WATER PLANNING AND THE QUALITY OF THE ENVIRONMENT: A STUDY OF THE ASSINIBOINE RIVER BASIN

A Thesis

Presented to

The Faculty of Engineering

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In Partial Fulfilment

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Master of Science in Engineering

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by

Paul E. Flatt

December, 1969.

FRONTSPIECE

THE SHELLMOUTH DAM AND THE LOWER PORTION OF THE RESERVOIR AREA

(Looking west and north from the look-out above the dam site)

Aug. 1968.

ABSTRACT

This thesis studies water development of the Assiniboine River Basin. The study is based on a conceptual framework which states that resource processes, consisting of inputs and outputs, function to alter their environments producing goods and services, and thus creating new environments. Further, the relevant environment of these processes is seen to be multi-dimensional in nature. In both the historical and future study, particular emphasis is given to the often-overlooked cultural dimension. It is seen that the engineer's imperative is to take a comprehensive accounting of the ramifications of his actions. In order to be able to act on this imperative it is seen that the engineer must work within an ongoing inter-disciplinary team.

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CHAPTER I

INTRODUCTION

The importance of taking into account all relevant interests when planning the development of a river basin has been generally recognized by engineers during the last decade. Benefits called social or intangible have become manifest in the feasibility studies of many large projects. The inclusion of non-quantifiable benefits in these studies has become a troublesome aspect with floodways and reservoirs alike. The main cause of this difficulty lies with the fact that the new demand by society for a pleasing environment is not readily quantifiable. Thus, social benefits are not easily integrated into the traditional economic criteria of development.[1]

The subject of this thesis is the Assiniboine River, in particular the Brandon and Shellmouth Dam areas of the basin. The object is to study, comprehensively, the development of these areas using a conceptual framework based on the nature of the development process itself and then to apply this understanding to future development plans on the river. The hypothesis is that all relevant dimensions or interests in water development - ethnology, ecology, economics, and politics - are not easily integrated into a single decision criteria. However, by conceiving of them as relevant dimensions within an encompassing framework, their relative importance becomes evident to the decision-maker.

The Assiniboine River has played a major role in the exploration

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WATER PLANNING
AND THE
QUALITY OF THE ENVIRONMENT

MASTER'S THESIS	SEPT. '68	FIG. 1

UPPER ASSINIBOINE BASIN

LOWER ASSINIBOINE BASIN

ASSINIBOINE NO. 25
STONE CR.
NO. 17
RIVER
KOP CR.
NO. 9
STURGIS
SWAN RIVER
SWAN R. DIVERSION
PELLY
PREECEVILLE
NO. 3
STENEN
KEYBROOK
CONJURING CR.
CREEK
NO. 38
NO. 33
CAMORA
KAMSACK
LITTLE SASK. CREEK
CUTE
SHELL RIVER
ROBLIN
DAUPHIN LAKE
DAUPHIN
GOOD SPIRIT LAKE
SHEHO
THEODORE RES.
THEODORE
WHITESAND RIVER
EBENEZER
NO. 161
CUSSED CR.
NO. 60
YORKTON
YORKTON CREEK
DROPMORE
INGLIS
SHELLMOUTH RES.
CONJURING CR.
RUSSELL
BIRDTAIL CREEK
CLEAR LAKE
ROLLING R
MINNEDOSA
RIVER
PORTAGE LA PRAIRIE
CARMAN
MORDEN
WINKLER
DIVERSION
ASSINIBOINE RIVER
MELVILLE
CUTARM CREEK
SPY HILL
ST. LAZARE
KAPOSVAR CREEK
ESTERHAZY
TANTALLON
VICTOR RES.
ARROW RIVER
OAK RIVER
RIVERS RES.
RIVERS
PHEASANT CR.
LIPTON
ABERNETHY
CROOKED L.
HYDE
ROUND LAKE
RIVER
ASSINIBOINE
MANITOBA
SASKATCHEWAN
MINIOTA
BRANDON
LITTLE SOURIS R.
CYPRESS RIVER
CYPRESS RIVER
FISHING LAKES
QU'APPELLE
INDIAN HEAD
MOOSOMIN
PIPESTONE
GOPHER CR.
BOSSHILL CR.
VIRDEN
WAWANESA
PLUM CR.
SOURIS
RIVER
OAK LAKE
DAVIN
MOOSE MOUNTAIN CREEK
CREEK
SEDLEY
PIPESTONE CREEK
SOURIS

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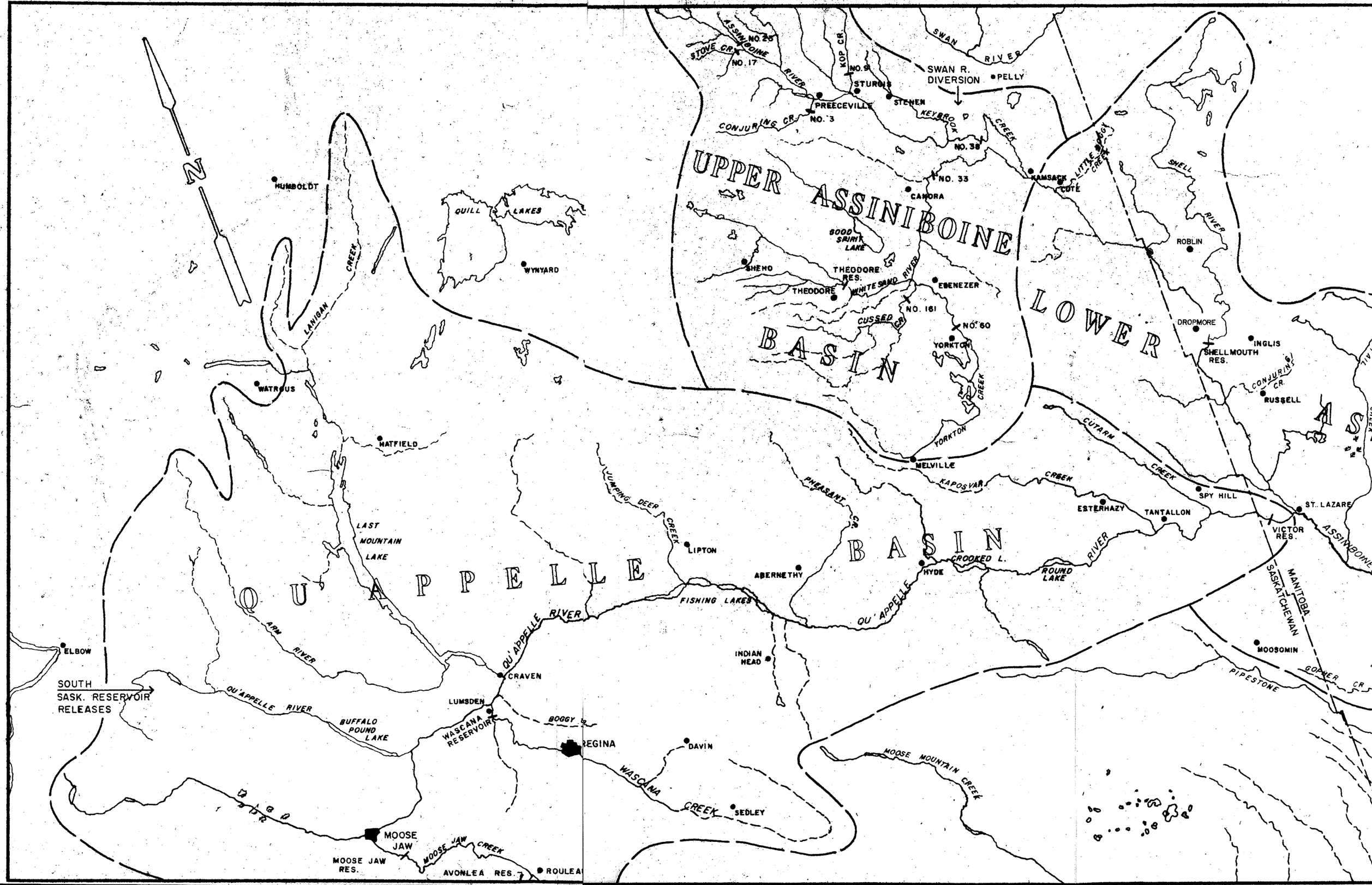
P.F.R.A.
ENGINEERING BRANCH

ASSINIBOINE & QU'APPELLE WATERSHEDS

PREPARED BY: W.L. KREUDER	MAY 1966
DRAWN BY: R.M. / S.A.M	HYD-C-234


N
HUMBOLDT
QUILL LAKES
WYNYARD
LANIGAN CREEK
WATROUS
HATFIELD
LAST MOUNTAIN LAKE
QU'APPELLE RIVER
ARM RIVER
ELBOW
SOUTH SASK. RESERVOIR RELEASES
QU'APPELLE RIVER
BUFFALO POUND LAKE
CRAVEN
LUMSDEN
WASCANA RESERVOIR
REGINA
BOGGY
MOOSE JAW
MOOSE JAW CREEK
MOOSE JAW RES.
AVONLEA RES.
ROULEA
LUMPING DEER CREEK
LIPTON
ABERNETHY
FISHING LAKES
QU'APPELLE RIVER
INDIAN HEAD
DAVIN
WASCANA CREEK
SEDLEY
MOOSE MOUNTAIN CREEK
PHEASANT CR
MELVILLE
KAPOSVAR CREEK
ESTERHAZY
TANTALLON
SPY HILL
ST. LAZARE
VICTOR RES.
ASSINIBOINE
CROOKED L.
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CUSSED CR
NO. 60
YORKTON
DROPMORE
INGLIS
SHELLMOUTH RES.
CONJURING CR.
RUSSELL
CUTARM CREEK

and development of the Canadian prairies. As one of Manitoba's major rivers it will continue to play a significant role in the future development of the Province. The geographical location of the river is such that it flows through three of Manitoba's major cities.[2]

The first comprehensive study of the Assiniboine River Basin was done by Professor Henry Youle Hind in 1858 under the auspices of the Legislature of Canada. In his report[3], published in 1859, he gives a beautifully detailed description of the Assiniboine Basin. Some excerpts are presented here to briefly develop an overall image of the Basin.

> East of Prairie Portage (Portage la Prairie), the Assiniboine flows through a flat, open, prairie country not sixteen feet below its general level where it is cut by the stream. The whole country rising in steps above or west of the Portage, the Assiniboine has excavated a deep broad valley in which it meanders with a rapid current.
>
> At the mouth of the Little Souris, or Mouse River, this valley is 880 yards across and eighty-three feet below the general level of the prairie. At Fort Ellice (near St. Lazare, Manitoba) its valley is one mile and thirty chains broad, and two hundred and forty feet below the prairie.[4]
>
> Issuing from the Duck Mountain are numerous streams which meander through a beautiful and fertile country. This area may be said to commence at the Two Creeks, ten miles from Fort Pelley, thence on to Pine Creek fifteen miles further. The vegetation is everywhere luxuriant and beautiful, from the great abundance of rosebushes, vetches and gaudy flowers of many species. After passing Pine Creek the trail to Shell River pursues a circuitous route through a country of equal richness and fertility. Shell River is 42 miles from Pine Creek, and in its valley small oak appear, with balsam, poplar and aspen covering a thick undergrowth of raspberry, current, roses and dogwood. Between Shell River and Birdstail River, a distance of 39 miles, the country is level and often marshy, with numerous ponds and small lakes, but where the soil is dry the herbage is very luxuriant, and groves of aspen thirty feet high vary the monotony of the plain. Between the trail and the Assiniboine the soil is light, and almost invariably as the river is approached it partakes of a sandy and gravelly nature, with boulders strewn over its surface.

