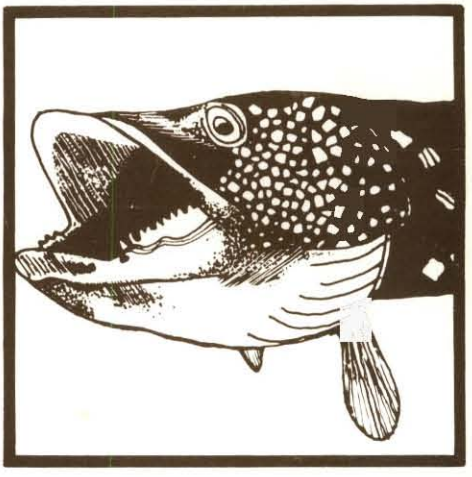
POLICY ISSUE STUDY ON

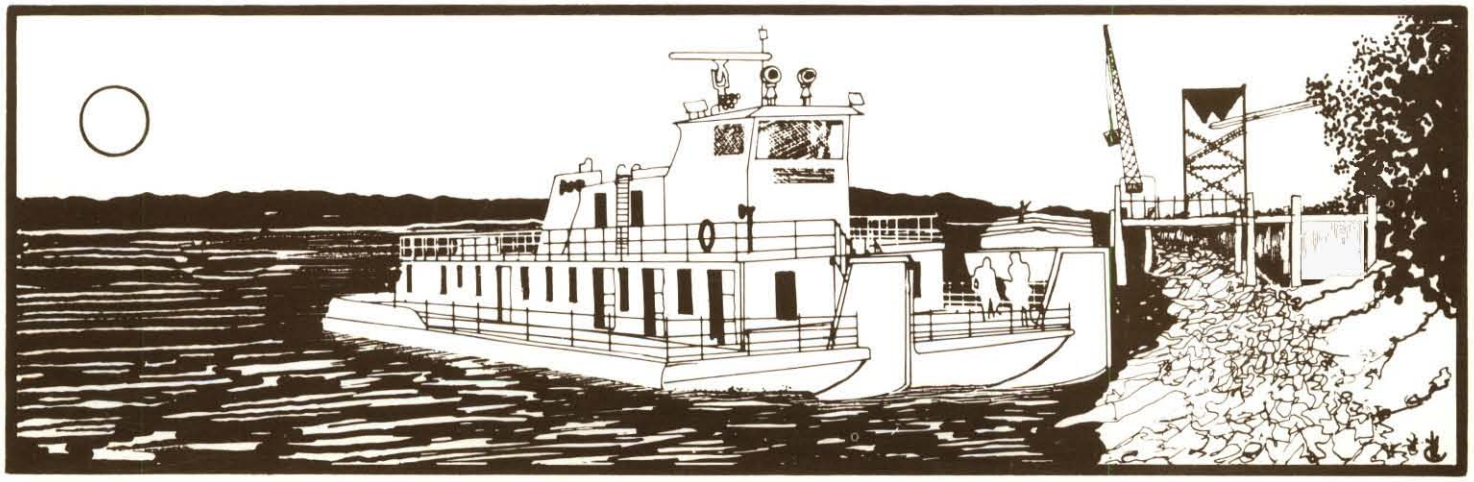
INSTREAM FLOWS



State Water Planning and Review Process

Nebraska Natural Resources Commission

JANUARY 1982



POLICY ISSUE STUDY
ON
INSTREAM FLOWS

STATE WATER PLANNING AND REVIEW PROCESS

INSTREAM FLOWS REPORT

REPORT
OF THE
NATURAL RESOURCES COMMISSION
TO
GOVERNOR CHARLES THONE
AND
THE MEMBERS OF THE NEBRASKA LEGISLATURE

JANUARY 1982

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PROGRAMS:

SOIL & WATER CONSERVATION
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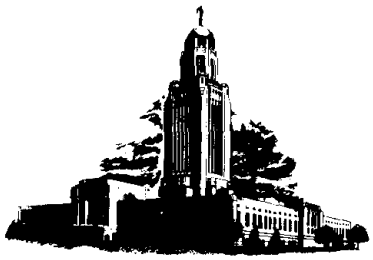

STATE OF NEBRASKA

NATURAL RESOURCES COMMISSION

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P.O. Box 94876
Lincoln, Nebraska 68509
Phone: (402) 471-2081

The Honorable Charles Thone
Governor, State of Nebraska
State Capitol
Lincoln, Nebraska 68509

Members of the Eighty-Seventh Nebraska Legislature
Second Session
State Capitol
Lincoln, Nebraska 68509

Dear Governor Thone and Members of the Legislature:

The Nebraska Natural Resources Commission is forwarding this final report on the Instream Flows Policy Issue Study for your consideration. It is the fourth report approved by the Commission in fulfilling its responsibilities under the State Water Planning and Review Process. We hope the information contained in the report will be useful to you as you consider this controversial water policy issue.

The report contains thirteen alternative policies regarding the legal status of instream uses of water. The Commission's recommendations on those alternatives are contained on the blue page immediately preceeding the summary.

The Natural Resources Commission is prepared to provide you with any additional information on the instream flows issue you may desire. In addition, if statutory changes are deemed appropriate we would be glad to assist in drafting the necessary legislation.

Sincerely,

Alvin Narjes

Alvin Narjes, Chairman
Natural Resources Commission

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Foreword

This is the final report on the Instream Flows Policy Issue Study. It was prepared for consideration, and action as deemed appropriate, by the Governor and Legislature. The Instream Flows Policy Issue Study is one of eleven water policy studies being conducted as part of the State Water Planning and Review Process.

The base document for this report was prepared by a task force of seven representatives from state agencies and two representatives from the University of Nebraska-Lincoln. However, the final report and recommendations were the responsibility of the Natural Resources Commission.

The members of the task force were:

Gerald Chaffin . . . . . Game and Parks Commission (Lead Agency)
Thomas F. Pesek . . . . . Natural Resources Commission
Lumir C. Kubicek . . . . . Department of Water Resources
John Bender . . . . . Department of Environmental Control
Ray Bentall . . . . . Conservation and Survey Division-UNL
Donn Rodekohr . . . . . Water Resources Center-UNL
Karen Langland . . . . . Policy Research Office
Owen Goodenkauf . . . . . Department of Health
John Alloway . . . . . Department of Agriculture

Previous task force members were Tom Hamer, Department of Water Resources; Bob Burns, State Office of Planning and Programming; Ruth Dickinson, Water Resources Center; and Steve Masters, Department of Health.

A number of individuals other than those on the task force also contributed greatly to the preparation of this report. They include: Chris Reck, Water Resources Center; Jan Bouc, Robert Anderson, Liz Huff, and Gene Zuerlein, Game and Parks Commission; and Jay Holmquist and Steve Gaul, Natural Resources Commission.

The task force report was released by the Commission for review by the public on November 18, 1981. Between December 8 and December 15 six public meetings were held to discuss the report and obtain comments from the public. These meetings were held in Norfolk, Valentine, Scottsbluff, North Platte, Grand Island, and Omaha. The official public hearing on the report was held in Lincoln on December 16. A summary of the comments made at the meetings and hearing is contained in Appendix A in the back of this report.

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Table of Contents

Page

LIST OF TABLES vi
LIST OF FIGURES vii
COMMENTS AND RECOMMENDATIONS OF THE NATURAL RESOURCES COMMISSION viii
SUMMARY ix

INTRODUCTION 1
Purpose and Scope 1
Legislative Background 1
Relation to Other Studies 2
Implementation of Policy Alternatives 2

CHAPTER 1 INSTREAM WATER USES 3
Fishery Resources 3
Recreation and Aesthetics 7
Interstate Compacts and Court Decrees 10
Hydroelectric Power 10
Livestock Watering 11
Aquifer Recharge 14
Subirrigation 14
Navigation 15
Wildlife 16
Wild and Scenic Rivers 18
Water Quality 20

CHAPTER 2 FLOW CHARACTERISTICS OF NEBRASKA STREAMS 23
Generalized Flow Characteristics Of Nebraska Streams 23
Flowing Waters in Nebraska and Water Right Commitments 35
Projected Streamflows 42

CHAPTER 3 FLOW REQUIREMENTS FOR INSTREAM USES 43
Fishery Resources 43
Recreation 52
Interstate Compacts 52
Hydroelectric Power 54
Livestock Watering 54
Aquifer Recharge 54
Subirrigation 54
Navigation 54
Wildlife 55
Aesthetics 56
Wild and Scenic Rivers 56
Water Quality 58

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TABLE OF CONTENTS, Cont. Page

CHAPTER 4 INTRODUCTION TO ALTERNATIVE INSTREAM FLOW POLICIES 59
Instream Flow Policies in Selected States 59
Alternative Instream Flow Policies for Nebraska 61
Description of Impact Analysis 63

CHAPTER 5 PRESENT STATE POLICY FOR INSTREAM USES AS AN ALTERNATIVE POLICY 69
Present State Policy Regarding Instream Use 69
Alternative: Continue Present Policy 73

CHAPTER 6 ALTERNATIVE STATE POLICIES THAT PROVIDE FOR THE MAINTENANCE OF STREAMFLOWS FOR INSTREAM WATER USE 75
Alternative: Declare that Natural Flow Permits May be Issued for Instream Uses 75
Alternative: Authorize Establishment of Protected Flow Levels by the Director of Department of Water Resources 78
Alternative: Provide for a State-Administered System of Protected River Reaches 79
Alternative: Declare that Instream Flow Needs May be Met Through the Use of Stored Water 81
Alternative: Authorize Department of Water Resources to Reassign Abandoned or Unused Natural Flow Permits for Instream Uses 83
Alternative: Allow Voluntary Transfers of Natural Flow Permits for Instream Uses 83
Alternative: Declare that Groundwater May be Used to Supplement Natural Flow to Meet Instream Flow Needs 85
Alternative: Impose Restrictions on the Use of Groundwater 86

CHAPTER 7 ALTERNATIVE STATE POLICIES THAT LIMIT OPTIONS FOR MAINTAINING STREAMFLOW FOR INSTREAM WATER USE 89
Alternative: Prohibit Issuance of Natural Flow Permits for Instream Uses Other than Hydroelectric Power Production 89
Alternative: Prohibit Exercise of Director's Discretionary Authority as a Means of Protecting Instream Uses 90
Alternative: Prohibit Use of Stored Water for Instream Flow Maintenance 90
Alternative: Prohibit Voluntary Transfers of Natural Flow Permits for Instream Uses 91
REFERENCES CITED 93
SOURCE DOCUMENTS 101
APPENDIX A SUMMARY OF PUBLIC HEARINGS ON THE INSTREAM FLOW POLICY STUDY 105

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List of Tables

Table		Page
1	Participation estimates for fishing by Nebraskans in 1977	3
2	Stream miles by river basin based on water temperature	4
3	Fish kills 1976 through 1978 by river basin	6
4	Participation in selected recreational activities in Nebraska during 1977	7
5	Stream miles, by river basin, presently subject and not subject to seasonal low flows that restrict canoeing	10
6	Active onstream hydroelectric plants in Nebraska	11
7	Sources of livestock water by river basin	11
8	Importance of streams for livestock watering by river basin	12
9	Complaints of inadequate flow to meet instream stock watering needs 1974-1979	13
10	Ratings of streams for wildlife	17
11	Natural free flowing rivers in Nebraska	19
12	Percent of average annual flow required to maintain various flow conditions	44
13	Recommended fishery flows: Ninemile Creek	46
14	Recommended fishery flows: Republican River	46
15	Recommended fishery flows: Elkhorn River	47
16	Recommended fishery flows: North Loup River	47
17	Recommended fishery flows: Cedar River	48
18	Recommended fishery flows: Snake River	48
19	Recommended fishery flows: Little Blue River	49
20	Recommended fishery flows: West Fork Big Blue River	49
21	Recommended fishery flows: North Fork Big Nemaha River	50
22	Recommended fishery flows: Long Pine Creek	50
23	Recommended fishery flows: Niobrara River	51
24	Recommended fishery flows: North Platte River (lower section)	51
25	Recommended fishery flows: North Platte River (upper section)	52
26	Acceptable flows for canoeing on selected streams	53
27	Flows required by the Blue River Basin Compact for the Little Blue River and Big Blue River	53
28	Flow requirements to meet installed generating capacity of Nebraska's onstream hydroelectric power plants	55
29	Flows required to recharge the aquifer of the City of Lincoln's Ashland well field	55
30	Flows required for navigation on the Missouri River	55
31	Recommended minimum flow regime to maintain whooping crane habitat on the Niobrara River	57
32	7-day 10-year low flows of twenty selected streams	58
33	Estimated value of an acre-foot of stream water to irrigated agriculture in each river basin	67

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List of Figures

Figure		Page
1	Stream classification for fishery	5
2	State parks, state recreation areas and wildlife management areas	8
3	Stream classification for canoeing	9
4	Stream-aquifer relationship: Niobrara River in northeastern Cherry County	25
5	Stream-aquifer relationship: Niobrara River along north border of Rock County	25
6	Stream-aquifer relationship: Lodgepole Creek	25
7	Stream-aquifer relationship: Platte River in eastern Lincoln County	26
8	Stream-aquifer relationship: Wood River north of Kearney in Buffalo County	26
9	Stream-aquifer relationship: Platte River in western Merrick County	26
10	Stream-aquifer relationship: Upper reach of North Branch of the Middle Loup River in southwestern Cherry County	27
11	Stream-aquifer relationship: Platte and Elkhorn Rivers in western Douglas County	27
12	Stream-aquifer relationship: Driftwood Creek in southeastern Hitchcock County	27
13	Stream-aquifer relationship: Big Blue River in eastern Polk County	28
14	Stream-aquifer relationship: Big Blue River in Saline County	28
15	Stream-aquifer relationship: North Fork Johnson Creek in Fillmore County	28
16	Flowing waters in Nebraska	37
17	Hypothetical array of instream flow requirements for several instream uses	44

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Comments and Recommendations of the Natural Resources Commission

Instream uses, as defined in the first paragraph of Chapter 1 of the report, are recognized by the NRC as valid and important uses in certain stream reaches in Nebraska. In order to maintain or develop those uses, we wish to make the following recommendations in regard to the Instream Flow report.

The NRC does not recommend Alternative 1, but recognizes that an updating and clarifying of the state's present policies would do much to meet present and future demands of surface water flows.

We agree with Alternative 7 that instream needs may be met through stored water.

Although certain of the other alternatives have merit in themselves, our recommendation is based upon a combination of several alternatives. Basically, Alternative 6 is nearest to our recommendation. However, instead of providing for a state administered system of protected stream reaches, we would recommend that the designation of protected stream reaches be the responsibility of the Natural Resources Districts that the stream reach lies within. Consideration of such designation would be made upon the request of any group, organization or individual to the local NRD board. A review or study of the stream reach would then be made to determine, if indeed, the stream or stream reach should be designated as a protected reach. The NRD could ask for assistance from other agencies in making their appraisal of the desirability of such a designation. Meetings to obtain public opinion on the designation would be required.

If a stream is so designated, any subsequent permits issued by the Department of Water Resources would be junior to the instream flow permit. The junior permit would apply only to water in excess of instream needs. All water rights held prior to such designation would remain in force and not be altered by designation.

Recognizing that conditions vary from area to area, restrictions on development of ground water adjacent to or upstream from a designated stream, the amount of land included in the designated area, use of ground water to supplement natural flow, and other considerations should be undertaken and resolved in the investigations before any designation.

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Summary

Introduction

The Policy Issue Study on Instream Flows was conducted as part of the Nebraska State Water Planning and Review Process. It is one of eleven water studies that analyze Nebraska's water policy issues. The study was conducted because the legal status of instream uses is not specified under the state's present water policy.

The product of the study is a report providing information to assist decision makers, including the Natural Resources Commission, the Legislature, and Governor in evaluating the adequacy of present policies and alternative policies that could be considered for adoption.

Instream Water Uses

Any use of stream flow that occurs within a stream channel and does not require diversion or impoundment is an instream use. The instream uses considered in this report are protection of fisheries, recreation, conformance with interstate compacts and court decrees, generation of hydroelectric power, instream stockwatering, recharge of aquifers, maintenance of subirrigation, navigation, water supply for wildlife and riparian vegetation, aesthetic appreciation, preservation of wild and scenic rivers, and maintenance of water quality.

Instream uses vary in degree of importance to Nebraskans and in some cases, for example aquifer recharge and hydroelectric power, are restricted to certain streams or stream segments. Some of the uses, such as protection of fisheries, livestock watering, and recreation, have been affected adversely during periods of low or no flow in recent years. Many streams in Nebraska exhibited very low flow or no flow during the drought years of the mid-1970's. The lack of precipitation, high demand for out-of-stream uses, and in a very few places, groundwater withdrawals, contributed to these low flow conditions and the problems associated with them. Although detailed streamflow projections were not conducted in the study, it is anticipated that most instream uses will be affected adversely to some degree by streamflow depletions in the future.

Flow Characteristics of Nebraska Streams

Some Nebraska streams are characterized by naturally continuous (perennial) flow, others by naturally intermittent flow. Man's development of water resources has made intermittent the flow of some streams that formerly flowed continuously and, vice versa, has made continuous the flow of some streams that formerly had intermittent flow. The flow of many stream reaches is composed partly of groundwater seepage and partly of overland runoff. Discharge rates increase in response to overland runoff and then decrease gradually to a relatively steady base flow derived from groundwater seepage. Most perennial streams in the state are in this category.

The degree and kind of hydraulic connection between streams and adjacent or underlying aquifers must be considered if instream flow problems are to be addressed. Because at least part of the flow of most Nebraska streams is derived from aquifers and some reaches of several streams lose water by seepage into aquifers, formulators of policy relating to resolution of instream flow problems need a good understanding of the stream-aquifer relationships existing in Nebraska.

Streams and Water Rights Commitments

Nebraska streams differ in the degree to which their flow is committed to existing water rights. The flow of some streams – for example, the tributaries of the North Platte River above Lake McConaughy – may be fully appropriated throughout the year as their flow is committed to storage during the non-irrigation season. The Platte River in central Nebraska, the Big Blue River above Milford, and the White River are examples of streams that generally have unappropriated flow only during the non-irrigation season. On the other hand, some streams have unappropriated flow throughout the year. These include the Niobrara River below Dunlap Diversion Dam, Long Pine Creek, the Elkhorn River below Holt Creek, the Little Blue River below Hebron, and the Platte River below the Loup Power Canal return. Most of the streams having unappropriated flow throughout the year are located in north central and northeastern Nebraska. Future irrigation development potential is greatest where land suitable for irrigation could be served by diverting from streams having year round unappropriated flow.

Flow Requirements for Instream Uses

The flow requirements for several of the instream uses considered in this study have been determined for certain streams. Instream flow requirements pertain to the flow rates needed to maintain instream uses. At a given location on a given stream only certain instream uses may occur. Therefore, flow requirements for each stream are based on the dominance of one use or on a combination of uses.

The methods available for estimating flow requirements range from sophisticated computer programs to simple estimates of the percentage of gaged flows adjusted for the observed effectiveness of the flows. Several methods are available to determine flow requirements for fisheries and some of these were applied to selected Nebraska

streams. The methods discussed for hydroelectric power, water quality maintenance, livestock watering, aquifer recharge, sub-irrigation, and recreation have not been evaluated under Nebraska conditions. For wildlife needs, wild and scenic rivers, and aesthetics no methods were identified, and flows must be determined on a case-by-case basis. For the remaining two uses, navigation and interstate compacts, flow requirements already had been determined and additional methods were not necessary.

Besides those flows identified for the uses considered in this study, an important but often overlooked element of satisfactory flow regimes is the periodic high flows necessary to move bed load, flush sediments, and generally maintain the desired stream channel characteristics. These flows are termed channel maintenance flows.

Present State Policy Regarding Instream Uses

Present state water law has been developed to regulate various aspects of surface water and groundwater use. Nebraska's laws regulating surface water use are based upon two legal doctrines: (1) the riparian rights to doctrine and (2) the doctrine of prior appropriation. The use of groundwater is subject to a separate body of law. In general, the state's present water laws are aimed at protecting the rights of those who use the water for purposes such as domestic needs, irrigation, manufacturing, and power production and do not provide a means for maintaining flows for instream uses.

The Nebraska Supreme Court has indicated that riparian rights may be acquired for instream stockwatering, power production and milling. Riparian rights by their nature are indefinite regarding the amount of water associated with them. The riparian rights doctrine is considered to be of little value as a means of ensuring a dependable supply of water for instream uses.

Nebraska's present system for acquiring and administering appropriative rights was adopted in 1895 and has undergone little change. An appropriation permit entitles its holder to impound a specific quantity of water or divert a specific rate of flow for a recognized beneficial use. Generally, under Nebraska law an appropriator may impound or divert the entire flow of a stream if necessary to satisfy his water right regardless of the impact on stream flow values. However, there are six provisions in existing law that may have potential for use as a means to protect instream uses.

There are few provisions in Nebraska's laws regulating groundwater use that can clearly be used to reduce or eliminate any adverse effects of groundwater withdrawals on instream uses.

Alternative Instream Flow Policies

Although their approaches vary, most western states have adopted policies to protect at least some of the instream flow values discussed in this report. These policies range from the management of stored water releases to the issuance of appropriative rights for instream uses and the regulation of certain wells for the benefit of instream flows. A survey of western state policies was made to identify those policies that are appropriate for consideration in Nebraska.

Thirteen alternative instream flow policies were developed to provide a wide array of choices for consideration by the legislature. The alternative policies are:

1. Continue present policy.

The state's present policies regarding surface water flows for instream uses would remain unchanged. Issues on which the present law may not be clear would continue to be addressed according to administrative and judicial interpretation.

2. Declare that natural flow permits may be issued for instream uses.

Present law is unclear as to whether natural flow appropriation permits may be issued for instream uses other than hydroelectric power production. This alternative would allow the Department of Water Resources to issue natural flow permits for such uses on stream segments having unappropriated natural flow and significant instream flow values.

3. Prohibit the issuance of natural flow permits for instream uses other than hydroelectric power production.

If the legislature believes natural flow permits should not be issued for instream uses other than hydroelectric power production, it could amend Nebraska water law to state that natural flow permits are not to be issued for any other instream use.

4. Authorize the establishment of protected flow levels.

This alternative provides for establishment of protected flow levels for stream reaches having unappropriated natural flow and significant instream flow values. Subsequent permits to appropriate water above or within a stream reach for which a protected flow level had been established would be subject to regulation when streamflow fell to the protected flow level.

5. Prohibit the exercise of the director's discretionary authority as a means of protecting instream uses.

The director of the Department of Water Resources has authority to deny applications for new surface water rights and may also impose conditions on the exercise of newly issued rights if dictated by the state's public policy. If the legislature believes the director's discretionary authority should not be used to maintain instream flow, its use in this manner could be prohibited.

6. Provide for a state administered system of protected river reaches.

To preserve stream segments having especially valuable scenic, wildlife, fishery, or recreational values, a state-administered system of protected river reaches could be created by the legislature. If a stream reach was designated as part of the system, modification of the stream or associated lands would be prohibited if it would have significant adverse effects on the values being protected. The Department of Water Resources would be required to insert protected flow conditions in new permits as described in Alternative 4.

7. Declare that instream flow needs may be met through the use of stored water.

In many of the state's streams, natural flow sometimes is not available to meet instream flow needs. To improve instream flows, natural flow could be supplemented by the

release of surplus water stored in reservoirs. Any stored water released into a stream to maintain instream flows could not be diverted legally for use by other appropriators.

8. Prohibit the use of stored water for instream flow maintenance.

Present law does not explicitly authorize use of stored water to maintain instream flows. However, the Department of Water Resources has interpreted the law to allow the holder of a storage right to use stored water for any purpose, including streamflow maintenance. If the legislature feels it should not be the policy of the state to allow stored water to be used for instream flow maintenance, its use for this purpose could be expressly prohibited.

9. Authorize the Department of Water Resources to reassign abandoned or unused natural flow permits for instream uses.

Under present law the Department of Water Resources can, under certain circumstances, cancel a permit to appropriate water. If the legislature authorized the issuance of appropriative rights for instream uses, it also could direct the Department of Water Resources to assign abandoned or unused natural flow rights, with the original priority date still in effect, to public and private entities for use in maintaining instream flows. This alternative would provide a means of increasing low flows in streams in which the natural low flows are fully appropriated.

10. Allow the voluntary transfer of natural flow permits for instream uses.

Another means of improving low flow conditions on streams that are already fully appropriated at times would be to allow the voluntary sale, lease, or donation of existing natural flow permits to a public or private entity that would use the permit to maintain instream flows. Whether this is permissible under existing law is open to question.

11. Prohibit the voluntary transfer of natural flow permits for instream uses.

If the legislature feels it should not be the policy of the state to allow the transfer of natural flow permits as a means of maintaining instream flows, it could clear up the ambiguity in existing law by expressly prohibiting such transfers.

12. Declare that groundwater may be used to supplement natural flow to meet instream flow needs.

Low flows in stream reaches that are fully appropriated could be augmented by pumping groundwater into the stream when necessary to prevent damage to instream values. Use of this water by other users along the stream or stream segment would be prohibited.

13. Impose restrictions on the use of groundwater.

Groundwater withdrawals may reduce the groundwater contribution to certain streams and affect instream uses adversely. To avoid or reduce this problem, the legislature could authorize imposition of restrictions on groundwater use upstream from or along stream reaches having significant instream flow values if studies show that groundwater pumping is reducing streamflow and impairing instream uses.

The alternative policies fall into three general categories. The first category is the continuation of present state policy and is represented by Alternative Number 1. The second category consists of Alternatives Numbers 2, 4, 6, 7, 9, 10, 12 and 13. Each could serve to provide for the maintenance of streamflow for instream uses. The third category includes Alternatives Numbers 3, 5, 8, and 11. These are designed to clear up ambiguities in existing law by expressly prohibiting the use of particular strategies for maintaining instream flows.

Because instream flow problems differ from one stream to another depending upon streamflow characteristics and the degree to which flow is committed to existing water rights different alternatives may be appropriate for different streams. For example, Long Pine Creek presently has sufficient natural flow for existing out-of-stream uses in the area and instream flow needs. Therefore Alternatives Numbers 2, 4, and 6 could apply to this and similar streams if instream uses are declared to be beneficial uses of water and this protection is determined to be in the public interest. On the other hand, the flow of streams such as the Big Blue River above Seward normally is committed entirely to existing water rights during the irrigation season, and Alternatives 7, 9, 10, 12, or 13 would be appropriate if instream flow uses are found to be in the public interest and are to be maintained throughout the year on this and similar stream segments. The adoption of an alternative from either the second or third category does not necessarily preclude the adoption of additional alternatives from that category or from the other category. Although some alternatives are mutually exclusive, more than one alternative may need to be adopted in order to bring about a particular policy.

Impacts Associated with the Policy Alternatives

Hydrologic, environmental, social-economic, administrative, and legal impacts associated with the thirteen policy alternatives have been identified. Hydrologic impacts – changes in quantity and/or duration of flow – were the first to be identified and served as a basis for determining the other impacts. The hydrologic impacts were developed on a site-specific basis using 11 selected streams. These streams are Long Pine Creek, the Platte River, the Little Blue River, Ninemile Creek, the Niobrara River, the Dismal River, the North Fork Big Nemaha River, the Republican River, the Cedar River, the Elkhorn River, and Thompson Creek. Other streams on which the alternatives would have similar impacts were identified.

Because the impacts associated with the alternative policies can differ widely from one part of the state to another, a detailed description of the magnitude of each impact either regionally or statewide was not possible. For example, the economic impacts of streamflow protection measures on out-of-stream uses and related economic activity in different parts of the state would require extensive study and could be unique for specific locations. Consequently many of the impacts presented in the report are qualitative assessments at the local, regional, or statewide level.

In general the various impacts are somewhat similar for the alternatives in each of the three categories. If Alternative Number 1 were to be adopted, periods of low flow or no flow could be expected to occur in more streams on a more frequent basis in the future. The potential for increased surface water irrigation and associated economic

development would not be inhibited but environmental and recreational values would be impaired on some streams, especially some of those with base flows that are not entirely committed to existing water rights.

Alternatives which constitute the second category – Numbers 2, 4, 6, 7, 9, 10, 12 and 13 – would serve to maintain or enhance environmental and social-economic values associated with instream flows. However they would limit to some degree the potential for increased irrigation and associated economic development in the state. Administrative costs would be highest with these alternatives.

Alternatives Numbers 3, 5, 8, and 11 would have impacts similar to those of Alternative Number 1. Basically they would result in the continuation of present state policy. In addition, their adoption would prevent some economic costs and environmental benefits associated with Alternatives Numbers 2, 4, 7, and 10.

It is important to note that the alternative policies generally would not affect existing water rights. Furthermore, any water they would protect for instream uses in a particular stream or stream segment would still be available for out-of-stream uses downstream.

Introduction

PURPOSE AND SCOPE

The purpose of this report is to provide information needed by Nebraska policy makers to assist them in deciding whether the present state policies on instream water uses should be changed and, if so, what state policies should be adopted.

Instream water uses have become an issue because the supply of surface water in some areas of the state is not always adequate to support all instream and out-of-stream uses. Water physically diverted from a stream and put to out-of-stream use for agricultural, manufacturing, and domestic purposes has contributed significantly to the growth of the state and the prosperity of its citizens. Water left in the stream can also be used in a number of ways. Many stream reaches in the state support valuable fisheries, stockwatering, and a variety of recreational pursuits. Other instream uses of water are navigation, interstate compact commitments, wildlife, aesthetics, water quality maintenance, hydroelectric power production, aquifer recharge, and subirrigation of lands adjacent to streams. The issue that has arisen is what status, if any, these instream uses should have under Nebraska law.

With few exceptions, the legal status of instream water uses in the state's water rights system has not been explicitly addressed by statute, court decision, or formal administrative ruling by the Department of Water Resources. The absence of an authoritative legislative, judicial, or administrative pronouncement regarding instream uses makes even understanding their present legal status a difficult matter.

The instream flow issue has been clouded further by a lack of information on the value of instream water uses to the people of the state, as well as a lack of readily available information on the adequacy of present and projected streamflow levels to support the various instream uses. In addition, there have been many unanswered questions concerning what the impact of allocating water to instream uses would be.

This report will address these concerns in two sections. An initial background section, Chapters 1, 2, and 3, will examine each instream water use and problems associated with that use. Ratings for some instream uses, streamflow characteristics, and methods of determining flow requirements for various instream uses will also be discussed.

The second section of the report, Chapters 4, 5, 6, and 7, will introduce alternative state policies on instream water use and examine the hydrologic, environmental, social-economic, administrative and legal impacts of each alternative. That examination will include an analysis of existing state policy as well as a description of policies of other states.

LEGISLATIVE BACKGROUND

The degree of protection that should be extended to instream water uses under the state's water policy has been the subject of some debate in recent years. The Nebraska Soil and Water Conservation Commission's 1971 *Report on the Framework Study* addressed the subject of the fish, wildlife, water quality, recreational, and scenic values of the state's streams. In the report the Commission expressed concern over the possible loss of these values. The Commission concluded that measures were needed to enhance and expand water related habitat, maintain proper water quality, and maintain minimum flows at desirable levels. In addition, the Commission recommended establishing a system of protected rivers to preserve the scenic, recreational, or environmental values of certain river reaches.

Legislative changes to the present instream flows policy have been attempted. Bills were introduced during the 1977 and 1980 legislative sessions which would have defined the term "beneficial use" to include most of the instream uses that are the subject of this study. The purpose of these bills was to allow the acquisition of rights to appropriate natural flow for instream uses as a means of ensuring that the entire flow of a stream would not be diverted to meet out-of-stream uses. Both bills failed to advance out of the Public Works Committee.

A bill to establish a protected rivers system in Nebraska was introduced during the 1980 legislative session. The intent of this bill was to provide a means to preserve river segments having outstanding scenic, recreational, fish, wildlife, historical or scientific, and other cultural values. However, this bill was indefinitely postponed by the Constitutional Revision and Recreation Committee.

Two bills introduced in the 1981 legislative session may have future importance regarding instream flows policy. One would allow certain public entities to obtain

water rights for a number of purposes, including some instream uses. That bill (LB 152) is still in committee.

The other bill (LB 252), which was passed by the legislature, requires the director of the Department of Water Resources to consider the impact of proposed transbasin diversions of surface water on instream uses, among other factors, when deciding whether to grant an appropriation permit for the diversion.

In terms of this report, a significant legislative action pertaining to instream flow was Legislative Resolution 300 in 1978. In addition to providing general guidance for state agencies to redirect their planning efforts, it identified environmental and recreational demands for water as a policy issue needing to be analyzed. The Natural Resources Commission and other agencies, in their report outlining the new planning process, combined into one suggested study the instream portion of those demands with other instream concerns. This report is the product of that study.

RELATION TO OTHER STUDIES

In addition to this analysis of the instream flow issue, studies have been scheduled or are underway on ten other Nebraska water policy issues. Each of these studies examines a selected aspect of water policy and several have a degree of relationship to the Instream Flows Study.

The Groundwater Reservoir Management Policy Study provides information on alternative policies for managing groundwater and the impacts of those policies. Because of the interrelationship between groundwater and surface water, one of the areas impacted by groundwater policies is streamflow.

The Selected Water Rights Issues Policy Study has several reports scheduled which relate to the instream flow issue. The reports are: Water Use Preferences, Transferability of Water Rights, Riparian-Appropriative Rights, and Beneficial Uses.

The Municipal Water Needs Policy Issue Study and the Instream Flows Study deal with a common concern, that of streamflow recharge of aquifers providing municipal needs. A proposed alternative to provide authority to reserve unappropriated flows to meet future municipal water supply needs from surface water was rejected by the Instream Flows Study Task Force. This proposal was based upon concerns that groundwater supplies currently being used will be reduced in quality/quantity to the extent they become inadequate. The Task Force determined that consideration could not be given to reserving flows to meet a single out-of-stream need. It is assumed this concern will be addressed in the Municipal Water Needs Policy Issue Study.

Other studies with significant relation to this study include the Supplemental Water Supplies Study (potential use of storage to maintain streamflow), and the Water Quality Study (however, most information on quantity/quality relationships is included in this Instream Flows Study).

IMPLEMENTATION OF POLICY ALTERNATIVES

The following pages provide information regarding instream uses, alternative instream flow policies, and the impact of those policies. The decision on which alternative policies best suit Nebraska's needs is dependent in large part upon value judgments beyond the charge of the task force which produced this report.

However, in considering the alternatives presented, the decision makers should keep several general points in mind. One relevant factor is that the choice of one alternative does not necessarily preclude another alternative from being adopted as well. Although some alternatives are mutually exclusive, in other instances more than one may be required in order to bring about a particular policy.

A second important consideration is that many of the alternatives presented would not necessarily require implementation on all of Nebraska's streams. Policy makers may desire to protect flows on only certain streams or streams having certain characteristics. Furthermore, it is possible that differing alternatives may be appropriate for different streams in different parts of the state.

A third and final relevant item is that implementation of some of the alternative policies would require application of methodologies for determining instream flow needs. Some of the methods available are described in Chapter 3 of this report.

Chapter 1

Instream Water Uses

An instream use of water is any use that occurs in a stream channel. The instream uses considered in the Instream Flows Policy Issue Study are: fishery resources, recreation, interstate compacts and court decrees, hydroelectric power, livestock watering, aquifer recharge, subirrigation, navigation, wildlife, aesthetics, wild and scenic rivers, and water quality.

This chapter provides background information on these instream water uses. For each instream use, there is a description of the use, a rating of streams important to the instream use, a discussion of present instream use problems, and an identification of future instream use concerns.

FISHERY RESOURCES

Description

There are thirteen river basins in Nebraska with approximately 23,686 miles of streams and canals.[1] Of this total, 12,368 stream miles (52.2%) are considered to be valuable to fishery resources.[2] The total stream miles in the state comprise 64,549 surface acres as compared to a state total of 183,772 acres of lakes and reservoirs.[3]

Nebraska's fisheries, in both streams and reservoirs, meet a large demand for outdoor recreation. The interest in fishing in Nebraska is evidenced by the number of fishing permits sold. Permit sales peaked in 1976 when 223,541 Nebraska residents bought fishing permits.

The importance of stream fishing is also shown by participation rates obtained from the 1978 Nebraska Annual Social Indicators Survey (see Table 1).

Reservoirs and lakes attracted more anglers than streams. However, stream fishing exceeded reservoir fishing on a surface acre basis.

The 1978 Nebraska Annual Social Indicators Survey also identified which regions in the state were most popular for stream fishing. The survey found that approximately thirty-one percent of all stream fishing in 1977 occurred in the Elkhorn and Missouri River areas of northeastern Nebraska.[5] Opportunity and population density are two important factors determining where fishing activity takes place.

In regard to their importance as fishing resources, streams in Nebraska are classified as cold water, warm water or mixed water. Cold waters are those supporting a cold-water fishery, especially trout species. Generally, trout habitat has been defined as water 70°F or colder and containing 3.0 ppm or more of dissolved oxygen. Most of the trout streams, including the cold water habitat in Lake McConaughy, are in the western and northern parts of the state. The stream fishing demand for trout in the productive cold waters of Nebraska exceeds supply.[6] This demand has necessitated supplemental stockings of rainbow and brown trout since the early 1900's. This is particularly true in the Pine Ridge area trout streams where Soldiers Creek is the most heavily used stream. Between June 1 and July 7, 1974, a total of 839 anglers fished Soldiers Creek for 3,354 hours, caught 1,947 trout at average rates of 0.58 fish per hour and 2.3 fish per angler.[7]

Warm waters support only warm-water fish species such as channel catfish, walleye, and carp. Mixed waters are those capable of supporting both cold and warm-water species of fish. Table 2 identifies the miles of warm, cold, and mixed water streams in Nebraska by river basin.

The North Platte River and some of its tributaries are excellent examples of a cold and mixed stream habitat as they support both warm-water fish and rainbow trout which use the streams for spawning runs upstream from Lake McConaughy. Trout spawned in the tributaries along the North Platte River spend approximately one year in feeder streams such as Ninemile Creek and Red Willow Creek before moving back to Lake McConaughy. A map of the warm, cold, and mixed water streams in Nebraska can be found in the report, *Nebraska Stream Fishery Resources*

Table 1: Participation estimates for fishing by Nebraskans in 1977.[4]

	Streams and rivers	Reservoirs and lakes
Number of Nebraskans fishing	334,236	475,940
Percent of population fishing	21.7	30.9
Average number of fishing days per person	11.8	10.9
Total number of fishing days	3,943,985	5,187,746

by Gene Zuerlein, Nebraska Game and Parks Commission, 1980.

Rating of Streams

Figure 1 classifies the streams in Nebraska according to their importance to the state's fishery resources. This map is based on the 1978 Stream Evaluation Map prepared by the Nebraska Game and Parks Commission and the U.S. Fish and Wildlife Service. Streams are classified into four value classes:

Value class	Class definition
I	Highest valued fishery resource
II	High-priority fishery resource
III	Substantial fishery resource
IV	Limited fishery resource

The appropriate value class for each stream reach was determined by the following criteria: occurrence of state or federal threatened species or existence of habitat for species of high interest to the state. Figure 1, however, shows only the streams in value Classes I, II, and III. In addition, the reduced scale of the map precluded inclusion of a few tributaries in these value classes. The 1978 map (scale 1:500,000) is available from the Nebraska Game and Parks Commission.

Present Problems

Streams are open ecosystems and exhibit a variety of physical, chemical, and biological conditions. Streams with permanent flows yield the best production of fishery stocks which can be utilized by the angling public. The survival of fish species depends upon the quality of their environment. Adequate food and shelter are essential and favorable reproductive habitat should be available.

A 1972 survey of stream channel length showed that 833 miles of stream channels which were valuable to the fishery resource had been lost primarily through channelization.[9] This is a 6.3% decline in stream mileage, from the 13,202 stream miles that were previously valuable fishery resources. Since 1972, additional stream developments have reduced further the mileage of streams valuable to the fishery resource.

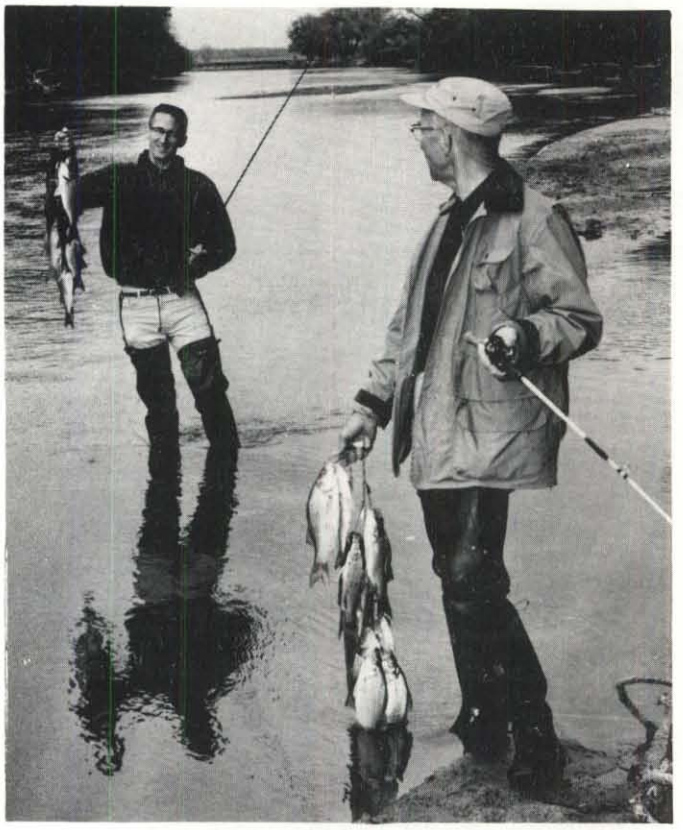
Sedimentation due to agriculture, streambank erosion, urban runoff, and other factors also has an influence on sport fishery development in many streams throughout the state. It is believed that control of sedimentation in the North Platte River and tributary streams above Lake McConaughy has the potential to improve the rainbow trout fishery to one of national significance.[10]

Water quantity is a factor affecting fishery resources. As streams are dewatered, fish are concentrated in pools, water temperature increases, and oxygen levels are lowered resulting in fish kills. Table 3 identifies those stream segments known to have been partially or completely dewatered due to man's activities or drought during the period 1976 through 1978. The table does not represent a complete list as it is based on public complaints and/or fish kill reports. The effect of dewatering on fishery resources is variable depending upon such factors as time of year, duration, weather conditions, length of stream influenced, and access to reservoirs or flowing tributaries. However, once a stream ecosystem has dried up it takes years for the fishery resources to regain original productivity. In order to reduce recovery time the Nebraska Game and Parks Commission has a restocking program. However, there are biologic and economic limitations to the maintenance of stream fisheries through restocking.

Fishery resources have been enhanced in some streams of the state by artificial supplementation of flow. For example, the flow of some of the small trout streams that are tributaries to the North Platte River is supplemented by seepage from irrigation canals that intersect the streams.[11]

Table 2: **Stream miles by river basin based on water temperature.**[8]

River basin	Stream miles		
	Warmwater	Coldwater	Mixed
Lower Platte	694	–	–
Middle Platte	616	5	9
South Platte	264	–	16
North Platte	63	174	175
Elkhorn	1,256	–	3
Loup	1,561	65	–
Missouri Tributaries	651	–	–
Big Blue	1,600	–	–
Little Blue	905	–	–
Nemaha	1,278	–	–
Republican	1,125	–	10
Niobrara	1,201	218	135
White-Hat	122	162	60
TOTAL	11,336	624	408



Fishing in the Republican River

Future Concerns

The future of Nebraska's stream fishery resources depends upon the quality and availability of aquatic habitat.

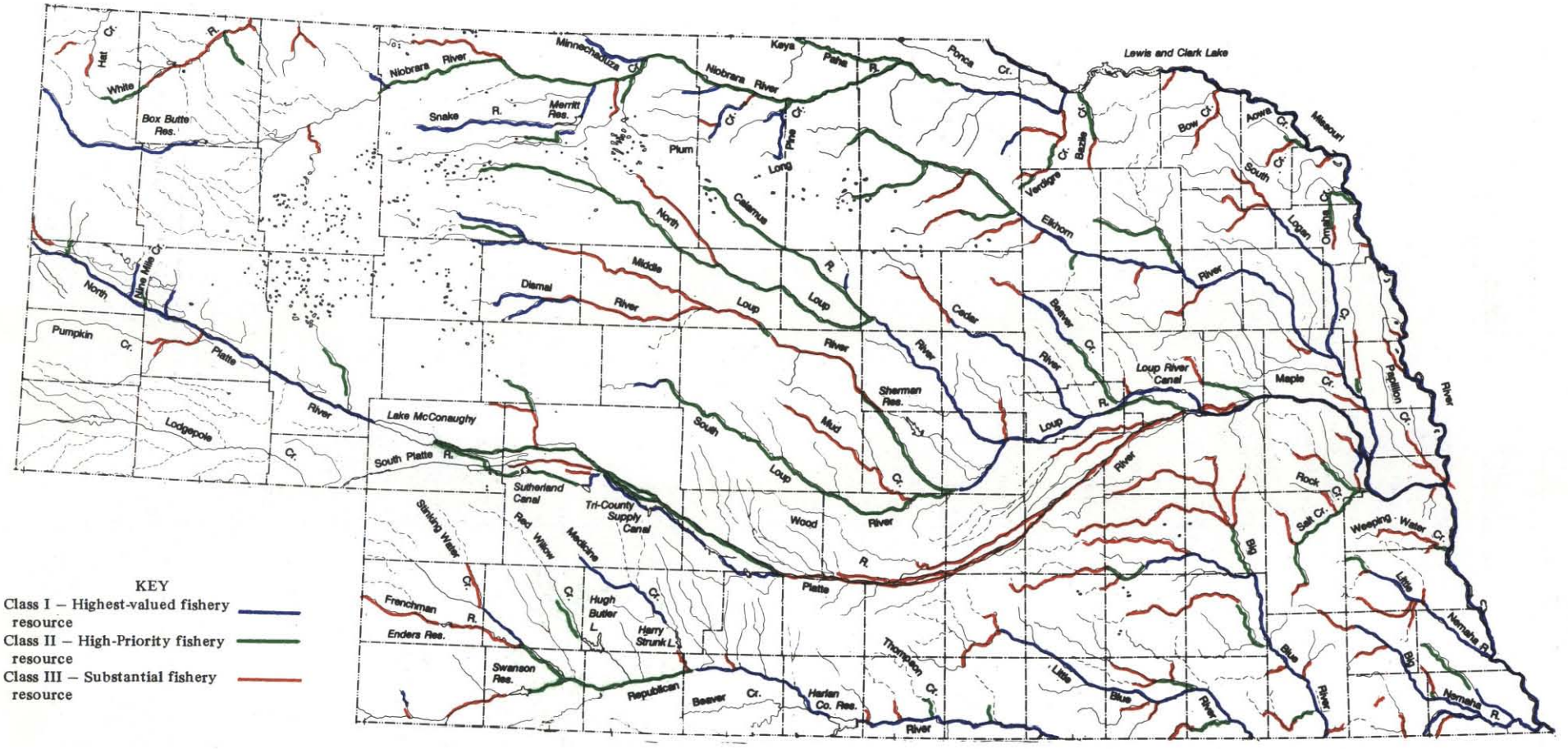


Figure 1: Stream classification for fishery.

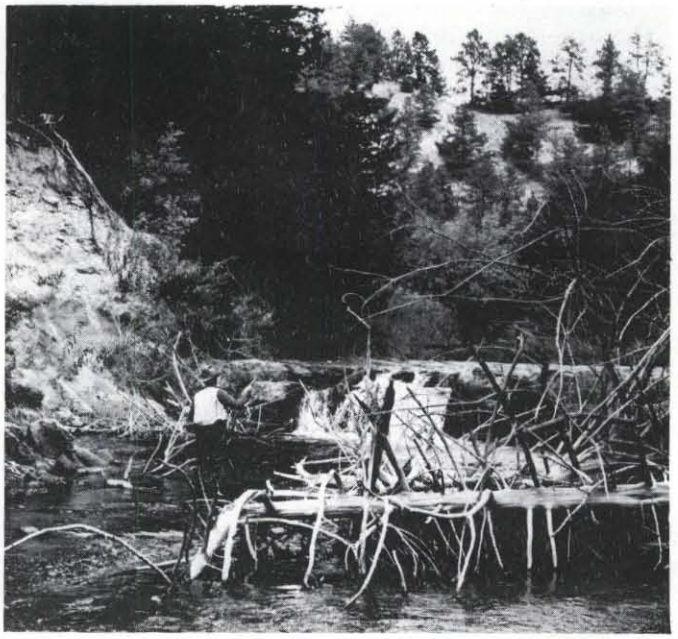
Table 3: Fish kills 1976 through 1978 by river basin.

NAME OF STREAM*	COUNTY	YEAR	EXTENT OF FISH KILL
LOWER PLATTE RIVER BASIN			
Platte River	Merrick, Platte	1976	Total
Lost Creek	Platte, Colfax	1976	Total
Rawhide Creek	Colfax	1976	Moderate
Barnum Creek	Platte	1976	Total
Shell Creek	Madison, Platte	1976	Light
Prairie Creek	Merrick, Platte	1976	Total
Clear Creek	Polk, Butler	1976	Total
ELKHORN RIVER BASIN			
Elkhorn River	Rock, Holt	1976	Heavy
Logan Creek	Thurston, Cuming, Burt	1976	Heavy
Willow Creek	Pierce	1976	Moderate
Bell Creek	Burt	1976	Undetermined
Cache Creek	Holt	1976	Undetermined
Tracy Creek	Stanton	1976	Undetermined
Buffalo Creek	Madison	1976	Undetermined
Middle Fork Maple Creek	Colfax	1976	Undetermined
East Fork Maple Creek	Colfax	1976	Undetermined
LOUP RIVER BASIN			
Loup River	Nance, Platte	1976	Heavy
Plum Creek	Nance	1976	Undetermined
Beaver Creek	Boone, Nance	1976	Moderate
MISSOURI TRIBUTARIES BASIN			
Bazile Creek	Knox	1976	Light
Aowa Creek	Dixon	1976	Undetermined
Box Creek	Cedar	1976	Undetermined
Weeping Water Creek	Cass	1977	Total
BIG BLUE RIVER BASIN			
Big Blue River	Seward	1976	Heavy
Turkey Creek	Saline	1977	Moderate
LITTLE BLUE RIVER BASIN			
Little Blue River	Clay, Nuckolls, Thayer	1978	Heavy
NEMAHA RIVER BASIN			
Little Nemaha River	Nemaha, Otoe	1977	Heavy
No. Fork Little Nemaha River	Otoe	1977	Total
Hooper Creek	Otoe	1977	Total
Silver Creek	Otoe	1977	Total
Russel Creek	Otoe	1977	Total
Muddy Creek	Otoe	1977	Total
Owl Creek	Otoe	1977	Total
Wolf Creek	Otoe	1977	Total
Brownell Creek	Otoe	1977	Total
Spring Creek	Otoe	1977	Total
Sandy Creek	Otoe	1977	Total
Jones Creek	Nemaha	1977	Total
Houschins Creek	Nemaha	1977	Total
Willow Creek	Nemaha	1977	Total
No. Fork Big Nemaha River	Richardson, Pawnee, Johnson	1977	Total
Big Nemaha River	Richardson	1977	Total
So. Fork Big Nemaha River		1977	Heavy
Rattlesnake Creek	Richardson	1977	Total
Spring Creek	Richardson	1977	Total
Easley Creek	Richardson	1977	Total
Four Mile Creek	Richardson	1977	Total
Honey Creek	Richardson	1977	Total
Rock Creek	Richardson	1977	Total
REPUBLICAN RIVER BASIN			
Republican River	Nuckolls, Webster, Franklin, Harlan	1977	Heavy
Republican River	Harlan, Furnas	1978	Total
NIOBRARA RIVER BASIN			
Keya Paha River	Keya Paha, Boyd	1976	Total

*The inclusion of a stream means that a low flow related fish kill was reported to have occurred on at least one reach of that stream. The exact location and length of the stream reaches are not known.

