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WATER CONSERVATION AS A LONG-RANGE STRATEGY IN MUNICIPAL WATER SUPPLY PLANNING: THE CASE OF OKLAHOMA

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WATER CONSERVATION AS A LONG-RANGE STRATEGY

IN MUNICIPAL WATER SUPPLY PLANNING:

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A DISSERTATION

APPROVED FOR THE DEPARTMENT OF GEOGRAPHY

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WATER CONSERVATION AS A LONG-RANGE STRATEGY IN MUNICIPAL WATER SUPPLY PLANNING: THE CASE OF OKLAHOMA

BY: ABDELFATTAH LUTFI ABDALLAH

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This study is concerned with Oklaoma water managers' attitudes toward the adoption or rejection of long-term water conservation options in small and medium sized cities under 50,000 in population.

In focusing upon Oklahoma water managers' attitudes, the following questions are addressed:

1. What factors influence Oklahoma water managers' attitudes toward the adoption or rejection of long-term water conservation measures?
2. What are the major incentives or disincentives that may encourage or discourage the adoption and implementing of long-term water conservation alternatives at the municipal level in Oklahoma?
3. What are the distinct geographical variations in attitudes toward adopting water conservation policies?

To address these and related questions, a questionnaire was mailed to each of the water managers in the selected Oklahoma towns and cities. The questionnaire was completed by 49 of the 60 managers who were requested to participate in the study. The obtained data were then analyzed using contingency tables.

The results of the study indicated that local water managers considered local governments as the most appropriate body to deal with water management issues. Local water managers in Oklahoma also place heavy reliance upon traditional structural solutions. If these solutions prove to be inadequate, long-term water conservation alternatives become more appealing. However, Oklahoma water managers in the selected cities and towns expressed their profound concerns about the potential revenue loss of long-term water conservation measures were to be adopted and implemented. Respondents also realized that implementing long-term water conservation alternatives often require sophisticated preparation and execution to be successful.

These results did not concur with Oklahoma state water policies which emphasized water supply augmentation solutions. But still, state efforts are needed to provide studied communities in order to encourage them to adopt permanent water conservation strategies.

CHAPTER I

Introduction

This study explores major factors influencing the adoption of water policy management options by water officials in selected medium sized cities and towns in Oklahoma. This study presents a framework that will allow water officials to consider utility-oriented long-term water conservation options as a supplement to traditional supply augmentation projects.

The significance of utility-oriented water conservation practices in municipal water supply planning depends upon the extent to which specific alternatives are implemented; that is, under what conditions water managers will adopt and implement particular conservation options. The fact that a water manager is aware of numerous long-term measures to conserve water is no guarantee that the given water utility will act upon that information. Except under conditions of emergency such as during dry periods, little is known about the major determinants that affect possible adoption of particular long-term water conservation options.

For the purpose of clarification and evaluation of the potentialities of adopting certain water management policy options by water managers, all cities and towns in Oklahoma within the size range from 5,000 to 49,999 population have been selected for this study. According to the 1980 United States Census

of population,[1] a total of 60 cities were in this range. A location map (figure 1) of the selected communities showed that they are widely distributed across the state, with more concentration around two metropolitian areas: Tulsa and Oklahoma City. A total of 60 observations was quite manageable and the needed information was collected within a reasonable time period. Since all cities in the range of 5,000 to 49,999 population were included, no systematic sampling procedure will be used to choose from. Nevertheless, all the chosen municipalities encompass and represent a broad range of city population size categories (5,000 to 10,000; 10,000 to 20,000; 20,000 to 30,000; 30,000 to 40,000; 40,000 to 49,999).

The reason for selecting this specific range is that most studies concerning urban water planning and conservation were done in cities of 50,000 or more.[2] Further, the reason for not studying towns of less than 5,000 population is that a small water systems study is currently under way in the College of Agriculture, Oklahoma State University, Stillwater, Oklahoma.[3] Also, no studies have been published which were specifically aimed at the investigation of determinants of adopting a conservation measure or conservation in general by water managers. Futhermore, no small town and medium city studies have been made in the State of Oklahoma.

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[1]U. S. Department of Commerce, Bureau of the Census, 1980 Census of Population and Housing - Oklahoma, (Washington, D. C.: September, 1982).

[2]U.S. Army Corps of Engineers, Tulsa District, Tulsa Urban Study: Water Supply - Stage II, (Oklahoma: September, 1982).

[3]Kay Stewart, "Residential Water Conservation Programs in Rural Water Districts," A Proposal Submitted for Funding to the Oklahoma Water Resources Board, (Oklahoma: December, 1981), 4 pages.