> The flanks of the Riding Mountain are covered with a dense growth of aspen and poplar, and cut by numerous small rivulets. From Birdstail River to the Little Saskatchewan, or Rapid River (Minnedosa River), a distance of thirty-three miles, the same kind of soil, timber, and vegetation prevail. About one hundred miles from the mouth the Rapid River issues from the densely wooded flanks of the Riding Mountain through a narrow excavated valley filled with balsam, poplar, and an undergrowth of cherry and dogwood, with roses, convolvuli, vetches, and various creepers. The slopes are covered with poplar eighteen inches in diameter. Descending the river, groves of poplar and spruce show themselves, with thick forests of aspen and balsam poplar covering the plateau on either hand. The river is here forty feet wide, with a very rapid current. Before it makes its easterly bend the ash-leaved maple shows itself in groves, and on both sides is an open undulating country, attractive and fertile, with detached clumps of young trees springing up in all directions. The region unwatered by the Rapid River continues beautiful and rich until within twenty-five miles of the Assiniboine, so that it may with propriety be stated, that for a distance of seventy-five miles this river meanders through a country admirably adapted for settlement. Ponds and lakes are numerous, wild fowl in great numbers breed on their borders, and the waters of the Rapid River abound in fish. Canoes and bateaux may descend it from the point where the Exploration terminated to its mouth, a distance of one hundred miles. It will probably become important as a means of conveying to the settlements on the Assiniboine and Red River supplies of lumber from its valley and the Riding Mountain.[5]

Before the study of the Basin's development may be accomplished, it is first necessary to establish clearly the definitions and conceptual framework used in the analysis. This is the task of Chapter II, "Defining Environment, Resources, Development and Quality". Chapter III "A Conceptual Framework for Water Development", presents the conceptual framework and briefly illustrates its application to water development.

The study of the Assiniboine River's development is undertaken in Chapter IV. This chapter serves not only to give an understanding of development of the Assiniboine River but also to illustrate the relevance of the conceptual framework. In Chapter V the future development of the river is studied within the conceptual framework. The material to be studied is taken from the P.F.R.A. Report No. 12 on water supply and water use in the Assiniboine and Qu'Appelle Basins.[6] Chapter VI is a summary discussion and a presentation of the conclusions of the thesis.

CHAPTER I

FOOTNOTES

1. Appendix I presents a description of the evolution and present status of decision criteria in water development planning.

2. Figure 1, page .

3. Henry Youle Hind, Reports of Progress on the Assiniboine and Saskatchewan Exploring Expedition (Toronto: John Lowell, 1859).

4. Ibid, p. 30.

5. Ibid, p. 31.

6. P.F.R.A., Hydrology Division, Water Supply and Water Use in the Assiniboine and Qu'Appelle Basins (Regina, Saskatchewan: Prairie Provinces Water Board, May 1966).

CHAPTER II

DEFINING ENVIRONMENT, RESOURCES, DEVELOPMENT, AND QUALITY

The field of water development involves professional people from so many fields that many words in the jargon of water development have come to have multiple and often vague meanings. The terms dealt with in this chapter are especially prone to this difficulty. In order to enable the use of these words so that their meanings are unambiguous, it is necessary to stipulate their precise definitions. Thus, the proposed definitions are not meant in any way to be authoritative, but are meant to be the functional definitions for the purpose of the thesis.

What, then, is to be meant by the word 'environment'? For the purpose of this thesis, it will have a functional definition in order to avoid the concept of the environment of something as being everything around it. Thus, the environment of an object or process is the sum of all things which it affects appreciably, or which have an appreciable effect on it. It has been said that if you throw a single stone into the sea you change the course of history. This vague extrapolation of the meaning of the word 'environment' is not relevant to the purpose of this thesis. For example, part of the environment of the Shellmouth Dam is the reach of the Assiniboine River below the dam, for it has an appreciable effect on the flows. On the other hand, the word's hydrologic cycle is not a functional part of the environment of the dam, as it will not have an appreciable effect on it. Further, it is asserted that the environment of an object or process has three conceptual dimensions, the natural environment, the cultural environment, and the social environment.

The natural environment consists of three further dimensions, the biotic, physical, and chemical environments. The biotic environment of water development is seen as the ecological communities dependent on the occurrence of water in lakes and streams. The physical environment of water development is seen to be manifest in the foundation conditions of a dam, the topography of a reservoir area, and the distribution of flow in rivers. The aspect of the chemical environment relevant in almost all water development is the chemical analysis of water itself.

The cultural environment consists of the values, attitudes and technology of society. Although the technology available to the engineer in water development is easily defined, the relevant values of society are much more difficult to ascertain. Nevertheless, they are often critically important in determining the success or failure of a project. For example, if farmers, in spite of the advantages of irrigation, refuse to invest time and money in changing from wheat to vegetable production, an irrigation scheme will be a failure.

The dimensions of the social environment most relevant to water development are the economic and political institutions. The political institution is, in fact, the vehicle which theoretically expresses the values of our society and is thus the main source of initiative in water development. Economics, on the other hand, is the restrictive force in water development. The economic benefit of a project determines to a great extent whether it will be constructed or not.

The environment of water development is thus seen to be an extremely complex phenomenon. To understand it is to realize that, even though it may be conceptually divisible, it is in reality indivisible by virtue of its intricate interdependencies.

Water resources are defined as those parts of hydrologic cycle which function to fulfil human wants. If it is not functioning to fulfil these wants, it is not a resource although it may be a potential resource. Thus it is seen that an understanding of human wants is necessary in order to grasp the nature of a resource. Human wants may be conceptually presented as being composed of physical needs, psychological needs, and cultural wants. For example, man needs water to exist. That is a physical need. Within our society a high value is placed on soft, tasteless, and odorless water. That is a cultural want.[1] Finally, the increasing use of lakes and rivers for recreation by the urbanites of North America is an example of how water is a resource by virtue of its fulfilling a psychological need. It is imperative to keep in mind the characteristics of the need or want being fulfilled by a water resource for these characteristics establish the manner in which the resource is developed.

In order to establish the meaning of the word 'development' it is first necessary to define two more fundamental terms. A 'resource event' is defined as a unique or unusual happening, with the property of space-time coincidence, involving the application of a technology to the natural environment. A resource event which recurs in time and which involves somewhat the same combination of technology and the natural environment is defined as a 'resource process'. The sum of all resource events and resource processes is referred to as resource phenomena.[2] The use of loose gravel as the only fill in a dam is an example of a resource event. In effect the technology applied to the natural environment to ensure more control over the flow in a river will be a

failure because the dam will be unable to hold water. Thus, assuming that the knowledge of this resource event is general, it will not recur. On the other hand the use of compacted clay core with boulders for surface protection was discovered at some point in time. Because the dam was effective this technology has been applied again and again in similar natural environments. Thus this particular practice is defined as a resource process.

Water resources are now seen to be the result of the elemental units of resource processes which transform the natural flow or natural occurrence of water in such a way as to fulfil human wants and needs. A stream or river becomes a natural resource when some technology, whether a pail or pump, removes it from the river and makes it available for human use. Finally, the development of water as a resource is defined as the continued application of resource processes and the natural environment to mobilize the natural flow or natural occurrence of water to fulfil human wants and needs.

The final question is, what is the meaning of the word 'quality' within the context of water development? The most important point in understanding the use of this word is that it is always the quality of something for something. Thus, water has qualities as related to irrigation and the environment has qualities as related to supporting human life, but it is meaningless merely to talk about the quality of the water or the environment. It is an advantage to the decision process of water development to be able to quantify the qualities of the water for the uses being considered. This quantifying is possible in such uses as irrigation and water supply, for the qualities of concern are

chemical and physical. However, in the case of water development for recreation the aesthetic qualities of the water and the surroundings become of equal importance with the chemical and physical qualities of the water. By definition, an aesthetic value is the result of objectivization of an emotional response to one's surroundings, fundamentally on the basis of sight and sound, but also on the grounds of smell, touch, taste, and religious and historical significance.[3] From this definition it is seen that any attempt to quantify aesthetic quality must only follow a careful study of the values of the people concerned.

In conclusion, quality is a word which describes the relative degree of excellence of an object for a specific purpose. In most cases the qualities of water and landscape of interest in water development are quantified with relative ease. However, in the case of the aesthetic qualities of water and landscape, the task is extremely complex and difficult.

The following table is presented for easy reference as a summary of the definitions developed in this chapter.

TABLE I

DEFINITIONS

The ENVIRONMENT of an object or process is the sum of all things which it affects appreciably or which have an appreciable effect on it.

WATER RESOURCES are those parts of the hydrologic cycle which function to fulfil human wants and needs.

A RESOURCE EVENT is defined as a unique or unusual happening, with the property of space-time coincidence, involving the application of a technology to the natural environment.

A RESOURCE PROCESS is a resource event which recurs in time and which involves somewhat the same combination of technology and the natural environment.

DEVELOPMENT of water as a resource is defined as the continued application of resource processes to the natural environment to mobilize the natural flow or natural occurrence of water to fulfil human wants and needs.

QUALITY is a word which describes the relative degree of excellence of an object for a specific purpose.

TABLE II

DIMENSIONS OF THE ENVIRONMENT

NATURAL	BIOTIC
	PHYSICAL
	CHEMICAL
CULTURAL	VALUES
	TECHNOLOGY
SOCIAL	ECONOMIC
	POLITICAL

CHAPTER II

FOOTNOTES

1. The use of the word'want' is intentional in this instance, for it is not a need but a desire which is being fulfilled.

2. Walter Firey, Man, Mind, and Land, (Illinois: The Free Press of Glencoe, 1960), p. 13.

3. George Santayana, The Senses of Beauty: Being the Outline of Aesthetic Theory, (New York: Collier Books, 1961), p. 43-60, 99-101.

CHAPTER III

A CONCEPTUAL FRAMEWORK FOR WATER DEVELOPMENT

In this chapter the conceptual framework for water development will be presented, and the application of the framework will be discussed. As part of the discussion the characteristics of water resource processes and their environment will be studied briefly.

The nature of the conceptual framework is as follows: at time one there is a given specific environment and subsequently a resource process is applied within the context of this environment. The resources process is understood to possess an environment consisting of that part of its total surroundings which affects it or is affected by it. The process functions to alter its environment to provide some service. This alteration results in a new environment at time two. This concept may be restated in the following manner. The conceptualization involves the understanding that a resource process may be studied as inputs which are then altered, producing outputs.[1] Thus by establishing the qualities and if possible the quantities of both the inputs and outputs, the essence of the environmental change is concisely presented.

In the remainder of this chapter, the manner in which this conceptualization is useful both in studying past development and in evaluating future development plans will be discussed. Because the discussion of both applications of the framework involves a great deal of repetition, the evaluation of future development plans will be chiefly studied. Subsequently, a short discussion of the framework's application to studying historical development will be made.