The projection of future streamflows was not accomplished in this study (see Chapter 2). However, other studies have projected future streamflows in Nebraska. The Missouri River Basin Commission's Platte River Basin Level B Study predicted streamflows based on modeling of high and low rates of groundwater development. Heavy declines in streamflows were predicted to be forthcoming in the Platte River from North Platte to its mouth near Plattsmouth.[12] Moderate reductions in average annual flows were predicted for the North Platte, Upper Loup, and Elkhorn Rivers.[13] Fishery resources in the moderately reduced regions could be maintained near present levels; however, fishery resources in heavily depleted regions will be hard, if not impossible to maintain.

Beaver Creek, a Class I and II fishery resource, is likely to deteriorate in fishery importance as streamflows are reduced by a combination of causes including: groundwater use, surface water appropriation, drought conditions, and changes in land use. Beaver Creek was partially dewatered in Wheeler, Boone, and Nance Counties in 1976 and some reaches were dry in 1980.



Fishing in the Snake River

Groundwater withdrawal and other contributing factors have reduced streamflows in the Frenchman River above Enders Reservoir and in Stinking Water Creek in Chase and Hayes Counties.[14] The lower reach of Stinking Water Creek, above Culbertson Diversion Dam, was considered an excellent natural reproducing fishery for channel catfish. However, the fishery is expected to diminish due to insufficient streamflow during the spawning period of channel catfish.

Cedar River, also a Class I fishery, is believed in jeopardy due to surface water withdrawls and recent expansion of well irrigation. Based on projected future streamflow depletions, fishery resources may decline dramatically.[15]

In summary, stream fishery resources will continue to deteriorate with depletions in streamflow in many streams across the state. However, fishery resources should remain good in perennial streams such as the Snake, Calamus, and Dismal Rivers along with extensive reaches of the North Loup, Middle Loup, and Niobrara Rivers. In addition, the Missouri River is expected to provide increased angling opportunities.[16]

RECREATION AND AESTHETICS

Description

Streams and rivers play an important role in outdoor recreation opportunities. They are important for providing both instream and reservoir recreational activies such as canoeing, rafting, swimming, fishing, hunting, power boating, and water skiing. Participation in some water-based recreational activities is shown in Table 4.

Table 4: Participation in selected recreational activities in Nebraska during 1977.[17]

Activity	Activity days
Reservoir fishing	5,187,746
Water skiing	2,919,105
Power boating	1,803,955
Canoeing	513,390
Rafting	420,492

Streams and rivers are also important as aesthetic resources. Aesthetics is defined as "a branch of philosophy dealing with the nature of the beautiful and with 'judgments concerning it'."[18] One reference suggests that the principal distinction between aesthetics and recreation is that recreation uses are active within the stream and aesthetic uses tend to be passive from outside the stream.[19]

Direct aesthetic appreciation relates primarily to the added dimensions that a stream or river gives to a landscape, either as viewed from the river bank or from a vantage point above and away from the river. River characteristics can include features such as falls, rapids, meanders, or channel braids. It can also include sounds associated with flowing water and the absence of the unpleasant odors associated with polluted streams.

Indirect aesthetic values relate to the positive influence of the stream course in occurrence with other landscape features such as woodland vegetation, wildlife and topographic variations. Prairie and plains landscapes are sometimes described as monotonous. Streamside woodlands provide landscape diversity.

The aesthetic importance of water is described also in the *Nebraska State Comprehensive Outdoor Recreation Plan.* This plan indicated that many outdoor recreational activities such as picnicking, camping, and hiking are centered around a body of water because the scenic background afforded by it adds pleasure to activities that actually do not require water at all.[20]

The importance of streams to outdoor recreation and to the quality of the recreational experience is evidenced by the number of state Game and Parks Commission areas, community parks, and private recreation areas located on streams.

Figure 2 shows the state parks, state recreation areas, and wildlife management areas that are associated with Nebraska streams. Three of the five state parks in Nebraska are on rivers – Indian Cave and Ponca on the Missouri River and Niobrara on the Niobrara River. The state recreation areas that have river frontage were acquired and developed for recreational use because of river access, water areas created by sand and gravel mining, or oxbow lakes. The wildlife management areas provide, in addition to wildlife habitat, opportunities for hunting, trapping, fish-

ing, hiking, nature study, photography, canoe launching, and in some areas, primitive camping.

Many communities in Nebraska have streams or rivers flowing through them. The streams make available to the communities, in addition to typical recreational activities such as baseball and tennis, such opportunities as scenic trails, quiet enjoyment of a flowing stream, and fishing. Some communities have taken advantage of their streams to expand their outdoor recreation programs. An excellent example is York, which has developed a recreation area along Beaver Creek.

A substantial amount of instream recreation in Nebraska occurs on streams in which the beds are owned or controlled by private landowners. The recreational use supported by these privately owned river areas includes swimming, tubing, rafting, canoeing, hunting, and fishing.

From 1977 to 1980, canoeing participation increased from 531,390[21] to 823,500[22] activity occasions. This increase is supported in part by a growing number of private canoe outfitting enterprises. The Nebraska Game and Parks Commission, recognizing the demand for overnight canoe campsites on private property, established the Canoe Trails Program. This program has been successful in leasing small tracts of land from owners to provide canoe campsites at intervals of about fifteen miles along seven river segments. Over 400 miles of streams are now available for canoe camping. The streams included in this program are: Calamus, Dismal, Elkhorn, Missouri, North Platte, Platte, and Republican Rivers.

Canoeing the Calamus River

Rating of Streams

Figure 3 shows Nebraska streams classified according to their importance for canoeing use. Canoeable streams occur in twelve of the thirteen river basins in Nebraska. Only the White River – Hat Creek Basin does not provide an opportunity for canoeing. Approximately 3,400 miles, or fifteen percent, of Nebraska's total river miles receive some canoeing use. This rating of canoeable streams is based on information provided by state conservation officers in response to a January 1981 survey.[23]

Many streams in Nebraska are considered by the public to have high aesthetic value. Since the determination of aesthetic value is very subjective most streams in their natural state could be considered to have aesthetic value.

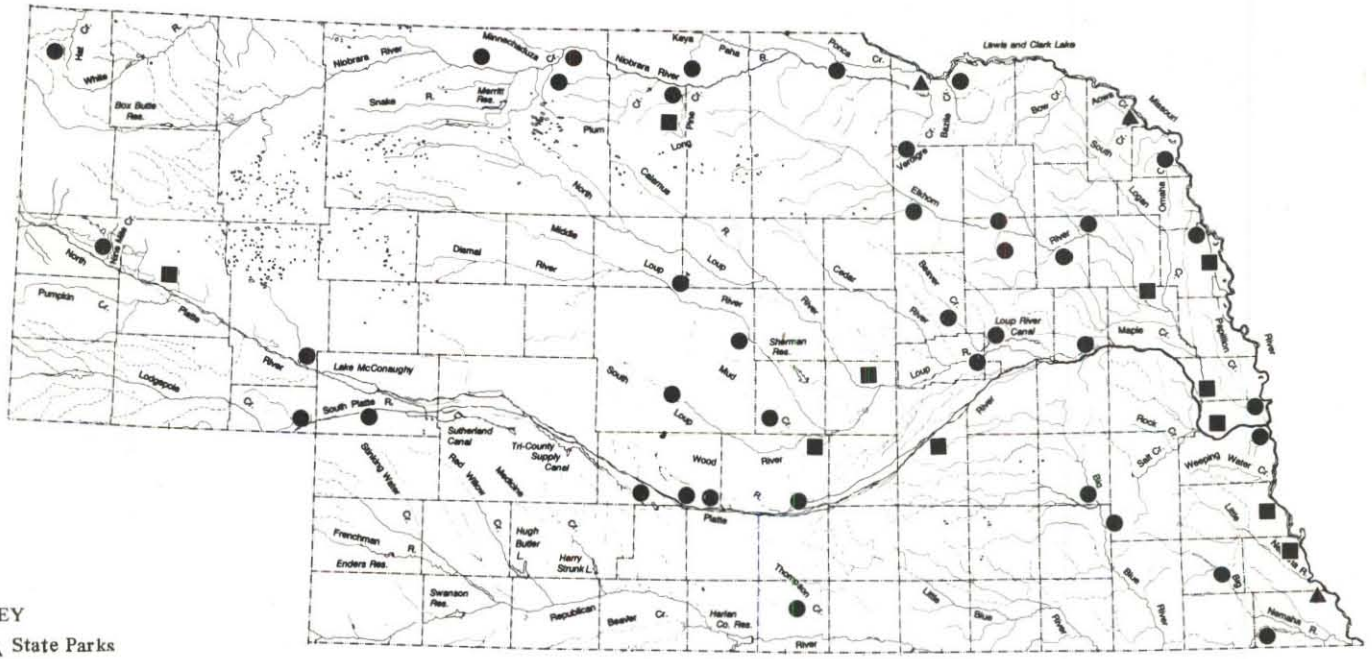


Figure 2: State parks, state recreation areas, and wildlife management areas.

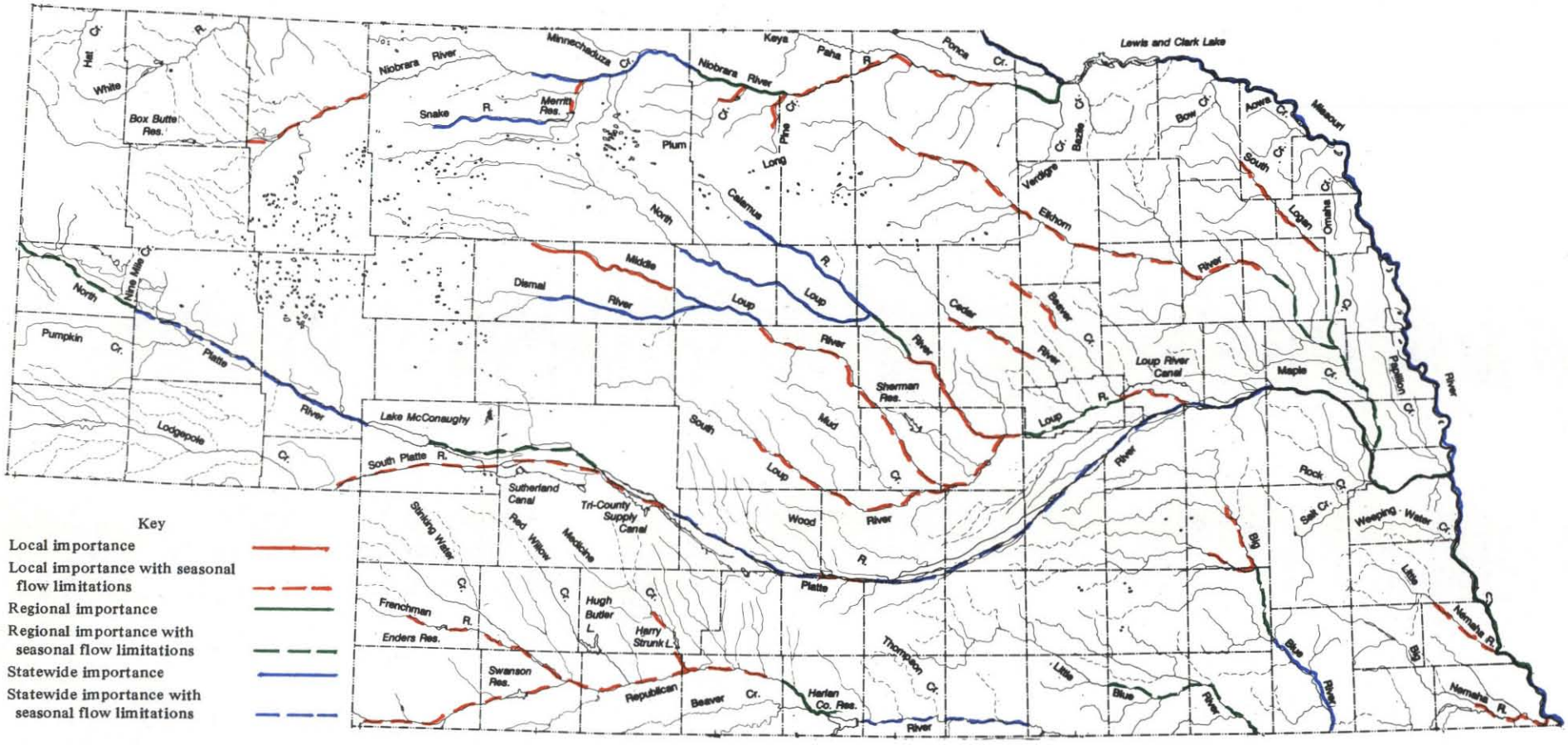


Figure 3: Stream classification for canoeing.

Present Problems

Of the 3,400 miles of streams that receive some canoeing use, 2,160 miles, or sixty-four percent, of those streams are subject to seasonal flow limitations such that canoeing is, at times, impossible. Table 5 identifies, by river basin, the stream miles subject to seasonal low flows restricting canoeing.

Table 5: Streams miles, by river basin, presently subject and not subject to seasonal low flow that restricts canoeing.[24]

River basin	Canoeing not restricted by seasonal low flows	Canoeing restricted by seasonal low flows	Total stream mileage
Lower Platte	–	122	122
Middle Platte	–	307	307
South Platte	–	105	105
North Platte	45	183	228
Elkhorn	20	355	375
Loup	533	428	961
Missouri River	363	–	363
Big Blue	50	48	98
Little Blue	–	52	52
Nemaha	–	50	50
Republican	–	343	343
Niobrara	234	167	401

Future Concerns

The projection of future streamflows was not accomplished in this study (see Chapter 2). However, based upon modeling for the Platte Level B Study (1976), it can be expected that increased water use will contribute to a decrease in the mileage of streams suitable for recreation and aesthetics.

INTERSTATE COMPACTS AND COURT DECREES

Description

Interstate compacts and court decrees are means by which water flowing in interstate streams can be allocated between states. As such, maintaining the flow of a stream to meet interstate compacts and court decrees can be considered as an instream use of water.

In addition, enforcement of the provisions of the compacts and the decree could contribute to meeting flow requirements for instream uses. However, this would be only an indirect benefit as flow requirements to meet instream water uses are not a stated purpose or requirement of any of the compacts or of the decree. The opportunity for negotiation of future compacts based upon instream flow values may be limited by the absence of explicit recognition of most instream uses under Nebraska law. The apportionment of water in all but the Big Blue River Compact and the North Platte Decree would have only minimal value for maintaining flows for instream uses.

Nebraska has entered into four interstate compacts and has been a participant in one U.S. Supreme Court decree. The interstate compacts which Nebraska has entered are the South Platte River Compact, Republican River Compact, Upper Niobrara River Compact, and Big Blue River Compact.

The Big Blue River Compact between Nebraska and Kansas was signed by the states on October 19, 1970. The compact sets minimum flow requirements for both the Big Blue and Little Blue Rivers at the Nebraska – Kansas state lines for the months of May through September.

The flows required at the state line are:

Little Blue River		Big Blue River	
May	45 cfs	May	45 cfs
June	45 cfs	June	45 cfs
July	75 cfs	July	80 cfs
August	80 cfs	August	90 cfs
Sept.	60 cfs	Sept.	65 cfs

The Nebraska Department of Water Resources is authorized to administer upstream uses, both groundwater and surface water, to a limited degree for the benefit of these minimum state line flows.

A U.S. Supreme Court decree has also apportioned waters between Nebraska and Wyoming. The decree was issued after Nebraska had instituted suit against Wyoming. Subsequently, the State of Colorado was joined as a defendant in order to apportion the waters of the North Platte River. Water in the North Platte River was apportioned by setting maximums on the amount of water that could be diverted and on the acreage that could be irrigated. The decree apportions seventy-five percent of the natural flows of the North Platte River from May 1 to September 30 to meet Nebraska appropriations.

HYDROELECTRIC POWER

Description

Onstream hydroelectric power production has been important in Nebraska and can be considered an instream water use. At present there are only five active hydroelectric plants that involve instream generation facilities relying on natural flow. These plants are listed in Table 6.

Hydroelectric power generation also serves to protect other instream water uses. Hydroelectric power differs from other water uses, such as irrigation, in that it is not a consumptive use of water and does not contribute to significant reduction of flows. Therefore, hydroelectric power plants with senior water rights can contribute to the protection of instream water uses above the point of diversion.

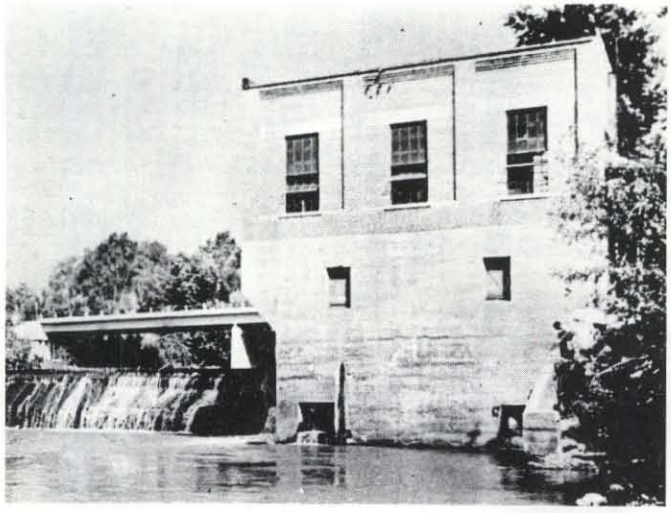
Present Problems

Streamflows have not been adequate to operate some of the hydroelectric plants at their designed capacities at all times. Decreased flow in the Cedar River during the summer of 1980 resulted in a reduction of the Spalding plant's power production by approximately one-third.[25]

Hydroelectric power generation, as an industrial use of water, has a lower preference than domestic and agricultural uses. Since many hydroelectric power plants have senior water rights, water reserved for hydroelectric power generation cannot be used for consumptive domestic or agricultural uses upstream, unless the hydropower generators are compensated for the loss of power production. However, hydroelectric power water rights have not been enforced in some cases, and on the Loup River some of the

Table 6: Active onstream hydroelectric plants in Nebraska.

Name of plant	Stream	Owner	Capacity in megawatts	Surface water rights (cfs)	Priority date
Blue Springs	Big Blue River	NPPD	0.42	450	1868
Spalding	Cedar River	City of Spalding	0.15	290	1890
Pierce	Minnechaduza Ck.	NPPD	0.20	35	1896
Valentine	Niobrara River	NPPD	1.85	1600	1902
Spencer	Niobrara River	NPPD	3.90	2000	1923



Hydroelectric plant on the Big Blue River at Blue Springs

flow allocated to hydropower was compensated for and is now being used by upstream consumptive users.

Future Concerns

In recent years there has been renewed interest in onstream hydroelectric power production. Future streamflow depletions, should they occur, could affect the feasibility of these proposed plants as well as the feasibility of maintaining active plants.

LIVESTOCK WATERING

Description

The use of streams to water livestock in Nebraska is generally of secondary importance to other sources of water for livestock such as wells and ponds. The Nebraska Soil and Water Conservation Commission *Report on the Framework Study* found that about eighty-one percent of Nebraska's livestock water supply in 1971 came from groundwater.[26] Table 7 shows the percent of groundwater and surface water used to water livestock in each river basin.

The findings of the Platte River Basin Level B Study completed in 1975 were similar. The Platte River Level B Study found that, on the average, surface water sources provide from ten to twenty percent of total livestock requirements. In addition, of the surface water used, seventy-five percent is from farm ponds and dugouts with only twenty-five percent from rivers, streams, and lakes.[28]

Even though statewide, the use of streams to water livestock is less important than water from other sources. There are many farms and ranches where streams are the only, or the major source of water for livestock. The *Report on the Framework Study* states: "In some areas of the state, rural groundwater supplies are not adequate from either a quantity or quality standpoint. General areas where problems are presently encountered are the following river basins: White River - Hat Creek, lower portion of the Niobrara, Missouri Tributaries, Nemaha, portions of the Lower Platte, and the southern portion of the Republican."[29]

In many parts of the state, especially eastern and southern Nebraska, relatively small tracts of land adjacent to streams are utilized for grazing. In these situations, streams generally are a dependable and adequate source of water for livestock at little or no cost to the landowner.

A stream that is an adequate and dependable source of water can be of value to a livestock producer for the following reasons: its presence can eliminate or reduce the need for development of alternative sources of water; little or no operation and maintenance costs are involved with a stream; and time is saved as a stream does not need to be turned on and off or routinely checked. Furthermore, streams can have convenience values or serve to reduce risks, even when other sources of water are available. For example, some streams never freeze thereby eliminating the need for tank heaters or ice removal. Streams can be a source of water for livestock isolated by blizzard or sickness. It should be noted, however, that a stream can be useable for livestock watering if it stops flowing for a short

Table 7: Sources of livestock water by river basin.[27]

River basin	Groundwater (%)	Surface water* (%)
White River - Hat Creek	40	60
Niobrara	75	25
Missouri Tributaries	80	20
North Platte	80	20
South Platte	80	20
Middle Platte	85	15
Loup	90	10
Elkhorn	80	20
Lower Platte	90	10
Republican	65	35
Little Blue	85	15
Big Blue	90	10
Nemaha	70	30
STATE AVERAGE	81	19

*Includes streams, stockdams, dugouts, and lakes.

period of time as water in pools can temporarily meet the needs of livestock.

In the White River - Hat Creek Basin, streamflows are seasonally inadequate in many streams for livestock watering. Livestock producers adjust their management practices so that when streams dry up, livestock are moved to tracts that have alternate sources of water.

The actual value of a stream as a source of livestock water varies according to the need for, and the availability of, alternative sources of water. A survey of realtors, appraisers, and agencies involved with land appraisal throughout the state was conducted by Natural Resources Commission staff during May and June, 1980. The survey asked how the value of grazing land is influenced by the presence of a continuously flowing stream that provides an adequate and dependable supply of livestock water. Although the views of the sixteen respondents were quite varied, they generally agreed that the value of a stream approximates the costs of developing, operating, and maintaining one or more alternative sources of water supply on the same tract of grazing land. In monetary terms they generally felt that a stream adds approximately ten to fifteen percent ($15 - $100 per acre) to the value of grazing land if alternative sources are not already developed, and little or no additional value if alternative sources are already present. Four respondents estimated that a stream adds $150 or more per acre to the value of grazing land if alternative sources of water are not present. On the other hand, four respondents commented that streams can reduce the value of grazing land if they are flood prone, have a disease carrying potential, or make conversion to center pivot irrigated cropland more costly.

Rating of Streams

A rating of individual streams for their importance to livestock watering is not possible because little data are available concerning individual streams. However, a relative ranking of the importance of river basins to livestock watering can be made (see Table 8).

Table 8: Importance of streams for livestock watering by river basin.

Importance	River basin
High	Nemaha
	Missouri Tributaries
	Niobrara
	White River - Hat Creek
	Republican
Moderate	Lower Platte
	Elkhorn
	Loup
	North Platte
Low	Little Blue
	Big Blue
	Middle Platte
	South Platte

The factors used in determining the rating were: (1) the number of flowing streams in the basin, (2) the amount of riparian grazing land, (3) the availability of groundwater, (4) the use of stock dams in the basin, (5) the existence of unconfined livestock operations, and (6) the 1980 livestock watering requirements by basin.

Livestock watering and irrigation – Cache Creek

Present Problems

In recent years some operators have experienced problems because the streams they have historically relied on have had inadequate flow to meet their livestock watering needs. The result has been, in some cases, complaints to state agencies regarding the lack of water for livestock use. Table 9 identifies those streams for which complaints regarding inadequate flow for livestock watering have been received. These complaints were received by the Department of Water Resources, Game and Parks Commission, and natural resources districts. The inclusion of a stream in Table 9 means that at least one reach of it was reported to have inadequate flow to meet livestock watering needs. The exact location and length of the reaches are not known.

When a stream has inadequate flow to provide water for livestock, an operator may either move the livestock to another tract where water is available or develop an alternate source of water. In some cases, hauling water to livestock will be necessary. Hauling water to cattle in pastures that formerly were served by flowing steams was quite common in the Nemaha River Basin in 1977.[30]

The many watershed structures constructed in Nebraska, especially in the eastern part of the state, have altered streamflows and thus have affected instream water uses. The development of reservoirs on perennial streams can result in improved flow conditions to meet livestock watering needs. Reservoir releases to meet downstream water rights, seepage losses, and special valves (watering devices) have served to provide more stable streamflow regimes than naturally occurred. In some instances, natural resources districts have released water from watershed structures to satisfy requests for water to meet downstream livestock needs even at times when there was no inflow to the reservoirs.[31]

Lowered water tables also affect the use of streams for livestock watering. Lowered water tables lead to increased costs for livestock wells. Therefore, livestock growers may choose to rely more on streams to meet their livestock water needs. During the summer of 1980 local ranchers relied more on the Cedar River for livestock water-

ing than in previous years when their stock wells provided adequate water.

Future Concerns

Twenty-seven streams or stream segments in ten river basins are projected to have inadequate flow to meet livestock water needs during the summer grazing season in the future. These streams are:

Missouri Tributaries
- Aowa Creek
- Bow Creek (East)
- Little Bazile Creek
- Norwegian Creek
- Pearl Creek
- South Creek

Republican River Basin
- Bushy Creek
- Center Creek
- Curtis Creek
- Fox Creek

Frenchman Creek (above Enders Res.)
- Republican River (Benkelman to Alma)
- Spring Creek
- Stinking Water Creek
- Thompson Creek

Niobrara River Basin
- Keya Paha River (state line to Niobrara River)

Table 9. Complaints of inadequate flow to meet instream stock watering needs 1974-79.

Streams	Number of complaints	Number of head affected	Year of complaint
Missouri Tributaries			
Bow Creek – East & West	3	Unknown	1975-77
Bow Valley Creek	2	Unknown	1975-76
Cascade Creek	1	Unknown	1977
Cedar Creek South	3	20-50	1977
North Creek	1	Unknown	1975-76
Norwegian Bow Creek	2	Unknown	1975-76
Pearl Creek	2	Unknown	1975-76
Rakes Creek Tributaries	1	25	1976-77
South Creek	2	Unknown	1975-76
Weeping Water	7	200 or more	1975-77
Elkhorn			
Bell Creek	4	Unknown	1977
Elkhorn River (Atkinson to O'Neill)	several	Unknown	1974-79
Logan Creek	3	Unknown	1976-77
Tracy (Meridian) Creek	2	Unknown	1976
Willow Creek	4	Unknown	1976-77
Niobrara			
Bone Creek & Tributaries	2	Unknown	1976-77
Plum Creek	2	380	1976-77
Verdigre Creek	2	Unknown	1977
Republican			
Frenchman Creek (state line to Enders Res.)	1	Unknown	1974-79
Indian Creek	4	100-150	1977-78
Republican River (Cambridge to Harlan Co. Res.)	20	1200	1974-78
Spring Creek	2	Unknown	1974-78
Stinking Water Creek	1	Unknown	1974-79
White River - Hat Creek			
Hat Creek and tributaries	5/yr.	2000	1974-79
Spotted Tail Creek (below Pathfinder Irr. Canal)	2	Unknown	1978
White River	6/yr.	1000-2000	1974-79
South Platte			
Lodge Pole Creek	19	4000-5000	1974-79
North Platte			
Pumpkin Creek	5/yr.	1000-2000	1974-79
Middle Platte			
Prairie Creek	12	Unknown	1976
Lower Platte			
Middle Oak Creek	1	50	1974-76
Oak Creek	5	200	1975-76

Niobrara River (state line to Box Butte Res.)
Ponca Creek
White River-Hat Creek Basin
Hat Creek and tributaries
White River (Whitney Res. diversion to Chadron)
Elkhorn River Basin
Elkhorn River (above O'Neill)
Big Blue River Basin
Big Blue River (upper reaches – both branches)
Turkey Creek
Little Blue River Basin
Little Blue River
Nemaha
Little Nemaha River
North Platte
Pumpkin Creek
South Platte
Lodgepole Creek (state line to Oliver Res.)

This information was based on a survey of state agency personnel and natural resource district managers who were asked in 1979 which streams, in their judgment, may have inadequate flows for livestock watering in the near future.

It is possible that additional streams in Nebraska will become dewatered and the periods of inadequate flow for livestock watering will increase. Livestock producers can be expected to develop additional alternative sources for water and to convert riparian grazing land to cropland if it is more effective to change land use than to develop alternative sources of water.

AQUIFER RECHARGE

Description

The instream use of surface water described as aquifer recharge occurs only in a limited number of stream reaches in the state. As is discussed in Chapter 2, stream reaches in Nebraska are generally one of two types: gaining or effluent and losing or influent. Most streams in Nebraska are groundwater drains and not sources of groundwater recharge.

Some stream reaches that lose flow to the zone of saturation contribute to recharge of groundwater supplies that are important for irrigation and public water supply wells. The following streams or stream reaches are known to be sources of groundwater recharge:

1. Lodgepole Creek. It is not known whether Lodgepole Creek is a losing stream throughout its entire course in Nebraska or for only part of its course. In recent years, all or virtually all of the inflow from Wyoming was lost to groundwater storage within the Nebraska reach of the stream. Because of pumping of groundwater, the town of Sidney, in particular, has experienced water supply problems and is considering relocation of its well field outside the Lodgepole Creek Valley.[32]

2. Wood River. Wood River is a losing stream between Riverdale and Alda. The loss of flow is believed due to the water table decline that has been caused by groundwater withdrawals for irrigation.

3. Warm Slough, Prairie, Moores, and Silver Creeks (tributaries of the Platte River). These formerly were groundwater drains, but now are sources of groundwater recharge when they convey overland runoff.

4. Loup River. More overland runoff enters the Loup River than is discharged from the river's mouth. Losses appear to be greatest in the reach of the Loup River between St. Paul and Genoa.

5. Platte River. The Platte River tends to be a losing stream between Kearney and the mouth of Salt Creek and at the Omaha well field, about five miles upstream from the river's mouth. Part of the loss is natural and part is induced by pumping from irrigation wells and municipal supply wells near the river. The municipal well fields for Grand Island, Fremont, Lincoln, Omaha, and other communities are located along the Platte River.

Present Problems

The stream reaches, known to be important to the maintenance of public water supply systems and to irrigation wells tapping adjacent aquifers, do not provide significantly different amounts of recharge on an annual basis under conditions of continuous flow or of flow interrupted by brief periods of no-flow. However, the length of the periods of no-flow that can be tolerated have not been determined.

Degradation of water quality may be caused by reduced flows. For example, Omaha water officials have noticed increases in sodium concentrations in water pumped from their well field.

Future Concerns

Maintaining sufficient streamflow for recharging aquifers that are sources of domestic water may become more important in the future, particularly for purposes of maintenance of acceptable water quality. The impact of future Platte River diversions on wells along the lower portion of the river has not been ascertained. Consideration should be given to improved capability for predicting future hydrologic conditions.

SUBIRRIGATION

Description

Natural subirrigation occurs where the water table is sufficiently near the surface to supply water to sustain plant life. The water table elevation required for natural subirrigation varies according to the species of plants dependent upon it.

A high water table may be maintained by either seepage from losing streams or by groundwater moving toward the stream. The water table must be near the surface to supply water for wet meadows. However, because their roots can extend to a considerable depth, alfalfa and some trees may benefit from natural subirrigation in areas where many crop plants would not.

The most extensive areas of subirrigation in Nebraska include a portion of the Sandhills, the Elkhorn River, Beaver Creek, Cedar River, and the central Platte River valleys. In addition, subirrigation occurs on the islands in the Platte River.

Present Problems

Changes in the subirrigated areas of the state have not been documented. Certainly a considerable portion of the central Platte River valley that is now intensively used for

the production of irrigated crops was subirrigated prairie. It is possible that isolated ranching or farming units have experienced reduced production of hay on their subirrigated lands as a result of reduced streamflow, but such losses have not been documented.

One area of concern now being studied is the relationship of river flow to wildlife habitat on several large Platte River islands south and west of Grand Island. Studies of sandhill crane use show that the highest concentration of use is in the vicinity of these islands. Research on food habits of cranes collected from the area shows that invertebrates are the principal food sought in subirrigated grasslands.[33]

Future Concerns

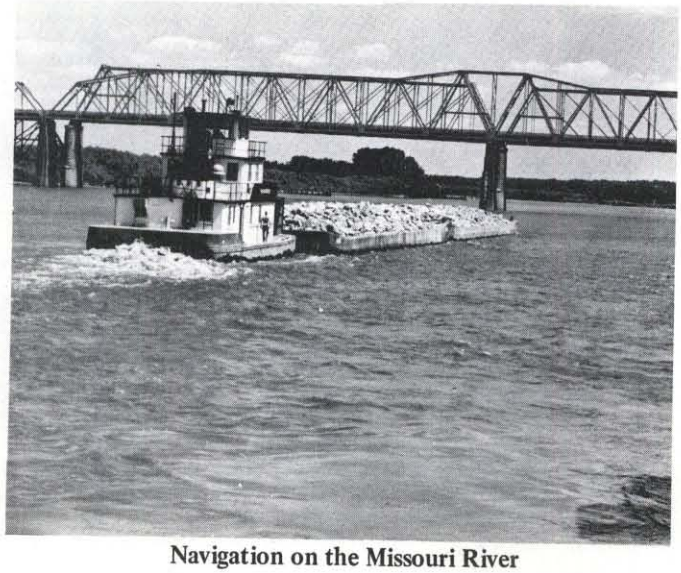
Reduction of subirrigated hay production and the deterioration of sandhill crane habitat could occur if subirrigation is adversely affected.

NAVIGATION

Description

Navigation in Nebraska occurs only on the Missouri River below Sioux City, Iowa. The navigational capabilities of the Missouri River were developed by the Missouri River Bank Stabilization and Navigation Project which was authorized by the River and Harbor Act of 1945. The project provides a navigation channel 9 feet deep and 300 feet wide from Sioux City, Iowa to the confluence with the Mississippi River at St. Louis, Missouri.[34] Navigation on the river is confined to the ice-free season with a full season normally beginning April 1 and ending December 1.

Commercial navigation on the Missouri River reached a record 3.3 million tons in 1977 and again in 1979. Principal commodities transported downstream are farm products and food and kindred products.[35] Commodities moved upstream are salt, fertilizer, molasses, petroleum products, cement, lime, and iron and steel products.[36] Harbor and terminal facilities accessible to Nebraska shippers are located in or near Sioux City, Blair, Omaha, Council Bluffs, Bellevue, Plattsmouth, Nebraska City, Brownville, and Rulo.



Navigation on the Missouri River

Although states along the Missouri River, including Nebraska, depended heavily on river transportation of goods and people from the early 1800's until mid-century, the use of the Missouri River to transport commodities significantly declined during the past 100 years. However, increasing land transportation costs due to fuel price increases and the shortage of rail cars and trackage have stimulated considerable interest in barge transportation on the Missouri River. The Missouri River Marketing Office in Omaha was established in 1980 to promote greater use of the Missouri River for barge traffic. Subsequent cuts in federal funding resulted in the office being closed in 1981.

Present Problems

At the present time, inadequate flow is not a problem affecting navigation on the Missouri River. Participants at a March 1980 conference identified the lack of upstream bound cargo and the need for improved terminal facilities as problems facing navigation on the Missouri River.[37]

The Missouri River's characteristics – high flow velocities, some sharp bends, and a relatively narrow channel – combine to limit barge tows to normally no more than six barges as compared to twelve to fifteen barges on the upper Mississippi River.[38]

At a few locations along the river there may be periods during the navigation season when the authorized 9 foot depth and 300 foot width may not be available.[39] At Decatur Bend near Decatur, Nebraska, the average depth is 8½ feet and the average width is 275 feet.[40]

Future Concerns

Streamflow depletions have been occuring on the Missouri River in the past and will continue to occur as the result of future water resource development.[41] Flow depletions are caused by irrigation, municipal or industrial use, power generation, coal development and other purposes.[42] As an example, a recent proposal by the Exxon Corporation would convey 1.7 million acre feet a year from the Missouri River to synfuel projects in Wyoming, Colorado, and Utah. The diversion of 1.7 million acre feet a year at a uniform rate of withdrawal would reduce downstream flows by about 2,300 cfs. If a 1930's type drought should occur in conjunction with such a diversion, service to navigation could not be provided for a full navigation season.[43]

The Corps of Engineers, in a 1980 report on mainstem reservoir regulation, updated previous depletion studies for the Missouri River.[44] The Corps concluded that at the 1975 level of water resources development in the basin it was possible to maintain full eight-month navigation seasons for seventy-three years of the eighty-two year period of record. During the other nine years (coinciding with the effects of the severe drought of the 1930's) it was necessary to reduce season lengths to a minimum navigation season of five and one-half months duration. Accelerated water resources development is projected to have a significant effect upon future navigation service on the river. At the year 2000 development level, full eight-month seasons are expected in only sixty-four years of the eighty-two year record period. Full eight-month navigation seasons decline further to fifty-eight years and thirty-five years of the eighty-two year record period at the year 2020 and 2060

development levels respectively. No navigation service is projected for one, five, and eleven years at the year 2000, 2020, and 2060 development levels respectively.[45]

If the streamflow depletion projects occur, navigation on the Missouri River would be adversely affected. Actions taken by Nebraska itself to maintain navigation flows would most likely have little, if any, consequence. Nebraska could, however, join together with the other downstream states of Iowa, Missouri, and Kansas to develop a policy in coordination with the federal government and the upstream states to guarantee minimum flows on the navigable portion of the Missouri. This would assist in maintaining a consistent, reliable shipping season. Because the 1944 law, which authorized the six mainstem Missouri River dams and the navigation channel, does not consider navigation a priority use, Nebraska and the other downstream states will be faced with losing significant amounts of Missouri River water in coming years unless the law is changed or compacts are negotiated to guarantee flows for navigation and other downstream uses.

WILDLIFE

Description

The value of a stream for wildlife is determined by a combination of factors: (1) streamflow, (2) physical characteristics of the stream, (3) riparian vegetation, and (4) land use adjacent to the riparian area.[46] Some wildlife species depend directly on surface water whereas others depend more on the woodland habitat associated with the waterways. This section is concerned with those wildlife species which are directly affected by streamflow. Many wildlife species are not directly affected by streamflow, e.g. white-tailed deer, bobwhite quail, and fox squirrel. However, riparian woodland habitat is vitally important to these species. In some areas of the state, streamside woodlands may provide the only high quality winter habitat for several species of birds and mammals. The value of riparian timber to nesting songbirds is obvious, considering that large expanses of land would otherwise be virtually treeless.

The various wildlife species depending directly on water and therefore adversely affected by reduced streamflows are discussed in the following four categories: furbearers, waterfowl, nongame species, and threatened and endangered species.

FURBEARERS

Nebraska statutes list the beaver, mink, muskrat, raccoon, and opossum as furbearers. These species, except the opossum, generally are directly associated with running water and the habitat associated with it. Most beaver live in association with running water although some may live near lakes and marshes. Water is the site of much of their activity and the woody vegetation along the water's edge provides their food base. The amount of bordering woody vegetation and the volume of flow determines the suitability of a stream for beaver.

Muskrats are always associated with surface water including marshes and the shallower portions of lakes, ponds, and streams. Streams supporting the highest muskrat populations are those streams where suitable soil for burrowing is associated with an adequate supply of aquatic vegetation for food. During periods of drought or when a stream goes dry, they generally move to open water but then move back to the stream when it begins to flow again.

Mink generally live where permanent water exists. Before the construction of farm ponds, mink were confined to the banks of perennial streams, marshes, and lakes. Any water body that goes dry periodically is not prime mink habitat.

Although raccoon are most abundant along the stream courses of Nebraska, they are not as dependent upon this habitat as the other furbearers. Adaptability to other habitats allows the raccoon to roam out of the riparian habitat and survive under normal weather conditions.

In 1977, the value of beaver, muskrat, mink and raccoon pelts sold in Nebraska exceeded $2,000,000.

WATERFOWL

Ducks and geese are very dependent on surface water and their distribution within any given area is determined by the amount and the quality of wetland habitat.

Most geese use only the larger rivers in Nebraska. For geese to use them, rivers must be fairly wide (100+ yards) with open sandbars and low banks. Many thousand geese frequent some segments of the Platte River during their spring migration.

Ducks use Nebraska's rivers and streams during spring and fall migration and as wintering habitat. Although local lack of flowing streams may not have significant influence on continental populations, it can have a marked effect on local populations. Nebraska streams that remain ice-free during the winter are an important factor governing the number of wintering waterfowl, primarily mallards. Large concentrations of ducks occur when the Missouri, Platte, and Republican rivers do not freeze over in the winter. During spring migration, segments of the Platte and Missouri rivers provide resting areas for thousands of ducks. In the fall, rivers such as the Platte, Niobrara, Loup, and Missouri provide resting areas for ducks on their way south. Limited duck production occurs on many streams in Nebraska. Wood ducks are the most common species produced on the streams.

Although waterfowl hunting is not restricted to flowing streams, prime hunting occurs on or adjacent to major rivers. This value is often reflected in the selling prices of these lands.

Least tern nesting on sandbar

NONGAME SPECIES

The sandhill crane provides an annual spectacle of national interest along parts of the Platte River Valley from Grand Island to North Platte and in the North Platte River valley as far west as Oshkosh. During March and April over 200,000 of these birds congregate in the valley, feed and loaf during the day in pastures and fields, and at night roost on submerged sand bars in shallow portions of the river. Their presence appears to be dependent on proper river conditions to provide needed roosting sites. Since this part of Nebraska provides the only site known to be suitable for the spring staging of more than eighty percent of the entire continental population, proper management is critical to the survival of the species as we know it.

Distribution and abundance of shore birds is determined by the amount of suitable surface water. Shallow streams and marshes are the primary areas used by these birds. Most shore birds pass through during migration and use the streams as temporary resting and feeding areas. However, a few spend the summer in Nebraska. Great blue herons are among the more common shore birds that summer in the state. They nest in colonies in mature timber in close proximity to a stream or marsh and feed on small aquatic animals and fish throughout the summer and fall.

THREATENED AND ENDANGERED SPECIES

Two endangered and one threatened species of wildlife in Nebraska are highly dependent on river and stream habitat for survival. The whooping crane and bald eagle are classified as endangered, and the interior least tern as threatened.

The whooping crane stops in the state during spring and fall migrations. Although some use marshes as resting areas, they are known to use the shallow water and open sandbars of both the central Platte, the Loups, and Niobrara rivers.

Bald eagles no longer nest in Nebraska, but do winter along the major river systems of the state. Most commonly associated with wintering waterfowl, they feed upon fish, waterfowl, or carrion and they roost in mature trees bordering the rivers.

The interior least tern is dependent upon open sand bars in the Platte, Niobrara, and Missouri rivers for nesting habitat. Should the braided channel and open sandbar habitat disappear from these rivers the least tern may no longer nest in the state.

Rating of Streams

Table 10 shows a rating of streams for those wildlife which are directly dependent on water. The stream rating was based on 1980 habitat and population levels and was done by wildlife specialists of the Nebraska Game and Parks Commission. A brief description of the importance of some of the streams to wildlife follows the table.

Niobrara River (Springview area) – The Niobrara is one of the highest rated streams for wildlife. During their migrations, the bald eagle is common and the whooping crane occasionally rests here. The interior least tern nests on sand bars of this reach.

Loup River (Fullerton area) – The Loup is a high quality wildlife river with an abundance of furbearers and waterfowl.

Table 10: Ratings of streams for wildlife.

Streams	Furbearers	Waterfowl	Nongame species	Threatened and endangered species
White River	Low	Low	High	
Niobrara River	Med	High	High	High
Long Pine Creek	Med	Low	High	
Bazile Creek	High	Med	Med	
Elkhorn River	High	Med	Med	
Omaha Creek	Low	Low	Low	
Loup River	High	High	Med	Low
Rock Creek (near Ceresco)	Low	High	Low	
N. Fork Big Nemaha River	Med	Low	Low	
W. Fork Big Blue River	Med	Low	Low	
Platte River (at Fremont)	Med	High	Med	Low
Little Blue River	Med	Low	Med	
Thompson Creek	Med	Low	Low	
Republican River	Med	Low	High	Low
Platte River (at Kearney)	Med	High	High	High
Cedar River	High	Med	Med	
N. Loup River	High	Med	High	Med
Dismal River	Med	Low	Med	
Medicine Creek	High	Low	High	
Frenchman River	Med	Med	Med	
North Platte River (at Bridgeport)	High	High	High	Low
Ninemile Creek	Low	Low	Low	

Rock Creek (Ceresco area) – Rock Creek and its adjacent wetlands provide good migration and moderately good breeding habitat for ducks.

Platte River (Fremont area) – This area of the Platte is important for wintering mallards and is also heavily used by ducks and geese during spring and fall migration.

Republican River (Guide Rock area) – Bald eagles winter along the river downstream of Harlan County Reservoir.

Platte River (Kearney area) – Along with the North Platte and Niobrara Rivers, the Platte near Kearney is one of the most important stretches of river for wildlife in the state. Good populations of furbearers are present together with excellent migrant populations of ducks and geese, nongame species, and threatened and endangered species. Interior least terns nest on open sand bars, bald eagles winter along the river, and whooping cranes rest in the area during migration. For sandhill cranes and numerous species of ducks and geese, this is the most important river for staging during spring migration. Maintaining the shallow river and open sand bar habitat is critical to the survival of the sandhill crane and whooping crane.

North Loup River (Ord area) – The North Loup provides excellent furbearer and nongame wildlife habitat.

North Platte River (Bridgeport area) – This reach of the North Platte River is rated as one of the most important wildlife streams in the state. Not only is it a major migration and wintering area for mallards and Canada geese, but it also ranks high for furbearers and nongame species. In winter bald eagles are common along this stretch of river, which is the only major wooded waterway that crosses the Panhandle.

Present Problems

Reduced streamflows can have four effects on wildlife: (1) removal of drinking water for terrestrial birds and mammals, (2) direct effects (reduced living space) on aquatic wildlife such as beaver and muskrat, (3) change in riparian vegetation eliminating essential elements of habitat for some species, and (4) change in patterns of flooding that may affect wetland habitats which depend on flood waters for their maintenance.[47]

The effect of altered flows on wildlife habitat in the central Platte River valley from Kearney to Columbus has become a subject of much controversy. The character of the river has changed significantly in the past fifty years. With the change of habitat from open channels and sand bars to woodlands there is a change in the types of wildlife that inhabit the river reach. This change in species composition does not appear detrimental until the importance of this stretch of the river to waterfowl during spring migration and the possible impact on migratory populations of the sandhill crane and whooping crane are considered.

Future Concerns

Future reductions in streamflow would have the following effects on wildlife that depend directly on streamflow:

Furbearers – The seasonal dewatering of streams will greatly reduce furbearer populations. However, where alternate sources of water (marshes or stock ponds) are readily available the furbearer populations will not be eliminated.

Muskrat feeding

Waterfowl – Reduction of streamflow can have several effects on waterfowl. Total flow loss eliminates all waterfowl use, but interrupted flows at certain times of the year may have little effect or may eliminate waterfowl use depending on the time of year. Spring reductions will reduce waterfowl use. However, most of the smaller streams have little use during that time of year. Summer reductions may alter production of waterfowl, especially where no alternate water source is available. Fall and winter flows (even without spring or summer flows) can maintain wintering waterfowl populations provided the general ecosystem is not greatly altered by the reduced summer flows.

Nongame species – Spring and fall are the primary periods of use of flowing water by shore birds and cranes. Summer residents normally are found along the larger streams and rivers. The effects of reduced flows on the general ecosystem would influence shore birds and crane use more than would the amount of actual water.

Threatened and endangered species – The principal endangered and threatened species affected by reduced streamflow are the bald eagle and whooping crane. Bald eagles require open flowing water during winter months. Reduced flows can alter water temperatures to a point where a normally open stream may freeze over. Whooping cranes may be associated either with flowing streams or, in some cases, wetlands associated with the streams. Reduced flow can alter these wetlands and thereby eliminate possible use by cranes.

In summary wildlife populations are expected to decrease as a result of reduced streamflows and associated land use changes.

WILD AND SCENIC RIVERS

Description

Rivers having outstanding scenic, recreational, fish and wildlife, ecological qualities, or historic and cultural features are valuable in their undeveloped and free-flowing state. Consideration should be given for protection of these public values for the benefit and enjoyment of present and future generations. One manner of protection is the inclusion of rivers in either a state or the National Wild and Scenic Rivers System.

The National Wild and Scenic Rivers System was created by the Wild and Scenic Rivers Act of 1968.[48]

Rivers, in their free-flowing state are eligible to be included in the system as either wild, scenic or recreational rivers. To date, only one Nebraska river has been added to the national system: the Missouri River from Gavins Point Dam to Ponca State Park.

The 1971 *Report on the Framework Study* by the Nebraska Soil and Water Conservation Commission identified nine river reaches that possess attributes that could qualify them for consideration in a protected rivers system.[49]

Rating of Streams

An identification of Nebraska streams that are still in a relatively natural, undeveloped condition was conducted under Phase I of the Nationwide Rivers Inventory. From this list of twenty-nine stream segments, the Department of Interior selected seven segments that it determined were worthy of designation as national wild or scenic rivers. These streams are shown in Table 11. It should be noted that several streams include features such as impounded areas that would be excluded from study or designation.

