of the samples (not less than five samples in any consecutive 30-day period) should have a total coliform density of less than 5,000 per 100 ml and a fecal coliform density of less than 1,000 per 100 ml. (The Maximum Permissible Limit of total coliform organisms in a single sample shall be determined by the Provincial Board of Health based on the type and degree of pollution and other local conditions existing within the watershed.) (b) In waters used for direct contact recreation or vegetable crop irrigation the geometric mean of not less than five samples taken over not more than a 30-day period should not exceed 1,000 per 100 ml total coliforms, nor 200 per 100 ml fecal coliforms, nor exceed these numbers in more than 20 per cent of the samples examined during any month, nor exceed 2,400 per 100 ml total coliforms on any day.

2. Dissolved Oxygen — A minimum of five mg/l at any time.

3. Biochemical Oxygen Demand (BOD_5) — Dependent on the assimilative capacity of the receiving water. The BOD_5 must not exceed a limit which would create a dissolved oxygen content of less than five mg/l.

4. Suspended Solids — Not to be increased by more than 10 mg/l over background value.

5. pH — To be in the range of 6.5 to 8.5 pH but not altered by more than 0.5 pH units from background value.

6. Temperature — Not to be increased by more than 3°C above ambient water temperature.

7. Odour — The cold (20°C) threshold odour number not to exceed eight.

8. Colour — Not to be increased more than 30 colour units above natural value.

9. Turbidity — Not to exceed more than 25 Jackson units over natural turbidity.

10. Organic Chemicals

Constituent	Maximum Concentration (mg/l)
Carbon Chloroform Extract (CCE) (includes Carbon Alcohol Extract)	0.2
Methyl Mercaptan	0.05
Methylene Blue Active Substances	0.5
Oil and Grease	substantially absent no irridescent sheen
Phenolics	0.005
Resin Acids	0.1

11. Pesticides — To provide reasonably safe concentrations of these materials in receiving waters an application shall not exceed 1/100 of the 48-hour Tl_m. Persistent insecticides such as DDT, Aldrin, Dieldrin, Endrin, Heptachlor should not be used on or near surface waters.

12. Inorganic Chemicals

Constituent	Maximum Concentration (mg/l)
Boron	0.5
Copper	0.02
Fluoride	1.5
Iron	0.3
Manganese	0.05
*Nitrogen (Total Inorganic and Organic)	1.0
*Phosphorus as PO_4 (Total Inorganic and Organic	0.15
Sodium (as per cent of cations)	between 30 and 75
Sulphide	0.05
Zinc	0.05

* These criteria are presently under study and may require adjusting according to naturally occurring concentrations or conditions.

NOTE: The predominant cations of sodium, calcium and magnesium and anions of sulphate, chloride and bicarbonate are too variable in the natural water quality state to attempt to define limits. Nevertheless, in order to prevent impairment of water quality, where effluents containing these ions are discharged to a water body the permissible concentration will be determined by the Provincial Board of Health in accordance with existing quality and use.

13. Toxic Chemicals

Constituent	Maximum Concentration (mg/l)
Arsenic	0.01
Barium	1.0
Cadmium	0.01
Chromium	0.05
Cyanide	0.01
Lead	0.05
Mercury	0.0001
Selenium	0.01
Silver	0.05

14. Radioactivity — Gross Beta not to exceed 1,000 pCi/l. Radium 226 not to exceed three pCi/l. Strontium 90 not to exceed 10 pCi/l.

15. Unspecified Substances — Substances not specified herein should not exceed values which are considered to be deleterious for the most critical use as established by the Provincial Board of Health.

APPENDIX B

BYLAW NO. 2458

A bylaw to amend Bylaw No. 1836 regulating the use of public and private sewers and drains and the disposal of sewage and waste into the Edmonton sewer system.

WHEREAS the sewer service charges provided for in Part VII of Bylaw No. 1836 as passed in the year 1957 and as amended, have provided for a method of testing sewage which has been unduly expensive to the Municipal Corporation and it is deemed appropriate to amend the provisions for such testing;

NOW THEREFORE Bylaw No. 1836 of the City of Edmonton amended is hereby further amended as follows:

1. By deleting from Section 701 (c) and by substituting the following:

"(c) A person, whether using City water or not, whose sewage discharge exceeds any or all of the limits set out in Section 506 shall from the 30th day of September A.D. 1961 be charged at N x 6¢ per 100 cubic feet of water consumed where N is determined by the following formula:-

$$N = 1 + \frac{x}{2100} + \frac{y}{1200} + \frac{z}{600}$$

where N is the multiplier of the standard six cents

rate for water.

X is the difference between the actual B.O.D. in parts per million and the allowable B.O.D. in parts per million.

Y is the difference between the actual suspended solids in parts per million and the allowable suspended solids in parts per million.

Z is the difference between the actual grease in parts per million.

The minimum charge shall remain at six cents per one hundred cubic feet of water consumed.