CONCEPTUAL FRAMEWORK

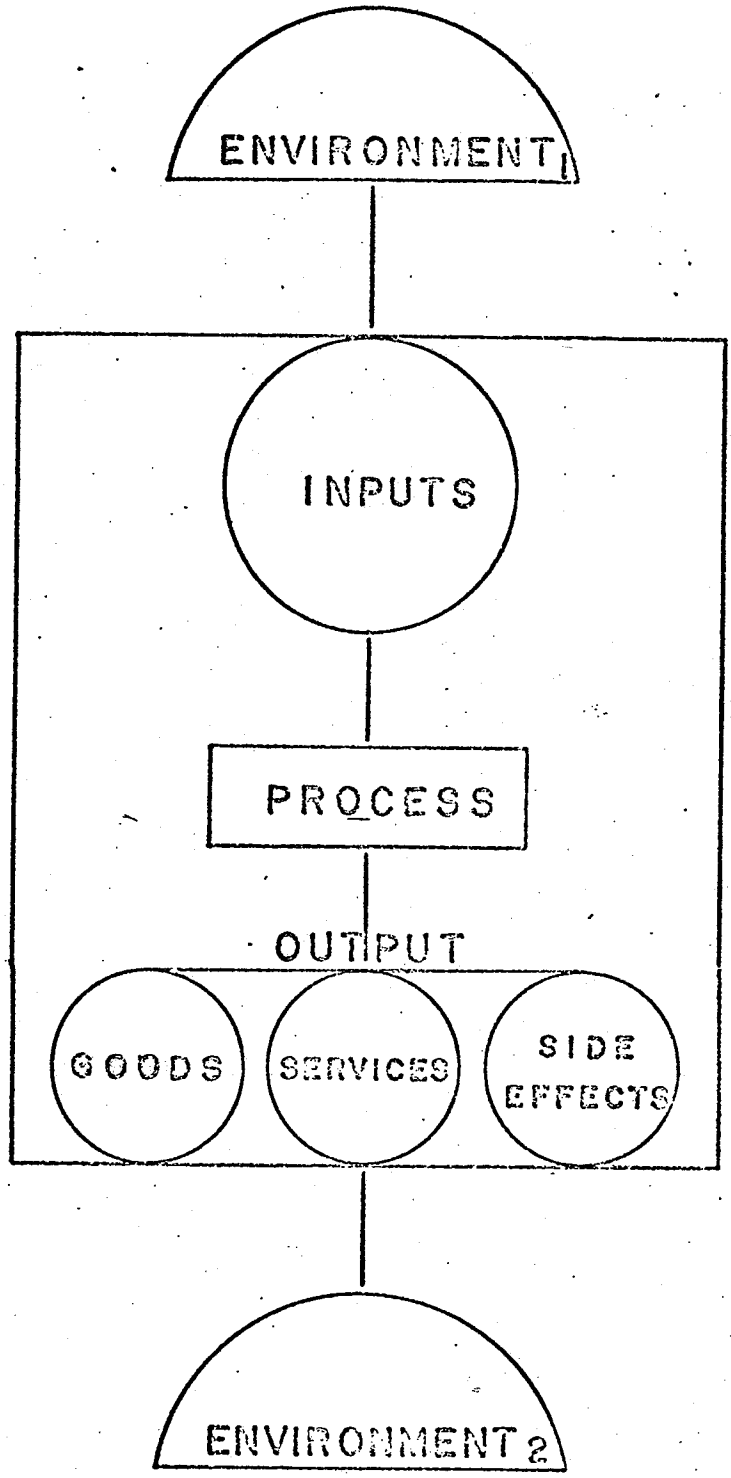


FIGURE 2

In order to define precisely what is to be studied as future development plans, it is assumed that the engineer's imperative is to plan water development projects within a comprehensive set of decision criteria. Further, the project must fulfil the needs for which it is designed without creating side effects which interfere unnecessarily with existing resource processes or impede needlessly future development.

The construction of a dam for a large reservoir is a good example for illustrating the application of the framework. It is assumed that this reservoir is to be used for flood control.

In this situation the technology available and the political climate are relatively set factors for the creation of the development plan. On the other hand, the engineer must constantly be aware of his responsibility for supplying feedback to the political institution. Nevertheless, of first concern to the engineer are the physical characteristics of the natural environment. It is necessary to determine the shape of the flood hydrograph, the topography of the river valley, and the nature of foundation conditions for the dam. By establishing the "project flood", the capacity of the reservoir can be determined. Through evaluation of topography and foundation conditions, the site of the dam is decided. After the preliminary design has been drawn-up, the economic feasibility of the project must be determined. Assuming that the project's construction is part of the government's policy and the benefit-cost ratio is favorable, the project will likely be constructed.

It is in the final detailed study of the project that the conceptual framework has its important application. That is, it forces the

engineer to take an accounting of all dimensions of the new environment he is creating. Each environmental dimension in effect asks a question. How is the reservoir going to affect life in the river and reservoir area? How is the reservoir going to affect the morphology of the river, the geography of the area? How is the reservoir going to affect the chemical composition of the water? Is the project compatible with the values of the community in the area? What are the economic ramifications of the project?

The vast knowledge required to answer these types of questions points to the need for inter-disciplinary teams in water development. It is necessary that the engineer understands the value of each discipline's contribution and be capable of integrating their contributions into the final design of a project. The most relevant aspect of each discipline's knowledge from the standpoint of water development is the decision criteria or ideals they possess. A sociological study can determine whether a resource process is adaptable, or not, in the minds of the people concerned. An economic study determines whether the resource is profitable or unprofitable. An ecologic study will determine whether a resource process will allow a stable biotic community to exist or whether it will destroy the ecologic balance.[2] Thus, it is seen that the conceptual framework forces a comprehensive evaluation of the environmental ramifications of a water development project.

The framework may be also used to conceptualize the interrelationships of water resource processes. In most cases an engineer, familiar with water development, will not have need of this tool. However, the understanding of each resource process in terms of its inputs and outputs

can give a lucid understanding of the water development process. In flood control, the major input is the river flow. The desired output is a relatively constant flow of water in the down-stream reaches of the river. In recreation, the same river flows may be developed. However, the desired output is a large reservoir of slow-moving water which maintains a relatively constant level. Thus, the use of the same reservoir for both resource processes is likely to create conflicts.

It is reasonably apparent that the full use of the conceptual framework requires a vast amount of information, some of which is difficult to obtain. In the field of water development, a great deal is still to be learned about the effects of chemical wastes and pesticides on fish life. There are difficulties in delimiting the environments of some resource processes. What is the environment of a factory producing toxic wastes? There are difficulties in defining, describing, and quantifying the inputs and outputs. Finally, there are many problems in determining the values of society as they relate to water development. On the other hand, it is equally apparent that these difficulties will be eliminated only through continued analysis and study.

Whereas in creating plans for water development the object is to make decisions, in studying historical development the object is to understand why decisions were made. Thus, where the technology and political environment are virtual givens in development planning, they are an integral part of the study of historical development. By studying the resource processes as inputs and outputs, the study moves logically through time from one environment to the next. In fact, it becomes clear how resource processes recreate their natural environment. By continually

evaluating all dimensions of the environment, greater insight into the forces behind water development is gained. As in development planning, the main difficulty found in studying historical development is a lack of information.

In summary this chapter has presented a conceptual framework for water development and briefly shown its application to past and future water development. It was seen that the framework points both to a comprehensive understanding of the environment of water development and to a lucid defining of water resource processes themselves.

CHAPTER III

FOOTNOTES

1. See Figure No. 2.

2. Firey, Man, Mind, and Land, pp. 19-36 and 243-252.

3. It may be noted that one resource process can, in fact, create an environment which has poor qualities for another resource process. This fact is apparent in the discussion of the conflict between flood control and recreation. However, it is also possible for a resource process to create a poor quality environment for its own continued operation. The irrigation of poorly drained soil with water of high salt content is a good example of this problem. The solution to these conflicts, assuming that the needs are to be fulfilled in somewhat the same manner, is to specially separate the conflicting processes as in the case of flood control and recreation, or employ a different technology or resource process as in the case of the irrigation problem.

CHAPTER IV

THE ASSINIBOINE RIVER: A STUDY OF DEVELOPMENT

The object of this chapter is to understand why and how water development in the Assiniboine River Basin has occurred as it has. In order to accomplish this end, the conceptual framework and the definitions, established in the two previous chapters, will be intensively employed.[1]

The year 1859 has been chosen as the starting date for the study. As seen in Chapter I, the natural environment had been only slightly influenced by man. Although man had not acted to develop the hydrologic cycle, he had brought about some change in the biotic environment. Both the buffalo and beaver had been drastically reduced in numbers. Transportation was either by canoe along the river or by horseback and Red River cart along trails created largely by the buffalo. Other than the trading forts there was nothing man-made of permanence in the Basin. The Indians' life of restlessness, of moving with the food supply, was still the predominant style of existence.

After the Hind report was published in 1859, a small but steady trickle of immigrants moved into the north-west. They were, however, settlers headed for the Red River Settlement, men headed for the north Saskatchewan gold, and American traders wishing to make money in the fur trade. Thus, they had relatively little direct effect on the environment of the Assiniboine Basin.

It was not until the arrival of the surveyors in 1869 that settlement of the Assiniboine Basin was to commence. Still, it was

not until after the grasshopper plagues of 1873 to 1875 that there was any substantial influx of settlers. The river was to have a major influence on the settlement.

> The summer of 1878 saw a large immigration to the country around Rapid City, and to meet the demands of trade an attempt was made to ascend the Assiniboine to a point about eight miles above the mouth of the Souris and discharge their cargoes at the foot of the "Rapid". This location obtained the name of "Rapid City Landing" as all goods destined for that point were landed here.
>
> Captain Webber, of the steamboat "Manitoba" examined the "Rapid", and pronounced his determination of taking freight and passengers to Fort Ellice. This was in May, 1879. His attempt was successful, although the wise ones at once condemned the whole undertaking.... The attention of both speculators and farmers was now turned to the river, and a large number settled a little east of Fort Ellice, and Birtle was founded by a gentleman, named Chambers, from St. Catherines. The Souris Plain was a great point of attraction, and many settlers took up claims and began farming around Rock Lake.
>
> During the winter of 1879-80, interested parties got up some excitement about Odanah and Minnedosa, two embryo cities, located where the "North Trail" crosses the Little Saskatchewan. In the spring, a rush took place, and the boats on the Assiniboine River were loaded with freight and crowded with passengers, destined for those two "cities". Instead of using "Rapid City Landing" as in the spring of the preceding year, the boats now ascended the river to "Grand Valley', six miles above the rapid, and here the nucleus of a new city was established. Hundreds of tons of freight came up the river in the spring of 1880, numerous immigrants arrived, and things looked lively.[2]

With the impending arrival of the railway in 1880, the period of rapid growth in the Assiniboine Basin started.

> As spring advanced speculators and actual settlers poured into the country, and as the cars were now running to Portage la Prairie there was no difficulty in reaching the centre of the new movement. The "Syndicate" decided to change the location of the road, and at once all eyes turned to "Grand Valley", as a possible point for profitable investment. McVicars, who owned the land at the 'Grand Valley", refused to sell except at an extravagant price, and the "Syndicate" decided to build their town one and a half miles farther upstream, and in a few days the new city of Brandon, 145 miles west of Winnipeg, was in the market.

> The works on the Canada Pacific Railway were pushed on with great vigor, and the public were informed that the cars would be running south of the Assiniboine before August. People poured in by the hundred. All the land south of the Assiniboine along the line of railway was taken up, and hundreds of lots sold in Brandon at fabulous prices. Stores, hotels, dwelling-houses, and other buildings were run up as if by magic, and where nothing but prairie was seen in the spring the nucleus of a thriving city with all civilized appliances appeared before the short summer was passed.[3]

Thus, in 21 years, from 1859 to 1880, a radical change took place in the style of life in the Assiniboine Basin. Where the Indian has no ties to any particular plot of land, the settler committed himself to one. It was critical that the area he became committed to had qualities which would ensure his immediate and continued welfare. He had neither the technology nor economic resources to make any radical alterations in the natural environment.

The presence of the river had a considerable influence in determining the quality of the land for settlement.

