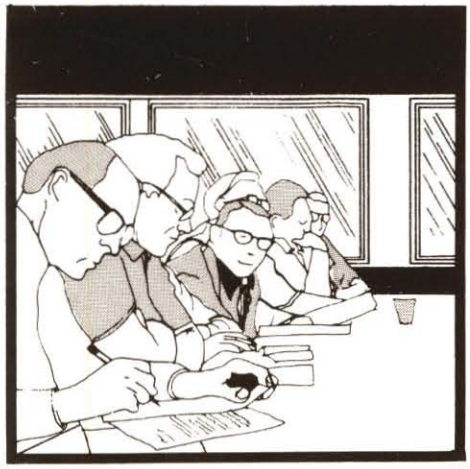
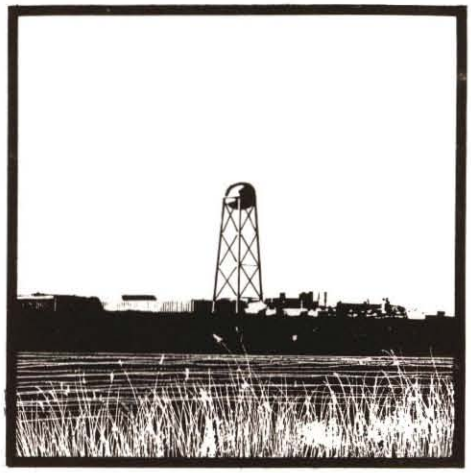


POLICY ISSUE STUDY
ON

MUNICIPAL WATER NEEDS



State Water Planning and Review Process
Nebraska Natural Resources Commission

MARCH 1983

POLICY ISSUE STUDY
ON
MUNICIPAL WATER NEEDS

STATE WATER PLANNING AND REVIEW PROCESS

MUNICIPAL WATER NEEDS REPORT

REPORT
OF THE
NATURAL RESOURCES COMMISSION
TO
GOVERNOR ROBERT KERREY
AND
MEMBERS OF THE NEBRASKA LEGISLATURE

MARCH 1983

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PROGRAMS:

SOIL & WATER CONSERVATION
WATERSHED PROTECTION
COMPREHENSIVE PLANNING
FLOOD PLAIN MANAGEMENT
DATA BANK
WATER CONSERVATION FUND
DEVELOPMENT FUND

STATE OF NEBRASKA

NATURAL RESOURCES COMMISSION

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February 3, 1983

The Honorable Robert Kerrey
Governor, State of Nebraska
State Capitol, 2nd Floor
Lincoln, Nebraska 68509

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

Governor Robert Kerrey and Members of the Legislature:

This report entitled "Policy Issue Study on Municipal Water Needs" has been reviewed and approved by the Natural Resources Commission. It is one of a series of Commission studies of water policy issues.

Nineteen policy alternatives related to Nebraska's municipal water needs are analyzed in this report. The Commission's recommended course of action is also provided and can be found on the blue pages immediately preceeding the summary.

It is the hope of the Natural Resources Commission that this report will be helpful in making policy decisions, and, if necessary, statutory changes. The Natural Resources Commission is prepared to answer any further questions you may have.

Sincerely,

Clinton VonSeggern

Clinton VonSeggern, Chairman
Natural Resources Commission

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Foreword

This is the final report of the *Municipal Water Needs* Policy Issue Study. It provides alternative policies for addressing Nebraska's municipal water needs and is being forwarded to the Legislature and Governor for action as deemed appropriate. It is one of a series of 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. Most of that document was prepared directly by the Department of Health, which also served as lead agency for the study. However, the final report and recommendations were the responsibility of the Natural Resources Commission.

The members of the task force were:

Cliff Summers ..... Department of Health (Lead Agency)
Jerry Wallin ..... Natural Resources Commission
Tom Lamberson..... Department of Water Resources
Bob Kuzelka..... Conservation and Survey Division-UNL
Bob Burns..... Water Resources Center-UNL
Karen Langland..... Policy Research Office
John Alloway ..... Department of Agriculture
Gene Zuerlein ..... Game and Parks Commission
Jon Atkinson..... Department of Environmental Control

Special credit should also be given to Owen Goodenkauf and Bill Lee of the Department of Health for their efforts on the report.

Following initial consideration of the task force report the Commission released it for public review on July 27, 1982. Public hearings were held on September 8, 1982 in Lincoln and September 29, 1982 in Ogallala. The public comment period concluded October 1, 1982. Summaries of these hearings are available as special sections at the back of this report.

The Public Advisory Board provided the Commission with a number of recommendations on the report. In addition, some written comments were received from members of the public representing either themselves or particular organizations. All such comments are on file at the office of the Commission and are available for review.

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Comments and Recommendations of the Natural Resources Commission

INTRODUCTION AND PURPOSE

The responsibility of the Natural Resources Commission in preparing policy issue study reports is twofold. First, the Commission is responsible for presenting policy alternatives which are representative in scope and objective in substance. It is hoped that this report accomplishes that purpose. Second, the Commission is responsible for providing their opinion and recommendations on the various alternatives presented in each report to the general public, the legislature, and the Governor.

The Commission arrives at its recommendations following a review of the report and consideration of comments generated from public hearings and from the Public Advisory Board. Comments and recommendations are offered in this section on each of nineteen alternatives identified in this report. Some alternatives are recommended in whole, some in part with qualifications, and others are not recommended.

RECOMMENDED ALTERNATIVES

ALTERNATIVE #2: Recognize municipal water use in the Constitution and Statutes as having a preference equal to or secondary only to domestic use.

In its report on *Preferences in the Use of Water* the Commission recommended that municipal uses be added to the preference system. At that time we suggested that municipal supplies be split into domestic and nondomestic uses. We also suggested that the domestic portion receive a preference equal to other domestic uses and that the nondomestic portion receive a preference after manufacturing. At this time we are modifying that recommendation to provide that **all** municipal uses should have a groundwater preference secondary only to domestic use.

The Commission favors adoption of *Alternative #2* in the following manner:

Recognize municipal water use in the groundwater preference statutes as having a preference secondary only to domestic use. Municipal use shall mean the use of water supplied through a distribution system by a municipality or other public entity for any beneficial purpose the intent of which is to promote the life, safety, health, comfort, and business pursuits of the municipality and its inhabitants. It does not include the irrigation of crops where the area to be irrigated exceeds two acres or the use of water outside the zoning jurisdiction of the municipality for any purposes other than domestic purposes, except where a municipality or other public entity furnishes water to another municipality, Natural Resource District or Rural Water District for the same purposes and with the same limitations.

The rationale for the above is as follows:

1. Eighty-five percent of the population is served from municipal water systems.
2. Municipal use accounts for only about five percent of the total water used in Nebraska; and much of that is used nonconsumptively. Hence, it has little, if any, impact on agricultural uses.
3. This alternative relates to groundwater statutory preferences **only**, because those few municipalities using surface water are not in conflict with other users, have no preference problems, and because amending the Constitution would be too unwieldy and unwarranted.
4. The preference would be secondary to domestic in order to balance equities in event of a conflict between domestic well and a municipal well. It appears unfair for a single domestic well owner to have to stand the entire expense of improving a well as opposed to spreading the cost over the total customers of a municipal system.
5. It is not feasible to separate domestic and non-domestic municipal uses. Note that this is a departure from the previous

action taken on the *Policy Issue Study on Preferences in the Use of Water.*

A municipality probably does not have the authority to terminate service to a "non-domestic" user except in an emergency. Further, who determines what uses are "non-domestic"? Is an apartment house (listed on the service records as a commercial customer) a domestic or a non-domestic user? Is a residence with a beauty parlor in the backroom a domestic or non-domestic user? Is a service station with restrooms and a drinking fountain domestic or non-domestic? Is the cafeteria in a factory domestic or non-domestic? In view of the foregoing practical difficulties involved in trying to separate the uses, the fact that "non-domestic" users are essential to the livelihood of the municipality, the fact that the quantities of water involved are so minor, and the fact that the great majority of the "non-domestic" uses are closely associated with agriculture in Nebraska, it is neither feasible nor warranted to separate municipal uses into domestic and non-domestic for preference purposes.

6. By defining municipal uses as we have and by limiting it to the zoning jurisdiction of the municipality, we believe we have established safeguards against exporting or misusing water or otherwise defeating the preference statutes under the guise of municipal use. At least that is our intent.

ALTERNATIVE #4: Act to allow voluntary sale or transfer of surface water rights for municipal use.

The Commission recommends adoption of this alternative in a manner consistent with our recommendations in our report on *Transferability of Surface Water Rights*. For a further discussion of this alternative and recommendation it is suggested that the reader refer to that report.

ALTERNATIVE #7: Authorize cities and villages to apply limited zoning and land use controls to areas within a prescribed distance of their water supply sources in addition to existing authority within designated distances from their existing corporate boundaries.

The Commission recommends adoption of this alternative, for protection of both water quality and quantity. Because this alternative would allow municipalities to zone in areas beyond their boundaries we feel it is very important that any legislation carefully specify the distances involved and the land use activities which may pose a direct hazard to the municipal water supply. We feel that it is very important that this alternative not disrupt any existing activities and that it not be used for any purpose other than protection of the municipal water supply.

The Commission feels that groundwater contamination from nitrates and other sources may pose a growing hazard to the water supplies of many of the state's municipalities. Some cities may be put in the position of needing to relocate expensive wellfields. In some cases finding a suitable site for that relocation may be difficult. Adoption of this alternative is probably necessary if cities are to successfully address that problem.

ALTERNATIVE #8: Adoption of miscellaneous actions that would serve to improve and protect the quality of groundwater used as a source of municipal drinking water. These actions have been presented in other policy issue reports and, if adopted, would exert favorable influence on municipal water supply sources.

Two of the miscellaneous actions mentioned in this alternative were recommended by the Commission in the *Policy Issue Study on Water Quality*. These were:

Problem 2. *Alternative 2.* - "Clarify and Strengthen the Law Requiring Backflow Preventive Devices on Groundwater Irrigation Systems."

Problem 13. *Alternative 1.* - "Require Licensing of Certification of Well Drillers and Pump Installation Contractors."

We have now decided to recommend a third alternative that we did not recommend at that time:

Problem 17. *Alternative 3.* - "State Develop Standards and Permit System for Storage of Chemicals and Petroleum, and Delegate Administration of the System to the proper authority."

Although the Commission continues to recognize the Administrative and regulatory burden this alternative would entail, we feel that it is outweighed by dangers to public health and safety and the groundwater resource.

The Commission also suggests that the Governor and Legislature consider means of implementing three management actions presented in the *Policy Issue Study on Groundwater Reservoir Management*. These were not included as alternatives in that report, but rather as other

types of management actions to reduce water need. However, we suggest these actions can best be implemented through adoption of the recommendations in our *Policy Issue Study on Groundwater Reservoir Management.* We believe that by requiring designation of control areas in problem areas the state could substantially reduce water use in the important areas.

While most of the alternatives presented in this report deal with improving municipal water service, it is also important to realize that preserving the quality and quantity of water supplies is even more a concern of the agricultural sector. Municipal supplies are responsible for only 3% to 5% of water use in Nebraska. Therefore much of the responsibility for using our supplies efficiently will rest with the irrigator. Both the municipal and agricultural sectors must use water wisely if they are to prosper.

ALTERNATIVE #11: Require filed audits from all political subdivisions owning water systems and specify separate accounting for income, expenditures, and accumulation and disposition of reserve funds associated with the water system.

The Commission believes that this alternative is acceptable only insofar as it is incorporated in *Alternative #13.* If money is to be supplied from state revenues, proper maintenance and bookkeeping should be assured. However to require audits of all systems would be burdensome on some small systems which lack the needed personnel.

ALTERNATIVE #13: Establish a state fund similar to the Natural Resources Development Fund to provide relief for municipal water systems needing improvement .

Many small communities will need to make substantial expenditures to improve their systems in coming years. In many cases these improvements could result in exhorbitantly high rates. In other cases the municipality may not even be able to acquire loans to make the improvement. To improve this situation we recommend that the legislature consider establishment of a state fund similar to the Natural Resources Development Fund. Although we are not recommending details on the organization of that fund, any legislation would have to recommend qualification requirements to target those communities most in need and specify what was eligible for a grant or loan. We would also suggest that it require filed audits of water system expenditures by communities accepting funds.

ALTERNATIVE #14: Adopt legislation that would require municipal systems to install back-flow prevention devices on all services connections; chlorinate or otherwise disinfect water entering the distribution system; and provide for sale of water through meters or other means of volume measurement.

The Commission recommends this alternative with the provision that backflow prevention devices need only be installed on industrial and commercial service connections where there is an apparent hazard. We feel that placing devices in every home would be a needless expense.

However we do feel that meters should be required on all service connections. Meters discourage overuse of water, can result in less repair, and delay need for expanding the water system. We also believe that chlorination results in fewer health problems at minimal expense and therefore should be a system requirement. Main breaks do occur throughout the nation and there are sometimes associated disease outbreaks. Chlorination can substantially lessen the occurance of these outbreaks.

ALTERNATIVE #16: Encourage large systems to share the source of supply from their wellfields with smaller satellite communities by providing grants or loans from the Nebraska Resources Development Fund and by assistance through the Natural Resources Districts.

The Commission believes that in a number of cases this alternative might provide a more efficient means of supplying municipal water. Setting funds aside specifically for this purpose would encourage communities to consider this option. However, we recommend that the fund utilized be the separate fund proposed in *Alternative #13* rather than the Natural Resource Development Fund.

ALTERNATIVE #18: Increase state funding and fee schedules as necessary to replace diminishing federal assistance for the purpose of encouraging local responsibility and technical application relating to the safety of the drinking water delivered by municipal and other public water systems.

The Commission believes that sound state supervision of municipal systems is a necessary step in providing for public health and safety. The existence of state field surveillance and laboratory service has helped the state's communities provide good quality water at reasonable cost. A reduction in funds could result in "after the fact" enforcement of standards. We don't believe that to be a wise approach. In addition, a doubling in the cost of laboratory service to small communities does not seem to be sound at a time when many of those communities are already facing high system maintenance costs.

ALTERNATIVE #19: Provide state funding to continue the Water Use Data Project.

Municipal use data is helpful in scheduling municipal system improvements and setting rates. Furthermore, a sound compilation of all water uses as needed to plan for future use of Nebraska's water resources. Therefore we recommend that this program be continued.

ALTERNATIVES NOT RECOMMENDED

The following alternatives are not recommended by the Commission:

ALTERNATIVE #1: (Make no change in the legal-institutional structure as it relates to municipal water use, management authorities, source acquisition, and protection of groundwater quality and quantity) was rejected because the Commission felt that certain changes were needed to accommodate Nebraska's future municipal water needs.

ALTERNATIVE #3: (Municipal Surface Water Rights for Induced Recharge) was rejected for the present time. The Commission recognizes that we recommended adoption of a similar alternative in the Policy Issue Study on Preferences in the Use of Water. However, since that time we have scheduled an additional policy study to address the interrelationship between surface and groundwater. That relationship applies to all uses, not just municipal. We believe that to single out municipal use for special legislation to provide a surface water right for recharge would create more problems at this time than it would solve.

ALTERNATIVE #5: (To reserve future streamflow for direct withdrawal or recharge) is also rejected partially because of its close relationship to *Alternative #3.* Since we are not now recommending the issuance of surface water rights for **induced recharge**, it would be inconsistent to allow reservation of flows for the same purpose. *Alternative #5* also addresses **direct diversions** of surface flows for municipal purposes. We recommended in the Preferences report that such reservations be allowed for preferred uses, a recommendation which we now retrace, at least for municipal uses. So few municipalities rely upon surface water as a direct source of supply that the alternative is likely to have little or no application. Whatever benefit it might have is outweighed by the hard feelings it could create between prospective water users.

ALTERNATIVE #6: (Revise selection of NRD Boards to better reflect population patterns) would involve a fundamental change in our Natural Resources District system. It could easily result in urban areas making most of the natural resources decisions which affect rural areas. We do not believe that change is justified.

ALTERNATIVE #9: (Make no change in the legal-institutional structure regarding municipal water system acquisition and management; fiscal responsibility and accountability; method of financing expansion or improvements; and protection against the entrance of contaminants) was rejected because the Commission believed that certain changes were necessary on these topics.

ALTERNATIVE #10: (A comprehensive review of statutory law relating acquisition, operation, and replacement of municipal water systems) was rejected because the Commission believes there were few cases where obsolete statutes hampered municipalities and any review of the statutes would be more expensive than it was worth.

ALTERNATIVE #12: (State Regulatory Board) was rejected because it would merely add another bureaucratic layer and result in little system improvement.

ALTERNATIVE # 15: (Place responsibility for operation and management of small systems with NRD's) was rejected because the Commission felt that responsibility for running a small system can often be handled well by the individual communities. Many problems require someone on site and experienced with the particular system to handle the difficulty. In addition this alternative could place a burden on NRD budgets and manpower. We do believe that voluntary operation and management arrangements can sometimes be a boom to both parties. However, that voluntary cooperation is possible under current statutes.

ALTERNATIVE # 17: (Accept a diminishing level of state assistance and service to public water systems as federal support is reduced or eliminated) was rejected because the Commission believes that some of these programs are needed for the public health and safety and others and proper water system management and promote sound water planning.

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Summary

INTRODUCTION

Approximately 1,250,000 Nebraska citizens depend on public water systems as their sole source of supply for drinking water, sanitation, fire protection, and lawn and garden watering. In addition, those citizens residing on homesteads and ranches and visitors to the state depend on these public sources of drinking water for short periods of time. The availability and safety of drinking water is therefore essential to the well-being of the resident population and their guests.

This report is a product of the Municipal Water Needs Task Force, led by the Department of Health. This study is part of the State Water Planning and Review Process. It was written to assist legislators, public officials, and the consuming public in understanding and evaluating existing conditions and emerging problems, and to encourage appropriate action necessary to assure the continued availability of a resource that is essential to human life. A special effort was made to provide references to source material, published and unpublished, that have been incorporated in the report findings. Any questions relating to the scope, validity or interpretation of the data base should be directed to the Department of Health, the lead agency for this policy review study.

CHAPTER 1
THE LEGAL RECOGNITION OF MUNICIPAL WATER SERVICE

The major influences in the development of state law regarding municipal water quantity needs were the preference system; the cases *Olson vs. City of Wahoo, MUD vs. Merritt Beach Co., Burger vs. City of Beatrice, Prather vs. Eisenmann;* and the 1963 City, Village and Municipal Ground Water Permit Act, as amended. Together they provide protections for domestic water use and show that municipal water does not enjoy the same protections. Particularly, use of a municipal system to supply commercial and industrial activities is not completely protected under the preference system. The pumping of groundwater associated with the Platte River has been determined by the courts to be a use of groundwater, not surface water. The process for transferring groundwater for municipal use is established.

The federal and state Safe Drinking Water Acts and the quality control area provisions of the Groundwater Management and Protection Act are laws that may affect the quality of municipal water and the management of municipal systems. The state Safe Drinking Water Act and regulations are more stringent than the federal in that they incorporate preventive measures. State contaminant requirements for drinking water are identical with the federal requirements. However, the state approach requires proper construction of systems, competent operation, pre-approval of siting and treatment techniques, and annual evaluation of each system's capability to meet community needs.

CHAPTER 2
MUNICIPAL WATER SYSTEMS IN NEBRASKA

Most Nebraska municipal water systems consist of a source of supply, minimal storage, and distribution to the point of use. Only 93 municipal systems provide water treatment. The degree of treatment ranges from relatively simple processes (disinfection with chlorine, retention of iron in solution by adding polyphosphate, or adjustment of fluoride concentration) to complex chemical treatment to remove dissolved solids. The physical condition of the water system is a significant factor in the safety of the water delivered. The maintenance of continuous pressure is considered a prime deterrent to contamination of the drinking water delivered by a system. The

adequacy of the source and storage elements are most important to the maintenance of pressure in the distribution element. Undersized water mains also cause pressure losses and the risk of contamination.

Management practices applied to municipal water systems in Nebraska, particularly those related to operation, maintenance, and replacement, have not prevented deterioration and reduced service in a substantial number of systems. Most of the systems require improvement and enlargement to provide full municipal water service meeting current standards. The upgrading of sources of supply, storage, and distribution to present design standards cannot be achieved without large increases in water rates.

CHAPTER 3 MUNICIPAL WATER CONSUMPTION

Approximately one-third of Nebraska municipal water systems studied provided 100-200 gallons per person per day, which is within the national range of water use with adjustment for industry. However, over 60 percent of the systems exceed national averages. The underpricing of delivered water by most municipal systems results in higher per capita use. Metered sales and rates designed to discourage heavy use can materially reduce the amounts of water removed from a fixed or depleting source of supply. The fixed supply would then be available for a longer period of time. Measurement of water diverted from the source, records of water sold, and assessment of water returned for subsequent reuse are highly useful. Experience has proven that a combination of fair rate structures and efficiency in producing and distributing water, coupled with voluntary or regulated changes in consumer habits definitely contributes to delayed capital expenditure and reduced demand for water on the part of the municipal consumer.

Municipal water use accounts for only three to five percent of all water used in the state, and will probably not significantly increase in the future. Much of the water withdrawn for municipal use is eventually returned to groundwater storage or discharged to streams as waste.

CHAPTER 4 SOURCE OF MUNICIPAL WATER SUPPLY

Nebraska communities depend almost entirely on groundwater as their source of supply. Only five water systems (including a rural water district and a subdivision) divert surface water for part or all of their supply. Nebraska has an abundant supply of groundwater, yet its distribution is uneven. Many communities have experienced difficulty in developing reliable sources of groundwater. This problem has been alleviated to some extent by development of rural water districts in these "water-poor" areas.

Surface waters must be treated to assure that safe, potable water is delivered to the consumer. While the treatment of water results in increased costs, the cost of delivering treated surface water is generally comparable to that of treated groundwater. Future use of surface water is more likely in the eastern part of the state, due to topography, climate, and population factors. The Missouri River should be considered as a potential source of municipal supply.

CHAPTER 5 DRINKING WATER QUALITY

A contaminant is any physical, chemical, biological, or radiological substance or matter in water. Since water is nearly a universal solvent, most the materials with which it comes in contact during the natural processes of precipitation, runoff, percolation, and storage contribute to contamination. Some of the materials occurring in nature dissolve in concentrations that are harmful to the individual consuming the water. Other contaminants are contributed by the activity of man and can be reduced or eliminated by intelligent management practices. Contaminants are classified as those that adversely affect the health of persons drinking the water, and those that affect the aesthetic and economic value of water. Contaminants of importance in Nebraska waters are bacteria, nitrate, radioactive chemicals, selenium, iron, manganese, sulfate, and petroleum products. All of these contaminants except bacteria nitrate, and petroleum products are natural contaminants. Bacteria and nitrate may be natural, but are generally introduced contaminants. Iron and manganese cause aesthetic and economic problems instead of health effects. The Department of Health Laboratory experiences difficulty maintaining capability to analyze newly designated contaminants with existing funding constraints.

The Safe Drinking Water Act and Nebraska Public Water System Surveillance Program have resulted in improved water system operation and, consequently, improved drinking water quality and safety.

CHAPTER 6
COMPETITIVE USE EFFECTS

Municipal water system management recognizes community economic dependence on agriculture, industry, and similar employment sectors that often compete with the municipal system for a source of water. There is a hesitancy to assume an aggressive position when the source of water is adversely affected by competitive users. Ample evidence exists that competing water users, agricultural and industrial for the most part, deplete the quantity and deteriorate the quality of water available to municipalities.

Some of these adverse effects are beyond the control of municipal management. Other adversities are the result of local political decisions relating to pricing of water, control of customer practices, and selection of the least expensive and most immediate means of developing a source and reinstating water service. Management practices often result in competition within the service area, particularly as individual auxiliary supply sources influence total system income. An increasing number of systems relying on induced recharge of surface water to supply well fields may be confronted with quality changes, and possibly quantity impacts. These may result from stream flow depletions caused by competitive uses.

CHAPTER 7
DRINKING WATER ECONOMICS

It is essential that all water delivered by a municipal system be safe for human consumption, though most uses, such as lawn watering, fire fighting, and household waste transport, could be accommodated with water of much lower quality. In addition to the costs associated with upgrading municipal systems to a point of assured reliable service, a substantial number of communities may find it necessary to remove harmful contaminants by treatment. The cost of treating all system water for the purpose of protecting the health of consumers could be materially reduced by application of water conservation practices. The impacts associated with financing, managing and operating systems capable of delivering safe water are predominantly associated with small systems. While these impacts will remain substantial as action is taken to reach conformance with the requirements of the Safe Drinking Water Act, reduction can be realized in many cases by physical consolidation of systems or by cooperative agreements for joint operation and management of two or more systems. Financing water improvements is largely dependent upon the management history of the system. Without the adequate demonstration of operation and management capability a municipal system cannot sell bonds to a commercial financial institution. If allowed to sell bonds it will be required to pay an unreasonable rate of interest. Government grant and loan funds are available in limited amounts to communities that cannot otherwise finance essential improvements to their water systems.

CHAPTER 8
SOCIAL AND POLITICAL ASPECTS

The standards and requirements for the quality of water delivered by municipal water systems are dictated at the national level. Consumers in Nebraska have not been overly concerned about the potential adverse health effects resulting from contaminated drinking water, although approximately 20 percent of the Nebraska municipal water systems violate drinking water safety standards each quarter. The cost of delivered water appears to be a main concern of the public, while little concern has been expressed over potential health hazards. Communities are encountering increased opposition to their water source development plans. Adjacent landowners and other competitive users can be expected to increasingly guard their property rights relative to a limited groundwater supply. The periodic change in municipal government frequently results in an absence of a long-term management plan. There is often little continuity in decisions necessary to the long-term solution of problems confronting municipal water systems.

CHAPTER 9
PROBLEM IDENTIFICATION

Source Problems

1. Municipal water use is not recognized by statute or Constitutional reference in the preferences system for ground or surface water.
2. Municipal wellfields inducing groundwater recharge from stream seepage are not recognized in the statutes as having surface water rights.
3. Existing or future legal and institutional constraints may prevent cities from effectively using surface waters.
4. Municipalities are encountering increasing resistance from competitive users relative to developing new and expanded sources of water supply. These competitive uses also

affect the quality of raw water available for municipal use.

5. A lack of municipal participation and influence exists in the institutional framework established to manage Nebraska resources.
6. Groundwater supplies are being contaminated by man's use of the overlying land surface. There has been reluctance, at both state and local levels of government, to exercise land use control as a tool in protecting groundwater resources.
7. Inefficiency of agricultural management practices contributes to groundwater pollution and water level declines.
8. No enforceable design standards exist for construction of wells serving other than public supply.

System Problems

9. Obsolete and sometimes conflicting authorities and requirements exist in the statutes regarding acquisition, management, and operation of public water systems.
10. The municipal user fails to appreciate the economic value of water delivered by municipal systems. Many consumers have demonstrated reluctance to pay the price necessary to assure the long-term delivery of a quality product.
11. There is an absence of fiscal accountability for operation and management of municipal water systems as self-supporting utilities.
12. Many water systems in Nebraska are in a deteriorated condition. Considerable funding will be required for rehabilitation. Locating such funding will be a significant problem.
13. Water treatment facilities will need to be constructed by a number of municipal systems found to be in violation of the contaminant levels established by the Safe Drinking Water Act.
14. A continuing need for water system consolidation has been demonstrated. An apparent lack of public interest and financial support for such consolidation has been encountered.
15. Numerous municipal systems experience greatly reduced or negative water pressure during fire fighting operations. A potential for backflow or backsiphonage and the resulting contamination of the water supply exists under reduced pressure conditions.

Program Problems

16. The public water system surveillance program (Safe Drinking Water Act) is being restricted in scope as federal and state funding is reduced.
17. Developing and maintaining laboratory capabilities necessary for identifying and measuring contaminants in drinking water is a continuing difficult task.
18. A need exists for the continuing collection and refinement of water use information.
19. Federal sources of financial assistance to municipal water systems are being reduced to the point of extinction. In the absence of subsidy at least half of the smaller systems cannot finance needed improvement to assure an acceptible quality of service to their customers.

CHAPTER 10
SOLUTION TO PROBLEMS

Alternatives Related to Source Problems

1. Make no change in the legal-institutional structure as it relates to municipal water use, management authorities, source acquisition, and protection of groundwater quality and quantity.
2. Recognize municipal water use in the Constitution and statutes as having a preference equal to or secondary only to domestic use.
3. Allow public water systems with induced recharge wellfields to obtain surface water rights.
4. Allow voluntary sale or transfer of surface water rights for municipal use.
5. Allow cities and villages to reserve future stream flow for the purpose of direct withdrawal of surface water or recharge of wellfields and condition other future water rights on utilization of such reserved rights.
6. Revise selection of Natural Resources Districts Boards to better reflect population patterns.
7. Authorize cities and villages to apply limited zoning and land use controls to areas within a prescribed distance of their water supply sources in addition to existing authority within designated distances from their corporate boundaries.
8. Adopt miscellaneous actions that would serve to improve and protect the quality of groundwater used as a source of municipal drinking water. These actions have been presented in other policy issue reports and, if adopted, would exert favorable influence on municipal water supply sources.

Alternatives Related to System Problems

9. Make no change in the legal-institutional structure regarding municipal water system acquisition and management, fiscal responsibility and accountability, methods of financing expansion or improvements, and protection against the entrance of contaminants.
10. Initiate a comprehensive review of the statutory law relating to acquisition, operation, and replacement of municipal water systems for the purpose of eliminating obsolete language and references; standardize authorities now granted on the basis of corporate ownership, and clarify the responsibility of elected management in areas of authority, fiscal, and service aspects associated with providing water to system customers.
11. Require filed audits from all political subdivisions owning water systems and specify separate accounting for income, expenditures, and accumulation and disposition of reserve funds associated with the water system.
12. Assure continuity of municipal water system service by providing for State regulatory agency review and acceptance of local management and fiscal decisions.
13. Establish a State fund similar to the Nebraska Resources Development Fund to provide relief for municipal water systems needing improvement.
14. Adopt legislation that would require municipal systems to install back-flow prevention devices on all service connections, chlorinate or otherwise disinfect water entering the distribution system, and provide for sale of water through meters or other means of volume measurement.
15. Place responsibility for operation and management of small municipal water systems with the Natural Resources Districts.

Alternatives Related to Program Problems

16. Encourage large systems to share the source of supply from their wellfields with smaller satellite communities by providing grants or loans from the Nebraska Resources Development Fund and by assistance through the Natural Resources Districts.
17. Accept a diminishing level of state assistance and service to municipal and other public water systems as federal funding support for water system supervision, operator training, laboratory service, consumer education and water use surveys is reduced or eliminated.
18. Increase state funding and fee schedules as necessary to replace diminishing federal assistance for the purpose of encouraging local responsibility and technical application relating to the safety of drinking water delivered by municipal and other public water systems.
19. Provide state funding to continue the Water Use Data Project.

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Introduction

Public water systems must have the capability to deliver safe, high quality water in amounts necessary to fulfill the requirements of all consumers. There are approximately 1,250,000 Nebraska citizens who depend on public water systems as their sole source of supply for drinking water and other domestic uses, sanitation, fire protection, and lawn and garden watering. In addition, those citizens residing on farms and ranches, together with visitors to the state, depend on these public sources of drinking water for short periods of time. The availability and safety of drinking water from the health standpoint is, therefore, essential to the wellbeing of residents and visitors to the state.

This report on the *Municipal Water Needs* Policy Issue Study was prepared as part of the State Water Planning and Review Process for presentation to the Natural Resources Commission. The report is intended to assist public officials and consumers in understanding and evaluating existing conditions and emerging problems, and in identifying the position of municipal water service in the social and economic base of the State. The report was prepared by a Task Force consisting of the following agencies:

Department of Health - Task Force Leader
Department of Water Resources
Department of Agriculture
Department of Environmental Control
Conservation and Survey Division - UNL
Water Resources Center - UNL
Natural Resources Commission
Game and Parks Commission

The expertise and experience provided by individuals representing these entities is reflected throughout the report. A special effort was made to provide references to source materials, published and unpublished, that have been incorporated in the report findings. Any questions related to the scope, validity, or interpretation of the data base should be directed to the Department of Health, the lead agency for this policy issue study.

The first eight chapters contain supporting information for the identification of problems (Chapter 9) and the listing of possible alternatives (Chapter 10). Chapter 1 reviews aspects of state and federal law that influence the ability of public water systems to provide adequate supplies of good quality water to consumers. Chapter 2 provides an overview of public water systems in Nebraska, including their capability to meet modern demands for water. Chapter 3 explores in some detail municipal water use and consumption in Nebraska. Chapters 4 and 5 discuss the availability and quality, respectively, of municipal water supply sources, while Chapter 6 evaluates the effects of competing uses of water. The economic aspects of providing safe drinking water are discussed in Chapter 7, and the social and political constraints are summarized in Chapter 8.

Much of the information presented in the first eight chapters deals with technical aspects of water system operation, economics, and public health with which few people have experience. Therefore, public officials considering the alternatives in the final chapter must familiarize themselves with this preliminary material before informed decisions can be made.

Identification of problem areas and presentation of alternative solutions are intended to aid in the democratic formulation of public policy. The findings recognize that agricultural production is the backbone of the state economy, with full realization that the goods and services provided by residents of cities and villages must be preserved for optimum economic balance within the social structure.

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Chapter 1

The Legal Recognition of Municipal Water Service

"Municipal Water Needs," as discussed in this report, refer to all the water needs of communities organized as municipalities in Nebraska, including cities and villages. The problems of non-municipal public water supplies (sanitary and improvement districts or other incorporated areas, for example), while not specifically addressed in the report, are similar in many respects to municipal systems.

Municipal water needs may be met by water supplied by (1) the municipality, (2) another organization, such as a metropolitan utilities district, rural water district, natural resources district, irrigation district, reclamation district, or sanitary and improvement district, or (3) private wells.

Municipal water needs also refer to all uses of water made by the inhabitants, businesses, industries, and governmental units which are part of the municipality.

WATER SYSTEM ACQUISITION AND MANAGEMENT

Statutory direction provided for the acquisition, management, and operation of public water systems by cities, villages, and other political subdivisions has developed over the years and contains obsolete authorities, requirements, and constraints that discourage the application of modern management techniques and initiatives. The earliest statutory reference to "water works" was included in the State Laws of 1881. Subsequent additions and amendments have served to extend or limit authorities to match the corporate classification of the political subdivisions. It is likely that this approach was followed to accommodate a problem confronting a single system without violating constitutional restrictions relating to special legislation. The result is a conglomerate of statutory guidance based on municipal classification rather than the size and complexity of the water system serving the community.

The laws governing municipal authorities are not directly pertinent to the development of state water policy. However, it must be realized that clarification and codification will be necessary to permit municipal corporations to implement and benefit from selected policy decisions. A tabular summary of current laws applicable to public water systems is included in Appendix A of this report.

QUANTITY ASPECTS

Federal Law

There are no federal laws or cases directly affecting the ability of Nebraska municipalities to obtain water.

State Law

In 1895, the Nebraska Legislature established surface water preferences.

> Sect. 46-204. The right to divert unappropriated waters of every natural stream for beneficial use shall never be denied. Priority of appropriation shall give the better right as between those using the water for the same purposes, but when the waters of any natural stream are not sufficient for the use of all those desiring the use of the same, those using the water for domestic purposes shall have the 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.[1]

In 1903, the Nebraska Supreme Court in *Crawford Co. vs. Hathaway,* a surface water case,

> held that the term domestic use included only those uses recognized as domestic uses in the riparian system, that is uses for drinking, cooking and livestock watering. Uses for "general municipal purposes" including water for sprinkling streets, for providing power for a lighting plant, and for flushing sewers were specifically rejected as domestic uses.[2]

In so ruling the court refused to extend protection of the preference system to municipal uses but restricted such protection to traditional domestic uses.

In 1920, preferences relating to surface water were added to the Nebraska Constitution and two additions were made to the material already in the law. The material added to the constitution was:

> Section 6 - The right to divert unappropriated waters of every natural stream for beneficial use shall never be **denied except when such denial is demanded by the public interest.** Priority of appropriation shall give the better right as between those using the water for the same purpose, but when the waters of any natural stream are not sufficient for the use of all those desiring to use the same, those using the water for domestic purposes shall have the 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. **Provided no inferior right to the use of the waters of the state shall be acquired by a superior right without just compensation therefore to the inferior user.**[3] (emphasis added)
>
> The underscorings above indicate those portions of the constitutional language that are additional to what is in the statute.[4]

The public interest consideration and the compensation requirement were added to the Constitution in this manner. Municipal uses were not directly addressed. In fact,

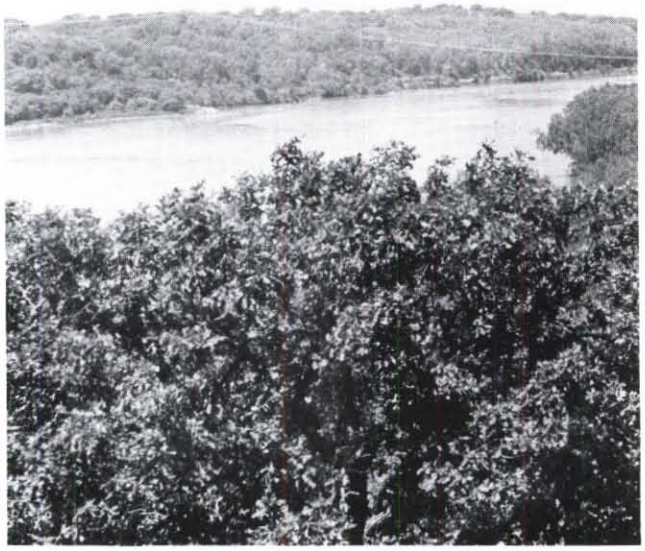
> After lengthy debate, the delegates to the constitutional convention of 1920 refused to approve a proposal that municipal use be preferred over all others except domestic.[5]

In 1933, the Nebraska Supreme Court considered *Olson vs. City of Wahoo*, a groundwater case in which a gravel operator claimed the city's pumping damaged his gravel operation. A lower court had ruled the operator had not proved such damages.

> In upholding the lower court, the supreme court reasoned that if it were true as Olson himself contended that the gravel pit was directly connected to the former bed and channel of the Platte River he could obtain an almost inexhaustible supply of water by simply deepening his pit through an existing clay bed.[6]

Communities continued to establish municipal well fields in the waterbearing sands and gravels along the Platte River. The wells were usually located on land purchased by the community.

> The first principal move directed toward insuring municipal use occurred in 1948 when Lincoln filed an application with the Department of Water Resources for an appropriation of underground water for its well field located on the banks of the Platte River at Ashland. Later



> Fremont, Grand Island and the Omaha Metropolitan Utilities District also filed. The applications were based on the rule of subflow which provides that water percolating through the banks and bed of a

stream and flowing in connection with the watercourse is subject to appropriation in the same manner as surface water. The applications were accepted and filed by the department with the understanding that they probably would not be granted. The position of the department's director has always been that only waters of a natural stream are subject to appropriation in Nebraska and he has construed the words natural stream to mean "natural stream flows".[7]

In 1957, the Legislature added groundwater preferences to the statutes.

> Sect. 46-613. Preference in the use of underground water shall be given to those using the water for domestic purposes. They shall have preference over those claiming it for any other purpose. Those using the water for agricultural purposes shall have the preference over those using the same for manufacturing or industrial purposes.[8]

The groundwater preference provisions have not been put into the Constitution, and do not mention compensation for acquiring an inferior use.