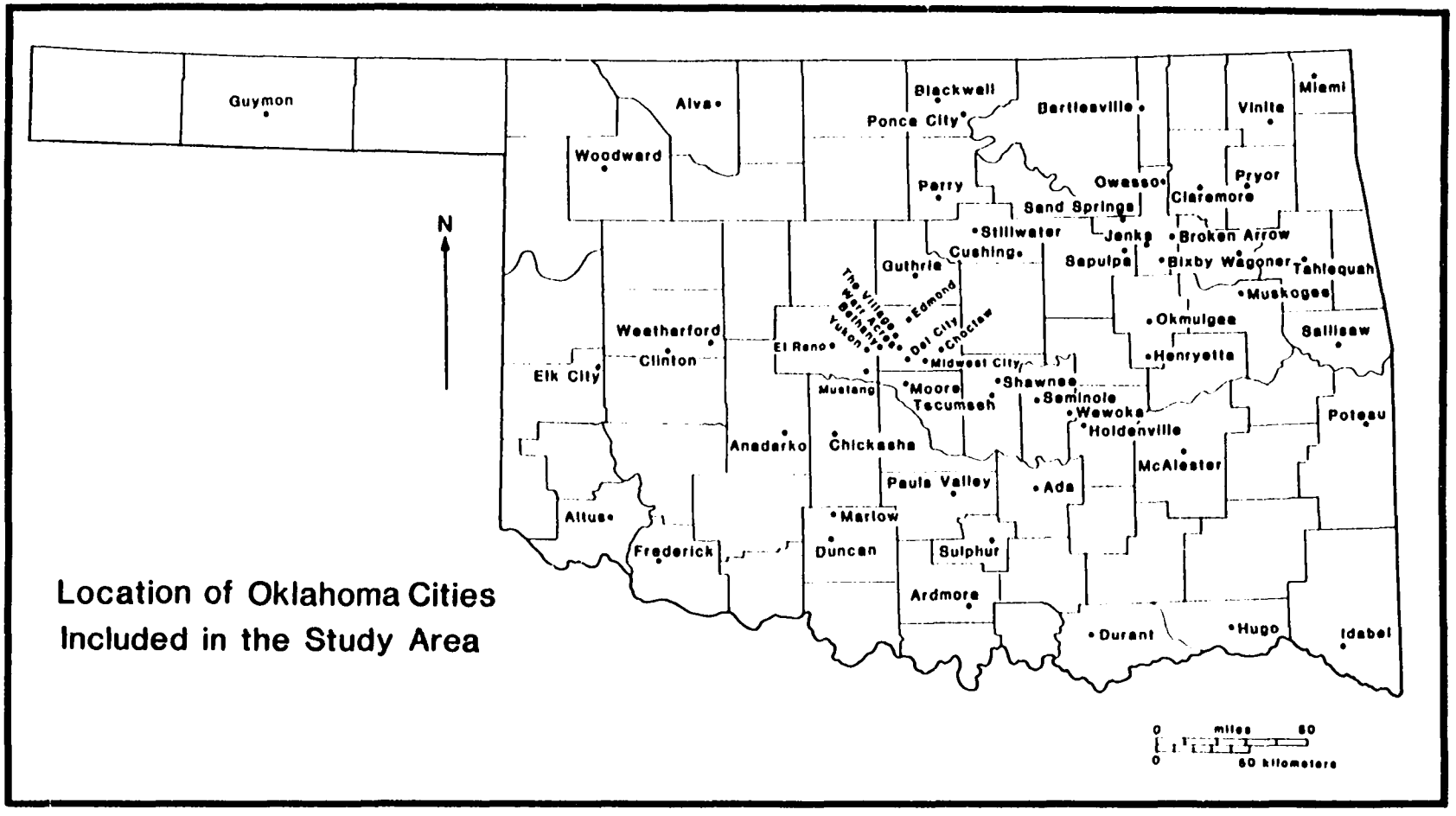
Guymon
Alva
Blackwell
Ponca City
Bartlesville
Vinita
Miami
Woodward
Perry
Owasso
Pryor
Claremore
Sand Springs
Stillwater
Jenks
Broken Arrow
Cushing
Guthrie
Sapulpa
Bixby
Wagoner
Tahlequah
Muskogee
Edmond
Okmulgee
Weatherford
Clinton
El Reno
Del City
Choctaw
Midwest City
Henryetta
Sallisaw
Elk City
Shawnee
Moore
Tecumseh
Seminole
Wewoka
Holdenville
Poteau
Anadarko
Chickasha
McAlester
Paula Valley
Ada
Altus
Marlow
Frederick
Duncan
Sulphur
Ardmore
Durant
Hugo
Idabel
N
Location of Oklahoma Cities
Included in the Study Area
0 miles 60
0 60 kilometers

Figure 1

Basic Definitions

Terms such as water conservation, water rationing, long-term water conservation, and efficiency in water use were considered by the author to require definition because of their particular use in the analytical development set forth in this study. A standard dictionary defines conservation as "the planned management of a natural resource to prevent exploitation, destruction, or neglect."[4] Preservation and protection implies, however, the postponement of consumption. This is not feasible because we must consume water to survive. However, there are various perceptions of what water conservation is; some see it as an ethical issue, a necessity for human survival: others view it in a cost-benefit context.[5] For the purpose of this study, we will define water conservation as a series of long-term water saving measures that will attain a notable degree of efficiency in water use. Specifically, efficiency in water use can be defined here as accomplishing a task with one gallon of water which previously required several gallons.

Given the above definitions of water conservation and efficiency in water use terms, the question is: What distinctions can be drawn between water rationing measures and long-term water conservation measures? By and large, water rationing measures have been planned for implementation in the event of a need to reduce water use rapidly and dramatically. Also, to be successful,

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[4] Webster's New Collegiate Dictionary, (Springfield, Massachusetts: G and C Merriam Company, 1972), p. 241.

[5] For a good discussion of the water conservation concept see: Duane D. Baumann, John J. Boland, and John H. Sims, "Water Conservation: The Struggle Over Definition," Water Resources Research, Vol. 20, No. 4 (April, 1984), pp. 428-434.

most such measures rely heavily on consumer cooperation. Therefore, rationing of water is an emergency measure but fixing leaky pipes is a permanent, long-range conservation effort. The assumption is that long-term water conservation measures may not require customer cooperation since they are under the manager's control.

The Problem and its Setting

Local water supply utilities in Oklahoma are periodically faced with inadequate storage and distribution facilities and temporary water shortages.[6] Such problems tend to be generated by excessive water demand on the existing water facilities or by variation in precipitation.

Ground water is a major asset in meeting Oklahoma's water needs but a notable decline in water levels in some areas (such as the Ogallala aquifer in the western part of the state) due to heavy withdrawals is creating serious problems. Since ground water is the direct source of domestic supply for many municipalities and industries in the northwestern part of the state, comprehensive water management programs which emphasize conservation are necessary today and will be even more so in the future.

Aside from the notable decline in ground water tables in some western areas of the state, small cities and towns in Oklahoma have been experiencing various problems in their water supply systems. According to the annual reports

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[6]Oklahoma Water Resources Board, Planning and Development Division, Report to Governor George Nigh on Community Water Problems and Funding Needs, (January, 1982).

and surveys carried out by the Oklahoma Water Resources Board,[7] several municipalities reported some type of current distribution line inadequacy, water and wastewater treatment plant problems (such as inadequate capacities), storage problems, and pump problems.

In some municipalities, adequacy of short range water supply at the time of the survey was not reported to be a major problem in the state.[8] However, one may anticipate that as municipalities increase in size, or if severe dry conditions prevail for several successive years, there will be major problems. One might conclude that if a municipality has an average daily use equal to its treatment capacity and expects a future increase in demand due to increased population growth or increased per capita water use, the municipality could experience water problems in the future.[9] Under these circumstances, it may be necessary to achieve either a long-term reduction in water use, or an increase in water storage capacity and financial capability to develop new water supplies and expand the existing water facilities.

A problem, however, is that little is known about local water officials' attitudes toward a number of water management policy options. The array of options available to local water supply managers is conditioned by major factors. For example, options that require bond elections, substantial changes in rate structures, and expansions of service areas are major examples of policies

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[7]Oklahoma Water Resources Board, "Final Report to Governor George Nigh on Water Supply Conditions in Oklahoma" (October 2, 1980), 38 pages.