One aspect was the fact that the river was the medium along which most communications and supplies travelled. However this influence lasted for only a short period. In 1881, with the arrival of the railway, the steamboats left the Assiniboine River after only three brief years of operation. The use of the river for navigation has no perceptible effects on the River itself, but it did have an important side effect. The river was legally defined as navigable. Thus, until quite recently, bridges across the river were either draw or swing types which would allow the passage of a boat. Also resulting from the classification as a navigable river was the partial jurisdiction of the river by both the Federal and Provincial governments. Thus, these political institutions became a relevant dimension of the Assiniboine's environment.

Another aspect influencing the quality of the land for settlement was the fact that the river served as a dependable water supply and as a source of food with its abundant supply of fish. The availability of water was a critical factor in any settlement attempt. Macoun, in giving advice to prospective immigrants, states:

> The first requisite is a dry level or gently rolling surface free from brush on at least two-thirds of the lot. The next necessity is permanent and pure water. Should there be ponds on the lot an examination is absolutely necessary, to see whether the water is pure or saline.[4]

With the continuing influx of immigrants into the Assiniboine Basin, water development was to commence in earnest. Because the settlers committed themselves to a plot of land, they had a vested interest in its qualities. With the increasing population, conflicts began to arise between various resource processes which had originally been innovated.

Initially, the village of Brandon depended on shallow wells and springs for its water supply. As the village grew, however, a problem was to arise. As Kavanaugh relates it:

> The health of the citizens was always a matter of concern to the alderman. August 28 (1882) found them ordering a sewer to be made from the immigration sheds to the Assiniboine River, and when it was reported that 'water closets were in a defective state in the city and were poisoning the wells, the council was quite solicitous.[5]

Thus, the resource process of disposing wastes into the ground reduced the quality of the environment for water supply. However, the construction of sewers served to rectify the situation by removing the wastes to a spatially separate area. In this way, the quality of the environment within the village was maintained for water supply, at the expense of the area downstream of the sewer outlet.

This resource situation is an excellent example of how the conflict between two spatially coincident resource processes may be solved. A resource process utilizing a different technology is innovated in order to alter the physical and, or, spatial characteristics of one process's outputs. The example also illustrates the importance of population density in determining the quality of the environment for a particular set of resource processes. In the example, the quality of the environment at Brandon to supply water and absorb wastes for a population of three, in 1880, was quite adequate, while it was not adequate in 1882 when the population was approximately 3,000.

As the population continued to grow, the demands which the city placed on its environment also grew. Although one well, known as Fleming's well, was to continue in operation until the late 1920's, the shallow wells could not furnish an adequate supply of water by the late 1880's.

> In 1891 the City Council attempted to drill artesian wells as a source of water but were unsuccessful in locating a sufficient supply and finally decided to avail themselves of the Assiniboine River. Although the river boats of the early Eighties had long since withdrawn, the Assiniboine was still considered to be a navigable waterway and certain legal steps had to be taken to get permission to use it as a source of water and as a depository for sewage. The contract for the installation of the waterworks was let in 1892 but the contractor was unable to complete the job and the city had to take over. During 1893 the installation was completed and in October of 1893 the water was turned on.[6]

In 1904 the old section of the present treatment plant was built. It used steam operated pumps and treated the water with chlorine and high pressure sand filtration. The steam operated pumps were replaced with electric pumps in the early 1900's. About 1930 the water tower was built to ensure adequate pressure in the mains. Water softening

and treatment for taste were initiated in 1948. In the early 1950's the plant was redesigned, a gravity sand filter and a new 60 inch reinforced concrete intake being installed. Finally, in 1958 a new plant addition was built bringing the total capacity of the treatment plant to six million imperial gallons per day.[7]

To understand the quality of an environment for water supply it is necessary to perceive the demands which society is placing on that environment for water supply. With this knowledge much of the change in the quality of the environment may be understood. Since the quality of the water in the Assiniboine River at Brandon has not altered appreciably since the founding of the city, the manifestation of the changing social and cultural demand is seen in the changing characteristics of the treatment facilities.[8] The increase in demand for volume of water as well as the demand for water which is germ-free, tasteless, odorless, and relatively soft indicates the growth of a village of the 19th century to a city in the 20th century. It is as a result of the changed demands, that it may be said that the quality of the environment is decreasing.

In the winter of 1937 unusually low flows on the Assiniboine caused a great deal of concern about a water shortage in the city. Thus it is seen that the qualities of the environment, in particular the flow distribution in the river, have a poor quality to meet the demand for water supply. Since that time, dams have been constructed at Rivers, on the Minnedosa River and Shellmouth, on the Assiniboine River, which modify the flow distribution in the River. Thus, by innovating new resource processes the demand for a dependable water supply in Brandon was met.

A resource process which has continued in practice since 1882, is that of using the River for sewage disposal. This situation points to the fact that the environmental quality of a resource process has a spatial dimension. The city had, as part of its environment, a river of high qualities for both water supply and waste disposal. Since this situation was satisfactory from the city's standpoint, it was not until 1962 when the Provincial government forced the city to stop dumping its raw sewage into the river, that the disparity between the qualities of the river above and below Brandon was rectified. The new process which was innovated was a primary and secondary lagoon system of waste treatment. The process decomposes the sewage to about 90% of its original B.O.D. The effluent is discharged into the river only after it has been carefully analysed and if the flow in the river provides adequate dilution.

This history is another illustration of the effect of population on the qualities of the environment for a resource process. In this case, the people downstream of Brandon, through the political institution, were a factor in creating an environment which forced Brandon to adopt a new resource process for its waste disposal.

In 1914, hydro power was considered as a possibility at Currie's Landing, about seven miles east of Brandon.[9] It was found, however, that the characteristics of the yearly flow distribution were poor:

> .... as the .... lowest output of the water plant would be coincident with the heaviest load requirements.
>
> Taking this into consideration and the fact that the water power plant in this location is not what can be termed a cheap development, considering the length and height of dam required, for the head obtained and power generated, it would be well for any private company or Municipality before committing themselves to the heavy overhead charges of the combined plants, to fully investigate all other sources of power, such as steam, oil, producer gas, etc.[10]

Thus, the Assiniboine River at Brandon was found to have poor qualities for water power.

On the other hand, water serves as a transmitter of energy in the steam plants which have and still supply much of Brandon's electric power. At present, the steam plant operated by Manitoba Hydro is located a mile east of the city on the banks of the Assiniboine across from the old site of Grand Valley. A weir has been built to ensure an adequate supply of water for cooling during low flows. The use of the river to dispose of the heat has not as yet altered the quality of the water for down-stream users. It is possible, however, that the heat may reduce the ability of the River to assimilate the sewage discharged from Brandon's sewage lagoons.

Until 1910, the spring melt was used to carry lumber down the Shell, Minnedosa and Assiniboine Rivers to a saw mill in Brandon. By that year, however, most of the lumber had been cut from the slopes of The Riding and Duck Mountains and operations ceased. This resource process is an excellent example of a resource process which recreated its environment in such a way that its eventual failure was imminent.

There is a long history of attempts to create an artificial lake on the River within the city limits of Brandon.[11] At least seven separate proposals have been made, the first being made in 1894 and the last in 1958. However, the economic and political environments have continually negated the project. On the other hand, a small weir has been constructed to keep the water supply intake below the ice level in winter. During the summer months, a few fishermen can usually be found casting out into the turbulent water below the weir, but the catch is small especially when it is compared to early reports of

fishing in the river. Nevertheless, Brandon's environment is aesthetically enhanced by the River flowing through it. In 1882, Macoun wrote:

> The situation of Brandon is very fine and with the picturesque hills on both sides of the river, presents even now a fine appearance from any point of approach. The site is well chosen in every respect and unlike Winnipeg is secure from floods, commands anyquantity of excellent water and will always prove healthy as drainage is quite practicable.[12]

After Macoun's statement, it is interesting that flooding has, nevertheless, been a continuing factor in the quality of the environment for Brandon. This fact is perhaps ironic since the city of Brandon owes its size, in part, to the floods of 1881 and 1882. At that time Grand Valley, although it had been by-passed by the railway, was a village at least equal to Brandon in size. However, these two floods were disastrous to the village situated on the banks of the river. Grand Valley died and Brandon grew.

As Brandon grew, most of the land above the railway became inhabited and the immigrants began settling in the flats along the river. The land was fertile but as was shown at Grand Valley not suitable for permanent buildings. The floods of 1902 and 1904 occurred before extensive settlement had taken place in the flats. But, in 1922, a relatively large flood occurred, flooding 200 houses for six weeks.[13] The following was a description of the situation:

> These houses are not connected with the city's water or sewer systems and are occupied by foreigners and laborers, and they are adverse to quitting the flats because of their desire for gardens on the flats. Mr. Anderson stated that the homes suffered considerable damage, the plaster being gone as far as the water line, the floor warped badly, and any furniture not removed was now practically worthless. A green slimy deposit remained on the floors and walls and could not be thoroughly cleaned away.[14]

In 1923 and 1927 the area was flooded again.

Thus, the Brandon flats were proven to be an area prone to flooding as well as an area attractive for gardens. The situation created a social demand for a change in the quality of the environment. This demand influenced the political environment to the extent that a number of studies were made of flood control and water supply on the Assiniboine River. Table III gives a chronological list of these reports.

TABLE III

ENGINEERING REPORTS ON THE DEVELOPMENT OF THE ASSINIBOINE RIVER

Preliminary Report Assiniboine River Development, G. L. MacKenzie and C. H. Attwood, 1945.

Report on Conservation and Flood Control, Assiniboine River, D.F.R.A., December, 1952.

Report on Investigations into Measures for the Reduction of the Flood Hazard in the Greater Winnipeg Area, Red River Basin Investigation, March, 1953.

Report of Manitoba Royal Commission on Flood Cost-Benefits, Royal Commission, Winnipeg, Manitoba, December, 1958.

Benefit-Cost Analysis: Assiniboine River Flood Control and Water Conservation Projects, E. Kuiper, Winnipeg, Manitoba, January, 1961.

These reports have led to the construction of Shellmouth Dam, and the Portage Diversion along the Assiniboine River. The city of Brandon has also constructed dikes around the most densely populated portion of the flats. The immediate result of these structures is that of increasing the quality of the land along the river for permanent buildings.[15] Thus, the commitment of individuals to specific plots of land near the river has resulted in the construction of structures which have improved the quality of the environment for the permanent occupancy of the land.

The detail of the political, economic, and cultural environmental dimensions which interacted to create these changes is beyond the scope of this thesis. However, in a comprehensive understanding of the development of the river and the changing nature of its environment, the detailed study of all dimensions of the environment is necessary.

The following part of this chapter will deal with the environment of the Shellmouth Dam. The section will briefly develop an historical background of settlement and water development before studying how the dam has changed the qualities of the environment in the area.

The first settlers came to the area in the early 1880's along the Pelly Trail. They quickly settled the land which was relatively level and had a dependable water supply. In general they settled along the Assiniboine and Shell Rivers. Ranching was extensive throughout the valley and course grains were grown on the uplands.

Between 1880 and 1890 the basis for the villages of Dropmore, Shellmouth, Roblin, and Russell were laid. With the construction of the Railway into the area in 1903 settlers came into the area in large numbers to settle the remaining land.

There has never been a difficult problem with the quality of the environment as it is related to water supply. Shallow wells, dug at first by hand, then by "horse power", and now with mechanically powered drilling rigs have almost always furnished an adequate supply of water for the farms and towns. There are only isolated instances where a number of wells had to be sunk before a supply of water was obtained.