The twenty-nine streams comprise approximately 1,640 river miles out of a total of 23,686 miles of streams and canals in Nebraska. The rivers streams considered to be worthy of designation measure 673 river miles.

Future Concerns

Of those seven streams identified by the Department of Interior as worthy of study for designation, portions of two rivers will become ineligible for consideration if Bureau of Reclamation projects are constructed. The two projects are the O'Neill Unit on the Niobrara River and the North Loup Division on the Calamus River. There are no other projects planned for the other five streams at this time.

Table 11: Natural free-flowing rivers in Nebraska.

	Stream	Stream segment	Approximate length in miles
1.	Rock Creek	South Fork Big Nemaha River to U.S. Highway 75	8
* 2.	Missouri River	Running Water, South Dakota to Ft. Randall Dam	40
* 3.	Niobrara River	Missouri River to Antelope Creek	271
	Niobrara River	Antelope Creek to Nebraska – Wyoming state line	140
4.	White River	Soldiers Creek to headwaters	25
5.	Loup River	Loup River Power Canal to confluence of North and Middle Loup Rivers	35
6.	Cedar River	Clear Creek to Ericson Dam and road bridge in Sec. 23, T 21 N, R 12 W to confluence of Big and Little Cedar Creeks	64
7.	North Loup River	Calamus River to headwaters	74
* 8.	Calamus River	North Loup River to source (Moon Lake)	80
9.	Goose Creek	North Loup River to road bridge in Sec. 35, T 27N, R 26W	30
* 10.	Middle Loup River	Milburn Dam to confluence of North and South branches	80
* 11.	Dismal River	Middle Loup River to confluence of North and South Forks	68
12.	North Fork Dismal River	Confluence of North and South Forks to road bridge in Sec. 35, T 22N, R 35W	21
13.	Middle Loup River	North and South branches to road bridge in Sec. 33, T 26N, R 36 W	24
14.	South Branch Middle Loup River	Confluence of North and South branches to source	30
15.	Birdwood Creek and North Fork Birdwood Ck.	North Platte River to source	30
16.	Elkhorn River	CNW R.R. Bridge southwest of Norfolk to source	144
17.	Steel Creek	Niobrara River to source	15
18.	Louse Creek	Niobrara River to source	20
19.	Redbird Creek	Niobrara River to source	35
* 20.	Long Pine Creek	Niobrara River to source	38
21.	Plum Creek	Niobrara River to Ainsworth Hydro Unit and Broyer Canyon to confluence of North and South Forks	33
22.	Fairfield Creek	Niobrara River to RR bridge 2 miles north of Arabia	19
23.	Schlagel Creek	Niobrara River to Big Alkali Lake	20
* 24.	Snake River	Niobrara River to source	96
25.	Boardman Creek	Merritt Reservoir to Sec. 29/32, T 30N, R 31 W	13
26.	Bear Creek	Niobrara River to U.S. Route 20 bridge	13
27.	Stinking Water Creek	Mouth to Chase/Perkins County line	34
28.	Blue Creek	Major diversion above mouth to headwaters	40
29.	Verdigre Creek System	Mainstream above town of Verdigre and north, middle, south and east branches to headwaters	98

*Rivers identified by the Department of Interior as worthy of designation in the National Wild and Scenic Rivers System.

WATER QUALITY

Description

Maintenance of water quality can be considered an instream water use as a stream's capacity to assimulate waste is directly related to its quantity of flow. When flows are reduced, streams are less able to assimulate waste discharges. Numerous municipalities and industries discharge wastes into Nebraska streams. When stream levels are low, wastewater flows can constitute a significant portion of the total streamflow. Concentrations of bacteria, viruses and certain chemicals may rise to levels that limit beneficial use of the water, possibly to the point of being hazardous to human health.

In addition, the use of streams for various instream and out-of-stream uses depends not only on sufficient water quantity but on adequate quality as well. Reduced streamflows can result in degradation of water quality. Stagnation can occur in pools, backwaters, and smaller channels due to reduced flows, causing increases in the concentration of various chemical and biological contaminants.

Certain bacterial and chemical contaminants are of special significance. A number of these factors and their relationship to streamflow were evaluated in a recent study by the Department of Environmental Control.[50] Results of the study, which included data from 126 sampling stations, confirm the relationship between water quality and water quantity.

A generalized summary regarding selected water quality parameters follows:

WATER TEMPERATURE

Water temperature generally was found to increase with decreasing streamflow during the spring and summer.

High water temperature can impair aquatic life. In addition, the oxygen holding capacity of water decreases with increasing water temperature.

TURBIDITY

Turbidity refers to the murky or cloudy appearance of water due to the presence of suspended matter.

Turbidity decreased with decreased streamflow. This improvement in water quality appears to be due to reduced non-point pollution, a consequence of reduced runoff during low flow periods.

Turbidity impairs water quality for fish and wildlife by decreasing productivity, requires additional treatment for water supply, causes water to be less suitable for full body contact, and impairs aesthetics.

CONDUCTIVITY

Conductivity was found to increase with decreasing streamflow.

High conductivity, which indicates high salinity, impairs water quality for agriculture, fish and wildlife, and water supply.

DISSOLVED OXYGEN

In the Loup and Big Blue River basins, dissolved oxygen decreased with decreased streamflow. This relationship demonstrated the physical dynamics of the relationship among water quantity, water temperature, and oxygen saturation. Lower quantities of water warm up more readily. As the temperature of water increases, the level of oxygen saturation and the amount of dissolved oxygen that can be held in the water decreases.

Dissolved oxygen is an important indicator of water quality. Aquatic organisms require certain levels of dissolved oxygen and severe decreases in dissolved oxygen can cause aesthetic deterioration, e.g., objectionable odors.

pH (HYDROGEN ION CONCENTRATION)

Water quality problems related to pH generally were associated with decreased streamflow at all sampling stations.

The parameter called pH is used to express the intensity of an acidic or alkaline solution. A "neutral" solution has a pH of 7. Values of pH less than 6.5 (indicating acidic conditions) impair water quality for fish and wildlife due to increasing cyanide and sulfide toxicity. Values of pH greater than 8.5 (alkaline conditions) impair water quality for fish and wildlife due to increasing ammonia toxicity.

DISSOLVED SOLIDS

Dissolved solids were found to increase with decreased streamflow.

An increase in dissolved solids refers to the mineral matter in solution in water and indicates increased dissolved salts, which impair water quality for agriculture, fish and wildlife, and municipal use.

AMMONIA

Increased ammonia concentrations were associated with low streamflows downstream from major points of pollution in the Lower Platte and Middle Platte River basins.

An increase in ammonia causes high un-ionized ammonia concentrations which impair water quality for fish and wildlife due to increased ammonia toxicity.

NITRATE

High nitrate concentrations were observed during low flow conditions in several tributaries of the North Platte River. Nitrate concentrations tend to be lower at higher streamflows and, higher at lower streamflows.

High nitrate concentrations impair the quality of drinking water supplies for infants and livestock. It also may promote eutrophication and excessive algal and macrophytic plant growth, which are aesthetically displeasing and may necessitate additional treatment if the water is to be used for certain uses, e.g., municipal supply.

PHOSPHORUS

High phosphorus concentrations, associated with low flows, were observed downstream from major sources of pollution in the Lower Platte and Middle Platte River basins.

High concentrations of phosphorus tend to promote eutrophication and excessive algal and macrophytic plant

growth, which are aesthetically displeasing and may necessitate additional treatment.

FECAL BACTERIA

Fecal bacteria concentrations decreased with decreased streamflow throughout the state. This improvement in water quality appears to be due to reduced non-point pollution, a consequence of reduced runoff during low flow periods.

Large numbers of fecal bacteria impair water quality for full and partial body contact because they generally indicate a potential for disease due to contamination by human or animal wastes.

SUSPENDED SOLIDS

Suspended solids are the particulate matter suspended in water. Suspended solids decreased as streamflow decreased. This improvement in water quality appears to be due to reduced non-point pollution, a consequence of reduced runoff during low flow periods.

Suspended solids impair water quality for aquatic life by decreasing productivity, smothering fish eggs and causing gill damage. High concentrations of suspended solids require additional treatment for municipal water supply, cause water to be less suitable for full body contact, and impair aesthetics.

Present Problems

The maintenance of water quality for various benefits (water supply, fish and wildlife, agriculture, industrial, and recreation) is of primary interest to the state of Nebraska.[51] Nebraska's water quality standards have been established to protect the waters of the state for these assigned benefits.[52] Specific numerical criteria and benefits have been assigned and vary by stream segment.

The Department of Environmental Control in the 1980 *Nebraska Water Quality Report* identified the water quality standards violated and the assigned beneficial uses for which water was not suited during 1978 and 1979.[53] Some water quality violations were considered to be associated with low flows. In the upper reaches of the Little Blue River near Ayr a violation of the dissolved oxygen standard occurred which may have been the result of low flow in combination with high temperatures. Dissolved oxygen violations also occurred, possibly as a result of low flows, in the Loup River at Fullerton, Mud Creek at Sweetwater, and the South Platte River at Big Springs.

Future Concerns

In addition to the parameters addressed by the Department of Environmental Control study, certain other chemicals are known to be present in some wastewater discharges and agricultural runoff. However, insufficient data are available to evaluate their relationship to streamflow in Nebraska. Synthetic organic chemicals, heavy metals, and sodium deserve consideration as potential problems associated with increasing water use in the state.

A variety of organic chemicals may be present in wastewater discharges and agricultural runoff. Some organics, like certain pesticides, are highly toxic and potentially carcinogenic to humans, while others, like oil or gasoline, are nuisance substances when released into a stream. Nationwide, more than 1,200 man-made organic substances have been identified in drinking water alone. Small amounts of these chemicals in a stream can be toxic to fish and wildlife, can restrict use of the water for body contact recreation, and render the water useless as a source of municipal supply. Reduced streamflows result in less dilution of these chemicals.

Some raw industrial wastewaters contain significant concentrations of toxic metals such as cadmium, chromium, lead, or mercury. Ingestion of these metals can be harmful to fish, wildlife and human health. Lack of pretreatment facilities or inefficient treatment can allow dangerous concentrations of metals into the receiving stream.

Sewage and industrial wastes contribute large amounts of sodium to water. Some people on medically supervised sodium-restricted diets may not be able to tolerate drinking water with elevated levels of sodium. Concentrations in unpolluted Nebraska waters are generally low. Pollution and reduced streamflow tend to increase sodium levels.

With any decreases in streamflow, especially during periods of low flow, streams will be less able to assimilate wastes. Certain beneficial uses may be restricted in some stream segments as a result.

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Chapter 2

Flow Characteristics of Nebraska Streams

The purpose of this chapter is to familiarize readers with the flow characteristics of Nebraska streams so that streamflow fluctuations, which affect instream water uses, can be understood more readily. The chapter begins with a generalized description of streams. Nebraska streams fall into two categories; streams having continuous flow (perennial) and those having intermittent flow (ephemeral). Stream-aquifer relationships play an important role in determining the flow of any stream. Figures 4 through 15 show the major stream-aquifer relationships in Nebraska. Stream-aquifer relationships are then described by river basin.

Next, the flowing waters in Nebraska that have significant instream flow values and the relative commitment of those waters to existing water rights are identified. Streams having continuous flow and streams having intermittent flow are shown in Figure 16.

Finally, the reason that projections of future stream flows were not developed by the Instream Flows Task Force is discussed.

GENERALIZED FLOW CHARACTERISTICS OF NEBRASKA STREAMS[54]

Introduction

Some Nebraska streams are characterized by naturally continuous flow, others by naturally intermittent flow. Man's development of water resources has made intermittent the flow of some streams that formerly flowed continuously and, vice versa, has made continuous the flow of some streams that formerly had intermittent flow.

Naturally continuous flow at a given point along a stream indicates that upstream from that point at least some reach of the stream or one or more of its tributaries is receiving seepage from an adjacent aquifer. Such streams are referred to as perennial. Their flow during rainless periods lasting a few weeks normally holds fairly steady but would decrease slowly if drought conditions persisted. Flow consisting wholly of groundwater seepage is termed base flow. The Snake, Calamus, and Dismal rivers and long reaches of the North Loup, Middle Loup, and Niobrara rivers are noted for their dependable flow because groundwater seepage constitutes so large a part of their discharge.

Naturally intermittent streams depend nearly entirely on overland runoff for their flow. They are referred to as ephemeral because their discharge rate increases sharply in response to rainfall amounts large enough to produce overland runoff and then tapers off to nothing as water returns from bank storage into the stream channel. The lower and middle reaches of some streams, particularly those draining the glaciated eastern part of Nebraska, and the headwater reaches of most streams fall into this category.

If underlain by sediments capable of transmitting water downward, such intermittent streams can be sources of some recharge to underlying aquifers. Few, however, are known to be important recharge agents. A few intermittent streams, particularly the headwaters of streams rising in the Sandhills region, do not receive significant amounts of overland runoff; instead, they flow only when the water table is at a relatively high stage and cease flowing when the water table lowers below the level of the stream bed.

The flow in many stream reaches is composed partly of groundwater seepage and partly of overland runoff. Discharge rates increase in response to overland runoff and then decrease gradually to a relatively steady base flow derived from groundwater seepage. Where the aquifer contributing seepage to streamflow is of small areal extent or not capable of transmitting large amounts of seepage, a stream may flow continuously during the larger part of the year but may become intermittent when bottom land vegetation intercepts the groundwater seepage that otherwise would maintain a low flow in the stream. The Elkhorn River is a good example of a stream that in a year of average precipitation on its drainage basin has about equal components of overland runoff and groundwater seepage in its total discharge where it joins the Platte River.

The flow regimes of the North Platte, South Platte, Platte, Loup, and Republican rivers have been affected greatly by storage reservoirs, controlled reservoir releases, and diversions for irrigation or production of hydroelectric power. This is illustrated by marked changes that the operation of Harlan County Reservoir has had on the discharge of the Republican River. Near Orleans, the river's discharge is controlled partly by operation of five reservoirs and diversions for irrigation; however, the river's discharge at that site is affected also by overland runoff entering the river between Orleans and Trenton Dam in Hitchcock County. Below Harlan County Dam, the river's regime is very different because discharge is controlled wholly by reservoir operation. In water year 1974, a large release of excess storage in the reservoir occurred in advance of a large release continuing during the irrigation season but, in most

recent years, the large releases were made only during the irrigation season.

The degree and kind of hydraulic connection between streams and adjacent or underlying aquifers must be considered if instream flow problems are to be understood or solved. Because at least part of the flow of most Nebraska streams is derived from aquifers and some reaches of several streams lose water by seepage into aquifers, formulators of policy relating to resolution of instream flow problems need a good understanding of the stream-aquifer relationships existing in Nebraska.

Various stream-aquifer relationships existing in Nebraska are illustrated by the diagrams in Figures 4 through 15. Each of these diagrams represents stream-aquifer relationships in a segment of some Nebraska waterway.

Middle Platte and Lower Platte River Basins

Formed by the confluence of the North Platte and South Platte rivers, the Platte River is affected greatly by the many water resources developments both upstream and downstream from the confluence. Diversion into the Tri-County Supply Canal at the confluence causes a large depletion of flow in the river's reach between the diversion dam and the point between Lexington and Overton where about half of the diverted water is returned to the river. Under natural conditions this reach probably averaged ten times as wide as now and was bordered by few, if any, large trees. Now it is a sinuous waterway through woodland that occupies the former river channel.

Within this reach, water is diverted from the Platte into six irrigation canals that convey water to valley land crops, some in eastern Lincoln County, but most in Dawson County. Return of water to the river by the Jeffrey Hydroelectric Plant near Brady ensures that sufficient water will be available for diversion into these six irrigation canals. Also adding to the river's flow in this reach is seepage of groundwater from both sides. This seepage is greater now than it was under natural conditions because mounding of the water table due to canal leakage has steepened the water table slope toward the river.

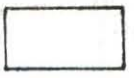
Return of water from the Johnson Hydroelectric Plant between Lexington and Overton accounts for a substantial portion of the annual discharge of the Platte downstream from the point of return. At times, however, the return is insufficient to maintain flow in the river channel downstream as far as Grand Island. Accounting for the loss of flow is the relation of the river to the adjacent and underlying aquifer. Beginning at about Kearney and continuing into Merrick County, the water table slopes northeastward away from the river instead of toward it, and the river thus becomes a source of recharge to the adjacent aquifer. In much of the same reach, the water table slopes away from the river on the south side also and thus the river loses water by seepage in that direction as well. Losses are great enough that periods of no flow near Grand Island have occurred in more than half the years since 1940; some such periods have lasted as long as three months. Periods of no flow at Grand Island also were observed by U.S. Geological Survey hydrographers in the 1890s, when upstream diversions were much lower.

Under natural conditions, the reach from the confluence of the North Platte and South Platte rivers to the mouth of the Loup River probably was subject to long no-flow periods, but now the no-flow segments are limited to the downstream half of the reach. These changes in the river's flow regime are the combined results of the water-storage features and the water-use developments in the Platte's drainage area. If not for the river's seepage losses in eastern Buffalo County and in Hall and Merrick counties, groundwater withdrawals for irrigation in the valley parts of those counties would have caused a much greater water level drawdown than has occurred to date.

Inflow from the Loup River and return of water diverted from the Loup River into the Loup River Power Canal greatly increase the downstream annual discharge of the Platte River. Although low flows occur occasionally, the river has not been dry at either of the two gaging stations downstream from the mouth of the Loup during their periods of record. Between the mouth of the Loup and the mouth of Salt Creek, the Platte apparently loses some water by seepage. Part of the loss is due to evaporation from sandpit lakes, which are especially numerous near Fremont, and to groundwater withdrawals for irrigation and for public supply at the Lincoln well field near Ashland. Other loss is due to the natural water table slope away from the Platte toward the Elkhorn River, which flows at a lower altitude than does the Platte in part of the valley that the two rivers share.

Salt Creek enters the Platte River near Ashland. At times much of its flow downstream from Lincoln is effluent from the Lincoln wastewater system. Such effluent constitutes return of water pumped from the city's well field just

EXPLANATION for figures 4-15



Moderately to highly permeable unsaturated sediments

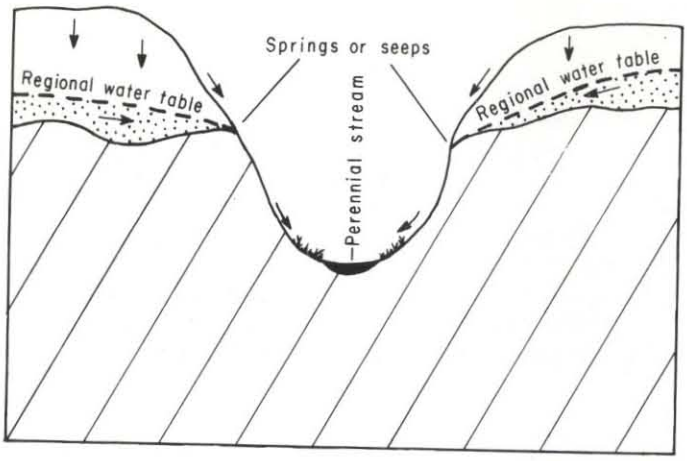
Moderately to highly permeable saturated sediments (aquifer)

Relatively impermeable material

Water table

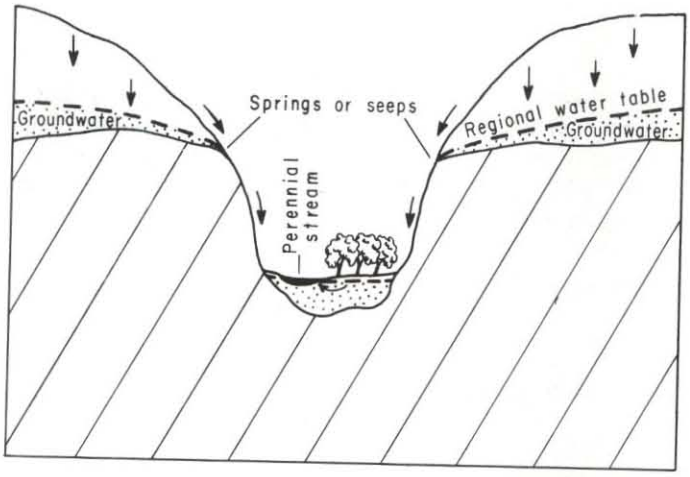
Stream

Direction of water movement



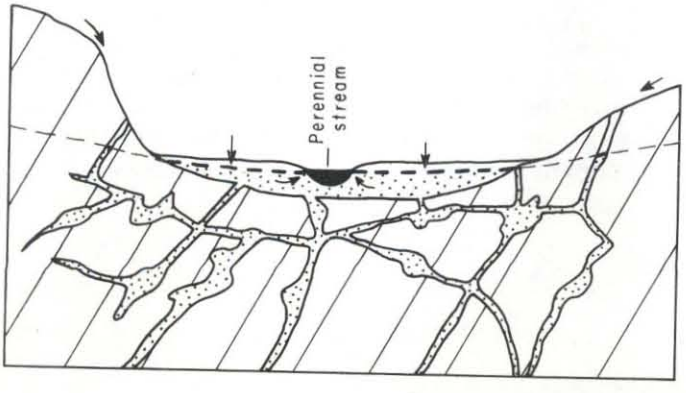
Perennial stream flowing on relatively impermeable rock. Adjacent upland mantled by unconsolidated and partly consolidated sediments that are saturated in their lower part. Water discharging from the upland aquifer into tributaries or issuing as springs is only partly intercepted by phreatophytic vegetation; the remainder contributes to the stream's flow.

Figure 4: Stream-aquifer relationships: Niobrara River in northeastern Cherry County.



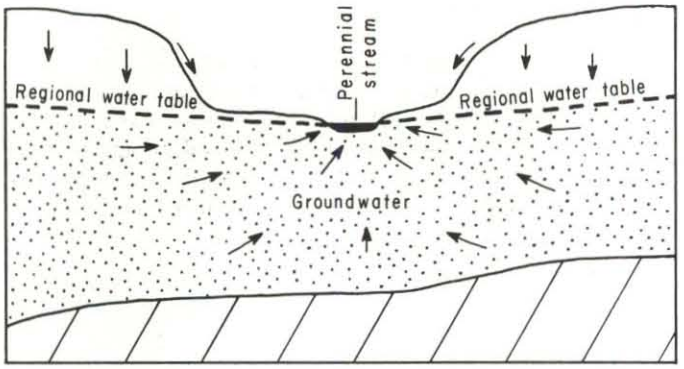
Perennial stream hydraulically continuous with alluvial aquifer that is limited to valley incised into relatively impermeable rock. Adjacent upland mantled by relatively permeable unconsolidated and partly consolidated sediments that are saturated in their lower part. Water discharging from upland aquifer reaches stream via tributaries or spring discharge or is intercepted by intervening vegetal uptake.

Figure 5: Stream-aquifer relationship: Niobrara River along north border of Rock County.



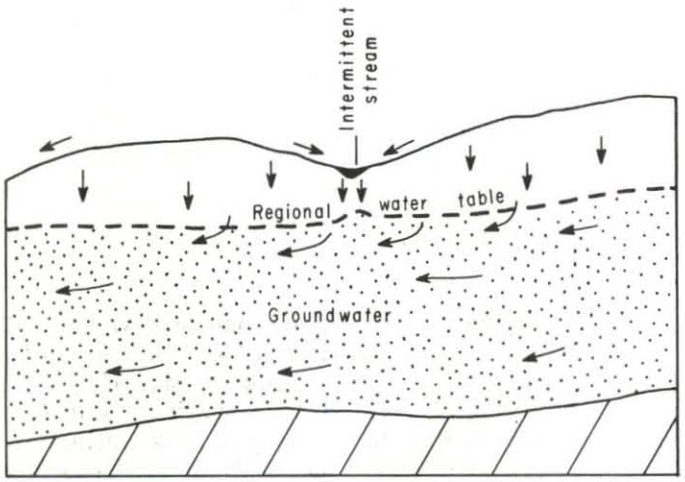
Perennial stream incised into relatively permeable unconfined aquifer that overlies relatively impermeable rock containing open water-filled fractures enlarged by process called "piping." Pumping from wells drilled into fractures causes water to drain from aquifer above and, in turn, may cause stream to become influent and possibly cease to flow.

Figure 6: Stream-aquifer relationship: Lodgepole Creek.



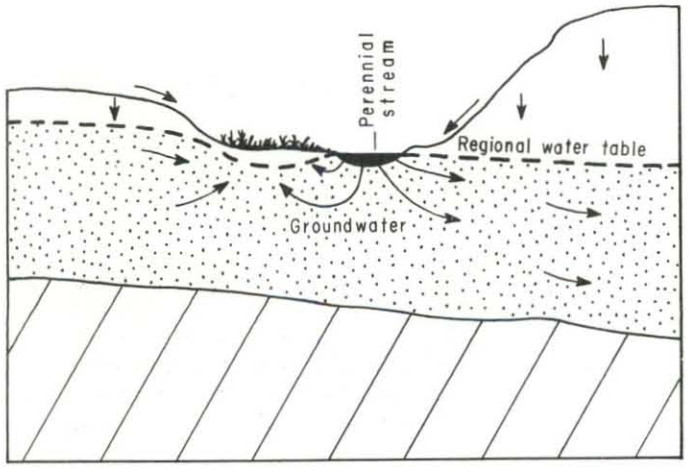
Perennial stream incised into areally extensive, relatively permeable unconfined aquifer. Groundwater seeps into stream except when stream is at high stage and temporarily loses water by seepage into aquifer. Arrows indicate groundwater flow lines at low stage of stream.

Figure 7: Stream-aquifer relationship: Platte River in eastern Lincoln County.



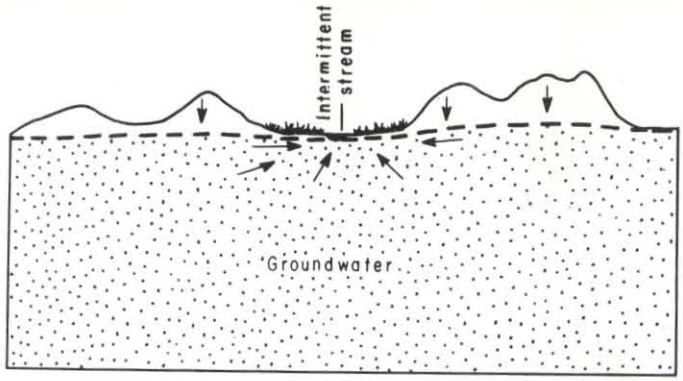
Intermittent stream incised into relatively permeable unsaturated sediments. No relatively impermeable sediments between stream and areally extensive zone of saturation. When stream flows it loses water by seepage to underlying regional aquifer.

Figure 8: Stream-aquifer relationship: Wood River north of Kearney in Buffalo County.



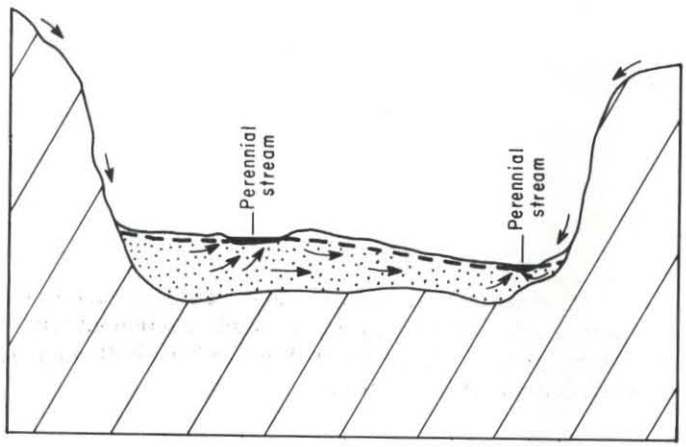
Perennial stream hydraulically continuous with water in areally extensive, relatively permeable aquifer. As shown here, seepage loss leftward from stream is caused by water uptake by phreatophytic vegetation. Pumping from wells close to stream similarly would induce seepage from stream. Seepage loss to right is due to natural hydraulic gradient away from river. Such seepage losses can occur at low to high river stages.

Figure 9: Stream-aquifer relationship: Platte River in western Merrick County.



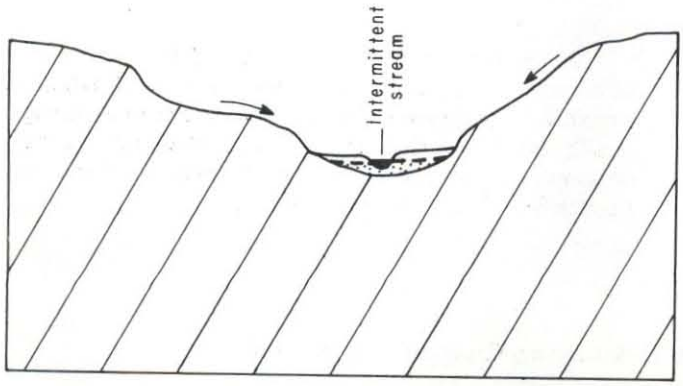
Intermittent stream on flat-floored interdunal valley. When infiltrating precipitation causes water table to rise above channel bottom, the stream flows. When water uptake by subirrigated vegetation lowers the water table to a level lower than the bottom of the stream channel, streamflow ceases.

Figure 10: Stream-aquifer relationship: Upper reach of North Branch of the Middle Loup River in southwestern Cherry County.



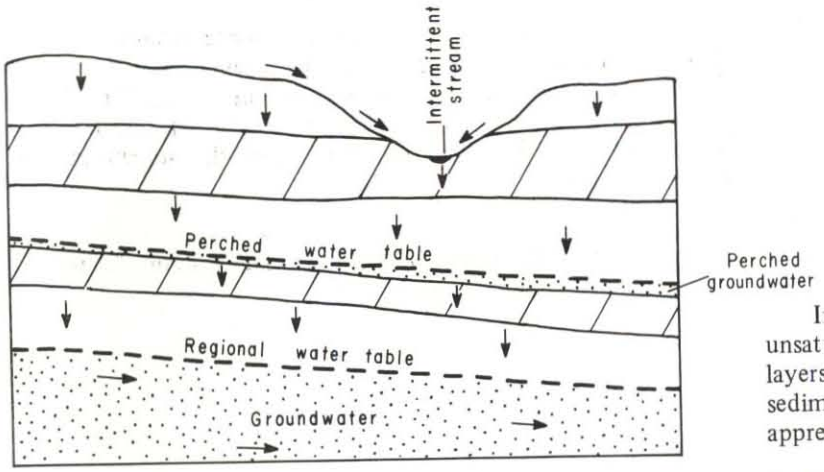
Two parallel perennial streams, one at a lower altitude than the other, incised into the same relatively permeable unconfined aquifer. Higher stream gains groundwater from one side but loses to groundwater on other side. Lower stream gains groundwater from both sides. Lower stream gain is partly loss from higher stream.

Figure 11: Stream-aquifer relationship: Platte and Elkhorn Rivers in western Douglas County.



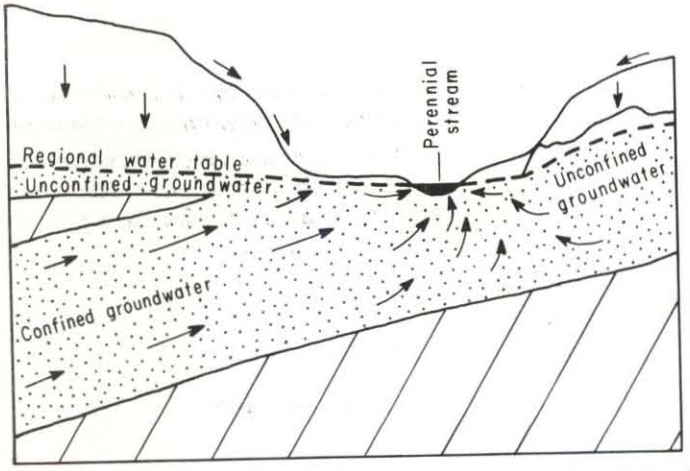
Intermittent stream flowing on thin relatively permeable alluvial deposits that are underlain and bordered by relatively impermeable materials. Stream flows when overland runoff occurs and water table in thin alluvium remains higher than bottom of stream channel. During prolonged dry weather, stream ceases to flow when water use by vegetation growing on bottom land adjacent to stream causes water table to decline to a level lower than bottom of stream channel.

Figure 12: Stream-aquifer relationship: Driftwood Creek in southeastern Hitchcock County.



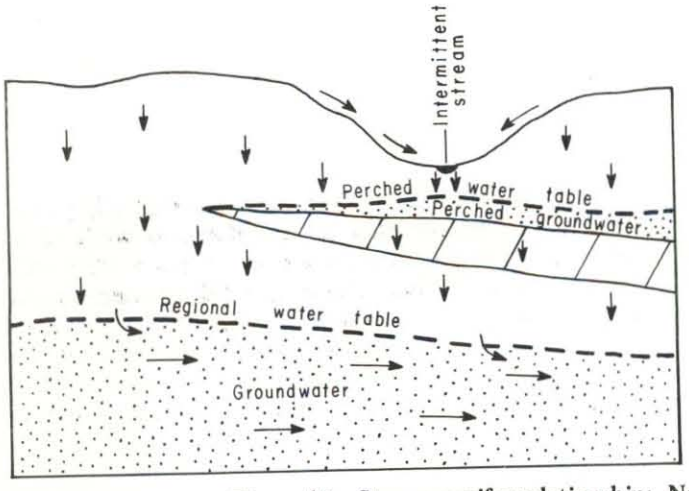
Intermittent stream incised into relatively impermeable unsaturated sediments that are underlain by alternating layers of relatively permeable and impermeable unsaturated sediments. Regional water table at depth not affected appreciably by influent seepage from stream.

Figure 13: Stream-aquifer relationship: Big Blue River in eastern Polk County.



Perennial stream incised into relatively permeable unconfined aquifer that is hydraulically continuous with a deeper lying confined aquifer. Seepage from both aquifers contributes to flow of stream.

Figure 14: Stream-aquifer relationship: Big Blue River in Saline County.



Intermittent stream incised into relatively permeable unsaturated sediments that overlie a lens of relatively impermeable sediments. Seepage from the stream recharges areally small perched aquifer supported by relatively impermeable lens. Regional water table at depth not appreciably affected by stream seepage.

Figure 15: Stream-aquifer relationship: North Fork Johnson Creek in Fillmore County.

north of the mouth of Salt Creek. Several reservoirs for flood control and recreation have been created on tributaries of Salt Creek. Evaporation from reservoir surfaces results in some depletion of annual runoff from the Salt Creek basin.

Downstream from Ashland the Platte River valley is much narrower and its sides consist mostly of consolidated rock. In this reach evaporation from the surfaces of "sand-pit lakes," which are adjacent to the river and are hydraulically continuous with it, may result in some depletion of river flow but possibly no more than the flood-plain vegetation that formerly occupied the present-day lake areas. Except for these localized depletions such as these, the Platte River gains from groundwater seepage throughout this reach.

Clear Creek south of Columbus

The Wood River, a minor tributary to the Platte, heads in south-central Custer County and flows southeastward into Buffalo County. There, instead of following a course directly to the Platte River, it first veers eastward and then northeastward along a sixty mile course parallel to the Platte before joining that river south of Central City. Whether Wood River formerly flowed continually throughout all but its uppermost reach is not known, but now it rarely flows its full length within the Platte River valley. Apparently most of its flow becomes recharge to the aquifer underlying Buffalo County and some becomes recharge in west-central Hall County. Wood River originally drained a much larger area than it does now, the reach of the South Loup River upstream from Callaway having originally been the headwater reach of Wood River.

South Platte River Basin

Like the North Platte River, the South Platte River heads in the Rocky Mountains of Colorado and a large part of its flow consists of snow melt. Several transmountain diversions from the Colorado River Basin add to the flow of the South Platte River in Colorado. Within Nebraska, the South Platte flows east-northeastward and eastward for a distance of about eighty miles to its confluence with the North Platte River.

The average annual amount of water flowing into Nebraska now is markedly smaller than it was under natural conditions. The size of this reduction of inflow is not known because much of it occurred before gaging of the river near the state line began. Prior to the many water resources developments in Colorado, the South Platte may have had no flow at the Nebraska state line during periods of drought but since 1903 flow has been continuous, though sometimes very low, during dry weather. Seepage of groundwater from beneath irrigated lands, particularly in northeastern Colorado, helps to account for the river not becoming dry at the state line despite the annual inflow being much less now than under natural conditions.

The flow of the South Platte in Nebraska is depleted by two major diversions. Less than one mile inside the state's border, water is diverted into the Western Canal. Then, about halfway between the state line and the confluence of the South Platte with the North Platte, water is diverted into the South Platte Supply Canal. Diversion into this canal results in a significant depletion of river flow between the point of diversion and the point of return flow from the power plant about four miles upstream from the confluence of the South Platte and North Platte Rivers. At that location, the return water causes a large increase in the discharge of the South Platte River.

The South Platte in Nebraska became dry at times prior to 1939 but has not been dry below Paxton since then. Whereas the South Platte formerly was a losing stream throughout its length in the state, it now is a gaining stream downstream from the Paxton vicinity because the steepened groundwater gradient has increased seepage into the river. This change was largely the result of seepage losses from the South Platte Supply Canal, the Sutherland Supply Canal, Sutherland Reservoir, and Maloney Reservoir.

Lodgepole Creek heads in the Laramie Mountains in Wyoming, flows across southern part of the Panhandle of Nebraska and empties into the South Platte River upstream from the Colorado – Nebraska state line. Water supply problems loom large in the Nebraska part of Lodgepole Creek's valley because demand exceeds the available supply.

Between 1876 and 1917 many small canals were dug to convey water from the creek to crop land, and in the early 1900's two reservoirs (Oliver and Bennett) were created in Kimball County to store water for irrigation use. Several additional rights to store water in small reservoirs and to divert water for irrigation were granted by the Department of Water Resources beginning in the 1940's, so that by 1978 the number of rights to appropriate streamflow totaled about 175. Through the years, about 700 irrigation wells were drilled in the valley of Lodgepole Creek and in Sidney Draw, the principal tributary valley. Towns in the Lodgepole Creek valley also obtain water from wells for public supply.

Concurrent developments in the Wyoming part of the drainage basin have caused inflow to Nebraska to diminish. Since 1943, when the gaging station at Bushnell was established, the creek's discharge at that station has declined. Furthermore, the water supply problem has been compounded by a succession of years when precipitation has failed to produce significant overland runoff. To forestall any increase in competition for the already short water supplies in the valley, the Department of Water Resources no longer grants permits to appropriate water from Lodgepole Creek or its tributaries.

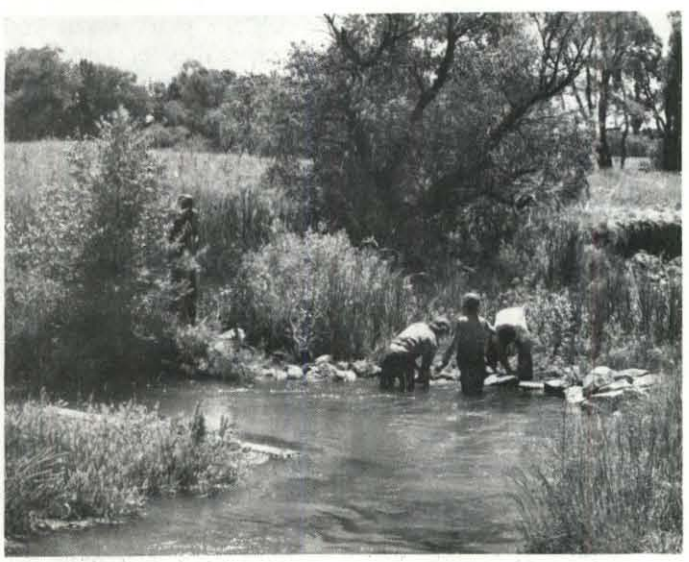
Throughout a little more than half its length in Nebraska, the channel of Lodgepole Creek is incised into the Brule Formation, which contains many interconnected openings. Such water-filled openings transmit water freely

to wells but do not have a large storage capacity, hence large withdrawals for irrigation soon exhaust the supply built up since the preceding irrigation season. Replenishment of storage by seepage from Lodgepole Creek occurs when the creek flows, and in each of the last several years enough of the openings in the Brule have been dewatered that storage space became available for much, if not all, of the available streamflow. For this reason, the creek's outflow to Colorado was less than the creek's inflow from Wyoming during eighty of the eighty-four months in the period 1972 through 1978. Whereas outflow to Colorado averaged 11.2 cfs, or 2,100 acre-feet per year, in the twenty year period ending in 1971, it diminished progressively during the period 1971-75 and since has been either almost nil or zero.

North Platte River Basin

The North Platte River rises in the mountainous north-central part of Colorado, about ninety miles northwest of Denver. Much of its flow originates as snow melt. Much of the snow melt runoff now is impounded by a series of onstream reservoirs in Wyoming, and the stored water is released for irrigation. A large volume of the released water is conveyed by canal into Nebraska for irrigation of cropland as far as seventy miles downstream from the state line. As a consequence of reduced flows in the North Platte, vegetation has invaded those parts of the channel no longer scoured clean by high flows.

It should be kept in mind that water use developments in the North Platte River drainage basin had depleted the river's flow prior to the establishment of any gaging station and, therefore, that none of the available discharge records are representative of natural flow conditions. When the North Platte River was still free flowing, it probably stopped flowing in Nebraska during dry seasons. However, two short reaches – one immediately downstream from the mouth of Blue Creek in Garden County and the other immediately downstream from the mouth of Birdwood Creek in Lincoln County – may have had continuous flow. Both of these tributaries rise in the Sandhills region north of the river and have perennial flow maintained by groundwater seepage. In rainless periods, their flow probably seeped into the valley alluvium, as did inflows from Wyoming. Storage space for seepage from the river, created by uptake of groundwater by bottom land vegetation, probably existed for part of each summer and fall.



Ninemile Creek near Minatare

Infiltration of irrigation water below the reach of crop roots has resulted in a buildup of groundwater beneath terrace lands on both sides of the North Platte. Seepage from the groundwater reservoir thus created has given the river a base flow that it formerly did not have. Only part of this seepage enters the North Platte directly, the remainder reaches it via several drains plus a series of tributaries that formerly were intermittent but now flow continuously. Thus, due to use of water stored in Wyoming for irrigation of crop land along the North Platte in Nebraska, the North Platte and several tributaries, such as Ninemile Creek, have changed from intermittent to perennial streams.

Inflow to the North Platte from Pumpkin Creek, which enters from the south in central Morrill County, is much less than it was under natural conditions. Many rights have been granted to divert from the creek. In recent years the creek has had no flow at its mouth at times in July and August. As a consequence, the Nebraska Department of Water Resources has discontinued granting of rights to divert from Pumpkin Creek.

Lake McConaughy was completed in 1941 by construction of Kingsley Dam about fifty miles upstream from the mouth of the North Platte River. Its purposes are to store water for production of electric power and for irrigation. Releases from the reservoir are diverted into the Sutherland Supply Canal, which conveys the water out of the North Platte drainage basin into the South Platte basin for power production. Diversion into the Sutherland Supply Canal greatly reduces the average annual discharge of the North Platte downstream from the diversion point. At times all the water being released from reservoir storage is diverted and for a short distance downstream from the diversion point the river is dry.

Nowhere in Nebraska is the North Platte River a source of significant amounts of recharge to groundwater in the alluvial deposits on which the river flows. Water diverted from the North Platte River for irrigation is, of course, a source of recharge to groundwater beneath the irrigated land.

Elkhorn River Basin

Rising in Rock County in northcentral Nebraska, the Elkhorn River flows in a generally southeasterly direction to its confluence with the Platte River. Most of the upstream half of the river's length is in an area of sandy soils bordering the Sandhills. All tributaries entering the Elkhorn in this reach head in the Sandhills region lying to the south. Nearly all their flow, and also that of the upstream half of the Elkhorn River, is maintained by groundwater seepage.

The terrain southwest of the North Fork Elkhorn River consists of sand, and the terrain northeast of it consists mostly of loess overlying till. Precipitation on the former produces negligible overland runoff and the part not returned to the atmosphere by evapotranspiration infiltrates to the water table. Hence the flow of Willow Creek, a tributary flowing into the North Fork from the west, consists almost wholly of groundwater seepage. Groundwater seepage also contributes additionally to the discharge of the North Fork downstream from the mouth of Willow Creek. Although some groundwater seeps into the North Fork from the northeast, the amount is small compared to the amount of overland runoff reaching the stream

from that direction. Thus, the North Fork in its middle and lower reaches has a fairly steady base flow and occasional higher flows in response to precipitation amounts large enough to produce overland runoff.

Downstream from the mouth of the North Fork, the Elkhorn River has a base flow due to groundwater seepage into the upstream reach plus the additional small amount of groundwater seepage from adjacent alluvial deposits. Supplementing the base flow are increasing amounts of overland runoff from the loess and till-mantled eastern part of the river's drainage area. Union, Plum, Pebble, Logan, Maple, and Bell creeks are the primary contributors of overland runoff to the Elkhorn River. Because overland runoff is by far the major component of their flow, the discharge of these tributaries and of the Elkhorn in its lower reach is highly variable.

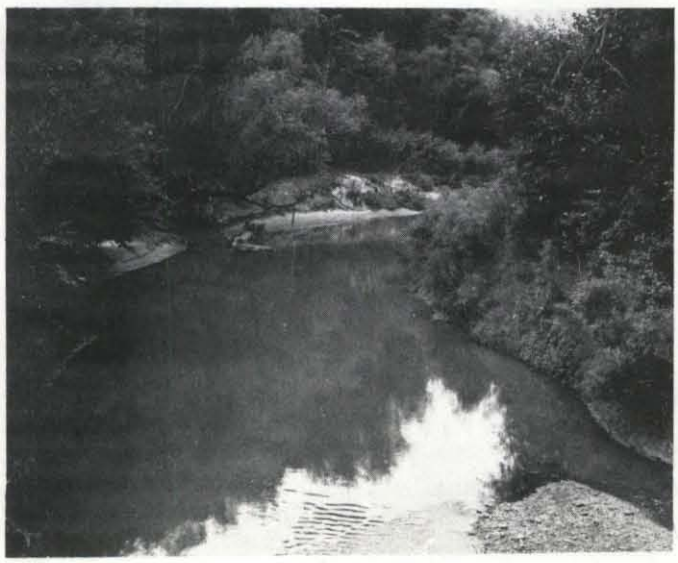
The Department of Water Resources has granted about 175 rights to appropriate water from the Elkhorn River and a few more than 400 rights to appropriate from tributaries of the Elkhorn. Many of these rights were aquired in the 1970's, nearly exclusively for irrigation. Almost all diversions are by privately owned pumps.

Loup River Basin

An area of about 15,200 square miles is drained by the Loup River and its tributaries. The higher lying three-fifths of the drainage basin is in the Sandhills region and the lower lying remainder is in the Dissected Loess Plains. Because soils in the Sandhills region are highly absorptive, they transmit to the underlying zone of saturation virtually all the precipitation not returned to the atmosphere by evapotranspiration. Thus, in this region, almost no water reaches streams as overland runoff; instead, streamflow is maintained almost wholly by groundwater seepage into stream channels.

Soils in the Dissected Loess Plains absorb precipitation at a lower rate than in the Sandhills region. They also transmit a smaller proportion of the precipitation to the zone of saturation. Thus, accretions to streamflow in this part of the drainage basin are due as much or more to overland runoff as to groundwater seepage.

Goose Creek and the Calamus River (both tributaries of the North Loup River) and the Dismal River (a tributary of the Middle Loup River) are entirely within the Sandhills region. Between two-thirds and three-fourths of the length of the North Loup and a little more than half of the length of the Middle Loup is in the Sandhills region and the remainder of each is in the Dissected Loess Plains region. Also in the Dissected Loess Plains region are all but the extreme upstream end of the South Loup and the full length of its principal tributary, Mud Creek. Cedar River and Beaver Creek, both tributary to the Loup River, head in the Sandhills region but their lower reaches are in the Dissected Loess Plains region. The full length of the Loup River, which is formed by the confluence of the Middle Loup and North Loup rivers, is in the Dissected Loess Plains region.



Beaver Creek near Genoa

Dismal River south of Thedford

Where streams leave the Sandhills region their discharge is remarkably steady but varies somewhat from year to year according to increases and decreases in the amount of groundwater stored in the areas they drain. Occasionally significant amounts of precipitation infiltrate to the zone of saturation throughout large areas, and groundwater seepage to streams increases accordingly. However, barring further large additions to groundwater storage, the seepage rate to streams gradually declines. Several years may pass before streamflow returns to its long-term normal discharge rate. Unless groundwater withdrawals in the Sandhills region are concentrated close to streams, they are unlikely to cause a significant depletion of stream discharge because the withdrawals will have little effect on hydraulic gradients close to the streams. With increasing distance from the Sandhills margin, stream discharge becomes more variable because contributions of overland runoff are sporadic and differ widely in amount. After each runoff event, stream discharge decreases fairly rapidly at first and then gradually recedes to the dependable rate of flow maintained by groundwater seepage.

Considerable quantities of water are diverted from the North Loup and Middle Loup rivers into canals that convey water to irrigation projects downstream from the Sandhills margin. Most diversions are made during the normal irrigation season, but diversions into the canal conveying water to Sherman Reservoir, which stores water for irrigation of the Farwell Project, generally begin earlier and continue longer than the others. Additional

depletions are caused by individual farmers who pump from the river to irrigate lowland crops. Summertime flows of other streams in the Loup River drainage system are similarly depleted by individuals diverting water to lowland crops. Since 1936 water has been diverted from the Loup River near Genoa into the Loup River Power Canal. At times the entire river's flow is diverted and if not for inflow to the river from Beaver Creek and for seepage losses from the canal the Loup River would be dry at its mouth. Most of the water diverted into the power canal becomes inflow to the Platte River about two miles downstream from the Loup's mouth.

The Loup's tributaries serve as groundwater drains, some more effectively so than others. In some respects the Loup itself appears to be a groundwater drain also, but seepage gains from the adjacent aquifer apparently are much less than the combined losses to evapotranspiration and possible seepage to some other underlying aquifer.