In 1963, the Legislature took three steps which clarified the position of municipalities seeking water supplies. The first step was to define domestic use of groundwater, by adding to Section 46-613:

> ...As used in this section, domestic use of groundwater shall mean all uses of groundwater required for human needs as it relates to health, fire control, and sanitation and shall include the use of groundwater for domestic livestock as related to normal farm and ranch operations.[9]

This definition made it clear that industrial uses supplied from municipal water sources did not enjoy the protection accorded to domestic use under the preference system.

The second step taken in 1963 was to define groundwater.

> Sect. 46-635. Groundwater is that water which occurs or moves, seeps, filters, or percolates through the ground under the surface of the land.[10]

The third step the Legislature took in 1963 was to pass the City, Village and Municipal Groundwater Permit Act. This act provides for permits to transfer groundwater for municipal use.

> Sect. 46-638. The Director of Water Resources of the State of Nebraska is hereby authorized to grant and administer permits to cities, villages or to municipal corporations supplying water to cities and villages: (1) To locate, develop and maintain groundwater supplies through wells or other means and to transport water into the areas to be served by the city, village or municipal corporation, and (2) To continue existing use of groundwater and transportation of groundwater into the area served by the city, village or municipal corporation.[11]

In 1965, well spacing protection for municipal wells was enacted.

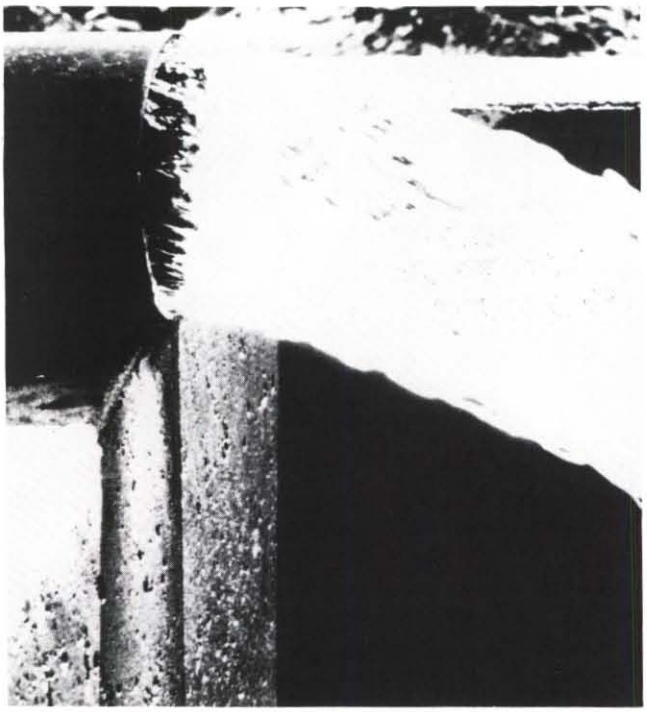
> Sect. 46-651. Except as provided in section 46-653 to 46-654, after November 18, 1965, no irrigation or industrial well or well of any other city or village shall be drilled within one thousand feet of any well of any city or village used to supply such city or village and its inhabitants with water, and no well of any such city or village shall be drilled within one thousand feet of any such irrigation or industrial well.[12]

Well spacing protection has since been extended to public supply wells.

In 1966, the Nebraska Supreme Court decided an important case regarding municipal use and transfer of water. As told by Harnsberger, Oeltjen, and Fischer:

> Pursuant to the Act, on February 19, 1965, the Metropolitan Utilities District of Omaha (hereinafter called MUD) filed its application for a permit to withdraw an average of forty mgd (million gallons per day), with a maximum of 60 mgd, from wells on the north bank of the Platte River and on an adjacent island. This site, close to the confluence of the Platte and Missouri Rivers, is ideal for pumping large quantities of high quality water. For example, MUD's thirty-seven wells spaced on 400 foot centers can each produce an average of 1400 gpm.
>
> At the hearing on the application, evidence was presented showing that eighty percent or more of the water from the proposed well field would come from the Platte River through induced recharge. Nevertheless, the director treated the water involved as groundwater. With

respect to the claims of some of the objectors that the contemplated withdrawals would lower their water levels, the director found that withdrawal of sixty mgd (approximately ninety-three cubic feet per second) would lower the Platte River less



than one and one-fourth inches at the time of the lowest recorded discharge (240 cubic feet per second on September 3, 1955) and that the stream would be lowered considerably less at the higher discharges which generally prevail. In addition, the director found that the water wells owned by those objectors whose properties were not being condemned were beyond the influence of withdrawals from the proposed MUD wells. Therefore, on June 9, 1965, he granted the application after expressly stating that he had given no consideration to the objection that the diversions were illegal because water was being transported from one watershed to another.

Five of those filing objections to the application appealed to the Nebraska Supreme Court. In *Metropolitan Utilities District v. Merritt Beach Co.*, the court upheld the granting of the permit on the theory that no appropriators, riparians or users of groundwater had proven they would be harmed. Thus, they had no basis upon which to challenge the order. Although the case was decided on the theory that the alleged damages were speculative, the court considered a number of questions. Among these were whether the water to be taken by MUD was groundwater or water from a stream, whether the diversions interfered with vested riparian rights and rights of property owners to groundwater levels in the area, and whether the diversion of water from one basin to another was sustainable under Nebraska law.

The court held that under the evidence and circumstances of the case the transbasin diversion was reasonable, for a public purpose and in the public interest. The court also decided that the diversions did not interfere with existing rights. The more technical question and a major issue was whether the water pumped from the wells was groundwater. If not, the MUD permit was invalid. The court answered in the affirmative even though the undisputed evidence was that to replace the sixty mgd to be pumped from the aquifer, four mgd would be groundwater and fifty-six mgd would be from surface waters of the Platte River. The court's conclusion therefore rested on a literal reading of the 1963 statute which defines groundwater in Nebraska as "that water which occurs or moves, seeps, filters, or percolates through the ground under the surface of the land." That this was of critical importance is indicated by the court's statement, "All of the water will be pumped from the ground, a direct diversion of water from the river not being contemplated."

Thus interpreted, the 1963 definition of groundwater seems to eliminate the possibility of adopting the doctrine that subflow is subject to appropriation as though it were part of a stream. Towns and cities seeking to protect their well fields are now restricted to obtaining permits under the City, Village and Municipal Corporation Groundwater Permit Act. These permits, because of their limited applicability, afford no

security against surface or groundwater users except other municipalities with later priorities.[13]

Thus the Nebraska Supreme Court rejected the subflow doctrine which might have allowed municipalities to appropriate waters from underground streams in the same manner as surface streams, and approved interbasin transfer for the public purpose of supplying water to the metropolitan area of Omaha.

In 1967, the Legislature added to the City, Village and Municipal Groundwater Permit Act standards for the director to consider in granting permits for transfers of water.

> Sect. 46-642. If the Director of Water Resources, after the hearing, finds that the withdrawal and transportation of groundwater requested by the applicant is reasonable, is not contrary to the conservation and beneficial use of groundwater, and is not otherwise detrimental to the public welfare, he shall grant a permit to the applicant to withdraw and transport water in the amount applied or in a lesser amount; **Provided,** any permit granted under the provisions of sections 46-638 to 46-650 prior to October 23, 1967, shall be and remain valid notwithstanding any lack of findings by the director of the conditions set forth in this section. The permit so granted shall have a priority date as of the time when the application is filed with the director.[14]

Municipal supply of water to industry was the subject of a 1967 Nebraska Supreme Court decision in the case of *Burger vs. City of Beatrice.* The city had begun condemnation proceedings for the purpose of supplying water to an industry outside the city limits. The court ruled the city could not condemn agricultural water rights for transfer to industries (inferior uses) located outside city boundaries. The ability to use municipal condemnation authority to supply water to inferior uses within city limits was apparently not addressed and remains unclear. Furthermore, a condemnation under the preference system must be for a public purpose. The court did note the term public use "is elastic and keeps pace with changing conditions."[15]

The 1975 Groundwater Management Act provided that when a control area has been established because the supply of water is or may become inadequate, a permit is needed for a new well in the control area. The act also stated that administration of the act shall be consistent with the groundwater preferences.[16]

In 1978 the Nebraska Supreme Court ruled on *Prather vs. Eisenmann*, a groundwater case where an irrigation well was shown to be interfering with domestic wells although there was an adequate water supply in the area. The court affirmed a district court ruling that the irrigator was liable for damages to the domestic users under the preference system and had to pay the cost of the necessary improvements to the domestic wells. This could be considered as stretching or expanding the preference system, at least for groundwater, because there was no shortage of water and it was only necessary to improve the domestic wells in order to alleviate the conflict.[17] Furthermore,

> The opinion implies, but does not definitely hold, that groundwater preferences are "true" preferences requiring no compensation to the damaged inferior user.[18]

In the 1979 groundwater case *McDowell vs. Rural Water District No. 2* the Nebraska Supreme Court ruled that a rural water district is not a municipal corporation under the 1963 City, Village and Municipal Groundwater Permit Act.[19]

In 1980, the City, Village, and Municipal Groundwater Permit Act was extended to include public water suppliers.

> Sect. 46-638 (1) The Director of Water Resources of the State of Nebraska is hereby authorized to grant and administer permits to public water suppliers: (a) To locate, develop, and maintain groundwater supplies through wells or other

means and to transport water into the area to be served and (b) to continue existing use of groundwater and the transportation of groundwater into the area served.

(2) For the purposes of sections 46-638 to 46-655, public water supplier shall mean a city, village, municipal corporation, metropolitan utilities district, rural water district, natural resources district, irrigation district, reclamation district, or sanitary improvement district which supplies or intends to supply water to inhabitants of cities, villages, or rural areas for domestic or municipal purposes.[20]

This brought metropolitan utilities districts and others into the group of organizations authorized to apply for a permit to transfer groundwater for domestic and municipal needs.

Summary

The major influences in the development of state law regarding municipal water quantity needs were the preference system, the cases *Olson vs. City of Wahoo, MUD vs. Merritt Beach Co., Burger vs. City of Beatrice, Prather vs. Eisenmann,* and the 1963 City, Village and Municipal Groundwater Permit Act as amended. Together they provide protections for domestic water use and show that municipal water use does not enjoy the same protections. Particularly, use of a municipal system to supply commercial and industrial activities is not protected under the preference system.

The pumping of groundwater associated with the Platte River has been determined by the courts to be a use of groundwater, not surface water.

The process for transferring groundwater for municipal use is established.

QUALITY ASPECTS

Federal Law

In 1974, the Congress of the United States enacted the Safe Drinking Water Act (P.L. 93-523), placing all water systems serving more than 25 persons daily, or having more than 15 service connections, under the regulatory authority of the U.S. Environmental Protection Agency (EPA). The act requires the owners of regulated supplies to continuously demonstrate the safety of water delivered to customers. The drinking water must meet standards for chemical and bacterial quality. Enforcement is based on the results of examinations performed by certified laboratories. The federal law permits the states to assume enforcement responsibility with associated grant assistance when state laws, regulations, and implementation are no less stringent than the federal. Nebraska has assumed this enforcement responsibility, as discussed on page 1-10.

The Safe Drinking Water Act of 1974 defines public system and municipality:

> The term 'public water system' means a system for the provision to the public of piped water for human consumption, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals...
>
> The term 'municipality' means a city, town, or other public body created by or pursuant to State law or an Indian tribal organization authorized by law.[21]

A potentially significant part of the federal law is the "sole source aquifer" provision. This refers to an area which "has an aquifer which is the sole or principal drinking water source for the area and which, if contaminated, would create a significant hazard to public health".[22] If the EPA Administrator makes such a finding, federal financial assistance (grants, contracts, or loan guarantees, for example) may be prohibited for any project which "may contaminate such aquifer through a recharge zone as as to create a significant hazard to public health..."[23]

Another provision of the Safe Drinking Water Act relates to the disposal of wastes by underground injection. The federal law requires the EPA to develop minimum requirements for effective state programs to prevent underground injection which endangers drinking water sources. Such an enforcement program is now pending in Nebraska and would be administered by the Department of Environmental Control and the Oil and Gas Conservation Commission.

In summary, main provisions of the Federal Safe Drinking Water Act include:

(1) Primary regulations relating to contaminants which may adversely affect health,
(2) Secondary regulations to protect public welfare and aesthetics,
(3) States to assume primary enforcement responsibility, including granting variances and exemptions,
(4) State underground injection control programs, and
(5) Protection of sole source aquifers including
    (a) No new underground injection wells except by permit, and

(b) No federal funds for projects that could contaminate the sole source aquifer.

State Law

The Nebraska Legislature adopted the Nebraska Safe Drinking Water Act (L.B. 821) in 1976 and in 1977 the State Health Department was granted responsibility for the program. The state law provides that the director of the Health Department shall adopt drinking water standards, requires permits to operate public water supply systems, formulates other provisions on siting, design, system alteration, and operator competency, and establishes a State Advisory Council.[24] In carrying out its program, the department reviews and approves plans for major system improvements, trains and certifies the capability of system operators, provides laboratory service at minimum cost, and prepares reports on system reliability and efficiency for consideration by owners. This approach materially decreases the impact (work load) of the Safe Drinking Water Act on the owners of water systems, particularly the owners of small systems. Complete copies of the Nebraska Safe Drinking Water Act (L.B. 821) and the Department of Health regulations implementing the law can be found in Appendices B and C, respectively.

Concern over the effects of development on the quality of groundwater led to the enactment of L.B. 146 (Section 46-658 R.S. Supp., 1981) in the 1981 legislative session. This law revised the Groundwater Management and Protection Act, stipulating that groundwater quality control areas could be designated to prevent current or future groundwater pollution. Under prior law, only groundwater degradation resulting from the dewatering of an aquifer could be controlled in this manner. L.B. 146 expanded the basis for authorizing regulation and added further control measures to those already authorized by law. With the establishment of a quality control area, a Natural Resources District (NRD) can now implement a number of management techniques, including setting of minimum standards for irrigation well construction, requiring irrigation scheduling, restricting well spacing, and regulating quantities of groundwater withdrawn.[25]

The authority of the Department of Environmental Control[26] in the prevention and control of pollution can be a factor in the maintenance of acceptable water quality in sources of municipal supply. This department has regulatory responsibility for groundwater quality protection, including wastewater treatment facilities, livestock waste control facilities and other potential sources of water pollution.

FOOTNOTES

1. **Neb. Rev. Stat**. section 46-204 (1943).
2. Task Force Report to the Natural Resources Commission, Policy Issue Study on Selected Water Rights Issues, *Report #1, Preferences in the Use of Water*, April, 1981, p. 2-4.
3. Nebraska Constitution, Section 6, Article XV.
4. Task Force Report to the Natural Resources Commission, Policy Issue Study on Selected Water Rights Issues, *Report #1, Preferences in the Use of Water*, April, 1981, p. 1-2.
5. Harnsberger, Oeltjen, Fischer, **Groundwater: From Windmills to Comprehensive Public Management**, 52 **Neb. L. Rev.**, 1973, p. 233.
6. **Id.**, p. 193.
7. **Id.**, p. 213.
8. **Neb. Rev. Stat**. section 46-613 (1943).
9. **Id.**
10. **Id.**, section 46-635 (1943).
11. Laws 1963, c. 276, section 1, p. 829.
12. Laws 1965, c. 270, section 1, p. 771.
13. Harnsberger, Oeltjen, Fischer, **Groundwater: From Windmills to Comprehensive Public Management**, 52 **Neb. L. Rev.**, 1973, p. 222-224.
14. **Neb. Rev. Stat.**, section 46-642 (1943).
15. Harnsberger, Oeltjen, and Fischer, **Groundwater: From Windmills to Comprehensive Public Management**, 52 **Neb. L. Rev.**, 1973, p. 230.
16. Task Force Report to the Natural Resources Commission, Policy Issue Study on Selected Water Rights Issues, *Report #1, Preferences in the Use of Water*, April, 1981, p. 1-11.
17. **Id.**, p. 1-11.
18. **Id.**, p. 1-10.
19. Aiken, **Nebraska Groundwater Law and Administration**, 59 **Neb. L. Rev. 1980, p. 970.**
20. Law 1963, c. 276, section 1, p. 829; Laws 1980, L.B. 643, section 2 (re-named Municipal and Rural Domestic Groundwater Transfers Permit Act).
21. Public Law 93-523, Safe Drinking Water Act, 1974, section 1401.
22. **Id.**, section 1424.
23. **Id.**, section 1424.
24. Laws 1976, L.B. 821, section 1.
25. Laws 1981, L.B. 146; Section 46-658 R.S. Supp., 1981.
26. Nebraska Environmental Protection Act of 1971, Sections 81-1501 through 81-1533, R.S. Supp. 1943.

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Chapter 2

Municipal Water Systems in Nebraska

For the purposes of this analysis a municipal water system is defined as any water system serving a city or village incorporated under Nebraska law. With few exceptions such systems are publicly owned and are managed by the elected officials of the political subdivision. There are 457 such systems under state regulation relating to the delivery of safe drinking water.

THE MUNICIPAL WATER SYSTEMS

Municipal water systems, in nearly every instance, provide for all the water needs of those individuals living within their service areas. These needs include water for drinking, culinary, sanitation, fire protection, lawn and garden watering, community recreation, and commercial and industrial purposes in amounts necessary to maintain the economic and social activities of the community. Based on 1980 census information, 1,271,881 people (81 percent of Nebraska's population) live in areas served by a municipal water system. Of the 457 municipal systems, only 234 maintained records of pumpage and sales, or could estimate water use, to the degree of reliability needed for this analysis.[1]

The 234 towns providing records utilized in this analysis supply water to 91 percent (1,156,178) of the total population served by municipal systems. Of these 234 towns, only 167 provided metered water use figures. However, the towns with metered information accounted for 88 percent (1,117,500) of the population served by municipal systems. The remaining 67 communities estimated their water use from power consumption, pumping time, and system pressures data.[2]

Components of Municipal Systems

A water supply system usually includes a combination of the following components:

1. A source of supply adequate to provide quantities of the best quality water available to meet all community needs.
2. Treatment of the raw water obtained from the source to the degree necessary to satisfy the demands of the consuming public.
3. Storage capacity to permit continued delivery of water during periods when demand exceeds short-term production and through periods of source breakdown.
4. Distribution through a system of pipes in amounts adequate to meet any anticipated requirement for water at any location in the area served.

A major portion of Nebraska municipal water systems consist only of a source of supply, minimal storage, and distribution to the point of use. Only 93 municipal systems deliver other than the raw source water to consumers. The degree of treatment, or conditioning, ranges from relatively simple treatment (disinfection with chlorine, retention of iron in solution by adding polyphosphate, adjustment of fluoride concentration, and aeration to remove taste and odor), to complex chemical treatment to remove dissolved solids.[3] Appendix D identifies those Nebraska municipalities that provide treatment, the purpose of treatment, and the processes and chemicals used to achieve this purpose.

An overview of all municipal water systems in Nebraska is given in Table 2-1. This analysis demonstrates the reliance on groundwater as a source of supply, the preponderance of small systems, and treatment applied by system size.

Evaluation of Municipal Systems

Table 2-2 illustrates the physical capacity of municipal systems in Nebraska and evaluates their ability to provide adequate amounts of water. The existing system size is compared to

current design standards that are applied to new construction.[4] These standards recommend at least 100 gallons per capita per day for sanitation and household use, storage and distribution lines sized to provide higher flows for fire protection, and a source of supply that will meet all needs simultaneously while maintaining a minimum pressure of 20 pounds per square inch (psi) at the point of delivery.

A single source of supply, such as one well, is not considered adequate to assure continuous water service to a community. A source is also considered inadequate when an auxiliary power source is not provided to assure operation of pumps when the primary power source fails.

Storage is evaluated on the basis of at least one average day's supply. The source of supply, or quantity of water available to the system, and the storage available must be considered together in design and appraisal of system capacity. An exceptionally high yield source with auxiliary power to assure continuous delivery of water may result in reduced storage requirements. Table 2-2 reflects this relationship by reporting both source and storage as adequate when they are properly balanced. A number of municipal systems, particularly in the group serving fewer than 500 persons, are deficient in both source and storage.

Sixty-four percent of municipal systems have inadequacies in the distribution component. Criteria for measuring the adequacy of a distribution system are:

1. Main size and arrangement that will maintain at least 20 psi pressure at any point in the distribution system under any condition of flow or patterns of water use.
2. No main under 4 inches in size.
3. No dead end mains.
4. Existence of known and operable valves to permit repair and replacement of main sections without extensive shut-down of service.

TABLE 2-1

MUNICIPAL WATER SYSTEMS IN NEBRASKA POPULATION SERVED, SOURCE OF SUPPLY, TREATMENT PROVIDED

	SOURCE OF SUPPLY			TREATMENT		
POPULATION SERVED	Ground	Surface	Both	Disinfection (a)	Solids Removal (b)	Conditioning (c)
Less than 100	24					
100 to 500	227			5	7	15
501 to 1,000	86			1	6	12
Greater than 1,000	116	1	3	1	22	24
Total System	453	1	3	7	35	51
Population Served	786,219	1,311	484,351	34,372	746,950	108,490
Grand Total	457			93		
Population Served	1,271,881			889,812		

(a) Application of chlorine only.
(b) Removal of suspended and dissolved solids plus chlorination.
(c) Addition of fluoride, polyphosphate, or other chemical plus chlorination in some cases.

TABLE 2-2

PHYSICAL CONDITION OF NEBRASKA MUNICIPAL WATER SYSTEMS

POPULATION SERVED	SOURCE & SUPPLY		STORAGE		DISTRIBUTION	
	Adequate	Inadequate	Adequate	Inadequate	Adequate	Inadequate
Less than 100	15	9	17	7	11	13
101 to 500	83	44	141	86	83	144
501 to 1,000	81	5	29	57	33	53
Greater than 1,000	113	7	75	45	57	63
Totals	392	65	262	195	184	273
Population Served	1,245,610	26,271	1,064,429	207,452	1,029,136	242,745

NOTE: Individual systems may have more than one inadequacy.

A deficiency in one or more of the water system components reduces the quantity and quality of water delivered to the user. An inadequate source, unless balanced by added storage, results in reduced quantities of water delivered to the distribution system. Maintenance of continuous and uniform pressure throughout the system is essential to delivery of a quality product. Undersized water mains and pipe layout that does not permit the flow of water from two directions to the service withdrawal point contribute to reduction in the pressures carried in the system. When pressure in the distribution system is reduced, or becomes negative, backflow and back-siphonage permit the contents of automatic dish and clothes washers, flush tanks, and other water-using appliances to enter the community system. Contamination of the water in mains serving large areas has been demonstrated when pressure loss occurs.

The deficiencies listed in Table 2-2 are based on the system capability to provide required amounts of water under maximum conditions of demand without serious losses in pressure. This conservative appraisal has not considered the effect of pumpers to augment fire hydrant flow. Most communities have such pumpers available within their own fire fighting unit or available from neighboring communities. The danger of system contamination and damage by collapsing water mains is much greater than indicated by the distribution system deficiencies illustrated in the table because of the availability of these pumpers.

Rehabilitation Needs and Costs

Fifty-four communities were selected at random for analysis of the investment required to bring their water systems into conformance with current standards. The costs of providing improvement for inadequate system elements were estimated from recent contracts awarded within the state. The results of this analysis are shown in Table 2-3. The costs presented in the table do not include the expense of replacing street surfaces, curbs, landscaping, and similar improvements that might be removed to gain access to the water system components, nor do the costs include land that might be needed for construction of a new well or storage reservoir.

An interest rate of 10 percent on municipal bond issues was selected as typical for a political subdivision with average to good credit rating. The rate on bonds issued by a municipality may be higher or lower depending on the history of repayment on past issues, soundness of system management practices, the nature of bonds (revenue, ad-valorem, or a combination), the bond market at the time of issuance, the population and assessed valuation of the community, and the amount of the issue.

In many instances rate increases of 300-900 percent would be required to upgrade the system to current design and construction standards. For example, the present water rate in Steele City is $4.00 per service connection per month. Assuming three persons in a household the monthly payment would increase to $27.73 with the suggested improvement.

TABLE 2-3

ECONOMICS OF REHABILITATION - SELECTED NEBRASKA WATER SYSTEMS

COMMUNITY	1980 POPULATION	COST IN DOLLARS: SOURCE	STORAGE	DISTRIBUTION	APPURTENANCES	ENGINEERING	TOTAL	PER CAPITA COSTS	20 yr. 10% MONTHLY AMORTIZATION	MONTHLY PER CAPITA RATE INCREASE
Allen	390	100,000	41,250	7,200	3,100	15,155	166,705	427	1,609	4.12
Ashland	2,276	-	12,450	113,230	29,100	11,333	155,563	68	1,501	0.66
Beemer	854	-	125,000	32,295	12,500	14,500	184,295	216	1,778	2.08
Benkelman	1,228	-	-	17,280	3,200	2,083	22,418	18	16	0.18
Bloomfield	1,391	-	142,400	36,900	5,800	18,500	103,600	146	1,965	1.41
Broken Bow	3,974	-	-	40,200	7,200	4,340	47,740	12	461	0.12
Burchard	122	-	-	19,356	3,100	2,225	24,702	203	238	1.95
Burwell	1,382	50,000	-	23,584	5,000	8,300	86,884	63	838	0.61
Chappell	1,086	-	-	156,713	24,800	8,510	200,023	184	1,930	1.78
Cody	178	-	42,038	21,708	5,200	6,895	75,841	426	732	4.11
**Crofton	949	-	106,169	-	-	10,000	107,169	112	1,556	1.64
Dunbar	216	-	75,350	38,360	8,800	12,251	134,761	624	1,300	6.02
Dwight	221	-	100,000	39,578	4,000	12,000	155,578	703	1,501	6.80
Edgar	704	-	200,000	25,200	4,800	23,000	253,000	360	2,332	3.46
Elmwood	599	-	-	38,592	12,150	5,074	55,816	93	539	0.90
Falls City	5,186	-	-	10,720	3,100	1,382	15,202	3	147	0.03
Ft. Calhoun	638	-	-	36,716	14,250	5,097	56,063	88	541	0.85
Garland	255	-	70,294	15,946	5,700	9,194	101,134	397	976	3.83
Gordon	2,167	-	-	27,872	11,400	3,972	43,244	20	417	0.19
Gothenburg	3,476	-	-	25,200	4,800	3,500	33,510	10	323	0.09
Hallam	293	-	44,146	16,784	7,300	6,823	75,053	256	724	2.47
Hartington	1,735	-	-	44,622	14,600	5,900	65,144	38	629	0.36
Hickman	1,123	-	-	2,144	1,300	500	3,944	4	38	0.03
Hyannis	334	-	-	9,240	1,200	2,000	12,440	37	120	0.35
Jansen	203	-	-	23,040	4,500	3,234	35,574	175	343	1.69
Kearney	21,149	-	-	2,441,000*			2,441,000	115	23,556	1.11
Lawrence	350	-	-	12,864	4,400	1,727	18,991	54	183	0.52
Lincoln	171,187	-	-	-	-	-	-	-	-	-
Louisville	1,023	-	-	40,200	15,850	5,605	61,655	60	595	0.58
McCook	8,361	-	-	18,090	5,600	2,369	26,060	3	251	0.03
Malcolm	355	-	33,450	8,603	2,600	4,460	49,113	138	474	1.34
Mitchell	1,984	-	-	89,862*			120,848	61	1,166	0.59

Continued

COMMUNITY	1980 POPULATION	SOURCE	STORAGE	DISTRIBUTION	APPURTENANCES	ENGINEERING	TOTAL	PER CAPITA COSTS	20 yr. 10% MONTHLY AMORTIZATION	MONTHLY PER CAPITA RATE INCREASE
Murray	467	(RWD)	87,500	21,440	7,800	11,674	128,414	275	1,239	2.65
Nelson	746	-	-	72,728	14,500	8,723	95,951	129	926	1.24
Norfolk	19,333	-	-	16,616	5,200	2,182	23,998	1	232	0.01
Oakland	1,393	-	-	-	-	-	215,000*	154	2,075	1.49
Ogallala	5,624	-	-	13,400	4,400	1,780	19,580	3	189	0.03
Ord	2,661	-	-	72,862	24,400	10,000	97,262	40	1,035	0.39
Pawnee City	1,158	-	-	19,062	10,150	2,921	32,133	28	310	0.27
Pierce	1,536	-	-	23,265*		2,327	25,592	17	247	0.16
Randolph	1,109	-	-	4,200	-	420	4,620	4	45	0.04
Ruskin	224	-	-	49,840	9,600	6,000	65,440	292	632	2.82
Schuyler	4,557	-	300,000	(12 hr. water reserve)		30,000	330,000	72	3,185	0.70
Seward	5,698	-	-	64,950*			64,950	11	627	0.11
Springfield	776	-	41,466	10,100	2,400	5,397	59,363	76	573	0.74
Steele City	137	35,000	10,000	56,700	9,500	12,000	112,400	820	1,085	7.91
Stromsburg	1,292	-	91,366	50,250	15,200	16,000	172,500	134	1,665	1.29
Syracuse	1,640	-	-	6,854	1,200	753	8,284	5	82	0.05
Tekamah	1,886	-	-	18,090	4,800	2,369	26,060	14	251	0.13
Utica	686	-	86,400	51,750	6,600	15,000	159,750	233	1,541	2.25
Walthill	852			14,000	4,800	1,900	20,700	24	200	0.23
Waterloo	400	56,000	200,000	57,340	9,500	32,000	354,840	865	3,424	8.56
Wisner	1,338	-		10,010	2,400	1,200	13,650	10	132	0.10
Yutan	636	-	-	8,375	4,800	1,318	14,493	23	140	0.22

***Hooking to Rural Water District*

**Based on Engineer's Report*

Maintenance

The municipal water systems in Nebraska were generally adequate when originally built. Two factors make many systems presently inadequate:

1. Increased water use by dishwashers and other appliances, along with seasonal outside use has caused shortages of water because the water source developed by the community is not adequate for the increased demand.
2. Distribution system and storage expansions to serve additional areas were not installed to meet today's higher water demands and still provide adequate system pressures. Mains of inadequate size and dead ends were used.

Necessary investments in many systems have been deferred, and problems in water service often result in emergency action without benefit of adequate planning and awarding of contracts by bid. This practice contributes to "shortcuts" and is usually a factor in the excessive cost of the rehabilitation or replacement ultimately needed. Adversities and subsequent cost for corrective action rarely occur at close enough intervals to demonstrate the continuing nature of the problem to elected management officials. Expediency usually dictates the measures applied to maintain water service or place the system back in operation when complete failure is experienced. Once the emergency is over and the recovering supply can meet the reduced fall and winter demand, interest in permanent corrections drops.

The city of Peru is an example of this tendency. It has a long history of water shortages, disruption of service to consumers, bacterial contamination, and aesthetic problems ("red water") due to excessive concentrations of iron. Lack of maintenance has contributed to the pressure and contamination problems as the water lines have gradually become plugged with scale and sediment. Treatment of the water was initiated some years ago but has since been suspended. The Department of Health has periodically made recommendations to the city regarding deficiencies in the system, with little action taken by city officials. Federal funds for water system improvements have been available, but were rejected by the city.

In April, 1981, the Department of Health approved city plans to drill a new well to meet an expected water shortage. This approval was conditional upon the city's acknowledgement of the temporary nature of this solution and agreement that further investigation for a more reliable supply of aesthetic quality would be necessary. In September, the local college opened for the fall term, but the new well was not yet completed. Existing wells could not supply enough pressure to "push" the water through the small, partially plugged water lines. Part of the college lacked water service and was closed. Contamination of the water system by cross-connection occurred due to loss of pressure. Water was hauled in by tank truck for several days. "Normal" water service was eventually restored with the completion of the new well.

While the "emergency" is over, similar problems can be expected in the near future as poor water continues to plug the distribution system and reduce well efficiency and cause taste and odor problems. A long-range solution is urgently needed involving (1) a new source of supply (or treatment of the existing supply), and (2) maintenance programs consistent with industry standards.

Management and Public Attitudes

Many systems have developed inadequacies because they are not run as self-supporting utilities, with rates set at a level that would provide for necessary maintenance and expansion. Even though income from water service must be carried in a special account, the surplus may be transferred annually to a general fund and used for other community expenses.

It can be difficult for elected officials to plan and conduct necessary rehabilitation and expansion work on the water system because cities and villages are subject to administrative change as often as every two years. Also, the public does not demand maintenance or upgrading of the system as long as it is getting adequate water. Both elected officials and the public usually view the water system as a necessary service that must be operated at minimum expense.

Operation

Nebraska law requires that the Department of Health certify the competency of the individual in charge of a municipal water system. As of May, 1981, the department had issued certificates to 555 individuals employed by 266 municipal water systems. In addition, 175 operators were issued "designated operator" certificates by reason of their experience in operating a specific system on the effective date of mandatory certification, January 1, 1979. This latter group received certification on the basis of experience only and are not certified to supervise other

systems without formal technical training and examination. Fifteen municipal systems, serving populations of 130 to 1,494 persons, did not provide persons of demonstrated competence as operators of their water systems.

The reasons for this failure to provide responsible water system operation vary with the size of the community. In nearly every case, the absence of consumer demand for upkeep of their public investment, until service is disrupted, is a major reason for operation and maintenance deficiencies. In some of the villages the labor force does not supply people with the technical and physical capability to operate the system on even a part-time basis. The cost of providing a qualified operator is a problem for the smaller systems, although several have negotiated the sharing of an operator with nearby systems.

OTHER PUBLIC WATER SYSTEMS

There are 214 other non-municipal public water systems that are classified as community systems. These systems serve rural water districts, subdivisions, sanitary and improvement districts, mobile home parks, custodial institutions, and similar groups. They provide water

service to residential consumers as opposed to transient populations. All public systems serving residential property are subject to the same standards as municipal systems because of the potential for adverse health effects resulting from long-term exposure to contaminants. These standards relate to the presence of contaminants and to the schedules for monitoring, or testing, for contamination.

In general, these systems are smaller than those defined as municipal systems. However, they are faced with similar problems relating to physical plant deficiencies, operation, maintenance, and replacement. Department of Health files contain information on these systems, but the data have not been arranged and presented since inclusion would not serve to identify additional problems. Similarly, the 741 public water systems serving transient populations such as rest stops and highway restaurants also are not included in this analysis.

FOOTNOTES

1. Nebraska Water Use Data Project, UN-L Conservation and Survey Division.
2. Nebraska Water Use Data Project.
3. Department of Health, Division of Environmental Engineering files.
4. Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, Recommended Standards for Water Works, 1979.

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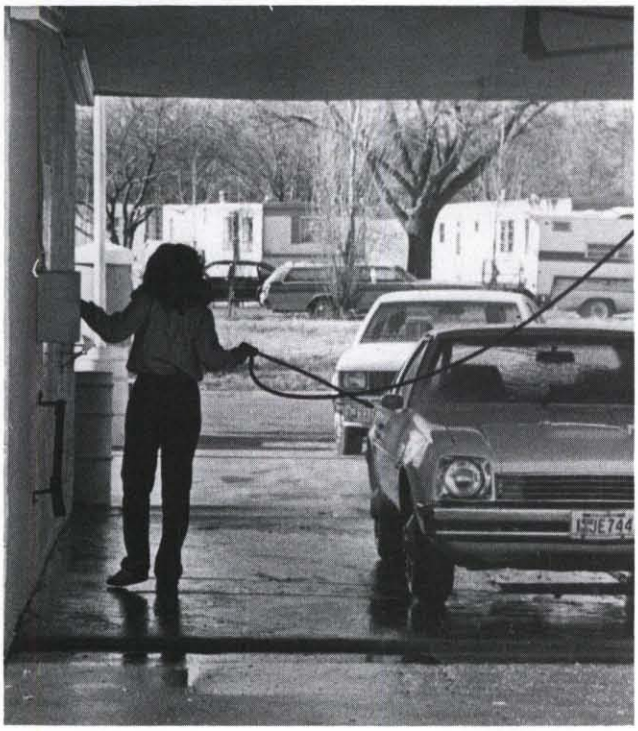
Chapter 3

Municipal Water Consumption

Municipal water systems provide water for drinking, sanitation, fire protection, lawn and garden watering, as well as commercial and industrial needs. Only a small portion of the water distributed by a municipal system is ingested by individuals served by the system. Two liters, or approximately 0.53 gallons of water, is generally adequate to satisfy a person's daily requirement for drinking water. An additional three to five gallons per day may be used for cooking, cleaning of utensils, or similar domestic activity resulting in the ingestion of some portion of the water. The small amount of water that is directly or indirectly ingested by the population cannot be identified or separated from the remaining system delivery used for flushing stools, watering lawns, fire protection, and other municipal uses.



In discussing and evaluating municipal water needs it is important to realize the relationships between (1) the amounts of water withdrawn from ground or surface sources by municipalities, (2) the amounts of water consumed and not returned to sources subsequently available for others, and (3) the amounts needed to maintain community social and economic standards. These relationships vary with the income of the consumers, size of the system, services for which the system was designed, management of the system, and precipitation patterns in the area.

The analysis in this chapter concentrates on municipal use of groundwater. Few communities utilize surface water. The Metropolitan Utilities District (Omaha area) is permitted by the Department of Water Resources and has the capability to divert over 140 million gallons per day (mgd) from the Missouri River. The Cedar-Knox Co. Rural Water District supplies Missouri River water to Crofton and St. Helena. The city of Blair also utilizes water from the Missouri River. The city of Crawford holds permits to divert water from White River and Dead Man Creek, and the Beaver Lake Home Owners Association holds a storage permit for the lake that is its source of water. These systems are not included in the analysis since the sources of supply and availability of water are not typical of the Nebraska public water system pattern.