[8]Oklahoma Water Resources Board, "Water Supply and Conservation Questionaire," (Oklahoma City: 1980).

[9]Ibid., p. 1.

that require a positive perception of their social acceptability by water officials. This study attempts an exploration of major factors influencing and limiting water policymaking options in the selected municipalities of Oklahoma. This study also is an initial effort in establishing an understanding of major determinants influencing the adoptability of long-term water conservation policies. Any future effort in formulating a comprehensive water conservation plan should take into account major components influencing the possibility of its implementation.

This study tested the hypothesis that as the cost of developing new water sources increases, water managers in Oklahoma would extend their planning perspective to include long-term water conservation measures as well as traditional supply augmentation strategies.

With the loss or decline in federal funding for major urban water development projects,[10] water utility managers may be advised to implement water conservation measures that bring about some more efficient use of existing supplies of water, rather than embark on a costly new water source expansion which could leave the utility with unnecessary and costly excess capacity.

Given the nature and significance of the problem, one major objective of this study is to evaluate the acceptability of a number of municipal water management policy options (development of new water supply sources, implementing water conservation on a regular basis, limiting the number of water

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[10]Jackie Sellers, and Ronald M. North, "Cost Sharing and Implementing of National Water Resources Policy," Water Resources Bulletin, Vol. 15, No. 1 (February, 1979), pp. 189-197.

users, transferring water from nearby communities, water reuse for nondrinking purposes, and implementing temporary water conservation measures) to Oklahoma's municipal water managers. The implementation of such policy options requires the acceptance by appropriate authorities and the public. This may be a fairly routine matter for most emergency rationing measures, but for long-term policy options there may be considerable political discussion, with some disagreement over whether a certain measure or specific alternative is the best one politically, economically, and technologically.

Though the need for implementing water conservation measures has been recognized by many state and municipal water planners, still major issues ought to be addressed before any attempt can be made to develop a comprehensive statewide water conservation plan. Therefore, the purposes of this research were to:

1. Identify factors that influence Oklahoma water managers' attitudes toward the adoption or rejection of long-term water conservation measures.

2. Identify geographical variations in attitudes toward adopting water conservation policies. Put in another way, do these communities located in the western part of the state have different attitudes toward adopting water conservation policies from those communities located in the central and eastern parts of the state?

3. Evaluate the existing state water conservation programs for compatibility with identified local perspectives on water conservation policies.

4. Recommend potential conservation management alternatives that are most likely to be adopted and implemented at local levels under current Oklahoma conditions.

In summary, this study attempts to identify some characteristics of transition from development of new water supply sources to implementing water conservation strategies in municipal water supply planning in Oklahoma. At this

point, one may ask whether there have been any new orientations in water management policies at the national and state levels that shape the existing local water policies. The following section will be devoted to outlining the underlying conditions that shaped contemporary municipal water management policies.

The Transition From Development to Management[11]

Municipal water supply planners have traditionally emphasized the planning, construction and operation of ever larger water supply systems to meet projected urban water demands. While the planning and implementation of such municipal water systems obviously required careful consideration of, and solutions to, numerous complex technical, political, and institutional problems, the solutions which have emerged in recent decades have been heavily oriented toward a combination of structural and non-structural alternatives[12] to satisfy a given level of future demands. And indeed there has been an increased interest in urban water conservation at private, academic, national, state, and

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[11]Water supply management is defined as any action (e.g., leak detection and repair program) taken by the water utility that conserves water within the supply system. On the other hand, water demand management is defined as implementing water conservation measures that conserve water by water users. New England River Basin Commission, Before the Well Runs Dry: A Handbook for Designing a Local Water Conservation Plan, (Washington, D.C.: Federal Emergency Management Agency, February, 1981), pp. 6-7.

[12]Structural alternatives are defined as building reservoirs and dams and development of new sources; while non-structural solutions are defined as those alternatives that reduce demand and minimize the building of capital-intensive facilities.

local levels. Therefore, the purpose of this section is to examine the evolving new orientations in municipal water management policies and the underlying conditions that have shaped such new orientations.

The President of the American Water Works Association (AWWA), representing individuals and agencies which supply much of the nation's water for municipal and industrial uses, recently stated that:

> We have been facing a water crisis that, although not perceived on a national scale, have been in existence since we developed this nation. This is nothing new. If you look at the history of water development in all of the great cities, particularly in the arid Southwest, everything was done in crisis, and we approach all our water problems that way. However, this crisis mentality in the long run makes it hard to achieve water conservation and efficient use.[13]

This statement suggests that one appropriate response to our immediate municipal water problems is the adoption of certain water conservation options that will yield long-term, sustained water savings. One may also imply from Gilbert's statement that unless water managers begin approaching their water supply problems on the basis of permanent conservation efforts, they will inevitably face the prospect of a water supply insufficient for their cities' demands. Gilbert's remarks and many others by several water experts were supported by data published in 1978 by the United States Water Resources Council. The statistical data indicated that several regions of the country face imminent threat of shortages. For example, in the Rio Grande region daily withdrawals

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[13] Jerome B. Gilbert, "A Future Look - What are the Unknowns?" In: Proceedings of the National Water Conservation Conference on Publicly Supplied Potable Water, (Denver, Colorado: United States Department of Commerce/ National Bureau of Standards, June, 1982), p. 421.

(6.3 billion gallons a day) greatly exceed mean daily streamflow (1.2 billion gallons a day).[14]

Traditionally, in response to the increased demand for water and inadequate supply, cities have chosen a water supply augmentation option over a conservation or efficiency option. This option has been heavily oriented toward structural, capital-intensive facilities to satisfy a given level of future water demands. For instance:

> The most common response of forty-eight Massachusetts communities during the drought of the early 1960s (aside from the unenforced plea for restrictions in water use) was to plan for increase in supply, new sources, improvements in present supply, emergency sources, and a cloud seeding experiment.[15]

The implications of the water supply augmentation option become vivid when one considers the ever-rising financial outlay forced on governments at all levels. Such implications were summarized in a popular fashion by National Geographic Magazine in the following statement:

> To manage water, we have rearranged our landscape on a colossal scale: built two million dams, irrigated sixty million acres, carved barge canals that carry a fifth of intercity freight, created 50,000 public and private water utilities, drained a hundred million acres of wetlands, and drilled millions upon millions of wells. Billions of dollars have been spent.[16]

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[14]U. S. Water Resources Council, The Nation's Water Resources: The Second National Assessment, Summary Report, Draft Copy, (Washington, D.C.: United States Water Resources Council, December, 1978).