Missouri River and Missouri Tributaries River Basin

The flow of the Missouri River downstream from Gavins Point Dam consists of releases from Lewis and Clark Lake, inflows from tributaries, and groundwater seepage from the valley alluvium. The releases are made for two principal purposes: maintenance of a navigable channel and passage of flood waters at controlled rates. When at high stages the river may lose water by seepage into adjacent valley alluvium, but ordinarily the river gains from groundwater seepage into the river channel throughout its length along Nebraska's eastern border. Total annual accretions to flow between Gavins Point Dam and Rulo (at the southeast corner of Nebraska) average about half the flow at Yankton but the ratio between the two varies widely.

Part of Omaha's water supply is pumped from the Missouri River. Considerable river water, most of which is returned to the river, is used for cooling at fuel electric plants, mainly in the Omaha vicinity. Some water returned to the river as effluent from sewage treatment plants and industries was pumped from wells along the Platte River.

Many relatively short streams flow into the Nebraska side of the Missouri River between the mouth of the Niobrara River and the mouth of the Platte. In downstream order, the principal tributaries are: Bazile, Beaver, Bow, Aowa, Elk, Omaha, Blackbird, Tekamah, New York, and Papillion creeks. Bazile Creek flows into Lewis and Clark Lake, but the others enter the river downstream from Gavins Point Dam. In their uppermost reaches these streams and the tributaries that join to form them are higher than the water table and flow only in response to overland runoff. When flow occurs, these reaches may be sources of small amounts of recharge to underlying groundwater. Downstream from them, where the streams are hydraulically continuous with groundwater in the valley alluvium, groundwater seeps into the stream channel. The base flow of these streams is small because the valley alluvium is mostly fine textured and transmits groundwater at relatively slow rates. Also, part of the groundwater moving toward streams is intercepted by vegetation and thus does not become seepage into streams. Some of these streams may have had periods of no flow when overland runoff events were infrequent. Along some of these streams periods of no flow have resulted from impoundment and from pumping from the streams for irrigation. A substantial number of water rights for irrigation from streams were acquired during the mid-1970's. Where the lower reaches of streams cross the floor of the Missouri River valley, several are bordered by levees. When at high stage, these streams probably lose some water by seepage into the Missouri River alluvium. However, before the levees were built, these streams occasionally overflowed their low banks and then probably were greater contributors of recharge than they have been since.

Big Blue River Basin

The Big Blue River and its more important tributaries rise on a very gently sloping upland plain. The topographic divide separating the Big Blue and Platte river drainage areas is so near the Platte that some of the overland runoff to the upper reaches of the Big Blue and several of its tributaries originate within one mile of the Platte.

In central Gage County, the Big Blue River leaves the upland plain and enters the rolling hills area lying east of the upland plain. From Beatrice to the state line, a distance of about twenty miles, the Big Blue flows in a relatively narrow valley incised into consolidated rocks.

The principal tributaries of the Big Blue River in Nebraska are Lincoln Creek, the West Fork Big Blue River, and Turkey Creek. Upper reaches of most streams in the Big Blue River Basin flow only when precipitation is sufficient to produce overland runoff. Some, however, have a flow maintained by discharge of municipal waste and/or cooling water that originally was pumped from wells. Upstream reaches of all streams are higher than the water table so probably are sources of some recharge to groundwater when they flow. Amounts of recharge generally are not great because the stream beds are mostly fine-textured sediments that transmit water slowly. The middle and lower reaches are hydraulically continuous with the water table and are groundwater drains except at times of high flow when the stream surface is temporarily higher than the adjacent water table.

Despite the large groundwater supply beneath the western and central parts of the Big Blue River's drainage area in Nebraska, the Big Blue and its tributaries have relatively low base flows. Discharge of groundwater by evapotranspiration together with the fine texture of the sediments through which groundwater must seep to reach stream channels in this drainage area probably account for groundwater being a small component of total stream discharge. Tributaries rising in the rolling hills area have an even smaller groundwater component in their total flow than tributaries rising in the upland plains area.

Small dams have been constructed near the head of hundreds of small drainage-ways in the Big Blue Basin. In aggregate, these prevent considerable overland runoff from reaching the principal streams but may contribute some recharge to groundwater. Furthermore, a few more than 1,000 rights to divert water from streams for irrigation of valley crop land have been granted by the Department of Water Resources.

Little Blue River Basin

The area drained by the Little Blue River adjoins the south side of the area drained by the Big Blue River but extends about thirty miles farther west. The more important tributaries entering the Little Blue are Sand, Cotton-

wood, Big Sandy, Spring, Little Sandy, and Rose creeks. Smaller tributaries are numerous.

Parts of the headwater area consist of nearly flat remnants of an upland plain that lies between the Platte and Republican rivers and extends eastward to the rolling hills or glaciated part of the state. Some of these remnants rarely produce overland runoff to streams because most of the precipitation is held in shallow rainwater basins that almost never overflow. Where streams are entrenched into the upland plain, they are bordered by rounded hills and rough areas carved out of sediments that formerly were continuous with sediments underlying the upland plain. These more steeply sloping parts of the drainage basin produce considerable runoff. However, small dams on many minor tributaries prevent some of the overland runoff from reaching the larger tributaries and the Little Blue. Seepage from impoundments and from the upper reaches of streams, when flow occurs, probably results in small amounts of recharge to groundwater.

The Little Blue River and several of its tributaries are hydraulically continuous with the water table and have continuous flow in their middle and lower reaches. However, the groundwater component of flow is relatively small compared to the overland runoff component. Pumping of groundwater in the basin appears to have caused little or no depletion of the base flow of the Little Blue River or its tributary streams.

The Department of Water Resources has granted about 550 rights to divert water from the Little Blue River and its tributaries for irrigation of valley land. It also has granted many rights to store water. These appropriations reduce streamflow, especially in summer, but depletion of the Little Blue's annual discharge near Fairbury is not obvious from the gaging station record, which is continuous since 1928.

Nemaha River Basin

Nearly all the area of rolling hills east of the Big Blue River drainage basin and south of the Platte River drainage basin is drained by Weeping Water Creek, the Little Nemaha River, the Big Nemaha River, and tributaries to these streams. The small remaining area is drained by several minor streams. With the exception of the Big Nemaha River all drainage enters the Missouri River upstream from Rulo, at the southeast corner of the state.

South Fork Big Nemaha River south of Humboldt

The flow of all streams in this basin is highly variable. Even though the middle and lower reaches of these streams are incised into saturated sediments, the base flows are small because the sediments are fine textured and transmit groundwater at a very slow rate. Large discharges occur in response to heavy rains because the terrain is hilly and slopes bordering nearly all drainage-ways are moderately steep.

Flood causing discharges may occur one or several times in some years and never in other years. In most years the maximum discharge is several hundred times greater than the minimum discharge.

The Department of Water Resources has granted about 250 rights to divert water and a few more than 200 rights to store water from these southeastern Nebraska streams. Many of these rights were acquired during the mid 1970's.

Republican River Basin

The North Fork of the Republican River and the Arikaree River originate in eastern Colorado and join in Nebraska to form the Republican River which flows eastward for 215 miles before it enters Kansas.

Contributing to the flow of the Republican River in Nebraska is a succession of tributaries, the more important of which are the South Fork Republican River, Frenchman, Blackwood, Red Willow, Medicine, Sappa, and Prairie Dog creeks. Even though the direction of groundwater movement throughout all the upland in the Republican River Basin is toward the valley of the Republican, only some of the tributaries and part of the river receive enough groundwater seepage to have sustained flow. Tributaries known to have continuous flow are Rock, Frenchman, Red Willow, Medicine, Turkey, Thompson, and Elm creeks. Stinking Water Creek, which is tributary to Frenchman Creek, also has continuous flow. Each of these streams is on the north side of the Republican. Downstream from the mouth of Frenchman Creek, the Republican has continuous flow maintained largely by tributary inflow but in small part from groundwater seepage directly into the river channel. At several places along the Republican River upstream from the mouth of Frenchman Creek, the adjacent bottom land is slightly lower than the river surface and the river loses water by seepage. Phreatophytic vegetation in these low areas not only intercepts groundwater draining from beneath adjacent upland but also consumes seepage losses from the river. Where the river swings from one side of its valley to the other in the reach downstream from the mouth of Frenchman Creek, it probably gains from groundwater seepage along the upstream side of its channel and loses by seepage into the adjoining aquifer along its downstream side.

Overland runoff generally is the major component of the Republican's flow because a significant part of the river's drainage area consists of moderate to steeply sloping land. Flood producing overland runoff is a lesser problem now than it was before surface reservoirs were created in the basin. Probably the intermittent upper reaches of tributaries entering the Republican from the north and the full length of the intermittent tributaries entering from the south are infrequent temporary sources of recharge to groundwater when flow occurs, but their importance as agents of recharge is small. A few creeks draining southward to Harlan County Reservoir and to the Republican River in

Franklin County are reported to have increased base flows due to mounding of the water table beneath lands in the Tri-County irrigation project.

Flows in the Republican River are highly regulated by reservoir releases and diversions for irrigation. In dry years, when inflows are not sufficient to fill reservoirs, river discharge immediately downstream from the dams is nil but increases gradually with distance because of groundwater seepage into tributaries and into the river itself. Quantities of seepage are small because the hydraulic connection between water in the regional aquifer and the river or its tributaries is relatively poor. Even so, in reaches where adjacent lands are irrigated with river water, the rate of seepage from valley alluvium into the river channel probably is greater now than it was prior to irrigation.

Depletion of inflows to Enders Reservoir on Frenchman Creek is a matter of concern to irrigators dependent on releases from this reservoir. The base flow of Frenchman Creek near the point of inflow to the reservoir had been reduced by as much as a third by 1975. The reduction is attributed to a decrease of groundwater seepage into the stream channel. This decrease is due to the large aggregate withdrawals of groundwater for irrigation in the Frenchman Creek drainage area. However, examination of the records of inflow to Enders Reservoir reveals that no significant overland runoff events occurred in the eleven year period beginning in 1968, so at least part of the decline of inflow is attributable to paucity of overland runoff. Some decline of inflow to Hugh Butler and Harry Strunk lakes may occur, via Red Willow and Medicine Creeks respectively, if groundwater withdrawals upgradient from those reservoirs continue to increase at the rate of the past few years. Early records show periods of no inflow to the state and of no flow at gaging stations on the Republican River downstream to the mouth of Frenchman Creek before any significant water resources developments had occurred in the upstream part of the drainage basin. Operation of the surface reservoirs in the Nebraska part of the basin virtually nullifies any effect of the depletion of inflow except in the reach of the Republican River upstream from Swanson Lake.

Niobrara River Basin

From the Wyoming line eastward to about Valentine, the Niobrara River and many of its tributaries are in hydraulic connection with the regional aquifer and in most years groundwater seepage accounts for ninety to ninety-five percent of the river's total discharge. Diversions from the Niobrara River to the Mirage Flats Irrigation Project and from the Snake River (a tributary to the Niobrara River) to the Ainsworth Irrigation Project are the major depletions of river flow upstream from Valentine. Additional depletions are caused by pumping from the Niobrara and its tributaries, and by many small upland impoundments. The Department of Water Resources has granted about 600 rights to divert water from streams in the Niobrara River Basin. Many of these rights were acquired in the mid-1970's, nearly exclusively for irrigation.

Eastward from Valentine the river has cut its valley into fine-textured rock that underlies the regional aquifer and yields virtually no groundwater seepage. In some places, the river flows on this fine-textured rock but elsewhere it flows on thin valley alluvium and is in hydraulic connection with the groundwater in it. With increasing distance eastward the valley broadens from narrowly U-shaped to broadly U-shaped and the margin of the regional aquifer is increasingly farther from the river. Overland runoff from the fine-textured rocks exposed between that margin and the river constitutes a progressively larger part of the river's discharge downstream from Valentine. The upper reaches of tributaries to the Niobrara River, particularly those draining the upland to the south, are hydraulically continuous with the regional upland aquifer and have a steady discharge maintained by groundwater seepage. Total groundwater contributions to the flow of the Niobrara River ordinarily account for about seventy-five percent of the river's total discharge at its mouth.

Nowhere along its course is the Niobrara River known to be a natural source of aquifer recharge. However, it would become one if large-yield wells were to be drilled near the river. Pumping from the wells would induce seepage from the river if the water table depression caused by pumping from them were to expand to the river's edge. Unless some large diversion, such as is proposed to supply irrigation water to the Springview and O'Neill areas, were to come about, the average discharge of the Niobrara at its mouth will continue to exceed one million acre-feet per year.

Heading in South Dakota, Ponca Creek enters Nebraska about twenty-seven miles west of the Missouri River, flows southeastward across Boyd County, and empties into the Missouri River about five miles upstream from the mouth of the Niobrara River. Some upland soils in the Ponca Creek drainage area are sandy and moderately to very permeable. However, these soils generally are thin, so precipitation not returned directly to the atmosphere by evaporation is largely absorbed and then is returned to the atmosphere by vegetal transpiration. Because other upland soils in the basin are clayey and do not absorb water readily, they sometimes produce considerable runoff in response to intense precipitation. Most of the upland runoff reaches depressions or is impounded in stock ponds around the upland margins. Although a small part of Ponca Creek's flow is contributed by groundwater seepage from valley alluvium, most of the flow consists of overland runoff from the valley sides. Because the Pierre Shale, which is exposed extensively on the valley sides, is too fine textured to

Niobrara River in eastern Cherry County

absorb moisture readily, rain falling on the valley sides runs off rapidly to Ponca Creek. At any point along Ponca Creek or its tributaries the flow is highly variable. Periods of no flow in Ponca Creek have historically been quite common.

The Nebraska Department of Water Resources has granted about thirty-two permits to pump irrigation water from Ponca Creek and its tributaries.

White River – Hat Creek Basin

Pine Ridge, in northwestern Nebraska, forms the divide between the east-flowing Niobrara River south of the divide and the lowland drained northward and northeastward by Hat Creek (tributary of the Cheyenne River in South Dakota), the White River, and White Clay Creek (a tributary of the White River in South Dakota). The ridge is composed of relatively permeable rock resting on nearly impermeable rock, and the lower lying land to the north consists of nearly impermeable rock similar to that beneath the ridge. Precipitation on the ridge infiltrates the relatively permeable rocks, thereby recharging an aquifer that maintains the flow of small springs and seeps along the exposed contact of the aquifer and the nearly impermeable rocks in the escarpment on the north side of Pine Ridge. These springs and seeps are points of origin for the many small tributaries that head in the escarpment and contribute to the flow of Hat Creek, the White River, and White Clay Creek.

Precipitation, which averages about sixteen inches per year, is the only source of flow in tributary streams that do not head in the escarpment. Because these tributaries are intermittent, many small dams have been built on them to hold runoff water for livestock.

Crawford's water supply is obtained from the White River at a location where its flow is continuous. About 300 other water rights have been granted to divert irrigation water by canal or by pumping from Hat Creek, the White River, White Clay Creek, and their tributaries. The largest diversion is to Whitney Reservoir, an offstream impoundment that is supplied with water diverted from the White River about three miles downstream from Crawford. Whether, in their natural state, any of these streams flowed continuously as far as the South Dakota state line is not known. Now they generally become dry in the summer before they reach the state line because many impoundments reduce inflow from tributaries and diversions for irrigation consume all the remaining flow.

FLOWING WATERS IN NEBRASKA AND WATER RIGHT COMMITMENTS

The flowing waters in Nebraska that have significant instream flow values and the relative commitment of those waters to existing water rights are shown in Figure 16.[55] The streams are divided into five categories depending upon their flow and commitment to water rights.

The stream and canal segments, which appear in Figure 16, were identified using the best available published data and the field experience of state agency personnel directly involved with administration, planning, and management of Nebraska's surface water resources. The production of the map involved both an identification of the streams to be considered and an analysis of flow conditions and existing appropriations on those streams. Information obtained during seepage studies in the autumns of 1979 and 1980 by the Department of Water Resources and the U.S. Geological Survey was used to ascertain the points of effluence for many of the stream segments included in the inventory.

Waters with Significant Instream Flow Values

As not all streams could be included in the identification of flowing waters, only those streams having significant instream flow values were considered. The Instream Flow Task Force utilized the 1978 Nebraska Stream Evaluation Map as the basis for determining which streams have significant instream flow values.

Those stream and canal segments identified on the Stream Evaluation Map as having "substantial," "high-priority," or "highest value" fishery resources were considered to have significant instream flow values. These segments generally support other instream uses as well, such as livestock watering and recreation.

Stream segments identified on the stream evaluation map as having "limited" fishery resources or none at all generally were not considered to have significant instream flow values. However, a few streams with "limited" fishery resources were included because they are important for other instream uses, such as livestock watering and aesthetics.

Water Right Commitments[56]

The Department of Water Resources provided its expertise in the field of water rights administration throughout the state to determine whether the flow of a specific stream segment was entirely committed to existing water rights. Their expertise was complemented by that of Game and Parks Commission fisheries personnel who regularly observe streamflow conditions.

If the base flow of a stream is not entirely committed to existing water rights, then some unappropriated flow is present in the stream. Unappropriated flow is defined as water that has not been appropriated pursuant to the procedures associated with Nebraska's system of appropriative water rights. It can also be defined as the water that is still available in a stream after all demands for diversion, both upstream and downstream of a given point, have been met.

Four different methods can be used to determine if unappropriated flow is present in a stream. The first method is the occurrence or absence of water rights administration on a stream which can indicate if the stream has unappropriated flow during any given time of the year. Downstream water rights have to be recognized in this determination. Basically, if water rights administration has never been necessary, adequate flow has always been present to meet existing demands. This was the primary method used to develop Figure 16: Flowing Waters in Nebraska. With this method, low flow data, if available, can be used to determine the quantity of unappropriated flow that is present after all demands have been met.

The second method involves the comparison of various flow values measured at a given point on a stream with the quantity of flow committed to existing water rights above that point. Commitments to downstream rights also have to be taken into account in this comparison. The most useful flow values to use are the base flow and the minimum flow

of record, the latter, it taken during the time of highest demand for withdrawals. Streamflow data must be available in order to use this method. This method is subject to several factors which can affect its accuracy. These include: (1) the natural variability of streamflow, (2) the effect of storage facilities, (3) the effect of irrigation return flows, (4) the distribution of water rights along the course of a stream, and (5) the fact that all water rights are not exercised at the same time.

The third method is a water rights accounting system developed and utilized by the Department of Water Resources to administer water rights in the Platte River Basin. This system is based on the distribution of senior and junior water rights along the river, the availability of natural flow and storage water, and a network of measuring devices to allocate available water and identify any unappropriated flow. This system, which is utilized to a lesser extent in the Republican River Basin, would require major increases in personnel and equipment in order to be implemented on a statewide basis.

The fourth method involves computer models such as the Hydrologic Simulation Program in Fortran which could be used to identify and quantify unappropriated flow. Much of the data necessary for computer modeling appears to be available but considerable requirements in terms of personnel, time, and funding would be necessary to set up the model and to calibrate it on a statewide basis.

Categories of Flowing Waters in Nebraska

CATEGORY A

This category includes streams with continuous flow throughout the year, significant instream flow values, and base flows that are not entirely committed to existing water rights.

The stream segments in Category A have not exhibited any known periods of no-flow during the past ten years – a decade that included extended periods of extremely dry climatic conditions and very high demand for out-of-stream uses of surface water. The analysis of existing water rights on each of these streams also indicated that the remaining portion of their base flow is not committed to downstream appropriations. Therefore, it is reasonable to conclude that their base flows are not entirely committed to existing water rights. It is anticipated that the base flows of some stream segments included in Category A could become entirely committed as a result of additional water rights applications in the near future, especially if drought conditions occur. Lands suitable for additional surface water development are considered to be available along these stream segments, which are denoted by an asterisk. The stream segments in Category A probably comprise the most important part of the inventory as they would most readily benefit from instream flow protection measures due to the fact that their base flows are not fully committed to existing water rights at the present time. Of the seventy-six stream segments in Category A, thirty-two are located in the Niobrara River Basin, fourteen in the Elkhorn River Basin and eleven in the Missouri Tributaries River Basins. Streams covered by the Blue River Basin Compact are included in this category.

The stream segments that comprise Category A are:

I. Lower Platte River Basin
   1. Platte River from Loup Power Canal return to mouth
   2. Salt Creek from point of effluence to mouth*†
   3. Wahoo Creek from confluence with Cottonwood Creek to mouth*
   4. Clear Creek from point of effluence downstream from Clear Creek diversion channel (to Platte River) to mouth*
   5. Little Salt Creek from point of effluence to mouth
   6. Oak Creek from confluence with North Oak Creek to mouth*
   7. Middle Creek from confluence with South Branch Middle Creek to mouth*
   8. Haines Branch from confluence with Cheese Creek to mouth*

II. Middle Platte River Basin – none

III. South Platte River Basin – none

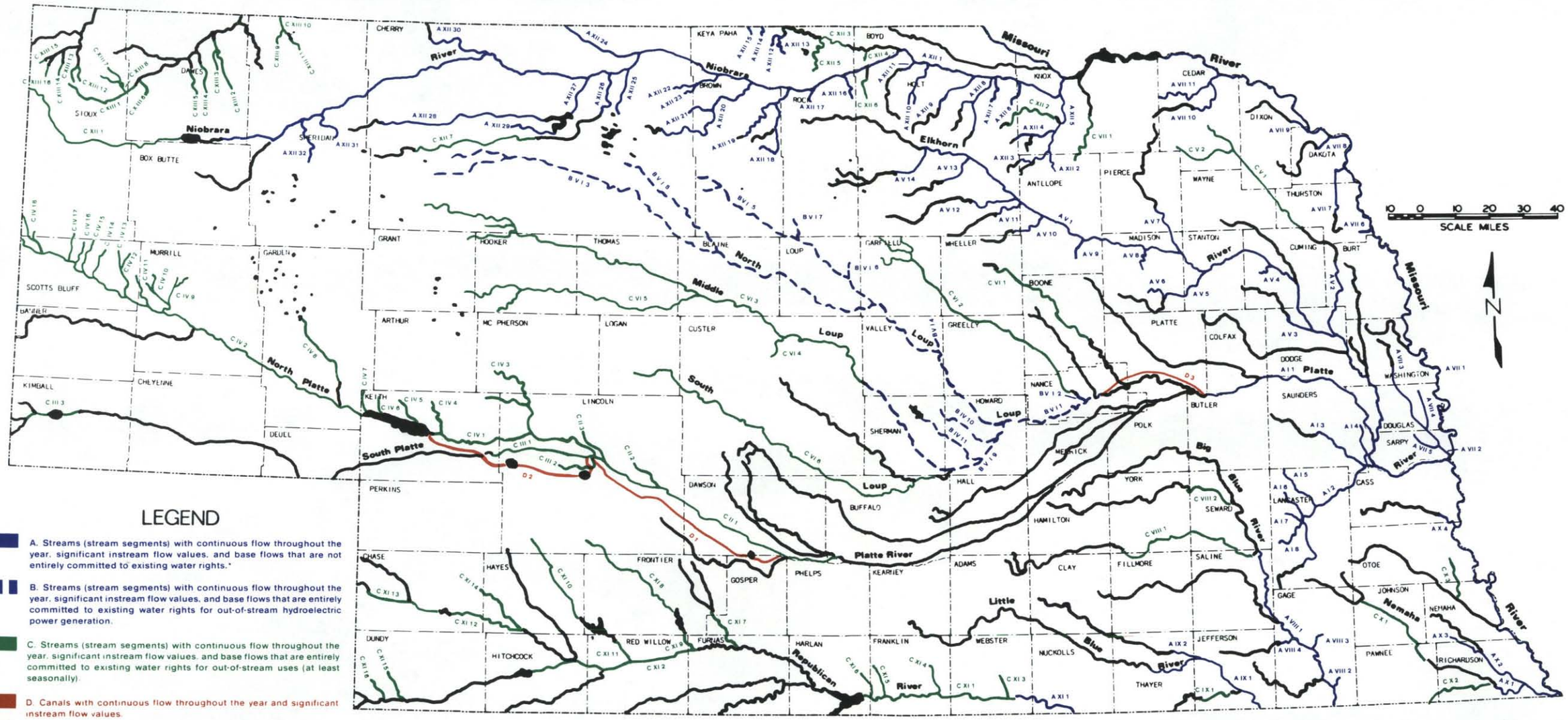
IV. North Platte River Basin – none

V. Elkhorn River Basin
   1. Elkhorn River from confluence with Holt Creek to mouth*
   2. Logan Creek from confluence with Little Logan Creek to mouth*
   3. Pebble Creek from confluence with unnamed tributary east of Snyder to mouth*
   4. Rock Creek (near Beemer) from point of effluence to mouth*
   5. Union Creek from confluence with Taylor Creek to mouth*
   6. Taylor Creek from point of effluence to mouth*
   7. North Fork Elkhorn River from confluence with Dry Creek to mouth*
   8. Battle Creek from point of effluence to mouth*
   9. Cedar Creek from point of effluence to mouth*
   10. Clearwater Creek from point of effluence to mouth
   11. Cache Creek from point of effluence to mouth
   12. South Fork Elkhorn River from point of effluence to mouth
   13. Dry Creek (near O'Neill) from point of effluence to mouth
   14. Holt Creek from point of effluence to mouth

VI. Loup River Basin – none

VII. Missouri Tributaries River Basin
   1. Missouri River from South Dakota – Nebraska state line to Nebraska – Kansas state line
   2. Papillion Creek from confluence of Big Papillion Creek and West Papillion Creek to mouth†
   3. Big Papillion Creek from point of effluence to mouth†
   4. Little Papillion Creek from point of effluence to mouth†
   5. West Papillion Creek form point of effluence to mouth†

FLOWING WATERS IN NEBRASKA



LEGEND

A. Streams (stream segments) with continuous flow throughout the year, significant instream flow values, and base flows that are not entirely committed to existing water rights.*

B. Streams (stream segments) with continuous flow throughout the year, significant instream flow values, and base flows that are entirely committed to existing water rights for out-of-stream hydroelectric power generation.

C. Streams (stream segments) with continuous flow throughout the year, significant instream flow values, and base flows that are entirely committed to existing water rights for out-of-stream uses (at least seasonally).

D. Canals with continuous flow throughout the year and significant instream flow values.

E. Streams (stream segments) that do not exhibit continuous flow throughout the year. This category includes the intermittent stream segments above the point of effluence of several streams in categories A, B, and C.

***This category includes the streams covered by the Blue River Basin Compact.**

Note: Numbers along stream segments correspond to segments listed in Chapter 2 of this report.

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Figure 16: Flowing waters in Nebraska.

6. Blackbird Creek from the confluence of South Blackbird Creek and North Blackbird Creek to mouth
7. Omaha Creek from confluence of South Omaha Creek and North Omaha Creek to mouth
8. Elk Creek from point of effluence to mouth*
9. Aowa Creek from confluence with South Creek to mouth*
10. Bow Creek from confluence with Norwegian Bow Creek to mouth*
11. Bow Valley Creek from Knox-Cedar County line to mouth*

VIII. Big Blue River Basin
1. Big Blue River from confluence with West Fork Big Blue River to Nebraska-Kansas state line
2. Wildcat Creek from confluence with Wolf Creek to mouth*
3. Bear Creek from confluence with Pierce Creek to mouth*
4. Cub Creek from point of effluence to mouth*

IX. Little Blue River Basin
1. Little Blue River from confluence with Spring Creek (near Hebron) to Nebraska-Kansas state line
2. Big Sandy Creek from confluence with Dry Sandy Creek to mouth*

X. Nemaha River Basin
1. Big Nemaha River from point approximately one mile below confluence of South Fork Big Nemaha River and North Fork Big Nemaha River to mouth*
2. Muddy Creek from confluence with Little Muddy Creek to mouth*
3. Little Muddy Creek from point of effluence to mouth*
4. Weeping Water Creek from confluence with South Branch Weeping Water Creek to mouth*

XI. Republican River Basin
1. Republican River from point of effluence below Courtland Diversion Dam to Nebraska – Kansas state line*

XII. Niobrara River Basin
1. Niobrara River from point of effluence below Dunlap Diversion Dam to mouth
2. East Branch Verdigre Creek from point of effluence to mouth
3. South Branch Verdigre Creek from point of effluence to mouth
4. Middle Branch Verdigre Creek from point of effluence to mouth
5. Verdigre Creek from confluence of East Branch Verdigre Creek and South Branch Verdigre Creek to mouth
6. Steel Creek from point of effluence to mouth
7. Louse Creek from point of effluence to mouth
8. Redbird Creek from points of effluence to mouth
9. Eagle Creek from confluence of East Branch Eagle Creek and Middle Branch Eagle Creek to mouth
10. Brush Creek from points of effluence to mouth
11. Big Sandy Creek from point in section 30 T 33N, R 14W to mouth
12. Holt Creek from point of effluence to approximately one mile below confluence with East Holt Creek*
13. East Holt Creek from point of effluence to mouth*
14. Cottonwood Creek from point of effluence to Nebraska – South Dakota state line*
15. Lost Creek from point of effluence to Nebraska – South Dakota state line*
16. Ash Creek from point of effluence to mouth
17. Coon Creek from point of effluence to mouth
18. Long Pine Creek from point of effluence to mouth
19. Bone Creek from point of effluence to mouth
20. Plum Creek from point of effluence to mouth
21. Evergreen Creek from point of effluence to mouth
22. Fairfield Creek from point of effluence to mouth
23. South Fork Fairfield Creek from point of effluence to mouth
24. Minnechaduza Creek from South Dakota – Nebraska state line to mouth
25. Schlagel Creek from point of effluence to mouth
26. Gordon Creek from point of effluence northeast of Merritt Dam to mouth
27. Snake River from Merritt Dam to mouth
28. Snake River from point of effluence to Merritt Reservoir
29. Boardman Creek from point of effluence to Merritt Reservoir
30. Bear Creek from point of effluence to mouth
31. Deer Creek from point of effluence to mouth
32. Pine Creek from point of effluence to mouth

XIII. White River-Hat Creek River Basin – none

* Denotes stream segment whose base flow has high potential to become entirely committed to water rights for out-of-stream uses in the near future.

†Includes stream reach that has been designated a water quality segment.[57] Water quality conditions may adversely affect instream flow values in this segment.

Note: Point of effluence is that point in a stream's channel where flow becomes continuous due to groundwater discharge.

CATEGORY B

This category includes streams with continuous flow throughout the year, significant instream flow values, and base flows that are entirely committed to existing water rights for out-of-stream hydroelectric power generation.

The stream segments in Category B differ from those in

Category A due to the fact that their base flows are entirely committed to the existing water rights for the Loup Power Canal and its associated hydroelectric power generation facilities. The canal supports various instream uses and empties into the Platte River which also sustains various instream uses. All eleven of the stream segments in this category are located in the Loup River Basin.

The stream segments that comprise Category B are:

I. Lower Platte River Basin – none
II. Middle Platte River Basin – none
III. South Platte River Basin – none
IV. North Platte River Basin – none
V. Elkhorn River Basin – none
VI. Loup River Basin
    1. Loup River from confluence of North Loup River and Middle Loup River to Loup Power Canal Diversion
    2. Cedar River from point approximately one mile below Fullerton gage to mouth
    3. North Loup River and its headwater streams from points of effluence to mouth
    4. Messenger Creek from point of effluence to mouth
    5. Calamus River from point of effluence to mouth
    6. Gracie Creek from point of effluence to mouth
    7. Skull Creek from point of effluence to mouth
    8. Goose Creek from point of effluence to mouth
    9. Middle Loup River from point of effluence below Arcadia Diversion Dam to mouth
    10. Turkey Creek from point of effluence to mouth
    11. Oak Creek from point of effluence below Sherman Dam to mouth
VII. Missouri Tributaries River Basin – none
VIII. Big Blue River Basin – none
IX. Little Blue River Basin – none
X. Nemaha River Basin – none
XI. Republican River Basin – none
XII. Niobrara River Basin – none
XIII. White River-Hat Creek Basin – none

CATEGORY C

This category includes streams with continuous flow throughout the year, significant instream flow values, and base flows that are entirely committed to existing water rights for out-of-stream uses (at least seasonally).

The stream segments in Category C also have not exhibited any periods of no flow during the past ten years even though their base flows are entirely committed to existing water rights for out-of-stream uses. Senior water rights located either on the downstream portion of a particular stream, or on the stream that a particular stream is tributary to, serve to protect the base flow in the stream segment from excessive withdrawals. Although cessation of flow has not occurred within the stream segment during the past ten years, it has occurred at some point downstream of the segment during that period. Of the seventy-eight stream segments in Category C, eighteen are located in the North Platte River Basin, and sixteen each in the Republican and White River – Hat Creek basins.

The stream segments that comprise Category C are:

I. Lower Platte River Basin – none
II. Middle Platte River Basin
    1. Platte River from Tri-County Diversion Dam to Kearney Canal Diversion Dam (near Elm Creek***
    2. Pawnee Creek from point of effluence to mouth**
    3. Whitehorse Creek from point of effluence to mouth**
III. South Platte River Basin
    1. South Platte River from point of effluence east of Paxton to mouth*****
    2. Fremont Slough from point of effluence to mouth**
    3. Lodgepole Creek from point of effluence above Bushnell to Owasco Canal Diversion Dam near Kimball (segment includes Oliver Reservoir)***
IV. North Platte River Basin
    1. North Platte River from unnamed drain approximately one half mile downstream from Keystone Diversion Dam to mouth*****
    2. North Platte River from Wyoming – Nebraska state line to Lake McConaughy*****
    3. Birdwood Creek and its headwater streams from points of effluence to mouth**
    4. Whitetail Creek from point of effluence to mouth**
    5. Lonergan Creek from point of effluence to Lake McConaughy**
    6. Otter Creek from point of effluence to Lake McConaughy**
    7. Clear Creek from point of effluence to Lake McConaughy**
    8. Blue Creek from point of effluence to Blue Creek Canal Diversion***
    9. Red Willow Creek from point of effluence to mouth**
    10. Wildhorse Creek from points of effluence to mouth**
    11. Stuckenhole Creek from point of effluence to mouth**
    12. Ninemile Creek from point of effluence to mouth**
    13. Alliance Drain from point of effluence to mouth**
    14. Winters Creek from Winters Creek Canal Diversion to mouth**
    15. Tub Springs from point of effluence to mouth**
    16. Mitchell Drain from point of effluence to mouth**
    17. Dry Spottedtail Creek from point of effluence to mouth**
    18. Sheep Creek from points of effluence to mouth**
V. Elkhorn River Basin
    1. Logan Creek from point of effluence to Thurston-Cuming county line***
    2. Mid Logan Creek from point of effluence to mouth**
VI. Loup River Basin
    1. Beaver Creek from point of effluence to Boone***

2. Cedar River and its headwater streams from points of effluence to point approximately one mile below Fullerton gage***
3. Middle Loup River from point of effluence to Arcadia Diversion Dam****
4. Victoria Creek from point of effluence to mouth**
5. Dismal River from points of effluence to mouth**
6. South Loup River from point of effluence to point approximately two miles above mouth***

VII. Missouri Tributaries River Basin
1. Bazile Creek from point of effluence to Center***

VIII. Big Blue River Basin
1. West Fork Big Blue River from confluence of School Creek to point approximately one mile above mouth***
2. Lincoln Creek from York – Seward County line to point approximately one mile above mouth***

IX. Little Blue River Basin
1. Rose Creek from Reynolds to point approximately one mile above mouth***

X. Nemaha River Basin
1. North Fork Big Nemaha River from its confluence with Middle Branch Big Nemaha River to Table Rock***
2. South Fork Big Nemaha River from Kansas-Nebraska state line to mouth**
3. Rock Creek (near Julian) from point of effluence to mouth**

XI. Republican River Basin
1. Republican River from Harlan County Dam to Courtland Diversion Dam****
2. Republican River from Trenton Dam to Cambridge Diversion Dam****
3. Elm Creek (near Amboy) from point of effluence to mouth**
4. Thompson Creek from confluence with West Branch Thompson Creek to mouth**
5. Center Creek from point of effluence to mouth**
6. Turkey Creek (near Naponee) from point of effluence to mouth**
7. Muddy Creek (near Arapahoe) from confluence with West Muddy Creek to mouth***
8. Medicine Creek from point of effluence to Harry Strunk Lake**
9. Medicine Creek from point of effluence below Medicine Creek Dam to mouth**
10. Red Willow Creek from point of effluence to Hugh Butler Lake**
11. Red Willow Creek from point of effluence below Red Willow Creek Dam to mouth**
12. Frenchman Creek from point of effluence downstream from Enders Reservoir to Culbertson Diversion Dam****
13. Frenchman Creek from point of effluence to Enders Reservoir****
14. Stinking Water Creek from confluence with Spring Creek to mouth**
15. Rock Creek (near Parks) from point of effluence to mouth**
16. Buffalo Creek (near Haigler) from point of effluence to mouth**

XII. Niobrara River Basin
1. Niobrara River from Wyoming-Nebraska state line to Box Butte Reservoir****
2. North Branch Verdigre Creek from point of effluence to point approximately one mile above mouth***
3. Keya Paha River from confluence with Spring Creek (near Mills) to point approximately six miles downstream***
4. Silver Gulch from point of effluence to mouth**
5. Spring Creek (near Mills) from point of effluence to mouth**
6. Beaver Creek from point of effluence to point approximately three miles above mouth***
7. Gordon Creek from point of effluence to point southwest of Merritt Reservoir***

XIII. White River-Hat Creek Basin
1. White River from point of effluence to Whitney Diversion Dam near Crawford****
2. Little Bordeaux Creek from point of effluence to mouth**
3. Big Bordeaux Creek from point of effluence to point approximately one mile above mouth***
4. Chadron Creek from point of effluence to point approximately two miles below the Chadron city dams***
5. Dead Horse Creek from point of effluence to point approximately four miles above mouth***
6. White Clay Creek (near Crawford) from point of effluence to mouth**
7. Soldiers Creek from points of effluence to point approximately one half mile above Carter P. Johnson Reservoir***
8. Soldiers Creek from confluence with Smiley Canyon to mouth**
9. White Clay Creek (near White Clay) from confluence with East Branch White Clay Creek to Nebraska – South Dakota state line***
10. Larrabee Creek from county road bridge in the center of Section 16, T34N, R44W to mouth**
11. Larrabee Creek from point of effluence to county road bridge to Section 26, T34N, R44W***
12. East Hat Creek from point of effluence to confluence with West Hat Creek***
13. West Hat Creek from point of effluence to confluence with East Hat Creek***
14. Sowbelly Creek from point of effluence to point in Section 8, T32N, R55W***
15. Warbonnet Creek from point of effluence to middle of Section 29, T33N, R56W***
16. Monroe Creek from point of effluence to center of Section 33, T33N, R56N***

** Tributary to stream whose base flow is entirely committed to existing water rights for out-of-stream uses (at least seasonally).

*** Below this segment, stream's base flow is entirely committed to existing water rights for out-of-stream uses (at least seasonally).

**** Stream's base flow entirely committed to meet large-scale irrigation project requirements below this segment (at least seasonally).

***** Stream's base flow entirely committed, in part to existing water rights for out-of-stream uses and in part to large-scale irrigation project (at least seasonally).

CATEGORY D

This category includes canals with continuous flow throughout the year, significant instream flow values, and flows that are entirely committed to existing water rights.

The canals that comprise category D are:

1. Tri-County Canal from Tri-County Diversion Dam to Tri-County Canal return to Platte River near Canaday Steam Plant
2. Sutherland Canal from Keystone Diversion Dam to confluence with South Platte River
3. Loup Power Canal from Loup Power Canal Diversion Dam to confluence with Platte River

CATEGORY E

This category includes streams that do not exhibit continuous flow throughout the year.

The stream segments in Category E have exhibited at least one period of no-flow during the past ten years. This interruption of flow may have resulted from natural conditions, excessive withdrawals for out-of-stream uses, depletions due to groundwater pumping, or a combination of these factors. In some cases, the cessation of flow occurred in only a short reach of the stream. This category includes the intermittent stream segments above the point of effluence of several stream segments in Categories A, B, and C.

PROJECTED STREAMFLOWS

Projections of future flow conditions are not provided as was intended at the initiation of the Instream Flows Study. These estimates were to have been the basis for comparing the levels at which instream uses could be sustained under alternative instream flow policies.

Work Element 2.3 of the April 1979 Instream Flows Study Design was to identify opportunities to meet instream flow needs from unappropriated flows. This work element was to produce two products: 1) a description of factors that affect streamflow, and 2) projections of future streamflow conditions. These projections were to reflect both surface water appropriations and groundwater withdrawals. The work element was scheduled for completion by the end of October 1979 and was to be the basis for indicating the future status of instream uses. However, the responsible agencies concluded that there was no basis for determining location or quantities of future surface water appropriations nor was there any reason to believe that future groundwater use beyond that occuring in close proximity to streams will cause any change in stream flows.

Therefore projections of future streamflows in either quantitative or qualtitative terms were deleted from the study design. However, some agencies disagreed with this conclusion and chose to reference estimates of future instream uses to streamflow projections contained in reports such as the Platte River Basin, Nebraska Level B Study.

A considerable amount of information on streamflow levels is contained in the hydrologic impact analysis sections of this report. This material was largely developed based on the familiarity of individual task force members with hydrologic conditions in the state. The hydrologic impacts were in turn used as a basis for determining the other impacts.

Chapter 3

Flow Requirements for Instream Uses

Instream flow requirements pertain to the amount of water flowing in a stream that is needed to maintain instream uses. At a given location in a given stream only certain instream uses may be applicable. Therefore, flow requirements for each stream are based on the dominance of one use or on a combination of uses.

The methods available for determining flow recommendations range from sophisticated computer programs to simple estimates of the percentage of gaged flows adjusted for the observed effectiveness of the flows. The methods used to determine flow requirements for fisheries have been evaluated by comparing field tests. On the other hand, the methods discussed for hydropower, water quality maintenance, livestock watering, aquifer recharge, subirrigation, and recreation have not been evaluated under Nebraska conditions. For wildlife, wild and scenic rivers, and aesthetic use no methods were identified and flows must be determined on a case by case basis. For the remaining two uses, navigation and interstate compacts, flows have previously been determined and methods are not required.

Besides those flows identified for the uses considered in this study, an important but often overlooked element of satisfactory flow regimes is the periodic high flows necessary to move bed load, flush sediments, and generally maintain the desired stream channel characteristics. These flows are termed stream maintenance flows.

A common misinterpretation of instream flow requirements is that if all of the identifiable instream uses are considered, the result will be total allocation of streamflow to instream uses. Contrary to this interpretation, a considerable degree of compatibility exists among many instream uses and downstream delivery requirements for offstream uses. The protection of complementary uses requires an instream flow regime that will satisfy several instream uses at once (e.g., fishery resources, recreation, hydroelectric power) with consideration given to those instream uses having the greatest flow needs at any given time. This can only be done by evaluating all of the instream flow uses, taking into account the conflicting aspects as well as the complementary features and the required flows to meet downstream appropriators.

Figure 17 shows a hypothetical array of instream flow requirements for several instream uses.[58] This hypothetical graph displays the compatibility among uses and the fallacy of a common assumption that if a flow is adequate for fisheries all other uses will be protected.

This chapter describes for each instream use alternative methods for determining flows and identifies, where possible, flow regimes for certain streams. One method not discussed in this report is the concept of Reserved Median Flows.[59] This method, which was developed recently in Missouri, is based on the natural carrying capacity of a stream and the amount of water available for qualified tenable uses. Time did not allow the use of this methodology in this study. However, this approach may prove to be valuable in future instream flow determinations for Nebraska streams.

It is beyond the scope of this study to identify specific flow requirements by use for each stream. Rather, the purpose is to aid in the understanding of instream flow requirements by describing the different methods available and by identifying some flow regimes. Should a decision be made to protect flows for instream uses the following separate actions will be needed: (1) select applicable streams; (2) determine the appropriate instream use or uses; (3) select or develop appropriate methodologies for determining flows; and (4) calculate flow requirements.

FISHERY RESOURCES

Methodology

Instream flow requirements for fishery resources are the flow regimes necessary to maintain desired levels of habitat for fish.[60] There are numerous methods for determining fishery flow requirements. The five chosen for review in this report are: (1) Tennant Method; (2) Modified Tennant Method: (3) Single Cross-section Method; (4) Incremental - Water Surface Profile Method; and (5) Incremental - IFG4 Hydraulic Simulation Method. Each method has strengths and weaknesses and as currently developed there is no one best method for statewide application.

The following sections briefly describe the five methods and discuss their advantages and disadvantages.

TENNANT METHOD

The Tennant Method of determining recommended flow regimes for fishery purposes consists of calculating flow quantities based upon fixed percentages of the mean annual or mean monthly streamflow.[61] The percentages to be applied should be selected according to the relative priority given the fishery (see Table 12).

An additional step in applying the Tennant Method is

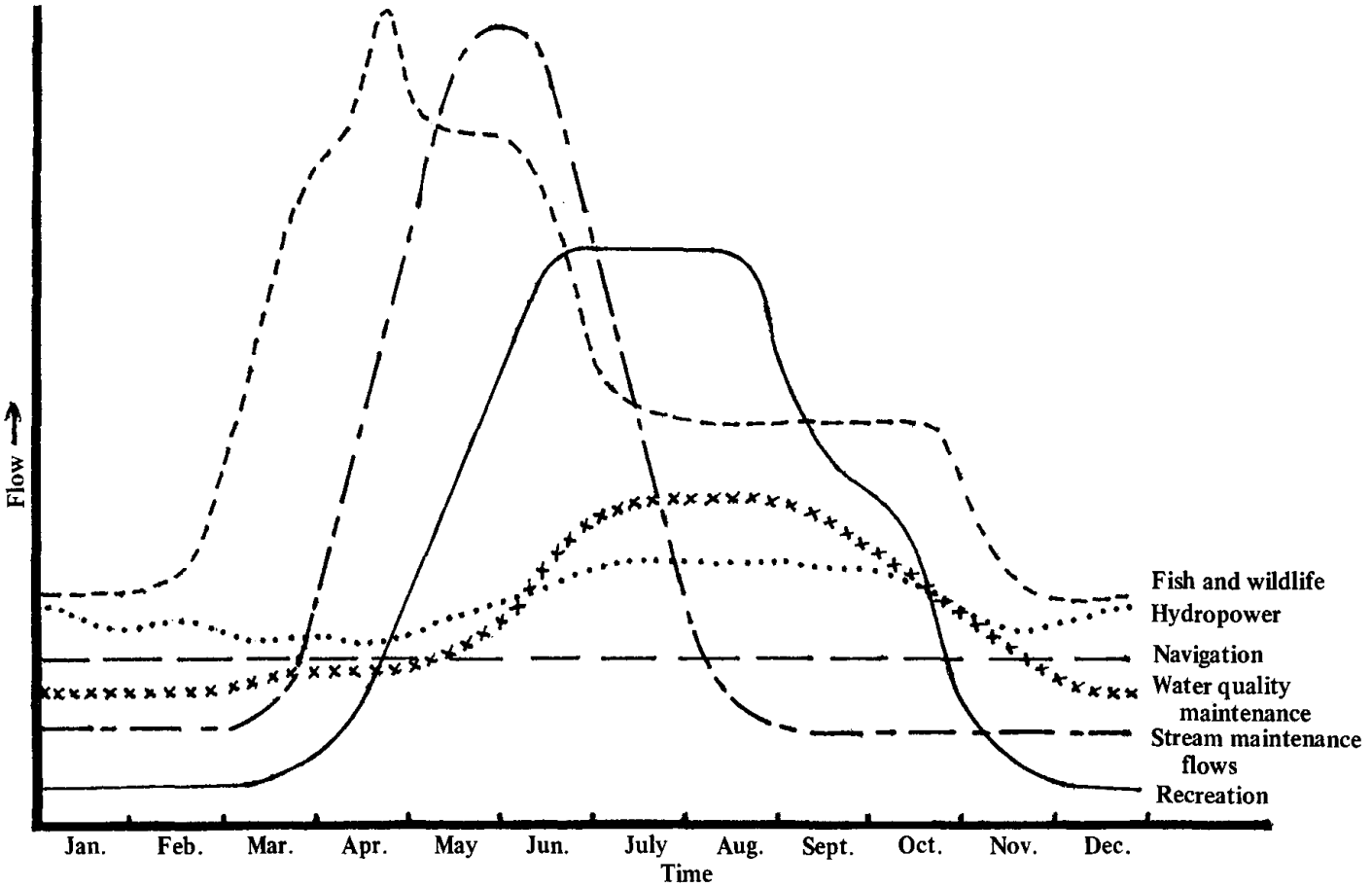


Figure 17: Hypothetical array of instream flow requirements for several instream uses.

Table 12: Percent of average annual flow required to maintain various flow conditions.

Flow Condition	Percent of Average Annual Flow	
	October-March	April-September
Flushing*	200	
Optimum range	60-100	
Outstanding	40	60
Excellent	30	50
Good**	20	40
Fair, degrading	10	30
Poor, minimum	10	10
Severe degradation	<10	<10

*Also termed Stream Channel Maintenance Flow.
**Flow condition used to develop flow regimes in this report.

adjustment of the recommendations according to field observations. This should be accomplished under the desired flow regime when flow control is available. In the event flow control is not available, the observer should study available cross section and velocity data developed for stream gaging stations until conditions can be visualized. The application of the Tennant Method in Nebraska utilized only the first step of the process.

MODIFIED TENNANT METHOD

The Modified Tennant Method uses percentages of the base flow instead of the average annual flow to determine desired flow levels.[62] Flow recommendations for twelve selected streams were developed through use of the Modified Tennant Method by taking thirty percent of the base flow for each stream. The thirty percent figure represents good stream condition, i.e., an average of the twenty percent to forty percent range for good stream condition under the Tennant Method. Base flow was determined by averaging the median monthly flow for November, December, and January for the ten year period 1968-77.

Use of the Modified Tennant Method yields results more accurate than those from the application of the Tennant Method in two situations. The first situation relates to occasions where use of the Tennant Method yields flow that are unrealistic in view of the available water supply. Examples of this situation include streams in the Nemaha Basin and the Republican River below Harlan County Dam. In the Nemaha Basin a high proportion of the flow is overland runoff and base flows are low. On the Republican River the flows are stored in Harlan County Reservoir for high releases during the summer months to meet irrigation demand. In both examples, the use of the Tennant Method would call for minimum flows substantially greater than is available during annual low flow periods.

The second situation in which use of the Modified Tenant Method provides more acceptable results is in application on streams with stable flows largely derived from groundwater, such a Sandhills stream. Flow quantities as derived by the use of the Tennant Method would provide for a far greater reduction in flows than is experienced under natural conditions creating the potential for significant fish mortality. In the case of the Cedar River, the

Modified Tennant method would result in a fifty-three percent greater winter flow than the Tennant Method.