PER CAPITA WATER USE

In order to determine per capita use of water and the relationships between pricing, metering, and demand, 76 municipal water systems using groundwater as a source of supply were selected at random from the inventory of public water systems. The communities selected provide service to populations ranging from 72 to 170,000 consumers. Information obtained from these communities, and verified by Department of Health field personnel, was used to determine the average daily withdrawal of water from the groundwater reservoir by each system. The average daily withdrawal was divided by the population served and plotted against the cost of water to the consumers (see Figure 1). The

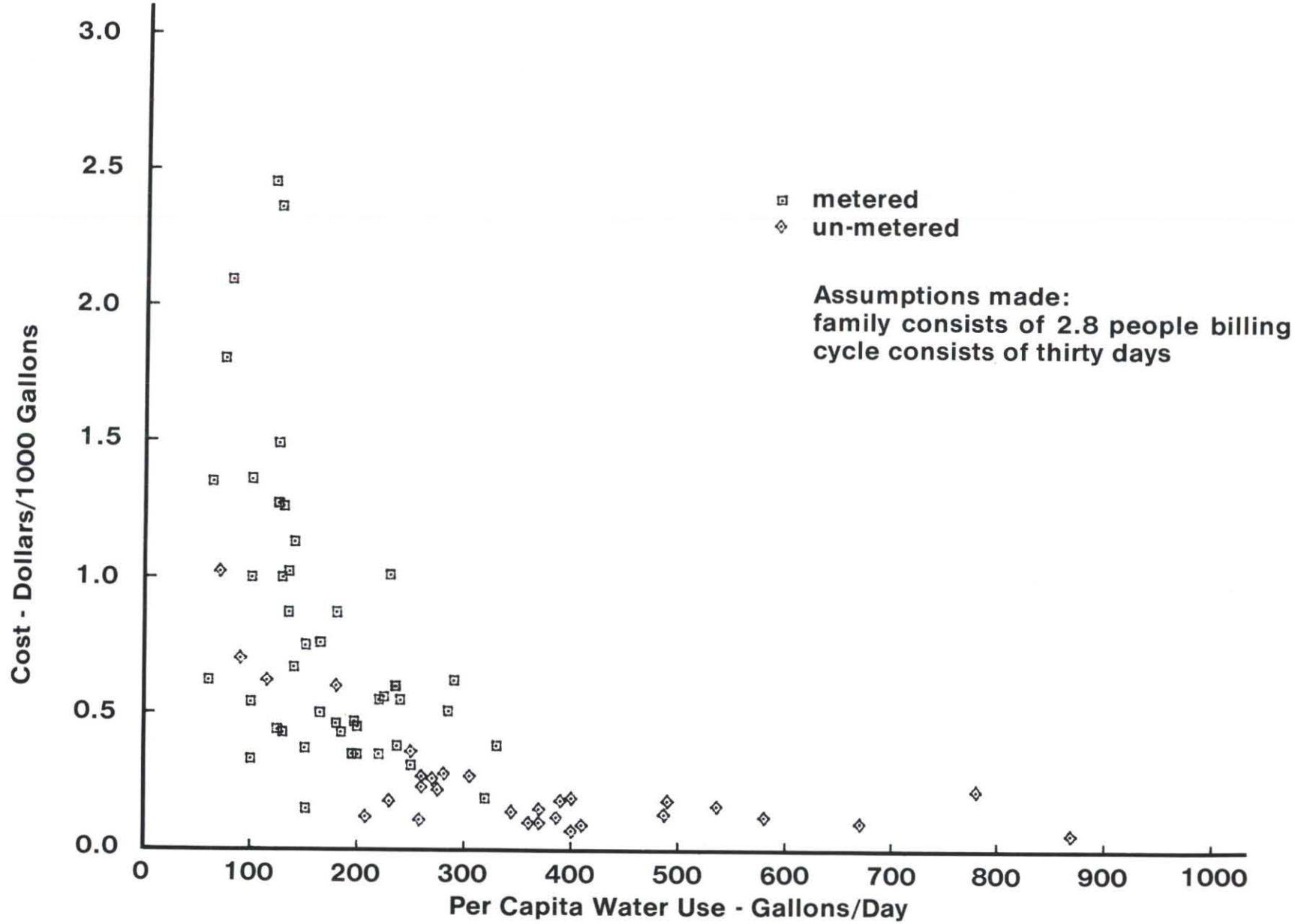


FIGURE 1
COST vs. USE
76 Representative Nebraska Communities

display illustrates the effect pricing and metering have on the demand for water. Higher costs and metering result in lower use. Only two communities deviate materially from this pattern. One unmetered system with low rates has achieved voluntary conservation of water by publicizing the fact that a contaminated well was taken out of service. The other community, while metered, sells water for only 25 cents per thousand gallons and has experienced considerable loss of pumped, but unsold, water through main breaks.

One-third of the systems studied exhibit water use within the range of 100 to 200 gallons per capita per day. These figures fall within the national range of water use with adjustment for industry. However, only three percent fall below this average and the remaining 64 percent of the systems exceed national averages by as much as 430 percent.

A review of Department of Health records revealed that many of the high-use systems are located in the western part of the state where climatic conditions contribute to consumer demand (see Figure 2). Outside uses for watering lawns and decorative plantings also create demand during summer months. Residents of the smaller communities often supplement their standard of living by raising and processing a portion of their food supply. This use of municipal water for "irrigation" results in over-taxing of the source or distribution system and can necessitate rationing or prohibition of outside uses during summer months. While historic records are not available, the Department of Health is aware of at least 18 municipal systems that applied control measures on outside water use during the summer of 1981.[1]

Characteristic water use patterns also occur in winter months. Many communities, especially those located in the western and northern parts of the state, experience more frequent freeze-up of water systems during the winter. Air temperature and precipitation combine to affect water transmission lines. Lesser snow cover, coupled with removal of insulating snow from streets above water mains, contributes to freezing of mains and service lines. Some consumers are encouraged to leave a water tap open during cold weather, as flowing water is less subject to freezing. Adjustments are sometimes made in water and sewer bills to accommodate this practice. Thus, hot, dry, and cold weather conditions contribute to increased municipal water use.

Pricing of water, however, remains the primary factor influencing water use practices. The flat rate schedule (a set fee per month regardless of amount used) applied in most unmetered systems discourages conservation and, in fact, encourages excessive use. When water is provided at a fixed price without regard for amount used, the consumer is not aware of the cost of his water use habits. Without economic incentive, most home owners may not replace worn washers in faucets or adjust floats on flush tanks. Water loss from these sources often accounts for 5 to 10 percent of the water pumped into the system.[2]

The metered customer can more easily relate to the fluctuation in water cost each billing period. When a water bill increases significantly the consumer may react by repairing leaks in the household plumbing system, operating the clothes and dishwashers only with full loads, shortening time in showers, scheduling lawn and garden watering and measuring application rates. By applying these and similar conservation measures the water customer exercises some degree of control over cost with no sacrifice beyond changed habits and attitudes.

Installing meters and raising rates is not always in the best interest of system management for very small water systems. The sale of water by metered volume has always resulted in a reduced demand. On occasion, adoption of high rate schedules has resulted in reduced use to the point that system income could not support operating costs. Setting utility rates is a highly specialized science and consultants in this field should be considered. Also, there are guidelines and rules for rate setting available that, when closely followed, will provide reasonable assurance of good results.[3]

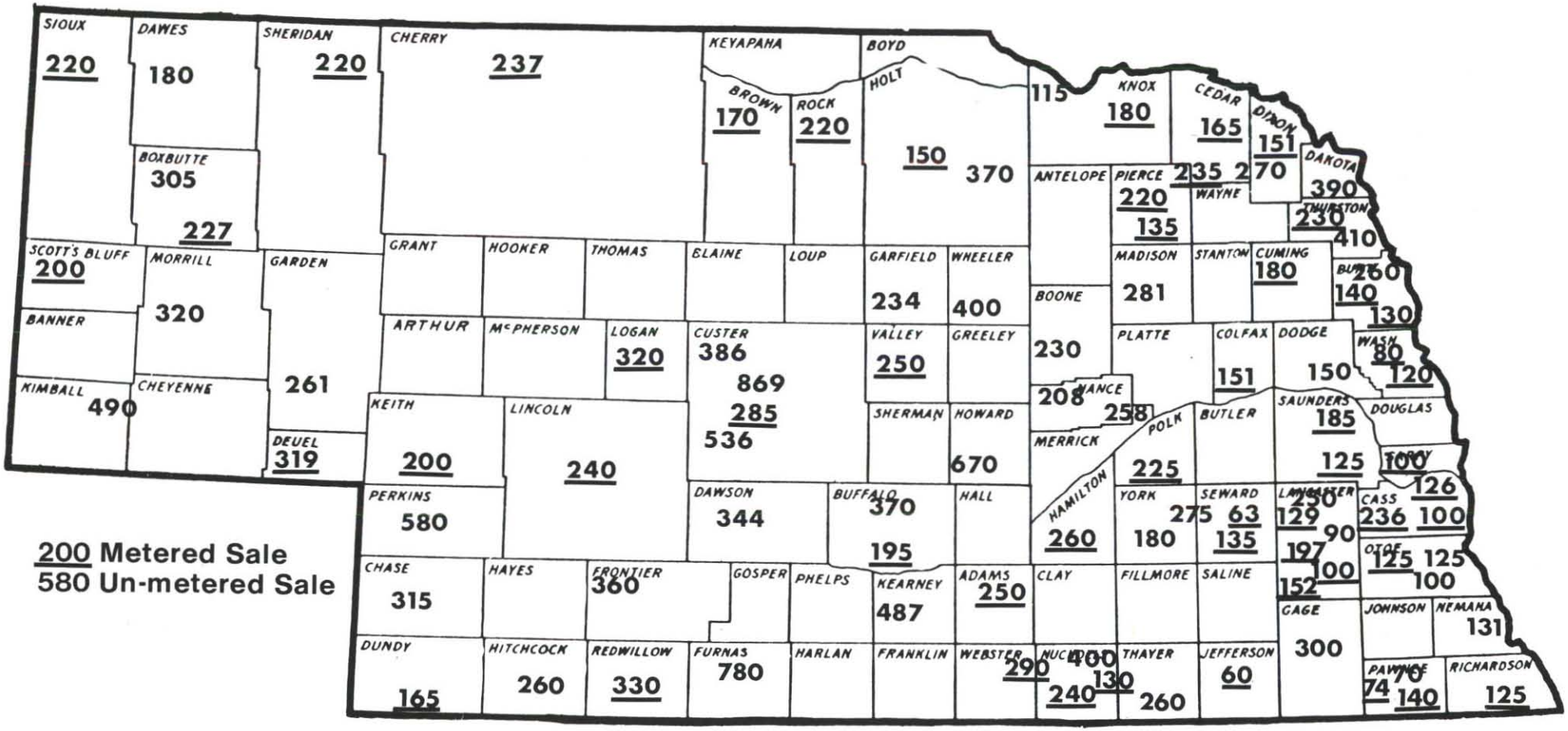


FIGURE 2

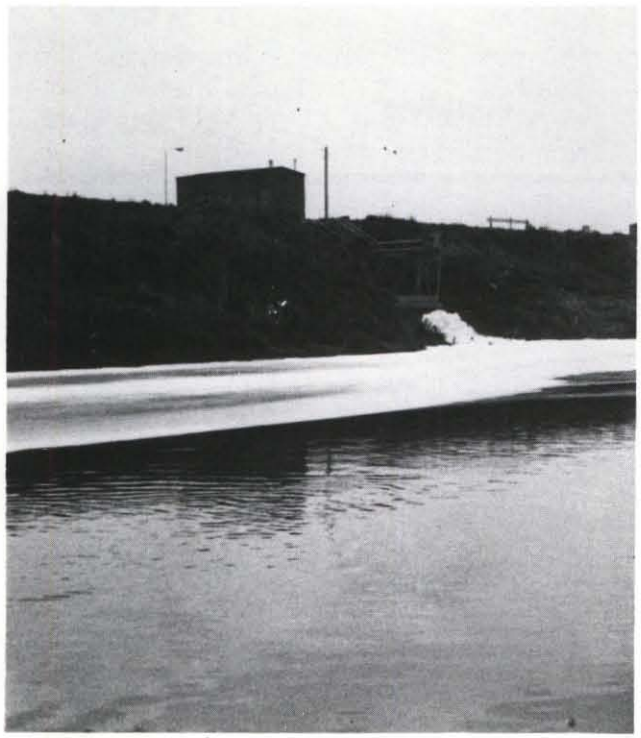
PER-CAPITA WATER USE BY TOWN LOCATION

(in gallons per person per day)

A number of the communities needing physical improvement to their water systems might delay the need for capital investment by encouraging water conservation. It is probable that reduced water use combined with a well-conceived rate structure could finance the improvements when they become essential to continued service. Each municipal system has authority to meter sales and adjust rates in the interest of reducing water use. Under current state policy they must act on their own initiative since there is no state entity authorized to supervise or monitor the fiscal conduct of public water systems.

WATER LOST

Most of the water withdrawn from a groundwater source for municipal use is eventually discharged to a stream as waste or returned to groundwater storage. This water is available for subsequent beneficial reuse, with some degradation of quality. Some water, however, is lost (consumed) and not available for further beneficial use. This consumed water may be lost to evapotranspiration from lawn and garden watering and other domestic activities, evaporation from wastewater lagoons and cooling towers, or other industrial processes. Considerable moisture is lost to respiration and evaporation from humans and animals.



Another category of water not available for immediate further use is "unaccounted-for" water. This is water lost from leaking pipes during transmission. It is essentially the difference between metered pumping figures at the source and metered customer sales. The percentage of water unaccounted-for is a measure of the efficiency of the distribution system. The percentages of unaccounted-for water in Nebraska systems range widely depending upon the age and construction details of the systems. In some systems, this leakage probably represents a significant fraction of the total water withdrawn. At certain times of the year this leakage from the distribution system can contribute to groundwater recharge. At other times, depending upon existing soil moisture and activity of vegetation, this leakage may be entirely lost to evapotranspiration.

Most communities treat their wastewater and usually return from 60 to 90 percent of it to natural surface drainage.[4] With proper treatment and adequate dilution water in the receiving stream this returned water is available for other beneficial uses not affected by limited quality deterioration. Other communities dispose of wastewater in lagoons, or holding basins. These lagoons may discharge to surface drainage or they may be complete retention ponds. With

proper design, lagoons are lined or constructed to minimize seepage. Thus, significant amounts of water may be lost to evaporation. In some cases, the water stored in lagoons is used to irrigate nearby land. In these instances an additional beneficial use is realized before the water is lost to evapotranspiration. Seepage from lagoons may be lost to evapotranspiration or it may recharge the groundwater under certain conditions. It is not unusual for the volume of wastewater discharged to exceed the volume of water pumped into the water supply system

when the community overlies an area of shallow groundwater. Sewer mains can collect natural groundwater infiltration. It is also conceivable that a break in a water main may go undetected when soil conditions and sewer construction permit subsurface drainage into open sanitary sewer joints.

In municipalities providing water and sewer service, water consumption and losses are influenced by a number of factors unique to each community. Each community would need to maintain adequate records on its water and sewer systems to determine community water use, consumption, and efficiency of the water and wastewater systems. Records assembled and maintained at the state level are not in the detail necessary to accomplish such an analysis. Only on rare occasions is the required information available in municipal records, and then only for large systems.

PROJECTION OF FUTURE MUNICIPAL WATER USE

Nebraska's population growth rate has been slower than the national rate. State population in 1980 (preliminary) was 1,570,006, compared to 1,485,321 in 1970 (a 5.7 percent increase, or approximately 0.5 percent per year). Most of the state's growth has been in urban and suburban areas. The rural farm population has experienced significant declines. While projections of Nebraska's population were not made for this analysis, projections are available from other studies. These figures indicate continuing slow growth of the urban population, with continuing loss of the rural farm population. The report on the Framework Study projected state population to barely surpass the two million mark by the year 2020.[5] Municipal water requirements may similarly increase. The amounts of additional water required by municipal systems in the future, however, may not correspond with the projected population increase. Water use will depend on many factors, including the rate of installation of meters and the revising of water rate schedules. Reduction of per capita use in many communities (reflecting increased cost of water) may offset any increase in population. Municipal water use in the future will probably not exceed the historical figure of 3 to 5 percent of total water used in the state.

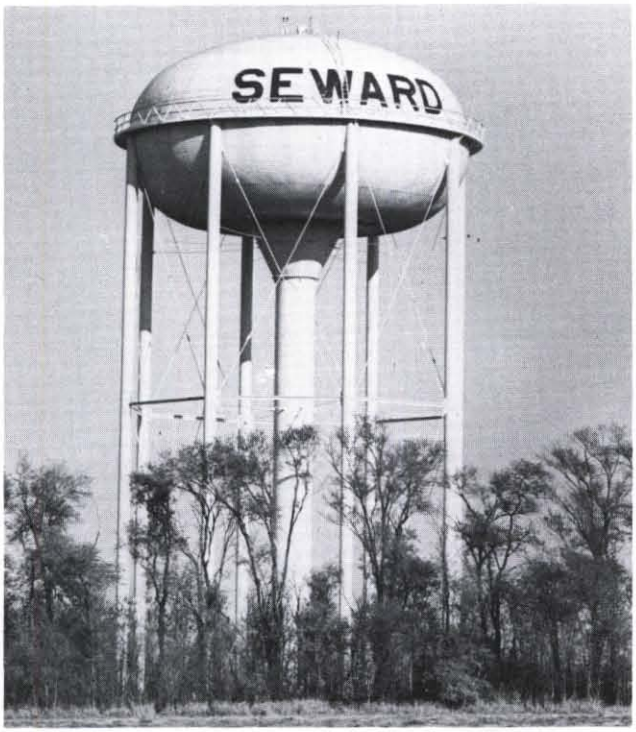
FOOTNOTES

1. Department of Health, Division of Environmental Engineering files.
2. Feth, J. H., 1973. Water Facts and Figures for Planners and Managers. USGS Circular 601-I, p. I-10.
3. U.S. Geological Survey and New England River Basins Commission. 1980. Before the Well Runs Dry: A Handbook for Designing a Local Water Conservation Plan.
4. Hammer, M. J., 1975. **Water and Waste-Water Technology**. John Wiley Sons, Inc., New York. pp. 296-307.
5. Nebraska Soil and Water Conservation Commission. 1971. Report on the Framework Study. State Water Plan Publication Number 101, p. 45.

Chapter 4

Source of Municipal Water Supply

Nebraska municipal water systems depend almost entirely on groundwater as their source of supply. Only the Metropolitan Utilities District (Omaha area), Blair, Crawford, the Cedar-Knox Rural Water District and Beaver Lake use surface water. Chadron has a surface water storage permit with an infiltration gallery near the impoundment to collect seepage. Chadron, Omaha and Blair are also equipped to use groundwater in an emergency. The availability and quality of groundwater is, therefore, of utmost importance to those Nebraskans relying on municipal service for their water supply.



The quality of groundwater exerts an influence on its value as a source of municipal supply. However, unless the natural chemical constituents adversely influence the health of those drinking the water, Nebraskans have expressed little concern, and at times point with pride, to the unique chemical characteristics of their water. Twenty percent of the municipal systems have elected to condition or treat water before delivery to customers.

GROUNDWATER AS A MUNICIPAL SOURCE

Geological Background

While groundwater is found in some quantity at almost any location in Nebraska, the production of wells is dependent on the thickness and texture of water-bearing formations, or aquifers. Both the quantity and quality of groundwater available for municipal use vary with the location and depth of aquifers selected as the source of supply. To assist in understanding the diverse source problems confronting many municipal water systems, the following summary is included.[1]

> When the word aquifer is used, what really is meant is saturated earth material having porosity for the storage of water and permeability for the transmission of water. Sand and gravel deposits make ideal aquifers because they have medium porosity and high permeability. Clay and silt deposits have high porosity but make poor aquifers because their pore spaces are so small that they greatly restrict the movement of water. Saturated fine-grained deposits are, however, an important part of the groundwater reservoir because the water they hold can be released, albeit slowly, to adjacent aquifers.
>
> Formation of aquifers requires a source of earth material and geologic processes that will sort and deposit this material. Nebraska's aquifers are formed in one or another of the following five geologic environments:

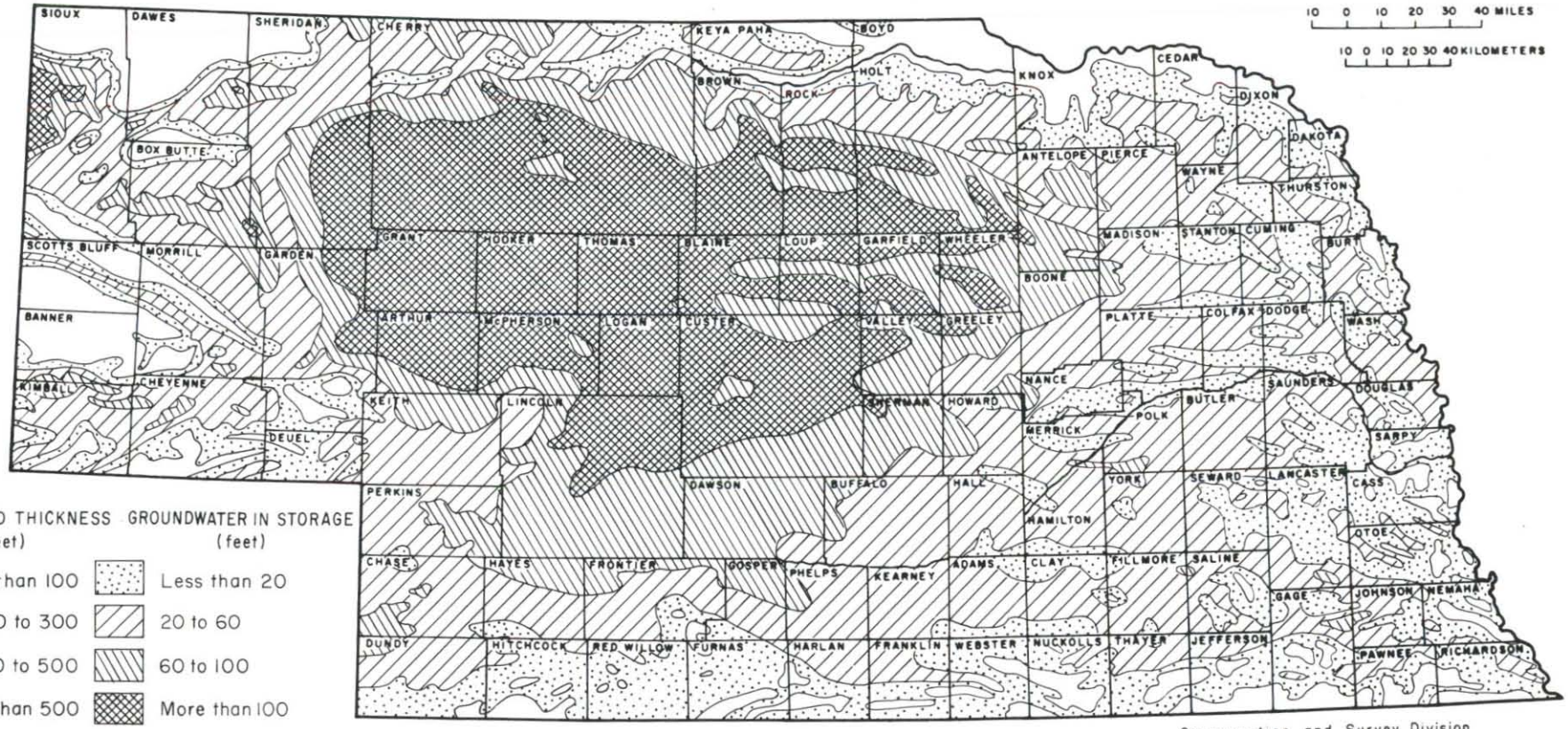


FIGURE 3

NEBRASKA GROUNDWATER STORAGE MAP

1. Fluvial environments in which sand and gravel was deposited by rivers draining the Rocky Mountains. Silt and clay layers deposited in floodplains and abandoned channels are interbedded with this sand and gravel. This type of deposit is characteristic of the Ogallala Formation found throughout central Nebraska.

2. Eolian environments where sand was effectively sorted and left as a lag deposit by winds that carried silt and clay particles away. Nebraska's Sandhills region was formed in this way.

3. Beach and shoreline environments in which wave action acted as the sorting agent, carrying away silt and clay particles, and leaving sand grains. Sandstones of the Dakota group were deposited in this type of environment. Unfortunately, water contained in these sandstones is usually too saline for human consumption or for irrigation.

4. Delta environments formed when rivers flowed into temporary lakes created when glaciers blocked existing drainageways. This type of environment existed in east-central Nebraska where sand and gravel deposits have accumulated.

5. Glacial environments in which rock debris was sorted by meltwater, deposited in localized deposits, and later buried beneath other glacial deposits. Aquifers of this origin are found throughout eastern Nebraska.

Most of Nebraska's aquifers can be described in terms of these five environments. In addition, the limestones and shales of southeastern Nebraska may yield water where they are fractured, or where solution channels have developed.

The amount of groundwater stored in the pore space of the aquifers in Nebraska is shown in Figure 3. The greatest amounts of groundwater in storage are found in the central and west-central part of the state, in the Sandhills and surrounding areas. More than 1,000 feet of saturated sediment are present in a portion of the Sandhills.

Aquifers are very thin, isolated, or limited in many areas near the borders of the state. Impermeable bedrock is at or near the ground surface in these areas. In the eastern part of the state, much of the water in storage is held in fine-grained sediments that do not yield water readily to wells. Many communities in these areas have experienced difficulty in developing and maintaining reliable public water supplies. These problems would be more acute if not for the development of rural water districts in the 1970's. The 17 rural water districts provide water to 21 municipal systems, providing the entire supply for 13 of them. Table 4-1 lists towns in "water-poor" areas that continue to experience problems.

TABLE 4-1

TOWNS CURRENTLY EXPERIENCING WATER SUPPLY PROBLEMS* DUE TO LIMITED AQUIFERS AND/OR COMPETITIVE USE EFFECTS.**

Big Blue Basin

Wilber

Republican Basin

Alma	Stamford
Danbury	Superior
Hardy	Wilsonville
Lebanon	

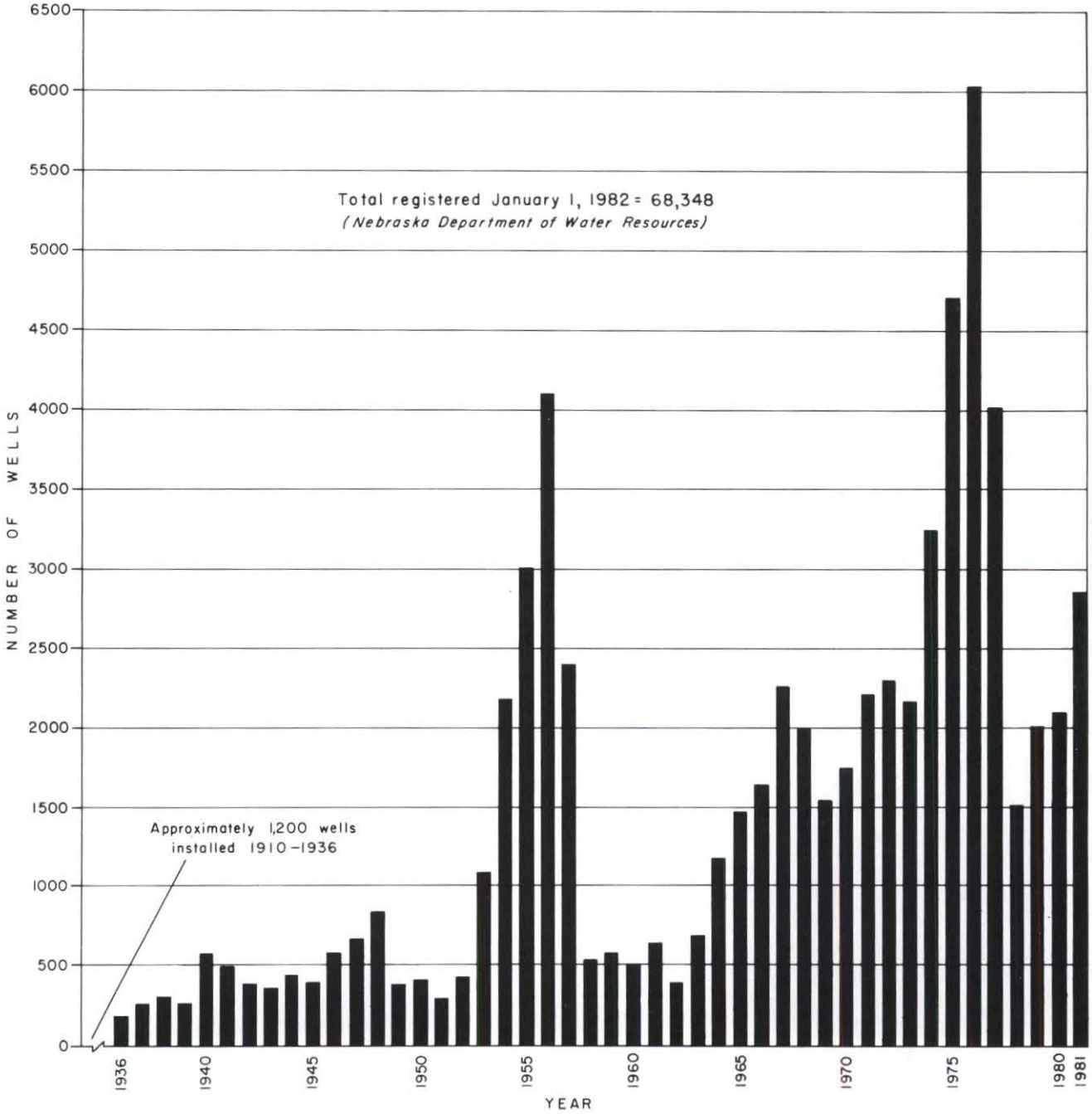
**defined as shortages, interference effects causing stress to systems, or limited prospects for increasing supply without importation or relocation of wellfields.*

***Does not include: (1) towns where problem is strictly due to inadequate system, (2) towns currently on RWD's, (3) towns with access to RWD, (4) towns where deeper bedrock aquifer available.*

Groundwater in storage is one component of the hydrologic system. As discussed in more detail in Chapter 5, groundwater tends to move from recharge areas to discharge areas, such as springs, streams, or wells. Relative amounts of water in storage are indicated by the water "table", or water levels in wells. Additions to or withdrawals from groundwater storage result in rising or declining water levels. Generally, most of the groundwater removed from storage originated as local precipitation. This fact can be important to communities because of water quality implications, and will be discussed further in Chapter 5. More detailed information on the geology and groundwater of Nebraska can be found in the **"Atlas Illustrating the Characteristics of Groundwater in Nebraska,"** a work report of the University of Nebraska Conservation and Survey Division, part of the output of the

Conservation and Survey Division
Institute of Agriculture and Natural Resources
The University of Nebraska–Lincoln

Institute of Agriculture and Natural Resources



Annual installation of irrigation wells in Nebraska through 1981
(estimated from historical surveys and irrigation well registration data)

FIGURE 4

Groundwater Reservoir Management Policy Issue Study (State Water Planning and Review Process).

The extensive development of groundwater for irrigation caused many additional communities to experience water supply problems. Local overdevelopment of groundwater resulted in progressive annual lowering of water levels over extensive areas, and significant seasonal water level declines. In some places, development has influenced the quality of water. The effect of competitive uses on municipal water supply is discussed in more detail in Chapter 6.

The Utilization of Water

The establishment of population patterns in Nebraska was determined by a complex interrelationship of many factors, including availability of natural resources (water, wood, soil), cultural and ethnic factors, economics, location of migration paths of early western movement and, later, location of rail routes.[2] A safe drinking water supply was one of the first requirements of the early settler.

Their homesites were located close to flowing streams which supplied water for the settlers and their livestock. More satisfactory water supplies were later developed by digging shallow wells in valley bottoms. Successful settlement of upland areas was slow because most streamflow was intermittent and the depth to groundwater generally was much greater than in bottomland areas.

Population centers developed as focal points for trade, agricultural supply, and transportation.

Railroad locations were critical in influencing the location of towns. In many instances the locations selected for community living were based on the rail heads determined by the time required to lay a convenient length of track. The success and prosperity of various towns and cities was closely tied to the fluctuations of the agricultural economy.

Large-scale development of the state's groundwater resources did not occur for some time. Even as late as the turn of the century, much of the popular press was dismissing the notion that surface water irrigation would ever be significant in the state.[4] Development of groundwater to the extent of today's 5 million irrigated acres was not foreseen. Only about 5,000 irrigation wells were installed by the middle to late 1940's. By 1960, over 20,000 wells were registered, and as of December, 1981 there were 68,348 irrigation wells in the state (see Figure 4).[5]

Communities located in areas of extensive irrigation development prospered. A stabilized population pattern was largely influenced by economics and the trade area that could be effectively served by surviving population centers. The availability of water has only recently resulted in community concern over continued economic growth, and in some instances, questions of maintaining the present level of community development.

SURFACE WATER AS A MUNICIPAL SOURCE

Surface waters must be processed to remove turbidity and disinfected as minimum assurance that safe, potable water is delivered to the consumer. Other treatment processes, such as softening, are often desirable. The cost of surface water source development and treatment results in high, but not exorbitantly high, charges to the consumer. In general, the cost for delivering treated water from a surface source compares favorably with the cost of treating groundwater to remove an undesirable contaminant.

Average annual rainfall, stream discharge, topography, and soil characteristics are factors to be considered in reviewing the feasibility of a surface water source for municipal use. Based on these criteria, it is questionable that the use of surface water as a municipal supply source would prove feasible west of Nebraska Highway 14 or, roughly a line drawn through Niobrara, Central City, and Superior. East of this line, topography and soil characteristics would exert the greatest influence on the feasibility issue, as natural reservoir sites are more plentiful. Topographic regions described as dissected plains,

rolling hills, bluffs and escarpments are found over much of the area located up to 120 miles west of the Missouri River. These general regions correspond closely with the areas of minimum groundwater storage as illustrated in Figure 3. The possibility of locating reservoir sites adequate to store water for municipal use is good to excellent in this area. Cities to the west could install infiltration galleries adjacent to major streams. Such installations would deplete surface water flow, but are legally defined as development of a groundwater source.

The Missouri River must also be considered as a source of supply to meet expanding municipal needs. Only the city of Blair, the Cedar-Knox Co. Rural Water District, and the Metropolitan Utilities District (Omaha area) presently use this source. Early in the state's history, other river communities withdrew water directly from the Missouri for municipal use. Problems associated with turbidity, changing chemical composition, and seasonal flooding caused individual communities to abandon intake structures and develop well fields on the alluvial plains adjacent to the river. Construction of the Missouri mainstem reservoirs and recent progress in the control of pollution has improved the chemical and physical characteristics of the river to a degree. It is conceivable that larger cities near the river may someday return to the Missouri as a source of supply instead of continuing to use the highly mineralized groundwater.

Many people in the state look with disfavor on the use of surface water as a source of their drinking water, even though it is treated and safe. Every effort will be made to continue to use groundwater as a source of municipal supply. Except for communities located near the Missouri River, public acceptance of surface sources for municipal water supplies will probably be delayed until all other alternatives have been exhausted.

Case Histories Associated With Available Groundwater for Municipal Use

The following information has been abstracted from Department of Health files to illustrate the problems and actions taken relative to water source deficiencies experienced by communities in the recent past. Additional case histories dealing with competitive use effects can be found in Chapter 6.

Tobias

Water quality and quantity problems have been partially remedied by recent additions to the village of Tobias (pop. 145) water system. Tobias is located in a "water-poor" area of Saline County. The fine-grained earth materials do not permit development of large capacity wells for irrigation or municipal use. Prior to 1981, the Tobias water source consisted of a single dug well with brick lining. Department of Health records indicate the well was dug in 1906 to a depth of 80 feet. This well furnished water that exceeded the 10 mg/l maximum contaminant level for nitrate-nitrogen. Village officials were unable to locate an adequate supply of water by test drilling in the vicinity of town.

In 1980-81, funding became available to drill a well into a much more substantial aquifer five miles south of town. This high-capacity well, tapping 40 feet of saturated sand, will supply enough low-nitrate water to meet Tobias' needs for many years to come. However, the cost of a project of this type is extremely high, and is especially significant considering the small population.

Lynch

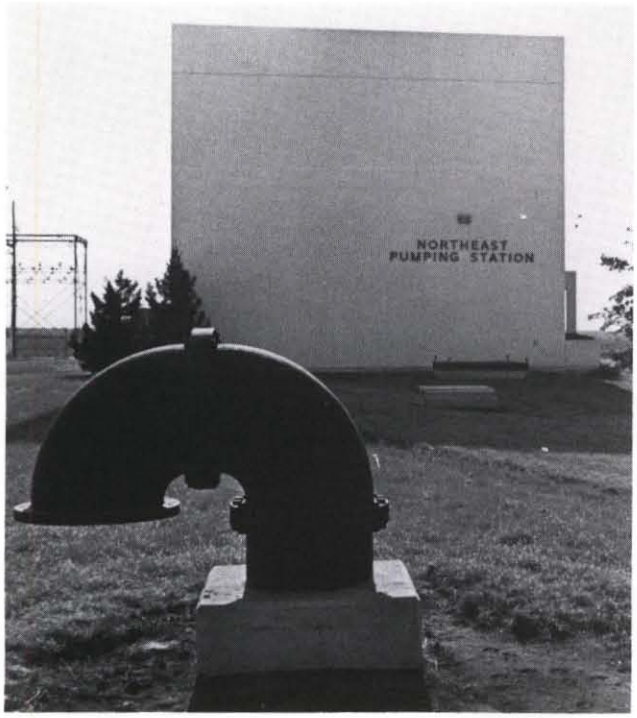
The village of Lynch (pop. 375), in Boyd County, is located in an area of limited groundwater supplies. Shale bedrock (yielding little or no water to wells) is at or near the ground surface. Water quality in the available aquifers is generally poor. Prior to 1979, the source of supply for the town consisted of a developed spring on the valley side-slopes west of town and a shallow well in the alluvium of Ponca Creek. This supply was known to have been inadequate for a number of years. The spring, developed about 1920, did not provide enough water to meet summer needs and was susceptible to bacterial contamination. The low-capacity alluvial well did not meet sanitary criteria, and was determined to be the probable cause of bacterial contamination of the town supply in 1977. The village supply had high concentrations of selenium and the village well contributed excessive levels of iron, causing "red water" at the consumer's tap.

Representatives of the Department of Health, the Conservation and Survey Division, and at least three consulting engineering firms studied the situation at various times over the past 15 years. No action was ever taken by the village on recommendations made by these agencies. In 1978, after the most recent engineering study, a decision was made to connect to the Boyd County Rural Water District No. 2. This additional supply of good quality water has solved the water supply problems of Lynch.

Lincoln

Until the early 1930's, the city of Lincoln's water supply source consisted of wells drilled into the Dakota sandstone beneath the city. Most of these wells had to be abandoned because they began to pump salty water. Wells near the present pumping station at 30th and "A" Streets generally remained usable. As population increased and demands on the system grew, however, water levels and quality declined significantly, causing concern that the entire supply might become salty.

In 1932, five wells with a pumping station were constructed near Ashland, in the Platte River valley. A 36-inch diameter cast iron transmission



line to Lincoln was laid. The Ashland facilities now consist of 39 wells, a treatment plant (for disinfection and removal of iron and manganese) and an additional transmission line. Dakota wells, still maintained in the city for use in meeting peak demand, are used sparingly to avoid encroachment of salt water.

The Ashland wells are located close to the river to induce groundwater recharge from the surface water. Available supply is in excess of the city's needs; past studies have indicated the wellfield could supply near-maximum water pumpage for several weeks with little or no flow in the river before excessive water level declines would occur. Part of the city wellfield has been affected by water quality problems, however. In 1979, episodes of taste and odor in the distribution system were traced to several wells at the north end of the wellfield. Since available treatment methods could not remove this contaminant, these wells had to be isolated from production. The cause of the problem is unknown, but it may be related to local land use. The affected wells are near a sand-pit lake developed with vacation cabins, private wells, and septic systems.

FOOTNOTES

1. Pederson, D. T. 1978. Formation of Aquifers. Proceedings of the Artesian (confined) Aquifer Seminar, November 10, 1977, Nebraska Center for Continuing Education, Lincoln, Nebraska.
2. Dick, E. 1975. Conquering the Great American Desert: Nebraska. Nebraska State Historical Society, Vol. XXVII.
3. Bentall, R. and F. B. Shaffer. 1979. Availability and Use of Water in Nebraska, 1975. Nebraska Water Survey Paper No. 48. Conservation and Survey Division, University of Nebraska-Lincoln, in cooperation with U.S. Geological Survey.
4. Barbour, E. H. 1899. Some Methods of Lifting Water in Nebraska. Report of the State Geologist. Reprinted from the Annual Report of the State Board of Agriculture.
5. Department of Water Resources well registration records.

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Chapter 5

Drinking Water Quality

The term "contaminant" is widely used for purposes of evaluating the quality of drinking water. The Safe Drinking Water Act of 1974, P.L. 93-523, defines a contaminant as any physical, chemical, biological or radiological substance or matter in water. Contaminants are further classified as those materials present in water that result in adverse health effects when ingested and those materials which, in excessive amounts, detract from the economic value of water for select use or are aesthetically objectionable. Water is the nearest liquid to a universal solvent (dissolves anything) and trace amounts of any material with which water comes in contact enter into solution. Therefore, the water sources available for municipal use must be considered as being naturally contaminated.