[15]Duane D. Baumann, and Daniel Dworkin, Water Resources for Our Cities, Resource Paper No. 78-2, Association of American Geographers, (Washington, D.C.: 1978), p. 8.

[16]Thomas Y. Canby, "Our Most Precious Resource: Water," National Geographic Magazine, Vol. 158, No. 2 (August, 1980), p. 148.

Because of these troublesome prospects, one may ask what can be done? Of course the answer will not be found indefinitely in more giant dams and vast land areas inundated by reservoirs. Likely, the best prospects for the future lie in implementing long-term water conservation. But, unfortunately, water conservation is an approach for which many water planners or decision makers and their communities are least prepared.

In the academic arena, several scholarly articles and investigations have begun calling for a broadening of the range of tools available for water supply management and planning by considering water conservation policies and more efficient use as an integral part of water resources management. In this regard, Gilbert White noted the growing need for new orientation in water management policies:

> As the more promising storage sites are built up with concrete and earth structures on our streams, large and small: . . . and, as the results of multipurpose basin developments spread out in a great visible array, it is becoming apparent that change in orientation of public efforts in water management is needed and is, in fact, taking shape.[17]

At the global level, the water situation is discussed in a paper issued by the Worldwatch Institute in December, 1984.[18] Postel renewed White's call for broadening the approach of water resources management strategies. Among the options recommended by the author for proper management of the earth's limited supplies of fresh water are conservation and marginal cost pricing. The

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[17]Gilbert F. White, Strategies of American Water Management, (Ann Arbor, Michigan: University Michigan Press, 1969).

[18]Sandra Postel, Water: Rethinking Management in an Age of Scarcity, Paper No. 62, Worldwatch Institute, (Washington, D. C.: December, 1984), 56 pages.

study also focused on the increasingly inefficient use of the earth's limited supply of water and the rising environmental and economic costs of traditional water strategies. The author maintained that the problem is mismanagement.

The above global concerns regarding water policy problems have emerged in recent years as a collective reflection of local water needs and problems. Developments in water management created substantial challenges that must be met at local levels. These challenges are more likely to be addrssed by changing the way local water managers manage and allocate water than by simply making more of it available at a low price. In this regard, one may ask about the major factors influencing the new orientation in water management policies at federal, state, and local levels. This will be discussed in the following section.

Major Factors Influencing the New Orientation in Municipal Water Management Policies

Before outlining the evolving role of federal, state, and local governments in dealing with urban water management policies, we will examine the major factors that encouraged consideration of the full range of demand management alternatives. Among these factors were the negative environmental impacts of developing new water supply projects, political, legal, and institutional constraints on interbasin water transfer; rising costs of developing new municipal water supplies; and, finally, the increasing competition among cities, towns, and irrigation districts for attaining new urban water supplies in recent years.[19,20]

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[19]Duane D. Baumann, "Evaluation of Conservation and Urban Water Supply Planning," Water Resources Specialty Group Newsletter of Association of American Geographers, Vol. 2, No. 1 (March, 1982), pp. 9-11.

[20]James E. Crew, "Water Conservation Supply Planning Activities," Water Resources Specialty Group Newsletter of Association of American Geographers, Vol. 2, No. 1 (March, 1982), p. 3.

One major obstacle to developing new water sources in recent years is the rising expenditure needed to finance major municipal water supply projects. The annual cost data prepared by the United States Bureau of Reclamation showed sharply rising cost levels per acre foot of storage for a standard 300,000 acre foot reservoir. For example, the construction cost per acre foot of storage in the Panhandle of Oklahoma has risen from $80 in 1960 to $244 in 1980.[21] Total annual expenditures for wastewater and storm sewage services were found to be increasing at a 5.30 percent annual rate.[22] This percentage was calculated from cost data collected by the United States Bureau of the Census for four fiscal years, 1977-1981. As total expenditures increase over time, water utilities may seek additional funds but these have been dwindling in recent years due to the declining level of federal participation in financing major urban water and wastewater projects. The future outlook seems to be gloomier than ever because of the huge sums of capital needed to finance major urban and wastewater projects. For instance, The Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force found that "urban water systems capital expenditure needed over the next 20 years (1980-2000) are estimated to total 75-110 billion dollars. This includes . . . new source

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[21] J. Gordon Milken, and G. Taylor, Metropolitan Water Management, (Washington, D.C.: American Geophysical Union, 1981), p. 71.

[22] John J. Boland, "Water/Wastewater Pricing and Financial Practices in the United States," Technical Report 1, MMI 19-83, Prepared for Near East Bureau, U. S. Agency for International Development, by Metametrics, Inc., (Washington, D.C.: August, 1983), p. 125.

development at $20-$25 billion."[23]

The decline in federal spending is reflected by the size of appropriations for new water projects construction in recent years. "Appropriations for water project construction under the four federal water agencies have declined by almost 80 percent over the last sixteen years, from about $6 billion in fiscal 1968 to 1.3 billion in fiscal year 1984."[24] Beginning with the Carter administration, the federal government has been in favor of implementing cost sharing policies for water projects development. The Reagan Administration has continued this policy and strengthened it. The cost sharing concept means greater responsibility for water project costs and financial arrangements should be taken care of by the states and/or local governments.

More recently, it was reported that there has been a notable drop in federal participation for funding municipal water and wastewater treatment facilities. For example, "on October 1, 1984, federal grants for construction and upgrade of municipal water and sewer plants were decreased from 70 percent to 55 percent of total costs."[25] The consequences of the decline of fund sources for future urban water supply projects were noted by Dick Whittington, administrator for Region VI of the United States Environmental Protection Agency (EPA):

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[23]Kyle E. Aschilling, "Urban Water Systems: Problems and Alternative Approaches to Solutions," In: Selected Work in Water Conservation and Water Quality Planning. Edited by James E. Crews, and James Tang. U. S. Army Corps of Engineers, Institute of Water Resources, (Washington, D.C.: May, 1981), pp. 441-442.

[24]U.S. Congressional Budget Office, Efficient Investments in Water Resources: Issues and Options, (Washington, D.C.: August, 1983), p. 21.

[25]"Ravan: Time has come for Privatization," American Water Works Association Mainstream, (November, 1984), p. 8.