Instream flow recommendations based upon both the Tennant Method and Modified Tennant Method have the advantages of being quickly calculated, and relatively inexpensive. The methods also do not require data on the life history and ecology of aquatic organisms as do the three computer methods – Single Cross-section, Water Surface Profile, and IFG4.

The Tennant Method and Modified Tennant Method have been critized due to their subjective nature as much reliance is placed on the judgment and knowledge of the investigator.

SINGLE CROSS-SECTION METHOD

The Single Cross-section Method utilizes a computer modeling technique developed by the U.S. Fish and Wildlife Service Instream Flow Group to predict average stream parameters from measurements taken at a single stream cross section.[63] Recommendations are set at the minimum discharge which will satisfy the physical requirements of selected fish species.

By applying a single physical limitation such as minimum flow depth for spawning catfish movement, which was used in the Nebraska evaluation of the technique, the program will yield the minimum flow required to maintain the required water depth.

The advantages of this method are the relatively low cost and that it uses stream specific hydraulic data. The disadvantages of the Single Cross-section Method are that it provides only the minimum flow quantity, does not provide a range of acceptable flows, does not indicate the optimum flow requirement or the degree a fishery was benefited or harmed by an altered flow regime. In addition, this method was found not to work well on streams with shifting sand beds.

INCREMENTAL: WATER SURFACE PROFILE (WSP) and IFG4 METHODS

Methods

Both incremental methods were developed by the Cooperative Instream Flow Service Group of the U.S. Fish and Wildlife Service.[64] The methods enable quantification of the amount of habitat available for a species to meet its seasonal and life stage requirements with variations in the quantity of streamflow.

Each method has four components: (1) simulation of the stream; (2) determination of the distribution of combinations of depths, velocities, substrates, and cover objects by area; (3) determination of a composite probability of use for each combination of depth, velocity, substrate, and cover occurring within the stream reach, for each species and life history phase under investigation; and (4) the calculation of a "weighted usable area" (roughly a habitat's carrying capacity based on physical conditions only) for each discharge, each species and each life history phase under investigation.

The distinctions between the two Incremental Methods is the modeling of a section of river at three different flow levels under the IFG4 Hydraulic Simulation Method, and at only a single flow level with the Water Surface Profile Method (WSP). The IFG4 method provides for modeling a range of flows from 40 percent of the lowest measured flow to 250 percent of the highest measured flow while the WSP method provides for modeling flows with a range of 40 percent to 250 percent of the single measured flow. In addition, the IFG4 program can only be used on stable bed streams while the WSP program can be used on both stable and unstable bed streams.

Determining fishery flow recommendations using Water Surface Profile Method (WSP) in the North Loup River

The WSP method was found to be less accurate than the IFG4 method in predicting flows on stable bed streams. However, the WSP method is less costly than the IFG4 method since field measurements are required only on a single flow.

The advantage of the incremental methods over other methods is that they are able to quantify the effects of hydraulic changes on the various life stages of the stream fishery. The flow recommendations for both the WSP and IFG4 methods, appearing in the Flow Regimes section, represent optimum flows for the fisheries of the streams to which they have been applied. The disadvantages of the incremental methods are the time and cost of applying the methods and the detailed information required on the life history and ecology of each species.

Flow Regimes

Flow recommendations for thirteen stream segments, based on the preceding five methods, are shown in the following tables. The flow recommendations represent instantaneous flows meaning that at no time should streamflow fall below that figure. In addition to the flow recommendations, the median daily flows for each stream segment during the period 1968-77 are given for comparison purposes.

Not all of the methods were applicable to all of the thirteen streams selected for evaluation. The Tennant and Modified Tennant methods are applicable to all stream segments with gaging stations. The Single Cross-section method is also applicable to all stream segments selected; however, it was not used on several sites because of time limitations. Both the IFG4 and the WSP methods require an evaluation of the habitat requirements of the existing fish population. This data is available for cold water species

Table 13: Recommended fishery flows: Ninemile Creek.

Stream Segment: Headwaters to confluence with North Platte River (18 miles)
Primary Fish Species: Migratory Rainbow Trout
Gaging Station Used: Ninemile Creek near McGrew

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section	WSP	IFG4
October	150	26	30	39	50	100
November	120	26	30	39	50	100
December	98	26	30	33	80	100
January	87	26	30	33	80	100
February	78	26	30	33	30	80
March	76	26	30	39	90	100
April	74	52	30	39	90	100
May	100	52	30	33	80	100
June	140	52	30	33	50	100
July	160	52	30	33	50	80
August	210	52	30	33	50	80
September	220	52	30	39	50	100

Table 14: Recommended fishery flows: Republican River.

Stream Segment: Superior – Courtland Diversion near Guide Rock, Nebr. to Nebraska-Kansas state line (25 miles)
Primary Fish Species: Channel Catfish
Gaging Station Used: Republican River near Guide Rock

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section	WSP	IFG4†
October	95	39	33	32	95	
November	110	39	33	32	110	
December	110	39	33	32	110	
January	110	39	33	32	110	
February	150	39	33	32	150	
March	150	39	33	32	150	
April	180	78	33	32	180	
May	150	78	33	32	150	
June	110	78	33	32	110	
July	57	78	33	32	57	
August	67	78	33	32	67	
September	89	78	33	32	89	

†Method is not applicable.

Table 15: Recommended fishery flows: Elkhorn River.

Stream Segment: Ewing, Nebr. to Norfolk, Nebr. (62 miles)
Primary Fish Species: Channel Catfish, Northern Pike
Gaging Station Used: Elkhorn River at Neligh

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section	WSP	IFG4†
October	120	46	44	42	120	
November	150	46	44	42	150	
December	140	46	44	42	140	
January	130	46	44	42	130	
February	180	46	44	42	180	
March	300	46	44	42	300	
April	370	92	44	42	370	
May	240	92	44	42	240	
June	200	92	44	42	200	
July	120	92	44	42	120	
August	76	92	42	42	76	
September	88	92	44	42	88	

†Method is not applicable.

Table 16: Recommended fishery flows: North Loup River.

Stream Segment: Confluence with Calamus River to confluence with Loup River (60 miles)
Primary Fish Species: Channel Catfish, Carp
Gaging Station Used: North Loup River near St. Paul

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section	WSP	IFG4†
October	870	176	269	286	870	
November	930	176	269	286	930	
December	870	176	269	286	870	
January	890	176	269	286	890	
February	1,200	176	269	286	1200	
March	1,100	176	269	286	1100	
April	1,000	352	269	286	1000	
May	880	352	269	286	880	
June	770	352	269	286	770	
July	420	352	269	286	420	
August	340	352	269	286	370	
September	730	352	269	286	730	

†Method is not applicable.

Table 17: Recommended fishery flows: Cedar River.

Stream Segment: Confluence with Little Cedar River to Lake Ericson (25 miles)
Primary Fish Species: Northern Pike, Channel Catfish, Carp
Gaging Station Used: Cedar River near Spalding

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section	WSP	IFG4†
October	140	30	46	21	140	
November	150	30	46	21	150	
December	140	30	46	21	140	
January	160	30	46	21	160	
February	160	30	46	21	160	
March	170	30	46	21	170	
April	160	60	46	21	160	
May	150	60	46	21	150	
June	140	60	46	21	140	
July	130	60	46	21	130	
August	120	60	46	21	120	
September	130	60	46	21	130	

†Method is not applicable.

Table 18: Recommended fishery flows: Snake River.

Stream Segment: Merritt Reservoir to confluence with Niobrara River (15 miles)
Primary Fish Species: Brown Trout
Gaging Station Used: Snake River near Burge

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section	WSP	IFG4
October	15	28	66	35	70	150
November	220	28	66	35	220	150
December	220	28	66	35	70	70
January	220	28	66	35	70	50
February	250	28	66	35	70	50
March	240	28	66	35	70	70
April	220	57	66	35	70	70
May	160	57	66	35	160	90
June	140	57	66	35	140	90
July	17	57	66	35	140	90
August	16	57	66	35	140	90
September	16	57	66	35	140	90

Table 19: Recommended fishery flows: Little Blue River.

Stream Segment: Confluence with Pawnee Creek, Deweese, Nebr. to confluence to Big Sandy Creek, Alexandria, Nebr. (51 miles)
Primary Fish Species: Channel Catfish
Gaging Station Used: Little Blue River near Deweese

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section	WSP	IFG4†
October	56	27	17	31	56	
November	59	27	17	31	59	
December	57	27	17	31	57	
January	58	27	17	31	58	
February	63	27	17	31	63	
March	73	27	17	31	73	
April	75	27	17	31	75	
May	86	54	17	31	86	
June	94	54	17	31	94	
July	72	54	17	31	72	
August	66	54	17	31	66	
September	53	54	17	31	53	

†Method is not applicable.

Table 20: Recommended fishery flows: West Fork Big Blue River.

Stream Segment: Confluence with School Creek to confluence with Big Blue River (51 miles)
Primary Fish Species: Channel Catfish
Gaging Station Used: West Fork Big Blue River near Dorchester

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section	WSP	IFG4†
October	56	30	17	36	56	
November	62	30	17	36	62	
December	57	30	17	36	57	
January	54	30	17	36	54	
February	66	30	17	36	66	
March	78	30	17	36	78	
April	83	60	17	36	83	
May	100	60	17	36	100	
June	94	60	17	36	94	
July	100	60	17	36	100	
August	110	60	17	36	110	
September	77	60	17	36	77	

†Method is not applicable.

Table 21: Recommended fishery flows: North Fork Big Nemaha River.

Stream Segment: Confluence with Elk Creek to confluence with South Fork Big Nemaha River (35 miles)
Primary Fish Species: Channel Catfish
Gaging Station Used: North Fork Big Nemaha River at Humboldt

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section	WSP	IFG4†
October	28	36	12	27	28	
November	40	36	12	27	40	
December	39	36	12	27	39	
January	38	36	12	27	38	
February	66	36	12	27	66	
March	85	36	12	27	85	
April	67	72	12	27	67	
May	89	72	12	27	89	
June	49	72	12	27	49	
July	28	72	12	27	28	
August	27	72	12	27	27	
September	27	72	12	27	27	

†Method is not applicable.

Table 22: Recommended fishery flows: Long Pine Creek.

Stream Segment: Headwaters to confluence with Bone Creek (22 miles)
Primary Fish Species: Brown Trout, Rainbow Trout
Gaging station Used: Long Pine Creek near Riverview

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section	WSP	IFG4†
October	120	28	37	65	114	
November	130	28	37	65	130	
December	120	28	37	65	114	
January	120	28	37	65	120	
February	130	28	37	65	114	
March	140	28	37	65	130	
April	140	56	37	65	130	
May	150	56	37	65	150	
June	150	56	37	65	150	
July	140	56	37	65	140	
August	140	56	37	65	140	
September	140	56	37	65	140	

†Method is not applicable.

Table 23: Recommended fishery flows: Niobrara River.

Stream Segment: Confluence with Fairfield Creek to confluence with Keya Paha River.
Primary Fish Species: Channel Catfish
Gaging Station Used: Niobrara River near Norden

		RECOMMENDED INSTREAM FLOWS (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section*	WSP*	IFG4†
October	640	156	239			
November	840	156	239			
December	790	156	239			
January	760	156	239			
February	1,000	156	239			
March	930	156	239			
April	950	312	239			
May	860	312	239			
June	750	312	239			
July	530	312	239			
August	490	312	239			
September	570	312	239			

*Method was not applied.
†Method is not applicable.

Table 24: Recommended fishery flows: North Platte River (lower section).

Stream Segment: Oshkosh vicinity to Lake McConaughy
Primary Fish Species: Migratory Rainbow Trout, Channel Catfish
Gaging Station Used: North Platte River at Lisco

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section*	WSP*	IFG4†
October	1,870	334	400			
November	1,500	334	400			
December	1,300	334	400			
January	1,200	334	400			
February	1,200	334	400			
March	1,200	334	400			
April	1,500	668	400			
May	1,300	668	400			
June	1,600	668	400			
July	690	668	400			
August	730	668	400			
September	1,300	668	400			

*Method was not applied.
†Method is not applicable.

Table 25: Recommended fishery flows: North Platte River (upper section).

Stream Segment: Wyoming-Nebraska state line to Oshkosh vicinity
Primary Fish Species: Migratory Rainbow Trout, Channel Catfish
Gaging Station Used: North Platte River at Mitchell

		RECOMMENDED INSTREAM FLOW (CFS)				
Month	Median Daily Flow (cfs) 1968-77	Tennant	Modified Tennant	Single Cross-section*	WSP*	IFG4†
October	880	190	184			
November	700	190	184			
December	610	190	184			
January	530	190	184			
February	520	190	184			
March	510	190	184			
April	770	380	184			
May	540	380	184			
June	1,000	380	184			
July	380	380	184			
August	290	380	184			
September	460	380	184			

*Method was not applied.
†Method is not applicable.

such as trout; however, only limited data is available for warm water species such as channel catfish, walleye, or sauger. Therefore, even though the IFG4 and WSP methods may be applicable to warmwater streams, additional biological data is desirable prior to their application in Nebraska. It should be noted that the WSP method has been successfully applied in several other states with sand bottom stream habitats similar to Nebraska.

RECREATION

Methodology

The flows required to support recreation activities in most Nebraska rivers relate to the depth requirements for the specific recreation activities pertinent to the stream. Although, the Single Cross-section Method, as described under the Fisheries section, could be used for determining flows for various recreational activities, it has not been applied to Nebraska streams.

Estimates of the flows required for canoeing were developed for a number of rivers by Nebraska Game and Parks Commission recreation planners.[65] These estimates were developed by comparing the ease with which selected stream segments could be navigated in a canoe to the gaged flow of the stream.

Flow Regimes

Flow regimes needed depend upon the activity, or activities, pertinent to a given stream reach. For example, if the only significant recreational use is canoeing, a flow regime sufficient to maintain depths adequate to float a loaded canoe during late spring and summer would be recommended.

Table 26 shows the acceptable flows for canoeing developed by the Nebraska Game and Parks Commission planners.

INTERSTATE COMPACTS

Methodology

The State of Nebraska is a party to two interstate compacts that deal with streams that flow out of the state. The compacts are the Republican River Compact[66] and the Blue River Basin Compact.[67]

The Blue River Basin Compact specifies the flows of the Little Blue River and the Big Blue River at the state line. These flows were determined by negotiation and therefore do not result from an actual methodology.

Flow Regimes

The flow required to meet the terms of the Blue River Basin Compact are shown in Table 27. These are mean daily flows that must be present at the state line gaging stations. The percent of time these flows were exceeded during the period 1969-78 is also shown.

Table 26: Acceptable flows for canoeing on selected streams.

River	Acceptable flows (cfs)	Percent of time acceptable flow was exceeded May-Sept. (1969-78)
Republican (Harlan County Dam to Guide Rock)	300	40.1
Elkhorn (West Point to Hwy. 36)	200-225	81.9-73.1
(Hwy. 36 to mouth)	275-300	89.6-83.3
Lower Platte (North Bend to mouth)	4500-5000	23.6-21.0
Dismal (Hwy. 97 to Hwy. 83)	191*	35.4
(Hwy. 83 to Dunning)	310-325	47.9-28.6
Calamus (Hwy. 7 to Hwy. 183)	297*	30.3
Big Blue (Crete to Wilber)	125-150	59.3-50.8
(Wilber to Beatrice)	150-175	78.5-71.1
Niobrara (near Sparks)	681*	26.2

*Mean Daily Discharge 1969-78.

Table 27: Flows required by the Blue River Basin Compact for the Little Blue River and Big Blue River.

	LITTLE BLUE RIVER at Fairbury		BIG BLUE RIVER at Barneston	
MONTH	Flow level specified in compact (cfs)	Percent of time flow was exceeded 1969-78	Flow level specified in compact (cfs)	Percent of time flow was exceeded 1969-78
January	*		*	
February	*		*	
March	*		*	
April	*		*	
May	45	100.0	45	100.0
June	45	100.0	45	100.0
July	75	99.6	80	91.6
August	80	94.1	90	88.0
September	80	93.0	65	93.6
October	*		*	
November	*		*	
December	*		*	

*Flow level not specified in compact.

HYDROELECTRIC POWER

Methodology

An engineering formula is available which can be used to determine the flow needed to realize the installed generating capacity of hydroelectric plants.[68] To determine the amount of streamflow required, it is necessary to know the turbine and generator efficiency (%), generating capacity (kw), and head (difference in elevation between the surface of the impounded water and the water level of the turbine exit).

Flow Regimes

The flows required for the five onstream hydroelectric power plants in Nebraska to realize their installed generating capacity are shown in Table 28. The percent of time the required streamflows were exceeded during 1969-78 also is identified. It should be noted that the Pierce plant on Minnechaduza Creek was designed to use stored water from a reservoir associated with the facility.

LIVESTOCK WATERING

Methodology

The minimum amount of flow necessary to meet livestock water needs, based on average animal intake, ranges from 0.0023 cfs per 100 wintering beef cows or yearling steers to 0.0054 cfs per 100 dairy cows.[74] These water requirements are based on the assumptions that the efficiency of use is 100 percent and that water is consumed on a rotational basis throughout a twenty-four hour period. However, seldom if ever would such ideal conditions be experienced and therefore these flow requirements require adjustment. Several factors that may increase the actual quantity of flow needed include the probability that many animals may drink from the stream at the same time, the water in the stream must be deep enough to allow the livestock to drink, and adequate flow and velocity are necessary to prevent freezing during the winter. Another important consideration in determining recommended flows to accommodate livestock watering is the availability of pools in a stream for drinking during periods with little or no flow.

Flow Regimes

Considering all of the above factors associated with livestock watering, it is estimated that flows of 0.1 to 1.0 cfs, depending upon the number of livestock and degree of confinement, would be adequate to meet livestock watering needs on Nebraska streams.

Flows of 0.1 and 1.0 cfs were exceeded no less than ninety-nine percent of the time on twenty gaged streams during the period 1969-78. Therefore, it would seem that few livestock watering problems exist. However, most of the complaints of inadequate flow for livestock watering have concerned small ungaged streams. No flow data are available for the small tributary streams, but it is probable that flows of these streams occasionally have become inadequate for livestock watering.

AQUIFER RECHARGE

Methodology

Several methods can be used to estimate the amount of streamflow that moves through a stream's bed into the groundwater system in losing stream reaches. The relationship between aquifer recharge in losing stream reaches and the amount needed to maintain the water table at a certain level is not well understood, however. In addition, the methods do not indicate what flow regimes are necessary to maintain the water table at a certain level.

The Lincoln and Omaha well fields along the Platte River derive nearly all of their supply from the Platte River via induced infiltration. Consultants for the City of Lincoln have utilized a computer hydrologic method for developing flow requirements for recharge of the groundwater reservoir at its Ashland well field.[75]

Flow Regimes

Table 29 shows the City of Lincoln water withdrawals[76] and estimates of the flows required to recharge the aquifer.[77] During the period 1969-78, the flows required to recharge the aquifer were exceeded 100% of the time.

SUBIRRIGATION

Methodology

Subirrigation of pasture land and alfalfa is known to occur in the central Platte River valley. The degree to which groundwater pumping and periods of low or no flow will affect subirrigation in the Platte valley is difficult to estimate and will depend upon the exact location being studied.

Methods used to determine aquifer recharge would appear to have potential application for determining flows for subirrigation. However, due to factors such as groundwater inflow to valley aquifers from adjacent uplands, groundwater pumping, and evapotranspiration, the relationship between streamflow and subirrigation is very much open to question and can only be determined by extensive studies that include detailed data collection.

Flow Regimes

No seasonal flow regimes can be proposed, due to the lack of understanding regarding the relationship between streamflow and subirrigation.

NAVIGATION

Methodology

Commercial navigation requires a minimum channel depth for tugboats and barges to navigate. A certain streamflow, in turn, is required to maintain the minimum channel depth.

Flow Regimes

Table 30 lists the flow regimes considered by the Corps of Engineers to be adequate to provide for the minimum

and full service levels of navigation at Sioux City, Omaha, and Nebraska City during the navigation seasons.[78] In addition, the percent of time the flows were exceeded is also shown.

In Nebraska, navigation occurs on the Missouri River below Sioux City. A navigation channel 300 feet wide and 9 feet deep is authorized with a navigation season normally extending from March 15 to December 5 at Omaha.

WILDLIFE

Methodology

Formal methods for developing flow recommendations for wildlife have not been developed. The methods which result in flow regimes with flat or stepped hydrographs similar to the Tennant, Modified Tennant, and Single-cross method are not adequate to provide high flows for channel habitat maintenance. Until such time as detailed models are developed recommendations for flows to sustain wildlife will need to be developed on a case by case basis.

Flow Regimes

Flows required to meet wildlife needs vary according to the water requirements of each species. The needs of wildlife relate to both direct and indirect water requirements.

Table 28: Flow requirements to meet the installed generating capacity of Nebraska's onstream hydroelectric plants.

Plant	Location	Stream	Flow required (cfs)	Percent of time required flow was exceeded (1969-78)
Blue Springs[69]	Blue Springs	Big Blue River	643	23.2
Spalding[70]	Spalding	Cedar River	148	46.0
Pierce[71]	Valentine	Minnechaduza Creek	116	1.1
Valentine[72] (Cornell)	Valentine	Niobrara River	1,272	1.2
Spencer[73]	Spencer	Niobrara River	1,936	13.9

Table 29: Flows required to recharge the aquifer of the City of Lincoln's Ashland well field.

Month	Average daily pumpage (gallons)	Mean flow required to recharge the aquifer (cfs)	Mean flow at North Bend (cfs)
Sept. 1979	44,950,402	116	1,250
Oct. 1979	32,844,859	62	1,624
Nov. 1979	23,669,129	62	3,495
Dec. 1979	23,152,933	62	4,913
Jan. 1980	22,798,319	62	3,040
Feb. 1980	23,219,588	62	5,255
March 1980	23,113,994	62	8,828
April 1980	27,729,531	62	10,250
May 1980	39,148,930	62	8,839
June 1980	47,545,219	116	807
July 1980	60,803,366	116	921
Aug. 1980	45,407,685	116	1,146

Table 30: Flows required for navigation on the Missouri River.

Location	Minimum service flow (cfs)	Percent of time during navigation season minimum flow exceeded (1969-78)	Full service flow (cfs)	Percent of time during navigation service flow exceeded (1969-78)
Sioux City	25,000	83.7	31,000	74.5
Omaha	25,000	96.6	31,000	82.2
Nebraska City	31,000	97.8	37,000	90.2

Direct water requirements include water for drinking and living space. Living space is normally most important for satisfying security needs. As an example, sandhill cranes have a direct need for water as a roosting habitat during spring staging which occurs in the central Platte River valley. Flows required to maintain roosting areas can best be determined by field observation. It is believed that flows in sufficient quantity to cover the stream bottom a few inches would be adequate. The need is highly seasonal, from approximately mid-February to mid-May each spring. Most Nebraska wildlife do not require open water for drinking since the foods they eat provide sufficient liquids. However, wild turkey and mourning doves are among those species that require open water for drinking and their distribution is controlled by its availability.

Roosting sandhill cranes – Platte River

Indirect water needs include flows to provide for habitat maintenance. Least terns require open sand bar habitat for nesting. Natural maintenance of these sand bars is accomplished by flow regimes that prevent the establishment of vegetation. Sandhill cranes also require open areas of shallow water for roosting. One means of maintaining this condition is by periodic high flows.

Two studies recently have been conducted to determine the streamflow regimes necessary to maintain wildlife habitat along specific reaches of the Niobrara and Platte Rivers. The Niobrara River Whooping Crane Habitat Study was an interdisciplinary study conducted between November 1979 and March 1981 to investigate physical and biological factors that produce and maintain habitats used by migrant whooping cranes on the Niobrara River. The study was initiated by the U.S. Bureau of Reclamation (Water and Power Resources Service) to gather information for use in formal consultation with the U.S. Fish and Wildlife Service regarding the potential effects of construction and operation of the proposed Norden Dam on whooping crane habitats of the Niobrara River. Minimum flow criteria were developed in the study to identify and quantify the principal controlling factors that maintain open channel habitat for roosting cranes and wetland habitat for feeding cranes. The resulting flow regime and accompanying rationale are provided in Table 31. The percentage of the time these recommended flows were exceeded (at the Norden gage) during the period 1969-78 also is shown in the table. This recommended flow regime was altered only slightly during the formal consultation between the Bureau of Reclamation and the Fish and Wildlife Service.[79]

In the other study, the U.S. Geological Survey (USGS) has determined that certain streamflows during the period May through August are most important in maintaining existing habitat conditions along the Platte River in central Nebraska.[80] This finding is based on the fact that plant germination begins in early May and can last through August. The USGS has concluded that flows of 3,800 cfs at Overton should occur a minimum of six percent of the time (eight days) during the period May through August in order to maintain the existing habitat conditions. During the period 1969-78 flows of 3,800 cfs at the Overton gage were exceeded 13.1% of the time during this period.

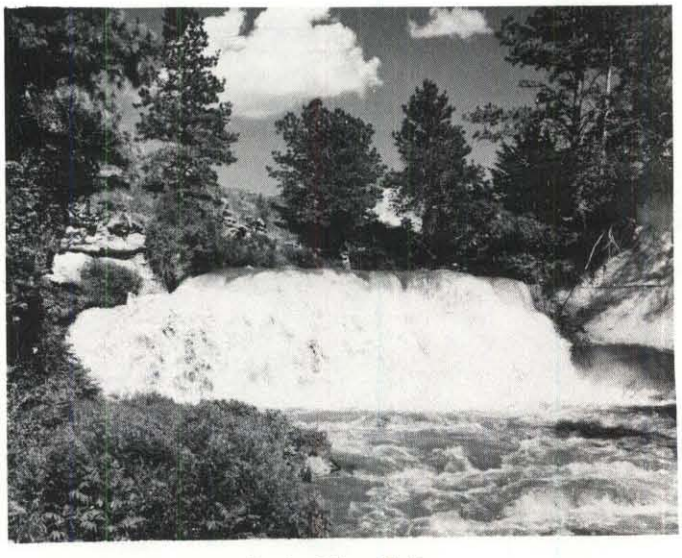
AESTHETICS

Methodology

Flows required to maintain the aesthetic values of Nebraska rivers must be determined on a case by case basis, according to the features that contribute to the aesthetic importance of each river.

Flow Regimes

The scope of this study does not enable a review of flows required to maintain the aesthetic values on Nebraska streams. However, observation of Snake River Falls by an area resident indicates that seepage flow of 15 cfs from Merritt Reservoir plus a release from the reservoir of 15 cfs (total of 30 cfs) would be adequate to maintain aesthetic values. During the period 1969-78 flows at Snake River Falls exceeded 30 cfs sixty-five percent of the time. The flow is less than 30 cfs primarily during July, August and September.



Snake River Falls

WILD AND SCENIC RIVERS

Methodology

Formal methodologies for determining flow requirements for wild and scenic rivers have not been developed.

Table 31: Recommended minimum flow regime to maintain whooping crane habitat on the Niobrara River.

Month	Minimum flow (cfs)	Percent of time flow exceeded (1969-78)	Rationale
January	400	99.0	Ice formation period. Recommended flow is sufficient to cover river channel with shallow water, allowing extensive ice coverage. Decreased flows, in comparison to historical record, indicate greater probability of ice formation.
February	400	98.6	Same as January.
March (1-25)	1000	38.7	Period of ice break-up. Important period for shifting of thalweg and scouring of river channel. Relationships between scouring "force," river flow, and ice coverage are not well understood, so approach is to maintain historic conditions during this critical period.
March (26-31)	500	99.4	Crane use period. Recommended flow increases available submerged sandbar habitat in comparison to historic flows. Approximately seventy eight percent of open channel is available as crane habitat.
April	500	100.0	Same as March 26-31.
May	500	100.0	First week is end of crane use period. Remainder of month is seed shed and seed germination period. Recommended flow is sufficient to cover about ninety three percent of open channel with water. This assures that there will be a minimum area of unsubmerged sandbar on which seeds could germinate.
June (1-15)	500	97.3	Same as May.
June (16-30)	100	100.0	End of seed germination period. Flows reduced to arbitrary level of 100 cfs. This flow is sufficient to maintain overall braided character of stream. Aquatic habitats should be maintained.
July	100	100.0	Same as June 16-30.
August	100	100.0	Same as July.
September (1-15)	100	100.0	Same as July.
September (16-30)	500	89.7	Crane use period. Recommended flow increases availability of submerged sandbar habitat in comparison to historic flow. Approximately seventy eight percent of open channel is available crane habitat.
October	500	98.4	Same as September 16-30.
November (1-15)	500	98.0	Same as October.
November (16-30)	100	100.0	River is essentially passive in terms of processes (vegetation encroachment) which control availability of crane habitat. Flow is sufficient to maintain braided stream and aquatic habitat.
December	100	100.0	Same as November 16-30.

Flow Regimes

The designation of a stream as a wild and scenic river in either a state or federal system would necessitate establishment of flow regimes on a case by case basis. The regimes would be keyed to protect those various activities such as recreation, aesthetics and fish and wildlife values for which the stream was designated.

WATER QUALITY

Methodology

Water quality and water quantity are interrelated. As streamflow decreases many water quality characteristics are impaired.[81]

The methods available for determining the amount of streamflow required to maintain certain levels of water quality include use of the 7-day 10-year low flow and the application of surface water quality computer models.

The 7-day 10-year low flow is the average low flow for seven consecutive days that is expected at a frequency of once every ten years. Although normally viewed as the minimum flow for water quality maintenance, the 7-day 10-year low flow is an arbitrary criterion selected for administrative purposes to establish a flow level at which Nebraska Water Quality Standards for Surface Water cease to apply. As such, the 7-day 10-year low flow is not a specific amount of flow, that if met, will insure the maintenance of acceptable water quality. However, the 7-day 10-year low flow can readily be determined for any stream for which there is a continuous discharge record.

The other means to determine the streamflow required to maintain water quality are surface water quality computer models, including the Dosag-I Model, Qual-I Model, Qual-II Model, Arkansas Wasteland Allocation Modeling, Middlesex County New Jersey Low Flow Model, and the Hydrologic Simulation Program - Fortran. These models are capable of computing the amount of streamflow augmentation needed to bring water quality parameters such as dissolved oxygen, dissolved solids, etc., to pre-specified target levels to meet water quality standards. These models differ in the number of water quality parameters they can simulate, the amount of data required, and the cost of use.

Flow Regimes

The 7-day 10-year low flows for twenty streams having continuous discharge gaging stations are listed in Table 32.

The 7-day 10-year low flow is computed from annual values of the lowest 7-day flow and no distribution is made as to the most likely month or season in which the lowest 7-day flow could occur. The percent of time that streamflow exceeded the 7-day 10-year low flow is also shown.

Swimming in a Nebraska river

Table 32: 7-day 10-year low flows of twenty selected streams.

Stream	7-day 10-year low flow (1969-78)	Percent of time that flow exceeded 7-day 10-year low flow (1969-78)
White River (at Crawford)	7.5	99.9
Niobrara River (near Norden)	396.0	99.3
Long Pine Creek (near Riverview)	93.0	99.5
Bazile Creek (near Niobrara)	1.5	99.5
Elkhorn River (near Norfolk)	54.0	99.5
Omaha Creek (near Homer)	1.8	99.3
West Fork Big Blue River (near Dorchester)	21.0	99.5
Rock Creek (near Ceresco)*	1.2	99.7
North Fork Big Nemaha River (near Humbolt)	2.0	98.9
Little Blue River (near Fairbury)	55.0	99.8
Thompson Creek (at Riverton)	14.0	99.9
Republican River (near Guide Rock)	0.8	99.7
Cedar River (near Spalding)	87.0	99.3
North Loup River (at Ord)	274.0	99.6
Dismal River (near Thedford)	166.0	99.5
Medicine Creek (above Harry Strunk Lake)	16.0	99.8
North Platte River (at Bridgeport)	307.0	99.8
Ninemile Creek (near McGrew)	58.0	99.7
Platte River (at North Bend)	192.0	99.6
South Platte River (at North Platte)	94.0	99.7

*Period of record is nine years; 1970-71 through 1978-79.

Chapter 4

Introduction to Alternative Instream Flow Policies

A purpose of this chapter is to describe briefly those efforts being made to maintain instream flow values in other states. Iowa, Kansas, Colorado, Wyoming, and South Dakota were chosen for more detailed description because their programs are fairly representative of the variety of approaches taken to the problem of maintaining instream flows. In addition, climatic conditions in parts of these states are similar to conditions in Nebraska.

Another purpose of this chapter is to provide an introduction to the alternative instream flow policies proposed in succeeding chapters for consideration by the Nebraska Legislature. An explanation of how the impacts for the alternatives were determined is also included.

INSTREAM FLOW POLICIES IN SELECTED STATES

Western States

Laws regulating the use of surface water were developed in most of the western states during the relatively early years of settlement. These laws were designed primarily to promote the economic growth of the region by facilitating the out-of-stream use of water for irrigation and mining. With the exception of hydroelectric power production, instream uses were largely ignored by those formulating these laws. More recently however, legislative and/or administrative efforts have been made in most of these states to prevent the loss of important instream flow values.

Alaska, California, Colorado, Idaho, Kansas, Montana, Nevada, Oklahoma, Oregon, South Dakota, Utah and Washington are western states in which legislative or administrative efforts to provide some form of protection for certain instream uses have been made.[82] Although actions to protect some instream uses have been taken in all of these states, the extent of these efforts and the approaches used differ greatly.

In Nevada, instream appropriations can be made for stock watering and a few have been allowed for fish and wildlife.[83] Utah law authorizes the administrator to deny new appropriation permits if public recreation or the natural stream environment would be affected adversely by granting a permit. This provision has been of little use in maintaining instream flows, because most of the water in Utah's streams was fully appropriated prior to passage. However successful efforts have been made in parts of the state to maintain instream flows through the use of stored water.[84] In Oklahoma, efforts to protect instream flow values are carried out primarily through the use of the state's Scenic Rivers Act.[85]

In contrast, the states of California, Washington, and Oregon have very extensive, long standing programs.[86] Alaska, Idaho, and Montana also have adopted policies of reserving or appropriating natural flows for fish, wildlife, recreation, aesthetics, and water quality maintenance. However, they have been applied to fewer streams than in Oregon, Washington, or California.[87]

States Surrounding Nebraska

The laws of five states surrounding Nebraska contain differing measures for the protection of some instream flow values.

IOWA

Since 1957, most major surface water users in Iowa have been required to obtain permits from the Iowa Natural Resources Council. Except for storage permits granted for the life of the structure, all permits are issued for a term not to exceed ten years. Upon receiving an application, the Council is required to determine whether the proposed use of natural flow will have an adverse effect on water quality, fish, wildlife, recreation, and other public rights.[88] A water use permit may be issued only if the "established average minimum flow" is preserved. The "established average minimum flow" or "protected flow" as it is most often referred to, is that amount of flow determined to be necessary to protect the public interest and specific instream uses. The instream uses provided for are fish, wildlife, recreation, waste assimilation, and aesthetics.[89] In addition, no water use that will impair the state's pollution control laws or the navigability of any navigable stream can be authorized.[90]

Protected flow levels have been established on approximately seventy Iowa streams.[91] With the exception of domestic and municipal users, surface water users on these streams must cease their diversions when streamflow reaches the protected flow level.[92] In addition, withdrawals of groundwater from wells within one-eighth mile of a protected stream are considered withdrawals from the stream and must also be discontinued when streamflow falls to the protected flow level. Withdrawals from wells located between one-eighth and one-fourth mile of protected stream may also be restricted if the flow reaches the 7-day

10-year low flow level; a level of flow lower than the protected flow. These restrictions on groundwater use have not been applied to holders of groundwater use permits issued prior to 1978.[93]

Instream flow values in Iowa also may be protected by the designation of "natural rivers" under a law passed by the legislature in 1970. This act authorizes the Iowa Conservation Commission to include river reaches that possess outstanding water conservation, fish, wildlife, scenic, historic, or recreational values in a state-administered system of protected natural rivers. In addition, the Commission is to include any lands adjacent to the stream if those lands are necessary for preservation and management of the natural river reach.

Before a river may be included in the natural rivers system, public hearings must be held and a plan for the development and management of the river reach prepared. After the river reach has been officially designated, political subdivisions with zoning jurisdiction over any lands included in the natural river area may establish land use regulations if necessary to preserve the values for which the river was designated.[94]

As of May 1980, only one stream reach had been included in the natural rivers system. This is an eighty mile segment of the Upper Iowa River in the northeastern corner of the state.[95]

KANSAS

In 1963 the Kansas Legislature directed the State Water Resources Board (recently renamed the Kansas Water Office) to prepare a comprehensive state water plan. This plan was to establish long range goals for the conservation, management, and development of the state's water resources. In formulating the plan the board was instructed to give consideration to methods for protecting aquatic and other wildlife and for augmenting streamflow for fish, wildlife, and the maintenance of water quality.[96] The act provided that after portions of the plan or revisions were prepared by the board, they were to be submitted to the legislature for approval before any recommendations, policy statements, or other contents became official.[97]

In 1980 the board was authorized to determine "minimum desirable streamflows" for any watercourse in the state as part of these water planning efforts. A proposal for establishing a minimum streamflow level is then to be submitted to the legislature for official approval before they can become effective.

Upon approval by the legislature, the state water rights administrator is required to withdraw from appropriation the amount of water determined to be necessary to maintain the minimum desirable streamflow. In addition, when determining whether approval of an application for a new appropriation permit is in the public interest, the water rights administrator is to take into consideration whether a minimum streamflow level has been established for the stream in question and may deny or condition the permit to ensure streamflow is not reduced below the minimum flow level.[98] Because these provisions were enacted into law recently, no minimum desirable streamflows have been established. However, efforts to determine these levels for a few key streams are underway.[99]

Efforts also are underway to execute agreements between Kansas officials, the Corp of Engineers, and the Bureau of Reclamation regarding use, for maintenance of instream flow, of water stored in federally operated reservoirs. The Kansas Governor's Task Force on Water Resources identified fourteen storage facilities in which some of the stored water supply has been specifically allocated for instream flow releases to preserve aquatic life and water quality. Although informal agreements for temporary releases of water from some of these facilities have been made in the past, recent efforts have been directed at executing more formal agreements under which the Kansas Division of Water Resources will police streams into which stored water is released to insure that the releases are not diverted.[100]

COLORADO

In 1973, the Colorado Legislature authorized the State Water Conservation Board to appropriate natural flow for the instream use of water for fish, wildlife, aesthetics, and recreation.[101] Pursuant to this authority, as of May 1980, the board had obtained instream flow appropriations for 3,500 miles of streams in Colorado.[102]

The level of flow needed to maintain instream uses is determined by the board with the assistance of the Division of Wildlife and the Division of Parks and Recreation. After an instream flow appropriation is approved and its priority date established by a state water court, diversions by appropriators with priority dates junior to the instream flow right can be restricted, if necessary, to protect instream uses.[103]

In addition, restrictions can be imposed on certain groundwater users if their withdrawals will impair an instream flow right. Under Colorado law, groundwater use is subject to the doctrine of prior appropriation and well owners are assigned priority dates as of the date their use was initiated. Groundwater that will take less than 100 years to affect the rate of flow in a stream is considered tributary to the stream and well owners who withdraw tributary groundwater are regulated as though they were appropriators of water from the surface stream.[104] Therefore, a user of tributary groundwater with a more recent priority date than an instream flow right could be ordered to stop withdrawing groundwater if this use was having an adverse affect on the instream flow right.[105] However, groundwater withdrawals would not be regulated if it would not result in an increase in streamflow soon

Another means of protecting instream uses in Colorado is through the purchase of existing rights to appropriate natural flow. Such sales are permissable under Colorado law[107] and the Water Conservation Board and Division of Wildlife have successfully negotiated purchases of existing rights for out-of-stream uses and converted them to instream flow rights. Although the costs are high in some cases, e.g., $18,000 for a small water right on Boulder Creek near the city of Boulder, this strategy has been used to increase the flow of streams that are fully appropriated.[108] Once a right is purchased for instream flow maintenance, holders of appropriative rights with priority dates that are junior to the instream flow right can be regulated for the benefit of instream uses.

WYOMING

Wyoming law contains a few provisions expressly providing for the protection of instream uses. With one

exception, to be discussed later, the underlying policy is that instream flow needs can best be met through management of the water resource and the use of stored water. This philosophy generally has been followed by the state's administrative agencies in their efforts to protect instream flow values.

The Wyoming Water Development Commission is responsible for the state's water development program. The Commission selects water resources projects to be studied for their feasibility and the desirability of including them in the water development program. Feasibility studies must be prepared for each project selected and these studies are to include the identification of prospective needs and opportunities for supplying stored water to maintain instream flows.[109] Pursuant to this statutory requirement, the Commission has taken instream flow needs into consideration in the planning for two projects on the Tongue and Cheyenne rivers.[110]

In 1979, legislation requiring the protection of instream flow values downstream from the Little Snake River Project was enacted. This project involves a number of stages and includes the diversion of water from one river basin to another. The legislature required that in determining the in-basin needs of the Little Snake River, instream flow requirements for fish, wildlife, and recreational purposes must be protected.[111]

Although it was not the result of specific legislative direction, action taken by the Wyoming Game and Fish Department to improve instream flows below Kortes Dam on the North Platte River provides an example of how stored water is used to maintain instream flows in Wyoming. Before the construction of the Kortes Reservoir, the stream reach below the dam maintained a good trout fishery. Once the Kortes hydroelectric power plant began operating, fish kills due to the shutdown of the power plant would occur frequently. In 1962, the Wyoming Game and Fish Department, with the assistance of the U.S. Fish and Wildlife Service, convinced the Bureau of Reclamation to conduct field studies to determine the flow regimes necessary to maintain the fishery. The result of these studies was a recommendation that the Bureau modify the operation of the facility to provide a continuous flow of at least 500 cfs in the reach between the Kortes Dam and Pathfinder Reservoir. A feasibility study analyzing the benefits, costs, revenues, and cost allocations for the project with and without the fishery flow revealed that the cost-benefit ratio of the project increased if fishery flows were provided. In 1971, legislation authorizing the 500 cfs releases received congressional approval.[112]

An exception to the general policy of using stored water to meet instream flow needs is contained in a statute dealing with instream stockwatering. In 1975 the Wyoming Legislature authorized the state engineer, when granting new surface water rights, to require that sufficient flow be allowed to pass downstream to meet reasonable demands for instream stock use.[113]

SOUTH DAKOTA

South Dakota law contains a number of statutory provisions authorizing the State Water Management Board to control the development and use of the state's surface water.[114] The board is to ensure that the use of water for private purposes does not affect the public interest adversely.[115] Pursuant to this authority, the Water Management Board has subjected certain recently issued appropriation permits to restrictions designed to protect the instream use of water for fish and wildlife. These restrictions have been placed in permits for the use of water from the James River. They prohibit certain water users from diverting water when the flow reaches the level determined by the board to be necessary for the protection of fish and wildlife.[116]

In addition, South Dakota law provides for the protection of instream values by designating reaches of especially valuable rivers as wild, scenic, or recreational rivers. The Water and Natural Resources Board has been directed to cooperate with the Game, Fish, and Parks Commission, private groups, and individuals in identifying streams that possess unique natural beauty or have water conservation, fish, wildlife, and/or recreational values that should be preserved. With the assistance of any private sponsor, the Board is to prepare a management plan for any river reach it proposes to recommend for inclusion in the system. Recommendations of the board must be submitted to the governor and legislature and must be approved by the legislature before they become effective.[117]

ALTERNATIVE INSTREAM FLOW POLICIES FOR NEBRASKA

This section serves to introduce the thirteen alternative instream flow policies that will be discussed thoroughly in the remainder of the report. The alternatives were developed to provide the full array of choices available concerning the instream flow policy issue. No recommendation of any alternative is made. The alternative policies are:

1. Continue present policy.	The state's present policies regarding surface water flows for instream uses would remain unchanged. Issues on which the present law is unclear may be resolved by judicial or administrative interpretation.
2. Declare that natural flow permits may be issued for instream uses.	Present law is unclear as to whether natural flow appropriation permits may be issued for instream uses other than hydroelectric power production. This alternative would allow the Department of Water Resources to issue natural flow permits for such uses on stream segments that have significant instream flow values and unappropriated natural flow.
3. Prohibit the issuance of natural flow permits for instream uses other than hydroelectric power production.	If the legislature does not believe natural flow permits should be issued for instream uses other than hydroelectric power production, it could clear up the ambiguity in the existing law by declaring that natural flow permits are not to be issued for any other instream use.

4. Authorize the establishment of protected flow levels.	This alternative provides for establishment of protected flow levels for stream reaches having unappropriated natural flow and significant instream flow values. Subsequent permits to appropriate water above or within a stream reach for which a protected flow level had been established would be subject to regulation when streamflow falls to the protected flow level.
5. Prohibit the exercise of the director's discretionary authority as a means of protecting instream uses.	The director of the Department of Water Resources has authority to deny applications for new surface water rights and may also impose conditions on the exercise of newly issued rights if dictated by the state's public policy. Unsuccessful efforts have been made to persuade the director to use this authority as a means of maintaining instream flows but whether the director's authority may be so used is not clear under existing law. If the legislature does not believe the director's authority should be used to maintain instream flow, its use in this manner could be prohibited.
6. Provide for a state administered system of protected river reaches.	To preserve stream segments having especially valuable scenic, wildlife, fishery, or recreational values; a state-administered system of protected river reaches could be created by the legislature. If a stream reach was designated as part of the system, modification of the stream or associated lands would be prohibited if it would have significant adverse effects on the values being protected. The Department of Water Resources would be required to insert protected flow conditions in new permits as described in Alternative 4.
7. Declare that instream flow needs may be met through the use of stored water.	In many of the state's streams, natural flow is sometimes not available to meet instream flow needs. To improve instream flow conditions in these streams, natural flow could be supplemented by the release of surplus water stored in reservoirs. Any stored water released into a stream to maintain instream flows could not be diverted legally for use by other appropriators.
8. Prohibit the use of stored water for instream flow maintenance.	Present law does not explicitly authorize use of stored water to maintain instream flows. However, the Department of Water Resources has interpreted the law to allow the holder of a storage right to use stored water for any purpose, including streamflow maintenance. If the legislature does not feel it should be the policy of the state to allow stored water to be used for instream flow maintenance, its use for this purpose could be expressly prohibited.
9. Authorize the Department of Water Resources to reassign abandoned or unused natural flow permits for instream uses.	Presently a permit to appropriate water can be cancelled by the Department of Water Resources under certain circumstances. If the legislature authorized the issuance of appropriative rights for instream uses, if also could direct the Department of Water Resources to assign abandoned or unused natural flow rights, with the original priority date still in effect, to public and private entities to be used to maintain instream flows. This alternative would provide a means of improving conditions on streams in which the natural flow is fully appropriated at the present time.
10. Allow the voluntary transfer of natural flow permits for instream uses.	Another means of improving low flow conditions on streams that are already fully appropriated at times would be to allow the voluntary sale, lease, or donation of existing natural flow permits to a public or private entity that would use the permit to maintain instream flows. Whether this is permissible under existing law is open to question.
11. Prohibit the voluntary transfer of natural flow permits for instream uses.	If the legislature does not feel it should be the policy of the state to allow the transfer of natural flow permits as a means of maintaining instream flows, it could clear up the ambiguity in existing law by expressly prohibiting such transfers.
12. Declare that groundwater may be used to supplement natural flow to meet instream flow needs.	Low flows in stream reaches that are fully appropriated at times could be augmented by pumping groundwater into the stream when necessary to prevent damage to instream values. Use of this water by other users along the stream or stream segment would be prohibited.
13. Impose restrictions on the use of groundwater.	In some portions of the state, groundwater withdrawals may reduce the groundwater contribution to certain streams and affect instream uses adversely. To avoid or reduce this problem, the legislature could authorize the imposition of restrictions on groundwater use above or along stream reaches with significant instream flow values if studies show that groundwater pumping is reducing streamflow and impairing significant instream uses.

Not all of the alternatives are designed to extend legal protection or "recognition" to instream uses. Alternative 1 maintains existing state policy and is discussed in detail in Chapter 5. The other alternatives can be divided into two categories. Alternatives 3, 5, 8, and 11 are designed to clear up ambiguities in existing law by expressly prohibiting the use of particular "strategies" for maintaining instream flows. These alternatives are discussed in detail in Chapter 7. On the other hand, Alternatives 2, 4, 6, 7, 9, 10, 12, and 13 would permit certain actions to maintain flows in streams having significant instream flow values. Adoption of any one of these latter alternatives would constitute recognition of the beneficial nature of some, or all, instream uses. These alternatives are discussed in detail in Chapter 6.

Although Alternatives 2 through 13 can be divided into two categories, the adoption of one or more alternative from one category does not preclude the adoption of alternatives from the other category. For example, the legislature may determine that present state policies should be changed to allow the issuance of natural flow permits for some or all instream uses (Alternative 2). This action would preclude the adoption of only one alternative from the other category. This is Alternative 3 which would prohibit the issuance of natural flow permits for instream uses. Even if Alternative 2 was adopted, the legislature might wish to select one or more alternatives that prohibit the use of certain other "strategies" to protect instream flow values.

In addition, the adoption of an alternative from one category does not necessarily preclude the adoption of additional alternatives from the same category. It is very important to realize that instream flow problems differ from stream to stream as do the opportunities to prevent or rectify problems. For example, no instream flow problems have been experienced on certain stream reaches in the state. They presently have enough natural flow to supply water for out-of-stream uses in the area and still meet instream flow needs. Alternatives 2, 4 and 6 are designed to apply to this relatively small number of streams. These alternatives would provide for action to insure that the unappropriated natural flow in these streams does not become committed to appropriators who obtain natural flow permits in the future. However, adoption of one of these alternatives would do little, if anything, to ensure a water supply for instream uses in the majority of the streams in the state because in most years their natural flow is committed to holders of existing appropriative rights. If the legislature determines that action to maintain instream uses in these streams is necessary, adoption of one or more of Alternatives 7, 9, 10, 12, or 13 would be necessary. On the other hand, if state action to protect instream uses is to be prohibited, adoption of Alternatives 3, 5, 8, and 11 would be appropriate.

DESCRIPTION OF IMPACT ANALYSIS

Chapters 5, 6, and 7 present the impact analysis for each of the thirteen policy alternatives contained in this report. In this chapter, the following discussion describes the approaches used to identify and evaluate the hydrologic, environmental, social-economic, administrative, and legal impacts.

For each impact area, the methods used to determine the impacts, the scope of the impact analysis, and the degree of the impacts are described. In the case of hydrologic impacts, data regarding streamflow characteristics, and water use is presented and serves as a basis for the other impacts that follow. Impacts associated with the policy alternatives were generally described on a stream specific basis. However, the administrative and legal impacts were described on a statewide basis. The hydrologic, environmental, and social-economic impacts used the same selected streams to illustrate impacts. Different streams were used for different alternatives.