Water found in nature is a solution with varying concentrations of contaminating materials. It is often unnecessary, infeasible, or impossible to completely remove these contaminants. As a result, the scientific community has attempted to establish maximum contaminant levels (MCL's) for those chemicals and compounds that adversely affect the health of consumers and that are economically or aesthetically undesirable. These MCL's are now expressed in terms of milligrams of contaminant per liter of water (mg/l) and formerly as pounds of contaminant per million pounds of water (ppm), both expressions being numerically identical. In general, the number assigned as an MCL is selected to protect the most susceptible members of society or accommodate the most demanding use for an uncontaminated water.

The MCL's established to date have been promulgated as drinking water regulations by the Environmental Protection Agency (EPA) and the Nebraska Department of Health. Those contaminants that adversely affect the health of the consumer are addressed by Primary regulations and must be removed from the water under penalty of law. Secondary regulations list the aesthetic and economic contaminants for guidance in evaluating water quality without enforcement authority. These Primary and Secondary limits (MCL's) are shown on Table 5-1. The limits and effects of specific contaminants are discussed later in this chapter.

Contaminants in water can be considered as natural or introduced. Natural contaminants are those originating in the geological environment. Introduced contamination is the result of man's activities.

NATURAL CONTAMINANTS

Water quality is largely controlled by geological materials and processes. Most groundwater originates as rain or snowmelt that infiltrates through soil into flow systems in the underlying sediments and rocks. As groundwater moves from recharge areas to discharge areas, its quality is changed by numerous geochemical processes. Those processes affecting surface water are apparent to the casual observer. Rivers and streams receive runoff, break down rocks and soils, dissolve the soluble materials, carry sediment, and undergo chemical and biological reactions.

The Water Cycle

A knowledge of the basic water cycle is critical in understanding the many factors that influence surface and groundwater quality. Figures 5 and 6 illustrate the cycle and summarize the influences on water quality.

Precipitation - "Pure" water, when defined as water devoid of minerals, does not exist. All chemical elements are soluble in water at least to a small degree. Even during the first moments of a rain or snow, water is rapidly picking up a variety of natural contaminants. Water vapor condenses around minute particles of solid material in suspension in the air. These particles include spores, pollen, dust produced by volcanoes,

TABLE 5-1

MAXIMUM CONTAMIANT LEVELS FOR DRINKING WATER

Primary Regulation (Health)

Contaminant	EPA MCL mg/l (except as noted)		Nebraska MCL mg/l (except as noted)
Arsenic	0.05		0.05
Barium	1.0		1.0
Cadmium	0.010		0.010
Chromium	0.05		0.05
Lead	0.05		0.05
Mercury	0.002		0.002
Nitrate (as N)	10.		10.
Selenium	0.001		0.001
Silver	0.05		0.05
Fluoride	-		1.8
Endrin	0.0002		0.0002
Lindane	0.004		0.004
Methoxychlor	0.1		0.1
Toxaphene	0.005		0.05
2,4-D	0.1		0.1
2.4.5 - TP Silvex	0.01		0.01
Turbidity	1 Turbidity unit		1 Turbidity unit
Microbiology (Coliform)	5 per 100 ml		5 per 100 ml
		or	
	average of 1 in all samples		average of 1 in all samples
Gross Alpha partial Activity	15 pCi/liter		15 pCi/liter
Radium 226 + Radium 228	5 pCi/liter		5 pCi/liter
Trihalomethane (1)	0.1		No MCL

Secondary Regulations (Aesthetic)

Contaminant		
Chloride	250	250
Color	15 color units	15 color units
Copper	1	1
Corrosivity (2)	non-corrosive	non-corrosive
Foaming Agents	0.5	0.5
Iron	0.3	0.3
Manganese	0.05	0.05
Odor	3 Threshold No.	3 Threshold No.
pH	6.5-8.5	6.5-8.5
Sulfate	250	250
Total Dissolved Solids (TDS)	500	500
Zinc	5	5
Sodium (3)	-	-

(1) Applies only to systems using chlorine as a disinfectant and serving more than 10,000 persons.

(2) To be determined and reported to enforcement agency.

(3) To be determined and made available to the medical profession and susceptible individuals and reported to the enforcement agency.

U.S. EPA is considering MCL's for an additional twenty-two synthetic organic chemicals for incorporation into the Primary standards. Most of these chemicals are solvents associated with industrial processes. Studies are being carried out to determine the extent of their migration into the environment and particularly their presence in public water supplies.

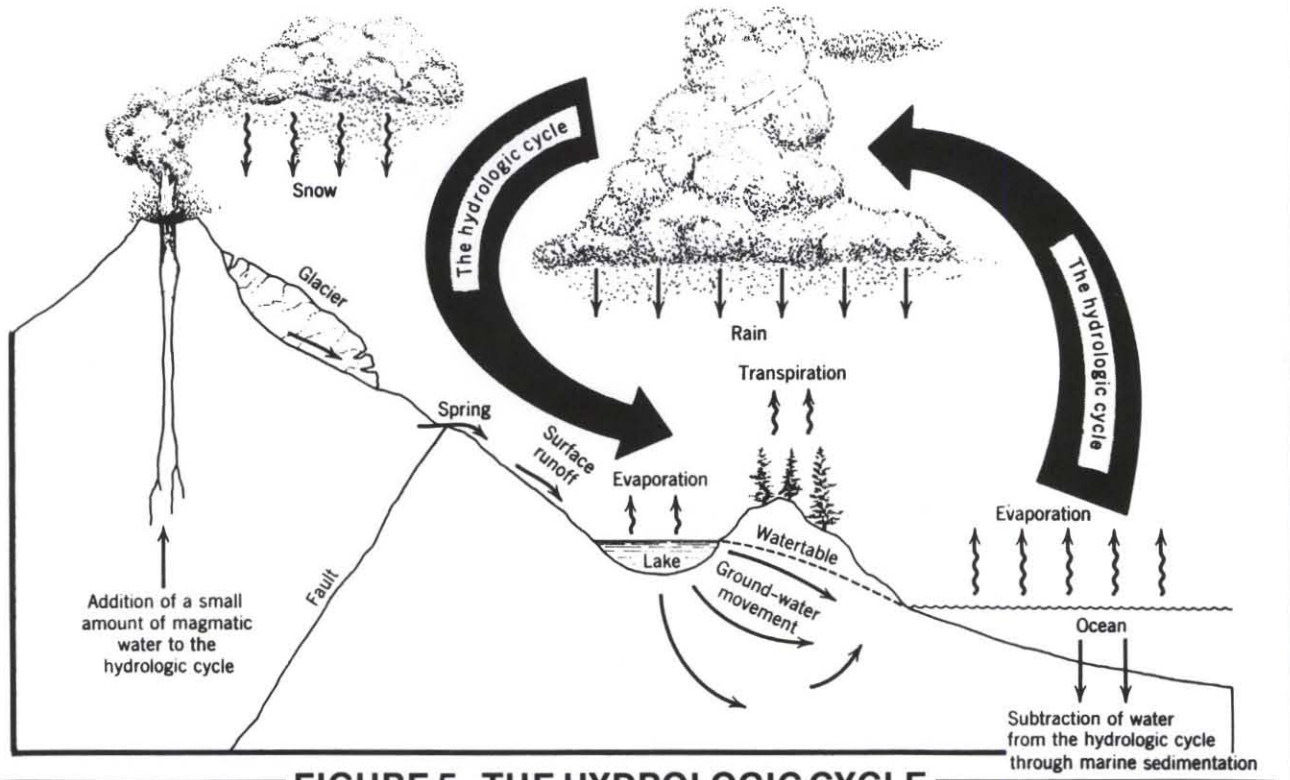


FIGURE 5. THE HYDROLOGIC CYCLE

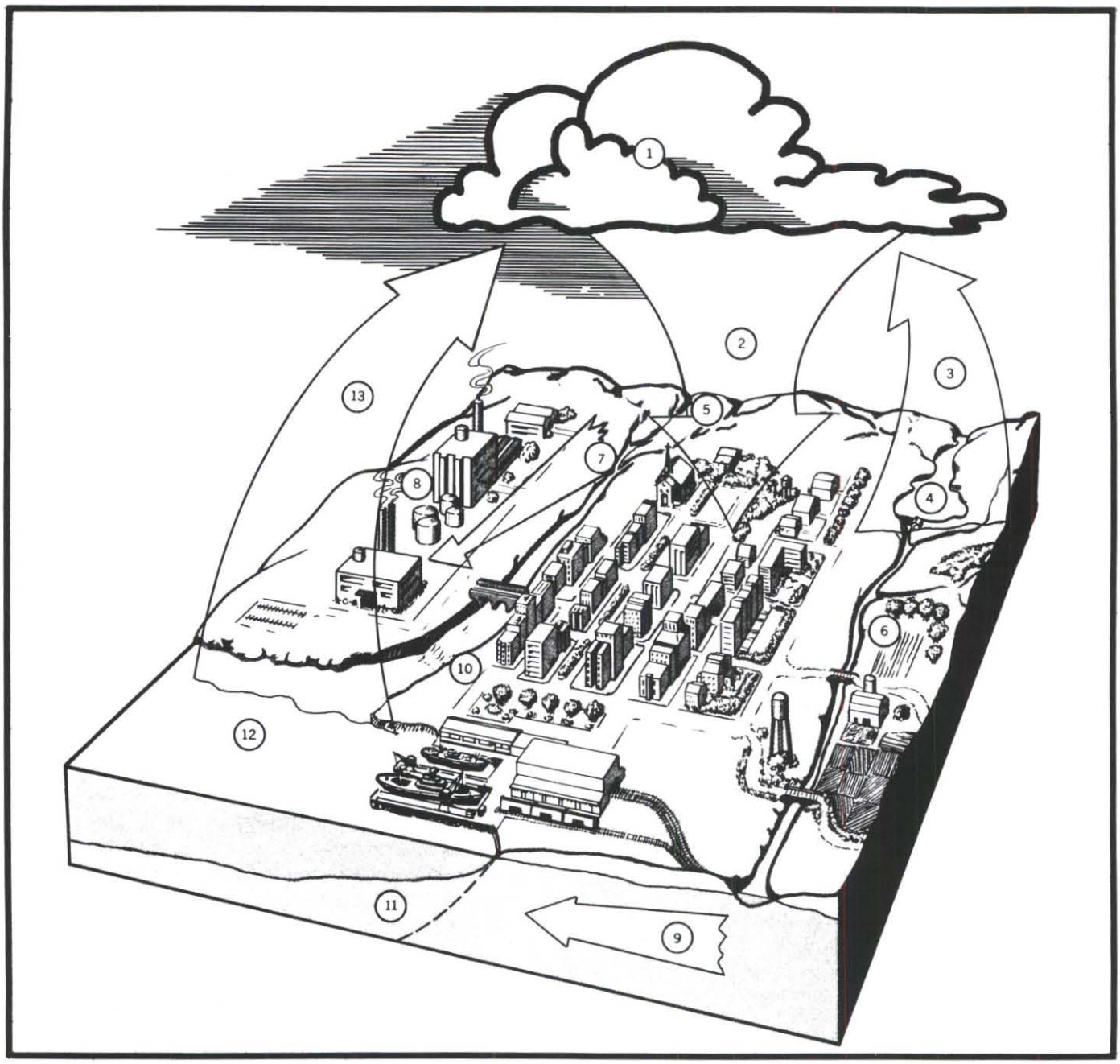
plowed fields, industries or traffic, or salt particles from dried sea spray. As it forms and falls to earth, this precipitation also dissolves various gases, such as carbon dioxide, nitrogen, oxygen, and sulfur dioxide. Thus, rain and snowfall contain small amounts of many chemical constituents.

Soil - Most precipitation that infiltrates into the groundwater first moves through a soil zone. A soil is a thin, mineral-rich, biologically active layer. As precipitation moves into the soil it dissolves significant amounts of organic and mineral matter. At certain times of the year, when soil moisture increases beyond the needs of vegetation and the capacity of the soil to hold water, drainage occurs downward to the groundwater. Figure 7 illustrates this relation between soil moisture and groundwater recharge.

The Ground Water Reservoir - Water drains downward from the soil under the influence of gravity, dissolving soluble minerals in its path. Natural material is rarely uniform; more recharge water moves through certain parts of this zone than other parts. Presence of "tight" impermeable layers (such as ancient soils, carbonate-"cemented" zones, or clay beds) may divert the infiltrating water from its downward course. Water may then be isolated above the main water table and it will move laterally.

The water table is the point below which all the earth materials are saturated. Water reaching this saturated zone moves under the influence of hydrologic (pressure) gradients toward discharge areas (springs, streams, lakes, wetlands, the ocean, or wells). Movement of groundwater is slow, generally in rates of feet per year, or at most, hundreds of feet per year. Figure 8 illustrates an idealized groundwater flow system. Multiple flow systems are possible due to the effects of topography and earth layering. Rocks and sediments along these groundwater flow paths contribute contaminants to the water. The type of earth materials and amount of time the water is in contact with them (essentially the length of flowpath) determine the quality of the groundwater. Water in deep bedrock aquifers, traveling slowly on long regional flowpaths, has been isolated for extremely long periods of time and is quite mineralized, and sometimes brackish or salty. Shallow groundwater that has percolated through thin sandy soils may be only slightly mineralized.

The type of rocks and sediments present affect water chemistry. Chapter 4 briefly discussed the main aquifers of the state. The glacial drift covering a large portion of eastern Nebraska contributes many chemical constituents to water, notably iron, manganese and "hardness". Limestones and related rocks are sources of hardness, calcium, magnesium, and sulfate. Clays and shales can contribute significant



1. Water vapor mixes with gas and dust in clouds
2. Vapor condenses around small particles to form rain or snow
3. Evaporation increases concentration of minerals in water left on the earth
4. Changes in water quality of lakes due to physical, chemical, and biological processes
5. Quality of surface water is modified by contact with soil and air
6. Irrigation increases concentration of salts in water
7. Surface-water quality further modified by chemical reaction among salts, sediments, and biological materials in the water
8. Cities and factories add chemical and organic pollutants to water
9. Groundwater modified chemically and physically by minerals and gases dissolved from the rocks
10. Salt water from ocean mixes with fresh water from river (surface water)
11. Mixing along salt-fresh water interface (groundwater)
12. Water quality in ocean altered by physical, chemical, and biological processes
13. Dust and spray are picked up by air movement from the land and/or water surfaces and introduced into the atmosphere

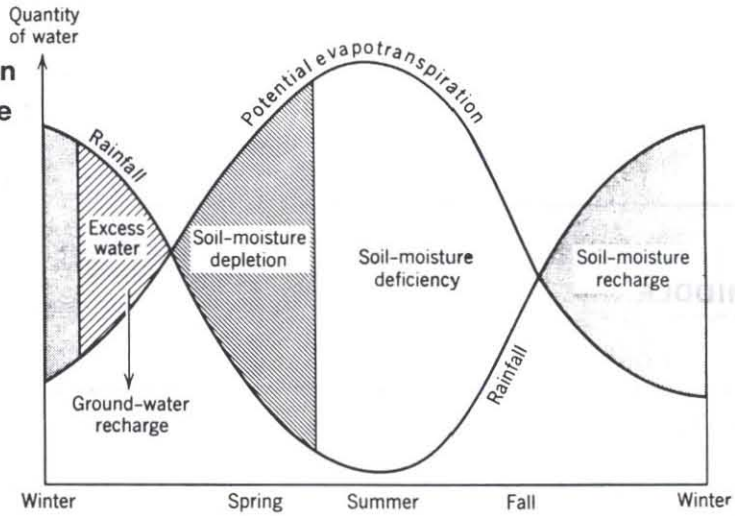
FIGURE 6.

HOW WATER QUALITY IS CHANGED AS WATER MOVES THROUGH THE WATER CYCLE

FIGURE 7

The effect of potential evapotranspiration on soil moisture in a region having little or no precipitation during the summer.

(Diagram modified from Thornthwaite and Mather [28].)



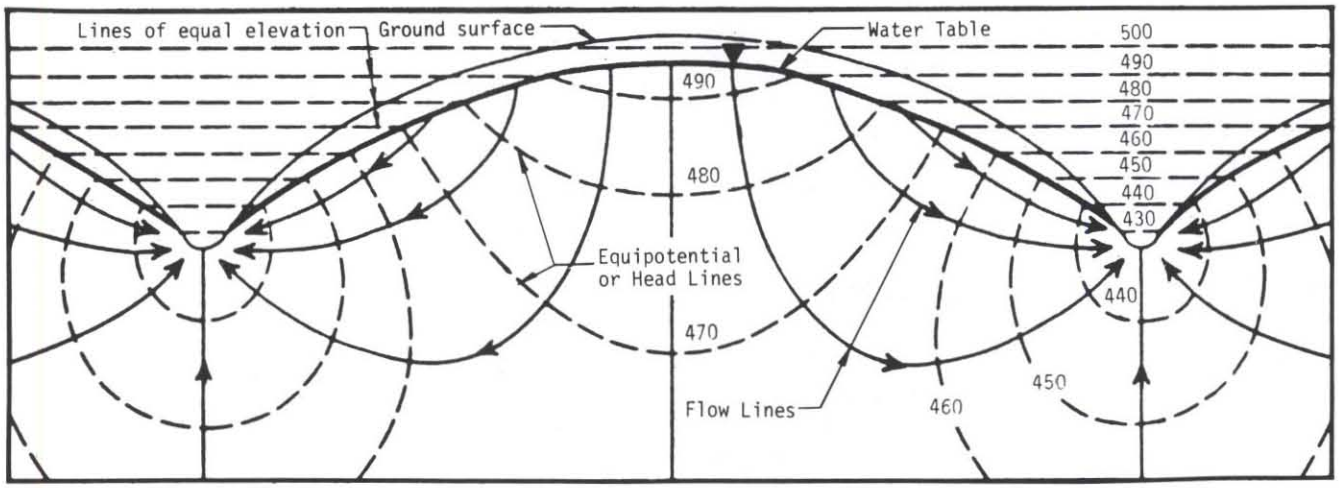


FIGURE 8.
FLOW NET IN UNIFORMLY PERMEABLE MATERIAL. AFTER HUBBERT (1940, p. 930, Fig. 45)

amounts of many chemicals to water, including sulfate, sodium, potassium, iron, and hardness. Certain shales are sources of selenium. Chloride and other salts in unpolluted groundwater originate from solution of evaporite deposits, ancient sea water entrapped in sediments, or weathering of certain rocks and minerals. Evaporation concentrates salts in water. Uranium, radium, and other sources of radioactivity in Nebraska groundwater appear to be related to certain sand deposits. Most nitrate in groundwater is due to some form of human or animal pollution or land use. Bacteria utilizing various chemical compounds may thrive inside wells and in the surrounding aquifer. Pathogenic organisms, however, are rarely found in groundwater.[1]

Based upon the previous discussion, it is apparent that groundwater quality may vary significantly over short distances, both horizontally and vertically. In a geological setting typical of Nebraska there are frequently (1) a sequence of earth layers of varying composition, and (2) a complex groundwater flow system, or a number of different flow systems. Stratification (layering) of the groundwater may occur in such environments. Table 5-2 reports partial results of a chemical analysis that evaluated such stratification at a site south of Lincoln.

Groundwater Discharge (Surface Water) - The termination of a groundwater flow system is a point or area of discharge. While some streams or

TABLE 5-2
STRATIFICATION OF GROUNDWATER

As indicated by water sample results, southern Lancaster County

Results in mg/l

	TOTAL DISSOLVED SOLIDS	SODIUM	CHLORIDE	SULFATE
TOP of test hole	940	89	204	104
MIDDLE	504	26	56	71
BOTTOM	1052	129	340	117

segments of streams do recharge the groundwater, most streams in Nebraska receive groundwater discharge. Such streams have been described as groundwater "drains". During dry periods, when no surface runoff is entering the stream, the flow of the stream is almost entirely groundwater discharge (the "baseflow"). At these times, the quality of the surface water closely approximates that of the groundwater. As runoff from precipitation enters the stream and the natural stream processes work (turbulence and aeration, biological activity, erosion), the quality of surface water changes from that of the groundwater.

INTRODUCED CONTAMINANTS

The activities of man introduce contaminants to water through application and storage of chemicals on land, mismanagement of waste materials, and by accidental spill of hazardous substances. For the most part, contaminants of this type are synthetic and can often be traced to their point of entry into the water supply. Land use and certain agricultural and industrial management techniques (applying excess fertilizer and irrigation water, for example) can cause contaminants to enter the groundwater. Since most of the recharge supplying a well is provided by local precipitation, the importance of a community controlling land use in the vicinity of its drinking water wells is obvious.

A municipal water supply is also subject to contamination from materials that gain entrance or come in contact with the water after it is removed from the source of supply. Biological contamination can be expected when loss of system pressure permits backflow or backsiphonage from sanitary fixtures and water-using appliances, or from direct connection with a contaminated auxiliary supply serving an industry or institution. Back flow from cooling towers is not uncommon under low pressure conditions and chemicals as well as bacteria may gain entrance to the distribution system. Open and unprotected storage reservoirs are susceptible to vandalism and permit access by birds and animals that contribute organic material to the water supply.

Of major concern is the capability of certain waters to dissolve material from pipes, conduits, and vessels in which they are transported or stored. Some waters, depending on the balance of chemicals in solution, exhibit corrosive tendencies. Certain constituents or contaminants in the water, including dissolved oxygen, carbon dioxide, chloride, sulfate, and acidity encourage metals to enter solution at a rapid rate. Health implications occur when lead and the impurities in galvanized surfaces are dissolved into the water. In many instances corrosion is a costly problem associated with system deterioration.

PUBLIC HEALTH PROBLEMS

Although dramatic progress has been made in the past century in preventing the spread of waterborne disease, it remains a sporadic problem in communities throughout the nation. In 1979, the Public Health Service reported 23 separate outbreaks of waterborne disease from community public water systems resulting in 6,764 cases.

In the past, serious problems have afflicted some Nebraska communities. In 1932, over 10 percent of 347 children in Huskerville, near Lincoln, contracted polio. A relationship was established between the disease and water system deficiencies. In 1947, at Milford, water system problems resulted in about 150 people contracting gastroenteritis. In recent years, contamination problems have occurred in the Humboldt, Boys Town, Seward, and Chambers systems.

Appendix F contains national information on 1981 outbreaks of waterborne disease through water systems, and a summary of some major incidents attributed to water system problems. These are only a sample of problems that have occurred. Well known incidents have occurred in other years.

Listing these incidents does not imply that there is a high risk of water quality problems and waterborne disease for Nebraska consumers, only that without proper operation and maintenance of water systems a public health risk does occur.

THE SAFE DRINKING WATER ACT

The United States Congress passed the Safe Drinking Water Act (SDWA) in 1974 in recognition of the increasing occurrence of waterborne disease outbreaks and the possible association of gastro-intestinal cancer incidence with the presence of organic chemicals in drinking water. As discussed in Chapter 1, this law authorizes the administrator of the EPA to identify those contaminants present in drinking water that may have any adverse effect on the health of persons and to specify a maximum permitted level for any contaminant so identified. The law applies to any water system providing piped water for human consumption to 25 or more individuals per day or having at least 15 service connections. The owner of the water system is responsible for assuring the safety of delivered water by monitoring, or routinely testing for the presence of contaminants, and reporting the results to EPA.

The law permits the administrator to grant variances and exemptions to the standards, or MCL's, when continued use of the water will not result in unreasonable risk to health and when a compliance schedule is accepted by the owner. A major feature of the law is the public notification requirement. The system owner must notify all consumers by direct mail, and through the media, of each violation of the monitoring schedule, violation of an MCL, acceptance of a variance or exemption, and failure to carry out any step in the compliance schedule. The notification must be repeated quarterly (every three months) as long as the violation, variance, exemption, or other failure continues.

The contaminant levels permitted in municipal water systems are the same in Nebraska as they are nationally. The regulations applied by the state have not been revised to include the ecently promulgated federal regulations limiting the concentration of trihalomethane in systems disinfecting their water with chlorine. Trihalomethane is the group of chemicals that can be formed when chlorine, a disinfectant, reacts with certain organic materials in the water. Even though this contaminant level cannot be enforced by the state, the Department of Health does not consider the problem serious. Routine testing for trihalomethane potential has revealed that its presence in excess of the established standard is highly improbable. Table 5-1 lists those maximum contaminant levels applied in assuring the safety of drinking water delivered by Nebraska municipal systems.

CONTAMINANTS OF CONCERN IN NEBRASKA

The waters delivered by municipal systems in Nebraska have been examined for the presence of those contaminants included in the primary regulations except radium 226 and radium 228. The department records also contain information on most of the contaminants listed in the secondary regulations and, while the information is not updated routinely, it is adequate to evaluate the economic and aesthetic problems associated with the quality of municipal water supplies. Only those contaminants that have been found in delivered municipal waters in excess of the established MCL will be discussed at this point. The adverse effects of all parameters used to determine the quality of drinking water are contained in the report of the National Research Council, National Academy of Sciences **Drinking Water and Health** (1977), which is available in the Department of Health files.

Biological

The coliform group of microorganisms, many of which inhabit the intestinal tract of warm-blooded animals including humans, is used as an indicator for the biological safety of drinking water. One species of bacteria included in the group, E. Coli, is considered pathogenic, or the causative agent for a communicable disease. The presence of any member of the group is indicative of a direct route of transport between a filth material and the drinking water supply. This route could also permit the entrance of microorganisms that cause typhoid and paratyphoid fever, cholera, amoebic dysentery, giardiasis and other waterborne diseases. The presence of coliform in drinking water requires immediate action to locate and eliminate the source of contamination.

An average of 20 percent of the municipal water systems are in violation of the biological requirements each quarter.[2] A majority of the violations involve not submitting samples on schedule or not taking corrective action when coliform are identified in a sample. Only four community systems failed to demonstrate compliance with the MCL's extending through two quarters in 1980. These were considered serious situations and indicative of negligent operation and management. Public notification was required and corrective action was taken as

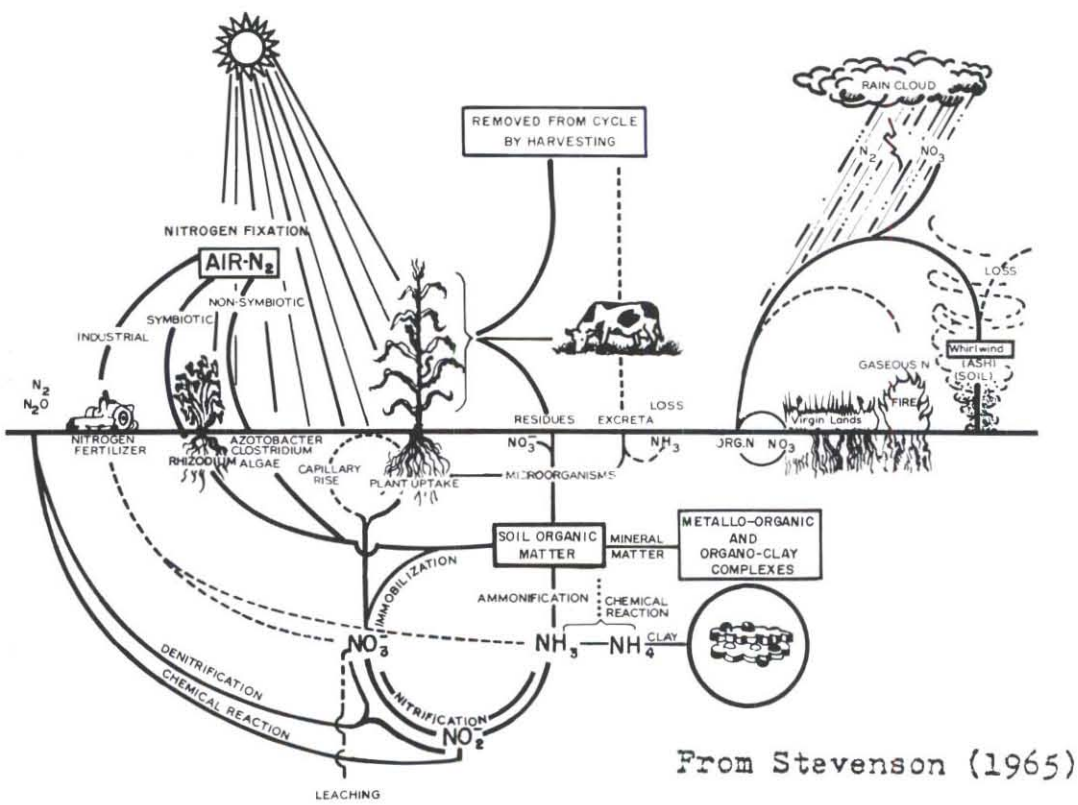
a result of administrative orders issued by the Director of Health.

The source of coliform contamination is rarely traced to the groundwater source of municipal systems. Entrance of biological contamination is usually associated with lack of system reliability, loss of pressure, and poor operation. Improved compliance with biological standards is heavily dependent upon the responsibility and attitudes of the elected officials and operators of municipal water systems.

Nitrate

The nitrate ion is the common form of inorganic nitrogen found in water solutions. The source of nitrate in surface water is associated with fertilizer runoff, the presence of decayed organic material washed from vegetated areas, the discharge of treated or untreated sewage, and the end product of biological action on nitrogenous compounds originating from these sources. Under natural conditions little nitrate is transmitted to the groundwater. The vegetative cover establishes a balance between the rate of decay and rate of growth by utilizing the available nitrogen within the root zone. Except under rare conditions, such as fire or flood, the nitrogen ion is recycled within the upper soil layer and to the atmosphere. The nitrogen cycle is presented in Figure 9, to help explain this phenomenon.

Agricultural development occurs on lands that contribute to groundwater recharge. The seasonal removal of vegetation and precipitation occurring during these periods accelerates the flushing of soluble nitrate beyond the root zone of vegetative cover with eventual concentration in the groundwater reservoir. Some sandy soils do not hold water adequately and are not well-suited to cultivation. Soluble nitrate in these soils is more readily flushed to the groundwater. Application of nitrogen-based fertilizers and irrigation of crop land materially increase the rate of nitrate build-up in the groundwater. Since productive agriculture is the base of the Nebraska economy it can be expected that a continual, and at times accelerated, increase of nitrate concentrations in groundwater will occur.



From Stevenson (1965)

FIGURE 9.
THE NITROGEN CYCLE

The presence of nitrate in drinking water has been determined to cause a blood disease in infants known as methemoglobinemia or "blue baby syndrome". The ingestion of nitrate reduces the oxygen-carrying capability of the blood. Clinical symptoms have been observed in infants under six months of age who have consumed water containing as little as 10 mg/l nitrate. The same reaction occurs in older children and adults but their greater volume of blood and stomach acidity permit much higher exposure to nitrate before adverse health effects occur. The MCL for nitrate in drinking water has been established at 10 mg/l as nitrogen to provide protection to the susceptible population.

There are over 48 municipal water systems that approach or exceed the nitrate MCL. Analysis for nitrate is performed monthly on most of these supplies and 12 have been found that consistently exceed the permitted nitrate concentration level. The 12 systems, listed in Table 5-3, have been granted exemptions until January 1, 1984, by the Department of Health and are scheduled to develop a nitrate-free source of supply, blend the existing water with nitrate-free water to reduce the contaminant level, or treat to remove or reduce nitrate by this date. Treatment to remove nitrate is costly and is considered infeasible in most cases due to interference with removal chemistry by the calcium and mag-

TABLE 5-3.
STATUS OF EXEMPTIONS GRANTED FOR NITRATE CONTAMINATION

SYSTEM (population)	CONTAMINANT (level, mg/l)	DATE GRANTED	PROGRESS
Allen (390)	11.6	3-19-81	Engineer Employed; Public Notified; Bottled water for infants.
Bradshaw (373)	12.5	2-13-80	Engineer Employed; Public Notified; Bottled water for infants.
Duncan (411)	10.8	2-21-80	Alternate Source located; Public being notified and bottled water being provided.
Exeter (807)	24.4	3-4-80	Abandoned High Nitrate Wells; Adjusted pumping schedule; Concentration reduced to 7.2 mg/l; Will be removed from exemption status.
Fairmont (769)	12.7	2-13-80	Adjusted pumping schedule reduced nitrate to 5.4 mg/l; Will be removed from exemption status.
Hardy (238)	13.9	4-10-80	Low nitrate source located on Federal land; Well construction rights being sought.
Liberty (105)	16.5	5-22-80	Engineer Employed; Public Notified; Bottled water for infants.
Pickrell (184)	13.0	4-10-80	Two new wells; Nitrate concentration reduced to 6.5 mg/l; Will be removed from exemption status.
Rising City (395)	14.5	5-22-80	Engineer Employed; Public Notified; Bottled water provided for infants.
Tobias (138)	15.1	3-5-80	New well and pipe line in service; Nitrate concentration reduced to below 3 mg/l. To be removed from exemption status.
Winnetoon (81)	27.9	6-2-80	Contracted with RWD for service in 1982. Notifying public and providing bottled water for infants until service complete.
Wood River (1,381)	18.3	12-12-79	Removed from Exemption status after completion of new well.

nesium (hardness) that is also present in the groundwater. In the interim the cities and villages with exemptions must notify the consumers of the nitrate level every three months, provide bottled water for infant use, and demonstrate continuing progress in finding a permanent solution to the problem. To date progress in the exempted communities has been encouraging. The city of Wood River has been removed from exemption status after drilling a new well into a deeper aquifer that has not become contaminated with nitrate. The concentration level has been reduced from a high of over 20 mg/liter nitrate-nitrogen to an average of 5 mg/liter after blending. The progress of other communities is shown in Table 5-3.

The Farmers Home Administration (FmHA) has placed high priority on providing financial assistance to those water systems that must make capital investments to meet the requirements of the Safe Drinking Water Act. Those municipal systems that are eligible for this assistance have applied for or have received funds to help solve their problem. However, federal funds will probably be reduced or eliminated in the future. As other municipal systems are confronted with the increasing nitrate contamination of their water supply source, many smaller systems will be hard pressed to meet the nitrate MCL without federal or state financial assistance.

Radioactivity

Gross alpha measurement is indicative of the natural radiation that comes from terrestrial sources. The average individual exposure to this natural ionizing radiation and to that contributed by cosmic rays is about 100 millirems per year, although the amount may vary with altitude and regional geological characteristics. (The "millirem" is a unit that relates to the effects of ionizing radiation on the human body). The amounts found in drinking water are but a small portion of the total human exposure and vary with the radiochemical composition of the soil and rock strata through which the water may have passed.

The drinking water standard established by federal and state regulation sets the maximum contaminant level for gross alpha radiation at 15 pCi/liter, (picocuries per liter, relating to the number of radioactive "counts" or disintegrations in the sample during a given period of time), with not more than 5 pCi/liter being contributed by radium 226 and 228. Alpha radioactivity contributed by radon and uranium is not included in the standard. The water supplies of 26 Nebraska communities may exceed the gross alpha standard of 15 pCi/l depending upon the source of radioactivity. These communities are listed in Table 5-4.

Nebraska public water supplies have not been examined to determine the amount of radioactivity contributed by radium 226 and 228. It is possible that the results of continued testing will reveal water supplies in excess of the 5 pCi/liter radium limit. Table 5-4 also lists those towns that could be in violation of the radium limit. Samples from four of these towns were analyzed at the University of Iowa for radium 226 and 228. Results, shown in Table 5-5, indicate very low levels of radium in these waters. Additional testing may also reveal that the source of radiation in the other towns is not due to radium.

The health effects reported to result from the radiologically contaminated drinking water are considered minimal by the Department of Health. Drinking water contributes less than one percent of the natural background radiation dosage. Natural radiation exposure from all sources has been estimated to cause from 4.5 to 45 cases of cancer per million people, depending on the risk model used.[3] Thus the radiation from radionuclides in drinking water may cause a negligible increase in the estimated rate. Should the source of radiation be radium 226 or 228 the risk associated with bone cancer would be expected to increase.

The National Research Council, in reviewing the radiological standard reports,

> It has been noted that in the United States 120,000 people are estimated to drink water containing between 9 and 25 pCi/liter of radium-226, and only a small number lie near the upper end of this range. The number of excess cancers in this group would, therefore, lie between 0.16 and 0.43 per year. Since not all of the 120,000 people drink water containing 25 pCi/liter of radium-226, the latter number is inordinately high.

The Council finally concludes that,

> The radiation associated with most water supplies is such a small portion of the normal background to which all human beings are exposed, that it is difficult, if not impossible, to measure any adverse health effects with certainty. In a few water supplies, however, radium can reach concentrations that pose a higher risk of bone cancer for the people exposed.[4]

The occurrence of high alpha radioactivity in municipal water supplies tends to be associated with the valleys, terraces, and tributaries of the North and South Platte, Platte, Lodgepole, Republican, and North Loup rivers, and in the

TABLE 5-4.
RADIOACTIVITY IN NEBRASKA PUBLIC WATER SYSTEMS

City or Village	Gross Alpha Radioactivity in PC/l	Possibly Exceeds Gross Alpha Limit	Within Gross Alpha Limit, but possibly exceeding Radium 226+228 Limit
Alliance	15.48	●	
Alma	6.41		●
Atlanta	8.11		●
Axtell	6.84		●
Bartley	10.40		●
Bayard	25.09	●	
Bellwood	25.09	●	
Benkelman	7.08		●
Bloomington	5.19		●
Bridgeport	26.83	●	
Broadwater	17.78	●	
Brock	7.00		●
Brule	9.07		●
Bushnell	10.44		●
Cambridge	6.92		●
Cedar Bluffs	16.98	●	
Central City	20.52	●	
Chappell	7.73		●
Clarks	49.56	●	
Clay Center	9.14		●
Coleridge	5.71		●
Columbus	5.10		●
Cook	5.64		●
Cozad	9.84		●
Crawford	5.95		●
Decatur	5.67		●
Dix	14.56		●
Elba	9.09		●
Elgin	6.49		●
Elm Creek	7.46		●
Elsie	14.94		●
Elwood	9.75		●
Eustis	5.08		●
Exeter	5.75		●
Farnam	6.47		●
Filley	6.87		●
Funk	12.39		●
Genoa	5.00		●
Gering	27.90	●	
Gothenburg	6.44		●
Grand Island	14.72		●
Hardy	17.83	●	
Hayes Center	5.38		●
Hershey	23.40	●	
Hildreth	13.20		●
Holbrook	9.86		●

(CON'T)

City or Village	Gross Alpha Radioactivity in PC/1	Possibly Exceeds Gross Alpha Limit	Within Gross Alpha Limit, but possibly exceeding Radium 226+228 Limit
Holdrege	5.67		●
Hordville	5.24		●
Indianola	22.08	●	
Kearney	13.44		●
Kimball	8.47		●
Lebanon	5.01		●
Litchfield	8.58		●
Lodgepole	8.27		●
Lyman	41.48	●	
McCook	19.90	●	
Marquette	8.02		●
Martinsburg	8.05		●
Minatare	28.25	●	
Mitchell	5.67		●
Morrill	29.49	●	
Naponee	6.20		●
North Loup	14.54		●
North Platte	18.41	●	
Ohiowa	7.31		●
Ord	8.30		●
Orleans	36.30	●	
Overton	34.16	●	
Paxton	13.96		●
Pender	6.28		●
Phillips	28.74	●	
Polk	6.14		●
Potter	8.00		●
Ragan	6.37		●
Rising City	27.04	●	
Riverton	10.11		●
Schuyler	34.32	●	
Scottsbluff	17.36	●	
Shelton	16.71	●	
Sidney	9.41		●
Silver Creek	13.78		●
Smithfield	5.74		●
Stanton	9.01		●
Stratton	20.45	●	
Sutherland	14.10		●
Terrytown	12.62		●
Trenton	18.22	●	
Waverly	7.29		●
Wayne	12.56		●
Wilcox	10.18		●
Wilsonville	6.82		●
Wolbach	5.07		●
Wood River	7.16		●
Wynot	6.33		●

TABLE 5-5
RADIUM CONCENTRATIONS IN SELECTED NEBRASKA COMMUNITIES (pCi/l)

Town	Radium 226	Radium 228
McCook	0.3	1.1
Morrill	0.2	0.6
Overton	0.5	2.8
Rising City	0.3	0.6

(Maximum Contaminant Level for Radium 226+228 is 5 pCi/l).

northwestern part of the state. Violations of the 15 pCi/l gross alpha MCL mainly occur along the North Platte, Platte, and Republican river valleys. The recent discovery of economically significant deposits of uranium-bearing sands and gravels in northwest Nebraska, combined with the geologic history of the state, leads to the idea that uranium might be the main source of alpha radiation found in municipal water supplies.