Drainage has also never been the cause of much difficulty. Although some areas exhibit only local drainage into sloughs, in general the drainage of water off the land is very good. In fact the difficulty

which is most often encountered is that of too rapid drainage. Some small drains have been dug in the valley flats to aid the draining of land after the spring flood. These drains were suggested by Macoun in 1881.

> Within the immediate valley of the Assiniboine, and subject to summer floods, are immense marshy meadows or bushy flats, which would produce millions of tons of hay every year, with a very trifling outlay. These marshes extend from Fort Pelly to far below the mouth of Shell River, but it is above this point where they are of the most value. Owing to the land near the river margin being often a foot or two higher than these marshes, they retain their water in many cases for months after it has fallen within the banks. Last September, I passed lakes many miles in length that could have been drained by one day's labour, and this land would produce from three to five tons of hay to the acre. The tracts not covered with water later than early in July, were covered with grass often four feet high and as thick as it could stand. No finer tract for dairy farms could be found than the Assiniboine River Valley from Fort Pelly to very near Fort Ellice.[16]

The river served as a route for river boats from 1879-81. However, for some time it served as a dependable source of fish which were caught daily in large quantities. But the edible fish have almost disappeared from the river since the turn of the century. Whether their disappearance was due to "over fishing" or to a natural cycle in the river, it is impossible to ascertain; however, in recent years they seem to be returning slowly.

The river has had another role in the development of the region defined by the Duck and Riding Mountains in the east and north, the Saskatchewan boundary in the west, and the Russell area in the south. It has acted as a boundary. Not only has it acted as a legal boundary between farms, but it has also acted as a natural boundary separating the Dropmore area from Roblin, Inglis and Russell. This separation

has been overcome to some extent by the construction of a number of bridges for the railways and highways. However, the fact that it is a relatively small separate area has worked against the development of the area. For example, the area belongs to the Roblin Hospital District and thus has not any medical facilities of its own.

In 1958, the Royal Commission recommended, among other structures, "a storage reservoir near Russell, Manitoba, at an estimated cost of $6,450,000'.[17] Since the preliminary report was completed in 1945, the Russell reservoir site was looked upon as more desirable than the alternate reservoir four miles above Shellmouth.

> While the flooding of the C.N.R. bridge and approaches near Shellmouth and of the C.P.R. bridge and highway bridge at Millwood are expensive items in the cost of the Lazare-Russell systems, this system appears to be the more commendable because of its greater storage capacity. It has been suggested that possibly the abandonment of the C.N.R. west of Shellmouth is a matter that has already been considered.[18]

Thus, the physical qualities of the river valley, especially the foundation conditions, and storage characteristics favored the location of the dam near Russell. However, the political environment of this particular project was to become turbulent. A farmer, Mr. Bill Wileman, organized the farmers in the valley, forming a Committee which, with Mr. Wileman as Chairman, vigorously fought the construction of the dam in the valley. By 1961, the Prairie Farm Rehabilitation Administration, P.F.R.A., had completed the engineering investigations of the flood control projects on the Assiniboine. With the technical advances made in soil mechanics, since the earlier investigations, it was found that it was now possible to build the dam at the Shellmouth location. Whether the farmer's agitation was a determining factor in

the move to the Shellmouth site is an open question. In Kuiper's study, submitted in January 1961, only the Shellmouth dam was included.[19] Mr. Wileman attempted to reorganize his Committee to fight the construction of Shellmouth Dam, but due to a number of factors he was unable to gain the support which he had had in fighting the Russell dam.[20]

In any case, the dam was constructed and completed in late 1968. The question must be asked; how has the dam altered the qualities of the environment for the community which is directly affected by it? It is clear that the dam alters the flood flows on the Assiniboine River in such a way as to improve the characteristics of the environment downstream of the dam.[21] However, does it improve the qualities of the environment in the dam area?

The following discussion is based directly on the conceptual framework of Part I. Simply, an environment existed with certain qualities before the construction of the dam. The construction of the dam is a resource process having inputs and outputs which alter the environment to create a new environment at a time two.

Ranching and farming are the primary means of livelihood in the area. A number of farmers owned land both in the reservoir area and in the uplands; however, there were some farmers who owned all their land in the valley. For them, the dam meant leaving the area completely and buying a new farm. Or, if they were lucky, they were old enough to retire.

Thus, a large area of very good hay land was removed from the economy of the area. The fact that it was mostly pasture subject to frequent flooding does not indicate the important role of the land in

the area's economy. The hayland could be depended on for a crop almost every year and was always there to fall back on when there was a crop failure on the plains.[22]

Also, the fact that a number of people have been forced to move from the area is a loss. The most critical resource for any community's development is people. Not only in the sense that a large population is desirable as a consumer market, but also in the sense that prosperity in a rural town is often the result of the energy and initiative of strong individuals.

There is another ramification of the dam construction. That is the accentuating of the Dropmore area's isolation. To help ease this situation, the Area Development Committee submitted a report to the Provincial government requesting a paved road over the dam.[23] Fortunately, the request was granted, but the fact remains that the distance which separates Dropmore from the area on the east side of the river has increased.

On a more positive point, a proposed land use plan has been prepared for the Water Control and Conservation Branch of the Manitoba Department of Highways as a joint Federal-Provincial project by the Manitoba Department of Mines and Natural Resources and the Canada Land Inventory.[24] The study assessed the "designated reservoir area" in order to determine the quality of the environment for a comprehensive list of resource processes under the main headings of agriculture, fisheries, recreation, and wildlife. The quality of the area for each resource process was determined separately using a numeric scale. Then the resource processes were integrated, assigning the land of highest

quality for a specific use to that purpose. Integration of conflicting uses, such as extensive and intensive recreation, was accomplished by leaving buffer zones of wood lands or the construction of fences. The study has resulted in an admirable plan of land use, based on the quality of the natural environment for an exhaustive range of resource processes associated with recreation, agriculture, fisheries and wildlife.

It has, however, overlooked a number of critical aspects of its relevant environment. The plan proposes that a total of 13,688 acres of 63% of the total area be used for extensive and intensive recreation.[25] Most of the people in the area already have cottages at, or frequent the large number of different lakes in the area. In addition, there appears to be no large potential market which is not already adequately serviced. In the minds of local people, the effects of the dam are only disastrous. In their minds at least, the development of the reservoir for recreation is not adoptable. It would appear that any hope that the development of the reservoir for recreation will, in the near future, offset the losses inflicted on the community is optimistic.

Another important facet of the plan's environment which appears to have been overlooked is the fact that the political environment was such that, when the dam was designed, flood control and water supply were the design criteria. Thus it becomes necessary to ascertain the qualities of the reservoir for the range of proposed resource processes by taking into account the reservoir regulations required for flood control and water supply.

It has been seen that the Shellmouth Dam area has experienced a reduction in the qualities valued by the people in the surrounding community. The future imperative becomes one of integrating the local

community more fully into the process of a reservoir's development.

In this study of the historical development of the Assiniboine River Basin, it was seen that to understand water development fully, it was necessary to take into account all dimensions of the environment. In addition, it was seen that the development of the Basin could be understood in terms of resource processes, consisting of inputs and outputs, which altered their given environment through time to create new environments.

CHAPTER V

FOOTNOTES

1. Table I of definitions, page , Table II of environmental dimensions, page , and Figure 2 of the conceptual framework, page , have been presented for easy reference.

2. John Macoun, Manitoba and the Great North-west (Guelph, Ont.; The World Publishing Company, 1882), p. 469.

3. Ibid, p. 472,473.

4. Ibid, p. 634.

5. Martin Kavanaugh, The Assiniboine Basin (Hammersmith, London, England: The Teacher Training College, 1966), p. 171.

6. MacDonald Coleman, The Face of Yesterday: The Story of Brandon Manitoba, (Brandon, Manitoba: The Leech Printing Ltd., 1954), p. 64.

7. R. J. Trent, interview, Brandon, Manitoba, September, 1968.

8. This assumption is made in the light that although there have probably been some changes which have taken place due to man's presence in the basin, they have not altered the water significantly.

9. J. W. Ireland, Report on Possibilities of Hydro Electric Development on the Assiniboine River at Currie's Landing, (Winnipeg, Manitoba Power Survey, 1914).

10. Ibid, pp. 24, 25.

11. Water Control and Conservation, Manitoba Department of Highways, Correspondence File, 91.2.5.

12. John Macoun, Manitoba and the Great Northwest, p. 485.

13. C. H. Attwood, Report on the Assiniboine River Floods: April and May 1922, (Winnipeg: Department of the Interior, Canada Dominion Water Power Branch, March 1923), pp. 1, 3.

14. Ibid, Appendix 1, p. 4.

15. At the same time that all three structures reduce flood damage, increasing the quality of the environment, it is important to remember the different manner in which each acts. Ultimately the quality of the environment protected by different structures is slightly different.

16. John Macoun, Description of the Province of Manitoba, (Ottawa: Printer to the Queen's Most Excellent Majesty, 1893), pp. 67, 68.

17. Report of the Royal Commission on Flood Cost Benefit, H. W. Manning, Chairman (Winnipeg, Manitoba, December 1958), p. 2.

18. G. L. McKenzie and C. H. Attwood, Preliminary Report: Assiniboine River Development (1945), p. 7.

19. E. Kuiper, Benefit-Cost Analysis Assiniboine River Flood Control and Water Conservation Projects (Winnipeg, Manitoba Department of Agriculture and Conservation, Water Control and Conservation Branch, 1961), pp. 3, 4.

20. The most important factors seen to be then, (1) the dam was beginning to be viewed as an inevitability by the people in the area and (2) he was dealing with people not immediately known to him, thus decreasing his power of leadership. The preceding information was gained in an interview with Mr. H. M. Boughton, Roblin, Manitoba, August 1968.

21. "It may be concluded after having taken into account the extent of flood control required along the Assiniboine River, together with Manitoba's estimated water supply requirements in the same drainage basin over the next three to four decades, that the most suitable and economic combination of works for development of the river, for these purposes, would be the construction of the Shellmouth Dam and the Portage Diversion". Kuiper, Benefit-Cost, p. 27.

22. There have been only one or two years since 1905 that a crop has not been harvested in the valley.

23. The report which also briefly mentions other ramifications of the dam construction is reproduced in Appendix II.

24. Canada Land Inventory, Shellmouth Designated Reservoir Area: Proposed Land Use Plan (Draft Copy: Winnipeg, Manitoba, June 1968).

25. Ibid, p. 48.

CHAPTER V

THE ASSINIBOINE RIVER, FUTURE WATER DEVELOPMENT

This chapter will deal with future water development in the Assiniboine River Basin. The Prairie Provinces Water Board Report, No. 12, Water Supply and Water Use in the Assiniboine & Qu'Appelle Basins,[1] will be used as the background material for the study. The object will be to analyze the report briefly, in the light of the conceptual framework, discussing the factors which will be of major importance in planning the Basins' future development.

In order to present a brief synopsis of the Report, the following excerpts are quoted:

> The stream flow records of the period 1921 to 1960 were assumed to be a measure of the water supply for a "representative" forty year period. It was also assumed that a maximum release of 1300 cfs from the South Saskatchewan reservoir was available to supplement the water supply.[2] The use of reservoirs was incorporated into this study.

4. Reservoirs Considered in Study

The following reservoirs were considered in this study:

a). Proposed reservoirs - Victor Reservoir on the Qu'Appelle River, Wascana Reservoir northwest of Regina, Moose Jaw Creek Reservoir and eight reservoirs in the Upper Assiniboine basin. It is assumed that some of these reservoirs would not be required, or constructed, until the Year 2000.[3]

The location of these reservoirs is shown on the Map, page 2.