Hydrologic Impacts

Hydrologic impacts can be defined as changes in the flow regime of a streams. Changes in quantity and/or duration of low flow is especially important.

The hydrologic impacts associated with the thirteen alternative policies have been developed on a site-specific basis. Eleven selected streams were used as examples in this analysis. These streams vary widely in terms of streamflow characteristics, degree of commitment to existing water rights, the availability of undeveloped adjacent irrigable lands, and the instream values associated with them. Estimates of future flows were made by persons familiar with flow conditions of the selected streams. These estimates were later used for the determination of environmental and social-economic impacts. The eleven streams illustrate the difficulty of making general statements on statewide impacts on flows.

The eleven streams are described individually below. Other streams on which the alternatives would have similar impacts are identified and thus provide a better picture of how the various alternatives would affect other streams (and areas) in the state. The eleven streams are:

LONG PINE CREEK (near Riverview) – This stream, a tributary of the Niobrara River in north central Nebraska, originates on the northern margin of the Sandhills region. Since groundwater discharge comprises much of its flow, this stream exhibits a relatively uniform flow regime throughout the year. Its average discharge at this location (for thirty years of record) is 137 cfs, and its minimum daily flow was 44 cfs recorded on January 10, 1963. Long Pine Creek supports a highly valued trout fishery and it flows through a state recreation area and a state wildlife management area. The stream also is used by wildlife, for livestock watering, and has high aesthetic value.

Existing water rights for irrigation total approximately 21 cfs and little additional development is expected in the near future (five years) because (1) the stream flows in a deeply incised and narrow valley and (2) the adjacent table lands generally have adequate surface water available from the Ainsworth Irrigation Project and/or have groundwater available for irrigation.

Some other tributaries of the Niobrara River are similar to Long Pine Creek regarding their flow characteristics and instream values. In addition, a significant portion of their base flow is not committed to existing water rights and little demand for out-of-stream diversions is anticipated along them in the near future. These streams, in downstream order, include Pine Creek, Deer Creek, the Snake River below Merritt Reservoir, Minnechaduza Creek, Fairfield Creek, and Plum Creek.

PLATTE RIVER (at North Bend) – The flow of the Platte River at this location is affected greatly by upstream water resources developments. The average discharge of the

Platte River at North Bend (for thirty years of record) is about 4,000 cfs and its minimum daily flow was 36 cfs recorded on July 29, 1974. During water year 1979 the Loup River contributed approximately sixty percent of the flow of the Platte River at North Bend. During the summer much of the flow of the Platte River at North Bend reaches the Platte via the Loup Power Canal. In this reach the Platte River supports a significant warm-water fishery and provides important waterfowl and furbearer habitat. It is important for recreational activities, e.g., swimming and canoeing, because of its proximity to urban population centers and also has high aesthetic value. In addition, the Platte River is important for aquifer recharge in this reach as the cities of Fremont, Lincoln, and Omaha have well fields along it. Many irrigation wells tap the valley aquifer as well.

Because precipitation generally is adequate and groundwater supplies are ample, little surface water development has occurred along this reach of the Platte River. Although little additional development is anticipated along this reach in the near future, the flow of the Platte River at North Bend could be depleted significantly by upstream developments, especially in the Loup River Basin. Severe summertime depletions would be possible. Despite this possibility, concern that flow will be depleted enough to reduce aquifer recharge in the North Bend vicinity or at any downstream location may be unwarranted since floods still are likely to occur and total stream discharge still is much greater than what can be lost wholly to seepage.

The lower portion of the Elkhorn River is somewhat similar to the lower Platte River in terms of size, flow conditions, and instream values other than aquifer recharge. However, its flow is not affected by large upstream water resources developments and, therefore, less marked streamflow depletions are anticipated along it in the near future.

LITTLE BLUE RIVER (near Fairbury) – The Little Blue River's flow in the vicinity of Fairbury is highly variable although groundwater discharge to it is significant. The average discharge of the Little Blue at this location (for fifty eight years of record) is 370 cfs. The recorded minimum daily flow was 14 cfs on November 22, 1929, but the dry weather flow always has been greater than 30 cfs. The lower portion of the Little Blue River supports an important warm-water fishery and some recreational activities such as swimming and canoeing.

Many water rights for irrigation have been acquired on the Little Blue River and its tributaries. This development has resulted in significant depletion of the river's flow during some summers. In August of 1978 the river ceased to flow in central Thayer County, approximately thirty miles upstream from Fairbury. Most valley lands in the basin suitable for irrigation already have been developed, through use of either surface water or groundwater. However, additional applications for rights to divert water from the Little Blue for irrigation could be made in the future and result in additional depletion of the Little Blue River's summertime flow.

Many streams in north central and eastern Nebraska are similar to the Little Blue River at Fairbury in terms of present commitment to existing water rights and the potential for additional water right applications to divert water from them in the near future. The base flows of these streams are not fully committed to existing water rights but they could become fully committed if a few more water rights are acquired on them. These streams include Eagle Creek, Steel Creek, Verdigre Creek, Bow Creek, Omaha Creek, the North Fork Elkhorn River, the lower portion of Logan Creek, Wahoo Creek, Salt Creek, the lower portion of the Big Blue River, and the Big Nemaha River. Depletions of summertime flow could progress to the point that periods of no-flow could occur at some locations.

NINEMILE CREEK (near McGrew) – This stream, a tributary of the North Platte River in Scotts Bluff County, has relatively constant flow. Originally intermittent, it became perennial following construction of irrigation canals in the area. Groundwater seepage and irrigation return flows now account for most of the stream's flow. The average discharge of Ninemile Creek near McGrew (for fourty-seven years of record) is 119 cfs and its minimum daily flow was 24 cfs recorded on July 5, 1961 and May 13, 1962. The stream supports a highly valued trout fishery which includes rainbow trout that migrate to and from Lake McConaughy.

Owing to the availability of project irrigation water in the Ninemile Creek basin, only one water right has been acquired to divert water from the stream. However, the flow of Ninemile Creek is committed to existing water rights on the North Platte and Platte rivers. These downstream rights serve to maintain the existing flow conditions of Ninemile Creek since they would be senior to any new appropriations. Few, if any, additional water rights are expected on Ninemile Creek in the near future.

Several other streams in Nebraska are similar to Ninemile Creek in terms of present commitment to downstream water rights and since there is little potential for additional water rights to be filed on them. Additional rights would be junior to existing downstream rights and therefore would have little effect on present streamflow characteristics. These streams include Sheep Creek, Tub Springs, Birdwood Creek, the Big Blue River above its confluence with the West Fork Big Blue River, North Branch Verdigre Creek, the South Fork Big Nemaha River, and Stinking Water Creek.

NIOBRARA RIVER (from mouth of Antelope Creek downstream to upper end of the proposed Norden Reservoir) – The Niobrara River in this reach has a relatively constant flow that is maintained by groundwater discharge. At the Sparks gage, the river has an average discharge (for thirty-four years of record) of 778 cfs and its recorded minimum daily flow was 100 cfs on January 10, 1957. Dry weather flows are generally above 400 cfs. In this reach the Niobrara River supports only a marginal fishery but does provide exceptional recreational opportunities. Canoeing is very popular and the river's aesthetic value is high. Many species of wildlife also make use of the river.

Box Butte Reservoir, which stores water for irrigation is upstream from this reach and Merritt Reservoir, which stores irrigation water, is on the Snake River a tributary of this reach. A hydroelectric dam is located on this reach. Because diversions from the river withdraw only a minor portion of the river's flow at the present time, much of the river's flow is not committed to existing water rights. Due to the scarcity of land suitable for irrigation in the incised river valley and the availability of groundwater for irrigation of adjacent tablelands, few applications to divert water from this reach of the Niobrara are anticipated in the near future. However, additional applications along the Niobrara below this reach are expected and their cumulative effect could be a significant depletion in the summertime flow of the lower portion of the Niobrara River.

The Niobrara River from the upper end of the proposed Norden Reservoir to the river's mouth is similar in terms of instream flow values and degree of commitment to existing water rights. Though smaller, the Snake River below Merritt Reservoir and the reach of the Niobrara River from the Dunlap Diversion Dam to Antelope Creek are also somewhat similar.

DISMAL RIVER (from its headwaters to its mouth) – The Dismal River is located entirely within the Sandhills region and its flow is quite uniform throughout the year. Although the river's flow is increased occasionally by overland runoff, most of the flow results from groundwater discharge. At Dunning, the Dismal River's average discharge is 322 cfs and its recorded minimum daily flow was 100 cfs on January 25, 1950 and January 9, 1962. Dry weather flows are generally above 300 cfs. The Dismal River supports a trout fishery in its upper reaches and is one of the most popular streams for canoeing in the state. Its aesthetic value is high and significant wildlife use and livestock watering also occur along the river.

Due to the scarcity of land suitable for irrigation in the river's valley, very few water rights have been acquired on the Dismal. However, the river's flow is entirely committed to downstream rights on the Middle Loup and Loup River for irrigation and power production purposes. Few, if any, additional water right applications are anticipated on the Dismal River. Any rights granted in the future would be junior to existing rights downstream and thus would have little effect on the flow characteristics of the Dismal River.

The upper reaches of the Middle Loup and the North Loup rivers and the Calamus River are similar to the Dismal River in terms of flow characteristics, size, and instream flow values. The flows of the North Loup and Calamus rivers are not fully committed to downstream rights for irrigation, however, and therefore are more apt to be affected by additional water rights in the future.

NORTH FORK BIG NEMAHA RIVER (from headwaters to Humboldt) – The flow of the North Fork Big Nemaha River is extremely variable as groundwater discharge comprises only a small portion of its total flow. At Humboldt the stream's average discharge (for twenty-seven years of record) is 197 cfs and its recorded minimum daily flow was 0.07 cfs on July 22 and 23, 1977. The North Fork Big Nemaha River historically has supported a significant warm-water fishery. Limited recreational uses, e.g., wading and swimming, and some livestock watering also occur along the stream.

Many water rights for irrigation have been acquired on the North Fork Big Nemaha River and its tributaries. At present the quantity of flow committed to these rights exceeds the base flow of the river. Resulting depletions of summertime flow in dry years have been severe as evidenced by the minimum daily flow on record. Since additional valley lands that are suitable for irrigation are present and groundwater supplies generally are inadequate for irrigation, additional water right applications on the river and its tributaries are anticipated in the near future. However, these rights would be junior to existing rights and therefore would have little effect on the streamflow characteristics of the river.

Several streams in eastern Nebraska having base flows that are entirely committed to existing water rights, at least on a seasonal basis, are similar to the North Fork Big Nemaha River. These streams include the Little Nemaha River, Rose Creek, the West Fork Big Blue River, Bazile Creek, and Logan Creek above the Lyons vicinity.

REPUBLICAN RIVER (from Harlan County Dam to Guide Rock) – The flow of the Republican River in this reach varies greatly in response to the operation of Harlan County Dam and Reservoir. During impoundment of all inflow to the reservoir, flows in this reach are low. On the other hand, large releases are made during the summer for the irrigation of crop land downstream from the dam. Much of the water released is diverted above Guide Rock by the Courtland Diversion Dam. The average discharge of the Republican River at Guide Rock (for twenty-nine years of record) is 354 cfs and its minimum daily flow was 0.1 cfs recorded on May 26, 1964. This reach of the Republican River supports a limited warm water fishery and provides good canoeing during the summer when releases are made from Harlan County Reservoir.

Nearly all of the summertime flow of the Republican River in this reach is committed to existing water rights for irrigation. The Courtland Diversion Dam serves the Bostwick Irrigation Project and numerous private pumps withdraw water from the river and its tributaries as well. Due to the lack of available streamflow, few additional water rights applications are anticipated in the near future. Those rights would have little effect on the present flow characteristics of the river as they would be junior to existing rights.

Frenchman Creek below Enders Reservoir, Red Willow Creek below Hugh Butler Lake, Medicine Creek below Harry Strunk Lake, the Republican River below Swanson Lake, the North Platte River below Lake McConaughy, and the Platte River above the Kearney Canal Diversion Dam are all similar to this river reach in that their flows are affected by upstream storage facilities and subsequent diversions for irrigation project purposes. Few additional water right applications on these reaches are expected to be filed in the near future.

CEDAR RIVER (from its headwaters to Spalding) – The flow of this reach of the Cedar River, located in the eastern Sandhills region, is quite uniform since it primarily consists mostly of groundwater discharge. Near Spalding, the Cedar River's average discharge (for thirty-one years of record) is 154 cfs and its recorded minimum daily flow was 30 cfs on January 30, 1946. The dry weather flow of the Cedar River near Spalding is generally greater than 100 cfs. This reach of the Cedar River supports a high value warm-water fishery and receives some canoeing use. It is also important for wildlife and for livestock watering and has high aesthetic value.

Relatively few water rights have been acquired on this reach of the Cedar River. Historically, ranching has been more prevalent than crop production in the area and in recent years most irrigation development has been with groundwater. Few additional water rights are anticipated to be filed on this reach of the Cedar River in the near future. Any rights that would be acquired would be junior to existing rights in the downstream reach of the Cedar River. Downstream rights currently exceed the baseflow of the river as the river ceased to flow near Fullerton for a short time during the summer of 1980.

Two other major streams in the Loup River Basin are generally similar to the upper Cedar River in terms of flow characteristics, degree of commitment to downstream rights, and low potential for additional water right applica-

tions on them in the near future. These streams are the South Loup River and Beaver Creek.

ELKHORN RIVER (near Norfolk) – The Elkhorn River rises in the northeastern margin of the Sandhills region. Groundwater discharge to the stream is significant but its flow is quite variable at Norfolk owing to the contribution of overland runoff after the river leaves the Sandhills region. The Elkhorn River at Norfolk has an average discharge (for thirty-four years of record) of 490 cfs and a minimum daily flow of 37 cfs recorded on August 30, 1976. Its dry weather flow is generally greater than 100 cfs. The river supports a significant warm-water fishery and some canoeing use occurs in the Norfolk vicinity. The stream reach is also important for wildlife and livestock watering.

Approximately 155 water rights have been acquired to divert flow from the Elkhorn River and its tributaries above Norfolk. These rights total approximately 100 cfs and have depleted the summertime flow of the river during dry years as evidenced by the minimum flow on record. At present the base flow of the Elkhorn River at Norfolk exceeds the quantity of flow committed to existing water rights. Additional water right applications can be expected along this reach in the near future since unappropriated flow and irrigable lands are both present. This development may be tempered, however, by some individuals choosing to irrigate with groundwater rather than surface water. Continued development of groundwater in the river valley may, in turn, decrease groundwater discharge to the stream.

Few, if any, other streams are truly similar to the Elkhorn River at Norfolk in terms of size, flow characteristics, degree of commitment to existing water rights, and potential for future water right applications. In regard to the last two factors, the stream reach is somewhere between Long Pine Creek and the Little Blue River.

THOMPSON CREEK (at Riverton) – The flow of Thompson Creek (Franklin County) is quite variable although a significant portion of it is due to groundwater discharge. The average discharge of Thompson Creek at Riverton (for seventeen years of record) is 30.3 cfs and its recorded minimum daily flow was 8.1 cfs on December 19, 1951. The stream supports a marginal trout fishery and livestock watering is important along the stream.

Only a few water rights have been acquired on the stream; however, the base flow of the stream is entirely committed to downstream senior rights for irrigation on the Republican River. Therefore, few additional water rights applications are expected to be filed on the stream in the near future as they would be junior to the downstream rights on the Republican River.

Several other tributaries of the Republican River are similar to Thompson Creek in terms of size, streamflow characteristics, instream flow uses, degree of commitment to downstream rights, and potential for future water right applications. These streams include Rock Creek, Indian Creek, Muddy Creek, Turkey Creek, Center Creek, and Elm Creek.

Environmental Impacts

The environmental characteristics of stream systems are often difficult to quantify. Values associated with some environmental features are impossible to describe in anything other than subjective terms. Although value and abundance may be interrelated, aesthetic values (nonmonetary) frequently increase as supply decreases.

Environmental impacts are identified when the quality or quantity of an environmental feature increases or decreases as a result of a particular alternative. Impacts were classified as positive or negative; and the degree of impact was designated as low, moderate, or high. No anticipated impact was also an option.

In assessing the probable impacts of the various alternatives, five general categories of environmental features were used. These categories, along with representative resources or human activities within each are:

1. Water Characteristics (physical and chemical properties of water: quantity, summer temperature).
2. Flora and Vegetation (riparian woodland, wetland, grassland).
3. Fauna (birds, mammals, fish, reptiles, amphibians, aquatic invertebrates).
4. Recreation (hunting, fishing, canoeing, swimming, camping, public recreation areas, public resorts).
5. Aesthetics and human interest (scenic value, unique physical features, unique species or ecosystems, historical and archaeological features).

The environmental impacts of each alternative were determined for selected streams and are therefore site specific.

Social-Economic Impacts

To evaluate the impacts of implementing these alternatives, a list of social and economic factors was developed. The factors were described explaining how they were related to streamflows and giving a range of values (where possible) that one would expect to find for them throughout Nebraska. Not all of the factors were easily quantifiable and in some cases were impossible to quantify in the time available. The factors were surface water irrigation, certainty of flow, industrial use, municipal/domestic use, fisheries, wildlife, hydropower, recreation, stock-watering, aquifer recharge, aesthetics, interstate compacts, and navigation. Directional change and the degree of change was listed in qualitative terms.

Impacts were developed by first analyzing a selected stream. The streams were analyzed at a specified point (i.e., gaging stations) rather than for their entire length. After analyzing each representative stream, the focus of the analysis was expanded to include the region surrounding each stream for each factor. The focus then was enlarged to include the entire state.

It was beyond the scope of this policy issue study to determine the value of the irrigation foregone due to an instream flow protection measures. The alternatives were general in nature and did not specify allocations for instream uses.

In responding to questions of water allocation among competing uses, the policy maker ideally would have accurate measures of the various impacts expressed in comparable units of measurement. Such is not likely in the "real world." Various natural as well as social-economic phenomena create conditions in which some impacts literally defy quantitative measurement. Methods available for estimating these values are enumerated in *Methodologies for Evaluating Benefits and Costs Associated with Alternative Instream Flow Policies*, by Glenn Schaible and Raymond Supalla.[118] In this report, ways of determining

monetary values associated with irrigation, recreation, aesthetics, fish and wildlife, stockwatering, navigation, interstate compacts, water quality, and hydroelectric power production are given. The results of applying these methods would be accurate and comparable; however, the cost of application was prohibitive for the Instream Flows Policy Issue Study.

Initially it would seem relatively straightforward to estimate the farm income differential between a condition where water is diverted for irrigation and the most likely situation without diversion. This differential could then be converted to a value per unit of streamflow and thus could express in dollar amounts the value per cubic feet per second (cfs) of irrigation income. Estimates of the value of an acre-foot of water for agriculture were made for each of the thirteen river basins in Nebraska (see Table 33). An acre-foot of water would cover one acre of land with twelve inches of water.

Table 33: Estimated value of an acre-foot of stream water to irrigated agriculture in each river basin.*

River Basin	Value of stream water/acre-foot: Dry land alternative	Value of stream water/acre-foot: Groundwater irrigation alternative
White River-Hat Creek	$70	$30
Niobrara	70	30
Missouri Tributaries	55	40
North Platte	70	30
South Platte	70	30
Middle Platte	60	45
Loup River	60	45
Elkhorn River	55	40
Lower Platte	50	40
Republican	70	43
Little Blue	60	45
Big Blue	60	45
Nemaha	42	40

*Estimates are based upon irrigating corn and are presented with dryland and groundwater irrigation as alternatives.

Since water is allocated for out-of-stream uses in cfs increments, with 1 cfs allocated for every seventy acres of land, the value of a new water right which uses the next increment of stream water can be calculated as well. However, the value to irrigation is dependent upon many site specific variables. Some variables to consider are:

1. River basin of the withdrawal. Different basins have different water values depending upon the annual rainfall, evapotranspiration rate, soil types, expected yields, and so forth.

2. Alternative agricultural practices available. In Table 33, the comparison is made between dryland and irrigation. The primary gain from using stream water as opposed to groundwater results from lower pumping costs. If the groundwater alternative is available, which is not always the case, the value of a cfs of stream water will be reduced. Many farm managers have other options besides groundwater irrigation, each having different rates of returns.

3. Time and duration of the withdrawal. If the withdrawal is made during the non-irrigation season or during a period of high flows, the withdrawal would be less likely to be administered for the benefit of a senior appropriator and thus would be more valuable to the holder of a new right.

4. Relative location of the withdrawal within the river basin. If the withdrawal is in the upper portion of the stream, the new right is likely to be administered for the benefit of a senior appropriator downstream. If the stream gains flow significantly from groundwater discharge, an upper watershed withdrawal is relatively secure. A new water right in the lower portion of the watershed usually will be in direct competition with senior rights and be of limited value to its holder.

5. Relative priority of the withdrawal permit in relationship to the number of existing water rights. A new water right on a stream that is almost fully appropriated, e.g., Little Blue River, probably would be administered by the Department of Water Resources more frequently than a new water right on a stream having a larger quantity of unappropriated flow. In the former case, the value of that appropriation is lessened.

6. Potential for development. Some areas of Nebraska are relatively undeveloped, for reasons including soil type, topography, accessibility to the stream, cultural practices in the area, etc. All of these factors differ from one area to another.

7. Pumping distance and conveyance losses. In some cases the irrigable land is some distance from the stream. If the water must be pumped to a higher elevation, costs may be quite high. Also, water may be lost during conveyance or off season storage because of leaks, seepage, or evaporation thus decreasing the value of the withdrawal.

8. Secondary economic impacts. For example, the addition of seventy irrigated acres in the Upper Big Blue area would have little impact on the existing seed and fertilizer dealers. However, an additional seventy acres of irrigated corn in the north central area may have relatively important secondary effects.

These variables illustrate the difficulty of determining the value of a specific withdrawal for irrigation. This information would be required to determine the opportunity costs to irrigation associated with an instream flow allocation. On the other hand, much information would be required to determine the opportunity costs to instream values of an irrigation withdrawal. Once again the values would be site specific and very complex.

There are some general statements that can be made concerning the opportunity costs to irrigated agriculture:

1. Existing water rights would be unaffected by an instream allocation under nearly all of the policy alternatives listed. Exceptions will be noted in the text of the impacts. The prior appropriation system nullifies any impact on senior appropriators by a junior permit. Therefore, any impact on surface water irrigation will be on lands yet to be developed.

2. Water rights junior to an instream appropriation will be affected in years when streamflow is inadequate to meet demand. In "normal" years, the junior appropriators may be able to withdraw without interference. The degree of interference in other years is dependent upon the size, extent, and location of the instream use permit and upon the local weather conditions and hydrology.

3. Potential irrigation development downstream of the instream allocation will be unaffected.

4. When a stream is administered for the benefit of an instream permit, the value of the production lost will be relative to the length of time the junior appropriators are without water, the expected yield with and without irrigation, and the number of potential appropriators affected.

5. As streamflows diminish, the relative value of the instream uses increase and in some cases exceed the value of water withdrawn for irrigation. The last increment of water that maintains the instream values may be worth more as a "public good" than if it were used for additional irrigation.

In order to derive any protection for instream uses, there will be some loss of out-of-stream values. The point at which instream values equal or exceed the out-of-stream values can be estimated, but would require extensive and rigorous study at a specific site. Consequently, the impacts presented in this report are qualitative assessments of effects on the local, regional, and statewide economy.

Administrative Impacts

Administrative impacts were judged according to the administration, documentation, and control required to execute effectively each alternative by a regulatory and managerial agency. The Department of Water Resources is assumed to be the regulatory agency while the managerial agency could be one of several state, local or municipal agencies including the Nebraska Game and Parks Commission, Department of Environmental Control, natural resource districts or the municipalities. Factors considered in this analysis were:

(1) Personnel, travel, and lodging expenses to monitor effectively and enforce allocation of water for beneficial instream uses.

(2) Design, construction, installation, and maintenance of metering equipment (flow meters), gaging and control devices (stop logs, Parshall flumes) to measure properly record, and allocate water requirements for recognized beneficial uses.

The degree of impact on a regulatory or a managerial agency will vary according to agency and alternatives implemented. Consequently, the following three degree categories were selected based on anticipated requirements in administering, documenting, evaluating, researching, and controlling needs:

1. No Impact – No cost or insignificant cost.
2. Moderate Impact – Up to $60,000.
3. Significant Impact – Up to $120,000.

"No Impact" requires no additional staffing, equipment, or other expenditures other than those presently existing within the regulatory or managerial agency. Any additional expenses would be insignificant. "Moderate Impact" requires some increases in personnel, equipment, and expenditures. Probably one additional full-time and possibly one part-time employee would be needed in each of two field offices. A "Significant Impact" would require major increases in personnel, equipment, and expenditures. One additional full-time and possibly one part-time employee would be needed in each of three to four field offices. The cost of one full-time employee is estimated to be $20,000 for salary plus $10,000 for overhead (travel, lodging, part time salary, etc.). If these figures are used the maximum cost for a regulatory agency of a moderate impact alternative would be $60,000, since a moderate alternative may require employing a maximum of two full-time employees. The maximum cost for a regulatory agency of a significant impact alternative would be $120,000, since a significant alternative may require employing a maximum of four full-time employees. The same costs apply to a managerial agency.

If instream uses were recognized by law, the state, city, or local agency having regulatory or managerial responsibility or concerns for a particular use would determine the flow requirements. It is assumed therefore that some other entities or local agencies also would incur expenses as outlined above.

An important assumption underlying the administrative impact assessments is that the alternatives would be implemented on a statewide basis. If the applicability of an alternative is limited to specific streams, the administrative impacts would be reduced accordingly.

Legal Impacts

This discussion of legal impacts focuses on the degree to which an alternative would impair existing water rights or property interests or, conversely, strengthen the protection for individual rights and property interests. The scope of the review will be statewide, that is, the legal impacts attributed to each of the alternatives will be discussed in terms of statewide impacts and not limited to regional or site specific impacts.

Possible increase in litigation is a legal impact that is not discussed for each impact but, instead, is summarized here. The impact of an alternative on the legal system includes any increase in litigation that would occur because of its adoption. A court challenge to any action of the director of the Department of Water Resources is attractive to opponents of that action because the director's decisions on matters relating to irrigation, water, power and drainage may be appealed directly to the Nebraska Supreme Court.[119] Any legislation that increases the director's authority and requires him to make decisions on controversial issues, such as the maintenance of instream flows, carries with it the likelihood of litigation challenging his decisions. Therefore, adoption of the seven alternative policies discussed in Chapter 6 would likely result in litigation. Court challenges to actions of the Game and Parks Commission would also be likely if Alternative 6 were adopted. However, questions regarding the constitutionality of legislation based on these alternatives should be settled after one court challenge if all constitutional issues are brought before the court at the same time. Therefore the impact of adopting an alternative on the legal system will be slight.

Continuing the present policy will not necessarily avoid litigation challenging the director's decisions. For example, objections have been raised to the proposed transbasin diversion of Platte River water by the Little Blue Natural Resources District on the ground that wildlife habitat would be affected adversely. This objection, and others, were overruled and the director's decision is now being appealed to the Nebraska Supreme Court. If proponents of the maintenance of instream flows continue to take an active interest in the water rights approval process, litigation can be expected to occur. This type of litigation can be expected to occur if any of the alternatives that do not provide for the protection of instream uses are adopted (Alternatives 3, 8, 11), with the exception of Alternative 5 which would effectively forestall this type of litigation.

Chapter 5

Present State Policy for Instream Uses as an Alternative Policy

Since Nebraska was first settled a considerable body of law has been developed to regulate various aspects of surface water and groundwater use. Nebraska's laws regulating surface water use are based upon two different legal doctrines. One is the riparian rights doctrine and the other is the doctrine of prior appropriation. The use of groundwater is subject to a separate body of law.

These laws are designed to implement a policy of protecting the rights of individuals to use water. This is accomplished, in part, by providing a framework for resolving disputes between water users when demand exceeds the available water supply. Although the state's water laws are clearly aimed at protecting the rights of those who use the water for traditional purposes such as irrigation, manufacturing, and power production, one cannot find a clear expression of the state's policy regarding most instream uses. Only a few scattered provisions in the law clearly could be used to prevent the reduction of streamflow below the level needed to maintain certain instream uses. In many respects the present legal status of instream uses is unclear.

The purpose of this chapter is to describe the present state policy regarding instream uses and to identify the impacts of continuing that policy. The chapter is divided into two sections. First, the present state policy is described in a discussion of Nebraska's surface water law – riparian rights and appropriative rights – and Nebraska's groundwater law. Second, continuing the present state policy is identified as a possible alternative and the hydrologic, environmental, socio-economic, administrative, and legal impacts of the alternative are described.

PRESENT STATE POLICY REGARDING INSTREAM USE

This section contains a discussion of some of the basic elements of the riparian rights and prior appropriation doctrines as they are applied in Nebraska, and the legal status of instream uses under these doctrines. Also provided is a brief description of Nebraska's groundwater law and provisions of existing law that can be used to protect instream uses from groundwater withdrawals that reduce streamflow.

Nebraska Surface Water Law

RIPARIAN RIGHTS

The riparian rights doctrine was developed by the courts of England and had been adopted by the courts in this state by the time of Nebraska's admission to the Union in 1867. It provided a means of settling water use disputes in the absence of legislation on the subject.[120] Today, use of surface water in Nebraska by persons relying upon riparian rights is believed to be insignificant. This is due to limitations placed on the scope of the doctrine by the Nebraska Supreme Court (discussed later) and the preference shown by most water users for the acquisition of appropriative water rights. Use of water by holders of riparian rights at present is thought to be limited primarily to small scale uses of water for livestock.[121] Although water use by holders of active riparian rights is relatively insignificant when compared to water use by holders of the large number of appropriative rights,[122] the riparian doctrine merits brief discussion because it has some applicability to the protection of certain instream uses in Nebraska.

Riparian water rights will be the subject of a separate study by the Selected Water Rights Issues and so will not be discussed in detail here. However, the reader should be familiar with the following seven attributes of a riparian right.

(1) To have a riparian right one must own riparian land, a term often used to refer to any land abutting a stream or lake. However, when used to refer to land to which riparian rights attach under Nebraska law, the term has a narrower meaning. The land not only must abut a river or a lake but also, according to the Nebraska Supreme Court, must have been transferred into private ownership by the federal government prior to enactment of the April 4, 1895, legislation that established the state's present system of administering appropriative water rights.[123] An owner of property meeting these requirements generally is referred to as a riparian.

(2) A riparian right does not necessarily entitle the holder to use a specific quantity of water. The owner of land that is legally riparian has only the right to make a "reasonable" use of the water, and each riparian along a stream has an equal right to make a reasonable use of the water. What is reasonable is determined by comparing the needs of other riparians along the stream or stream system, the uses competing riparians want to make of the water, the quantities claimed by each, and a number of other factors.[124]

(3) If conflicting claims by riparians over the right to use surface water cannot be resolved by agreement among the parties, their only means of arriving at a solution is court action.

(4) A riparian right attaches to riparian land even if the right is not exercised and a riparian may initiate his or her use at any time.[125]

(5) The right cannot be lost by non-use.[126]

(6) In resolving conflicts between riparians, the dates their use commenced are not to be considered.

(7) Riparians must contend with other persons on the same stream system using water pursuant to appropriative water rights. If a conflict arises between a riparian desiring to use streamflow for stockwatering, and an appropriator, the Department of Water Resources will, if its assistance is requested, try to help the parties reach an agreement which will meet both the riparian's and appropriator's needs. The Department also enforces any court decrees that establish the respective rights of competing riparians and appropriators.[127] However, in the absence of an agreement or a previous court decree, disputes between riparians and appropriators must be settled in court. The rights of the parties involved will be determined by balancing the equities between them and, again, all of the circumstances of the individual case before the court will be considered.[128]

APPROPRIATIVE RIGHTS

For a number of reasons, the riparian rights doctrine did not provide a suitable means for allocating water in a state such as Nebraska. As settlement of the state proceeded during the late 1800s, competition for water for irrigation was increasing and day-to-day management of water users often was needed. No provision was made in the doctrine for the use of water on lands suitable for irrigation but not part of a tract of land abutting a stream. Because riparian rights are subject to the needs of other riparians, and therefore indefinite as to the amount of water to which the right attaches, this doctrine did not provide for the certainty of a continued supply of water. This supply was needed to encourage the investments necessary to develop water storage and diversion facilities for irrigation. In addition, the necessity of court action to protect one's right reduced further the utility of this doctrine as a means of allocating surface water between a large number of water users on a stream system.[129] These shortcomings led to the adoption of the prior appropriation doctrine in Nebraska.

The first explicit statutory authorization for the acquisition of appropriative rights in Nebraska occurred in 1889,[130] however, the state's present system for acquiring and administering appropriative rights was adopted in 1895[131] and has been changed little since then.

The prior appropriation doctrine differs greatly from the doctrine of riparian rights as can be seen by comparing the following six points with the first six attributes of a riparian right discussed previously.

(1) The acquisition of appropriative rights is not limited to owners of land abutting a lake or stream.[132]

(2) An appropriative right entitles the holder to impound a specific quantity of water or divert or use a specific rate of streamflow.[133]

(3) In Nebraska, most conflicts between holders of appropriative rights are resolved by administrative action of the Department of Water Resources rather than court action.[134]

(4) The only ways to acquire an appropriative right are by obtaining a permit to appropriate water from the Department of Water Resources, or by purchasing land to which a valid appropriation permit applies. The water must actually be put to the use specified in the permit for the right to be valid.[135] The department issues three types of appropriation permits. A natural (or direct) flow permit[136] must be obtained to use streamflow directly from the stream. Natural flow includes all water occurring in a stream except storage water being transported for use downstream. A storage permit[137] must be obtained before natural flow can be impounded. The holder of a storage permit may not impound storage water being transported downstream, or natural flow needed for immediate use by the holder of a natural flow permit. A storage use permit[138] must be obtained before water that has been stored can be put to use.

(5) An appropriation permit can be cancelled by the Department of Water Resources if it is abandoned or not used for a certain period of time (three years).[139]

(6) In marked contrast to the riparian rights doctrine, the date an appropriator's use is initiated is usually the determining factor in resolving water use conflicts been appropriators. The date an application for an appropriation permit is filed with the Department of Water Resources serves as the "priority date" for that permit. When the flow of a stream is insufficient to fulfill the demands of all appropriators, this priority date determines who has the superior right to use the water among those using the water for the same purposes. For example, take an over-simplified case where three appropriators are withdrawing water from the same source for irrigation purposes. Irrigator A has a priority date of April 1, 1900, irrigator B has a priority date of April 2, 1900, and irrigator C has a priority date of April 3, 1900. Of these three appropriators, irrigator A has the superior right to use the water. He or she would be the "senior" appropriator and, if requested, the Department of Water Resources could order irrigators B and C to cease their diversions if such action was necessary to supply irrigator A the water to which he was entitled. B and C are both "junior" appropriators in relation to A. However, if there was sufficient flow to meet the needs of two of the appropriators, irrigator C would be ordered to cease his or her diversion so that both A and B receive the water specified in their permits, because irrigator C is a junior appropriator in relation to both B and A. (Irrigator C would be senior to any appropriator who filed for his permit at a later date.) Although both natural flow and storage rights are administered on the basis of priority, a natural flow permit is always superior to a storage permit.[140]

When competing appropriators are using the water for different purposes, the priority dates of their permits may not in all cases determine who has the superior right to use the water. The Nebraska Constitution provides that, while the priority date of an appropriation is to determine who has the superior right among those using the water for the same purpose, when streamflow is not sufficient for the use of all appropriators "those using the water for domestic purposes shall have preference over those claiming it for any other purpose, and those using the water for agricultural purposes shall have the preference over those using the same for manufacturing purposes."[141] In addition, by statute, the use of water for agricultural purposes is preferred over its use for power production where turbine or impulse water wheels are installed.[142] These constitutional and statutory provisions are the source of what is referred to as the preference system. The preference system is a

modification of the rule of strict priority in the allocation of water among holders of appropriative rights. It provides the mechanism, in some instances, whereby a "preferred" user with a junior priority date can use the water to which an "inferior" user with a senior priority date would otherwise be entitled.

Contrary to popular opinion, the preference system does not operate automatically for the benefit of a preferred water user. A preference may not be exercised unless the preferred appropriator pays damages, or compensates in some way, the senior appropriator who would otherwise be entitled to the water. If the parties cannot arrive at an agreement regarding compensation, the preferred water user must initiate court proceedings to establish the compensation to be paid. The Department of Water Resources is not authorized to administer water rights on the basis of preferences until the parties have reached an agreement or a court has arrived at a decision on the matter.

In addition, whether a preference may be used by a private party to interfere with the water right of another is open to question. The preference system may be available only to governmental or other entities which have been granted the power to condemn property for public purposes. Another limitation on the exercise of preferences is that a preference apparently can not be used to interfere with the use of water by the holder of a riparian right or by the holder of an appropriative right vested prior to April 4, 1895, when the preference provisions were first enacted into law.[143]

These clear and potential limitations on the exercise of a preference, coupled with the issuance of few appropriation permits for uses other than agricultural ones, and economic considerations, have restricted severely the effect of surface water preferences.[144] The only known application of the surface water preference system has occurred in the Loup River basin where irrigators rely on their agricultural preference to interfere with a senior appropriation for power purposes.[145] Where water use conflicts occur among appropriators using the water for different purposes included in the preference provisions and no preference is exercised, the priority dates of the appropriator's permits continue to be the sole factor in determining who has the superior right to use the water.

LEGAL STATUS OF INSTREAM USES UNDER THE RIPARIAN RIGHTS DOCTRINE

The Nebraska Supreme Court has indicated riparian rights may be acquired for instream stockwatering, hydroelectric power production, and milling.

The Nebraska Supreme Court has indicated riparian rights may be acquired for instream stockwatering, hydroelectric power production, and milling.[146] It also appears that riparians may have protectable interest in the subirrigation and groundwater recharge benefits derived from streamflow, although the extent of this protected interest is not clear.[147] While uses of water for fish, recreation, and wildlife have been recognized as legitimate riparian uses in other states,[148] the issue of whether riparian rights may be acquired for these instream uses in Nebraska has never been addressed by the courts of this state. It is questionable, however, whether a secure riparian right for an instream use could be established if the instream use was competing for water with some other use having a well recognized economic value and an appropriative right. An example is the use of water for aesthetic purposes versus the use of water for irrigation.

Riparian rights are by their nature indefinite as to the amount of water to which the right attaches. Therefore, the riparian rights doctrine would be of little value as a means of ensuring a dependable supply of water for major instream uses if a policy of maintaining natural flow for instream uses was adopted by the legislature. In addition, the necessity of time-consuming court action to protect a riparian right further reduces the usefulness of the riparian rights doctrine as a means of protecting instream flow values.

LEGAL STATUS OF INSTREAM USES UNDER THE PRIOR APPROPRIATION DOCTRINE

As previously stated, an appropriation permit entitles its holder to impound a specific quantity of water or use a specific rate of flow. Although appropriators generally may not legally impound or divert more water than the quantity specified in their permits, under Nebraska law, any appropriator may impound or divert the entire flow of the stream if necessary to satisfy his or her water right regardless of the effect of that action on instream flow values.[149] There are, however, six provisions in existing law that can be used as a means of protecting instream uses.

(1) Natural flow permits can be obtained and have been issued in Nebraska for instream hydroelectric facilities.[150] These rights have been assigned priority dates and, when necessary, holders of junior rights upstream from the facilities can be regulated by the Department of Water Resources to supply water to the holder of the hydroelectric right unless the junior appropriator is a preferred user and has exercised his or her preference.

(2) Although state statutes do not explicitly allow the use of stored water for instream flow maintenance, the Department of Water Resources has interpreted the law as allowing the issuance of storage use permits for instream uses.[151] If stored water were to be released to maintain instream flows pursuant to a storage use permit, the Department of Water Resources would have the authority to police a stream to ensure that other water users along a stream did not divert from or impound it. No storage use permits have been issued for instream flow maintenance in Nebraska.

(3) Nebraska law places certain limitations on the power of an appropriator to impound water in order to protect the instream use of water for fisheries. Under Nebraska law – Neb. Rev. Stat. Sec. 37-406 (Reissue 1978) – it is:

> . . . the duty of every person who owns or controls any dam or other obstruction across any watercourse within the jurisdiction of the state, where such impounded water is returned to the bed of the stream, to make such provision as may be necessary that sufficient water shall be returned at all times to the bed of the stream or river below such dam or obstruction as to preserve fish life in such stream; Provided, however, this act shall not apply under conditions of unusual circumstances resulting from natural causes, which make the fulfillment impractical; and provided, also, that every person owning or controlling such dam, shall open and close gates or locks at a rate slow enough to protect the water below from a sudden

flushing or sudden decrease in water flow, which would be detrimental to the fish and their habitat.

It should be noted that this statute applies only when impounded water will be returned to the stream bed. It is assumed that the language relating to impracticability due to natural causes refers to the absence of inflow to the reservoir. The Game and Parks Commission is responsible for overseeing the enforcement of this statute. Violation of this provision is a class V misdemeanor but no enforcement activity is known to have occurred.[152]

(4) Nebraska appropriation law also provides some protection for stock growers who rely on streamflow for their stock water needs. The owner or operator of a reservoir, except a political subdivision, must pass a portion of the inflow through the outlets of the reservoir in order to furnish water for livestock downstream. However, the reservoir owner cannot be required to pass through water that has been legally stored.[153]

(5) By the terms of the Blue River Basin Compact, Nebraska must pass a certain rate of flow into Kansas from May through September. To supply this streamflow to Kansas, the Nebraska Department of Water Resources is empowered to regulate appropriations in Nebraska with priority dates junior to November 1, 1968. In addition, the Department may regulate irrigation wells installed after that date in certain areas. The compact also limits the storage capacity of reservoirs on the Big Blue and Little Blue rivers.[154] In effect, the flow committed to Kansas has the status of a natural flow right having a priority date of November 1, 1968. The regulation of certain groundwater withdrawals provides this interstate compact commitment somewhat more protection than would be afforded a natural flow permit with the same priority date. Upon entering Kansas the water is subject to appropriation for out-of-stream use.

(6) When an application for an appropriation permit is filed with the Department of Water Resources, the director may refuse to approve it if denial is "demanded by the public interest."[155] When making this public interest determination on applications that involve a transbasin diversion, the director must take into consideration "any current beneficial uses being made of the unappropriated water in the basin of origin." For the purposes of this provision, "beneficial use" includes subirrigation, fish and wildlife, groundwater recharge, interstate compacts, water quality maintenance, and recreational purposes.[156] This clearly requires the director to consider the effects of a proposed transbasin diversion on these instream uses. It does not, however, require the director to deny the application if the instream uses listed would be affected adversely, nor does it require the imposition of conditions designed to protect instream uses if the application is approved. It only requires the director to take these instream uses into consideration when deciding whether to approve the application. However, the director could, if it was deemed to be in the public interest, impose conditions on the exercise of an approved permit for a transbasin diversion to protect instream uses.[157]

With the exception of the provisions listed above, it is unclear whether, or how, other elements of Nebraska law may be used to maintain instream flows. A brief discussion of some of the issues on which present Nebraska law is unclear follows.

The Department of Water Resources has never issued a natural flow permit for an instream use other than hydroelectric power generation. If such permits could be obtained for other instream uses, diversions of natural flow by junior appropriators that would reduce streamflow below the level specified in the instream flow permit could be prevented. Whether these permits can be obtained for the other instream uses is unclear because the Department of Water Resources has never ruled formally on a natural flow permit application for any other instream uses, and state statutes are not clear on this point. The Department of Water Resources has issued natural flow permits for out-of-stream uses other than those mentioned in the surface water preference provisions, including fish culture.[158]

Another issue is the extent of the authority of the director of the Department of Water Resources to deny or condition new permits if their approval would affect instream uses adversely. The director has the authority to deny or condition permits if necessary to protect the public interest[159] but, with the exception of appropriation applications involving transbasin diversions, statutory guidance to the director on how to exercise this authority is lacking. Consideration of the effect of a proposed diversion on instream uses is neither explicitly provided for or prohibited.

Nebraska Groundwater Law

The Nebraska Supreme Court has stated that groundwater is a publicly, as opposed to privately, owned resource. However, the right of landowners to make a reasonable use of groundwater underlying their property for beneficial purposes is well established. This right is subject to certain limitations designed to prevent waste and protect the rights of other groundwater users. Groundwater may not be withdrawn in an amount exceeding that which can be put to a reasonable and beneficial use on the overlying land, especially if this use is detrimental to the rights of other landowners to use the groundwater. If the supply of water is insufficient for all those who have the right to use it, each user is entitled to a reasonable share. However, certain uses are preferred over others and will be afforded a greater level of protection than others.[160] The groundwater preference statute provides that the use of groundwater for domestic purposes is preferred over all other uses and its use for agricultural purposes is preferred over its use for industrial or manufacturing purposes.[161]

There are a number of state statutes relating to the use of groundwater in Nebraska,[162] the most important of which is the Ground Water Management and Protection Act.[163] This act gives the Department of Water Resources the authority to designate groundwater control areas, if requested to do so by a natural resources district. Once a control area is designated, the natural resources district can regulate groundwater development and use within the control area.

LEGAL STATUS OF INSTREAM USES UNDER NEBRASKA GROUNDWATER LAW

A stream that derives part of its flow from the natural discharge of groundwater into the stream may have its flow reduced by the pumping of water from aquifers with which the stream is hydraulically connected. However, at the present time, few provisions in the law provide instream (or out-of-stream) uses protection from groundwater withdrawals that reduce streamflow. Maintaining streamflows is

not an authorized objective of the Ground Water Management and Protection Act.

Provisions of existing law that can be used to prevent or mitigate the adverse effects of groundwater withdrawals on instream uses are as follows:

(1) The Blue River Basin Compact authorizes the Department of Water Resources to regulate irrigation wells installed after November 1, 1968 (except replacement wells) within one mile of the Little Blue River from the Nebraska-Kansas border to the mouth of Walnut Creek near Deweese and within one mile of the Big Blue River from the state line to the mouth of Turkey Creek near DeWitt. However, if the regulation of these wells fails to result in a measurable increase in streamflow the regulation must be discontinued.[164]

(2) A permit must be obtained from the Department of Water Resources before water can be pumped from a pit within fifty feet of a streambank. When deciding whether to approve a permit application, the director is to consider the effect the withdrawal would have on surface water appropriators.[165] The only instream use the provision would have any bearing on at present is hydroelectric power production since it is the only instream use for which appropriations of surface water have been made. It could have a broader applicability if natural flow permits are obtained for other instream uses in the future.

(3) A permit must also be obtained from the Departmen of Water Resources before commencing construction of wells if more than 3,000 acre-feet of groundwater per year will be withdrawn for industrial, power production, or commercial purposes. In determining whether approval of the permit application is in the public interest, one of the factors the director must consider is the potential adverse effects of the proposed use on existing surface water users. If the permit is granted, the director may impose conditions on the groundwater withdrawal, if necessary, to protect existing uses.[166] Here again, the applicability of this provision to instream uses may be limited only to hydropower generation. Whether other instream uses will be considered depends on the Department of Water Resources' interpretation of the phrase "existing surface water users."

(4) One recent judicial development deserves mention. In a 1981 Sioux County District Court case, a groundwater irrigator was required to pay damages to a neighboring landowner because the irrigator's withdrawals reduced subirrigation and reduced streamflow that was relied on by the neighbor for instream stockwatering.[167] Apparently, the basis for this decision was a section of the Restatement of Torts rather than a previous Nebraska Supreme Court decision.[168] This decision has not been appealed and so the Nebraska Supreme Court will not have the opportunity to decide the issues involved. However, it may be followed by other lower courts when confronted with the same issue.

ALTERNATIVE: CONTINUE PRESENT POLICY*

Description

The state's present policies on maintaining surface water flows for instream uses, as described in the preceding pages, would remain unchanged. Issues on which present law is unclear may be resolved by judicial or administrative action.

**This alternative is shown in Chapter 4 as Alternative 1.*

Impacts

This section describes the hydrologic, environmental, social-economic, administrative, and legal impacts of continuing the present policy regarding instream uses.

HYDROLOGIC IMPACTS

The hydrologic impacts of continuing the current policy of granting surface-water rights until no unappropriated water remains in the stream will depend on such factors as type of new uses, location of diversion and storage sites, timing and magnitude of the uses, amount of water returned after use, and travel route (overland or subsurface) of the return water. The hydrologic impacts on selected streams are:

Long Pine Creek (near Riverview): Since opportunities to divert water from streams in the Long Pine Creek drainage basin are limited, continuing the present policy is not likely to have any significant hydrologic impact other than a slight depletion of summertime flow.

Platte River (at North Bend): Continuation of the state's current water policy would permit further depletion of the Platte's annual discharge at North Bend. Several applications have been made for rights to divert water during the off-season (i.e., between irrigation seasons) to reservoirs that would store water for irrigation use. If all were to be granted, their combined effect on river discharge at North Bend would be significant when the diversions were in progress. Summer discharges also may be depleted additionally because applications for rights to pump from or divert from streams in the basin still are being granted. Most of the applications are for small amounts, but if most rights were to be exercised simultaneously their combined effects could be very noticeable. However, so long as the Columbus power plant continues to operate, its discharge to the Platte River should maintain a good flow at North Bend. Narrowing of the river and encroachment of vegetation on parts of the channel are a likely prospect unless effective preventative efforts are undertaken. Both would diminish the capacity of the river channel to transmit high flows. Since floods still are likely to occur and total stream discharge still is much greater than can be lost wholly to seepage, concern that flow will be depleted enough to reduce aquifer recharge in the North Bend vicinity or at any downstream location seems unwarranted. A slight increase in average water temperature would be likely if stream discharge is less, and some deterioration of water quality could be expected if, as probably would be the case, a larger proportion of the depleted flow consists of irrigation return flows. The sediment transporting capacity of the river also would be reduced. Whether this will have any adverse impacts in the North Bend vicinity is doubtful because inflow from the Loup River should continue to be sufficient to prevent problems relating to sediment deposition.

Little Blue River (at Fairbury): Continuing present water policies would result in the granting of additional rights to create reservoirs or divert from the Little Blue and its tributaries. However, the small number of applications made for rights in recent years may indicate that most valley lands suitable for irrigation are being irrigated. Seepage returns from irrigated lands may account for the relatively good dry-weather flows that continues

to characterize the Little Blue to date. However, additional rights could serve to reduce summertime low flows and move downstream the point where flow previously has been continuous.