Selenium

Selenium exists naturally in sedimentary rocks with certain shales containing the highest amounts in Nebraska. As the rocks weather, the elementary selenium oxidizes to selenite and selenate. In acid soils the oxidized form is usually selenite, which has an extremely low solubility in water. In the alkaline soils of semi-arid regions, the common form is selenate, which is soluable in water and available to vegetation. Certain plants are important in the conversion of insoluble selenium to the soluble form. Even in these regions, both surface and groundwater generally contain low concentrations of selenium as selenate.

Selenium is an essential element in the diet of animal and man. Dietary deficiency retards growth while excess amounts result in toxicity. The range between deficiency and toxicity varies with the species; for humans the range is wide since the body can excrete the selenium in excess of biological need, within a reasonable upper limit. The minimum daily intake of selenium for optimum human health is not well defined. Furthermore, only limited data are available on the amounts supplied in human diets. Since all foods contain trace amounts of the element everybody receives some dietary selenium. It is found in human blood, urine, milk, and tissues even in nonseleniferous geographic areas. Selenium tablets are available in 0.02 - 0.05 mg doses, particularly in health food stores, with a label stating: "The Committee on Dietary Allowances of the National Academy of Sciences has approved a provisional recommended intake of 0.05 to 0.20 mg/day". The Food and Drug Administration has also approved the use of selenium as a food additive for livestock.

Historically, however, excess selenium has been associated with cattle diseases referred to as "alkali poisoning" or "blind staggers". The disease occurred when cattle grazed on seleniferous vegetation. Selenium toxicity in humans has usually been associated with industrial situations. The only reported case of human poisoning from drinking water occurred when an isolated family consumed water containing 9 mg/l selenium.[5] The children, ranging in age from 6 months to 10 years, showed no abnormalities other than lassitude (felt tired or weak), and loss of hair and fingernails. These symptoms in humans are similar to alkali disease in livestock. Regrowth of hair and nails began after the family changed to an alternate water supply. The parents and the pet dog also displayed some symptoms of poisoning.

The EPA adopted the very conservative figure of 0.01 mg/l as the MCL for selenium in drinking water. Nebraska accepted this MCL as a condition of assuming primary enforcement responsibility with regulations no less stringent than those applied at the federal level. The National Academy of Sciences (NAS) has been critical of the selenium standard in its legally mandated review of EPA regulations. Complete monitoring of municipal water has revealed that 19 Nebraska systems exceed the selenium MCL. Table 5-6 lists those communities with selenium problems. Of these systems only one exceeds five times the adopted MCL. The NAS has suggested that the adopted MCL could be increased ten-fold without adverse health effects.

The Nebraska Department of Health has placed a low priority on requiring removal of low level selenium contamination from drinking water supplies based on the levels of selenium found in Nebraska ground water, the report and nature of comments provided by NAS, and the complete absence of reported symptoms associated with selenosis. The EPA has accepted this administrative decision and is seeking the additional data needed to establish a realistic MCL for selenium in drinking water.

Iron

Iron is common in the environment. In groundwater it is generally present in its soluble (dis-

solved) form and can be identified by the metallic taste it gives the water. When exposed to air (as when the groundwater is pumped) this soluble iron is gradually oxidized to its insoluble form, and begins "settling out" of the water. The result is discoloration by formation of a red-brown flocculent material that often causes the water to look like strong, cloudy tea. The presence of iron in drinking water is not of health significance but is of aesthetic and economic importance. Iron in water contributes to hardness, but the important effects relate to staining of fixtures, taste, and incrustation of water mains. Concentrations above 0.3 mg/liter will result in conditions that are readily observed by most consumers.

TABLE 5-6

NEBRASKA WATER SYSTEMS EXCEEDING SELENIUM LIMIT*

SYSTEM	SELENIUM CONCENTRATION mg/l
Brainard	.020
Concord	.015
Dixon	.024
Dunbar	.017
Edgar	.015
Funk	.016
Goehner	.017
Holdrege	.017
Howells	.043
Humphrey	.070
Maskell	.018
Milligan	.018
Pender	.046
Seward	.016
Sholes	.016
Stanton	.030
Tobias	.046
Wilcox	.019
Wisner	.035

**The maximum contaminant level for Selenium is 0.01 mg/l.*

The presence of dissolved iron in water is a necessary element in the life cycle of one type of crenothrix bacteria. These bacteria are common in the environment and gain entrance to the water system during construction and repair work, due to the failure to properly disinfect well screens and casings, reservoirs, and service mains. They oxidize the dissolved iron to iron oxide or rust. In addition to accelerating the aesthetic deterioration of water, the bacteria deposit iron oxide and slime on metallic surfaces. This results in clogged well screens and incrustation on pipe walls and an associated decrease in the efficiency of the distribution system. Iron may be removed and crenothnix bacteria controlled by aerating, filtering, and disinfecting the water supply.

These aesthetic and economic deteriorations, while noticeable to the general public, are usually accepted as the natural condition of the water. Only 31 of the 111 municipal systems having high iron concentrations in source water have elected to remove iron by treatment.[6]

Manganese

Manganese occurs less frequently and in smaller amounts in water than does iron. It may be associated with iron, and trouble can be expected when manganese concentrations exceed 0.05 mg/l. Manganese is also oxidized into a sediment which clogs pipes, discolors clothes and fixtures, and encourages bacterial growth. The color of stain ranges from dark brown when iron is present to black when the manganese oxide is the only material deposited. Manganese is removed by the same treatment processes applied for iron removal, but it is often necessary to add a chemical oxidant. There are 136 systems using sources of water high in iron, manganese, or a combination of the two.

Sulfate

Mangesium sulfate is present in all Nebraska groundwater. This chemical, commonly known as "epsom salt", exerts a laxative effect on many individuals when water contains over 200 mg/liter.[7] The effect is particularly uncomfortable for transients and those who consume the contaminated water occasionally. Constant exposure, as occurs with the resident population, results in resistance or immunity to the laxative effect. For this reason sulfate is not regulated as a primary contaminant even though clinical symptoms are obvious on initial exposure.

Although approximately 20 percent of the initially exposed population experiences laxative effects at the 200 mg/l concentration of magnesium sulfate, the secondary drinking water regulations set the MCL at 250 mg/l. Twenty-six Nebraska municipal water supplies exceed the 200 mg/l level and six exceed the 250 mg/l level. Removal is accomplished by lime or resin softening (see Table 2-1).

Petroleum Fuel Products

Large amounts of petroleum fuel products are transported, stored, and used in Nebraska.

Groundwater contamination resulting from leaking or spilled fuel is a significant and growing problem in the state. The Department of Health, Department of Environmental Control, and Conservation and Survey Division have investigated numerous complaints of petroleum product contamination of public and private water wells. Fuel products in water cause extremely strong tastes and odors, even at low concentrations (human taste thresholds for detection of gasoline, for instance, are generally in the range of parts per billion or tens of parts per billion).[8] Fortunately, toxic levels of known constituents of these fuels are well above the "taste threshold".

Most of a petroleum contaminant that leaks downward to the water table will float at the upper part of the saturated zone and may migrate slowly in the direction of groundwater flow. Vapors rising from a contaminated water table normally dissipate at the surface, but they can accumulate in basements or other enclosed spaces and reach explosive levels. Several such explosions and fires are documented in technical literature.[9] At least one major explosion has occurred in Nebraska.

Contrary to popular belief, not all oil or gasoline floats on water. Some petroleum products have a significant water-soluble fraction. Thus, traces of dissolved fuel can travel long distances along groundwater flow paths (farther than the original fuel mass itself), causing foul tastes and odors.

The specific source of contamination is frequently difficult, and in some cases impossible, to determine. Contamination can result from major spills, pipeline or valve breaks, slow leaks in buried tanks, or accumulation of small amounts of spillage from daily operations at fuel storage facilities. Once contaminated, groundwater is difficult or impossible to clean up. Normal treatment methods are ineffective or not economically feasible at the scale of small water supply systems. Such contamination frequently results in abandonment of the well at considerable cost to the community.

MONITORING

As mentioned earlier, each municipal water system is required, under both state and federal regulations, to examine and demonstrate conformance with health-related contaminant levels in the water that is delivered for human consumption. The Department of Health was selected as the official monitoring agency and, as such, decides the schedules and contaminants for examination. The schedule for monitoring, or testing, water for the presence of contaminating material varies from a minimum of daily for biological contaminants (in systems serving large populations) to once every three years for chemical contaminants. The Nebraska water system surveillance program recognizes the problems confronted by small systems in maintaining these scheduled analyses and the minimal number of laboratories available to perform the required service. The Department of Health has elected to provide this service to municipal systems by performing the required laboratory analyses for a fee.

Laboratory capability is subjected to continuous expansion as new chemical contaminants harmful to the health of persons are found in drinking water. Research results in identification of these contaminants influences the federal adoption of regulatory and monitoring actions. As the primary laboratory service unit the state laboratory must be able to examine water for the presence of all federally controlled contaminants. It has proven difficult to maintain a laboratory capability to accomplish the analysis of newly designated chemical contaminants within the time frame demanded by federal law. Sources of funding for extending laboratory capability have included program grant funds, fees charged to system owners to partially defray the costs of laboratory service, and state appropriations. The amounts available for this purpose have not been timely or sufficient to acquire needed instrumentation or to train personnel in advance of the imposed implementation of onitoring requirements. As a result, laboratory service for system owners has been delayed to the point that monitoring time schedules are often six months to one year behind.

The accomplishment of biological monitoring has been satisfactory to date. However, recent research reports lead to the conclusion that required examination for the presence of virus in drinking water will emerge in the future. Future laboratory needs are, envisioned to include expansion to accommodate examination for an additional 22 synthetic organic chemicals which are proposed for regulation by EPA in 1982, and the eventual development of capability in the field of virology. Existing funding sources will not accommodate fulfillment of these needs.

FOOTNOTES

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2. Department of Health, Division of Environmental Engineering files.
3. National Research Council. 1977. Drinking Water and Health. National Academy of Sciences. p. 897.

4. **Id.** p. 898.
5. Environmental Protection Agency. 1976. **National Interim Primary Drinking Water Regulations,** p. 114.
6. Department of Health, Division of Environmental Engineering files.
7. EPA. 1976. p. 127.
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9. Osgood, J. O. 1974. Hydrocarbon Dispersion in Groundwater: Significance and Characteristics. Groundwater vol. 12, no. 6 Nov-Dec. p. 28.

Chapter 6

Competitive Use Effects

The previous discussion identified areas where groundwater availability is limited, and described some of the natural influences on water quality. In addition to those natural constraints, competitive use effects further hinder some communities' efforts to provide reliable supplies of good-quality drinking water. The state of Nebraska, by the establishment of the preference system, recognized the existence of competition. Competition with agricultural water- and land-use is a significant problem for many Nebraska water systems. Other competitive uses include industry and "internal competition" (the development of private water wells within the service area of a community water system). Instream flow water use is a specialized problem that also requires discussion. Despite the importance of communities as trade, transportation, and agricultural-industrial support centers, these competing users of water, land and other resources force cities and towns into increased expenses for the development, operation, and maintenance of their public water systems. As indicated in conversations with Health Department personnel, many of the managers and consumers of municipally supplied water do not consider these uses to be competitive in nature. Rather, they accept depletion of supply and deterioration of quality as a part of the economic structure that contributes to the continued existence of the community as a trade and service center. These attitudes are almost uniformly associated with agricultural water use, although it is not uncommon for municipal interests to encourage industrial development without serious concern over the long-term effect on the water source.

The analysis in this chapter is based on the facts that human life cannot exist without an available supply of water suitable for consumption and that in Nebraska groundwater is the most reliable source available to meet this basic need. These facts are supplemented by the following assumptions garnered from the findings and conclusions of this and other study groups working on the water policy issue analyses:

1. Several areas or regions within the state have experienced groundwater development to the point that depletion of the groundwater reservoir can be expected to restrict large-scale withdrawals within the forseeable future (30-100 years);
2. Agricultural practices, beyond reasonable utilization of natural vegetative cover, contribute to deterioration of groundwater quality ranging in degree from the effects of dry cropping to accelerated contamination associated with applied irrigation water, fertilizer and chemical pesticides;
3. Industrial development, without full consideration of the natural resource base, can contribute to depletion and quality deterioration of the available water supply;
4. The land, water and air constituting the resource base establishes the optimum level of development that can be expected for an area;
5. The availability of usable water should not be exploited to accomplish immediate economic gain, locally, regionally, or statewide in effect without full consideration of the influence exerted on the remaining resources.

AGRICULTURE AS A COMPETITOR

Although cities and villages in Nebraska are dependent on the agricultural economy, the affects of agricultural use on the quantities and quality of water available for community use are of serious concern. Falling water levels, due in part to large-scale withdrawals of water for irrigation, are affecting many communities. In many

places the quality of water distributed by municipal systems or used by household systems providing drinking water to isolated rural families has been degraded by agricultural development.

Quantity

Water supply problems for many communities accelerated with the rapidly expanded use of groundwater for irrigation in the mid-years of the twentieth century. Difficulty associated with reliable municipal groundwater supply frequently involves development of groundwater for agricultural use. Figure 10 illustrates the intensity of development in the state. In many parts of the state, density of irrigation wells exceeds 3 to 4 per square mile. A single irrigation

well can withdraw as much water during a pumping season as a small town will utilize in an entire year. For example, an irrigation well that withdraws 150 acre-feet per season, or almost 50 million gallons (about 14 inches of water applied to a 133-acre pivot circle), uses as much water as a city of 900 people (assuming 150 gpcd).

Local overdevelopment results in the progressive annual lowering of water tables over extensive areas. Recharge from precipitation cannot replenish groundwater storage and lateral flow from undepleted areas is so slow that it cannot replenish the aquifer as the withdrawal continues. Municipal water systems in overdeveloped areas are constantly faced with decisions to lower pump settings, drill deeper wells, or locate a new source of supply remote from the influence of overdevelopment. Figure 10 also shows those areas experiencing significant declines from predevelopment water levels. Pronounced declines have been experienced in the Big Blue and Little Blue River Basins, in southwest Nebraska, Box Butte County, Cheyenne County and elsewhere. Considerable municipal population is located in these areas.

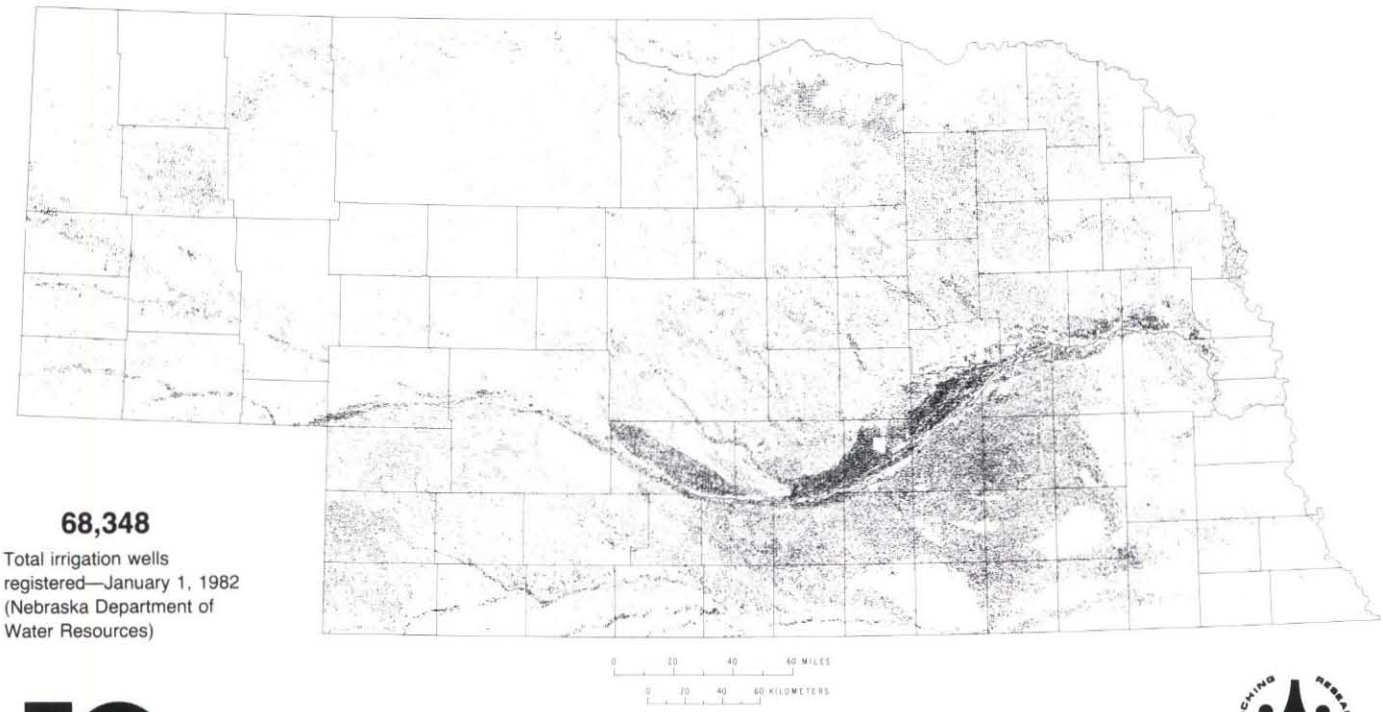
During the Policy Issue Analysis on Groundwater Reservoir Management areas that are projected to experience depletion within relatively short periods of time (30-100 years) were identified. Under the Groundwater Management and Protection Act three areas are subject to management controls instituted by local and state action. Boundaries of these areas are shown in Figure 11. Cities and villages within these areas should be concerned about their continued ability to provide the amounts of water required to maintain a viable community existence.

Conversely, when surface water is diverted for irrigation of farm lands, a rising water table is not uncommon (see Figure 10). This occurrence may be beneficial to the municipal water source by reducing energy costs for pumping. Whether a positive or negative influence is exerted on groundwater storage, the effects of development, including land use, influence the quality of groundwater. As discussed in Chapter 1, LB 146 permits Natural Resources Districts (NRD's) and the Department of Water Resources to protect groundwater quality as well as quantity by establishing control areas.

The effect of agricultural water use on municipal water systems is not limited to the long-term changes that are occurring in regions where groundwater is being mined. Most municipal wells experience a lowering of the static water level during the irrigation season. This condition is most noticeable in areas having extensive groundwater irrigation development. The changes in water level may be significant, exceeding 60 - 100 feet in certain geological settings.[1], [2] These seasonal declines may influence the amount of water that can be pumped in addition to reducing the energy efficiency of the pump and motor. The most serious result of the lowered water table occurs when the pumping water level in the well falls below the location of the pump or the top of the well screen. Damage to pump and motor can occur as the well "pumps air". Also, water cascading through the screen openings is mixed with air and takes on corrosive or encrusting properties. The resulting damage to the exposed screen is permanently reflected in well production and the useful life of the well screen.

Case histories of communities affected by agricultural water uses are given beginning on

GROUNDWATER MAPS, 1981

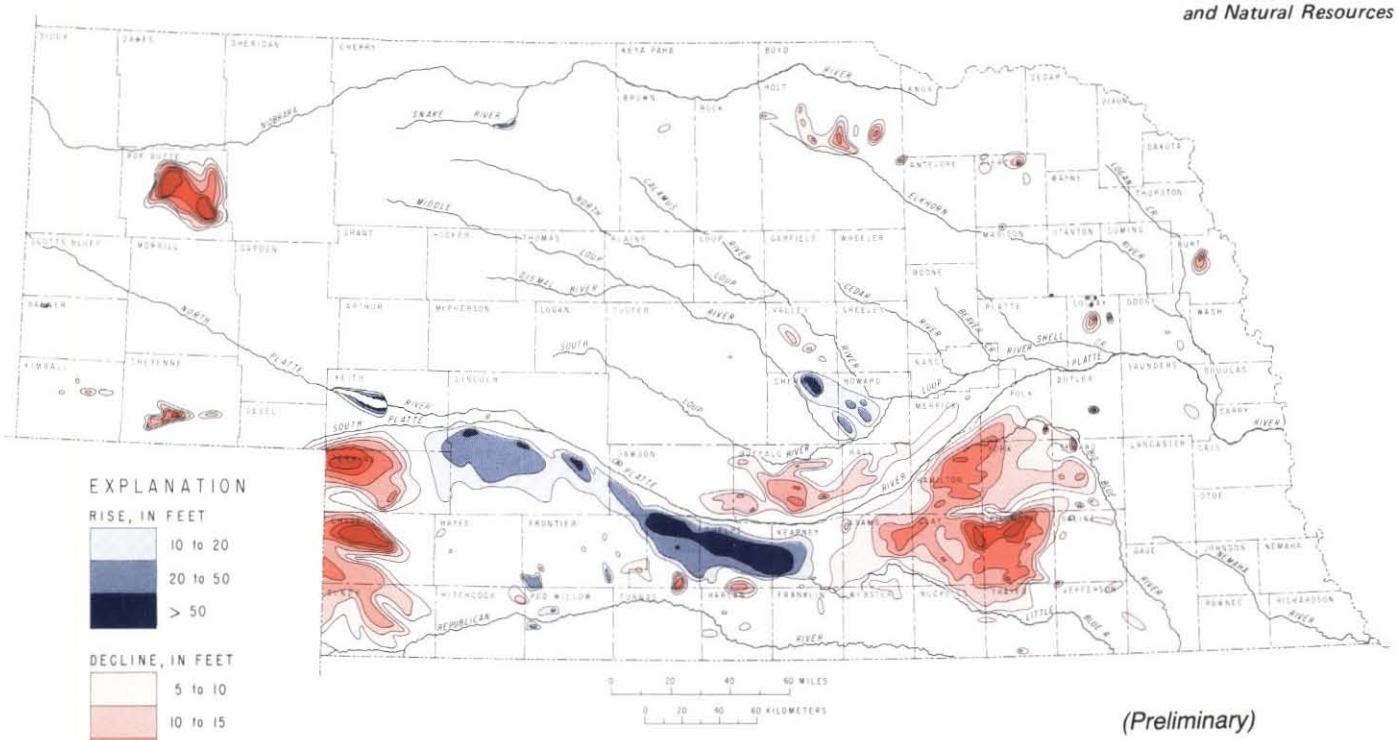


68,348

Total irrigation wells registered—January 1, 1982 (Nebraska Department of Water Resources)

Location of registered irrigation wells as of January 1, 1982

Institute of Agriculture and Natural Resources



(Preliminary)

Significant rises and declines in Nebraska groundwater levels from predevelopment as of fall 1981

Prepared cooperatively by
U.S. Geological Survey and
Conservation and Survey Div., IANR,
The University of Nebraska–Lincoln

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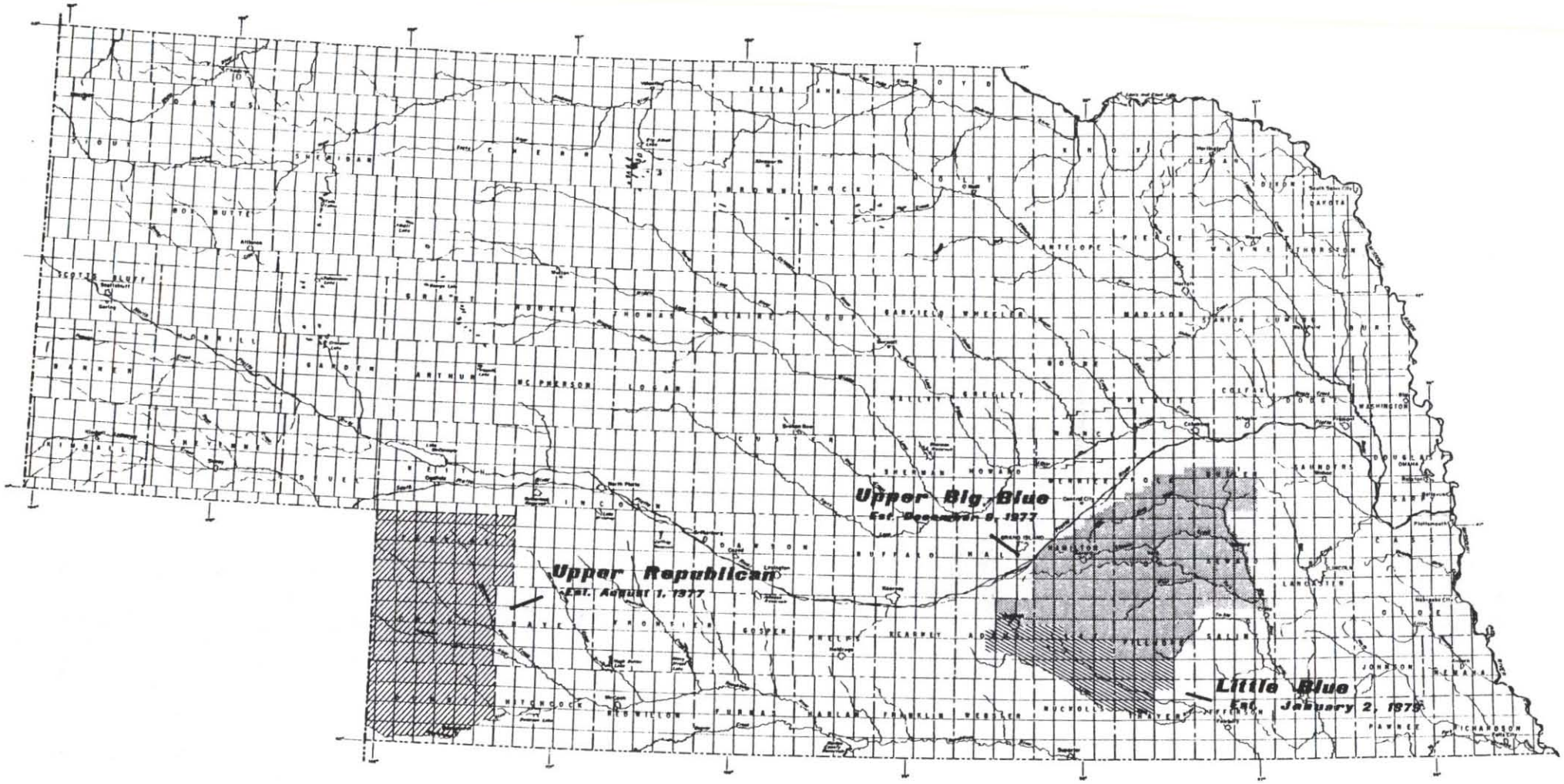

FIGURE 11

LOCATION OF GROUNDWATER CONTROL AREAS

Department of Water Resources
State of Nebraska

TABLE 6-1

TOWNS THAT HAVE EXPERIENCED WATER SUPPLY PROBLEMS* RELATED TO COMPETITIVE USE

Beatrice	Genoa	Norfolk
Beaver City	Grant	Petersburg
Benedict	Hardy	Rising City
Bradshaw	Hastings	Seward
Cambridge	Imperial	Sidney
Culbertson	Indianola	Stamford
Danbury	Lebanon	Superior
Davenport	Litchfield	Wakefield
David City	Madrid	Wilsonville
		York

**Reduction in yield, lowering of water levels, and related air- or sand-pumping.*

TABLE 6-2

TOWNS EXPERIENCING WATER SUPPLY PROBLEMS DUE TO DETERIORATING WATER QUALITY, POSSIBLY FROM COMPETITIVE USE EFFECTS.*

Big Blue Basin	Central Platte Area	Republican Basin
Beatrice	Central City	Culbertson
	Duncan	Danbury
	Grand Island	Hardy
	Kearney	Indianola
	Wood River	Lebanon
		Naponee
		Wilsonville

**Does not include towns where quality problems known to be point source pollution, with better quality supplies easily available.*

page 6-9. Tables 6-1 and 6-2 list some towns that have experienced quantity and quality problems related to competitive water and land use.

It is generally agreed that complete depletion of the groundwater reservoir will not occur. Irrigated acreage will probably diminish gradually as the availability of water and the cost of pumping influence individual decisions relating to farm operations. In effect, the least efficient irrigable lands will probably be converted to dryland farming and the most efficient will continue to be irrigated. Eventually this reduction in withdrawals should allow groundwater levels to stabilize at some lower level. Throughout this transition period and beyond, the municipal user will hold a competitive edge over the agricultural user regarding the acquisition of water to meet user demands because the economic value of water for municipal use far exceeds the price that can be paid for irrigation water.

The problems associated with quantities of water available for municipal use are less severe than those associated with quality. Based on the accepted premise that community life is dependent upon the success of the agricultural economy, or income, it can be reasoned that shortages of water for agricultural use will result in a reduction of the agricultural work force. A reduction in the number of persons providing support service to the agricultural sector can also be anticipated. As employment opportunities dwindle, people may leave the affected area. As a result of population loss, the municipal water requirements can be expected to diminish. Conversely, cities and villages located in these affected areas may not experience loss of population. As water tables decline, the difficulty and cost of maintaining individual wells for isolated

dwellings may encourage migration to communities served by a public water system. Population, location, and socio-economic conditions will probably be factors in how, or whether, a community survives water level and agricultural declines. Many municipal officials and their constituents accept interference to their water service as a fact of life associated with dependence upon an agricultural economy.

Quality

Agricultural practices on the land exert a major influence on the quality of both surface and groundwater. Contamination of surface water by sediment is easily observed, but the presence of bacterial contamination, nutrients, dissolved organic materials, and agricultural chemicals are less obvious to the human senses. All Nebraska systems using surface water are confronted, to some degree, with the occurrence of these contaminants in their raw water supply. The city of Crawford experiences almost constant contamination of its source by sediment and bacterial contamination resulting from direct watering of grazing cattle in Dead Man Creek immediately above its intake structure.

In the event more communities elect, or are forced, to develop surface water sources to replace depleted groundwater supplies, the selection and protection of the contributing watershed will become increasingly important. In the heavily populated areas of the eastern United States it is customary to acquire the complete watershed and dedicate its use to fish, wildlife and limited recreation activity. Controls could be less stringent in Nebraska, but should limit land uses in the drainage areas to those that are compatible with the collection and storage of high quality runoff water.

Much of the presence and build-up of nitrate in Nebraska groundwater has been definitely associated with the application of fertilizer and water to overlying crop lands. Recognition of this quality-deteriorating factor has resulted in efforts to reduce the rate of build-up through improved practices associated with the amounts of fertilizer and water necessary for optimum crop production. Economic return to the landowner should occur as a result of reclamation of nitrate from irrigation water, less applied nitrate, lower water use and pumping costs. Data leading to the above conclusions have been reported, and are being refined, by the Hall County Water Quality Special Project, sponsored by the Central Platte Natural Resources District.

Almost any soluble material applied to the land surface to improve crop production can be transported to groundwater in the same manner as nitrate. Municipal water supplies have been examined for the presence of chlorinated hydrocarbons and chlorophenoxys compounds commonly used as pesticides. No significant quantities of these compounds were found, most likely due to their ability to adhere to soil particles on or near the ground surface. Rapid development of synthetic inorganic chemicals, and their acceptance for agricultural use, could encourage application of chemicals capable of penetrating to the groundwater. The Department of Health and the Department of Environmental Control are developing a capability to measure groundwater contamination from these emerging sources.

INDUSTRY AS A COMPETITOR

The resource base of Nebraska is not of sufficient extent to encourage the location of heavy water-using, raw material-dependent industry. Most industry is located within the corporate limits of municipalities providing water service. The few exceptions are gravel pit operations and food processing plants including packing plants, which are initially located in part to take advantage of a reliable water supply, as well as work force and transportation advantages. Gravel pit operations may be the most serious industrial competitor of municipal water supply. Loss of well field sites, lowering of water levels, and potential for groundwater contamination through ponds are among the impacts of mining operations. Legal conflicts between municipalities and gravel pit operators have occurred (see Chapter 1). While industry generally utilizes the municipal source of water for processing, they frequently provide an auxiliary supply for fire protection. This supply taps the groundwater source used by the municipal system. Poor construction of wells serving the fire system may permit contamination of the aquifer. Heavy pumping required during fire operations could also permanently damage the production capability of the municipal wells.

A greater concern involves the potential of cross-connection or back-siphonage from the industrial system into the municipal water supply. This occurrence is common when the industry does not provide any part of its water requirements. Submerged inlets and direct connection of make-up water supply to process water permits siphoning of contaminating material to the drinking water source when the municipal system pressure is reduced or lost. Experience indicates city and village officials can be reluctant to require proper plumbing practices, including the installation of back-flow prevention devices for fear that the industry will close or

relocate. There is no evidence that an industrial or commercial establishment has reacted in this manner however.

Industrial progress is highly dependent upon new chemicals that reduce production costs. Most new chemicals entering the industrial market are synthetic organics used as solvents, cleaners, or additives to the final product. These new chemical products are approved by the state or federal governments for specific uses or handling procedures. However, the risk of accidental spill, mishandling, or improper disposal of excess material remains a problem. Therefore, industry must be considered a hazard to municipal water systems based on its potential to contaminate the water supply source or the delivered water through backflow or cross-connection with an industry-owned contaminated water supply.

COMPETITION RELATED TO INSTREAM FLOW USES

A number of cities and villages have located their wells adjacent to streams. In some instances, these sites were selected to utilize the water-bearing sand and gravel deposits of the stream valley. Some of the larger municipal systems have located well fields adjacent to the rivers to gain advantage of induced recharge (water moving directly from the stream into the wells). Four public suppliers, Metropolitan Utilities District (Omaha area), Lincoln, Fremont, and Grand Island, designed their well fields to take advantage of induced recharge from the Platte River. Other water systems, like that of Sidney on Lodgepole Creek, while not designed as induced recharge systems, have wells that withdraw water from aquifers that are recharged in part from local losing streams.

Existing law does not recognize the interrelationship of surface water and groundwater. Those systems relying on stream flow to recharge their well fields cannot obtain a surface water right to assure continued availability of surface flow for this use. Conversely, other surface water rights are not protected against reduction in flow resulting from induced recharge or interception of groundwater flow to the stream. The reduction of inflow to Enders Reservoir on Frenchman Creek is an example, attributed in part to large groundwater withdrawals in the drainage area and the resulting decrease of groundwater seepage into the stream channel.[3]

Streamflow may influence the quality of water withdrawn by adjacent municipal well fields. When Platte River flows are reduced by lack of rainfall and upstream diversions, the effect of poor quality water contributed by Salt Creek and possibly seepage from adjacent bedrock aquifers results in higher sodium and chloride concentrations in Metropolitan Utilities District wells. At the M.U.D. wellfield, changes in surface water quality are reflected in well water within about ten days.[4] Elsewhere, induced recharge may be a viable alternative for certain cities facing degradation of groundwater quality in their existing sources of supply. Particularly along the central Platte valley, the river could be a reliable source of low-nitrate water. The City of Kearney is presently investigating the possibility of inducing surface water recharge.

In the event instream flow uses are recognized as beneficial and water rights are acquired or dedicated to this use, future concerns relate to uses of water below stream reaches that recharge groundwater or where induced recharge withdrawals are occurring. The water "accounting system" must be sophisticated enough to account for groundwater recharge as a stream-depleting factor. Under some conditions, stream depletion due to groundwater recharge could impact certain downstream users.

INTERNAL COMPETITION

Municipal water systems are not provided an exclusive franchise to supply all water service within their area of jurisdiction.[5] Large water users often construct private, commercial or industrial wells as a means of reducing payments to the city for water service. These wells seldom influence the quantity of water available from the municipal source of supply. However, these unsupervised installations may contaminate the municipal supply through faulty construction or backflow if interconnected to household plumbing that also receives water from the city mains. Reasonable regulation and periodic inspection are needed to protect the quality of water delivered to other consumers served by the system.

A major concern is the reduced income for operation, maintenance and replacement of the municipal system. The storage facilities, main sizing, and valve locations are dictated by design standards that provide adequate fire protection throughout the system. The capital investment is determined by these factors and is repaid from income generated by water sales. Any loss in system revenue causes either a cutback in maintenance or an increase in rates to the remaining customers. Unfortunately, an increase in rates may accelerate individual decisions to seek another source of water. Alternative methods of funding not based on water sales (capital facilities charges or hydrant levies, for

example) could lessen the financial impact of this type of competition.

Case Histories Associates With Competitive Use Effects

The following information has been summarized from Department of Health files to illustrate municipal water supply problems related to interference by other large-capacity water users.

SIDNEY

The city of Sidney (pop. 6,092), in Cheyenne County, has experienced severe water supply problems and is relocating its wellfield. The city utilizes eight wells in the Lodgepole Creek valley as its source of supply. The wells, generally 80 to 100 feet deep, draw water from the fractures and joints of the Brule Formation siltstones. These openings in the rock transmit water freely but provide limited storage space. Consequently, when heavy pumping of the aquifer occurs, storage is depleted and water levels decline significantly.

The aquifer in the Sidney area is severely stressed by irrigation and municipal pumping. More than 30 irrigation wells are registered within about a two-mile radius of the city. During the irrigation season, water levels in city wells drop to within a few feet of the bottom of the wells. In addition to the seasonal stress, a progressive annual decline in water levels has occurred, indicating a deficit in recharge to the aquifer. Water levels have declined approximately 20 feet from estimated predevelopment levels.

In 1978, a consulting engineering firm was hired by the city to conduct a study of future water needs. One result of this study was a test drilling program to explore the Ogallala Formation approximately 2 to 15 miles north of town. Efforts are currently continuing to evaluate this source and relocate the municipal wellfield. This will obviously be an expensive undertaking; a preliminary estimate of the cost to bring this water into town was in excess of $250,000 per mile.

SEWARD

The city of Seward (pop. 5,294) has dealt with water supply problems for many years. Until recently, the city's sole source of supply was a wellfield three miles west of town. This wellfield consists of nine wells, each approximately 120 feet deep. These wells are in an area of extensive irrigation development. Water levels have been declining since the 1960's. Pumping levels in the wellfield are extremely low during the summer due to the nearby irrigation wells and interference between the closely-spaced city wells. Water-use restrictions have been instituted periodically, the most recent in the summer of 1980.

In September, 1980, test-drilling was initiated at the airport property south of the city. Three wells were eventually developed; this new "south wellfield" began pumping into the system in July, 1981. A landowner adjacent to the south wellfield has filed suit over the pumping of these wells.

Use of the south wellfield has alleviated Seward's immediate supply problems, but additional sources of water will be required in the future. City officials are planning development of yet a third wellfield. Test drilling has begun several miles west of the city. An ultimate solution to Seward's water problems will be extremely expensive, involving transmission of water several miles into town from at least three separate wellfields.

STAMFORD

The village of Stamford (pop. 207), in Harlan County, has a history of supply problems resulting from a limited aquifer, interference from numerous irrigation wells, and an inadequate distribution system. In these respects, Stamford is typical of several towns in the Republican River Basin. The village is located in the Sappa Creek valley, and taps the alluvial aquifer with four low-capacity wells. Wells are 60 to 65 feet deep and pump approximately 50 gallons per minute or less.