2. Water Use Demands

a) The water requirements for irrigation, industrial and municipal uses and for pollution dilution were taken from P.P.W.B. Report No. 9.[4]

TABLE IV

AVERAGE ANNUAL WATER REQUIREMENTS
IN THE ASSINIBOINE & QU'APPELLE WATERSHEDS

By Manitoba in the Lower Assiniboine Basin:

Year 1980, consumptive use	96,900 acre feet
Year 1980, dilution	437,000 acre feet
Year 2000, consumptive use	354,300 acre feet
Year 2000, dilution	1,323,400 acre feet

By Saskatchewan in the Upper Assiniboine Basin:

Year 1980, consumptive use	20,600 acre feet
Year 2000, consumptive use	87,300 acre feet

By Saskatchewan in the Qu'Appelle Basin:

Year 1980, consumptive use	99,000 acre feet
Year 1980, dilution	357,000 acre feet
Year 2000, consumptive use	191,300 acre feet
Year 2000, dilution	434,400 acre feet
Evaporation Demand in the Qu'Appelle Basin	111,000 acre feet[5]

The most striking aspect of the proposed allocation of the Basin's water resources is the large quantity of water allotted to pollution dilution. Table I of the Report shows that in fact the volume of water allotted to dilution is a number of times the volume of water allotted to consumptive use. As was illustrated in the history of Brandon, sewage may be dealt with by a number of different resource processes. It becomes obvious that other resource processes, utilizing a different technology, are required in order to reduce this demand. As pollution is invariably the result of the waste output of some process, it is also obvious that, given a new technology, it may be possible to reduce the wastes produced by these processes. When it is realized that the ratio

of consumptive use to dilution requirement in the P.P.W.B. study is one to four in most cases, the need for a new technology to deal with the wastes of resource processes becomes urgent. To place such a burden on the natural environment not only requires a large capital investment to insure adequate flows in the river, but also often reduces the aesthetic qualities of the river and its immediate surroundings.

The construction of the reservoirs, proposed in the Report, will have a profound effect on all dimensions of the environment in the Basin. By viewing the development of a reservoir site within the conceptual framework, the multi-dimensional character of its relevant environment is defined. When the development comes to be viewed as the creator of a new environment instead of merely a resource process fulfilling a want, the multi-dimensional character of the environment's qualities also becomes evident.

In engineering studies, certain environmental dimensions are invariably taken into account. It is general practice to evaluate the physical environment of a dam site for its foundation conditions and reservoir characteristics. It is also necessary to evaluate the social environment of the development, especially the economic dimension. It is also general practice to construct those projects which are desirable from a political point of view. In a sense, this statement is trite for it is the political dimension which controls development of water almost exclusively, using economics and engineering reports to aid in making its decisions.

However, if the development process is viewed in the context of its total environment and in light of the social imperative of 20th century development, a number of further dimensions must be taken into account.

The biotic environment of a reservoir is important if forms of recreation are to be associated with the completed project. These activities may range from swimming and boating to merely enjoying the scenery. In the proposed land use plan of the Shellmouth Designated Reservoir Area, Canada Land Inventory appears to have done a thorough study of this dimension of the reservoir's development. Where that particular study appears to have failed is in its seeming isolation from the other dimensions of the development's environment.

The aspect of the environment consistently overlooked is the cultural dimension. The organizations and values of the community directly affected by the dam construction are often viewed by engineers as irrelevant and thus they are excluded from the planning process. In a sense they are irrelevant. They have little relevance to the compaction of dam fill or the stage-storage curve. On the other hand, they are very relevant to understanding how the qualities of the environment are changing. If all the results, or outputs, of the development process are to be gauged, the social structure in which they take place must be understood. A comprehensive sociological study, however, would serve more than merely to aid understanding of the change in environmental qualities. It would also serve as a guide in helping reduce adverse effects the construction may have on communities. It would serve as the basis for programmes designed to help the communities adjust to and take advantage of development in its area. Despite the advantages of such a study, it is usually not carried out in any rigorous manner. Nevertheless, it is submitted that if the object of a reservoir development is to increase the qualities of the environment, the community in the construction area has an importance equal

to that of a down-stream community.

The additional sub-dimension of the cultural environment, technology, is extremely important in understanding the value of a report, such as Water Supply and Water Use in the Assiniboine & Qu'Appelle Basins. As seen in the historical development of the Assiniboine Basin, the technology available to the engineer is constantly expanding. Thus, in the case of the P.P.W.B. Report, it is necessary that the report be viewed as the 1966 future development plan for the Assiniboine and Qu'Appelle. The older the report becomes, the less relevant it becomes to the realities of the actual development. Thus it is necessary that the planning of water development be an on-going process.

This understanding is corroborated by the fact that all environmental dimensions, especially the political and economic, are continually evolving. The responsibility for the on-going evaluation of all environmental dimensions is not that of the engineer. The evaluating of the characteristics of a dimension must be the task of a professional in that discipline. The responsibility of the engineer, however, is to perceive the necessity for the other disciplines to be integrated into the water development planning process.

In summary, it has been seen that if the Assiniboine River Basin is to be developed to create an environment both functional and aesthetically acceptable, an on-going and comprehensive evaluating of the Basin's total environment is imperative. This task is not the imperative of the engineer alone. More precisely, it is the imperative of an inter-disciplinary team working in close communication.

CHAPTER V

FOOTNOTES

1. P.F.R.A., Hydrology Division, Water Supply and Water Use in the Assiniboine & Qu'Appelle Basins (Regina, Saskatchewan: Prairie Provinces Water Board, May 1966).

2. Ibid, p. 1.

3. Ibid, p. 7.

4. Ibid, p. 6.

5. Ibid, p. 22.

CHAPTER VI

SUMMARY DISCUSSION

Man by virtue of his omnipresence in the Assiniboine Basin cannot help but alter the qualities of the environment in many ways. But changes have, in general, increased the qualities of the environment for his occupancy. The protection of fertile flood plains and the maintenance of a dependable flow for water supplies, through the construction of reservoirs, are examples of such favorable changes.

With an increasingly high standard of living, people have acquired the time and means to become more aware of the natural environment around them. Outdoor recreation is one of the fastest growing industries in North America. Because the city has, to a large extent, become devoid of natural aesthetic beauty, the urbanite has turned to areas unaffected by the development which has created our society. However, as more and more of the country becomes developed these "natural" areas are becoming fewer and fewer. In the Assiniboine Basin, the development plan for the Shellmouth Dam designated reservoir area is a good example of an attempt to create an area which will be a future asset in this respect.

Because the development of water affects all aspects of the environment in both direct and indirect ways, it is imperative that the water development engineer comes to realize the full ramifications of his actions and plans. The need for this realization was seen to be particularly crucial in forcing an evaluating of society's values, both at large, and in particular areas directly affected by a development process. By studying the resource processes involved in a development project within the comprehensive environmental framework, it became possible to gain an awareness of these ramifications.

Thus, the conceptual framework, presented in this thesis, is an aid in understanding water development by forcing a realization of the total environment of a water development project. By stating the nature of resource processes as inputs and outputs, the framework gives the decision-maker an effective tool for lucid analyses of a project's ramifications. In the case of cultural values, it was seen that only a thorough sociological study is able to establish their relevancy as inputs to the development process. It was found in the case of Brandon's water supply that the qualities of the environment for a resource process must be evaluated and re-evaluated as one moves through time.

As today's environment is the result of the solutions to yesterday's problems, tomorrow's environment will be determined by the manner in which today's problems are solved. Today the natural environment is being altered faster than ever before in history. Not only are changes taking place faster, but they are also on a much vaster scale. These changes are for all intents and purposes irreversible. Only by using a comprehensive conceptual framework, such as was presented in this thesis, can the engineer be intentional in creating an Assiniboine River Basin which has the optimum qualities for the widest range of uses and communities of people.

In conclusion, it has been found that when considering the future development of the Assiniboine River Basin, it is imperative that all environmental dimensions be given due consideration. In order to act on this imperative, it will be necessary for the Government of Manitoba to establish a closely coordinated multi-disciplinary team. This team must work in conjunction with the traditional governmental structure, but at

the same time it must be a unit by itself. It will be only through the efforts of such a team that comprehensive, on-going planning for the future development of the Assiniboine River Basin will become a reality.

APPENDIX I

AN HISTORICAL OVERVIEW OF THE PRESENT STATUS OF WATER DEVELOPMENT CRITERIA

The object of this appendix is to develop an understanding of the present decision criteria in the field of water development. In order to establish this understanding, a brief study is made of the historical foundations of our present society and engineering knowledge. Finally, the status of the thesis in relation to present decision ceiteria in water development will be discussed.

Thus, the first question is, how is the society of the last part of the twentieth century to be understood? It is proposed that the seventeenth and eighteenth centuries be understood to be the time of the political revolutions and the nineteenth century be understood to be the time of the economic revolutions. Both of these revolutions have radically affected our time. The twentieth century is understood to be the manifestation of a cultural revolution, founded on the preceding two revolutions.[1]

The political revolutions of the seventeenth and eighteenth centuries formed the basis for the present institutional complex. With the growing awareness of individualism brought on by the protestant reformation and the closely associated scientific revolution, feudalism was dealt its death blow. Many countries experienced strife which opened the way for a new political order and a new class. Although the entrepreneur class was growing and although men had gained a certain amount of political freedom, the majority of the population was, however, still tied to

the land. Man still appraised his environment as to its capacity to furnish him directly with what he wanted.[2]

The engineer of this time was just beginning to adopt the scientific approach to understanding phenomena.[3] However, he was still restricted by the materials he had to work with and a lack of empirical understanding. On the other hand, his inheritance was large. The Egyptians, Greeks, and Romans had together developed an extensive intuitive knowledge of water supply and irrigation systems, to name two outstanding examples. The fact remained, however, that the engineer played a utilitarian role, providing basic necessities with an essentially intuitive knowledge.

The economic revolution of the nineteenth century saw a change in this relation of man to his natural environment. Although the industrial revolution was an extremely complex social, agricultural, and technical phenomenon, its ramifications are very apparent. The machine extended man's ability to use and mold his surroundings. The market economy as we know it came into being. With the use of machines, capital was easier to accumulate and re-investment was possible with rapid returns. The advances in medical science were lowering the death rates and the population or consumer market was expanding rapidly to utilize the goods produced. The goods produced were viewed in terms of economic more than utilitarian value. It is in this way that the consumer and the producer became separated. Quantity, not quality, was required to serve the market which was composed of a rising middle-class agglomerating in the growing urban centres.[4]

The hydraulic engineer now had at his disposal a growing battery of theoretical design criteria.[5] Dams for electric power were built.

Water supply systems were designed and constructed, river regimes were "improved". Not only was the engineer's empirical knowledge improving, but the machines and materials on which he depended were becoming increasingly refined. The economic factor in designs was extremely important. The projects were now being directly supported by a population which had only recently gained its political freedom.

Now in the middle of the twentieth century the ramifications of the economic revolution are more striking than ever. There has been such a movement of people into the city that the society has become predominantly urban. The division of labour and mechanization have increased steadily, if not exponentially, to the point where the factory is almost the only producer and the market is effectively the only place where necessities are obtained. The distance in understanding between the consumer and producer has continued to grow. There is little feeling left in the production sector toward the quality of its products; quantity is the critical factor in success. The increasing population is putting continued demands on its environment. The general result has been that the individual has obtained a relatively high economic standard of living with an increasingly large proportion of his time being free for leisure. This increased leisure has helped to increase his awareness of changes in his environment at the same time as society has the financial and technical ability to radically alter them. What is happening, in fact, is that the economically orientated urban sector is recreating the natural environment as a side effect of its demand for goods and services.