> Nationwide, neither states nor cities could generally afford needed projects. . . .the most likely solution is to decrease water demand on municipal water systems through more efficient use of water resources permanently available to them.[26]

Moreover, the administrative processes by which water projects are evaluated, authorized, and funded are long and complex, often resulting in project delays of up to 25 years; in the meantime leaving water needs unmet.[27]

In summary, the above mentioned factors have shaped new roles for the federal, state, and local governments regarding the consideration and evaluation of a broader range of alternatives to balance water supply and demand. Therefore, it is important to recognize the distinct responsibilities and roles that each level of government brings to municipal water conservation problems. The existing roles in water conservation of these levels of government are outlined in the following sections.

Federal Role

At the federal level, President Lyndon B. Johnson, on November 12, 1968, sent to Congress his first National Assessment of the Nation's Water Resources under the Water Resources Planning Act of 1965. His report contained the following remarks: "A nation that fails to plan intelligently for the development and protection of its precious water will be condemned to wither because

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[26]Oklahoma Water Resources Board, Water: A Time for Action, Conference Summary. The Governor's Second Annual Water Conference (Oklahoma City, Oklahoma: 1982), p. 9.

[27]G. E. Galloway, Jr., Impediment of Federal Water Resources Projects: Why All the Delay and What Can We Do About It? Consultant Report Prepared for the United States Water Resources Council, (September, 1981).

of its short sightedness."[28] Less than a decade later, President Carter, on May 23, 1977, updated and sharpened the focus on the problem of excessive water use and the issue of water conservation. His message to Congress contained the following remarks:

> In the arid west and across the entire nation, we must begin to recognize that water is not free--it is a precious resource. As with our energy problems, the cornerstones of the future water policy should be wise management and conservation. . . .We need comprehensive reform of water resource policy with conservation as its cornerstone.[29]

This statement suggested that an increased federal role in water resource management should: 1) strengthen state and local government awareness of the problems associated with increasing demands on the national water resource; and 2) promote programs for water conservation through technical and financial assistance. To facilitate water conservation implementation, the 95th Congress authorized a 10 million dollar program in fiscal year 1980 for technical assistance for conservation activities.[30] Further, the increased federal role in encouraging water conservation practices at the state level was reflected by the effort of the U. S. Water Resources Council in developing the State Water Conservation Guide. The main objective of the guide was to accomplish efficient water use by extending federal technical and financial assistance to

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[28] National Assessment of the Water Resources Council, (Washington, D.C.: The United States Government Printing Office, 1968), p. 77.

[29] Federal Register, Vol. 42, No. 136 (1977), p. 36794.

[30] U. S. Congress, Amendments to the Water Resources Planning Act of 1965, (Washington, D.C.: September 20, 1979).

the states and, through the states, to local governments.[31] However, this guide is not designed to be used as written by individual states, but simply as a general guide to water conservation planning.

The goal of President Reagan's Administration is for major responsibilities for water programs such as planning and technical assistance to be returned to the states. If implemented, this should mean that planners of future water construction projects should seek greater efficiency in the use of the water stored, transported, and treated in order to control costs. Unfortunately, federal water resource management policies which stress state and local self-sufficiency, conservation, and planning have not seemed to have the funding incentives which are associated with structural solutions. Therefore, states and local governments will have to pursue appropriate conservation or water supply management policies to meet their future needs for water without much monetary assistance from federal sources.

State Role

In addition to the changes in the federal government's role in dealing with the urban water supply situation, new orientations in state and local urban water management policies have been emerging as a response to certain conditions in recent years.

In response to the continuing decline in federally funded water projects, the State of Oklahoma has enacted new laws and policies that are intended to

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[31] U. S. Water Resources Council, State Water Conservation Guide, (Washington, D. C.: The United States Water Resources Council, October, 1980).

lead to improvement in the efficiency of water use. For example, the Oklahoma Water Resources Board was authorized by the state legislature:

> To develop statewide and local plans to assure the best and most effective use and control of water to meet both the current and long-range needs of the people of Oklahoma; . . . and to aid, at all times, counties, incorporated cities and towns, and special purpose districts in the state in promoting and developing . . . water conservation in the state.[32]

The above law will grant the Oklahoma Water Resources Board a valuable opportunity to expand its conservation activities. Among the activities of the Oklahoma Water Resources Board in carrying out this charge is the provision of current municipal and rural water suppliers with necessary information on available conservation measures for obtaining efficient use of water supplies.[33]

Some of the best water conservation efforts of state and local governments were presented at the Oklahoma Annual Governor's Water Conference in 1981. A common theme in the presentations at the conference was to bring together the best ideas on what we need to do now to assure sound water management for the year 2000 and beyond. Results of the annual conferences sponsored by the Oklahoma Water Resources Board have helped to foster a more informed public and local water official awareness of the water management issues facing Oklahoma.

Historically, the support given by the Oklahoma Water Resources Board to water conservation by municipalities has been quite limited. From time to time,

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[32]Oklahoma Statute 82: 108S.2 (Supp. p. 1-82).

[33]James W. Schuelein, Public Water Supply Conservation Guide, Pub. No. 106, Oklahoma Water Resources Board, (Oklahoma City: September, 1981).

the Oklahoma Water Resources Board issued water conservation tips in the form of brochures for outdoor, kitchen and laundry, bathroom, agriculture, and industrial water use. The Oklahoma Water Newsletter,[34] (April, 1982) contained an essay on landscaping and how it can aid in reducing water use. The main message of the essay is that Oklahomans should be encouraged to consider plants that can survive without much water as a part of structuring a water conservation program.[35] The implementation of such conservation tips will help reduce water waste. Additional recent conservation activities of the Oklahoma Water Resources Board included tying the approval of grants and loans to municipalities with the potential changes in their pricing policies.[36] In other words, the guidelines stated that when it is time to approve applications for grants, a municipality which could change its water charges from declining block rate to increasing block rate will be considered ahead of those municipalities who are not willing to make such changes. Another water conservation activity of the Oklahoma Water Resources Board was the designation of May 4, 1982 as Water Awareness Day, a day on which concerned state agencies, businesses, and manufacturers displayed water conservation devices and a great variety of printed water conservation materials in the State Capitol Building, in Oklahoma City.

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[34]Oklahoma Water Newsletter, "Landscaping? Choose Native Plants to Reduce Water Use," (Oklahoma City, Oklahoma: Printed by the Central Printing Division of the State Board of Public Affairs, April, 1982), p. 1.

[35]Ibid., p. 3.

[36]Oklahoma Water Resources Board, "Emergency Grant Priority System," Unpublished Guidelines, (No. Date Provided), 8 pages.