Ninemile Creek (near McGrew): Continuing present water policy seems hardly likely to have any impact on the flow regime of Ninemile Creek since additional applications for rights to appropriate water from that creek probably will be very few. All, or nearly all, irrigable lands in the creek's drainage area already are amply served by water diverted from the North Platte River. Hence, barring the unlikely, the creek's flow regime will continue to be nearly the same as in the past forty years whether or not present water policy is changed through legislation.

ENVIRONMENTAL IMPACTS

Continuing present policy has statewide environmental implications as problems with low flows have been documented for most regions of the state. The notable environmental impacts of continuing present policy for four selected streams are as follows:

Long Pine Creek: Continuing present policy could result in a moderate loss to a significant trout fishery because the flows of Long Pine Creek are presently below the optimum level for trout production. Therefore, even though the flow changes expected from this alternative would be minimal, any reductions that do occur will be of statewide concern.

Platte River (at North Bend): Fishery losses will occur due to increased water temperatures and associated reductions in dissolved oxygen levels if flows are reduced. In addition, recreation uses (which are tied to aesthetics) of the Lower Platte area are important factors to consider. Continuing the present policy could indirectly have a detrimental effect on the Platte River islands, recognized as being a nationally significant recreation resource by the U.S. Department of Interior,[169] by making the islands more accessible for agricultural and commercial development.

Little Blue River (above Fairbury): Fishery losses will be possible due to increased water temperatures and associated reductions in dissolved oxygen levels if flows are reduced.

Ninemile Creek: At the present time the flow of Ninemile Creek is entirely committed to existing water rights. Therefore, the continuation of present policy should not affect adversely the environmental qualities associated with the stream.

SOCIAL-ECONOMIC IMPACTS

The social and economic impacts of continuing the present policy would be realized at the local, regional, and statewide levels. For the four streams selected for analysis, there would be some economic impacts resulting from environmental losses, most notably on the Little Blue River above Fairbury and the Platte River at North Bend. Regional impacts will vary as well. In the middle to lower Niobrara area, the development of irrigated agriculture using surface water would thus allow the use of the state's largest concentration of streams with unappropriated flow. Some secondary benefits also would be derived from this development. In the south central area, there would be little or no impact on irrigated agriculture because most areas that have potential to be irrigated with surface water are already developed.

In areas where the development of surface water sources for irrigation has been more extensive and little streamflow is unappropriated, little or no impact will result. Those areas with unappropriated flows and undeveloped land would benefit from this policy; i.e., the north central and eastern portions of the state. As new areas are developed, the certainty of having streamflow available for diversion will decrease, at times possibly resulting in overcapitalization by junior appropriators. The important municipal well fields would probably be unaffected by streamflow depletions in the foreseeable future.[170]

ADMINISTRATIVE IMPACTS

If the present policy is continued, the Department of Water Resources staff requirements for administration of water rights are expected to remain about the same. A small increase in personnel that can be met with part-time employees may be required in some years. This increase in administrative activity would most likely occur in north central and eastern Nebraska where several streams have unappropriated flow available for future diversions.

Managerial agencies can be expected to experience increased costs for field and laboratory investigations due to a greater number of fish kills caused by low flows. These kills would be caused by greater duration and frequency of reduced flow conditions. However, even during drought years, when demands on management are greatest, existing staffs are not expected to be increased significantly.

LEGAL IMPACTS

Existing surface water rights would not be impaired by continuation of present policies regarding instream uses. However, if withdrawals from wells reduce streamflow available to downstream users, the rights of these surface water users would be affected adversely by the continuation of present policies since no provision in the law provides for groundwater users to be regulated by the Department of Water Resources for the benefit of downstream appropriators. Such protection could be provided by adoption of Alternative – Declare that natural flow permits may be issued for instream uses, including groundwater recharge.

Some impairment of as yet undefined property interests of landowners in subirrigation and perhaps groundwater recharge may occur. In 1936, the Nebraska Supreme Court stated that a landowner's interest in the subirrigation benefits derived from streamflow were entitled to legal protection,[171] although in a 1966 case the court appeared to take a less protective view of this right.[172] This interest, whatever its nature may be, could be subject to impairment by the issuance of new appropriation permits for surface water use above and within stream reaches where subirrigation from instream flows occurs.

Chapter 6

Alternative State Policies that Provide for the Maintenance of Streamflows for Instream Water Use

This chapter describes eight alternative state policies that provide for the maintenance of streamflows for instream water use. For each of the eight alternatives the legislative changes and the hydrologic, environmental, social-economic, administrative and legal impacts are identified.

ALTERNATIVE: DECLARE THAT NATURAL FLOW PERMITS MAY BE ISSUED FOR INSTREAM USES*

Description

Although in most years the natural flow of the majority of streams in Nebraska is committed to holders of existing appropriative rights, a few streams in the state have both significant instream flow values and sufficient unappropriated natural flow to support these values. However, if new appropriation permits for consumptive uses are issued on these streams, their natural flow could become committed to out-of-stream uses and no longer be available to maintain instream uses. This potential problem could be avoided if public entities or private parties desiring to maintain instream flows were to obtain permits to appropriate a portion of the natural flow of these streams for instream uses. The holder of a permit obtained for this purpose would be entitled to have the Department of Water Resources restrict the diversion or impoundment of natural flow by holders of junior permits.

The only instream use for which natural flow permits have been issued is hydroelectric power production. Whether natural flow permits may be issued for any other instream use is not clear under existing law. Therefore, if the legislature feels the state should allow such appropriations, they should be explicitly authorized.

The first step in obtaining an instream appropriation of natural flow would be to quantify the amount of flow needed to maintain the instream uses for which a particular stream reach was important. If the legislature is concerned that the continued issuance of surface water rights for consumptive uses on a stream under study might result in the stream's flow becoming fully committed to holders of rights to divert, it could authorize or direct the Department of Water Resources to impose a moratorium on the issuance of new appropriative rights while the study is being conducted. These quantification studies would be performed by the prospective permit applicant. For example, the Game and Parks Commission or a private group could conduct studies to determine the instream flow needs for fisheries, wildlife, or recreation. A public water supplier such as a natural resources district or a municipality could conduct studies of the flow needed to maintain groundwater recharge in certain areas. Studies of this type have already been conducted on several streams in the state. Recommended flow levels for certain instream uses on these streams are reported in Chapter 3.

After the quantification study was completed, an application for a natural flow appropriation permit would be filed with the Department of Water Resources. The application would be included in the department's monthly list of applications received, which is posted at the department office and distributed to interested parties. Objections to the issuance of the instream flow permit could be filed in the same manner that objections are filed to the issuance of any other appropriation permit. If objections were raised, the department could hold a hearing on whether the permit should be granted.[173] The director's decision to grant or deny the application for an instream flow appropriation would be based on a determination of whether unappropriated water was available and whether approval of the permit would be in the public interest.[174] If no objection was filed, the application would be approved by the middle of the following month unless the director of Department of Water Resources determined on his or her own motion that there was no unappropriated flow in the stream or that approval of the permit would be detrimental to the public welfare.[175]

If the application were approved, the instream flow permit would be administered in the same way other natural flow rights are administered. The date the application was filed would serve as the priority date for the permit. The holder of the permit would be entitled to have Department of Water Resources regulate diversions by junior appropriators, unless the holders of these junior permits could, and did, exercise a preference. Existing natural flow rights would not be affected by the issuance of an instream natural flow permit unless a particular instream flow use was granted a preference over the existing use and that preference was exercised and compensation paid for interference with the existing right.

The importance to and effect of preferences on this particular alternative is discussed under "Legislative Changes." Preferences are discussed in more detail in

This alternative is shown in Chapter 4 as Alternative 2.

Chapter 5 of this report entitled "Present State Policies for Instream Uses as an Alternative Policy" and the Selected Water Rights Issues Policy Study entitled *Preferences In The Use of Water.*

LEGISLATIVE CHANGES

To implement this alternative the legislature should declare that those instream uses for which it desires natural flow permits to be issued are beneficial uses of water and direct the Department of Water Resources to issue natural flow permits for them when requested. If the legislature feels the acquisition of instream appropriations should be limited to certain streams or stream segments, applicable reaches should be identified. In addition, the legislature should define the term "appropriation" to indicate clearly that a physical diversion of water out of the stream is not necessary to have a valid right to appropriate natural flow.

The legislature should also address the issue of who may acquire natural flow rights for instream uses. If it is decided to permit the acquisition of natural flow rights for instream stockwatering it would be appropriate for these rights to be held by an individual since this use is by its nature a private one. However, streams having high value for fisheries, wildlife, recreation, or scenic beauty generally are viewed as public resources. Therefore acquisition of instream flow rights for these uses could be restricted to public entities such as the Game and Parks Commission, a natural resources district, or some other agency or political subdivision. If natural flow permits could be acquired for groundwater recharge, natural resources districts and other public water suppliers could be explicitly authorized to hold such permits. The Department of Environmental Control, municipalities, and sanitary and improvement districts could be designated as the appropriate entities to hold instream appropriations for water quality maintenance.

A very important issue that also would need to be addressed is whether to include instream uses in the preference provisions of state statutes and the constitution and, if so, in what position relative to other water uses. How this issue is addressed would impact on the effectiveness of this program and determine whether existing natural flow rights would be affected by the issuance of natural flow permits for instream uses.

Under existing law, the use of water for domestic purposes is preferred over all other water uses including instream uses. The use of water for agricultural purposes is preferred over its use for manufacturing and hydroelectric power production.[176] However, agricultural uses are not expressly granted a preference over any instream use other than hydroelectric power production, nor are manufacturing or power uses granted a preference over any instream uses. If no reference to instream uses other than hydroelectric power production was included in the preference provisions it would be unclear how conflicts between holders of instream flow permits and holders of permits for agricultural, manufacturing, and power uses would be resolved. If they were not specifically mentioned, a court could conclude preferences have no bearing on such conflicts and the priority dates of the competing permits would determine who had the right to use the water.

This issue could be dealt with in a variety of ways. One would be to not address the issue in legislation implementing this alternative, thus leaving it to the courts to resolve. A second approach would be to place instream uses, other than hydroelectric power production, in a fourth preference category, inferior to domestic, agricultural, manufacturing, and hydropower uses. A third would be to grant instream uses a preference over agricultural, manufacturing, and hydropower uses. A fourth way to address the issue would be to include a declaration that the only use for which a preference may be exercised against all instream uses is domestic use. Preferences would have no bearing on conflicts between holders of instream flow appropriations and agricultural, manufacturing, and hydropower users, except that existing law would remain unchanged in that agricultural users could still exercise a preference over hydropower users.

Adopting the second approach could impair the effectiveness of this alternative because subsequent appropriators of natural flow for agricultural, manufacturing or hydropower purposes could use their preference to interfere with an instream flow appropriation if compensation were paid. The negative effect of affording these uses a preference would be increased if a court were to rule that preferences may be exercised by an appropriator who does not hold the power of eminent domain, i.e. private individuals (see discussion of the right to exercise preferences in Chapter 5).

Granting instream uses a preference over agricultural, manufacturing, and hydropower uses also would have serious impacts. This, in effect, would grant public entities who held instream flow appropriations the power to condemn existing appropriative rights held by agricultural, manufacturing, and hydropower users. However, just compensation would have to be paid for interfering with existing rights. In addition, there is some question whether this preference could be used against the holder of an appropriation issued prior to the change in preference.

By adopting the fourth approach described above, the legislature could avoid affecting holders of existing rights adversely or impairing the effectiveness of this alternative. Existing law would remain unchanged. Domestic water uses would have a preference over all other water uses and agricultural use would be preferred over manufacturing and hydropower uses. However, conflicts between agricultural, manufacturing, and hydropower users and holders of instream flow appropriations would be resolved strictly on the basis of the priority dates of the competing users permits.

The legislature could also consider whether the Department of Water Resources should be authorized to impose a moratorium on the issuance of new appropriative rights on streams on which quantification studies are being conducted.

Impacts

HYDROLOGIC IMPACTS

Legislative adoption of this alternative could help to ensure availability of water for instream uses and, depending on the amount of the instream flow right, would tend to reduce or prevent further flow regime changes that additional water resources developments would cause. Instream flow permits could have value on streams that still flow perennially, especially those that in the future are likely to become intermittent owing to granting of additional rights to divert for out-of-stream uses. Instream flow

permits for amounts greater than the recorded lowest 1-day discharge could not be guaranteed unless the flow regime has changed enough that the lowest 1-day discharge in the future is likely to be greater than the lowest 1-day discharge in the past.

Instream flow permits for amounts less than the lowest 1-day discharge in the past would guarantee, not perfectly but as much as is possible, that discharge would not be lower than the amount of the application. Permits for greater amounts would have a lesser guarantee but would help to ensure against additional depletions of flow. Administering instream-flow rights might become a problem if the stream naturally loses water by seepage into adjacent aquifers, e.g., the lower Platte River.

Where one or more senior rights exist near the mouth of a stream, sufficient flow to meet exercise of those rights is guaranteed except when precipitation or storage releases upstream cannot supply the amount of the right. Conversely, where exercise of senior rights at upstream locations exhausts the water supply that otherwise would be available downstream, downstream flow for instream use cannot be guaranteed. Therefore, granting of natural flow permits for instream uses would not be effective within any stream reach that sometimes requires administration.

If the legislature were to declare that natural flow permits could be granted for instream uses, the likely impacts on the four stream sites selected for analysis would be identical. Because none of the streams have a record of ever having been dry at the specified location, such a permit would help to prevent such an occurrence in the future. Reasonable maximum discharge rates that could be applied for (but not guaranteed completely) at the four selected stream sites are as follows:

Long Pine Creek near Riverview – 75 cfs.
Platte River at North Bend – 125 cfs.
Little Blue River near Fairbury – 35 cfs.
Ninemile Creek near McGrew – 40 cfs.

Flows of these amounts could be met except on rare occasions.

ENVIRONMENTAL IMPACTS

This alternative has statewide potential for environmental benefits in water characteristics, fauna, recreation, and aesthetics. This alternative would apply to those regions having streams with unappropriated flow, i.e., the north central and eastern portions of Nebraska.

The issuance of natural flow permits to maintain flows for important instream uses has the potential to result in environmental benefits in the areas of water characteristics, fisheries, recreation, and aesthetics for three of the four streams evaluated – Long Pine Creek, Lower Platte River and the Little Blue River. There is no impact on Ninemile Creek as its flow is fully appropriated.

SOCIAL-ECONOMIC IMPACTS

The social and economic impacts of issuing water rights would have impacts on site specific stream reaches and regions surrounding some reaches. As stated in the hydrologic impacts, the issuance of an instream water right would achieve the desired results in streams not already being administered for the benefit of senior permit holders. The streams primarily affected by this alternative are several in the north central and eastern portions of the state. The primary impact would involve those streams that have irrigable land that had not yet been developed. In some cases, an instream flow appropriation may preclude the development of a specific site if that site were totally dependent upon stream water for irrigation purposes. Such an impact could be anticipated in the lower and middle Niobrara basin.

The extent to which an instream flow allocation would inhibit irrigation development would be dependent upon the number of sites affected, the size of the allocation for instream uses, and the frequency that junior appropriators would be administered. There would also be some economic benefits spinning off of the environmental benefits, most notably in the area of recreation, fish, and wildlife. These benefits would vary depending on the amount of water that otherwise would be used for irrigation. Hydroelectric power production may also benefit, particularly in the Blue River basins. Statewide impacts would be limited to opportunity costs resulting from inhibited irrigation development at certain sites. There could be some over capitalization by junior appropriators who would be administered frequently to meet the instream flow appropriation.

ADMINISTRATIVE IMPACTS

The regulatory agency, Department of Water Resources, would experience moderate to significant administrative impacts should this alternative be adopted. Initially, little regulatory activity would be required. However, additional activity in administration and regulation would be necessary as the number of appropriations for instream uses increase. Most activity would occur in north central and eastern Nebraska associated with instream flow uses such as aquifer recharge, fish, wildlife, and recreation.

Managerial agencies would experience moderate to significant administrative impacts. Administrative costs will be related to staffing or contractual services for data gathering, determination of minimum flow regimes, and monitoring. For example, the cities of Lincoln and Omaha (as well as several others along the Platte River) would incur administrative costs in determining flows necessary to meet aquifer recharge and thus, supplies needed for human consumption. The data required varies with the method selected for determining flows to meet instream flow needs. It is anticipated that the simpler low cost methods would be used initially with conversion to computer modeling techniques as more precise flow regimes are required. To develop computer models an extensive data base is necessary. Overall costs, although significant during early years, will be only moderate during the long term. Flow monitoring or surveillance will be accomplished in conjunction with other routine activities.

LEGAL IMPACTS

Existing appropriative rights would not be impaired by the adoption of this alternative unless instream uses (or some of them) were given a preference over some other use. If instream uses were preferred over agriculture or manufacturing, prior rights issued for these purposes could be interfered with by the holder of an instream appropriation. However, just compensation would need to be provided before such interference could occur. Another potentially limiting factor is the possibility that no preference could be exercised against the holder of a right issued prior to any

modification of the preference provisions that could be associated with this alternative.

ALTERNATIVE: AUTHORIZE ESTABLISHMENT OF PROTECTED FLOW LEVELS BY THE DIRECTOR OF DEPARTMENT OF WATER RESOURCES*

Description

This alternative provides a different method of setting aside unappropriated natural flow in streams having significant instream values and sufficient unappropriated natural flow to maintain these values. It is similar in many respects to policy Alternative 2 but differs in that an appropriation permit would not be issued for the instream use. Instead, the Department of Water Resources would establish protected flow levels or standards for particular stream reaches. This protected flow level would be set at the rate of flow shown by site-specific studies to be the level of flow needed to maintain the instream uses for which the stream reach is important. This amount of flow would be "reserved" from use by anyone acquiring an appropriation permit after the protected flow level was established. Conditions prohibiting the diversion or impoundment of water when streamflow declined to the protected flow level would be inserted in all subsequently issued permits to appropriate water upstream from or within the protected reach. This alternative could be implemented on a statewide basis or its applicability could be limited to specific streams by the legislature.

The legal basis for this alternative is the power of the state to enforce its policy by imposing, when necessary, conditions upon the exercise of appropriative rights. This power has been upheld by the Nebraska Supreme Court.[177] An advantage of this alternative over Alternative 2 is that the issue of whether and, if so, where to place instream uses in the state's surface water preference provisions is not a concern. A preference only can be exercised by or against the holder of an appropriative right.[178] Because no appropriative right would be issued for an instream use, preferences would not have any effect on the establishment of protected flow levels.

To establish a protected flow level for a particular stream reach, a state agency, political subdivision, or private party first would submit a formal request to the Department of Water Resources that such action be taken. This request would be accompanied by a supporting study performed to determine the amount of flow needed to maintain the instream use or uses for which the establishment of a protected flow level is requested. The legislature could authorize or direct the Department of Water Resources to impose a moratorium on the issuance of new water rights on a stream while an instream flow needs quantification study was being conducted. Notice of the request could be included in the department's monthly listing of water right applications received. A hearing on the request would be held if objections were filed to the establishment of the protected flow level, or if the director of the Department of Water Resources determined on his or her own motion that a hearing would be necessary. Regardless of whether a formal hearing is held, the director would be required to determine whether the amount of flow requested is reasonable, whether unappropriated natural flow is available, and whether establishment of the protected flow level would be in the public interest. The director would be authorized, but not required, to conduct an independent study to determine whether the amount of flow requested was reasonable.

If the director was satisfied that the request was reasonable, that unappropriated flow was available, and that granting the request would be in the public interest, an order establishing the protected flow level would be issued. After the date the protected flow level was established, permits to appropriate water above or within the stream reach for which a protected flow had been established would be conditioned to prohibit the withdrawal or impoundment of natural flow when streamflow declined to the protected flow level. When necessary, closing or restricting orders would be issued to these appropriators in inverse order of the priority dates of their conditioned permits. The holder of the most recently issued conditioned permit would be first to receive a closing order, the holder of the oldest conditioned permit would be last to receive such an order. No closing orders would be issued to holders of permits in which no conditions had been inserted, that is to say, no water rights in existence at the time the protected flow level was established would be affected. If diversions by holders of these existing rights reduced the flow below the level needed for instream uses there would be no recourse under this alternative to prevent their withdrawals.

As the agency responsible for issuing and administering surface water rights, the Department of Water Resources would have a primary role in implementing this alternative. However, the technical expertise of other state agencies, political subdivisions, and private parties would be necessary to quantify the amount of water needed to maintain instream uses. For example, the Game and Parks Commission would have primary responsibility for determining the amount of flow needed for fish, wildlife, recreation, and aesthetics. Public water suppliers would be responsible for providing information on the flow needed to maintain groundwater recharge. In addition, these other parties would share responsibility for monitoring flow conditions and alerting the department when the streamflow was nearing the protected flow level. When notified, the department would issue its closing or restricting orders to any permit holders whose permits were subject to the protected flow conditions.

LEGISLATIVE CHANGES

The legislature would need to declare that it is the public policy of the state to allow the Department of Water Resources to establish protected flow levels on stream reaches having significant instream flow values and unappropriated natural flow when establishment of a protected flow level would be in the public interest. This legislation should specify the procedure to be followed in requesting the establishment of protected flow levels, and the standards to be followed by the Department of Water Resources in deciding whether to approve a request. In addition, the insertion of protected flow conditions in appropriation permits granted after establishment of the protected flows should be explicitly authorized. Granting the Department of Water Resources authority to declare a moratorium on issuance of new appropriative rights while quantification studies are conducted also could be considered.

**This alternative is shown in Chapter 4 as Alternative 4.*

Impacts

HYDROLOGIC IMPACTS

The hydrologic impacts resulting from adoption of this alternative would vary according to the discharge rate and the date the protected low flow was established. If the protected low flow were to be established at a discharge rate no greater than the lowest 1-day mean discharge ever recorded during a period of thirty years or more, the hydrologic impact at the four selected sites would be no different from that described for the previous alternative. Appropriators junior to the date that the protected flow level was established would be unable to exercise their rights during times when discharge declined to the established protected rate. Thus, except in unforeseeable extreme circumstances, flow would not decline to a rate lower than the protected rate. Although additional rights to divert from the stream still could be granted, the times that those rights could be exercised would be fewer than if the protected rate had not been established.

ENVIRONMENTAL IMPACTS

The statewide and site-specific environmental impacts for this alternative are the same as the Alternative – Declare that natural flow permits may be issued for instream uses.

SOCIAL-ECONOMIC IMPACTS

The social and economic impacts of this policy alternative would essentially be the same as the previous policy alternative. That is, inhibition of irrigation development in the north central and eastern portions of the state would occur and benefits associated with recreation and fish and wildlife would be maintained. In addition, hydroelectric power production would benefit, especially in the Big Blue and Little Blue river basins. This alternative may help alleviate over capitalization by junior appropriators as they would receive specific guidelines indicating the flow levels at which the new appropriation would be administered.

ADMINISTRATIVE IMPACTS

The regulatory agency would experience moderate to significant administrative impacts similar to those of the previous alternative. Increases in staff and associated expenditures would be necessary. The majority of administrative impacts would occur in north central and eastern Nebraska where several streams with unappropriated flows still exist. Impacts would be associated with extra personnel needed in the field offices for the administration and regulation of flows. This includes such activities as verifying, monitoring, evaluating, recording and researching the effectiveness of instream uses and permits as well as regulating users. Even though much of the regulating could be administered under the complaint system presently used, the above activities would still be necessary for proper administration and regulation.

The managerial agencies would experience moderate to significant administrative impacts similar to those of the previous alternative. The administrative costs for this alternative will be related to staffing or contractual services for data gathering, determination of minimum flow regimes and monitoring.

The possibility of interference with existing rights presented under the previous Alternative – Declare that natural flow permit may be issued for instream uses (see discussion of preferences) does not exist under this alternative because no appropriation permit would be issued for instream uses. Therefore preferences would not apply.

ALTERNATIVE: PROVIDE FOR A STATE ADMINISTERED SYSTEM OF PROTECTED RIVER REACHES*

Description

Allowing instream appropriations of natural flow or establishing protected flow levels would help to protect the scenic, recreational, fishery, and wildlife values of a stream. However, the construction of impoundments and roads, channel alterations and modifications of the landscape associated with a stream have an adverse impact on these values. A greater level of protection for these instream uses could be provided by creation of a state administered system of protected river reaches.

To be eligible for inclusion in the system, a feasibility study would be conducted to identify and evaluate those qualities which make a stream appropriate for inclusion in the system. Any citizen, group, agency, or political subdivision could request the study of a stream reach. Stream reaches that were generally unpolluted and relatively free of cultural intrusions such as power plants, roads, railroads and impoundments and had outstanding scenic, recreational, fishery and/or wildlife values would be eligible for inclusion in the system. Adjacent lands needed to preserve and manage the scenic, recreational, fishery, or wildlife values also could be included in the system.

Among the items addressed in the study would be the hydrologic characteristics of the stream reach; the extent to which it had been modified by impoundments, channelization, or residential developments; water quantity and quality problems; notable features of the stream such as vegetation, geology, fish, and wildlife; recreational potential; and public access and use facilities. In addition, the study would address long term management objectives for the stream reach such as plans for land use regulation and the acquisition of easements or lands. A study to quantify the amount of streamflow needed to maintain the instream values for which the stream was recommended for inclusion in the system also would be conducted.

If, after the study was completed, the responsible planning agency found the stream reach eligible for designation as a protected river reach it would submit its study report and findings to the legislature. The legislature would have responsibility for designation.

Once a river segment was included in the system, permits would be required for the construction of roads, sewage facilities, surface water impoundments, rip-rapping, channelization, diversions, canals, or any other development that could change the character of the river or impair its scenic wildlife, fishery, or recreational values. No use or development of the water or related lands within a specified distance, for example one-fourth mile, of a river reach included in the system could be approved if it was found the use or development, when considered alone or in conjunction with existing or approved cultural intrusions,

**This alternative is shown in Chapter 4 as Alternative 6.*

would have a significant adverse effect on the values for which a river or stream was included in the system.

Designation as a protected river by the legislature would authorize acquisition of conservation and preservation easements by purchase, gifts, or will to ensure certain lands along the stream reach would not be developed. In addition, state and local agencies or units of government would be required to exercise their powers in a manner consistent with the act and the report approved by the legislature. For example, the Department of Water Resources would be required to insert protected flow conditions, as described in Alternative 4, in new permits for surface water use above or within stream reaches included in the system.

LEGISLATIVE CHANGES

Legislation would be needed to authorize the planning and management agencies to conduct the appropriate stream studies. Provision would also have to be made for the permit system for construction activity or uses that would result in an adverse impact on a stream reach included in the system. In addition, the statutes regulating surface water appropriations would need to be amended to require the Department of Water Resources to insert protected flow conditions in new appropriation permits for water use from stream reaches included in the system.

Impacts

HYDROLOGIC IMPACTS

Protection of the reach of the Niobrara River between the mouth of Antelope Creek and the upper end of the proposed Norden Reservoir would mean that additional water resource developments would be limited within that reach and possibly upstream from it.

Since no large developments are proposed within the Platte River from the mouth of the Loup River to its confluence with the Missouri River, inclusion of this reach within a system of protected river reaches would have little effect on its flow regime. It would, of course, forestall any major developments that might otherwise occur within that reach. Designation of this reach as a protected river would inhibit development of major water resources projects for which water right had not been filed.

Several years ago, the U.S. Corps of Engineers proposed construction of a dam on the Platte River near Ashland. Although opposition to such construction was great at that time, an identical proposal might meet with approval some years hence if the reach is not given protection. Other developments could be expansion of existing well fields and possible development of new well fields that could induce additional seepage from the river. Unlike diversions for irrigation, seepage induced by pumping from public supply wells would not be confined to the summer season when river flow is likely to be the least.

Prospects that the Dismal River's flow would be depleted by diversions for out-of-stream use are small. Hence, inclusion of the Dismal River in a system of protected river reaches probably would have little effect on the flow regime other than preventing developments that are only remotely possible. If groundwater withdrawals were near enough to the river to induce recharge from it, the Dismal's average discharge would decrease slightly, but groundwater withdrawals a mile or more away from the river would need to be very great to have any appreciable depletion effect on the river. Since groundwater withdrawals tend to be concentrated in places where the water table is at a shallow depth, they are more likely to result in salvage of natural losses due to evapotranspiration than in reduction of groundwater seepage into the river. Thus, protection of the reach would require not only prohibition of diversions but also control of groundwater withdrawals close enough to the river to induce recharge from it. Stream flow protected by this alternative would continue to be available for downstream uses.

ENVIRONMENTAL IMPACTS

A protected rivers program would be applicable to so few streams that statewide environmental impacts would not be expected. However, the applicable streams are sufficiently important that such a program would have statewide significance.

Regarding site-specific impacts, this alternative would result in environmental benefits in the area of maintaining and enhancing resources contributing to the recreation potential of the Niobrara and lower Platte rivers. Little or no change is expected in the case of the Dismal River, since land use changes and water use developments are not expected to occur on that river.

SOCIAL-ECONOMIC IMPACTS

The social and economic impacts of this policy alternative are also restricted to the few streams in Nebraska meeting the criteria of the scenic river legislation. It is doubtful whether the areas adjacent to the streams would have extensive areas of irrigable lands, therefore the impacts of this policy alternative on irrigated agriculture would be minimal. If streamflow protection was expanded to include large areas upstream, major irrigation development could be inhibited if water right applications had not been filed.

Benefits from this policy alternative would be realised by recreation, fish, wildlife, and aesthetic values. These benefits are spin-offs of environmental benefits in site specific areas.

ADMINISTRATIVE IMPACTS

The regulatory agency may experience up to moderate administrative impacts. Some staff increases and associated expenditures by the regulatory agency would be required for administering and regulating users. Due to the few stream reaches that would be affected, the impact would be moderate.

Any managerial agency would experience no impact to moderate impact. The estimate of administrative impact of this alternative is based on the assumption that flow maintainence in a protected rivers program is only a part of the overall planning of such a program. The level of precision required to determine flow levels for recreation and aesthetics is not as high as that for other instream uses and could be determined as a small part of very detailed plans required for each of the rivers in a protected rivers program.

LEGAL IMPACTS

Since the Alternative – Authorize establishment of

protected flow levels – is included within this alternative, the impacts identified for the previous alternative would occur if this alternative was adopted.

In addition, the property rights of landowners along a protected river reach could be restricted if land use controls were enforced. Land uses and developments that would have significant adverse affects on the values for which the river was included in the system could be prohibited. Any prohibition which amounted to a "taking" or "damaging" of the property would require compensation.

ALTERNATIVE: DECLARE THAT INSTREAM FLOW NEEDS MAY BE MET THROUGH THE USE OF STORED WATER*

Description

Because the natural flow in many Nebraska streams is fully appropriated at certain times in some or all years, adoption of Alternative 2 (natural flow permits for instream uses) or Alternative 4 (establishment of protected flow levels) would not prevent the impairment of instream values on these streams throughout the year. However, instream flow in some of these stream reaches could be maintained through the use of surplus water stored in reservoirs. Although Nebraska law does not explicitly authorize the use of stored waters to meet instream flow needs, the Department of Water Resources has interpreted state statutes to allow the issuance of storage use permits for this purpose.[179] In spite of this interpretation, no public or private entity has attempted to use stored water as a means of maintaining instream flows. If the legislature believes this "strategy" should be encouraged, it could provide specific authorization for a program to supply stored water to maintain instream flows in those streams in which unappropriated natural flow is not available for that purpose.

Stored waters could be obtained by a number of means. A state agency, political subdivision, or individual could enter into an agreement with the owner of an existing storage facility (e.g., an irrigation, reclamation, or natural resources district) to obtain water service. Storage use permits to allow the release of water into a stream would be obtained from the Department of Water Resources. Alternately, the Game and Parks Commission currently holds some rights to stored water throughout the state and, if necessary to prevent the dewatering of a stream, could use water presently stored for other purposes to maintain instream flows. Releases of surplus stored water for instream flow maintenance could be also incorporated into the operation plan for an existing or new multipurpose reservoir.

When stored water subject to a storage use permit is released into a stream it cannot legally be diverted or impounded by other appropriators without an agreement with the owner of the storage facility. The Department of Water Resources has authority to "police" a stream in which stored water has been released to prevent its unauthorized use and the holder of a storage use permit for instream flow maintenance would be entitled to obtain the same protection.

The Nebraska Department of Water Resources would issue and administer storage use permits obtained for this purpose. A variety of public and perhaps private entities could be explicitly authorized to use stored water for instream flow maintenance. For example, storage use rights could be held by: the Game and Parks Commission for fisheries, wildlife, recreation, and aesthetics; a natural resources district or public water supplier for groundwater recharge; the Department of Environmental Control, a municipality, or sanitary and improvement district for water quality maintenance; or a livestock producer for livestock watering. The holder of the storage-use permit would be responsible for notifying the Department of Water Resources when releases would be made. The Department would be responsible for issuing closing orders when necessary to prevent the unauthorized use of released water.

This alternative is shown in Chapter 4 as Alternative 7.

LEGISLATIVE CHANGES

To provide explicit statutory authority for a program of this nature, the present statutes regarding storage and storage-use permits could be amended, or a new section enacted, to allow expressly for the acquisition of these permits and the use of stored water to maintain instream flow. Entities the legislature desires to hold such rights could be mentioned specifically.

In addition, statutes regarding irrigation districts, reclamation districts, public power and irrigation districts, and natural resources districts could be amended to authorize these districts to provide water service to an entity desiring to use stored water to maintain instream flow.

Statutes regulating any public entity authorized to use stored waters for instream flow protection also could be amended to allow it to obtain water service, acquire storage and storage use permits, and expend public funds for this purpose. The legislature also could amend the statutes relating to the Resources Development Fund to authorize the Natural Resources Commission to provide funding assistance for a project or project component designed to maintain instream flows.

Impacts

HYDROLOGIC IMPACT

Water in reservoirs generally is classified as unusable, or "dead," if below the level of any outlet, and as usable if above the level of any outlet. The usable capacity ordinarily is related to the purpose(s) for which the reservoir was created. Storage may be for irrigation, hydroelectric power production, public or industrial supply, recreation, or for control of floods. In some circumstances, water released for power production can be used later for some consumptive purpose. Water impounded for flood control is released as soon as it can be conveyed downstream without causing damage. Except for the flood-control storage, usable storage generally is committed to some particular use. Since amounts of future inflow to a reservoir are uncertain, any water stored for irrigation use but not released in one season is kept in reserve for the next season. In other words, little or no stored water is currently available to provide for instream flow needs.

Usable storage capacity possibly could be increased in some reservoirs by adding to the height of the dam and thus provide water that could be released to maintain downstream flow at a significant rate. However, since

inflow amounts to some reservoirs occasionally (chronically, in some cases) are less than enough to provide for the original purposes of storage, adding to the usable storage capacity in those reservoirs would provide no guarantee that water would be made available for instream flow needs. Only reservoirs having inflows consistently greater than their present storage capacity have a potential for increased storage and then only if topographic and geologic conditions permit increasing the dam's height. Where water released from storage is conveyed by the stream channel to a point of diversion several miles downstream, the flow between the release and diversion points can be used to maintain an open channel and to provide recreational opportunities, such as swimming and boating for part of each year. For example, releases from Harlan County Reservoir during the irrigation season afford flows for boating and canoeing between it and the Superior-Courtland diversion dam, a distance of about forty-five miles.

Creation of new reservoirs having as their principal purpose the storage of water for maintenance of flow is a possible solution to problems of low flows insufficient for desirable instream uses. However, whether the cost of storage features for this purpose is justified is an important consideration.

No surplus storage of consequence exists in the drainage area of the North Fork Big Nemaha River above Humbolt at the present time. Therefore, new reservoirs would be needed to provide storage for maintenance of a guaranteed low flow. The rate of such flow would dictate the quantity of storage needed. Since flow upstream is not gaged at any point, the runoff characteristics of the basin would need to be evaluated to determine how large a drainage area would be required to provide the needed storage.

Storage facilities would have no hydrologic impact on the streams draining the upgradient areas. Downstream from the reservoir(s), flow greater than a specified minimum could be maintained by controlled releases. Storage would tend to decrease the potential for downstream flooding and lessen the problems of erosion generally associated with flooding. However, minor erosion problems might occur immediately below the dam because the water released would be virtually free of sediment.

Very small daily discharges have been measured in the reach of the Republican River from Harlan County Dam to Guide Rock. These low flows result from impoundment of all inflow to the Harlan County Reservoir. Large releases are made during the summer for irrigation of about 86,000 acres of cropland in Nebraska and Kansas. The storage capacity of the reservoir (exclusive of storage for flood control) is 319,800 acre-feet, but storage in the beginning of the irrigation season was less than 200,000 acre-feet in some years during the drought of the middle 1950's. Thus, releases during the non-irrigation season to maintain a specific minimum flow could mean occasional short supplies for downstream irrigation use.

Hydrologic impacts other than increasing the river's discharge during the non-irrigation season would be relatively minor. Vegetation possibly would have less opportunity to encroach on the river channel, thus helping to keep the channel clear.

Lake Ericson, a small onstream reservoir, is located on the reach of the Cedar River above Spalding. This reservoir possibly could be operated to provide releases that would prevent future occurrences of low flow at Spalding. If not, storage would need to be created elsewhere in the reach to provide such releases.

The hydrologic impacts of guaranteeing that flow would not be less than specified minimum of 100 cfs would be small because such occurrences have been uncommon and of short duration. If, as possibly might happen, pumping from wells were to result in significantly less groundwater seepage into the river channel, storage reservoirs may need to be constructed if a specified minimum flow is to be maintained. In determining the release rate necessary to maintain a specified minimum discharge at some downstream location, possible consumptive losses in the intervening distance would need to be considered.

ENVIRONMENTAL IMPACTS

This alternative has potential for use in all regions of the state. It should be recognized that the proper siting of dams and reservoirs is essential to realize net environmental benefits.

Potential environmental benefits exist in the areas of water characteristics, flora, fauna, and recreation and would occur on a site-specific basis. Benefits would accrue from this alternative to each of the rivers selected for evaluation. These rivers include the North Fork Big Nemaha River, Republican River, and Cedar River. The level of aesthetic value of these rivers would not be changed. Some aesthetic characteristics might be improved while others would likely be diminished, therefore no net gains under the aesthetic category are expected.

SOCIAL-ECONOMIC IMPACTS

Because this policy alternative deals only with stored water, there would be little or no impact to existing irrigated agriculture in any area of the state. There could be some opportunity costs to irrigated agriculture in some areas of the state. Public values and environmental values would improve in the streams affected. Stream related recreation, fish, and wildlife benefits would need to be balanced against the loss of those values in the reservoir.

ADMINISTRATIVE IMPACTS

The regulatory agency would experience moderate impact if this alternative was adopted. Assuming stored water could be obtained and released in high value streams the regulatory agency would need additional staff for the administration and protection of flows released downstream from the storage reservoirs.

Managerial agencies would be expected to experience no impact to moderate impact. It is assumed that storage projects will not be constructed exclusively for augmentation of low flows and that future use of the alternative will be limited to multiple purpose projects. Therefore, the costs to managerial agencies of this alternative will be low and can be carried out in conjunction with other routine activities.

LEGAL IMPACTS

No legal impacts are anticipated with the exception that land could be condemned for the purpose of building storage facilities. Just compensation would have to be provided in all cases.

ALTERNATIVE: AUTHORIZE THE DEPARTMENT OF WATER RESOURCES TO REASSIGN ABANDONED OR UNUSED NATURAL FLOW PERMITS FOR INSTREAM USES*

Description

Because the flow of most streams is already committed to holders of existing natural flow appropriations, allowing the issuance of natural flow permits for instream uses or inserting protected flow conditions in new permits would not provide any significant protection for instream flow values on these streams. However, if an existing water right is abandoned or has not been exercised for three consecutive years it may be cancelled by the Department of Water Resources, after notice and a hearing. Low flow conditions in stream segments that are fully appropriated for out-of-stream uses at present could be improved if the legislature authorized the Department of Water Resources to take natural flow permits that were abandoned or not used for the statutory period and reassign them, with the original priority date still in effect, to a private party or public entity authorized to hold natural flow permits for instream uses. The holder of the reassigned permit would be entitled to have the Department of Water Resources issue closing or restricting orders to any junior appropriator who was withdrawing natural flow to the detriment of the instream use or uses to which the reassigned permit applied.

The Department of Water Resources would continue with their water right cancellation program and notify public entities who were authorized to hold instream rights when abandoned or unused permits became available for reassignment.

LEGISLATIVE CHANGES

Section 46-229.04 R.R.S. 1943 would need to be amended to allow the Department of Water Resources to reassign abandoned or unused rights.

Impacts

HYDROLOGIC IMPACTS

Reassignment of abandoned or unused natural flow permits to instream flow permits would result in flow rates greater than they would be if natural flow permits had been exercised. Since the priority dates of the abandoned and unused permits would not be the same and their locations would differ, several permits generally would need to be acquired to achieve a significant increase in low flows. Two stream reaches have been selected for impact analysis, the Elkhorn River (near Norfolk) and the Little Blue River (near Fairbury).

Many abandoned or unused permits would need to be reassigned to instream flow permits to effect a significant increase in low flows of the Elkhorn River near Norfolk since the average rate of flow allocated under existing rights is less than 1 cfs. This alternative could serve to increase the discharge rate and depth of low flows, the hydrologic impacts resulting from adoption of this alternative would be negligible.

If the transfer of abandoned or unused permits to instream flow permits were authorized, a great many transfers of permits having an early priority date would need to be made before an appreciable increase in low flows of the Little Blue River near Fairbury could be guaranteed.

If low flows of the Little Blue River near Fairbury were to be increased by transfer of rights, the additional benefits would be increased uniformity of flow and slightly greater width and depth.

ENVIRONMENTAL IMPACTS

This alternative rarely would be used since senior water rights seldom are abandoned, other than a relatively few permits for hydroelectric power production. Therefore, the impact of this alternative would be local and site-specific and would not be expected to have statewide impact. The site specific impacts, however, would not be significant as few senior water rights are cancelled.

SOCIAL-ECONOMIC IMPACTS

Because the location, priority date, and volume of water appropriated to abandoned and unused permits cannot be determined, it was deemed not possible to assess the economic impacts of this policy alternative. It could be assumed that most of the appropriations that are unused or abandoned are done so because the value of those rights is low to the user, most likely because the permit is junior and is subject to frequent administration. There would be little impact of assigning a junior permit to an instream appropriation. However, appropriators with rights junior to the transferred rights could experience a less dependable supply of water.

ADMINISTRATIVE IMPACT

The regulatory agency would incur moderate impacts. The agency could become involved with some litigation that may develop over controlling and administering the reassignment of abandoned or unused natural flow permits. Administrative activity would also be needed in the area of monitoring, controlling and administering the reassigned permits.

This alternative would result in no impact for managerial agencies. Its use would be so limited that it could be easily carried out by existing staff in the conduct of routine duties.

LEGAL IMPACTS

Existing water rights and property interests would not be impaired by adoption of this alternative. The holders of water rights reassigned would have lost the water right by abandonment of nonuse prior to its reassignment.

ALTERNATIVE: ALLOW VOLUNTARY TRANSFERS OF NATURAL FLOW PERMITS FOR INSTREAM USES*

Description

If existing natural flow permits could be voluntarily sold, leased, or donated to public or private entities, they could be used to maintain flows in streams that otherwise

This alternative is shown in Chapter 4 as Alternative 9.

This alternative is shown in Chapter 4 as Alternative 10.

might become dry. Whether such transfers can be made under existing law is not entirely clear. A number of commentators on the subject of the transferability of water rights in Nebraska have concluded that appropriative rights for irrigation issued since 1895 cannot be transferred apart from the land to which the right applies.[180] These conclusions have been based upon statements made in Nebraska Supreme Court cases and a federal court case, and certain statutory provisions.[181] However, the statutory prohibition against transfers of appropriative rights appears to apply only to water rights obtained by an irrigation district.[182] Therefore, the use of this statute in court opinions as authority for the proposition that appropriative rights are not transferable may be questioned and the issue is in need of clarification. If the legislature feels voluntary transfers of natural flow permits apart from the land to which they apply should be allowed as a means of maintaining instream flows, such transfers could be authorized explicitly.

The only purpose for which water right transfers would be allowed under this alternative is to maintain instream uses. Transfers between other uses such as agricultural water rights to industry will be addressed in a policy issue study on the transferability of water rights.

All transfers would be strictly voluntary. A request for approval of the transfer and change in use would have to be filed with the Department of Water Resources. The request would be granted unless objections were filed by holders of existing appropriative rights. If formal objections were raised, a hearing would be held on the issue of whether the transfer would affect the objecting appropriator adversely. If the objector was unable to demonstrate that his or her right would be damaged, the transfer would be approved. If some potential damage was shown, approval of the transfer could either be denied or approved subject to conditions that would protect the interests of the other appropriator.

Transferred permits would continue to be administered on the basis of their original priority date. If necessary to maintain streamflow for the instream use to which the transferred natural flow permit applied, the Department of Water Resources would restrict diversion by holders of natural flow permits with later priority dates.

LEGISLATIVE CHANGES

A new statutory provision would be needed to authorize the sale, lease, or donation of existing natural flow permits for the purpose of maintaining instream flow. Provision also should be made for the Department of Water Resources to conduct a hearing on transfer requests if objections were filed by other appropriators. In addition, the standard for review by the department would need to be specified.

Impacts

HYDROLOGIC IMPACTS

The implementation of this alternative could serve to increase low flows in certain stream segments. The degree to which flows would be increased and maintained, however, would depend on the priority dates attached to the transferred rights and the total quantity of flow allocated to them.

Voluntary transfer of some senior appropriation rights to instream flow rights would prevent a recurrence of the previously, unprecedented low flow of less than 1 cfs recorded at Humboldt in the North Fork Big Nemaha River. This low flow occurred during twenty-one days out of twenty-nine days during the summer of 1977. However, to obtain a larger guaranteed minimum discharge, e.g., 15 cfs, as many as fifteen of the senior rights would need to be transferred.

Since the lowest mean daily discharge of the Little Blue River near Fairbury since 1929 was slightly more than 30 cfs, a fairly large number of older appropriation rights would need to be transferred to instream flow rights to guarantee a minimum flow significantly greater than 30 cfs. If such could be achieved, the hydrologic impacts would be the same as described for the stream site under Alternative 5. Authorize the Department of Water Resources to reassign abandoned or unused natural flow permits for instream uses.

Flow in the Republican River near Guide Rock is almost wholly controlled by operation of the several upstream reservoirs, particularly Harlan County Reservoir. Unless rights to divert from Turkey Creek, Thompson Creek, Center Creek, and other tributaries flowing into the Republican River below Harlan County Dam were to be transferred to instream flow rights and the inflows from these streams were to remain in the Republican instead of being diverted at the Superior-Courtland dam, periods of virtually no flow near Guide Rock are likely to recur.

The hydrologic impacts of guaranteeing that tributary inflows below Harlan County Dam remain in the river as far as Guide Rock would not necessarily guarantee a very large minimum flow there but probably would ensure larger minimum flows in the future than in the past.

ENVIRONMENTAL IMPACTS

This alternative has potential for application in several regions and therefore would have a statewide impact. Notable benefits could accrue in the following resource components: water characteristics, fauna, flora, recreation, and aesthetics.

Cost would be a controlling factor. Notable benefits could accrue for protection of fishery resources in some streams, e.g., North Fork Big Nemaha River.

SOCIAL-ECONOMIC IMPACTS

The degree of economic impact that this policy alternative would have is dependent upon the basin in which the water right is located, the priority date of the transferred right, its location in the watershed, the number of junior permits affected, the number and productivity of the acres affected, the quantity of water allocated to the transferred right, and the value of the instream uses affected. It is impossible to estimate any of these variables with any degree of certainty. Therefore no estimates of the social-economic impact of implementing this alternative is given. However, impacts to irrigated agriculture and related economic development would tend to be negative in those areas where instream flows are maintained.

ADMINISTRATIVE IMPACTS

The regulatory agency may experience a moderate impact with this alternative as it may be involved in admin-

istrative hearings over transfers. Increased administration and control would be needed because water rights on several streams might change. Additional activity will be generated due to need for monitoring, verifying, evaluating and regulating the established and transferred flow permits.

The managerial agencies will experience no impact. The use of this alternative would be so limited that it could be easily carried out by existing staffs in the conduct of routine duties.

LEGAL IMPACTS

The usefulness of this alternative is dependent on adoption of Alternative – Declare that natural flow permits may be issued for instream uses, so it is assumed that the impacts described under that alternative would already be occurring. There would be no additional legal impacts from adoption of this alternative. All transfers would be voluntary and Department of Water Resources would condition approval of transfers upon their not affecting other water rights adversely.

ALTERNATIVE: DECLARE THAT GROUNDWATER MAY BE USED TO SUPPLEMENT NATURAL FLOW TO MEET INSTREAM FLOW NEEDS*

Description

Another way to augment flow in stream reaches where the natural flow is fully appropriated at critical times is to authorize the pumping of groundwater into a stream when its flow falls below the level needed to maintain instream uses. When necessary to meet an emergency situation, a public entity or private party desiring to augment the natural flow of a stream would either construct a new well from which groundwater could be pumped into the stream, or contract with the owner of an existing well for a water supply. Although this alternative would be of limited usefulness on the state's larger streams, it would provide an effective method of temporarily supplementing streamflow in a relatively small stream having especially significant instream values, for example, a small trout stream.

For this alternative to be effective, groundwater pumped into a stream would have to be accorded the same legal status as stored surface water which is released into a stream. That is, the Department of Water Resources would need to be empowered to prevent appropriators from diverting or impounding this supplemental water as it moves downstream.

The Department of Water Resources would be assigned the primary management role under this alternative. The department would be responsible for "policing" a stream reach into which groundwater was pumped to maintain instream flows in order to prevent diversions of that water by other users along the stream. The public entity or private party who had constructed the well, or contracted for a water supply with the owner of an existing well, would be responsible for notifying the department when it intended to pump groundwater into the stream.

LEGISLATIVE CHANGES

The legislature would need to declare that the use of groundwater to temporarily augment natural flow when necessary to protect specific instream uses is a reasonable and beneficial use of groundwater. In addition, the legislature would declare that groundwater pumped into a stream for instream flow maintenance is not subject to appropriation and direct the Department of Water Resources to ensure that no unauthorized diversions of that water occur.

The statutes of the Game and Parks Commission and any other public agency the legislature wishes to use groundwater for the benefit of instream flow values should also be amended to grant explicit authority for such action.