How does one understand the nature of our society? It is, in

the first place, operating out of the context of the political freedom gained in the eighteenth century and the economic freedom gained in the nineteenth century. With these freedoms, man is now able to remake the very nature of the landscape and society itself. Using the institutions now in existence every member of our society has some opportunity to participate in choosing the nature of this re-creation. At the same time there is no imperative for each individual to participate in the technical remaking of society. If the individual does participate, he normally does so only as a small input into the political process. The danger, however, in that technology, guided by inadequate criteris, will alone reshape the nature of the environment, excluding human meaning and purpose.

As a key social innovator, the engineer is in the very nucleus of this dilemma. He must come to understand his position and its possibilities. As the basic necessities of society are filled, the engineer must realize the possibilities open to him. His imperative is to apply our technology in a way which enhances the aesthetic quality of our surroundings, expressing the meanings and purposes of human life, instead of dehumanizing and depleting our surroundings. The problem is, therefore, not seen as one of leaving an unspoiled landscape for posterity; nor one of preserving an ecological balance; nor one of remaining in touch with life by being in "communion with nature".[6] It is seen, rather, as a need for a radical remaking of the environment for man. This vision may, however, have need of these other elements in its existential form, but they are initially not crucial to its conception.

With this imperative, what are the criteria available to aid the engineer in making his decisions?

The most important criteria in water development is benefit-cost analysis.[7] It is used for both justification of a project and determination of the best alternative project. Here "best" is taken to mean the project which is the most efficient expenditure of money. The benefit-cost analysis is very dependent on the existence of market values for the evaluation of benefits which accrue from a project. The strength of the final ratio is weakened by the fact that a great deal of uncertainty is attached not only to the costs of the project but also, and to an even greater extent, to the various "intangible" benefits attributed to water development projects. The present concern is not as much with the ability of benefit-cost analysis to allocate capital resources according to the criteria of efficiency, but with the effect the attempt has on the qualities of the natural environment. Benefit-cost analysis is seen to be an application of welfare economics in order to allocate resources in a rational manner. But in this case, the words "rational" and "efficient" are interchangeable. The question is whether efficiency is an adequate criteria for rationality.

There is a growing understanding that it is not. A second criteria used to supplement that of efficiency is redistribution of income. This criteria is usually demanded by the political institution. Its objective is to maintain a relatively even distribution of income between different political jurisdictions.

The goals of these criteria are maximization and redistribution of capital returns. To use an analogy, efficiency might be termed maximization of the total volume of a cake while redistribution of income would then be termed the manner in which the cake is divided between jurisdictions. This, by necessity, leads to two difficulties, as contemporary

development is understood. The first being that the physical ramifications are not conceptually integrated and the second being that social benefits are equated to only capital returns. That is, with these criteria the difference between chocolate cake and white cake is not evident and the taste is also overlooked. These difficulties are qualitative in nature. It is suggested, therefore, that the great need in water development planning is a technique in which will allow due consideration to both the physical and social ramifications involved.

The task of the development planner has not fundamentally changed. He must still somehow decide what is good and what is not so good. Today, the dimension of quality has been added to the characteristics of the natural environment.

FOOTNOTES

1. This approach to understanding the twentieth century is proposed in a course given by the Ecumenical Institute, Chicago, called "The Cultural Revolution".

2. Erich W. Zimmerman, World Resources and Industries (New York and London: Harper and Brothers Publishers, 1933), p. 30.

3. Hans Straub, A History of Civil Engineering, trans. by Erwin Rockwell (Massachusetts Institute of Technology, Cambridge, Massachusetts: The M.I.T. Press, 1964), pp. 1-35, 105. Also: Hunter Rouse and Simon Ince, History of Hydraulics (State University of Iowa: Iowa Institute of Hydraulic Research, 1957), pp. 1-58.

4. A good general discussion of this transformation is by Lewis Mumford, "Quality in Control of Quantity", Natural Resources: Quality and Quantity, ed. by S. V. Ciriancy-Wantrup and James J. Parsons (Berkeley and Los Angeles: The University of California Press, 1964), pp. 7-18.

5. Straub, A History of Civil Engineering, pp. 187-197, and Rouse and Ince, History of Hydraulics, pp. 59-138.

6. These points of view are presented eloquently by numerous authors. Among them are: Ramond F. Dasman, The Last Horizon (New York: The Macmillan Company, 1963) who presents an emotional plea for the preservation of wilderness. Arnold M. Schultz, "The Ecosystem as a Conceptual Tool in Management of Natural Resources", Natural Resources: Quality and Quantity, ed. by Ciriancy-Wantrup and Parsons, pp. 139-161, who proposes the ecosystem as the only reference point for resource management; and Harold J. Barnett and Chandler Morse, Scarcity and Growth (Baltimore: The Johns Hopkins Press, 1963), pp. 17-50 who present a collection of the contemporary view points in resource management.

7. The subsequent discussion on nature of contemporary allocations is based on: Stephen A. Marglin, "Objectives of Water Resource Development a General Statement" in Design of Water Resource Systems, Arthur Maass, et al. (Cambridge, Massachusetts: Harvard University Press, 1962), pp. 17-86, and Robert H. Haveman, Water Resource Investment and the Public Interest (Nashville, Tennessee: Vanderbilt University Press, 1965), pp. 95-107.

APPENDIX II

Area Development Committee Report
in cooperation with the
Communities of Inglis, Russell and Roblin
in support of a
Double Prime Thirty Foot Top Access Road
over the Shellmouth Dam

We, the representatives of Roblin Area Development Committee and the neighboring communities of Russell, Inglis and Roblin, request that the provincial government review the proposed standard of road slated to serve as the access route for the Dropmore community. This access route linking Highway #83 passing over to the Shellmouth Dam site and connecting Highway #5 at the Saskatchewan border.

We make the following presentation, in view of the fact, that there is a tremendous loss of revenue to the farming community of Dropmore and the surrounding business centres. The most striking loss to the farming community is the annual reduction in cattle herds totalling between 3,000 and 3,500. The revenue from the sale of livestock has a strong impact on farm purchasing power. The secondary fact is the result of the loss of many thousands of acres of hay meadow and farm land in the Assiniboine basin which generally yielded 200,000 tons of hay serving as the feed resources to the local residents' livestock herds.

The burden imposed upon the farming community as a result of the flooding of the Assiniboine Valley causes us to assess the grain handling and marketing program both present and future. We are given

to understand that the application procedural step has been taken for the abandonment of the rail line linking Russell and Yorkton. This application which eventually could be accepted will mean additional transportation costs of grain movement to the elevator association and directly to the farmer. This link is also of keen concern to the Russell community and we feel that it has been accelerated because of the Shellmouth Dam.

We believe that eighty-five per cent of the revenue of this area that is affected by communication break-down, is spent in towns of Russell, Inglis, Roblin and neighboring hamlets.

From review of the area residents, it was established that the following constitutes the average traffic between the Dropmore community, Russell, Inglis and Roblin:

Family cars - twice weekly trips to Russell, Inglis, Roblin.

School bus - two trips per day to Roblin and Inglis.

Livestock shipped - 50 trucks per year.

General merchandise - 35 trucks per year.

Cost of owning and operating a 4-door family sedan - 10¢ per mile.

Cost of owning and operating a truck under 10,000 GVW - 12¢ per mile.

Operating on paved surface reduces the costs by - 1¢ per mile for passenger cars and 1½¢ per mile for trucks over the cost of operating on gravelled surfaces.

All calculations are based on a twenty-year period and taken from reports published by the University of Manitoba and U.S. Bureau of Public Roads as basis for calculation.

Additional Costs to Area Residents because of extra mileage

Passenger cars	- 3,194,880 miles @ 10¢ (sic)	=	$31,948
School Bus	- 128,000 miles @ 12¢	=	15,360
Truck Mileage	- 33,280 miles @ 12¢	=	3,994
	Total extra cost		$51,302

Savings accrued if main access road were paved:

Passenger cars	-10,782,720 miles @ 1¢	=	$107,827
School Bus	- 432,000 miles @ 1½¢	=	6,480
Trucks	- 176,920 miles @ 1½¢	=	2,654
	Total savings		$116,961

We, representing the broad area both municipally and from the business aspect, would like to point out that we feel the justified concern for the area west of the Shellmouth Dam and bounded by Saskatchewan border in its property value depreciation as a result of the dam and communication losses.

We believe that the farming area to reinstate their property values are justified in requesting a double prime thirty foot top road. We believe as business people; that the proposed Shellmouth Park which has a value to the Province in tourist dollars that cannot be estimated, also justifies this added expenditure in support of the road concern.

Submitted by:

"H. W. Kaey"
H.W.Kaey,
Reeve, R.M. of Shellmouth

"F. H. Wilson"
F.H. Wilson,
Reeve, R.M. of Shell River

"P. Gaber"
P.Gaber,
Reeve, R.M. of Boulton and Town of Inglis

"F. A. Newton"
F.A. Newton,
Mayor of Roblin

"J.A. Burgess"
J. A. Burgess,
Mayor of Russell

APPENDIX III

A BRIEF PHOTOGRAPHIC STUDY

OF THE BRANDON AND SHELLMOUTH AREAS

The city of Brandon and the Assiniboine River. Note the houses just above the river bank. (looking south).

"The situation of Brandon is very fine and with the hills on both sides of the river presents, even now, a fine appearance from every point of approach". Macoun, Manitoba, p. 485 (Looking south from the north hill).

On the cairn in the foreground is written:

GRAND VALLEY

1879 TOWN SITE 1885

ERECTED IN MEMORY OF PIONEERS WHO CAME BY OXCART AND STEAMBOAT TO SETTLE IN THIS AREA AND BUILT THE TOWN OF GRAND VALLEY (POP.400).

THE TOWN'S FUTURE WAS DOOMED BY THE RAILROADS CHOICE OF BRANDON AND TWO DISASTROUS RIVER FLOODS IN 1881 AND 1882.

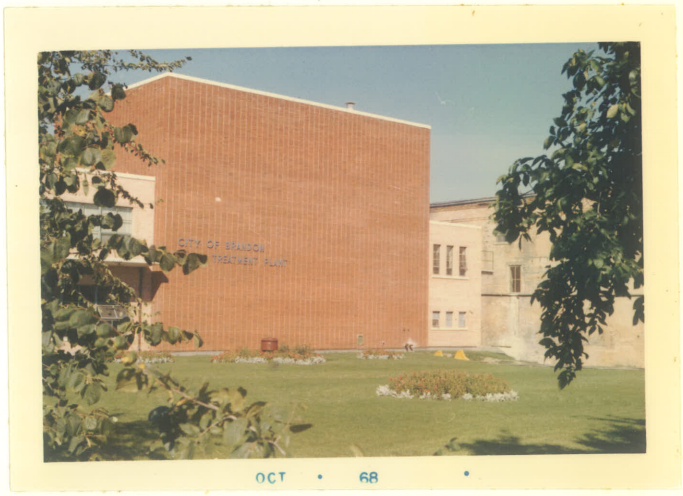
DEDICATED JULY 13, 1968

(Looking south to the steam plant across the river).

In 1959 the Rivers dam was constructed. The reservoir is operated to ensure an adequate water supply for Brandon and Rivers. (looking northwest).

The Assiniboine River at the Brandon water supply intake. (Looking north).