To determine the rate and amount to be charged each month, the City will -

(a) in the case of existing industries already connected where testing has been done in the past to determine the strength of their sewage discharged, charge such industry an average rate (N factor in the formula) based on the strength of sewage as determined by tests for the past twelve months prior to the date of passage of this Bylaw amending Bylaw No. 1978.

(b) (i) In the case of new industries connecting to the system, or existing industries that change their method of treatment so as to vary the strength of sewage discharged, establish a new basis of charge based on at least twenty-four hour tests carried out

by the City over a period of one month and using an average of four (4) separate tests.

(ii) The above provision will apply when an industry has established new treatment equipment or for any reason is of the opinion that the nature of its sewage being discharged has a substantially lessened degree of pollution than as shown by prior tests, it may request the City to make new tests, such tests to be at the expense of the industry.

(iii) If the City is satisfied that such tests were made when the plant was operating under normal conditions, the results of the latest tests shall be used in computing the monthly charge as set forth in Section 701 hereof.

(iv) The City shall periodically at its discretion, run tests at each plant to determine the strength of the sewage discharged as a check. If these tests show that the strength of the sewage is consistently stronger than the average previously determined, then a new average will be determined based on four 24 hour tests in one month.

APPENDIX C

SECOND QUESTIONNAIRE

1. What is your (occupation) professional training?
2. How long have you (been) worked in this (group) position?
3. Did you feel that the previous Division of Environmental Health was adequate to control water pollution in the province? Why?
4. Will the new Department of the Environment be more effective?
5. If yes, why?
6. Is the North Saskatchewan River polluted upstream before it reaches Edmonton?
7. Is it polluted when it leaves the city?
8. What are the principle sources of water pollution in the Edmonton area?
9. What tests are used by the government in determining water quality?
10. Do you think any other tests should be used?
11. Is the public generally well informed about the condition of the river? If yes, what is their main source(s) of information?
12. Is the public well informed about the responsibilities and powers of the government in regard to water quality management?
13. Does the public have much influence on decision-making regarding water quality management?
14. If yes, how?
15. (Omit for anti-pollution group)
    Are the anti-pollution groups generally a help or a hindrance to decision-makers?
16. Do the anti-pollution groups have more influence as a group than an individual would have?

17. Do you think the public usually overreacts to pollution scares?

18. Is industry generally eager to cooperate with government regulations regarding pollution, or do they try to get away with what they can?

19. What are the implications of water pollution on the future growth of Edmonton?

20. What would you expect the quality of river water to be in ten years?

21. Will water pollution ever be eliminated in the North Saskatchewan River, or only controlled within set standards?

APPENDIX C

ANTI-POLLUTION GROUP RESPONSES

		Comments
1.	housewife 2, student 3, draftsman 1, personnel administrator 1, teacher 1 professor 1, nurse 1	
2.	1-1/2 years 3, 1 year 4, 2 years 2, 3 months 1	
3.	no 8, don't know 2	Monitoring system inappropriate. Didn't enforce. Didn't care as long as no one was bothered. There were constant complaints from downstream.
4.	Probably not 2, yes 3 hopefully 2, don't know 3	
5.		If they enforce the rules they have. They have stricter standards. They are more aware. They will give out information.
6.	yes 9, no 1	
7.	yes 9, don't know 1	
8.	sewage 9, chemical industries 4, industries 4, thermal from power plant 4, street runoff 2, farm runoff 2, water treatment plant 1, dairies and packing plants 1, snow dumping 1, litter from dam 1, university 1	
9.	7 didn't know 2 mentioned two tests 1 mentioned eleven tests	

10.	7 didn't know 1 no	Should follow up tests. Should aid towns that need improvement. Should test heavy metals and have more sampling. Phosphate level and harmful chemicals.
11.	no 10	Information is too technical. Information should come from govt. Information should come from people's groups, not govt. Govt should tell, but they hold back information. Should be on the front page of the newspaper. Radio talk shows. People don't care to know.
12.	no 10	
13.	no 3, yes 1, perhaps 1, don't think so 3	Don't have a chance against big business. Could but haven't been aroused enough. Public is beginning to be heard. Some influence--must show politicians they are willing to go halfway. Yes, through public pressure, letters to the editor and decision-makers.
16.	yes 6, don't think so 1	Depends on the group. If they are sincere, well-informed and large enough. Group strength encourages others. Group strength can spread the word better. Depends on the individual, he could be stronger. Groups may do things to antagonize. A handwritten letter from an individual would mean more than a printed card from a group member. Groups get more people involved.
17.	yes 2, no 6 for a short time 2	How can one overreact? Can't overreact. Inappropriate reaction. Sometimes are misinformed.