The numerous irrigation wells in the valley (six per square mile) severely stress the thin aquifer during peak pumping periods, lowering water levels significantly. Increasing village demand frequently cannot be met by the existing wells and small-diameter distribution piping, resulting in low pressure in the system and the risk of cross-contamination. There is also some evidence that nitrate levels are increasing, possibly in response to agricultural land use.

The problem has been aggravated in recent years by a number of factors, including: (1) changes in village administration, (2) replacement of the town's consulting engineer, (3) a lack of an organized test drilling program, and (4) an unwillingness by the Village Board to test certain areas because of reported quality problems.

GRANT

The city of Grant (pop. 1,099), in Perkins County, is located in a region of extensive irrigation development. Municipal and irrigation wells penetrate the Ogallala formation to con-

siderable depth. Static water level is relatively deep and large drops are recorded in water levels during the irrigation season.

The city has been troubled by these large seasonal declines and has had to drill new wells with deeper screen settings. One of the wells drilled in 1979 replaced a 440-foot well only three years old. Summer pumping levels in this 1976 well had dropped below the upper screens (at the 228 ft. level), causing cascading of water and associated problems, such as pumping sand.

BEATRICE

The city of Beatrice (pop. 12,389) water system is regarded as one of the finest in the state. Source, storage and distribution facilities are considered adequate, and operation of the system by city personnel is very efficient. Beatrice, however, faces a potentially serious water quality problem in the future.

The source of supply for the city is a wellfield consisting of eight wells northwest of town in the Big Blue River valley. These wells are 90 to 100 feet deep and supply several hundred to approximately one thousand gallons per minute each. These wells pumped over 1400 million gallons (MG) in 1979, and almost five MG on the peak day of that year.

The Department of Health has been monitoring an apparent water quality trend at the Beatrice wellfield. Concentrations of nitrate in the groundwater appear to be steadily increasing. Preliminary calculations indicate an average concentration of about 1.5 mg/l in the 1976-77 period but over 5 mg/l in 1980-81. Maximum concentrations were 7 mg/l in 1976-77 and 9 mg/l in 1980-81. Rising nitrate levels may be related to the extensive irrigation and heavy application of fertilizer in the valley surrounding the wellfield.

FOOTNOTES

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2. Department of Health, Division of Environmental Engineering files.
3. Lappala, E. G. 1978. Quantitative Hydrogeology of the Upper Republican Natural Resources District, Southwest Nebraska. U.S. Geological Survey. Water Resources Investigations 78-38.
4. Department of Health, Division of Environmental Engineering files.
5. *Edward H. Eckstein, et. al. vs. the City of Lincoln,* 202 Neb. 741, 277 N.W. 2d 91 (1979).

Chapter 7

Drinking Water Economics

Per capita water use patterns reported in the discussion on municipal water use in Nebraska (Chapter 3) materially influence the economics of municipal water service. Applied conservation practices by both management and consumers have been demonstrated as effective means of delaying the need for capital investment to enlarge the system. Conservation cannot help communities needing capital investment to bring their water systems up to modern design criteria except when lesser water use might reduce storage requirements. A number of systems will be confronted with the need to remove harmful contaminants from their water through treatment. In these instances effective conservation programs will contribute to lowered capital investment and operation costs due to the lesser volume of water to be treated.

Any reduction in municipal water system demands will not materially influence the availability of water for other beneficial uses since less than five percent of total groundwater withdrawn is accomplished by municipal systems. However, the application of conservation measures within a municipal system will ultimately reduce the cost of essential service to the customer and might encourage conservation practices by other user groups.

Water system economics must also consider the effects of consolidating systems or system management functions, costs of monitoring the condition of delivered water and State supervision activities, and sources of financing necessary improvements. The following discussion will attempt to relate all influences on water system economics.

UPGRADING EXISTING SYSTEMS

Table 2-2 reveals that there are a total of 467 inadequacies in the physical condition of Nebraska municipal water systems. Inadequacies are found in source of supply (55), storage capacity (117), and distribution piping (295), singly or in combination. Table 2-3 presents the cost breakdown for rehabilitating a 12 percent random sampling of these systems. Extrapolations of these findings to all municipal systems result in the following statistical evaluations:

(1) An investment of $36 million would be required to modernize 457 municipal water systems in the state.

(2) The rate increase, amortized over twenty years at 10 percent interest, would average $0.27 per month per person served, although some smaller systems might require rate increases as high as $10.00 per month per capita in the absence of subsidy through grants and low-interest, long-term loans.

The criteria upon which this analysis was made are based, in part, on the ability of the system to provide uninterrupted fire flow throughout the area served. This system capability, coupled with other factors such as fire fighting equipment and training of firemen, are used to establish fire insurance rates. Smaller cities and villages electing to modernize their water systems might receive a re-evaluation of their insurance classification and in some instances the reduction in insurance premiums would reduce the impact caused by increased water rates. Other benefits associated with a modernized system include improved pressure and service to all customers, a reliable service with minimum breakdown and disruption, protection of delivered water from external contamination, and the satisfaction that the water system serving the community is the best that can be obtained.

THE NEED FOR TREATMENT

As discussed in Chapter 5, federal and state regulations have established maximum levels for

contamination permitted in public water supplies. The current levels for harmful contaminants have been adopted on the basis of existing knowledge and research that indicates adverse health effects are associated with each suspected contaminant. These contaminant levels have been adopted as an interim measure pending the results of on-going studies relating to the acceptable levels that can be demonstrated as having no adverse health effects on humans. Although only a small portion of the water distributed by a municipal system is ingested by humans, all the water delivered by the system must be maintained at the quality level required for drinking water.

The EPA position has been extremely conservative on the numerical limit established for suspect contaminants. Limits have often been established at the lowest level reported as harmful by a research report, and often at the lowest level detectable by laboratory procedures. In order to retain primary responsibility for the Water System Supervision Program, the Nebraska Department of Health has adopted the EPA numerical limits, but hesitates to force compliance until the actual health risks are evaluated and reflected in the federal regulations. The levels of contamination, particularly those adopted by the EPA and by the Nebraska Department of Health relative to selenium and radioactivity, have been seriously questioned as being unnecessarily low by a substantial number of the members of the scientific community.

The following presentation of treatment costs is based on compliance with the interim contaminant levels presently in effect. The cost estimates for treatment are based on the current state of the art, therefore, it is possible that costs can be reduced as treatment technology evolves. A number of the communities listed may be eliminated from the treatment requirements in the event the contaminant levels are raised. However, other systems probably will be required to treat their water as additional harmful contaminants are identified and regulated.

Nitrate Reduction

There are a number of Nebraska municipal water systems that have consistently exceeded the 10 mg/liter maximum contaminant level for nitrate-nitrogen. Twelve systems have been placed on exemption status under directive to notify all consumers of the existing contamination at three month intervals, to provide nitrate-free bottled water for use by infants under six months of age, and to actively seek a permanent solution for reducing the nitrate contamination to acceptable levels (see Table 5-3).[1] Under the provisions of federal law (P.L. 93-523) such exemptions terminate on January 1, 1984. Although considerable progress has been made in these towns, experience indicates that from three to five additional municipal systems will be confronted each year with high nitrate contamination and associated costs for eliminating the problem. After January 1, 1984, the time element for achieving correction will become critical since exemption status will no longer be recognized under law.

Three treatment processes have been recognized for removal of nitrate from drinking water. These are reverse osmosis, electrodialysis, and ion exchange. These processes require a high degree of technical capability in design, construction and operation features and are extremely costly to obtain and operate. The Department of Health has hesitated to recommend or accept removal of nitrate by treatment for these reasons. The breakdown of costs for the three treatment processes are shown in Table 7-1 based on 1977 dollar values. The costs are based on actual review of treatment plant costs adjusted to the 1977 dollar value.[2] The construction index of 1981 is 34 percent higher than the 1977 values.

All water needing treatment differs in chemical composition and exerts an influence on the efficiency of the treatment technique selected. For example, should the raw water supply source contain calcium or magnesium salts in solution, the efficiency of nitrate removal by ion exchange will suffer. In many instances, it may be necessary to process the water through two resin contact beds, one to remove calcium and magnesium, and one to remove nitrate. This process would increase costs by as much as 70 percent over the cost to remove nitrate without the presence of calcium and magnesium ions. Since all Nebraska groundwaters are known to contain calcium and magnesium the cost figures for ion exchange presented in Table 7-1 are on the conservative side. Further, the cost figures presented do not include the expense associated with pilot plant studies which would be necessary, in varying degrees, for determining the most economic treatment design.

The cost of nitrate removal by treatment, coupled with the lack of operators having the necessary technical background to operate such facilities, has encouraged the Department of Health to promote the development of nitrate-free sources of supply as an alternative to treatment. Replacement of existing high-nitrate wells with new or relocated wells, designed to take advantage of nitrate stratification or location within the aquifer, can be accomplished at costs ranging from $15,000 to $60,000 per system.

TABLE 7-1

COST OF NITRATE REDUCTION BY TREATMENT

	TREATMENT PROCESS					
	Reverse Osmosis (percent of removal)		Ion Exchange (percent of removal)		Electrodialysis (percent of removal)	
	90%	45%	98%	49%	80%	40%
CAPITAL COST, in 1977 dollars						
Population 200	283,700	216,500	69,600	61,800	290,000	236,500
Population 1,000	545,000	435,000	85,200	80,000	539,000	432,000
ANNUAL CAPITAL COST 30 years @ 12% interest						
Population 200	35,219	26,876	8,640	7,672	36,000	29,360
Population 1,000	67,656	54,000	10,577	9,931	66,911	53,628
ANNUAL OPERATIONS & MAINTENANCE						
Population 200	64,280	50,940	1,400	1,175	50,230	38,190
Population 1,000	114,600	90,500	2,310	1,925	93,990	77,875
TOTAL ANNUAL COST						
Population 200	99,500	77,816	10,040	8,847	86,230	67,550
Population 1,000	82,256	144,500	12,887	11,856	160,901	131,503
ANNUAL PER CAPITA COST						
Population 200	497.50	389.08	50.20	44.24	431.15	337.75
Population 1,000	182.26	144.50	12.89	11.86	160.90	131.50
MONTHLY PER CAPITA COST						
Population 200	41.46	32.42	4.18	3.69	35.93	28.14
Population 1,000	15.20	12.04	1.07	0.99	13.41	10.96

Assuming that competitive water users will act to reduce the rate of nitrate contamination in groundwater, the replacement of groundwater supply sources may serve as a permanent solution to the contamination problem. Should nitrate levels in groundwater continue to increase at the present rate, it is possible that advances in technology will provide an economical treatment process before the maximum contaminant levels are again exceeded. If nitrate contamination continues to increase in concentration and scope while treatment technology remains uneconomical or infeasible, some towns may be without a reasonable solution to the problem. Consolidation of systems (see p. 7-6) may be an alternative.

Removal of Selenium and Radioactivity

The processes available for removal of nitrate are also capable of removing selenium and radium at essentially the same per capita costs. As discussed in Chapter 5, the Department of Health is not overly concerned with the presence of low level selenium found in Nebraska groundwater and will not act to require removal unless scientific evidence demonstrating its harmful effects is forthcoming.

The problems associated with radioactivity in Nebraska drinking water could be much more serious. As many as 90 municipal supplies might find it necessary to remove radioactive chemicals that contribute to gross alpha radiological contamination. Ongoing research into the effects of radioactivity in drinking water, and continued testing of water to determine the chemical source of the radioactivity, will ultimately determine those systems that will find treatment necessary and advantageous. As in the case of selenium contamination, the Department of Health will not require treatment until scientific evidence associated with the contaminant is confirmed. The costs of removal of radio-

active material are comparable with those illustrated for nitrate removal since metallic ion removal by softening is the technique of treatment.

The History of Expedient Development

A preponderance of Nebraska water systems are faced with the problem of transporting water from a number of sources to a central point in the event treatment or conditioning proves necessary or desirable. New wells have historically been located to accommodate the growth pattern or pressure demands associated with providing new or expanded service. These wells have been connected directly to the distribution system, with little apparent concern over the quality or safety of delivered water. System expansion accomplished in this manner was, without question, the least costly alternative for distributing water throughout the system at the time of installation. The practice is still preferred by most municipal systems although the Department of Health now requires that the groundwater source be examined for quality and safety of delivered water before the wells are completed.

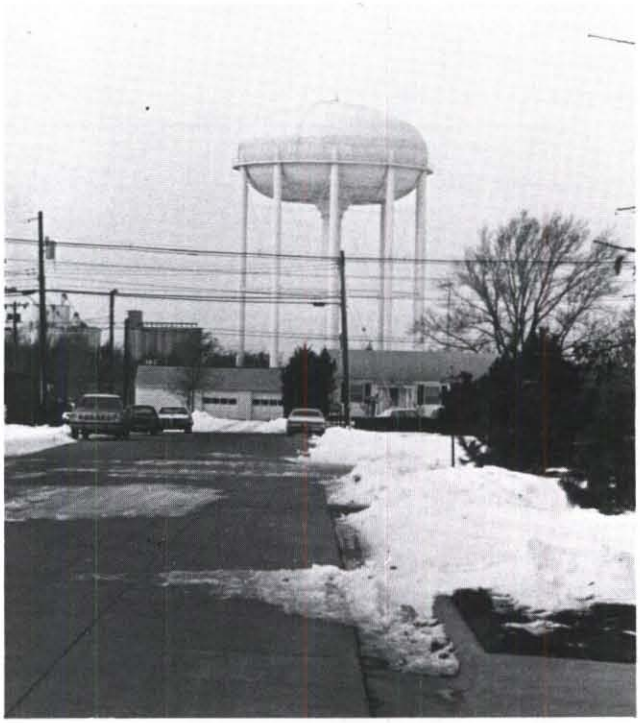
The historic method of expanding water systems has resulted in a scattering of supply sources throughout the service area. In the event that treatment of water to remove contaminants becomes necessary, added investment to transport the water from these sources to a common point of treatment will be required or a new source of supply will need to be developed. If the treatment option is chosen, the construction of assembly mains would be required to eliminate delivery of untreated water to consumers located between the numerous well sources and the treatment plant site. A duplicate system of water mains would result in most instances, with one transporting raw water to the plant and one delivering finished water to consumers. It is conservatively estimated that at least seventy percent of the systems would be confronted with this added cost should treatment of water be required.

CONSERVATION OF MUNICIPAL WATER

Water use has a direct effect on water system economics. Increased water use results in higher costs for pumping, treatment, and maintenance. Excessive water use can reduce system efficiency, further increasing costs. Reduced water use can extend the effective life of source, storage, and distribution elements of the system, and delay capital investment needed to expand the system.

There are few, if any, Nebraska municipalities that could not materially reduce per capita water use by applying management actions selected to accomplish this purpose. These actions are separated into two general categories: supply and demand. Supply side actions can be implemented by management without direct repercussion on consumer interests. Examples include metering and meter maintenance, leak detection and repair, and pressure reduction. Demands from the customer may be reduced by pricing, regulation, and education to accomplish voluntary user changes or attitudes relating to waste of water.

A combination of conservation actions are usually necessary to implement a successful water conservation program. As an example, metering of both production and distribution to customers is necessary to determine if waste is occurring from leaks in the water mains. Metering alone will not affect consumer use, but must be accompanied by pricing as an economic incentive for the user to reduce water use.



Implementation of a successful water conservation program is not an easy task. The permanency of the benefits must be directly associated with changed public habits and attitudes whether effected by pricing, regulation, or education. Public resistance to change, particularly changes that require public participation, is commonly observed in programs of this type. Resistance from elected officials charged with

responsibility for applying efficient utility service can also be expected when consumer support must be developed. Nevertheless, reductions in municipal water use and demand must be considered as an alternative to immediate capital investment and as a contribution to long-term efficiency in municipal water system management.

REGULATORY COSTS AND IMPACTS

Beyond the costs associated with modernizing and upgrading the distribution, storage, and treatment facilities necessary for continued delivery of safe drinking water, municipal water systems are also faced with other costs that must be recovered from consumers. These costs are associated with laboratory examinations to demonstrate compliance with permitted contaminant levels, the maintenance of records and analytical results for extended periods of time, notification to consumers when violations of the regulations occur or when exemptions are granted, and, in some cases, increased salaries and wages necessary to attract and retain qualified individuals to operate and manage the water system. The regulatory activities of the state and federal governments, while paid from general tax sources, must also be considered as a cost contributing to the assured safety of delivered drinking water.

Costs associated with meeting regulatory requirements vary considerably with system size. The number of examinations required for biological monitoring is based on system size and per capita consumer costs are relatively uniform for all systems. However, the number of chemical and radiological examinations required does not vary with system size. The per capita cost for small systems of 100 to 200 population might exceed four to five dollars per year while larger systems, with over 100,000 consumers, would rarely exceed five cents per consumer per year. The Department of Health Laboratory fee schedule has attempted to equalize this discrepancy by charging an average of fifteen cents per consumer per year for all tests required of systems subscribing to the service. This direct charge to system owners is subsidized by appropriation from the state general fund in amounts approximating fifteen cents per resident of the state.

Costs associated with record maintenance are relatively uniform since the smaller communities do not experience the volume of biological results that must be filed and retained for three years. Small systems are prone to higher costs for public notification when regulations are violated, however, because violations are more frequent in the smaller systems and because many do not bill in a manner that permits direct communication with each consumer without a special mailing. Furthermore, the rates for legal notice in the media are fairly uniform regardless of the size of audience that must be reached. Public notification cost can become a major budgetary item for small systems that are in persistent violation of the drinking water regulations.

Nebraska law requires the Director of Health to certify the competency of each individual in charge of a municipal or other public water systems. A procedure for evaluation of operators and the issuance of certificates was included in the implementation regulations adopted by the Department of Health. This certification activity is now in its third year and is beginning to create a demand for formal training by both operating personnel and their employers. Training is available through correspondence courses, community and technical colleges, and through operator seminars conducted by Health Department staff. Over four hundred individuals have been trained and certified since 1977, the effective date of the regulations, and time, tuition, and travel was provided by municipal employers in most cases.

The expanded expertise and increased responsibility associated with requirements to deliver safe water can be expected to increase the wages paid to qualified operating personnel. This trend has been observed in the wastewater treatment field of employment and can be expected to follow in the drinking water field as the consuming public becomes more conscious of the health effects associated with minute amounts of contaminants in drinking water. As with other costs influenced by regulation, the smaller systems, employing part-time operators or using voluntary labor, will be subject to the greatest impact.

Reports of the EPA reveal that the administrative costs for carrying out the Fiscal Year (FY) 1980 Public Water System Supervision Program range from as much as $1.25 per capita to as low as $0.05 per capita for several states. The Nebraska per capita cost was $0.35. However, this does not include $0.08 per capita state contribution for laboratory services. In most states the owner of the system pays for all laboratory work and passes the cost to the consumers through sale of water. Those states operating in the lower ranges of regulatory cost do not provide inspection and advisory service to owners as Nebraska does. Rather, the owner is completely responsible for delivering safe drinking water and is subjected to court action upon failure to demonstrate this responsibility through elaborate reporting procedures.

The logistics associated with serving Nebraska municipalities contribute greatly to the per capita cost of providing inspections, plan reviews, and training activities. The distance between population centers in the sparsely populated western half of the state consumes a major portion of travel allocation. Additionally, it is necessary to operate two biological laboratories, Lincoln and Scottsbluff, because the Postal Service cannot guarantee one day mail service to a single location. Inflation and recent reduction in funding has resulted in utilization of Health Department resources by those municipal systems that experience contamination problems identified by laboratory results. This approach will not serve to prevent contamination of municipal water systems, but to date has permitted timely correction even though the consumer has been exposed. This approach will continue out of necessity since the anticipated funding for FY 1982 will be reduced to slightly less than $0.34 per capita from the $0.43 spent in FY 1980.

CONSOLIDATION OF SYSTEMS

A number of small water systems have found it advantageous to purchase water from another system. These decisions have been based on both quantity and quality considerations. The practice was initiated in the 1970's when rural water districts (RWD's) began purchasing water from existing municipal systems. The Falls City, Auburn, Nebraska City, Plattsmouth, Metropolitan Utilities District (MUD), Tecumseh, and Fairbury systems make water sales to RWD's which in turn sell at bulk rates to other districts and to municipal systems within their service areas. In other circumstances, municipal systems sell water directly to other municipal systems. MUD provides approximately one-third of the water delivered by the Bellevue system and Beatrice is the source of supply for the Village of Filley.

Table 7-2 illustrates system consolidation that has occurred to date. There is great potential for

TABLE 7-2

CONSOLIDATION OF MUNICIPAL WATER SYSTEMS IN NEBRASKA

Primary System*	Source	Secondary System	Tertiary System
Beatrice	Groundwater	Filley	
Boyd Co RWD #2	Groundwater	Lynch Spencer	
Cass Co RWD #2	Groundwater		
Cedar-Knox RWD	Missouri River at Lewis & Clark Lake	Crofton St. Helena	
Dawes Co RWD #1	Groundwater	Whitney	
Falls City	Groundwater	Richardson Co RWD #2 Rulo	
Fairbury	Groundwater	Little Blue NRD #1 Pawnee Co RWD #1	Burchard DuBois Lewiston - partial Pawnee City - partial Steinauer Virginia
Johnson Co RWD #1 (south part)	Groundwater	Crab Orchard	

(Continued)

Primary System*	Source	Secondary System	Tortiary System
Lancaster Co RWD #1	Groundwater	Bennet - partial Panama	
Metropolitan Utilities District	Missouri River	Carter Lake, Iowa Papio NRD RWD #1 Bellevue - partial	Ft. Calhoun
Nemaha Co RWD #2	Groundwater	Johnson - partial	
Nebraska City	Groundwater	Otoe Co RWD #1 Avoca Douglas Manley Otoe Palmyra - partial	Otoe Co RWD #2
Otoe Co RWD #3	Groundwater	Unadilla	
Plattsmouth	Groundwater	Cass Co RWD #1	Nehawka Murray
Tecumseh	Groundwater	Johnson Co RWD #1 (north part)	
West Point	Groundwater	Cuming Co RWD #1 - partial	
Wymore	Groundwater	Blue Springs	

**Explanation: Primary systems provide water to the secondary systems, which in turn provide water to the tertiary system.*

additional consolidation, particularly in southeast, northeast, and north central Nebraska. Consolidation of systems can be expected to continue as groundwater quality deteriorates and as localized shortages of groundwater are experienced. This analysis has not attempted to identify specific potential for the physical consolidation of municipal water systems. It is conceivable that the groundwater resource of the Sandhills region may be tapped to provide transported municipal water to the populated areas in the central and eastern portions of the state in the event groundwater quality in those areas continues to deteriorate. Cooperation between communities in need might also result in diversion of Missouri River water to provide municipal and other water service in the eastern third of the State. While such projects may seem grandiose and infeasible at this point in time, they are mentioned to alert decision-makers in case they should desire to keep these options open for future generations.

Consolidation of management and operating functions by two or more municipal systems can effect immediate economic benefits to participants. Shared certified operators, a practice encouraged by the Department of Health, joint ownership of spare parts inventories and maintenance equipment, and application of central billing and record keeping can be demonstrated to reduce the cost of water delivery by each of the systems participating. In some states, commercial concerns have been organized to provide these services with apparent success. The Department of Health will continue to encourage both physical and management consolidation of

municipal water systems when such actions are cost-effective and improve service to the consumers.

Funding Sources

Municipal corporations with records of fiscal responsibility can usually sell improvement bonds through commercial outlets. The maintenance of records of income and expenditures, operation and maintenance, and water system needs are important factors that influence the sale of bonds and the interest paid during debt retirement. A significant portion of small Nebraska water systems cannot provide this record of responsibility and effort to maintain self-sufficiency. This phenomenon is not unique to Nebraska, but can be observed nationwide. As a result, Congress has provided a number of subsidy programs to accommodate those systems that cannot finance improvements through normal channels.

The two federal assistance programs presently available for water system improvement are administered by the Department of Housing and Urban Development (HUD) and the Farmers Home Administration (FmHA). HUD assistance is through block grant funds distributed through the Nebraska Department of Economic Development. FmHA provides low-interest, long-term loans as well as outright grants to communities with populations under 2,500. In general, both sources require the same demonstration of eligibility and need from applicants. The Department of Health assists in establishing priority between applicants to assure optimum contribution to health protection from proposed improvements. The amount of funding available from these sources is estimated at $7-8 million for 1982, and even though grant funds from FmHA will be materially reduced it is possible for a community to combine the sources in cases of need.

FOOTNOTES

1. Department of Health, Division of Environmental Engineering files.
2. Gumerman, R. C., Culp, R. L. and S. P. Hansen. 1978. Estimating Costs for Water Treatment as a Function of Size and Treatment Efficiency. Environmental Protection Agency, EPA-600/2-78-182.

Chapter 8

Social and Political Aspects

The Safe Drinking Water Act of 1974 (P.L. 93-523) was formulated to encourage consumer awareness over harmful contaminants that might be present in water provided by public water systems. This is evidenced by the existence of provisions requiring effective public notification when contamination is found to be present and for initiation of lawsuits by consumers when any provision of the law or implementing regulations are not enforced by a regulatory agency. The intent is further confirmed by committee reports and floor debate on the initial House Resolution. The sponsors expressed the view that a knowledgeable public would demand that the system owner deliver safe water and would be willing to pay for this health protection.

During the formative years leading to enactment of the federal law, 1969-1974, public input was almost entirely limited to the efforts of environmental and consumer protection groups whose activity was largely supported by the urban population. The influence of these groups or organizations is not only reflected in the federal law but in subsequent regulatory actions to implement the law. The most significant effect has been the adoption of a "no-risk" policy by the Environmental Protection Agency (EPA) in its promulgation of maximum levels for contaminants (MCL's) permitted in drinking water. This so-called "no-risk" policy has led to extremely low MCL's, sometimes near the point of laboratory detection. Firm evidence that these low levels of contaminants are harmful is sometimes lacking.[1]

The Environmental Defense Fund, a coalition of consumer and environmental organizations, has initiated a number of class action suits against the EPA with a resulting influence on program implementation through court directive or negotiated settlement. The particulars of these actions are not considered pertinent to the policy issues facing Nebraska, beyond an understanding that the federal leadership has not been able to establish a consistent direction toward implementation of the Act, that state implementation has been influenced by these external delays, and that as federal regulatory strategy becomes finalized, it will be necessary for Nebraska municipal systems to conform with the interpretation of the law. It should also be recognized that the states, including Nebraska, are provided some degree of flexibility in determining appropriate ways to obtain the delivery of safe drinking water within their jurisdictions. Accomplishment of scheduled compliance by individual water systems, however, must conform with national requirements to prevent intervention by the EPA under provision of federal law.

CONSUMER REACTION IN NEBRASKA

As discussed in previous chapters, Nebraska consumers have not demonstrated great concern over the quality and safety of their drinking water. Direct Health Department contact with consumers has been through isolated inquiries from individuals, frequently after media coverage of contamination discovered in distant drinking water supplies. Public notification has not resulted in consumer demands for immediate corrective action to remove contaminants. Only when high concentrations of nitrate were reported has the public reacted in support of the cost required to conform with the drinking water standards. Concern about nitrate in the state appears to be widespread. Examples of local concern include the request for a groundwater control area by the Lower Loup NRD based in part on nitrate contamination, the nitrate study financed by the Lower Big Blue NRD ,and the request to the NRD for a groundwater quality control area surrounding the town of Wood River.

The Department of Health is not aware of organized consumer protection groups within the state. During the formulation of the Nebraska Safe Drinking Water Act and subsequent re-

gulations the Nebraska League of Women Voters supported the position of the Health Department and the Legislative Committee on Public Works. The National League of Women Voters obtained a grant from the EPA for the purpose of disseminating information and creating public interest regarding the Safe Drinking Water Act. The Nebraska chapter did not participate to any great extent in this effort.

Public notification of contamination or of failure to test water has been carried out by numerous Nebraska municipal water systems. Approximately 20 percent, or 90 systems, are found to be in violation each three-month period (quarter).[2] The Health Department routinely advises the owner of the violation and of the necessity to inform consumers of the infraction. When the violation is serious and continuing the owner is requested to provide proof of notification for the department records. The notification is accomplished by direct mail, publication in three consecutive editions of a newspaper with local circulation, and by release to radio and television media. Consumer reaction has been negligible when the violation involves the presence of bacteria in the drinking water supply or when the owner fails to test the water routinely. The Department of Health has seldom been questioned regarding the health effects of bacterial contamination and has yet to be contacted by a consumer concerning failure to test water.

Reaction from consumers has been much more associated with chemical contaminants. Again, this reaction is frequently based on national publicity that may or may not be applicable to Nebraska consumers. Many of the organic chemicals have been reported as being carcinogenic (cancer-causing) and have been identified in trace amounts in water supplies contaminated by industrial operations. Most of these chemicals have not been introduced into Nebraska, although the publicity associated with their environmental and health effects initiated numerous inquiries from the public. Most inquiries can be handled promptly, yet on occasion considerable time is required to satisfy an individual's inquiry.

Experience indicates that the Nebraska consumers can and will become concerned over their drinking water when they believe the water will immediately or dramatically affect their health. This is evidenced by their reaction to: (1) nitrate contamination, and (2) proposals for controlling tooth decay by the addition of flouride to the water supply. There has been almost universal support for developing a nitrate-free source of supply. However, controversy has developed over the addition of fluoride to drinking water. A great deal of misinformation has been spread, alarming people unnecessarily. In most towns, this concept of health protection has been rejected. The cost associated with these public decisions has not been the influencing factor. The two situations are similar in that they protect the health of a small segment of the population without adverse effects on the remainder, they are supported by law, and there are alternatives available to achieve the same results, although not to the same degree of assurance.

Based on past experience, it is anticipated that consumers, particularly those served by small systems, will continue to resist any increase in the cost of delivered water. Public demand for modernizing water systems is not expected to occur until major disruption of service forces attention to the water system problems (see Chapter 2). Also, the consuming public will not seek improvement of the aesthetic nature of the water delivered by the public systems even though approximately twenty percent of the households have installed home treatment devices such as softeners, distilling units, and filters.[3]

The history of consumer interest and involvement in the municipal water system and the safety of drinking water is not sufficient to completely anticipate future reaction. External influences, the nature of local leadership, and the ultimate cost of conforming with modern technology are essential catalysts in the development of consumer interest in public water systems and their product. Consumer demand for improved

service and protection will vary by community, with the more aggressive solving their own problems, the less agressive requiring outside assistance, and the remaining few forced to protect themselves by state or federal intervention.

THE COMPETITION'S VIEWPOINT

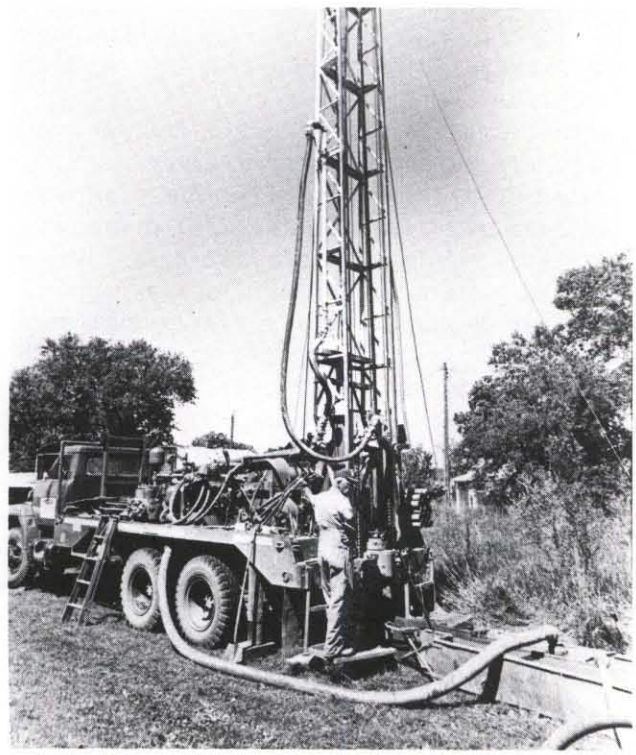
Concern over the management and distribution of Nebraska waters was originally related to surface water sources. With the exception of a single statutory reference, there is no indication that competitive use of water was a recognized municipal problem prior to 1900. The Laws of 1881 granted Second Class Cities and Villages jurisdiction for a distance of fifteen miles beyond their corporate limits for the purpose of preventing pollution or injury to a stream or source of water supply for the community. This law was never repealed.[4]

Enactment of this law may have indicated serious concern over the welfare of developing communities and their importance as service centers for farm and ranch operations. It is also possible that the belief that a viable, strong, municipal government would attract in-migrants to the area exerted some influence on the action. Whatever the reason, the importance given municipal water use in Nebraska law has diminished compared to the sweeping nature of this 1881 law. Cities and villages became more reliant on the adjacent agricultural economy and the farmers and ranchers less reliant on local communities by reason of improved transportation and communication networks. By 1920, the growth of surface water irrigation and an apparently lessened dependence of farm operations on the financial resources and service provided by residents of cities and villages resulted in slowly changing attitudes regarding the use of water. This is evidenced by the rejection of a proposal to include municipal water use in the preference system adopted by the 1920 Constitutional Convention (see p. 1-2). The decision might have been influenced by the fact that the constitutional preference addressed surface water use and that most municipal systems had developed groundwater as their source of supply. The vast potential of groundwater as the resource available for future irrigation development was not widely recognized at this time.

Throughout the first half of this century, and during the 1960's in some areas, it was not uncommon for a municipal water system to locate and construct its wells on private property. A verbal agreement with an adjacent landowner was considered adequate assurance that the city or village system could develop and withdraw water at that location. As a result there are still a number of municipal wells in use that are located on land for which the community has no legal title or easement. Legislation requiring registration and spacing of wells has created an awareness of the relationship between ownership of land and usage of the underlying groundwater. Publicized records of seasonal and permanent water table changes have sharpened landowner concern over property rights relative to groundwater.[5]

Municipal water systems are finding it difficult to obtain land or interest in land needed for development or expansion of groundwater supply sources. It is increasingly necessary to resort to condemnation proceedings with the associated costs. In one instance a rural water district acquired land for its wells only to find that an adjacent landowner had subsequently drilled and registered an irrigation well within one thousand feet of its property. The effect of this action was to prevent development and transportation of water to the district distribution system. The irrigation well had not been completed or used at last report, yet the district found it necessary to acquire other lands to serve as a source of supply. The result was increased rates for subscribers to the system over a forty-year debt period.

A more recent experience involved a city which negotiated the drilling of test wells on privately



owned pasture land approximately one mile from its corporate limits. An ample supply of quality groundwater was located. After completion of test drilling, the property owner informed the city

that the tract might be developed for irrigation in the future, but until that time an annual lease and unit payment for all water transported to the municipal system would be acceptable. An investment estimated at $150,000 would have been needed to construct the well and transmission main. The city is seeking an alternative solution to its water supply problem.

The above examples demonstrate the changing trend in attitudes relating to competing water uses. Increasing landowner concern over water rights is making it difficult for municipal water systems to develop sources of supply in rural areas. The pattern is most prevalent in areas of groundwater decline but can be expected to continue and intensify between users as the importance of water to the continued maintenance and growth of the state economy is realized.

MANAGEMENT CONTINUITY

The management of municipal water systems in Nebraska is accomplished through three general organizational patterns. While the organizational structures are not dictated by the population served, those systems serving more than twenty thousand persons are usually operated by a board of public works with a professional staff under the general supervision of the city council. Intermediate-size systems are operated by water departments staffed with career personnel, and the small systems are managed directly by the council or village board, employing a full or part-time operator in charge of the system.

The training and certification of water system operators has contributed to the continuity of system management. However, these individuals are employees and do not control management decisions relative to rate structures, replacement of system components, or major maintenance needs such as storage reservoir cleaning and painting. The Department of Health has experienced difficulty in establishing rapport with elected officials regarding their responsibility for the stewardship of the water utility. Their attitude may reflect a view that the water system is an inherited nuisance and that as long as it is operative no expenditure will be made for preventive maintenance. As a result, breakdowns create emergencies that can be handled as expeditiously and cheaply as possible. Furthermore, in an emergency it is not necessary to bid the work, and direct negotiation for the repair is permitted.

It is not unusual for smaller communities to maintain a single corporate bookkeeping system that shows only income and disbursements as their complete fiscal record. When this happens there is no continuing record of the water system fiscal status. A new administration does not realize the profits or losses associated with the water utility operation. The water system operation may subsidize or be dependent on other income sources. Under this method of fiscal accountability the cost of the utility operation overshadows the income realized from the sale of water. Without continuing financial records the gradual physical decline of the system occurs until costly emergency action becomes necessary. Continuity of management is the prime influence in preventing such occurrence.

Experience indicates that better fiscal and managerial accountability occurs when systems are run by boards composed of individuals with overlapping terms of responsibility or by designated departments having a lesser degree of political interruption. Each change in management personnel requires extra effort by the regulatory agency to orient and explain the details of water system operation and the regulatory process. In many instances, assistance from the state has been considered infringement on the integrity of local elected officials as they attempt to conduct the city or village business. By the time communication and understanding is accomplished, the problems have multiplied or a new local administration is in authority. In either event the conveyance of responsibility to the local level is a continuing task. Ideally, the maintenance of meaningful records, continuity of responsible personnel, and well-considered, timely management actions based on knowledge and experience are essential to maintaining an efficient and reliable municipal water system.

FOOTNOTES

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2. Department of Health, Division of Environmental Engineering files.
3. Culligan Water Conditioning, Inc.
4. **Neb. Rev. Stat.** section 17-536.
5. Lincoln Journal, Nov. 29, 1979 (UPI). Survey: Water Shortage a Reality to Nebraskans.

Chapter 9

Problem Identification

There are few, if any, municipal water systems in Nebraska that are without problems associated with management, operation, maintenance, or replacement of the system, or with the quantity and quality of the water supply source. In numerous instances the problems are not recognized as such and continue to multiply in both magnitude and number. Prior discussion has attempted to identify those factors that contribute to, or constrain, the ability of a public water system to provide the best service possible. The following is a review and expansion of the problems that have been described in previous chapters. The identified problems are grouped to reflect those associated with: (1) source of supply, (2) operation, maintenance and replacement of systems, and (3) those that affect financing and evaluation of municipal water service provided to consumers. No attempt is made to place priority on either individual or groups of problems.

SOURCE PROBLEMS

This grouping of source-related problems includes those associated with public attitudes and involvement, the resulting legal and institutional arrangements that have evolved, the effects of competitive uses, and the development practices that contribute to exploitation and deterioration of the water resource base.

1. Municipal water use is not recognized by statute or Constitutional reference in the preferences system for ground or surface water.

Water distributed and sold through municipal systems is usually the sole source of supply for the system subscriber and may be used for any number of purposes. This delivered water is dedicated to uses which include domestic, industrial, lawn and garden watering, recreation and the maintenance of aesthetic values. The mix of uses experienced by any municipal system is

dependent upon, and contributes to, the social and economic character of the community served. The combination of uses accommodated by a municipal system is not recognized under Nebraska law as a classified entity receiving equal consideration with other established uses.

Chapter 1 discussed the development and significance of the uncertain status of municipal water use in statutory and case law. Some municipal uses are superior (domestic) and some are inferior (manufacturing and industrial). The uncertainty surrounding the ability of municipal water systems to continue service to commercial and industrial users in times of shortage, even on a limited basis, does not encourage economic development. Recognition and categorization of municipal use as domestic and other uses could impact employment opportunities in areas of depleting water resources. The position of

municipal water supplies could be improved by policy decisions recognizing the contribution of agri-business and other supporting industries to the economic utilization of agricultural production.