In 1958 a new plant addition was built bringing the total capacity of the Brandon treatment plant to six million gallons per day.



During the summer months, a few fishermen can usually be found casting out into the turbulent water below the 3rd Street weir, but the catch is small especially when it is compared to early reports of fishing in the river.

In 1962 the city of Brandon started to treat its sewage with a system of lagoons, which were constructed about four miles east of the city. (Looking southwest).

Five miles east of Brandon the Assiniboine River acts as both a water supply and fence for a herd of cattle. (Looking upstream).

Not only has the river acted as a legal boundary between farms, but it has also acted as a natural boundary separating the Dropmore area from Roblin, Inglis and Russell. (Looking west across the Assiniboine Valley to Dropmore).

"Within the immediate valley of the Assiniboine, and subject to summer floods, are immense marshy meadows or bushy flats, which would produce millions of tons of hay every year with a trifling outlay".

Macoun, Description, p. 67
(Looking downstream from the vicinity of the Dropmore Bridge).

Once the site of a saw mill, Asessippi is now the site of a camping and swimming area. (Looking northwest up Bear Creek to the right, and Shell River to the left).

BIBLIOGRAPHY

Ackerman, Edward A. and Lof, George O. Technology in American Water Development. Baltimore: The Johns Hopkins Press, 1959.

Attwood, C. H. Report on the Assiniboine River Floods, April and May 1922. Winnipeg: Department of the Interior, Canada Dominion Water Power Branch, March 1923.

Boulding, Kenneth E. The Image. United States of America: University of Michigan Press, Ann Arbor Paperback, 1961.

Barnett, Harold J. and Morse, Chandler. Scarcity and Growth, The Economics of Natural Resource Availability. Baltimore: The Johns Hopkins Press, 1963.

Canada Land Inventory, Shellmouth Designated Reservoir Area: Proposed Land Use Plan (Draft Copy: Winnipeg, Manitoba: June 1968.

Ciriancy-Wantrup, S. V. Resource Conservation: Economics and Policies. Rev. Ed. Berkeley: University of California, Division of Agricultural Sciences, Agricultural Experimental Station, 1963.

Ciriancy-Wantrup, S. V. and Parsons, James J., ed. Natural Resources: Quality and Quantity. Berkeley and Los Angeles: The University of California Press, 1967.

Coleman, MacDonald. The Face of Yesterday: The Story of Brandon, Manitoba. Brandon, Manitoba: The Leech Printing Ltd., 1954.

Craig, John. Report on the Assiniboine River Floods, April and May 1927. Winnipeg: Department of the Interior, Canada Dominion Water Power and Reclaimation Service, September 1927.

Darling, Fraser, F. and Milton, John P., ed. Future Environments of North America. Garden City, New York: The Natural History Press, 1966.

Dasman, Raymond F. The Last Horizon. New York: The Macmillan Company, 1963.

Department of Industry and Information, Economic Research Branch. Future Industrial Water Demands from the Qu'Appelle and Assiniboine Rivers in Saskatchewan. Saskatchewan: Department of Industry and Information, Jan. 1964.

The Environmental Pollution Panel President's Science Advisory Committee. Restoring the Quality of Our Environment, Report to the White House, Washington, D. C.: U.S. Government Printing Office, 1965.

Erlich, W. A.; Pratt, L. A.; and Poyser, E. A. Report of Reconnaissance Soil Survey of Rossburn and Virden Map Sheet Areas. Manitoba Soils Survey, Report No. 6, Canada Department of Agriculture, Provincial Department of Agriculture, and Soils Department, the University of Manitoba, 1956.

Erlich, W. A.; Pyser, E. A.; and Pratt, L. E. Report of Reconnaissance Soil Survey of Carberry Map Sheet Area. Manitoba Soils Survey, Report No. 6, Canada Department of Agriculture, Manitoba Department of Agriculture and Immigration, and Soils Department, The University of Manitoba, 1957.

Erlich, W. A.; Pratt, L. E.; and Leclaire, F. P. Report of Reconnaissance Soil Survey of Grandview Map Sheet Area. Manitoba Soil Survey, Report No. 9, Canada Department of Agriculture, Manitoba Department of Agriculture and Conservation, Department of Soils, the University of Manitoba, 1959.

Extracts from Surveyor's Report of Township Surveys in Manitoba and the North-West Territories. Canada: by authority of Sir David Lewis, Minister of the Interior, 1884.

Firey, Walter. Man, Mind and Land. Illinois: The Free Press of Glencoe, 1960.

Gist, Noel P. and Fava, Sylvia Fleis. Urban Society. 5th ed. New York: Thomas Y. Crowell Company, 1967.

Halstead, E. C. Ground-Water Resources of the Brandon Map Area, Manitoba. Ottawa: The Queen's Printer and Controller of Stationery, 1959.

Hamilton, H. R., Owens, D. H., Carroll, T. E. Glenn, A. R., and Gilmour, B. A. Bibliography on Socio-Economic Aspects of Water Resources. Washington, D.C.: Department of the Interior Office of Water Resources Research, 1966.

Haveman, Robert H. Water Resource Investment and the Public Interest. Nashville, Tennessee: Vanderbilt University Press, 1965.

Hayes, Samuel, Jr. Evaluating Development Projects. Place de Fontenoy, Paris-7e: United Nations Educational, Scientific and Cultural Organization, 1966.

Henderson, Lawrence J. The Fitness of the Environment. Beacon Hill, Boston: Beacon Press, 1958.

Herfindahl, Orris C. and Kneese, Allen V. Quality of the Environment: An Economic Approach to Some Problems in Using Land, Water and Air. Baltimore: The Johns Hopkins Press, 1965.

Hill, Robert B. Manitoba: History of its Early Settlement, Development and Resources. Toronto: William Briggs, 1890.

Hind, Henry Youle. Reports of Progress on the Assiniboine and Saskatchewan Exploring Expedition. Toronto: John Lovell, 1859.

Ireland, W. J. Report on Possibilities of Hydro Electric Development on the Assiniboine River at Currie's Landing. Winnipeg: Manitoba Power Survey, 1914.

Kavanaugh, Martin. The Assiniboine Basin. Hammersmith, London, England. The Teacher Training College, 1966.

Kneese, Allen V. The Economics of Regional Water Quality Management: Baltimore: The Johns Hopkins Press, 1964.

Kreuder, W. L. and McMorine, J. G. S. Water Supply and Water Use in the Assiniboine and Qu'Appelle Basins. Regina, Saskatchewan: Prairie Provinces Water Board, Sept. 1966.

Kuhn, Alfred. The Study of Society A Unified Approach. Homewood, Illinois: Richard D. Irwin, Inc., and The Dorsey Press, Inc., 1963.

Kuiper, E. Benefit-Cost Analysis Assiniboine River Flood Control and Water Conservation Projects. Winnipeg, Manitoba: Department of Agriculture and Conservation, Water Control and Conservation Branch, 1961.

Kuiper, E. Report Conservation and Flood Control Assiniboine River. Regina, Saskatchewan: Department of Agriculture, Prairie Farm Rehabilitation Branch, December 1952.

Kuiper, Edward. Water Resources Development Planning, Engineering and Economics. London: Butterworths, 1965.

Maass, Arthur; Hufschmidt, Maynard, M; Dorfmaro, Robert; Thomas, Harold A. Jr; Marglin, Stephen A.; and Fair, Gordon Maskew. Design of Water Resource Systems. Cambridge, Massachusetts: Harvard University Press, 1962.

Macoun, John. History of the Great North-West. Guelph, Ontario: The World Publishing Company, 1882.

MacKenzie, G. L., and Attwood, C. H. Preliminary Report, Assiniboine River Development. Manitoba Department of Mines and Natural Resources and P.F.R.A., 1945. (Blue Printed.)

McKay, G. A. Evaporation from Lakes and Reservoir on the Canadian Prairies. Regina, Saskatchewan: Prairie Provinces Water Board, 1965.

Mayer-Oakes, William J., ed. Life, Land and Water. Winnipeg: University of Manitoba Press, 1967.

Minister of the Interior. Description of the Province of Manitoba. Ottawa: Printer to the Queen's Most Excellent Majesty, 1893.

Morris, W. V. Report on Assiniboine River Flooding. Winnipeg: Department of Mines and Natural Resources, Water Resources Branch, August 1955.

Morton, W. L. Manitoba: A History. Toronto: University of Toronto Press, 1957.

Nelson, Lowry; Ramsey, Charles E.; and Verner, Coolie. Community Structure and Change. New York: The MacMillan Company, 1965.

Platt, Robert B. and Griffiths, John F. Environmental Measurement and Interpretation. New York: Reinhold Publishing Corporation 1964.

Prairie Farm Rehabilitation Administration, Hydrology Division. Compilation and Reconstruction of Monthly Streamflow Records for the Qu'Appelle - Assiniboine Study. Canada: Prairie Provinces Water Board, October 1963.

Prairie Farm Rehabilitation Administration, Hydrology Division, Estimated Water Requirements Qu'Appelle and Assiniboine River Basins. Regina, Saskatchewan: Prairie Provinces Water Board June, 1964.

Prairie Farm Rehabilitation Administration, Hydrology Division, Water Supply and Water Use in the Assiniboine and Qu'Appelle Basins. Regina, Saskatchewan: Prairie Provinces Water Board, May 1966.

Red River Basin Investigation, Water Resources Division. Report on Investigations into Measures for the Reduction of the Flood Hazard in the Greater Winnipeg Area. Canada: Department of Resources and Development, Engineering and Water Resource Branch, Oct. 1953.

Report on Sewage Collection and Treatment for the City of Brandon, Manitoba. Winnipeg: Haddin, Davis and Brawn Co. Limited, Consulting Engineers, November 1962.

Report on the Study of the Water Distribution Facilities for the City of Brandon. I. Teranishi. Manitoba: Underwood McLellan & Associates Limited, November 1962.

Regional Development Branch, Department of Industry and Commerce. "Roblin Town Trading Survey". Peter Nowasad, Chairman. Roblin September 1965.

Roblin (Manitoba) Community. Histories of the Districts of the Roblin Community as Compiled for the 50th Anniversary Held July 21-26th, 1963. (Mimeographed.)

Rouse, Hunter, and Ince, Simon. History of Hydraulics. State University of Iowa: Iowa Institute of Hydraulic Research, 1957.

Russell's Women Institute, The History Committee. Banner County. Steinbach, Manitoba: Derksen Printers, 1967.

Santayana, George. The Sense of Beauty Being the Outline of Aesthetic Theory. New York: Collier Books, 1961.

Sewell, W. R. D.; Davis, John; Scott, A. D.; and Ross, D. W. Guide to Benefit-Cost Analysis. Ottawa, Canada: Queen's Printer and Controller of Stationery, 1965.

Smith, Stephen C. and Castle, Henry N., ed. Economics and Public Policy in Water Resource Development. Ames, Iowa, U.S.A.: Iowa State University Press, 1964.

Spry, Irene M. The Palliser Expedition: An Account of John Palliser's British North American Expedition 1857-1860. Toronto: The MacMillan Company of Canada Limited, 1963.

Straub, Hans. A History of Civil Engineering. Cambridge, Massachusetts: The M.I.T. Press, 1964.

Thomas, William I., Jr., ed. Man's Role in Changing the Face of the Earth. Chicago and London: The University of Chicago Press, 1956.

Warkentin, John. The Western Interior of Canada. Toronto: McClelland and Stewart Limited, 1964.

Water Control and Conservation, Manitoba Department of Highways, Files.

Zimmerman, Erich. W. World Resources and Industries. New York and London: Harper and Brothers Publishers, 1933.