18.	Try to get away with what they can 6 Try to work with govt 1 Some of each 2 Don't know 1	A segment of industry tries to get away with things. Profits are the primary concern of industry.
19.		We don't have much water left. Population should be limited. Treated water is not as good as natural water. Probably no effect. City growth should be stopped. If nothing is done the river will die. We have to improve the sewage system. We have plenty of water but treatment is expensive if we keep putting waste back in. There should not be any future growth unless it is planned with open space. Sewage will increase with growth. We will have to have tertiary treatment. Treatment will cost more in the future.
20.	greatly improved 2 worse 4	Much worse unless things change. If nothing is done, much worse. Same or worse. Stringent methods could improve it. Could get better if the public wakes up. Probably not better. Cleaner hopefully.
21.	controlled 7	Could be eliminated but would cost much money. Could be eliminated but probably won't be. Maybe eliminated. Depends on what we can afford and are willing to pay. Can never be eliminated because of the population.

APPENDIX C

GOVERNMENT AND CIVIL SERVANT RESPONSES

1. biology 1
   chemical engineering 1
   civil engineering 3
   sanitary engineering 1
   chemistry 1
   business administration 2
   none 1

2. 3 years 2
   4 years 1
   4-1/2 years 1
   5 years 2
   8 years 1
   13 years 2
   22 years 1

3. no 5, yes 4
   don't know 1

   Comments:
   Couldn't handle the volume of the problem.
   Didn't cover biological aspects.
   Didn't have control at source.
   Not enough staff or facilities.
   Too much work--not enough resources.
   There may be a lag in action because of the political process.

4. yes 5, don't know 1
   possibly 3
   probably not 1

   Comments:
   It is just as good as the people who enforce it.
   Better if there is more biological monitoring.
   Pollution has been accepted--now they can focus full attention on it.
   More coordination.
   Coordinates responsibility and provides for massive penalties.
   More enforcement powers but still no staff.
   Good act. Brings groups together for more strength.
   New legislation and coordination of functions.
   More directed to the problem.

6. no 6 yes 2

All rivers are polluted in some way.
It is not quite natural.
It depends on what use you are talking about.

7. no 3, yes 7

If you expect to have to treat it, then it is not polluted.
It has certain additives, but is controlled.
Any change of the natural system is pollution.

8. sewage plant 6, industries 8, individual waste and litter 1, the city 2, oil spill or runoff 1, surface runoff 1, thermal pollution from power plant 1

9. 3 didn't know
1 mentioned one test
3 mentioned two tests
3 mentioned eleven or more tests

10. 2 didn't know
4 no

Expand sampling.
More continual monitoring.
Starting testing for heavy metals, pesticides, more tests but not more stations.

11. 10 no

Are as informed as they want to be.
Apathetic.
It is available but there is not enough interest.
Is it necessary?
The new information section of the Dept. of the Environment should help.
There should be no secrecy in govt or industry.
There is an information bulletin available on request from the City.
Pollution information should be on the front page of Edmonton Journal.
Should be through the news media.

12. 9 no

Vaguely.
Not as fully as they should be.
Not until it directly affects them.

13.	10 yes	
14.		Write to the decision-makers. Complaints to the Dept. of Environment. Depends on the politicians. Indirectly. Through the minister. Public involvement through public hearings. Contact MLA. Ministers and members talk to constituents. Influence political leaders. News media, MLA, city council. Through elected representative, but most people don't understand this.
15.	help 4, hindrance 2 both 1, depends 1	They don't state their case clearly, logically and concisely--overdramatize and have no clear solutions. Make noise but don't always listen to reason. Didn't care enough to attend public meeting on resources. More emotional than realistic. Pressure groups bring attention to an issue.
16.	yes 6, no 3	Groups get the individual more worked up, but individual has more power. Groups have the money for research and lobbying. Groups have power if they are organized properly. Not emotional, uninformed groups. Groups have power through political process. The groups shout too much and don't know the facts.
17.	yes 6, no 3 depends 1	Yes, but that is not necessarily bad. A sector does. They are pushed into it. It is a necessary thing. News media overreacts. Some people who yell still use phosphates. Probably underreacts.

18. yes, they cooperate 6
not eager to cooperate 1
half and half 2

They usually only do what is asked.
They cooperate for a good public image.
Until about 3 years ago they tried to get away with things, but now it is a political issue so they cooperate more.
Industry wants tough standards so they can set up their facilities and know that standards won't change soon.
It is an economic choice. Either you accept some pollution, or you lose some industry because they must close down.

19.

Pollution doesn't have to get worse if we are willing to pay for it.
With growth, we will have to have tertiary treatment and it will cost more.
Controlled growth should take care of it.
If uncontrolled, pollution will increase.
Edmonton is in a good position--the North Saskatchewan River is artificially controlled.
Won't make much difference.
Plans are underway to expand water treatment facilities.
Edmonton will need tertiary treatment and it will cost more.
Growth can occur.
There should be a new set of rules for location of industry away from the river.

20. better 2, the same 1
about the same, maybe slightly better 5,
don't know 2

21. controlled 10

Public doesn't want to spend that much money.
Higher standards will be set.
Controlled unless there is some drastic new development.
Not eliminated because humans still use it.