This problem of municipal water use in the preference system has also been identified in the Policy Issue Study on *Preferences in the Use of Water* (April, 1981).

2. Municipal wellfields inducing groundwater recharge from stream seepage are not recognized in the statutes as having surface water rights.

The legal definition of groundwater includes any water below the land surface. The pumping of groundwater associated with the Platte River has been determined by the courts to be a use of groundwater, not surface water (see Chapter 1). Potential problems and opportunities related to induced recharge by municipal wellfields were discussed in Chapter 6. Induced recharge may be an economical alternative for certain cities facing degradation of groundwater quality in their existing source of supply. Surface water may have lower concentrations of certain chemical contaminants, such as nitrate, that are difficult to remove. Slightly degraded groundwater quality has already been correlated with lowered streamflow in at least one induced-recharge wellfield. No problems with quantities of water available from such wellfields have arisen as yet.

The Instream Flow Task Force Report discussed the relationship between groundwater and surface water. The importance of certain streams as sources of aquifer recharge was evaluated. Several of the alternatives listed in that report are pertinent to this municipal problem.

3. Existing or future legal and institutional constraints may prevent cities from effectively using surface waters.

Use of surface water for public supply in Nebraska may increase in the future, especially in the more heavily populated eastern part of the state. Treated surface water may be an economical alternative to those towns or consolidated systems with limited or poor quality groundwater available. Future problems could arise as cities attempt to obtain additional surface water supplies. Flows may be fully appropriated, with streams regularly depleted during periods of peak demand. Adequate appropriation rights of sufficiently high preference must be available for a reliable supply of drinking water. Under present law, diversion rights cannot be acquired or combined except by using preference provisions. Currently, municipal use is not recognized as a preferred use; only that part used strictly for domestic purpose is preferred. Problems would likely be incurred in attempting to acquire existing agricultural rights for municipal purposes. Legal challenges of a city's use of condemnation authority for this purpose would be inevitable. Some Nebraska cities - Omaha and Beatrice, most notably - have already encountered legal action to contest certain planned expansions of their water systems.

This problem was identified by the Instream Flow Task Force and included in drafts of that report. However, it was not included in the final *Instream Flow Policy Issue Study* Report because of the task force regulation that municipal uses of water are technically "out-of-stream" uses.

4. Municipalities are encountering increasing resistance from competitive users relative to developing new and expanded sources of water supply. These competitive uses also affect the quality of raw water available for municipal use.

Chapter 6 discussed the increasing competition between municipal water systems and other users of water. Chapter 8 discussed public attitudes relative to these conflicts. The nearly total reliance of municipal water systems on groundwater as a source of supply for drinking water establishes reason for concern over the continued availability of this source. From the standpoint of quantity the municipalities, in most cases, can be expected to compete for the available supply. This is because the value of water for community use far exceeds the economic return that can be realized from other uses. However, seasonal water level interference will continue to affect a communities' ability to utilize water. The quality requirements for public supply are also much more stringent than for other uses and the combined cost of source development and treatment to remove contamination could become the deciding factor in the continuation of acceptable municipal water service. Based on the assumption that all but the smaller systems can acquire needed amounts of water, quality parameters become elevated to a position of greater importance.

5. A lack of municipal participation and influence exists in the institutional framework established to manage Nebraska resources.

Representation on Natural Resources District boards is not determined strictly by population patterns, but is weighted somewhat in favor of rural areas at the expense of cities and villages. Chapters 5, 6, and 8 demonstrated the increasing competition between municipal needs and other water users, the increasing resistance to development of new or expanded municipal supplies, and the effects of certain competitive uses on the quality of raw water available for municipal use. Municipalities may find it difficult to redress problems or complaints because of this imbalance in representation.

6. Groundwater supplies are being contaminated by man's use of the overlying land surface. There has been reluctance, at both state and local levels of government, to exercise land use control as a tool in protecting groundwater resources.

As discussed in Chapters 5 and 6, man's activities to develop and utilize the resource base exert a significant influence on the quality of groundwater. Agricultural practices, the disposal of waste material, and even the rates of withdrawal practiced by those utilizing the groundwater reservoir have increased the rate of quality deterioration. The geological setting of Nebraska contributes to the rapidity of man's influence on the quality of groundwater. The permeable nature of many surface soil structures encourages the percolation of precipitation to the groundwater. This increases those problems associated with the use of land as it influences the quality of groundwater. Soluble material placed on the land or in the upper soil strata without proper precaution will likely reach the groundwater reservoir eventually and cause quality deterioration of the resource. Development of these unsuitable soils by private enterprise can result in water quality deterioration or erosion problems that society must deal with, generally at public expense. Management Action Five of the *Groundwater Reservoir Management Policy Issue Analysis* deals with this problem.

With the absence of land use controls, municipal wells are particularly vulnerable to groundwater contamination and pumping interference effects by nearby development. As discussed in Chapter 5, controlling the land surrounding municipal wells is the best assurance a community can have of minimizing quality deterioration and pumping interference effects. Currently, few communities have protected wellfields. Wells are scattered throughout town, susceptible to point sources of contamination or interference by surrounding irrigation wells.

7. Inefficiency of agricultural management practices contributes to groundwater pollution and water level declines.

This problem has been discussed extensively in Policy Issue Analyses on *Water Quality and Groundwater Reservoir Management* and will be examined in the *Water Use Efficiency Study.* Chapters 5 and 6 of this report discussed the impact of agricultural practices on municipal water systems. Irrigation systems frequently have very low efficiencies. Excessive application of water and fertilizer results in groundwater pollution. Rates of water level declines could be slowed by decreased withdrawals from the groundwater reservoir.

8. No enforceable design standards exist for construction of wells serving other than public supply.

Poorly constructed wells that permit accelerated entrance of surface water to the underground reservoir also contribute to localized contamination. Excessive withdrawal of groundwater, by single wells and in areas of intensive development, increases the flow of water through the aquifer and over a period of time encourages the movement of local contamination into otherwise unaffected areas. Wells that penetrate two or more aquifers present a potential for contamination by permitting water of low quality to mix with higher quality water. This mixing action can be controlled by proper well design and construction and by applying adequate precautions when such wells are abandoned.

SYSTEM PROBLEMS

Problems listed under this heading include those that have resulted from obsolete and unclear statutory law directing those responsible for the stewardship of publicly-owned water systems, the existing condition of municipal water systems and the costs associated with rehabilitation, the need and cost for treatment to remove harmful contaminants, and public reaction to improved water service and their desire to pay for this service.

9. Obsolete and sometimes conflicting authorities and requirements exist in the statutes regarding acquisition, management, and operation of public water systems.

A brief discussion of this problem can be found on page 1-1. More detail can be found in

Appendix A. While not immediately affecting development of state water policy, clarification or codification may be necessary to allow public water supplies to implement policy decisions as intended. A complete review and evaluation of state law regarding those municipal authorities is beyond the scope of this study.

10. The municipal user fails to appreciate the economic value of water delivered by municipal systems. Many consumers have demonstrated reluctance to pay the price necessary to assure the long-term delivery of a quality product.

The physical condition of many municipal water systems has been described in Chapter 2. The deterioration of facilities and the acceptance by the public of aesthetically substandard water are closely related to public demand for quality service. The Department of Health rarely receives complaints or inquiries from consumers regarding water service failure or the condition of delivered water. As indicated in Chapters 2, 3 and 8, public apathy extends beyond the lack of concern for the immediate condition and serviceability of the municipal water system. The economics associated with maintaining a modern water system are accepted as secondary to the establishment of a minimum service fee that is often inadequate to cover the energy costs required to deliver the water to the point of use. There is little interest for, and often resistance to, the adoption of a water rate structure that will provide for operation, maintenance, and replacement of the municipal water systems. These attitudes influence the decisions of elected officials and eventually the public facilities serving the community erode to the point that repair or replacement cannot be accomplished. The water system is an important element in maintaining community life, but it is subjected to a lower priority for attention since its important components are not obvious and visible.

11. There is an absence of fiscal accountability for operation and management of municipal water systems as self-supporting utilities.

As discussed in Chapters 2 and 8, there is little demand at the local level for fiscal accountability beyond achieving a balance between total municipal revenue and expenditures. Similarly, at the state level there is no agency responsible for oversight of the fiscal management of local water systems. The Department of Health is not authorized or equipped to become involved in system management functions beyond those necessary for current delivery of safe water. There is a requirement for each political subdivision of the state, except villages, to submit an annual audit report to the State Auditor of Public Accounts. This audit verifies the balance of income and disbursements for the subdivision, but does not attempt a performance or efficiency audit. In the case of many small cities, the revenue and cost of operation for the water system cannot be identified.

12. Many water systems in Nebraska are in a deteriorated condition. Considerable funding will be required for rehabilitation. Locating such funding will be a significant problem.

The failure of municipal systems to perform routine maintenance and provide for replacement of system components, and eventual total system replacement, has created numerous problems relating to continued system service. The situation has been compounded by public attitudes (see previous identified problems). The need for additional investment has become a current issue for those still reliant on the service provided by the municipal water system. Numerous routine actions could have been applied over the years to reduce demand for unscheduled investment. Failure to accomplish the optimum level of operation, maintenance, and replacement actions has resulted in system deterioration to the point that major capital in-

vestments are required to prevent total system failures.

Municipal water systems are now confronted with rehabilitation costs that, in many cases, cannot be supported by the existing tax base or by the ability of consumers to pay for the continuance of reliable service. Present sources of external financial assistance are diminishing and are not of an adequate magnitude to meet the needs of all problem systems. The findings of this report (see Table 2-2) indicate that over 500,000 municipal water customers must accept service that does not meet modern standards until a source of financing needed improvements can be arranged. The majority of those affected do not realize that they are subjected to loss of service at any time and that their property is not provided with full fire protection.

13. Water treatment facilities will need to be constructed by a number of municipal systems found to be in violation of the contaminant levels established by the Safe Drinking Water Act.

A number of municipalities, perhaps as many as 100, will eventually be confronted with the need to remove harmful contaminants from their delivered water. Treatment costs could be significant, depending upon a number of factors discussed in Chapters 2, 3, 5 and 7. Financing this work will be difficult, as identified in the previous problem discussion.

14. A continuing need for water system consolidation has been demonstrated. An apparent lack of public interest and financial support for such consolidation has been encountered.

A number of water systems have found it advantageous to purchase water from another system due to quality or quantity considerations. Limited groundwater supplies, particularly in the southeastern part of the state, and poor quality led to the development of rural water districts. There remains great potential for additional consolidation. Merging of operations and management by small water systems could increase efficiency. Shared operators, a central "pool" of spare parts and maintenance equipment, and central billing and record keeping procedures can reduce the cost of delivered water. With adequate sources of funding and a supportive institutional framework this will be a viable alternative for small water systems encountering water quality deterioration and localized shortages of supply.

15. Numerous municipal systems experience greatly reduced or negative water pressure during fire fighting operations. A potential for backflow or backsiphonage and the resulting contamination of the water supply exists under reduced pressure conditions.

The importance of adequate pressure in the distribution system for the maintenance of water quality was discussed in Chapter 2. Experience indicates that serious reductions in pressure occur during use of high-capacity pumpers for fighting fires or local fire department training operations. Episodes of bacterial and chemical contamination of public water systems have coincided with these reductions or losses of pressure. A potentially significant threat to public health exists from the backsiphonage of sewage, household cleaners, industrial solvents, pesticides, or other chemicals into the water system.

PROGRAM PROBLEMS

Problems identified under this heading are related to state and federal support to municipal and other public drinking water systems. Specifically, the problems concern: (1) the degree of technical and advisory assistance provided to system owners by upper echelons of government, (2) the provision of centralized laboratory services with capability to provide specialized analyses of water quality, as well as continued routine examination for the presence of harmful contaminants, (3) state responsibility in assembling data and information necessary to determine the consolidated needs of its political subdivisions, and (4) the social desirability of subsidizing those water systems that cannot afford quality service within the ability of the consumer to pay for such service.

16. The public water system surveillance program (Safe Drinking Water Act) is being restricted in scope as federal and state funding is reduced.

Enactment of the Safe Drinking Water Act of 1974 prompted Nebraska to establish a comparable state program as a means of reducing the impact of federal regulation on the owners of municipal and other public systems. This decision necessitated a major expansion in Department of Health water supply activities, accomplished with federal grant funds, for the purpose of informing system owners of their legal responsibilities, training and providing technical assistance for system operators, developing laboratory capability to examine water for the presence of

harmful contaminants, and providing total laboratory service to assist owners in demonstrating and assuring the safety of drinking water delivered to consumers.

The Health Department program has been preventive in nature, and is based on the theory that preventing the contamination of drinking water is preferable to removal of the contaminant after the consumer is exposed to its harmful effects. This approach has resulted in a measurable improvement of Nebraska water systems and in the quality of delivered water.

Since the program began in 1977, funding has not kept pace with inflation, and it has been necessary to apply a portion of the income to the purchase of refined laboratory instrumentation. Continued reductions in funding will result in the abandonment of the preventive approach and force application of after-the-fact corrective action. The continuance and scope of this program are uncertain at this time because of funding restrictions.

17. Developing and maintaining laboratory capability necessary for identifying and measuring contaminants in drinking water is a continuing, difficult task.

Chapter 5 discussed monitoring requirements and the need for advanced laboratory capability. Chapter 7 discussed the economics associated with providing laboratory services. The impact of federal water quality monitoring requirements on Nebraska communities is reduced by the state laboratory service. Accomplishing the public water system monitoring within the time frame demanded by federal and state law has proven difficult. Laboratory monitoring capability is subject to continuous refinement and expansion as new chemical contaminants harmful to human health are identified in drinking water. Examination for additional synthetic organic chemicals and virus may be required in the future. Existing funding sources may be inadequate to meet these needs.

18. A need exists for the continuing collection and refinement of water use information.

As discussed in Chapter 3, accurate records of water use and system performance are extremely useful. Careful analysis of records can save a community thousands of dollars. Low efficiency, unexpected breakdowns, and large amounts of lost water can be a financial drain on a small town. From a legal standpoint, it is probably in the best interests of a community to protect itself by maintaining reliable records, yet many communities keep no water-use records.

The Department of Health has cooperated with the Nebraska Water-Use Data Program, a joint effort of the Conservation and Survey Division and the U.S. Geological Survey. The goal of this program has been to serve the state by providing a better understanding of the use of water throughout Nebraska. Data from a variety of uses, including municipal, have already been collected and stored for use by any interested person. Users of this system to date have included engineers, hydrologists, planners, legislators, city and county officials, state agencies and others. The analysis presented in Chapter 3 of this report is based on data collected by this program. The program has directly benefited cities and villages. During the past year, detailed record keeping systems were initiated by several towns with technical assistance from Department of Health and Conservation and Survey Division staff.

19. Federal sources of financial assistance to municipal water systems are being reduced to the point of extinction. In the absence of subsidy at least half of the smaller systems cannot finance needed improvement to assure an acceptable quality of service to their customers.

As discussed in Chapters 2 and 5 and Problem 12, a number of municipalities are faced with the need to upgrade the physical condition of their systems or provide treatment to remove harmful contaminants. The cost of needed improvement is usually beyond the ability of the user to pay, or the history of the system management discourages the extension of commercial credit. The number of individuals exposed to ingestion of a sub-standard water supply is increased beyond the permanent residents by reason of social factors that encourage a mobile, or transient population. The problem prevails in most municipal systems that serve fewer than 200 population and becomes less serious as the system size increases.

The amount of federal financial assistance has continuously declined in recent years and this trend is expected to continue. Grants and loans to municipal water systems through HUD and FmHA programs have decreased from as much as 10 million dollars per year in the middle 1970's to an estimated 5.5 million dollars in the current year. This reduction, coupled with the effects of inflation, has seriously reduced the ability of municipal systems to keep pace with water system modernization needs.

Chapter 10

Solution to Problems

The problems confronting municipal water systems, as identified in Chapter 9, are sufficiently serious to warrant consideration in the development of state water policy. There are a number of actions that singly or in combination would benefit municipal water systems in the areas of source acquisition, management, operation, and financing of capital improvements. The following alternatives constitute a listing of action proposals, together with anticipated reaction and impacts, that could result from adoption of the proposal. The reactions and impacts are based on decisions to follow the method of implementation presented for the alternative proposal. There could be varying degrees of reaction or impact associated with the selection of intermediate courses of action through policy decision. The scope of this study did not permit presentation and analysis of the anticipated effects of such intermediate solutions.

The alternatives are presented as a statement of action that will influence state water policy as applied to municipal water systems. Following the alternative statement a discussion of the alternative is presented under five headings: **Description and Methods of Implementation; Socio-Economic Impacts; Physical-Hydrological-Environmental Impacts; Legal-Institutional Impacts;** and **Public Health and Safety Impacts.**

The discussion under the first heading, **Description and Methods of Implementation**, will describe the alternative, its potential effect on state policy, and how it might be implemented. Further information relating to the need for legislative action and administrative costs will be included as appropriate. The discussion will cross-reference the specific numbered problem, identified in Chapter 9, that will be wholly or partially solved by the implementation method. Examples of implementation actions and anticipated results will be presented when they serve to clarify the intent of the implementation method.

The remaining four headings will present the anticipated impacts that will occur as a result of the implementation method. The socio-economic and legal-institutional impacts were prepared by the Natural Resources Commission staff. The physical-hydrological-environmental impacts were prepared by the Conservation and Survey Division and the Natural Resources Commission. Public health and safety impacts were prepared by the Department of Health. The three "no-action" or base-line alternatives and impacts were also prepared by the Department of Health using information provided by the other agencies. In general, the impacts are presented as trends without quantification. When documented information assembled for this and similar studies, or from other sources is available for impact analysis, impact statements reflect use of such material without reference.

ALTERNATIVES RELATING TO SOURCE PROBLEMS

ALTERNATIVE #1: Make no change in the legal-institutional structure as it relates to municipal water use, management authorities, source acquisition, and protection of groundwater quality and quantity.

Description and Methods of Implementation

This alternative would continue state water policy as it now exists and would not address Problems 1 through 8 as identified in Chapter 9. Recognition of water rights and preferences for municipal use would remain unresolved. Municipal water systems would continue to be hampered by competitive use effects relating to quantity and quality of the water supply source. Certain

aspects of state water management authority would continue to constrain municipal water supply activities

While this alternative requires no implementation measures, changes in the existing legal-institutional structure could occur as a result of court involvement.

Socio-Economic Impacts

In the absence of altered policy, the social and economic trends observed in the past half century can be expected to continue over the short-term. The agricultural sector will continue to be the primary factor governing the social and economic levels experienced by the state and its people. Agricultural production will increase as additional acres are placed under irrigation and subject to prices received for agricultural products, the total state economy is expected to expand. There are indications that certain areas or regions might experience water depletions and an associated change in agricultural practices in the near future. While localized or regional reduction in available water supplies is not expected to materially reduce the overall growth potential of the agricultural sector due to continued development in other areas, the adverse impact on the water-short area could be serious. Agriculture will be forced to revert to dryland farming, which will probably result in a decline in farm population and economic activity. This decline will affect the communities which serve as trading centers for the area. Continued deterioration in the quality of the water sources due to extensive agricultural practices would cause health effects or the need for treatment, which would be expensive. Should small communities be confronted by both water source problems and a reduction in economic base due to conversion from irrigated to dryland farming in their service area, their problems will be multiplied. There would be a decline in commercial activity, household expenditures, and industrial activity. There has been substantial manufacturing growth in the state in recent years, increasing the role of industry in the overall local economic scene. According to the Department of Economic Development, manufacturing consistently ranks higher than agriculture in employment. A decline in the industrial sector due to inadequate municipal water supply would have a considerable economic impact on any community.

Declines in employment would be followed by declines in population. People not only have to be employed to live in an area, but they also need good water for their health and household uses. As a community begins to decline due to water problems, these prolems may increase because there are fewer people to pay for any needed improvements. The continued out-migration of families from smaller cities and villages which are experiencing problems would add to the financial burden on the remaining population trying to make the necessary repairs and improvements.

Physical-Hydrological-Environmental Impacts

Maintaining present policy would allow the continuation of observed physical and hydrological changes that have caused concern with the state water supply. Declines in groundwater levels would continue in some areas, with a deterioration of quality in those areas subjected to intensive agricultural development. The problems associated with developing and maintaining municipal water sources can be expected to increase. Local quality deterioration, reductions in surface flows, and subsurface drainage problems will continue as a result of surface water diversion for irrigation use. Impacts on recreation, aesthetics, and fish and wildlife and their habitat would also continue under existing conditions. Lowered water tables will result in increased energy costs and eventually locally reduced base stream flow, as well as deteriorated quality in the groundwater reservoir, where groundwater is the irrigation source of supply.

Legal-Institutional Impacts

The legal and institutional structure would be impacted to some degree by anticipated court load involving resolution of conflicts between competitive users of water. The eventual outcome could be the establishment of court decreed water policy without benefit of legislative guidance.

Public Health and Safety Impacts

The public health problems confronting municipal water systems are expected to continue and intensify. Public health risks associated with loss or reduction of a source of supply, either seasonally or permanently, increase in direct proportion to source reliability. Health risks resulting from the entrance of contaminants, particularly nitrate, are also expected to increase. Investments needed to develop new sources, or for treatment to remove contaminants, might detract from a community's capabilities to provide other needed health services, such as medical and waste disposal. With possibly limited industrial development (see socio-economic impacts) and associated

revenues, this reduction in health services might be compounded. The degree of fire protection provided might also be influenced by a diminished source of supply.

ALTERNATIVE #2: Recognize municipal water use in the Constitution and statutes as having a preference equal to or secondary only to domestic use.

Description and Methods of Implementation

Cities and villages must provide a reliable supply of water for domestic, commercial, industrial and other uses to maintain a balanced economy and a viable mix of social and aesthetic characteristics that contribute to an acceptable level of community living. Yet, the combination of uses accommodated by a municipal system is not recognized under Nebraska law as having a single, high priority. The position of municipal water withdrawal or diversion in the present preference system is limited to only that portion of municipal water that is distributed for domestic use. This alternative would permit municipal corporations to acquire water for all uses from inferior users after just compensation. Prior appropriators of surface waters would be included as inferior users. Such recognition would assure the availability of a water source for the total municipal complex and encourage community growth and development as a center for providing goods and services, including a market for products, for the surrounding area. Implementation of this alternative would satisfy the conditions described in Problem 1, and contribute to the solution of Problem 4. A similar alternative was proposed in the Policy Issue Study on *Preferences in the Use of Water.*

Socio-Economic Impacts

These impacts fall in two areas: benefits to the municipalities, and costs to the other users who might be affected. The economic impacts of reducing irrigation to provide for more municipal supplies could include decreased agricultural production, a reduction in returns to agriculture, and possible reduction in land value. This reduction in the agricultural economy would have an impact on the economic activity in the community if it served as a trade and service center. Condemnation of water rights or restrictions on irrigation pumping would be very controversial. Any dispute over the right to pump or reductions in pumpage would probably create antagonism in the agricultural sector, which might cause additional disruption in the normal trading pattern of farms in the area. Farmers outside the restricted area might also start trading in different service centers. Adoption of this alternative would help considerably in assuring the availability of a water source for the total economic and social environment that comprises a viable community. This would nearly eliminate water shortages as a threat to the continued growth and development of commercial and industrial sectors of the community. By itself, this would not guarantee growth because there are many other factors that influence it. In some cases, however, the availability of a suitable supply of water is one of the conditions that leads an industry to locate in a community. At the very least, the assurance of a continuous water supply would allow the community to retain its stability. This could enable it to endure the period of trade disruption and eventually restore its former activity. This might prevent the loss of commercial and industrial enterprises and the jobs they provide, and help to avoid the cycle of loss of population, loss of consumption and revenue, decreased maintenance and more interruptions of service, leading to more loss of business.

Physical-Hydrological-Environmental Impacts

There would be little change in impact from this alternative since municipal uses account for such a small portion of the state's total water use. The practical effect would be the substitution of one use for another. The year-round use for municipal compared to the seasonal use for agriculture (the state's major water user) could have limited impact through continuously reduced streamflow or declining water levels.

No direct environmental impacts could be identified. NRC Selected Water Rights Issues Report #1, *Alternative #4,* proposed to "modify the preference system by adding municipal use." For surface water, this alternative notes environmental impacts to change in type of use from agriculture to municipal could include changes in water quality from agricultural runoff to regulated discharges by municipal systems. Chemical impacts are possible, as are thermal effects on these discharges. These effects could be associated with changes in aquatic vegetation and habitat.

For groundwater, this alternative notes changes in type of use should not have significant environmental impact on groundwater quality in that discharges are regulated and not

returned to the groundwater supply. Continued drawdowns based on full year patterns of use could lead to reduced streamflows, loss of wetlands, changes in water quality, vegetation and habitat as they may be related to changes in groundwater level, particularly in areas of high water levels.

Legal-Institutional Impacts

Much of the impact of this alternative would depend on the changes in water use likely to occur as a result of its implementation. This alternative does provide an incentive for industrial and manufacturing water users to obtain their water supplies from municipal systems. To the extent this occurs, an increased demand for water by municipal systems may occur. There is only limited municipal reliance on surface water supplies at the present time, and unless this changes, most of the impact of this alternative will affect groundwater supplies.

This alternative significantly changes the legal relationship between agricultural water use and municipal water use. Potential liability is created for agricultural uses which interfere with municipal uses. Agricultural water users may be required to pay the cost of deepening or replacing municipal wells if it can be established that they have caused the municipal wells to go dry. In addition, since agricultural use would be deemed inferior to municipal uses, municipalities using surface water would be able to exercise preference for the water supply in times of shortage. The municipalities would be required to pay just compensation to inferior users with earlier priority dates. If combined with *Alternative #3,* this might serve to limit agricultural development in areas close to municipal wellfields.

Public Health and Safety Impacts

This action would assure municipal water systems the capability to obtain the highest quality water available for commercial and industrial customers in the event their historic source of supply became contaminated. Under present law, a city or village could not obtain a better quality source in amounts beyond that required for domestic use from an inferior user, except by negotiation. Since domestic use includes quantities necessary to provide fire protection, the city or village would probably install wells or diversion structures capable of removing water to meet this instantaneous demand. In times of shortage when existing preference provisions are in effect, however, capital investment required to provide fire protection would not be amortized by the uniform sale of water to commercial and industrial users. Thus, with inadequate sources of funding, system capability to provide fire protection may also be inadequate.

ALTERNATIVE #3: Allow public water systems with induced recharge wellfields to obtain surface water rights.

Description and Methods of Implementation

Acceptance of this alternative could result in legal recognition of the hydrologic relationship between groundwater and surface water and eventually lead to conjunctive management of the water resource. The most direct method of implementation would involve a statutory amendment clearly directing the Department of Water Resources to issue surface water rights for flows diverted through artificial or induced recharge of wells, wellfields, and infiltration galleries adjacent to streams. A second method could result from administrative decisions to issue such surface water rights with subsequent acceptance of the action by the courts. This latter method involves risking the anticipated result should the courts disagree with the administrative decision.

Adoption of this alternative in itself, without elevating total municipal use in the preference system, would not benefit municipal interests in times of water shortage. The newly acquired municipal rights for induced recharge would be junior to other water rights and in the absence of a higher preference, continued surface flow for recharge in drought periods could not be acquired. This alternative would contribute to the solution of Problems 1, 2 and 4 identified in Chapter 9. Concurrent acceptance of both *Alternative #2* and *Alternative #3* would assure many communities that normal life and the services provided through centers of population would continue through the most serious conditions of water shortage. Acceptance would also contribute to management of sustained stream flow in the event this water use is recognized in the final state water policy. This subject will be discussed further in the *Surface-Groundwater Integration Study.*

Socio-Economic Impacts

The social and economic impacts of this alternative would be very small. It would provide more security for the municipal supplier and could remove the threat of shortages that might

prevent future development in the city. On the other hand, assuring a supply for the municipality might reduce the likelihood of future supply for other uses such as agriculture and might preclude agricultural development.

Physical-Hydrological-Environmental Impacts

There is no accurate method to determine the relationship between streamflow volumes and induced recharge. Therefore, the impacts of this alternative are hard to determine since the hydrologic basis for the alternative is unclear. Due to limitations in determining streamflow/aquifer storage relationships, excessive streamflows could be dedicated for recharge and could result in streamflow volumes that might be considered, by some, as inefficient uses of surface water. The site specific problems of this alternative make a generalized prediction of impacts impossible. Effects could extend over large areas due to constraints placed on acquisition of future water rights or interbasin diversions.

The intent of this alternative is to ensure a more reliable water supply. It would involve junior water rights, so environmental impacts would occur at municipal wellfields along streams with unappropriated flow. The Fremont, Lincoln, and Omaha wellfields would primarily fit this condition. Continuous streamflow now occurs in the Platte River from the Loup River Power Canal to beyond these wellfields. Water rights obtained from the wellfields would ensure the presence of a specified quantity of streamflow for this stream segment.

The stream segment environment has several beneficial uses. *Alternative #3* would have the positive impact of maintaining the following uses:

1. Fish and Wildlife
   A. Fishery Resource

The segment is classified in the NRC *Instream Flows Report* as a warm water fishery supporting only warm-water fish species such as channel catfish, walleye, and carp. Its location between the relatively large Lincoln and Omaha urban areas indicate it is a high value fishery due to its frequent use.

B. Wildlife Value

The wildlife of the segment can be divided into four groups: furbearers, waterfowl, nongame species, and threatened and endangered species. The *Instream Flows Report*, Table 10 rates the value of several Nebraska streams for wildlife. The Platte River at Fremont is rated medium for furbearers, high for waterfowl, medium for nongame species, and low for threatened and endangered species.

2. Recreation and Aesthetics. Possible surface water recreation activities include canoeing, rafting, swimming, fishing, hunting, power boating, and water skiing. The *Instream Flows Report* notes the segment receives canoeing use "restricted by seasonal low flow."

The streamside woodlands of the segment, when compared to other Nebraska streams, are extensive and aesthetically pleasing.

3. Assimilation of Wastewater Treatment Plant Effluent. The specified streamflow above Salt Creek would provide better assimilation of wastewater, improving downstream surface and groundwater quality, particularly for the wellfields. Deterioration of groundwater due to the Lincoln Wastewater Treatment Plant effluent in Salt Creek can occur around the Lincoln wellfield. Stream gaging records above the plant reveal baseflow during summer months is usually insignificant, indicating streamflow at the stream mouth is mostly plant effluent.

There is also a year-round presence of excessive levels of naturally occurring salts in Salt Creek. Improved assimilation, or dilution, of these salts as a result of *Alternative #3* would also provide better water quality for wellfields on the Platte River downstream from the mouth of Salt Creek.

4. Aquifer Recharge. The *Instream Flows Report* notes the Platte River is "a losing stream between Kearney and the mouth of Salt Creek, and at the Omaha wellfield." The specified streamflow insured by *Alternative #3* would supply the induced aquifer recharge due to wellfields such as Omaha's.

Legal-Institutional Impacts

A number of municipalities have developed wellfields on major Nebraska streams. Those wellfields provide an important source of water to these municipal systems. Public water suppliers are currently allowed, after obtaining a permit from DWR, to develop groundwater supplies through wells or other means and to transport that water to the area to be served (Municipal and Rural Domestic Groundwater Transfers Permit Act 46-638 to 46-650). Permits may also be obtained to store excess, unused, and unappropriated water for recharging groundwater reservoirs.

This alternative would go a step further in allowing public water systems to obtain surface water rights for the purpose of recharging their wellfields. The impact of this alternative would not be immediate because these municipal water rights would be junior to other existing water rights. They would, however, be senior in time to after-acquired rights. In times of shortages, the

municipality could exercise its preference for at least the water necessary to satisfy domestic needs.

Public Health and Safety Impacts

Acceptance of this alternative would clarify the right of certain municipal water systems to continue service to customers in times of water shortage. It would further reduce the possibility of adverse effects resulting from excessive withdrawals of the surface source and the subsequent temporary depletion or quality degradation of water stored in alluvial deposits along streams. Cities and villages would be more likely to provide a source adequate to maintain pressure in the distribution system under conditions of normal or regulated consumer demand. Smaller communities without adequate storage for fire protection could rely on the water source for emergency use. Thus, the adverse health effects associated with temporary changes in source water quality, reduced pressure and disrupted service, as well as short supply for fire protection, could be eliminated or reduced for certain cities during periods of extended drought and the associated competition for the available water supply.

ALTERNATIVE #4: Act to allow voluntary sale or transfer of surface water rights for municipal use.

Description and Methods of Implementation

Permitting the sale of water rights with the associated priority of appropriation would permit cities and villages to acquire surface flow for utilization as a more reliable source of supply or groundwater recharge. The ability to acquire long-term tenure and reliable sources of supply could be accomplished through negotiation or agreement. Adoption of *Alternative #4* would complement the purposes of *Alternatives #2* and *#3* and would contribute to the solution of Problems 2, 3 and 4. In itself, it could provide partial relief for municipal systems but would not totally assure the availability of a source capable of serving all community needs. Implementation could be accomplished by authorizing the Department of Water Resources to recognize and record the water rights transfers as a part of the regulatory process.

This alternative, including impacts to agricultural water users, is treated more thoroughly in the *Transferability of Water Rights Report* of the Selected Water Rights Issues Policy Study.

Socio-Economic Impacts

The social and economic benefits to the municipality would be the same as those identified in *Alternatives #2* and *#3.* The economic impacts on other users may be reduced by the price paid for the water right. However, the decrease in production from the agricultural sector would still have a small impact on the local economy. The trade-offs in benefits and costs would be affected by the distance separating the municipality and the location of the diversion of the purchased right. Impacts would be balanced within the region if they were close, but if there were sufficient distance between them, there could be differing impacts in two regions. The number of transfers would probably be controlled by the cost of the water to the municipality and the value of the water to the irrigator. This would be complicated by the possibility of loss of water in transit, which might increase with increasing distance.

Physical-Hydrological-Environmental Impacts

This alternative could result in a change in the point of diversion and in the point of return or recharge, possibly to another drainage area. It could also result in limited stream morphology changes, such as sediment transport ability, changes in stream bedding characteristics, as well as associated width, depth, and velocity changes. These changes would occur because a constant use, municipal, would be replacing a seasonal use, agriculture. Water quality and quantity could be affected if this alternative results in interbasin water transfers, such as in the Omaha area with Platte River water being emptied into the Missouri River upstream from their confluence. The impact of this alternative would be more significant if applied to uses other than municipal.

The intent of this alternative is the same as for *Alternative #3,* but could apply across the state since streams that are fully appropriated at present could be affected. The environmental impacts noted in *Alternative #3* could occur, as well as seasonal impacts on water-dependent wildlife.

Legal-Institutional Impacts

This alternative could significantly change the manner in which water is allocated. Factors such as the economic and social utility of particular water uses would become more important. This market approach to water allocation should contribute to the efficiency and equity of the overall

system. Some governmental oversight of these transfers would be required to ensure that conservation is preserved, overall consumption is not increased, and certain classes of uses (environmental, for example) are not left out completely.

The legal-institutional impact of this alternative on municipalities is likely to be limited. The impact on the Department of Water Resources would depend upon how the alternative is enacted. If limited to purchases of water rights for municipal uses, the impact would be slight.

Public Health and Safety Impacts

The addition of this alternative to the proposals presented in *Alternatives #2* and *#3* would recognize a permissive approach to resolving problems confronting municipal water systems. Maintenance of continued service under conditions of adequate pressure is the most reliable means of preventing the contamination of water delivered to consumers. Adoption of this alternative by itself would provide a limited tool to eliminate the adverse health and safety impacts described under previous evaluations. Coupled with the implementation of actions proposed under *Alternatives #2* and/or *#3,* it would serve to accomplish the same results by negotiated agreement.

ALTERNATIVE #5: Allow cities and villages to reserve future stream flow for the purpose of direct withdrawal of surface water or recharge of wellfields and condition other future water rights on utilization of such reserved rights.

Description and Methods of Implementation

This alternative allows cities and villages the option of reserving streamflow for future utilization as an additional or replacement source of supply. Rights could be reserved for use at some future date; subsequent appropriations for other uses junior to the reserved right would be conditional upon the cities' eventual use of the water. In the meantime, the junior users could divert the water. This mechanism would allow public water supplies greater flexibility in dealing with and planning for eventual contamination or depletion of their sources of supply. Favorable action would extend legal mechanisms contributing to the solution of Problems 2 and 3. Implementation could address, singly or in combination, rights for direct diversion or storage of surplus stream flow. In either case, legislative recognition of reserving water for future use would be necessary through appropriate statutory instruction to the Department of Water Resources.

Socio-Economic Impacts

Reservation for future use would provide instream flow and associated social and economic benefits above the point of use. These impacts were detailed in the *Instream Flows Policy Issue Study.*

Impacts from the implementation of this alternative would be similar to *Alternatives #2, #3,* and *#4.* This alternative would be another means of assuring municipal water supply, thereby removing a threat to the continuation of present community standards. Financing for public surface water supply projects could be obtained easier due to the more reliable supply that would be available. Impacts on a community could also include benefits from the appreciation in value of the water that accrues prior to the community's need to utilize the reserved water. These factors could result in the continued economic stability or growth of a community based on the assurance of the future availability of a water supply. This introduces the element of social well-being and its relative importance in promoting overall sense of community satisfaction. The diversity of a town's economy would be an important factor in determining impacts, since the effect on local agriculture would be significant.

This alternative would have economic impacts due to the prevention of future uses upstream. It could prevent the construction of certain types of irrigation projects that would depend on future stream flow. The negative economic impact could be considerable. On the other hand, certain flood control projects could be encouraged if they stabilized the stream flow. This would cause a positive economic impact.

Water rights granted on the condition that they can be cut off when the reservation is exercised will alleviate some of the effects caused by preventing upstream development. Small developments could use some of the water. Major developments for uses such as irrigation will be precluded, however. It would be impossible to secure financing for a project that could not be assured a long-term supply in order to pay off its debts.

Physical-Hydrological-Environmental Impacts

Assuming that this alternative would not be retroactive, streams which are currently fully appropriated would experience no changes from

base line impact (see *Alternative #1*). In other streams, this alternative could discourage future surface water withdrawals due to a lack of protection on appropriations which might be cancelled at a later date by the municipal reservation. It is unlikely that this alternative would have any impact on groundwater conditions.

This alternative could also apply to streams statewide and has the same intent as *Alternative #3*. Considering this alternative and the last two discussed, it would provide the most reliable supply. The environmental impacts associated with this alternative could be the same as *Alternative #3*.

Legal-Institutional Impacts

If reservations for future use would be granted only to cities and villages, as this alternative implies, challenges in the courts and an increase in litigation will most likely occur. Such a reservation, to be justifiable, would have to be fairly definite as to the amount of water reserved, public purpose of use, and future development dates.

Implementation of this alternative would make the exercise of a preference unnecessary in the future.

Public Health and Safety Impacts

Implementing this alternative would assure the continuing availability of municipal water supply sources adequate to provide for community health and safety requirements. It would extend the availability of water for municipal use beyond the more immediate acquisition proposals presented in *Alternatives #2, #3,* and *#4* of this report and could encourage long-range contingency planning.

ALTERNATIVE #6: Revise selection of Natural Resources District Boards to better reflect population patterns.

Description and Methods of Implementation

Candidates for election to natural resources district boards are presently nominated by subdistrict and then elected at large. The nomination subdistricts were created following considering of a number of factors, only one of which was population. As a result, considerable population differences can and do exist between the subdistricts. Since all directors are elected at large and therefore actually represent all voters equally, this procedure has been found to not violate one-person, one-vote principles. However, it does result in fewer residents of urban areas being elected to the boards than if the subdistricts were based strictly on population. This alternative has been presented for the purpose of considering policy that would give municipal interests greater voice in NRD activities relating to the management and regulation of the available water sources. Implementation could be accomplished by amending the statutes to require NRD subdistrict boundaries to be based on population rather than area. This alternative would address Problem 5 in Chapter 9.