Local Role

In Oklahoma, efforts have been made to promote water conservation awareness among the public and water managers of various municipalities across the state. With a water conservation slogan, "Don't Desert Tulsa,"[37] the city of Tulsa and its Waterworks and Sewage Division listed several uses which may waste water under normal conditions and how such waste could be reduced through certain water conservation measures. The Oklahoma Water Newsletter, (April, 1982), reported a summary of results produced by the implementation of a water conservation program in Tulsa during the dry summer of 1981. The program included an educational campaign, brochures, and billboards. Teachers were also trained to teach water conservation to students. It was reported that Tulsans used an average of 18 million gallons less water per day during the summer of 1981 than in the summer of 1980.[38] Municipal water rationing in Oklahoma has been practiced to reduce the use of water during dry summers.[39] The reason for this move was that several Oklahoma cities and towns have experienced water shortages (maps 2 - 5) during recent droughts (1980-1984) and many more anticipate an inadequate water supply within the next few decades due to growth and gradual supply depletion. However, the formulation and implementation of emergency conservation measures during drought periods are

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[37]Tulsa Waterworks and Sewage Division, "Tulsa's Water: How to Save Until Rainy Days," (Tulsa, Oklahoma: 1981).

[38]Oklahoma Water Newsletter, "Tulsa's Conservation Program Lingered to Become a Life Style," Monthly Newsletter of Oklahoma Water Resources Board (April, 1982), pp. 2-3.

[39]Oklahoma Water Resources Board, Planning and Development Division, "Water Supply Conditions in Oklahoma," (August 1981, 1982, 1983, 1984).