Impacts

HYDROLOGIC IMPACTS

If an ample groundwater supply underlies a stream, pumping of groundwater into the stream could supplement low flows sufficient for instream flow needs. A well discharging 1,800 gallons per minute would increase stream discharge by 4 cfs. Such supplementation of flow would be more feasible along smaller streams and probably would be impractical along a broad braided stream such as the Platte River. Where a good hydraulic connection exists between the aquifer and the stream, water pumped from the aquifer at a generally high rate would be replaced soon by seepage from the stream. Generally supplementation of flow would be necessary for only a week or two and in some years would be unnecessary.

Two streams, the Little Blue River at Fairbury and Thompson Creek at Riverton were selected for hydrologic impact analyses if this alternative were to be adopted.

At several locations along the Little Blue River and its principal tributary Big Sandy Creek, large yield wells could be drilled and then pumped to supplement low flows downstream to Fairbury and beyond. Unfortunately, the hydraulic connection between stream and aquifer is relatively poor in most places, therefore subsequent replenishment of the aquifer by seepage from the river could not be achieved easily.

A relatively ample groundwater supply underlies part of the area drained by the several small streams that converge to form Thompson Creek. Hence, wells could be drilled in this area to obtain groundwater for supplementing downstream low flows. Since the headwater streams are not hydraulically connected to the aquifer, replenishment of the aquifer by subsequent seepage from the river would not occur. Replenishment could be achieved, however, by using recharge wells to inject stream water into the aquifer after flow had increased naturally.

ENVIRONMENTAL IMPACTS

The use of this alternative would be so costly that environmental benefits would be expected to be limited to local and site specific situations only. The alternative might be put to very limited use to protect high value fishery resources in selected stream segments. However, significant environmental impacts on streams such as the Little Blue River and Thompson Creek would generally not be expected because implementing and operating this alternative would probably be less cost effective than restocking.

**This alternative is shown in Chapter 4 as Alternative 12.*

SOCIAL-ECONOMIC IMPACTS

There would be no statewide or regional impacts associated with this policy alternative because of the site specific nature of implementation. Due to the relatively high costs involved with withdrawing groundwater for any reason, it is doubtful this policy alternative would be utilized frequently. The benefit cost ratio of pumping groundwater to sustain instream values would be negative in most cases. Fisheries values may be high enough in some stream segments to justify short term pumping to augment stream flows in order to avert a fish kill, but the probability of having a well and pump located along the proper stream segment at the critical time is low.

ADMINISTRATIVE IMPACTS

The regulatory agency would be expected to experience moderate impact. This alternative could generate considerable activity when implemented which would continue as long as the permits were in force. Activities in monitoring, verifying, evaluating and regulating would be necessary for proper administration.

The managerial agencies would be expected to experience no impact. Use of this alternative would be so limited that it could be easily carried out by existing staffs in the conduct of routine duties.

LEGAL IMPACTS

Adoption of this alternative might impair existing property interests in the vicinity of the well used to supplement natural flow if groundwater levels were lowered significantly. Existing surface water rights would not be affected adversely. In fact, holders of permits below the "protected" reach could benefit from more stable flows.

ALTERNATIVE: IMPOSE RESTRICTIONS ON THE USE OF GROUNDWATER*

Description

In some areas of the state, the withdrawal of groundwater is reducing or may reduce future instream uses.[183] To avoid or reduce these adverse effects, the Legislature could amend the Ground Water Management and Protection Act to authorize the designation of a control area and imposition of restrictions on groundwater use above or along stream reaches having significant instream flow values. A control area could be designated for this purpose only if studies showed groundwater withdrawals were reducing, or would reduce streamflow and impair instream flow values in the foreseeable future. The restrictions that could be imposed would be those that the Ground Water Management and Protection Act currently authorizes a natural resources district to adopt in a control area, including spacing restrictions, rotation, allocations, and imposition of a moratorium on construction of new wells for one or more years.[184]

The same procedure for designating groundwater control areas contained in the current law would be followed in the case of a control area declared because groundwater withdrawals were having an adverse effect on instream uses. Any private person or group, state agency, or political subdivision could attempt to persuade a natural resources district to request a hearing on the question of whether a control area should be designated. These parties could present supporting studies to justify their request. At the discretion of the natural resources district board, it could request the Department of Water Resources to hold a hearing to consider evidence on whether a control area should be established. The director of the Department of Water Resources could, but would not be required to conduct an independent study on the issues presented. The final decision regarding the designation of a control area would be made by the director.[185]

LEGISLATIVE CHANGES

The legislature would need to amend the Ground Water Management and Protection Act to allow a control area to be designated if studies show that groundwater withdrawals are reducing or will reduce streamflow and affect instream uses adversely in the foreseeable future.

Impacts

HYDROLOGIC IMPACTS

Low flows of some streams are maintained by groundwater seepage. Pumping from nearby wells can reduce surface flow by inducing recharge from the stream. Restricting pumping from such wells during periods of low streamflow would halt such depletion. If, however, wells farther from the stream are merely intercepting groundwater that eventually would have seeped into the stream, restricting pumping from those wells during periods of low flow would have little or no beneficial effect because none of the groundwater being removed by pumping would have reached the stream in time to alleviate the low flow problem. A fact not generally appreciated is that only part of the groundwater moving toward a stream ever reaches it. Instead, a significant part is consumed by vegetation having roots that extend to the water table. Streamflow in some reaches may gain from groundwater seepage during the nongrowing season and may lose by seepage into the groundwater reservoir during the growing season. Although use of groundwater may reduce the flow of some streams, it also helps to salvage water that otherwise would be lost to evaporation and to transpiration by vegetation.

Three streams, Long Pine Creek, the Elkhorn River, and the Cedar River, were selected for analysis of the hydrologic impact of the alternative.

A great many irrigation wells have been drilled in the drainage area of Long Pine Creek and its principal tributary, Sand Draw Creek. However, a large part of the upper part of the drainage area is included within the Ainsworth Irrigation District, which is served by water imported via a canal supplied from storage in Merritt Reservoir on the Snake River. Seepage resulting from use of surface water and return of groundwater used for irrigation apparently more than balance consumptive use of groundwater. Hence, the groundwater contribution to the flow of Long Pine Creek near its mouth has increased in the last few years. Restriction of pumping in the drainage area probably would cause future annual lowest 1-day mean discharges and annual mean discharges to be greater but also would result in waterlogging of parts of the irrigation project.

**This alternative is shown in Chapter 4 as Alternative 13.*

Numerous irrigation wells have been drilled in the area drained by the Elkhorn River near Norfolk, but the concentration of wells is not nearly so great as in some other drainage areas. Examination of the annual lowest 1-day and lowest 7-day mean discharges indicates a declining trend in both. Whereas the median of the annual lowest 1-day discharges during the thirty-five years of record is about 120 cfs, the lowest 1-day discharges in the 1979 and 1980 water years were 33 cfs and 14 cfs, respectively. Annual mean discharges indicate no such trend. The decline in annual lowest 1-day and lowest 7-day discharges probably is due in part to pumping from an increasing number of irrigation wells, but also is due in part to an increasing number of permits to appropriate streamflow. Both increases probably are related to the occurrence of less than normal precipitation during the growing season of several years in the period of record. Imposition of stringent restrictions on groundwater pumping probably would help somewhat to increase summer low flows but not restore them to their former higher level unless permits to appropriate water from the river are revoked as well.

In recent years many irrigation wells have been drilled in the area drained by the Cedar River upstream from Spalding. No decrease in the base flow of the river can be demonstrated to date but possibly could occur in the future. In some recent years, 1976 and 1980 in particular, summer discharge was, for a week or two, significantly less than normally occurs. Although attributed by many to pumping from wells, these low flows probably were due mostly to drought conditions and greater than usual appropriations by permit holders.

Since the water table is naturally close to the land surface throughout much of the area drained by the Cedar River upstream from Spalding, pumping from wells results in salvage of groundwater that otherwise would have been lost to the atmosphere by evapotranspiration. Hence, pumping from wells distant from the river (that is, a mile or more away from the river or one of its tributaries) probably has or will have insignificant effect on summer low discharges. Restricting groundwater pumping within a mile of the river might, however, help somewhat to maintain summer discharges but would not be nearly so effective as restricting appropriations by permit holders.

ENVIRONMENTAL IMPACTS

Adoption of a policy to regulate use of groundwater for streamflow enhancement is not believed to have potential for statewide application. Therefore, this alternative would have no statewide environmental impact. However, this alternative could provide site-specific benefits for maintaining water characteristics in streams such as the Elkhorn and Cedar rivers where reduced flows may occur due to groundwater development.

In Long Pine Creek this alternative could serve to increase flows to their optimum level for trout reproduction.

SOCIAL-ECONOMIC IMPACTS

As this policy alternative is written, the language of the Ground Water Management and Protection Act would be extended to include instream uses. There could be some costs to existing groundwater irrigation as the withdrawals are regulated. Potential development of groundwater may be inhibited depending on the type of management techniques used. Streamflow benefits would be environmental related gains. There could be an increased number of surface water permits due to the enhanced streamflows, however any benefits derived from surface water irrigation would probably be less than the losses to groundwater irrigation.

ADMINISTRATIVE IMPACTS

The regulatory agency may incur significant administrative impact. Increased personnel possibly would be needed to monitor groundwater use. Several other entities such as natural resources districts could also experience significant administrative impacts in the form of additional personnel for monitoring activities.

The managerial agencies may incur significant impact. Groundwater monitoring including development of computer models could result in substantial cost.

LEGAL IMPACTS

Existing surface water rights would not be impaired and would probably benefit from more stable flows. However, existing rights to use groundwater could be restricted in certain areas.

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Chapter 7

Alternative State Policies that Limit Options for Maintaining Streamflow for Instream Water Use

This chapter describes four alternative state policies that are designed to clarify ambiguities in existing law by expressly prohibiting the use of particular "strategies" for maintaining instream flows. For each of the four alternatives the legislative changes and the hydrologic, environmental, social-economic, administrative, and legal impacts are identified.

ALTERNATIVE: PROHIBIT ISSUANCE OF NATURAL FLOW PERMITS FOR INSTREAM USES OTHER THAN HYDROELECTRIC POWER PRODUCTION*

Description

As noted previously, the only instream use for which natural flow permits have been issued in Nebraska is hydroelectric power production. The Department of Water Resources has never ruled officially on an application for a natural flow permit for any other instream use, nor has the director of the Department of Water Resources even been given any guidance by the legislature as to whether such permits should be granted if an application is filed. If the legislature decides that the state should not allow the acquisition of natural flow permits for instream uses other than hydroelectric power production, it could prohibit their issuance by the Department of Water Resources.

LEGISLATIVE CHANGES

A declaration would be necessary to the effect that the issuance of natural flow permits for instream uses other than hydroelectric power production is contrary to the public policy of the state.

Impacts

HYDROLOGIC IMPACTS

Granting of natural flow permits for instream uses would help to ensure year round availability of water for instream use in river reaches where summer flows have not yet been wholly depleted by appropriators. This alternative, prohibiting the issuance of natural flow permits, would have the opposite effect. However, it would not necessarily mean that future summer flows would be depleted significantly more than at present.

Long Pine Creek, Platte River, at North Bend, and Little Blue River, above Fairbury, were selected for analysis of the hydrologic impacts of this alternative.

Appropriations of water from Long Pine Creek have never depleted summertime discharge below about 75 cfs. However freezing temperatures in water have resulted in discharges as low as 45 cfs. Since annual lowest 1-day and 7-day mean discharges have tended to be larger in recent years owing to an increase in the groundwater contribution to the creek's flow, adoption of the alternative probably would have little, if any, hydrologic impact on the flow regime of Long Pine Creek.

If current proposals for diversion of water from the Platte River to the Republican, Little Blue, and Big Blue River basins ever materialize, annual discharge of the Platte River at North Bend would decrease. Whether summertime low flows would be affected proportionately would depend on whether the diversions were made only during other seasons of the year or were to occur in summer also. Adoption of this alternative would permit additional reduction of flow at North Bend but it would not necessarily reduce significantly the capacity of the Platte River to recharge the aquifer relied on for public-water supplies. Currently the river's flow exceeds greatly the amount of water needed for such recharge.

So many permits have been granted to appropriate water from the Little Blue above Fairbury that a potential exists for zero flow in an excessively dry year. To date, however, not enough permits have been exercised simultaneously to reduce flow below 31 cfs. Therefore, adoption of this alternative would permit issuance of additional rights to appropriate and would increase the likelihood that more rights would be exercised simultaneously than in the past and that lower flows could result in the future.

ENVIRONMENTAL IMPACTS

The statewide and the site specific environmental impacts would be the same as the impacts of Alternative – Continue Present Policy. That is, a moderate loss to the fishery of Long Pine Creek, and more significant fishery and recreation losses to the Platte and Little Blue rivers are expected.

SOCIAL-ECONOMIC IMPACTS

Because this policy alternative is a reinforcement of present policy, the impacts of implementing this policy

**This alternative is shown in Chapter 4 as Alternative 3.*

would be the same as those listed for alternative – Continue present policy as described in Chapter 5. Briefly stated, these impacts are: continued irrigation in the north-central and eastern portions of the state, and a reduction of several public values associated with maintaining stream flows for instream uses.

ADMINISTRATIVE IMPACTS

There would be no impact on the regulatory agency. Activity would remain at about the same level with no change in present staff or expenditures.

Managerial agencies would experience a moderate impact. The impacts of this alternative will be similar to the Alternative – Continue present policy. These include increased costs such as those for fish stocking and investigations of low flow related problems.

LEGAL IMPACTS

The impacts on existing water rights and property interests would be the same as in the Alternative – Continue present policy as described in Chapter 5. Adoption of this alternative could prevent litigation that could result under continue present policy.

ALTERNATIVE: PROHIBIT EXERCISE OF DIRECTOR'S DISCRETIONARY AUTHORITY AS A MEANS OF PROTECTING INSTREAM USES*

Description

The director of the Department of Water Resources has the legal authority to deny applications for new water rights if necessary to protect the public interest[186] and may also impose conditions on the exercise of newly granted rights if dictated by the state's public policy.[187] Unsuccessful attempts have been made to persuade the director to use this power as a means of maintaining instream flows. Objections have been filed to water right applications and the director has been requested to disapprove the applications on the ground that approval would affect instream uses adversely and therefore would not be in the public interest.[188]

The director might or might not be inclined to use his discretionary authority to protect instream values. Thus, prohibition of that authority without other provision for protection of instream flow values could result in no protection in some cases where protection otherwise might have been afforded through exercise of discretionary authority.

Present law neither expressly authorizes nor prohibits the use of the director's authority in this manner. If the legislature does not feel the director should be able to use this authority as a means of maintaining instream flows, it could prohibit such action.

LEGISLATIVE CHANGES

Needed legislation would state that the director of the Department of Water Resources may not, for purpose of protecting instream uses, deny or impose conditions upon the exercise of new appropriative rights.

**This alternative is shown in Chapter 4 as Alternative 5.*

Impacts

HYDROLOGIC IMPACTS

The hydrologic impacts associated with this alternative should be similar to those discussed under the previous alternative. These impacts would be expected on each of the three streams analyzed: Long Pine Creek near Riverview, Platte River near North Bend and the Little Blue River near Fairbury.

ENVIRONMENTAL IMPACTS

The environmental impacts of implementing this policy alternative would be the same as those listed for Alternative – Continue present policy.

SOCIAL-ECONOMIC IMPACTS

The social-economic impacts of implementing this policy alternative would be the same as those listed for Alternative – Continue present policy.

ADMINISTRATIVE IMPACTS

There would be no impacts on the regulatory agency. The impacts of this alternative to the managerial agencies would be similar to the Alternative – Continue present policy. This includes costs for fish stocking, investigation of problems related to low flows, laboratory routines, and educational programs.

LEGAL IMPACTS

Adoption of this alternative alone would result in impacts similar to those of Alternative – Continue present policy – as described in Chapter 5. However, it might lessen the potential for future litigation.

ALTERNATIVE: PROHIBIT USE OF STORED WATER FOR INSTREAM FLOW MAINTENANCE*

Description

Nebraska law does not explicitly allow or prohibit the use of stored water to maintain instream flow values. If applications for storage use permits for instream flow maintenance are filed with the Department of Water Resources in the future, the director will have no guidance from the legislature on whether to approve or deny the applications. Based on the current administrative interpretation of the law, the application could be approved if it did not suffer from some technical defect. If the legislature does not feel it should be the public policy of the state to allow stored waters to be used for instream flow maintenance, the issuance of storage use permits for this purpose could be prohibited.

LEGISLATIVE CHANGES

Section 46-242 R.R.S. 1943 would need to be amended to prohibit the issuance of storage use permits for maintaining instream flow.

**This alternative is shown in Chapter 4 as Alternative 8.*

Impacts

HYDROLOGIC IMPACTS

Prohibiting use of stored water for maintenance of instream flow would preclude the benefits that might be possible by using stored water to augment low-flow conditions. On some streams, construction of new storage facilities specifically designed to meet instream needs may be the only possible means for maintaining flow for that purpose.

If such use of existing or new storage facilities were to be prohibited on the North Fork Big Nemaha River, occurrences of inadequate flow for instream needs will be about as frequent in the future or even more frequent than in the recent past. Greater frequency is likely if the present state policy of approving permits to store or divert natural flow is continued unchanged.

No surplus water exists in Harlan County Reservoir. Therefore, prohibiting the use of stored water for maintenance of downstream flow in the Republican River would have no different hydrologic impact than would authorization of such use.

On the Cedar River above Spalding the adoption of this alternative would mean that the augmentation of river flow from Lake Ericson could not occur. Therefore, the potential for inadequate flows in the future could not be reduced by this method.

ENVIRONMENTAL IMPACTS

The implementation of this alternative would preclude those specific environmental benefits of the Alternative –

Declare that instream flow needs may be met through the use of stored water. That is, benefits to water characteristics, flora, fauna, and recreation would be forgone.

SOCIAL-ECONOMIC IMPACTS

The impacts of this policy alternative are the opposite of the Alternative – Declare that instream flow needs may be met through the use of stored water. That is, irrigated agriculture and related economic development would continue uninhibited, although environmental values would be impaired.

ADMINISTRATIVE IMPACTS

The Department of Water Resources would incur no administrative impacts because no additional activity would be generated by this alternative.

Adoption of this alternative would preclude those activities estimated to result in moderate impact to managerial agencies in the alternative – Declare that instream flow needs may be met through the use of stored water.

LEGAL IMPACTS

The only potential legal impact of this alternative is possible reduction of litigation.

ALTERNATIVE: PROHIBIT VOLUNTARY TRANSFERS OF NATURAL FLOW PERMITS FOR INSTREAM USES*

Description

As noted, present law is unclear as to whether the holder of a natural flow permit for an out-of-stream use could sell, lease, or donate the permit to a public or private entity for the purpose of maintaining instream flow values. No such transfers are known to have occurred to date but if an attempted transfer of this type should occur in the future, the Department of Water Resources would have no guidance from the legislature on whether to allow it. If the legislature does not feel it should be the policy of the state to allow transfers of natural flow permits as a means of maintaining instream flows, such transfers could be prohibited.

LEGISLATIVE CHANGES

Legislation would be needed to declare that natural flow permits may not be transferred to public or private entities for purposes of instream flow maintenance.

Impacts

HYDROLOGIC IMPACTS

At each of the stream sites selected for analysis, legislative adoption of this alternative together with legislative failure to make any other changes in present state water policy, the hydrologic impact would be the same. The Department of Water Resources would continue to approve applications for permits to appropriate water for beneficial out-of-stream use, and the frequency of low-flow and no-flow problems will increase, especially during protracted dry spells. Three stream sites were selected for analysis: Long Pine Creek near Riverview, Platte River at North Bend, and the Little Blue River near Fairbury.

ENVIRONMENTAL IMPACTS

The site specific impacts on streamflow would be the same as those under the Alternative – Continue present policy.

SOCIAL-ECONOMIC IMPACTS

This alternative is the opposite of Alternative – Allow voluntary transfers of natural flow permits – as described in Chapter 6. The impacts of this alternative can not be predicted.

ADMINISTRATIVE IMPACTS

There would be no administrative impacts on the regulatory agency or the managerial agencies.

LEGAL IMPACTS

The only legal impact is possible reduction of litigation.

**This alternative is shown in Chapter 4 as Alternative 11.*

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[122]See, Neb. Dept., of Water Resources, Forty-third Biennial Report to the Governor of Nebraska, 1979-1980 [Hereinafter referred to as Biennial Report].

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[133]Id. at 354–56.

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[135]P. Gessaman and J.D. Aiken, An Overview of Appropriative Water Rights (Univ. of Neb., Cooperative Extension Service Neb. Guide, April 1979).

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[140]Neb. Rev. Stat. Sec. 46–203–204 (Reissue 1978); See, Nebraska Streamflows, supra note 121 at 353–54; J.D. Aiken, An Introduction to Nebraska Water Rights Law 5 (Univ. of Neb. Ag. Econ. Staff Paper, 1979) [Hereinafter cited as Aiken]. There appears to be different views regarding whether this preference for natural flow permits extends to natural flow permits for any use or only to natural flow permits for irrigation. See, C. Yeutter, A Legal Economic Critique of Nebraska Watercourse Law, 44 Neb. L. Rev. 11, 23 (1965) [Hereinafter cited as Yeutter], wherein the author appears to take the restrictive view. The Dept. of Water Resources takes the position that all natural flow permits are included. Neuberger, supra note 121.

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[152]Neb. Rev. Stat. Sec. 37–406 et. seq. (Reissue 1978).

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[174]See, Neb. Rev. Stat. Sec. 46–235 (Reissue 1978).

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[179]J. Neuberger, "Problems in Maintaining Minimum Stream Flows," published in Rationing the River– The Why and How of Instream Flows 94 (proceedings of symposium sponsored by the Neb. Wildlife Federation, Nov. 4, 1978).

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[185]Id. at Sec. 46-658.

[186]See, Neb. Rev. Stat. Sec. 46-235 (Reissue 1978).

[187]Kirk v. State Board of Irrigation, supra note 177.

[188]In re Objections to the Granting of Application 15654 for a Permit to Impound Water from the Elkhorn River, August 27, 1981 (order overruling objections); In re Applications 15146 and 15148 of the Little Blue Natural Resources District, December 30, 1980 (order approving applications).

Citation style for non-legal material was determined by: *Council of Biology Editors Style Manual*, 3rd edition 1972.

Citation style for legal material was determined by: *A Uniform System of Citation,* 12th edition 1976.

Source Documents

The Instream Flows Policy Issue Study was developed from work element reports that were written by members of the Instream Flow Study Task Force and others.

The work element reports contain additional and more detailed information that was not possible to include in the final report. The following material identifies the scope of those work element reports that were used as source documents for each chapter. Many of the work element reports are unpublished but copies may be obtained from or examined at the designated agencies or the Nebraska Natural Resources Commission.

CHAPTER 1

Chaffin, G., *Report on Instream Recreation and Esthetic Value of Nebraska Streams,* Unpublished report – Work Element 2.6, 1981, Nebraska Game and Parks Commission, Lincoln, Nebraska. 15 pages.

The recreation and aesthetic values of streams are described. The importance of streams for water-based recreation is identified through a description of the stream related state parks, state recreation areas, state wayside areas, wildlife management areas, community parks and privately owned areas. Canoeing is the only recreational activity described in detail. Streams are ranked by their importance for canoeing. Also given is the mileage of the canoeable streams having seasonal flow limitations that restrict canoeing.

Zuerlein, Gene, *Nebraska Stream Fisheries Report*, Unpublished report – Work Element 2.4, November 1980, Nebraska Game and Parks Commission, Lincoln, Nebraska. 44 pages.

The report discusses many aspects of Nebraska's stream fisheries. The relative importance and role of stream fisheries in satisfying recreation needs is described and participation rates by state planning regions are shown. Streams are classified according to type and value for fisheries. A map shows the warm water, cold water and mixed water streams in the state. In addition, a water importance classification map identifies those national, statewide, regional, local, degraded and non-productive streams in the state. The known distribution of state designated threatened species of fish is identified. Factors controlling productivity and/or importance of streams for various fisheries values and the relations of these factors to flow conditions are described. A table lists documented fish kills and gives location, cause, date, severity, and species killed. The final section of the report describes the expected future status of stream fishery resources based on available projections of stream flow conditions.

Dey, Norm, *Nebraska Stream-Related Wildlife*, Unpublished report – Work Element 2.5, September 1980. Nebraska Game and Parks Commission, Lincoln, Nebraska. 24 pages.

The report describes the importance of streams as wildlife habitat. The wildlife discussed in the report are furbearers, upland game, big game, waterfowl, coyote, sandhill cranes, bobcat, shorebirds, hawks and owls, song birds, small mammals and threatened and endangered species. The importance of water to wildlife is also identified in terms of the economic impact of hunting. The number of hunters and trappers for 1979 are given along with total days hunted, total number of animals harvested, value of pelts sold and the revenue derived from hunting and trapping permits sold in 1978. The report further classifies twenty-two streams by their importance to wildlife. The streams are classified high, medium, or low and a description of each stream is included.

Pesek, Thomas F., *Navigation and Other Potential Instream Uses*, Unpublished report – Work Element 2.9, March 1981, Nebraska Natural Resources Commission, Lincoln, Nebraska. 5 pages.

Navigation in Nebraska is limited to the Missouri River from Sioux City, Iowa, to the Nebraska – Kansas state line. The report identifies the flows required for navigation, the length of the navigation season, the commodities transported on the river, and the capacities of a typical tow operating on the river. The future of maintaining navigation on the Missouri River at its present level is discussed in relation to streamflow depletions calculated by the Missouri River Basin Commission and the U.S. Army Corps of Engineers. The other potential instream uses discussed in the report are hydroelectric power production and milling.

Pesek, Thomas F., *Livestock Watering*, Unpublished report – Work Element 2.8, October 1980, Nebraska Natural Resources Commission, Lincoln, Nebraska. 13 pages.

This report deals with the importance and values associated with the use of streams to provide water for livestock in Nebraska. Those river basins in the state where the use of streams for livestock watering is considered to be most important are identified. Alternative sources of livestock water – such as electrically operated groundwater wells, windmills, stock dams and dugouts – are discussed and costs associated with them are estimated. Surveys regarding the monetary value of streams for livestock watering and recent instream stockwatering problems resulting from the lack of flow are included. Nebraska's existing state policy regarding the use of streams for instream stockwatering also is discussed.

Bender, John F., *Relationships of Water Quality and Water Quantity in Selected Nebraska Streams,* Work Element 2.7, April, 1981, Nebraska Department of Environmental Control, Lincoln, Nebraska. 393 pages.

This study was designed and conducted to determine what effects on water quality, if any, may be associated with changes in the amount of water flowing down a stream. It is intended to provide statistically reliable information that can be used with a reasonable degree of confidence in the decision making process concerning instream flows.

Pearson product-moment correlation coefficients were calculated for pairings of streamflow vs. a number of water quality parameters to determine if changes in water quality are associated with changes in water quantity.

Data from 126 stations throughout Nebraska were used in these calculations. The parameters used for these calculations were streamflow, instantaneous streamflow, and the water quality parameters of water temperature, turbidity, conductivity, dissolved oxygen, pH, dissolved solids dried at 105°C, total ammonia, nitrate, orthophosphate, total phosphorus, fecal coliform, fecal streptococcus, suspended solids, dissolved solids dried at 180°C, and un-ionized ammonia.

Correlation coefficients were calculated from the data in six different treatments. These treatments involved all data from individual stations, seasonal data (spring, summer, fall and winter) from individual stations, and data from all stations within a river basin. Correlation coefficients which were considered to be meaningful were those within the 95% confidence limit and having a value of 0.5 or greater. These correlation coefficients were considered to provide an indication that the change of one parameter (water quality) is associated with the change of another (streamflow).

CHAPTER 2

Bentall, Ray and T. Hamer, *Stream-Aquifer Relationships in Nebraska*, Preliminary report – Work Element 2.3, 1980, University of Nebraska – Lincoln, Conservation and Survey Division and the Nebraska Department of Water Resources, Lincoln, Nebraska. 102 pages.

This report presents a narrative description of the present relationship between Nebraska's principal streams and adjacent aquifers. For those streams whose flow regimes have been altered significantly by water resource developments – such as onstream surface reservoirs, diversions for irrigation, return flows from irrigation and hydroelectric power plants, and pumping of groundwater – a description of the changes is also included. In addition, there are graphs displaying the annual lowest 1-day, 7-day mean discharges and the annual mean discharges for each stream.

Pesek, Thomas F., *Methodologies for Determining Unappropriated Flow*, Unpublished report – Work Element 4.4, 1981, Nebraska Natural Resources Commission, Lincoln, Nebraska. 20 pages.

This report defines the term "unappropriated flow" and describes the four methodologies that can be used to quantify unappropriated flow. Twenty streams are used as examples in the discussion of the methodologies.

CHAPTER 3

Hilgert, Phil, *Alternative Methodologies for Determining Stream Flow Requirements for Fishery Resources*, Unpublished report – Work Element 4.1, January 1981, Nebraska Game and Parks Commission, Lincoln, Nebraska. 118 pages.

This report describes the following five methods designed to quantify fishery instream flow requirements: (1) Tennant Method; (2) Modified Tennant Method; (3) Single Cross-Section Method; (4) Incremental – Water Surface Profile Method; and (5) Incremental – IFG4 Hydraulic Simulation Model Method. These methods were applied to thirteen stream segments. The recommended flows are displayed on graphs allowing comparison of the five methods. In addition, the recommended flows for various life stages of certain fish species are plotted.

Pesek, Thomas F., *Methodologies for Determining Instream Flow Requirements for Specified Uses,* Unpublished report – Work Element 4.2, July, 1981, Nebraska Natural Resources Commission, Lincoln, Nebraska. 44 pages.

This report identifies and evaluates alternative methods for determining instream flow requirements for the following uses: livestock watering, navigation, compact commitments, hydro-electric power generation, maintenance of water quality, aquifer recharge and subirrigation. For each of the instream uses the methods used to determine instream flow requirements are described. Wherever possible, seasonal flow regimes for each instream use are identified for selected streams.

CHAPTER 4

Holmquist, Jay, *State Instream Flow Programs,* Unpublished report – Work Element 3.5, August, 1980, Nebraska Natural Resources Commission, Lincoln, Nebraska. 64 pages.

This report describes the ways other states have attempted to ensure that there is sufficient water for maintenance of instream uses. The instream flow policies of the following states are described: Alaska, California, Colorado, Connecticut, Idaho, Indiana, Iowa, Montana, Oregon, Utah, Washington, and Wyoming. In addition, information is also presented on the progress these states have made in implementing their programs, problems

encountered in implementation, and the costs of these programs where available.

Bentall, Ray, *Hydrologic Impacts,* Unpublished report – Work Element 5.3, September, 1981, University of Nebraska – Lincoln, Conservation and Survey Division, Lincoln, Nebraska. 41 pages.

This analysis deals with the identification and description of hydrologic impacts associated with the thirteen alternative policies. Eleven selected stream segments that varied in terms of streamflow characteristics, instream uses, commitment to existing water rights, and potential for future surface water irrigation development were used in this analysis. Changes in future flow conditions on these streams, resulting from the implementation of the respective alternative policies, were projected. Rationale for the projections also are given.

Rodekohr, D. and K. Sheets, *Social-Economic Impacts of Instream Flow Policy Alternatives*, Unpublished report – Work Element 5.4, 1981, University of Nebraska – Lincoln, Water Resources Center and Nebraska Natural Resources Commission, Lincoln, Nebraska. 85 pages.

The purpose of this report is to identify and assess the social and economic impacts of each instream flow policy alternative as identified in previous work elements.

To evaluate the impacts of implementing these alternatives, a list of social and economic factors is developed. The factors are described in terms of their relation to streamflows. Where possible, the range of values that one would expect to find for the factors throughout Nebraska is indicated. Not all of the factors could be quantified easily and in some cases were impossible to quantify. The factors are: surface water domestic use, fisheries, wildlife, hydro-power, recreation, stockwatering, aquifer recharge, aesthetics, interstate compacts, and navigation. Directional change and an approximation of the degree of change was listed in a matrix for each alternative. After listing, the factors were assigned values according to the direction and degree of impact anticipated upon implementation of a particular alternative. The impacts are based upon flow levels resulting from assumptions agreed upon by task force members involved in the impact analysis. Flow levels are assumed to be linked with the amount of out-of-stream withdrawals, especially in dry years. The alternatives are not mutually exclusive, but no attempt is made to evaluate combinations of the alternatives.

Impacts are developed by first analyzing representative streams. These streams are used as an example and are not always "typical" of the region, but they exhibit different characteristics that should be considered when evaluating instream flow policy alternatives. The streams were analyzed at a specified point (i.e., gaging stations) rather than for their entire length. After analyzing each representative stream, the focus of the analysis was expanded to include the region surrounding each stream for each factor. Following that step, the focus was enlarged to include the entire state.

Schaible, G. and R.J. Supalla, *Methodologies for Evaluating Benefits and Costs Associated with Alternative Instream Flow Policies,* Preliminary report – Work Element 4.3, University of Nebraska – Lincoln, Department of Agricultural Economics, March, 1981, Lincoln, Nebraska. 63 pages.

This paper was developed to provide information on alternative methods for benefit/cost analysis of allocating surface water to instream uses. Several methods for estimating values of the various instream uses are described. A comparison is provided of the accuracy, data requirements and application costs of the techniques. Methods for estimating irrigation values forgone should water be allocated to instream uses are described.

Kubicek, L.C. and Gene Zuerlein, *Administrative Impacts of Adopting Policy Alternatives,* Unpublished report – Work Element 5.1, Nebraska Department of Water Resources and Nebraska Game and Parks Commission, Lincoln, Nebraska. 15 pages.

This report briefly explains what administrative impacts would most likely be incurred, primarily by a regulatory and management agency, should any instream flow policy alternatives be adopted in Nebraska. Most alternatives were estimated to have a low impact in terms of personnel, equipment, and financial resources, although a few are judged to have significant impacts based on the above criteria.

Twedt, C., J. L. Hutchinson, and Gene Zuerlein, *Environmental Impacts of Alterntive Policies,* Unpublished report – Work Element 5.2, September, 1981, Nebraska Game and Parks Commission, Lincoln, Nebraska. 12 pages.

Eleven selected stream segments provided the basis for evaluation of probable environmental impacts associated with adoption of alternative policies. Analysis involved assigning impacts to the following general categories and elements: (1) water characteristics (water quality, summer water temperatures); (2) flora (riparian woodlands, wetlands, grasslands); (3) fauna (terrestrial vertebrates, fish, aquatic invertebrates); (4) recreation (swimming, camping, canoeing, hunting, fishing, parks/recreation areas); and (5) aesthetics and human interest (scenic views, unique ecosystems, unique physical features, historical/archeological sites). Impacts were classified as positive, negative, or none anticipated; degree of impact was designated low, moderate, or high. Results of the environmental analysis were displayed in five summary tables based upon the categories and elements described above.

CHAPTERS 5, 6 and 7

Holmquist, J., *Alternative State Policies Regarding Instream Uses,* Unpublished report – Work Element 3.6, May, 1981, Nebraska Natural Resources Commission, Lincoln, Nebraska. 29 pages.

This report identifies and describes thirteen alternative policies the legislature could adopt regarding instream uses of water. The alternatives fall into three general categories: (1) existing policy, (2) policies that would provide additional protection to instream uses, and (3) policies that would clarify existing policy by removing possible protection to instream uses. Legislative changes that would be needed if any of the policies are to be adopted are also described for each alternative.

Bentall, Ray, *Hydrologic Impacts,* Unpublished report – Work Element 5.3, September, 1981, University of Nebraska – Conservation and Survey Division, Lincoln, Nebraska. 41 pages

(See earlier Bentall summary)

Rodekohr, D. and K. Sheets, *Social-Economic Impacts of Instream Flow Policy Alternatives*, Unpublished report – Work Element 5.4, 1981, University of Nebraska – Water Resources Center and Nebraska Natural Resources Commission, Lincoln, Nebraska. 85 pages.

(See earlier Rodekohr and Sheets summary)

Kubicek, L. C. and Gene Zuerlein, *Administrative Impacts of Adopting Policy Alternatives*, Unpublished report – Work Element 5.1, Nebraska Department of Water Resources and Nebraska Game and Parks Commission, Lincoln, Nebraska. 15 pages.

(See earlier Kubicek and Zuerlein summary)

Twedt, C., J. L. Hutchinson, and Gene Zuerlein, *Environmental Impacts of Alternative Policies,* Unpublished report – Work Element 5.2, September 1981, Nebraska Game and Parks Commission, Lincoln, Nebraska 12 pages.

(See earlier Twedt, Hutchinson and Zuerlein summary)

Appendix A

Summary of Public Meetings On the Instream Flows Policy Study

A total of six public meetings and one public hearing were held to inform the public about the Instream Flows Study and obtain public comments for consideration by the Natural Resources Commission, the Governor, and the Legislature. In addition, the Public Advisory Board met to formulate their recommendations to the Commission.

The public meetings were held in Norfolk, Valentine, Scottsbluff, North Platte, Grand Island, and Omaha. The public hearing was in Lincoln. At each of the public meetings staff gave a presentation to explain the contents of the report. Following this the audience was invited to ask questions and make comments. A summary of the meetings and hearing follows.

Public Advisory Board: The meeting was held on December 2 at the Natural Resources Commission office. The PAB members discussed each of the alternatives and asked questions of the staff. Generally the members expressed appreciation for the value of instream uses such as fish, wildlife, recreation and aquifer recharge but did not wish to advocate legislative action to "reserve" natural flow for these uses because such action might affect future storage/irrigation projects adversely. Members noted that storage projects provide more stable streamflows and would benefit instream flow values. The general feeling was that using water for economic growth is more important than using it for instream flow maintenance.

The official action of the Board was to recommend that NRC support a continuation of the state's present policy with emphasis on giving natural resources districts the authority to work together for basin regulation and that impoundments be given a high priority so they may enhance instream flows in the future. The Board also wished to express its concern over our lack of ability to store water and wanted the Commission to encourage the state to find financing for such projects.

Norfolk: The Norfolk meeting was held at the Commercial Federal Savings and Loan community room at 7:00 p.m. on Tuesday, December 8. Approximately 40 people attended including Commission members Warren Patefield and Clinton VonSeggern. Approximately 10 people were from the general public. A large percentage of those attending were NRD personnel or board members or personnel from a state agency. Board members present were from the Lower Elkhorn, Upper Elkhorn, and Lower Niobrara NRDs. Representatives of the Livestock Feeders, Center Pivot Manufacturers and Sierra Club attended.

Most of those who made comments at the meeting were in favor of changing the state's present policy regarding instream uses to provide some method for maintaining instream flows. A few people expressed concern over the inadequacy of many streams to support livestock watering. A number of people expressed support for building storage facilities and using some of this water to maintain instream flow.

Support for a modified version of **Alternative 6 – Provide for a state administered system of protected river reaches** – was expressed by a few people. Although alternative 6 was favored by the Lower Elkhorn NRD board, they did not want protected river reaches to be designated by the Legislature. The board advocated having designations made by joint action of the local NRD, the Department of Water Resources, and the Game and Parks Commission. Once a stream was designated the Department of Water Resources would be authorized to issue, reassign, and approve voluntary transfers of natural flow permits for instream uses (alternatives 2, 9, & 10). They recommended that in the designated reaches, instream flow permits be given a preference second only to domestic use. Natural flow permits for instream uses could not be issued on streams that were not designated as protected. The district strongly advocated the use of stored water to maintain instream flows. Some opposition to the land use controls provided for in alternative 6 was expressed by individuals in the audience.

A number of people expressed concern over the effect of ground water pumping on stream flow and some support was expressed for **Alternative 13 – Impose restrictions on the use of ground water.** Representatives of the Livestock Feeders and Center Pivot Manufacturers voiced opposition to the moratorium authority currently contained in the Ground Water Management and Protection Act. One member of the audience commented that most of the instream flow maintenance alternatives place the entire burden of maintaining instream flow on future surface water users. He pointed out that any legislation on the subject needs to balance restrictions on ground and surface water users.

The Sierra Club representative expressed support for alternatives 2, 4, 6, 9, 10, & 12.

Approximately 20 people raised their hands when asked whether they felt the state's present policy should be changed to maintain flows for instream uses in some stream reaches. Two or three people raised their hands in opposition.

Valentine: The Valentine meeting was held on December 9, at 1:00 p.m. in the Cherry County Court House. Approximately 30 people attended. Roughly half

were from the general public. The Lower Niobrara, Middle Niobrara, Upper Niobrara-White, and Upper Loup NRDs were represented. Senator Lamb also attended. Commission member Jim Cook presided over the meeting.

Although a few people indicated they supported recognizing instream uses as beneficial, most of the people who commented indicated they favored not changing the current law. They generally were opposed to any government interference in their lives whether it be for the purpose of maintaining instream flows or any other purpose. They emphasized the importance of storage and the need for irrigation to promote economic growth. They felt economic growth was more important than maintaining flow "so someone can play on the river" or for other instream uses. They felt changing the law would allow more water to flow out of the state.

One comment made was that "problems" should be defined and solved locally.

Concern was expressed over the impact ot ground water use on streamflow, and wet meadows, especially ground water use in Wyoming.

Scottsbluff: The meeting was held on December 10, at 7:00 p.m. in the UNL Panhandle Station. Approximately 60 people attended. Ten to fifteen were members of the general public. The North Platte, South Platte, and Upper Niobrara-White NRDs were represented, as were a number of local irrigation districts, the Sierra Club, and the W. Nebraska Sportsmans Association. PAB Chairman Don Steen also attended. Commission member Bob Gifford presided over the meeting.

The majority viewpoint at the Scottsbluff meeting was that no change should be made in the present law. This was the position adopted by the N. Platte NRD board. Two or three members of the audience were in favor of legislation to prohibit the use of water specifically for maintaining instream flows (alternatives 3, 5, 8, 11). Ten to fifteen were in favor of changing the law to provide for instream flow protection in at least some streams in the state.

The benefits of storage and the need for additional impoundments were emphasized by a number of people in the audience. They noted the ground water recharge and return flows resulting from irrigation projects along the North Platte had significantly improved instream flows in many streams in the area and additional irrigation projects could have similar benefits.

A number of people expressed concern over the impact of any instream flow legislation on existing water users and stressed that if any such legislation is enacted it should not be applied statewide and should not harm existing users. They noted it would be impossible to maintain a certain level of instream flow in many, if not most, of the state's streams. The importance of irrigation to the economy was stressed and many commented that diverting water from the stream for irrigation and other users is more beneficial than leaving it in the stream to maintain instream flow values.

One person objected to the map of flowing waters on page 36 of the report, noting that because a couple of irrigation projects along the North Platte had permits that would entitle them to divert the entire flow of the North Platte River, it should not have been described as a continuously flowing stream. Concern was also expressed over the difficulty of determining the amount of flow needed to maintain a particular instream use.

Those who testified in favor of legislation to recognize instream uses as beneficial favored some combination of alternatives 2, 4, 6, 9, 10, and 12. Alternatives 7 (storage) and 13 (restrictions on ground water) also received limited endorsement. The gist of their remarks were that in most cases the value of instream uses cannot be measured in economic terms but they are very important to maintaining the quality of life. They were concerned about the adverse effect of increased demands for ground and surface water on instream flows and wanted legislative action to preserve instream values in at least some streams so they can be enjoyed by future generations. They also expressed concern over the impact of any instream flow legislation on existing users and indicated they did not want existing water rights to be impaired. They did not feel maintaining instream flows would be incompatible with irrigated agriculture.

North Platte: This meeting was held on Friday, December 11 at 1.00 p.m. in the UNL North Platte Station Auditorium. Approximately 30-35 people attended. The South Platte, Lower Republican, Middle Republican, and Upper Republican NRDs were represented. Representatives of W.I.F.E., the City of North Platte, Tri County, N.P.P.D. and the Extension Service were in attendance. Commission Chairman Al Narjes presided over the meeting.

Although we did not poll the audience it appeared that most of those present favored **Alternative 1 – Continue present policy**. There were about five people who spoke in favor of the concept of recognizing and protecting at least some instream uses such as water quality, fish, and wildlife.

The remarks made in favor of continuing the present policy were very similar to those made at the Scottsbluff meeting. Speakers emphasized the need for additional storage/irrigation projects in the state noting that instream flow values would benefit from return flows and recharge. They were very concerned about the impact of any change in policy on holders of existing water rights. It was noted that although the primary purpose of the alternatives to provide recognition to instream uses might be to maintain flows in streams that currently have unappropriated flow, there was no assurance that a change in policy would not affect other streams or be extended into other areas in the future. This commentator objected to letting proponents of instream flow maintenance "get their foot in the door". Generally they felt using water for irrigation was more beneficial than using it for waterfowl and fish.

A number of people expressed opposition to **Alternative 9 – Reassign abandoned or unused natural flow permits for instream uses**. They noted that many producers in the area grow alfalfa and do not need to irrigate on a regular basis. They were concerned over these producer's water rights being cancelled to provide water for instream uses.

Grand Island: The meeting was held on Monday, December 14, at 1:00 p.m. in the Conestoga Mall Civic Room. Approximately sixty people attended. One-third of the group were members of the general public. Senator Howard Peterson and PAB members Bob Lowry and Vance Anderson were present. The Central Platte, Little Blue, Upper Big Blue, Lower Loup, and Tri-Basin NRDs were represented as were ground water conservation districts, the Platte River Trust, W.I.F.E., N.W.R.A., the Grand Island Chamber of Commerce, corn growers, and

irrigation equipment manufacturers.

Commission members Erv Lechner and Richard Hahn attended the meeting. Richard Hahn presided over the meeting.

As at the previous meetings, the need for additional storage projects and the flow stabilizing benefits from existing projects were emphasized by many in the audience. It was noted that return flows and recharge would benefit instream flow values. Considerable concern was expressed over the availability of funding for future projects. A water user tax was discussed.

Since we did not poll the audience it is difficult to say what percentage of the audience favored a continuation of present policy or conversely, favored recognition of instream uses as beneficial. However there was widespread concern over the possible loss of certain instream values in the Central Platte. The importance of aquifer recharge for municipal supplies and ground water irrigation was stated by many. In addition, a number of commentators expressed concern over the negative impact reduced flows in the Platte may have on water quality and habitat for migratory waterfowl, Sandhill cranes, and fish. Representatives of the Grand Island Chamber of Commerce, Central Platte NRD, and Platte River Trust were among those expressing these concerns. It was noted that if the state wants to maintain these instream values the state will have to take some action to preserve them. However, with exception of favoring construction of surface water impoundments, those in the audience who were concerned over the loss of instream flow values did not express a preference for any particular alternative.

Omaha: The meeting was held on Tuesday, December 15, at 7:00 p.m. in the Douglas County Extension Service Office. Twenty-six people attended. About half of those attending were members of the general public. The Papio NRD, Sierra Club, and Audubon Society were represented. Commission member Maureen Monen presided over the meeting and Wayne Johnson also attended.

As at the other meetings, the full spectrum of views was represented. The representative of a group of 38 irrigators from southeast Nebraska testified in favor of continuing the present policy. The basis for their objection to instream flow legislation was concern that their water rights would be taken from them. They did not feel there were any instream flow problems in the area, noting that when streamflow drops, fish can find deep pools in which to live.

Testimony by a canoe outfitter stressed the importance of maintaining sufficient streamflow in the Niobrara below Valentine to support canoeing. He also expressed concern about low flows in the Grand Island to Columbus reach of the Platte. He commented that canoeing can economically benefit an area and the state's recreational resources should be preserved to increase local tourism.

Others testifying in favor of instream flow legislation expressed concern over instream stockwatering, fish, wildlife, water quality, aquifer recharge and aesthetics. They felt maintaining these resources for present and future generations was in the interest of all the people in the state. It was asserted that maintaining instream flows was a duty of the state because the state's natural resources are held in trust for all the people. The effects of ground water withdrawals upon streamflow was also a concern. Generally, alternatives 2, 4, 6, 7, 9, 10 and 13 received support. No one wished to impair the rights of existing users.

The former director of the Department of Water Resources, John Neuberger, also testified. He stated there were too many alternatives and NRC should eliminate the impractical alternatives that did not have potential "for meeting the legislature's public interest test." He felt the task force should have received more direction from NRC at the beginning of the study to narrow the range of alternatives.

He did not feel the problems described in the study supported changing the state's present policy, noting that stored water and return flows provide significant benefits to instream uses. He didn't feel sport and fish should be favored over the needs of people.

He was concerned that Governor Thone's suggestion at the 1980 Water Conference that base flows could be established for selected high value streams in certain areas of the state was not an alternative. He felt it should be included and apparently that it had some merit.

Lincoln: The public hearing was held at 7:00 p.m., December 16, at the Continuing Education Center, UNL. Attendance was light due to a snowstorm. Approximately 20 people attended, six of whom testified. The Lower Platte South NRD, Sierra Club, Audubon Society and Wildlife Society were represented. Commission members Al Narjes and Richard Hahn were present for the meeting.

All who testified expressed serious concern over the loss of instream flow values. Fish, wildlife, recreation, aquifer recharge, aesthetics, and water quality were the instream uses most frequently mentioned. The Middle and Lower Platte, and Niobrara Rivers appeared to be the rivers of primary concern although the concerns expressed were by no means limited to those rivers. The Platte was noted for its importance to wildlife and aquifer recharge benefiting irrigators and cities. Considerable concern was expressed over the impact of ground water pumping on streamflow. Although those testifying appreciated the importance of irrigation and did not wish to impair the rights of existing users, they felt state water policy lacked the proper balance between economic growth, a healthy environment, and an aesthetically pleasing environment.

With the possible exception of one person, all who testified generally supported the alternatives in Chapter 6 that would provide recognition of the value of instream uses and legal protection. However, there appeared to be a difference of opinion on the best approach to take. A couple of commentators expressed support for protecting instream values in selected high value streams through the adoption of **Alternative 6 – Protected river reaches** or perhaps a combination of that alternative with **Alternative 4 – Establish protected flow levels.** Alternatives 2, 9, 10 also received general support. One person felt if alternative 2 is adopted by the Legislature, instream uses should have a preference second only to domestic use and the unappropriated flow in every stream in the state should be appropriated for instream use.

Providing stored water for instream flow maintenance and imposing restrictions on the use of ground water also received limited support.

One person felt NRDs should voluntarily pass a certain amount of flow into downstream NRDs and Nebraska should voluntarily pass a certain amount of flow into downstream states. This commentator felt more emphasis should be placed on water conservation and ground water recharge.