Socio-Economic Impacts

There would be an economic impact in the cost of the administrative changes and the elections required. Net economic impacts would probably change very little because the types of projects implemented by the NRD's would not change very much. Statutory responsibilities concerning the types of projects implemented would not change. The social impacts would include the effects of any shift from rural to urban emphasis. A reduction in the rural orientation of projects would impact the farm population slightly and an increase in urban oriented projects might improve the health, safety, and recreation opportunities of the urban dwellers.

Physical-Hydrological-Environmental Impacts

The variables this alternative might introduce are so great that its impacts cannot be assessed at this stage of the proposal. Direct environmental impacts could not be identified.

Legal-Institutional Impacts

It is unlikely that implementation of this alternative would have any significant long-term legal-institutional impacts. In the short term, however, some of the 24 NRDs would be required to reestablish subdistrict boundaries. Considerable turnover on the boards of directors could take place with the implementation.

Public Health and Safety Impacts

Implementation of this alternative would ensure municipal interests an opportunity to effectively participate in the water management and regulatory decisions of NRD's. This opportunity

would provide additional public input, individually and collectively, into NRD decisions relating to quality and quantity of water required for the public water service. Municipal water systems are required by law to deliver high quality, safe water to consumers. Increased municipal representation in resources management decisions could result in actions that would better protect the quantity and quality of water available for future human consumption. Thus, the potential for future violations of drinking water standards by municipalities could be expected to decline with a resulting assurance of greater health protection for the consumer.

ALTERNATIVE #7: Authorize cities and villages to apply limited zoning and land use controls to areas within a prescribed distance of their water supply sources in addition to existing authority within designated distances from their corporate boundaries.

Description and Methods of Implementation

An increasing number of municipal systems are finding it necessary to locate wells and wellfields at sites several miles distant from corporate limits. This must be done to obtain an adequate supply of suitable quality water for distribution to consumers within the city or village. When the well location is beyond the planning and zoning jurisdiction of the political subdivision, the only protection to the source of supply consists of the spacing requirements for registered wells. Selection of a well site includes consideration of sources of contamination such as irrigated cropland, chemical and petroleum storage, feedlots, and waste disposal facilities. Authority to control adjacent land use is desirable to prevent future deterioration of the groundwater by encroachment of contaminating activities. Control measures might recognize existing land uses with approval required for any change that could contribute to groundwater contamination. Prohibited activity might include development of new irrigation without assurance that scheduled application of chemicals and water would prevent contamination of groundwater, landfills, feedlots, or chemical storage tanks, industrial plants handling hazardous materials, or housing developments requiring waste disposal facilities. Adoption of this alternative would contribute to the solution of Problems 9 and 10 as identified in Chapter 9.

Implementation could be accomplished by a statutory recognition of well sites or wellfield boundaries, in addition to corporate boundaries, as the originating point for extended zoning authority.

Socio-Economic Impacts

These impacts fall in two areas: (1) benefits to municipalities, and (2) depression of future development potential on lands adjacent to municipal wells or wellfields. The economic impact on land and water users in the affected area would be negligible until landowners determined that their individual actions might result in greater personal monetary return under changed land uses. There would be no influence exerted on current agricultural production, although any expanded production might be required to locate in areas that are not subjected to the proposed controls. The above projections are based on the premise that the existing or future well spacing requirements will continue to protect the quantity of water available for municipal use and that the land use controls will be applied for the purpose of protecting the quality of groundwater. It can be expected that opposition will emerge from the agricultural sector. Temporary disruption of normal trading patterns could occur.

Municipal systems would be encouraged to locate their water source at more remote distances from the service area with assurance that quality could be maintained. This would permit selection of high production sources that would not be materially influenced by competitive use withdrawals. Industrial growth could be encouraged without immediate threat of depleted water supply and confrontation with competitive users.

A city or village electing to implement the provisions of this alternative would be required to develop a comprehensive plan and apply zoning and land use control to their total jurisdiction. This could be costly and the resulting impact within the community proper might exceed that occurring in the vicinity of the water supply source.

Physical-Hydrological-Environmental Impacts

This alternative could reduce both water quantity and quality problems for municipalities and could materially influence future change in areas placed under control. In the areas where it might be imposed, the natural environment would probably be better preserved. A reduction in withdrawal of groundwater and surface water could result from better management of use. This

could have some positive environmental affect, although it does create the possibility for continuous year-round withdrawal in contrast to the seasonal withdrawal of agriculture uses.

Legal-Institutional Impacts

Increased zoning activity on the part of city and village boards and resultant litigation challenging those actions are likely to come about with the implementation of this alternative. It could have a significant impact on future water uses, depending upon the size of the area subject to controls and upon the nature of the zoning regulations enacted. Those desiring to change land uses might find it necessary to demonstrate that their proposal would not contribute to water pollution. The expected result could be greater emphasis and support for applied research and general voluntary acceptance of improved water management practices.

Public Health and Safety Impacts

Implementation of this proposal would permit cities and villages to act on their own initiative to protect their water sources from contamination resulting from actions by others. A tool would be provided to permit control of contamination that might affect remote water supply sources. Compatible land use would reduce the changes for the drinking water supply to violate health standards and thus extend the health protection afforded the consumers. Prevention of source contamination would reduce the need for treatment as the primary protection against harmful material introduced into the water source with the associated risk of operational failure.

ALTERNATIVE #8: Adoption of miscellaneous actions that would serve to improve and protect the quality of groundwater used as a source of municipal drinking water. These actions have been presented in other policy issue reports and, if adopted, would exert favorable influence on municipal water supply sources.

Description and Methods of Implementation

A number of alternatives that would indirectly benefit municipal water systems have been reported in other policy issue studies. No attempt is made to detail the impacts of these alternatives or their specific effects on municipal water supply beyond recognition that they would serve to protect the quality and quantity of water available for future municipal and other uses. The alternatives and their source are as follows:

"Report: Policy Issue Study on Water Quality", March 1980.

Problem 2. *Alternative 2.* - "Clarify and Strengthen the Law Regarding Backflow Preventive Devices on Groundwater Irrigation Systems"

Problem 13. *Alternative 1.* - "Require the Licensing or Certification of Well Drillers and Pump Installation Contractors"

Problem 17. *Alternative 3.* - "State Develop Standards and Permit System for Storage of Chemicals and Petroleum, and Delegate Administration of the System to Capable Local Governments"

"Groundwater Reservoir Management Policy Issue Study", Nov. 2, 1981.

Management Action 1: "Reduce irrigation water need by improving irrigation efficiency"

Management Action 2: "Reduce irrigation water need by improving crop water use efficiency"

Management Action 3: "Reduce irrigation water need through improved water conservation practice"

"Selected Water Rights Issues Policy Study" Report #1, Preferences In the Use of Water.

A number of alternatives in this report could have impacts on municipal uses.

Environmental Impacts

Applicable land use controls include those (1) "to obtain an adequate" water supply and (2) maintain a "suitable quality water" supply. Maintaining water quality depends on the problem to be corrected. Possible measures to reduce groundwater contamination from chemicals applied to cropland include restricting irrigation water, fertilizer and pesticide application rates. The shallow water table and light textured (sandy) soils in areas such as the Platte River valley increase the problem and would require the most stringent control.

Environmental impacts due to water quality protection include:

1. Maintenance of fish populations. Some pesticides are very toxic to various fish species.
2. Recreation and aesthetics. Fertilizer use in a watershed above a surface water impoundment can lead to nutrient enrichment and undesirable algal blooms. This is a problem in the Salt Valley reservoirs including Branched Oak Lake.
3. Improved groundwater quality. Along with positive health and safety impacts to the human population, this alternative would lower the incidence of abortion, spinal deformities and other livestock health problems associated with contaminated water supplies.

Environmental impacts due to land use control measures to obtain an adequate water supply would be more indirect than those discussed above. Measures to control water supply competitors such as irrigators, could result in cropping pattern changes. Irrigators normally producing corn may have to grow more water efficient crops like milo, soybeans, alfalfa and wheat. Wildlife habitat diversity would increase as a result.

ALTERNATIVES RELATED TO SYSTEM PROBLEMS

ALTERNATIVE #9: Make no change in the legal-institutional structure regarding municipal water system acquisition and management; fiscal responsibility and accountability; methods of financing expansion or improvements; and protection against the entrance of contaminants.

Description and Methods of Implementation

This alternative would relate to Problems 9 through 15 as identified in Chapter 9. Antiquated verbiage and confused authorities will remain in the state statutes. The lack of fiscal accountability for water system revenues and expenditures will continue to allow for inefficient management and planning. Funding needed for system rehabilitation and water treatment plants will be unavailable. The potential for backflow and back-siphonage and the resulting contamination of the water supply will increase significantly.

Socio-Economic Impacts

Major impacts would include continued water system problems and the reduced contribution of small cities and villages to the agricultural sector due to failures of water systems. The cost of living and employment opportunities influence the growth or decline of the community economic base. While the cost of community water is only a contributing factor influencing emmigration from an area, system abandonment or excessive investment to retain the water service could be a major contribution to the economic decline of the community. As community services deteriorate, it becomes necessary for those within the trade area to rely on other, usually larger, communities. As those businesses supporting the agricultural economy are removed from the immediate area, the cost of support can be expected to increase. Therefore, the gradual deterioration of the social and economic contributions from small cities and villages will continue.

Physical-Hydrological-Environmental Impacts

Most municipal water systems will continue to expand and develop new groundwater sources. Municipal diversion and withdrawal of water can be expected to increase gradually by reason of uncontrolled individual use. There would be little incentive to conserve municipal water through improved management and pricing efforts. Environmental changes associated with existing conditions would continue.

Legal-Institutional Impacts

No legislative change would be required to implement this alternative.

Public Health and Safety Impacts

System failures are expected to become more frequent, and associated pressure losses will increase the potential for entrance of contaminants harmful to the health of consumers. Preventive public health practices, such as disinfection and cross-connection control, will continue as voluntary actions and can be expected to occur only after serious contamination has been found in the drinking water supply. The consuming public will continue to be exposed to the periodic presence of harmful materials.

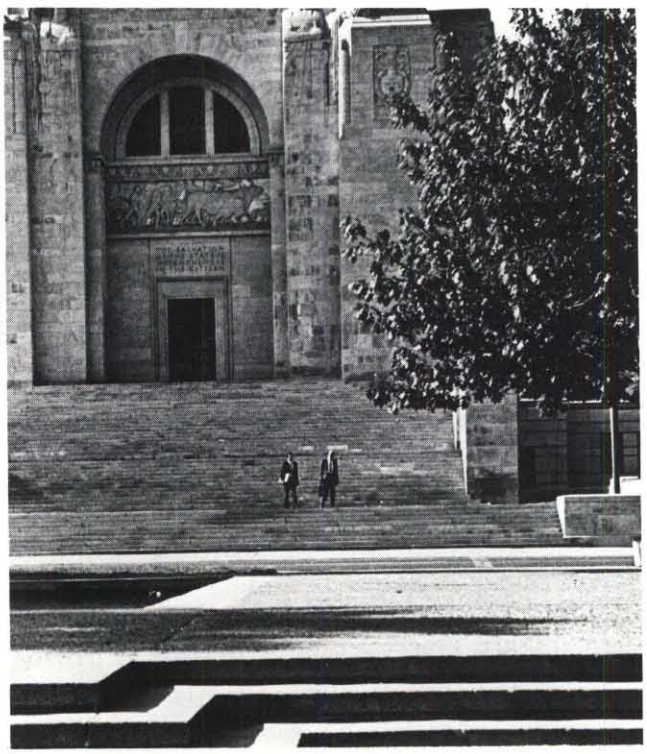
ALTERNATIVE #10: Initiate a comprehensive review of the statutory law relating to acquisition, operation, and replacement of municipal water systems for the purpose of eliminating obsolete

language and references; standardizing authorities now granted on the basis of corporate ownership; and clarifying the responsibility of elected management in areas of authority, fiscal, and service aspects associated with providing water to system customers.

Description and Methods of Implementation

The several municipal classifications are forced to operate their systems under different conditions of statutory guidance and control. For example, general differences in lagnuage refer to **industrial, mechanical,** or **manufacturing** to describe users for which municipal systems in different classifications may, or are required to, provide water service. A more detailed listing of these constraints, authorities, or requirements for classified municipal service is included in the appendix to this report.

Implementation could be accomplished by establishing and funding a select committee of the legislature to review and codify the laws relating to acquisition, management, operation and replacement of publicly-owned water utilities, with provision for input from those affected



or otherwise influenced by the end result. Consideration could be given to providing continuity and codification of future amendments and additions for the purpose of clearly informing water system management of its reponsibilities and constraints. Action on this alternative would address the situation described under Problem 9 in the previous chapter.

Socio-Economic Impacts

The economic impacts of this alternative would be in the form of added costs to review and change the statutes. Other economic and social benefits would the same as those for *Alternatives #2* through *#8* to the extent they enhance the implementation of those alternatives.

Physical-Hydrological-Environmental Impacts

This alternative is too broad in potential scope to be assessed as to impacts. Environmental impacts would primarily be to the system consumer and are discussed under the public health and safety impacts.

Legal-Institutional Impacts

The legal-institutional impacts likely to result from implementation of this alternative would not be known until the review had been completed.

Public Health and Safety Impacts

Initiation of improved management practices would help assure reliable operation, maintenance, and timely replacement of water system components. Clearly defined management responsibility could result in a reduced number of service disruptions and subsequent emergency actions. Consumers could receive a high degree of health protection since the entrance of harmful contaminants to a drinking water supply is usually associated with system failure.

ALTERNATIVE #11: Require filed audits from all political subdivisions owning water systems and specify separate accounting for income, expenditures, and accumulation and disposition of reserve funds associated with the water system.

Description and Methods of Implementation

Requiring municipal accounting systems to detail fiscal information relating to specific muni-

cipal operations would require a change in statutory law. Under existing law all political subdivisions except villages are required to submit to audit by the Auditory of Public Accounts. However, the state auditor does not have regulatory authority covering the bookkeeping procedures. The purpose of the law is to assure that receipts balance expenditures as a means of discouraging or exposing embezzlement of public funds. Statutory amendment could require bookkeeping procedures to separate receipts by source and expenditure by purpose, with application to all public water systems. Continuity of municipal water system management could be further improved by requiring performance audits, or review of the efficiency and effectiveness of management actions. Performance audits would materially increase the work load of the state auditor as well as extending the records kept by the owners of public water systems. Adopting this alternative would contribute to the solution of Problem 11 identified in Chapter 9.

Socio-Economic Impacts

The social impacts of this change might be significant in some communities. By publicizing the condition of the water system and the financial situation, it could lead to greater public awareness of the potential water supply problems in the community. In some communitites, similar situations have already produced significant controversy and turnover in elected officials. If this alternative eventually leads to improved system management and greater reliability of the water supply system, the impacts on the community would be positive. The impacts of an assured supply would be similar to those given in *Alternative #2.*

Immediate economic impacts would include costs associated with record keeping and reporting to a state administrative agency. Benefits would be dependent on the number of improvements made as a result of the discoveries of inadequacies and attempts to correct them. These impacts could be as great as those listed in *Alternative #2.*

Physical-Hydrological-Environmental Impacts

This alternative might result in more efficient municipal water operations and use. In turn, this efficiency might result in less water use. There would then be resulting positive impacts, such as decreased water level decline and increased streamflow. Once efficiency is accomplished, though, growth and development might result in greater municipal demand on the available water source. These circumstances would have positive environmental impacts. These environmental impacts would primarily be to the system consumer, and are discussed under the public health and safety impacts.

Legal-Institutional Impacts

Implementation of this alternative should not have a major legal-institutional impact apart from the increased workload on the Auditor of Public Accounts, and the extra cost to local governments.

Public Health and Safety Impacts

Selection of this alternative would result, to a lesser degree, in public health and safety impacts similar to those described under *Alternative #10.*

ALTERNATIVE #12: Assure continuity of municipal water system service by providing for state regulatory agency review and acceptance of local management and fiscal decisions.

Description and Methods of Implementation

There is presently no regulation of municipal water systems beyond statutory requirements to deliver water that is safe for human consumption. This regulatory authority is with the Department of Health and relates to new construction, competency of operators, and laboratory examination of delivered water. The Health Department also provides technical advice to the extent permitted by available funds and personnel resources. Experience has shown that a majority of the systems serving fewer than 500 persons give little attention to system management beyond that required by department regulations. It is not uncommon to find that Cities of the Second Class and Villages maintain a single bank account recording income and outgo of funds. When this occurs, it is difficult to separate water system income and costs from sewer use fees, fines, general property tax, and payments for street improvement. Villages, in particular, are not required to account for any income or expenditures except when questioned by a resident of the community. These practices contribute to the areas of discrepancy regarding the ownership and management of municipal water

systems that were proposed for consideration under *Alternative #10.* Adoption would address Problems 10, 11, and 12.

Implementation of this alternative could be accomplished in varying degrees. The most rigid would be the establishment of a public service agency with authority to approve balance between income and expenditure by a municipal or other public water utility, and to require water facilities necessary to meet community needs; maintenance of a sinking fund for emerging and future investment needs; and establishment of rate structures to accommodate daily operation costs and the above purposes. The mechanism for establishing rates, with state approval, could inform interested users of the degree of service to be expected from the system. For example, the system management would document the purpose and cost of a proposed improvement, and the method of repayment including rate adjustments, as a condition of obtaining state approval of the proposed action. Public hearings associated with the regulatory decision would inform the consuming public of the purpose and cost of the proposal and influence more responsible local management of the system. This action would result in total recognition of the water system as a self-supporting, non-profit utility.

Socio-Economic Impacts

With the exception of slightly smaller administrative costs, the social and economic impacts of this alternative would be similar to those for *Alternative #11.*

Physical-Hydrological-Environmental Impacts

Impacts would be similar to those of *Alternative #11.*

Legal-Institutional Impacts

Considerable legal-institutional impact would result with the establishment of a public service agency to carry out the functions suggested in this alternative. It would also have the effect of increasing state oversight of local decisions. There would be a greatly increased workload because of the number of municipal water systems to be regulated even if an existing state agency were designated to oversee the implementation of this alternative.

Public Health and Safety Impacts

Properly selected management actions would improve the level of health protection afforded consumers of municipal water by minimizing distruptions of service and entrance of contaminants into the water supply. The regulatory process would be designed to assure the reliability of the system and to achieve the best possible return on system investment through guided management. The health impacts described under *Alternatives #10* and *#11* would also apply.

ALTERNATIVE #13: Establish a state fund similar to the Nebraska Resources Development Fund to provide relief for municipal water systems needing improvement.

Description and Methods of Implementation

Federal loan agencies utilize guidelines that indicate a family can afford to pay approximately 1% of its annual income for municipal water service. System income from charges within this general range should be adequate to provide for all necessary operation, maintenance, and replacement costs. Numerous small systems have relied on federal grant and loan assistance for expansion and system rehabilitation. In recent years, the amount of federal assistance has diminished and it is probable that this source of funding will be eliminated in the future. *Alternative # 13* would provide funds to complement or replace the reduced federal subsidies and would contribute to the solution of Problems 12, 13, 14 and 19. Disbursement of these funds would be based on need, with funds going to communities which might not otherwise obtain loans, which might use state money to help obtain federal loans, or which otherwise demonstrate substantial need.

Implementation of *Alternative #13* could be patterned after the Nebraska Resources Development Fund, or the Development Fund itself could receive additional earmarked appropriations for distribution to municipal or other public water systems. Under either arrangement, combined grants and loans could be used to modernize water systems while maintaining water rates that are within the municipal users ability to pay eventually. The fund could eventually be self-supporting when principal repayment balances loan requests and when interest income becomes sufficient to provide for grants to needy communities. As noted in Chapter 7, approximately $36 million would eventually be needed to modernize all municipal water systems in the state.

A second method of implementation could

parallel the Nebraska Mortgage Finance Fund, although certain legal, financial, and tax-related questions would need to be resolved.

Socio-Economic Impacts

The net state-wide economic impact would be nearly the same if loans were provided by a state fund or if the municipality secured financing itself. There might be some economic benefit to the community in the form of lower interest rates if the community has a poor bond rating. If grants are provided, the cost would be redistributed from the municipal users to the general taxpayer. Other economic and social impacts would stem from providing an assured supply of water and would be the same as *Alternative #2.*

Physical-Hydrological-Environmental Impacts

The variables that this alternative might introduce are so great that its impacts cannot be assessed at this state of its proposal. Environmental impacts would primarily be to the system consumer and are discussed under the public health and safety impacts.

Legal-Institutional Impacts

The legal-institutional impact resulting from implementation would be an increased workload on the state agency designated to administer any such fund. Rules and regulations would need to be developed, and funds to get the program started would need to be appropriated by the legislature.

Public Health and Safety Impacts

Any action to ease costs of water system rehabilitation and improvement would contribute to the ability of municipal water systems to comply with the requirements of the Safe Drinking Water Act. Until such time as the physical and mechanical condition of all municipal water systems assures the delivery of acceptable quality water under pressure to consumers, the risk of disease and adverse health effects must be anticipated. The degree of risk and cost associated with reducing the risk are not well understood by most municipal water system customers. The monthly cost of service is the primary consumer consideration in supporting improvements that result in rate increases. Any contribution to reducing the cost of improved service will result in greater public acceptance of the change, whether to provide for quantities delivered or to improve quality by elimination of contaminants.

ALTERNATIVE #14: Adopt legislation that would require municipal systems to install back-flow prevention devices on all service connections; chlorinate or otherwise disinfect water entering the distribution system; and provide for sale of water through meters or other means of volume measurement.

Description and Methods of Implementation

The combination of actions proposed in this alternative would provide incremental protection for the quality of water delivered by systems experiencing frequent breakdown or disruption of service. The owner of the water system is legally responsible for the safety of water delivered to the consumers service line. Any contamination entering through defective plumbing on a private premise is not an owner responsibility unless pressure differential permits the reentry of contaminated water into the main for subsequent distribution to other premises. Backflow prevention devices on service lines would minimize this potential source of system contamination and provide added protection for the elected managers of the municipal water system.

The continuous disinfection with chlorine would ensure the biological safety of water entering storage and distribution systems. Chlorine also provides additional residual effect capable of destroying micro-organisms that enter the storage and distribution systems at a later time. Other disinfectants such as ultra-violet light, ozone, and chloramines could be used for initial disinfection but have little or no residual effect.

The proposal for metered sale of water is presented to effect conservation by consumers. Very small communities, as well as unmetered larger systems, are encouraged to evaluate the economics of meters. Thus, pressure reduction would occur at less frequent intervals with a related reduction in the risk of contamination resulting from backflow. The three elements of this alternative could be expected to reduce the potential for system contamination at lesser cost than system rehabilitation. Coupled with system modernization to meet current standards, their application would provide optimum assurance

for delivery of safe water at all times. This alternative would address Problem 15.

Implementation would require legislative action.

Socio-Economic Impacts

The proposals to install backflow prevention devices and to chlorinate or otherwise disinfect water entering the distribution system would have social impacts on the communities adopting these measures. The provision to provide for the sale of water through meters or other means of volume measurement could be controversial. Measurement of household water use would provide for improved community water utilization, but would be subject to negative public reaction as it is a regulation of personal habits. Resistance to the addition of chemicals to the water supply might also occur. There could be an additional cost per household as a result of these proposed changes. It has been estimated that the cost of this alternative could be as high as $30 per household and up to $5,000 for commercial and industrial firms over a twenty year period. In return for these added costs, a higher level of service of safe and heathful water would be provided. This would tend to provide some of the assurance that provides the benefits listed in *Alternative # 2*

Physical-Hydrological-Environmental Impacts

Mandatory meter installation as provided in this alternative could result in reduced usage and the associated positive environmenal benefits. Environmental impacts would primarily be to the system consumer and are discussed under the public health and safety impacts.

Legal-Institutional Impacts

Implementation of this alternative would require legislation.

Public Health and Safety Impacts

Public health officials strive for the ultimate in automated and individual health protection. The upgrading of water system components to meet modern standards, coupled with back flow prevention, disinfection, and reasonable use of water, are considered as ultimate management actions needed to assure the highest degree of health protection available to the consumers of municipal water. The effectiveness of the proposals presented in this alternative are dependent on the degree of control exercised by water system managers and employers. Taken individually, any of these actions would give greater assurance against entrance and distribution of harmful contaminants by the water system.

ALTERNATIVE #15: Place responsibility for operation and management of small municipal water systems with the Natural Resources Districts.

Description and Methods of Implementation

There are 147 municipal water systems in Nebraska that serve fewer than 300 persons. In general, these are the systems that experience operation, management and unsafe water problems. The person in charge of the water system is usually a part-time employee of the city or village. The smaller systems often rely on volunteer help to maintain the pumps or assign the responsibility to a member of the village board. While there are exceptions, the above described operation and management practices are believed to be a major contribution to the municipal water system problems described in this report. This alternative addresses Problem 14.

The economy of scale has been demonstrated as a factor in improving effectiveness and reducing costs associated with water service. Consolidation of operation and management functions could be accomplished through utilization of the Natural Resources District (NRD) structure. The districts could provide operation and management for water systems within their jurisdiction by developing staff capability to perform technical services. Savings might be realized by pooling parts and equipment inventories, through mass billing procedures, and by utilization of a trained staff. Other savings could occur through capital financing using the "mortgage fund" concept suggested in *Alternative #13,* since the entities involved are government corporations.

Some degree of implementation could be accomplished under existing law and through voluntary cooperation. Legislation defining and establishing participant relationships could encourage management consolidation. The economy of scale concept would require a relatively high degree of participation to accomplish the desired results.

Socio-Economic Impacts

The range of social impacts with the implementation of this alternative will depend on the approach used to solve small municipal water system problems. If the magnitude of the problem can be clearly identified and explained first, then the placement of responsibility of the operation and maintenance of small municipal systems with the NRD's could be viewed favorably. If the NRD's are forced to define and solve the problem, thereby raising rates, they might be viewed as the creator of the problem. This could produce resistance from municipalities, resulting in legal action that could hold up implementation of this alternative.

The positive impacts of this alternative include the provision of better community service, health, security, and the sense of community well-being. Systems presently well run could also benefit through the availability of a trained system operator from the NRD which would help the community and possibly reduce operation costs.

The economic impacts for this alternative range from small to considerable depending on the situation.

If a village's operation and management is presently below standard, transferring the responsibility to the NRD's would result in some immediate costs to bring the systems up to standards. These costs should be more than offset by the future benefits of having properly maintained systems.

If, on the other hand, a city's operation and management is presently up to standards, then a shift in responsibility to the NRD's would be a shift in costs from a village to the NRD, assuming the NRD absorbed those costs. If the NRD charged all costs to the users, there would be little change. Regardless of how the costs are distributed, there could be considerable savings due to economies of scale by shifting responsibility to the NRD's. Villages that may not have been able to afford to hire an expert manager for their operation would share in the services of one provided by the NRD. In addition, the NRD could provide a single store of parts and equipment for each village not able to carry the needed supplies to properly maintain their system.

Additional savings might result from shifting responsibility to the NRD's due to a change in financing methods. For example, a village's method of financing would probably be more limited than an NRD's. If an NRD could sell bonds at a cheaper rate, because they would be more secure, then the savings in interest over time could be considerable.

Physical-Hydrological-Environmental Impacts

The variables that this alternative might introduce are so great that its impacts cannot be assessed at this stage of its proposal. Environmental impacts would primarily be to the system consumer and are discussed under the public health and safety impacts.

Legal-Institutional Impacts

This alternative would have a significant legal-institutional impact on NRD's, which would assume the responsibility for management and operation of small municipal systems. While voluntary consolidation of these systems under NRD control would be preferable to NRD's, it is likely that some water boards will not want to relinquish their local authority. Therefore, legislation mandating consolidation of systems under a certain size within a specified period of time may be required to implement this alternative as described. This could make the shift to NRD operation and management a difficult one, with the potential for disputes over consolidation developing into lawsuits.

If basic ownership of these municipal systems is to remain with the individual community, a clear delineation of authority between community and NRD will be necessary to avoid duplication of functions. In most cases, the NRD would need to hire additional technical and managerial staff to carry out these new duties. It might also require an expansion in NRD facilities to accommodate the added staff.

If this new responsibility over small municipal water systems were to be implemented, residents of small towns would likely show additional interest in becoming NRD board members.

Public Health and Safety Impacts

Implementation of this proposal would reduce the numbers of entities presently subjected to Safe Drinking Water Act regulations. Reduction in required contacts would permit greater emphasis on the technical and training efforts of the regulatory agency, with associated improvement in the level of basic support. As the consolidation movement advances, a fewer number of better trained individuals would become responsible for providing health protection to the public. Operation of water systems by trained personnel would result in safe drinking water supplies, as has been demonstrated in many Nebraska communities.

ALTERNATIVES RELATED TO PROGRAM PROBLEMS

ALTERNATIVE #16: Encourage large systems to share the source of supply from their wellfields with smaller satellite communities by providing grants or loans from the Nebraska Resources Development Fund and by assistance through the Natural Resources Districts.

Description and Methods of Implementation

There are a number of communities whose location is such that their water could be supplied by larger central communities that provide the economic activity for the area or region. This is not a new concept in Nebraska as shown in Table 7-2, page 7-6. Financial encouragement to accomplish these consolidations has usually occurred through FmHA subsidy for transmission mains. Additional potential for consolidation or sharing of the supply source exists in the Omaha, Lincoln, Grand Island, South Sioux City, and Scottsbluff areas. Existing statutes would permit institution of this alternative by administrative decision changing the use priorities for the development fund. Priorities for the fund would be changed to allow it to provide grants. Implementation would contribute to the solution of Problems 11, 13, 14, 15 and 16 identified in Chapter 9.

Socio-Economic Impacts

Current constraints on financing municipal water systems improvement detract from local support for the concept of consolidation. Minimal investment to solve an immediate problem is usually preferred over capital costs necessary to accomplish permanent solutions. Additional funding sources, recognizing the need for longer repayment periods, could encourage commitment to actions benefitting future users of the systems involved. To implement this alternative, realignment of priorities for which the development fund is used, or additonal appropriations to the fund, would be required. Adoption of *Alternative #6,* which would realign the composition of NRD boards, could catalyze implementation of this proposal.

Physical-Hydrological-Environmental Impacts

The consolidation of water systems, particularly sources of supply, could result in major physical, hydrological, and environmental impacts. For example, a large area could be acquired and dedicated as a site for municipal water development. The land surface might be used for wildlife management or limited recreation. The concentration of groundwater withdrawal from the area might exert greater effect on the groundwater storage reservoir than would lesser and separated points of withdrawal located closer to the systems served. With proper planning and foresight, the impacts under consideration could be positive.

Legal-Institutional Impacts

This alternative could be implemented without legislative change beyond appropriations dedicated to its objective. Institutional impacts would relate to administrative decisions that could detract from conventional resource development in the absence of increased and directed funding.

Public Health and Safety Impacts

The effectiveness of regulatory programs would be positively impacted because fewer water systems would be involved. With consolidation, the larger systems could be expected to provide technical personnel capable of assuming and accomplishing the detailed operation and management required for delivery of safe water. As a result, the supervisory efforts of the health agency could be concentrated on the remaining systems.

ALTERNATIVE #17: Accept a diminishing level of state assistance and service to municipal and other public water systems as federal funding support for water system supervision, operator training, laboratory service, consumer education, and water use surveys is reduced or eliminated.

Description and Methods of Implementation

"New Federalism" and its associated budgetary policy will mean a reduction or elimination of

federal support for a number of grant and aid programs. The Public Water System Supervision Program, Federal Catalog 66.432, is among those assistance programs being considered for reduction. This alternative could be implemented by a decision not to replace reduced federal support with appropriations from the state General Fund. Continuation of the present level of state financial contribution would permit the Department of Health to continue a limited supervision program. Failure to maintain this minimum degree of state activity could result in a loss of program responsibility to the EPA and direct enforcement of the Safe Drinking Water Act in the federal courts.

The U.S. Geological Survey Water Use Data Project in Nebraska is also scheduled for elimination.

Socio-Economic Impacts

The economic impact of this alternative would be a continuing shift in the burden of the cost of testing water supplies and professional advice on system reliability to the local water system and user. To the extent that this would result in contaminated water supplies or shortages in supply, the economic impacts would be similar to *Alternatives #1* and *#10*. The overall social impact of this shift in funding would be minimal, but it could be substantial in some communities. To the extent that it affected the quantity or quality of the water supply, the impacts would be similar to those of *Alternatives #1* and *#10*.

Physical-Hydrological-Environmental Impacts

Acceptance of this alternative would have little immediate physical, hydrological, or environmental effect.

Legal-Institutional Impacts

Acceptance of this policy would primarily involve the appropriation of state General Funds. Continuation of present state funding levels would continue water quality monitoring and enforcement action when contamination exceeds safe levels. In the absence of change in the Nebraska Safe Drinking Water At, the Department of Health would continue to be responsible for the review of water improvement plans and the certification of water system operators. The time required for review and approval of plans and specifications would be extended and thoroughness in evaluating operator capability prior to certification would be sacrificed. If the formal enforcement approach were fully implemented by the EPA, the case load of the Nebraska court system would be increased, with an associated need for legal service by municipal systems found to be in violation of law and related regulations.

With the elimination of the U.S.G.S. Water Use Data Project, future state water policy decisions could be affected by the limited amount of reliable data available.

Public Health and Safety Impacts

The primary health concern is the delay in obtaining protection for the consuming public. In those instances where correction occurs after regulatory action, the consuming public continues to be exposed to the contaminant during the legal process. The preventive approach (system improvement to preclude entrance of contamination) would become the total responsibility of the system owner without the benefit of technical advice provided by the state. Past experience indicates that small municipal systems are unlikely to exercise preventive health measures designed to protect the safety of the water supply without external persuasion.

ALTERNATIVE #18: Increase state funding and fee schedules as necessary to replace diminishing federal assistance for the purpose of encouraging local responsibility and technical application relating to the safety of drinking water delivered by municipal and other public water systems.

Description and Methods of Implementation

Since 1975, the State Department of Health has received a majority of the financial support for public water system supervision from federal grants. Total program costs, including field surveillance and laboratory service, approximated $610,000 in fiscal year 1982. Of this amount, approximately $390,000 came from federal sources and $100,000 was generated from laboratory fees. State financial support for technical services has remained fairly constant at a rate of $120,000 per year since 1975. As documented in this report, significant and measurable improvement in the condition of Nebraska water systems and drinking water safety has resulted from this program. However, an anticipated reduction in the federal grant

offering from 1983 will force a de-emphasis on providing technical services and field inspections (activities of preventive nature) while continuing monitoring and enforcement at the level demanded as conditions of the grant. Acceptance of this alternative would address Problems 16 and 17. Implementation of this alternative would require a commitment from the state General Fund to replace reductions in federal money for programs that have been accepted and implemented as beneficial to the state.

Federal law expects the owner of the water system to pay the cost of examining drinking water for the presence of harmful contamination. The Nebraska Safe Drinking Water Act recognizes the the Department of Health Laboratory as the official facility to examine water and authorizes the establishment of fees to partially recover the cost of examination. The present rate of recovery is 52 percent of actual costs, which is considered to be within the socpe of legislative intent. The remainder of the examination cost, approximating $100,000 annually, comes from the state General Fund. The above laboratory income has not been sufficient to acquire instrumentation and hardware needed to examine drinking water for newly identified harmful contaminants. To date, federal grants have been used to accommodate nonrecurring laboratory costs for instrumentation. Any reduction in the federal source will necessitate increased fees and will add general appropriations if the required level of laboratory service is to be retained.

In the case of the Public Water System Surveillance Program, the added state contribution would enable continuation of activities designed to reduce the impact of state accepted federal regulations and continue the improvement of drinking water safety and system reliability. Continuation of the 1982 funding level, with greater state contribution (an additional $85,000 in FY 83), would permit the gradual transfer of responsibility and expertise necessary for assuring the safety of drinking water to the municipal officials. As the transfer occurs, the need for state and federal regulatory involvement would be proportionately reduced.

Socio-Economic Impacts

Impacts would be similar to *Alternative #2,* as this alternative would help ensure a water supply that is adequate in quantity and quality. Some social impacts could be related to any failure to provide a safe drinking water supply. The added cost to municipal systems for laboratory service would probably double for the smaller communities.

Physical-Hydrological-Environmental Impacts

The variables that this alternative might introduce are so great that its impacts cannot be assessed at this stage of its proposal.

Legal-Institutional Impacts

If this alternative is successfully implemented, the transfer of responsibility for the safety of drinking water to local levels should eventually result.

Public Health and Safety Impacts

Education of local officials and the public, as a continuing approach in preventing disease resulting from unsafe drinking water, would result in fewer public health problems. The state, in accepting federal assistance, has agreed to enforce federal standards and requirements in a manner no less stringent than would be applied directly by the EPA. The EPA enforcement approach places total responsibility for delivery of safe drinking water with the owner of the supply. Compliance is dependent on owner reporting and legal enforcement when compliance cannot be demonstrated. Any reduction in funds reduces the capability to continue the educational approach. Health protection is generally equal under both methods of enforcement, although "after-the-fact" legal enforcement does not prevent public exposure to harmful contaminants. The educational approach is also considered more permanent.

ALTERNATIVE #19: Provide state funding to continue the Water Use Data Project.

Description and Methods of Implementation

The continuation of the Water Use Data Project would provide greater coverage and refinement of municipal, agricultural, industrial, energy, and other water use data required for both policy and management actions. Funding for this project was provided by the U.S. Geological Survey to the University of Nebraska Conservation and Survey Division, and will not be continued. The Department of Health assisted by encouraging municipal water systems to maintain water use information, together with the records required by law for drinking water quality assurance. Municipal use data is of importance to manage-

ment in scheduling improvements and establishing appropriate rates. The Department of Health will continue to encourage maintenance of such local records. In the absence of a coordinating agent with data storage and retrieval capability, however, the data for all use purposes will not be centrally located. Decision makers and water managers would not have the benefit of reliable use comparison as a tool in resolving water problems.

Continual development and refinement of the Water Use Program would require state funding in the range of $100,000 per year for several years. Appropriations in the range of $50,000 per year would be required to effect coordination of data collection, storage, and retrieval once the system becomes established.

Socio-Economic Impacts

To the extent that this would help ensure the provision of water supplies in adequate quantity and quality, the impacts of this alternative would be similar to those of *Alternative #2.*

Physical-Hydrological-Environmental Impacts

The variables that this alternative might inoduce are so great that its impacts cannot be assessed at this stage of its proposal.

Legal-Institutional Impacts

An increase in funding for this project would assure the continued collection of accurate data on water use and system performance. It may also continue the trend toward shifting this responsibility to local municipalities. With an expanded data collection system, however, increased administrative duties and costs, at least initially, are also likely to result.

Public Health and Safety Impacts

A continuted effort to assemble water use data would encourage participation in the program by municipal water systems. Records leading to the submission of annual water use would contribute to improved management, with resulting improved service. Continuity of service under adequate pressure conditions has been demonstrated by this study to be the prime deterrent against entrance of contamination to drinking water system. Daily records of use would alert the system operator to peak periods, effects of fire flow and mainbreaks, and generally improve his ability to respond promptly to unusual situations. Reliable information on municipal and competing water uses would permit more equitable distribution of a depleting groundwater supply source, probably to the advantage of obtaining sufficient water to meet health, sanitation, and safety needs during periods of shortage.