1980 DROUGHT

Local Water Problems In Oklahoma

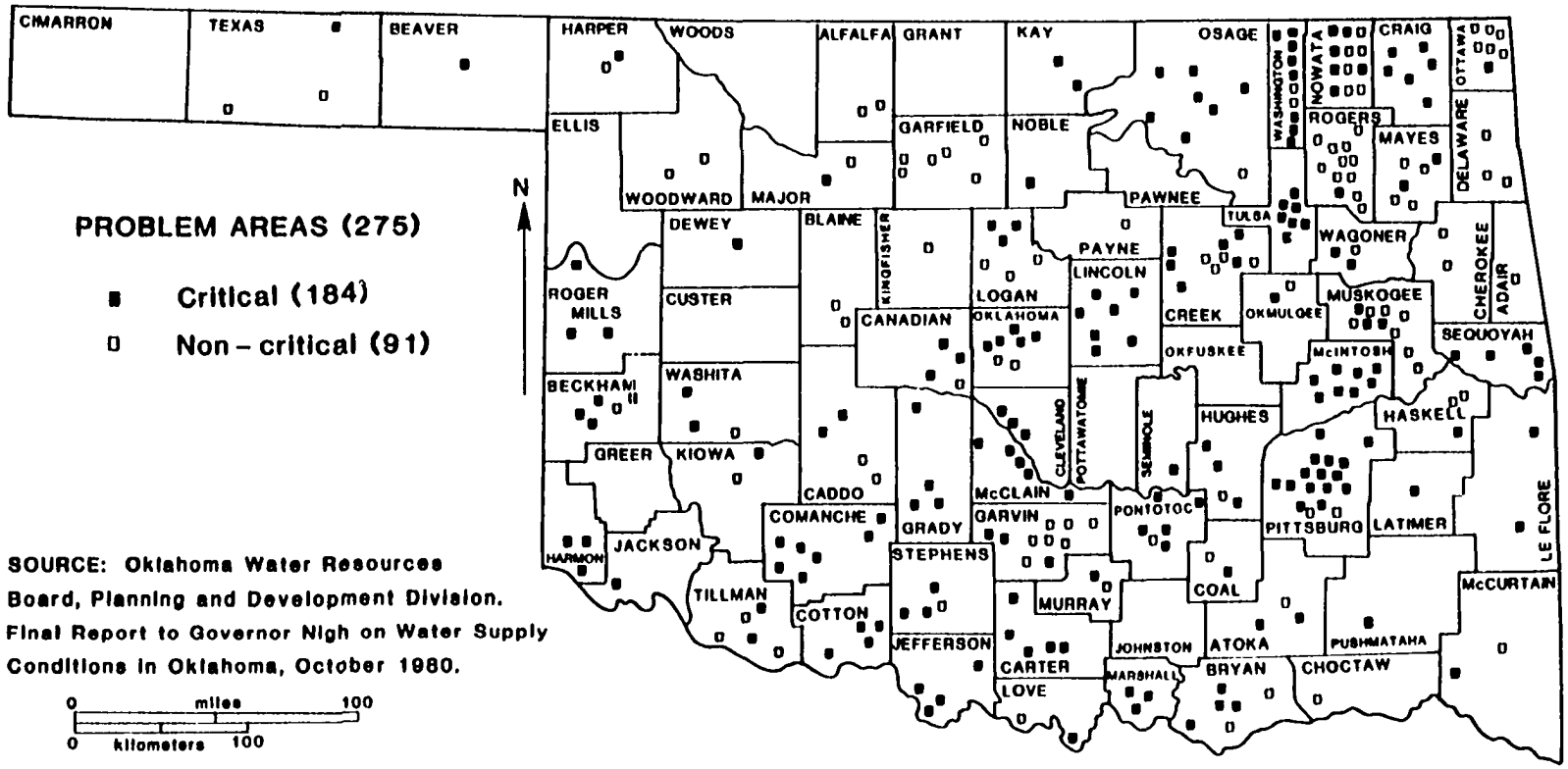


Figure 2

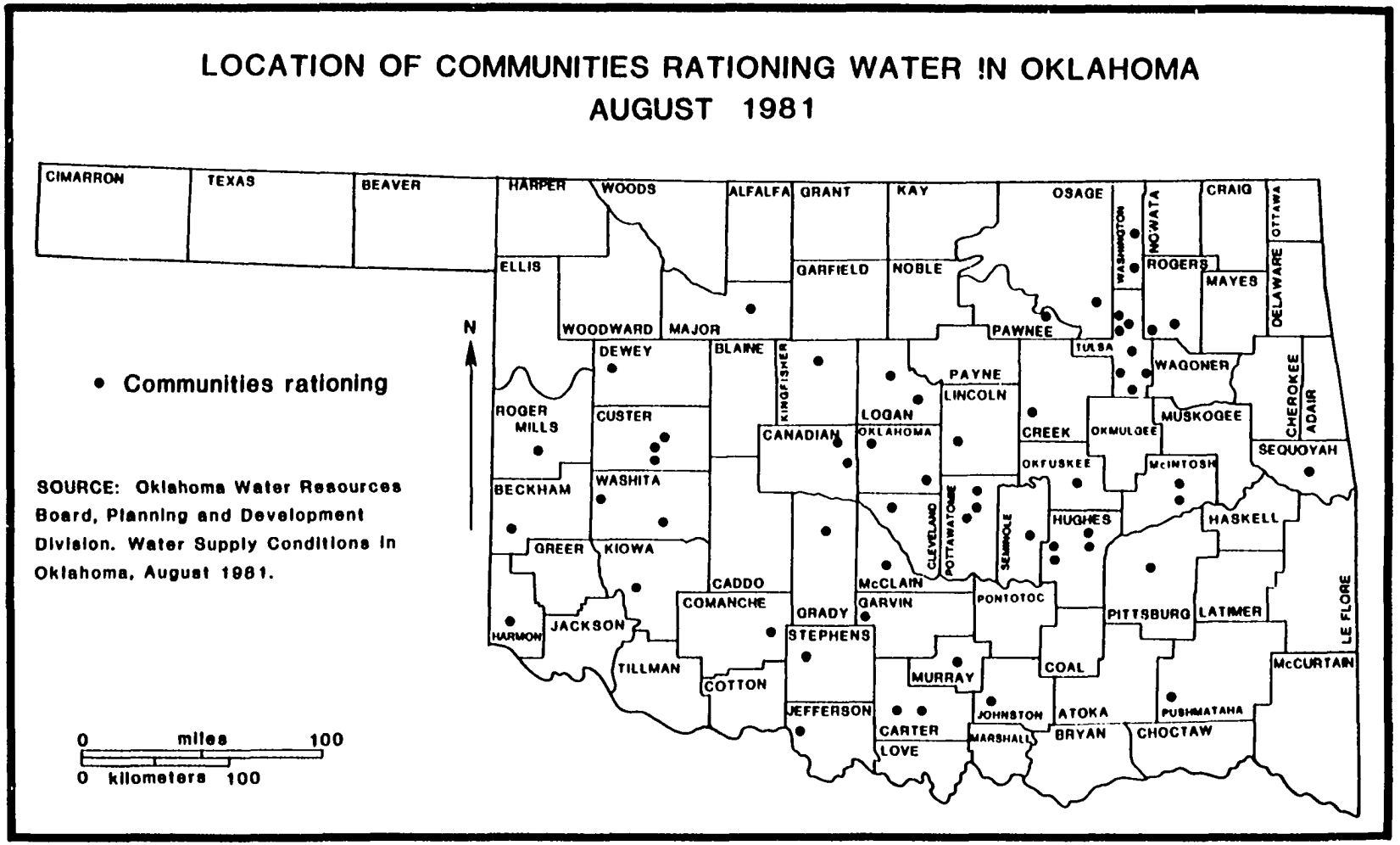

LOCATION OF COMMUNITIES RATIONING WATER IN OKLAHOMA
AUGUST 1981
• Communities rationing
SOURCE: Oklahoma Water Resources Board, Planning and Development Division. Water Supply Conditions in Oklahoma, August 1981.
N
0 miles 100
0 kilometers 100
CIMARRON
TEXAS
BEAVER
HARPER
WOODS
ALFALFA
GRANT
KAY
OSAGE
WASHINGTON
NOWATA
CRAIG
OTTAWA
ELLIS
GARFIELD
NOBLE
ROGERS
MAYES
DELAWARE
WOODWARD
MAJOR
PAWNEE
TULSA
WAGONER
DEWEY
BLAINE
KINGFISHER
PAYNE
LINCOLN
CHEROKEE
ADAIR
ROGER MILLS
CUSTER
LOGAN
CREEK
OKMULGEE
MUSKOGEE
CANADIAN
OKLAHOMA
OKFUSKEE
McINTOSH
SEQUOYAH
BECKHAM
WASHITA
CLEVELAND
POTTAWATOMIE
SEMINOLE
HUGHES
HASKELL
GREER
KIOWA
CADDO
McCLAIN
GARVIN
PONTOTOC
PITTSBURG
LATIMER
LE FLORE
HARMON
JACKSON
COMANCHE
GRADY
STEPHENS
TILLMAN
COTTON
MURRAY
COAL
McCURTAIN
JEFFERSON
CARTER
JOHNSTON
ATOKA
PUSHMATAHA
LOVE
MARSHALL
BRYAN
CHOCTAW

Figure 3

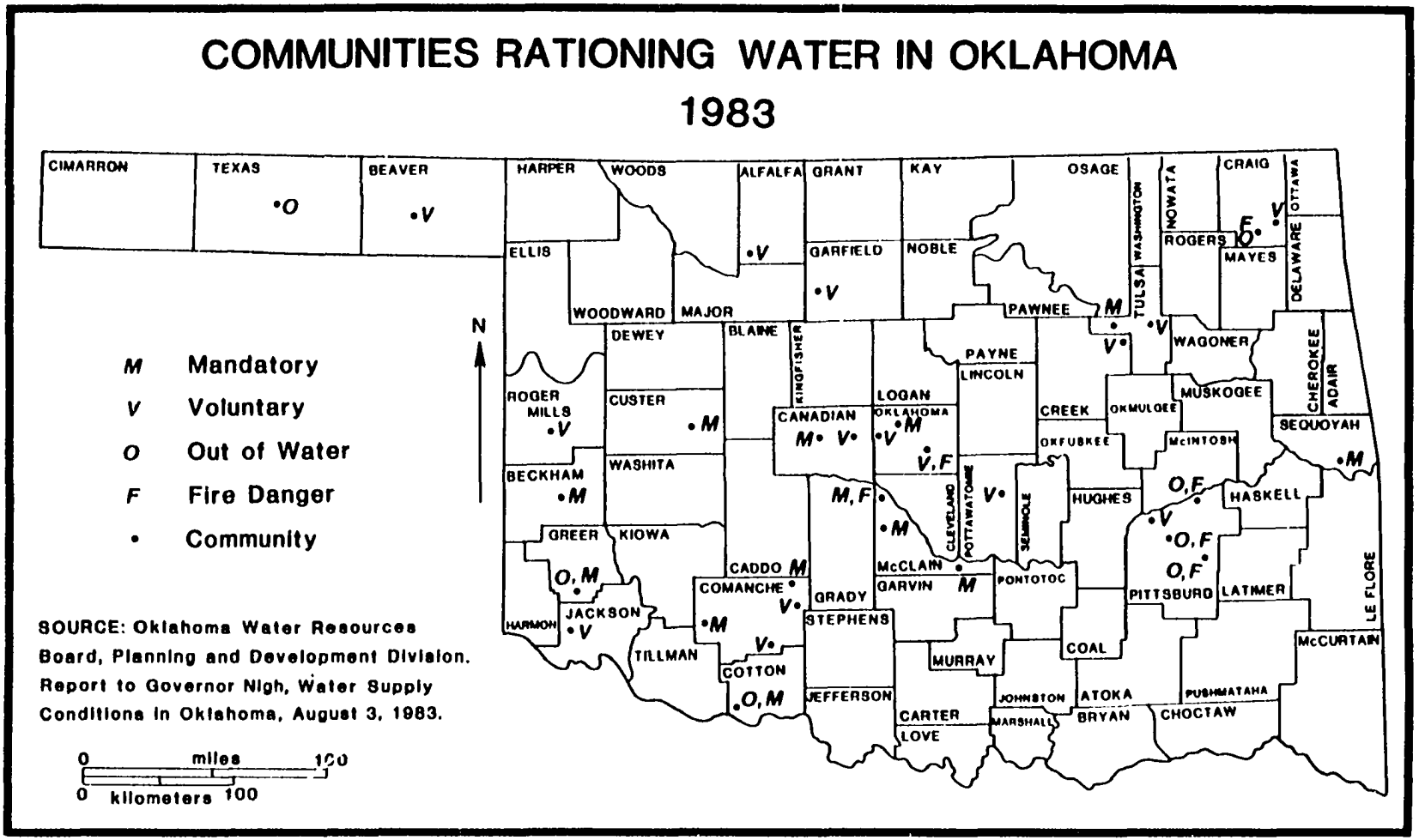
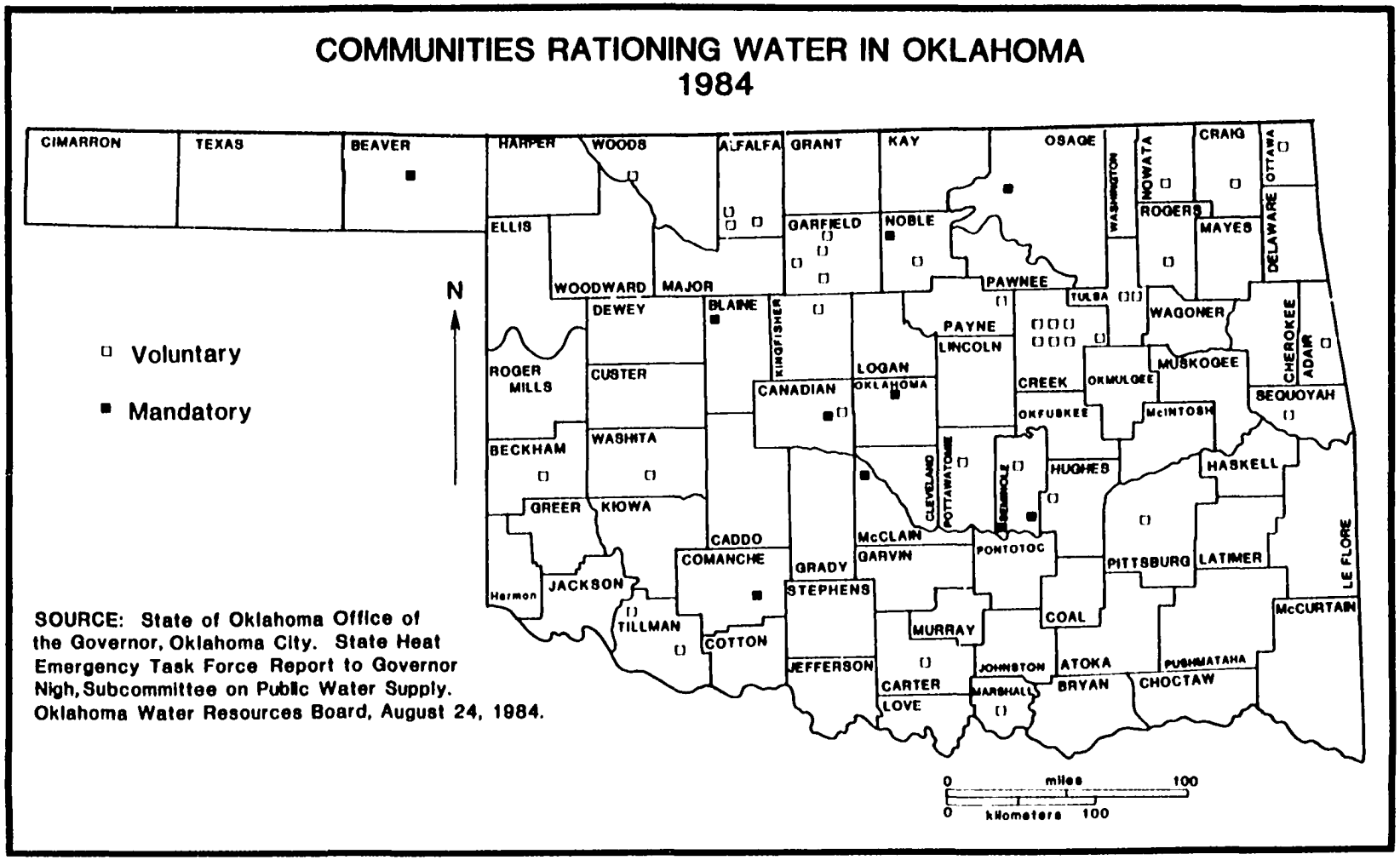

COMMUNITIES RATIONING WATER IN OKLAHOMA
1983
M Mandatory
V Voluntary
O Out of Water
F Fire Danger
• Community
N
SOURCE: Oklahoma Water Resources Board, Planning and Development Division. Report to Governor Nigh, Water Supply Conditions in Oklahoma, August 3, 1983.
0 miles 100
0 kilometers 100
CIMARRON
TEXAS
BEAVER
HARPER
WOODS
ALFALFA
GRANT
KAY
OSAGE
CRAIG
NOWATA
OTTAWA
WASHINGTON
ROGERS
MAYES
DELAWARE
TULSA
ELLIS
GARFIELD
NOBLE
PAWNEE
WOODWARD
MAJOR
DEWEY
BLAINE
KINGFISHER
PAYNE
LINCOLN
WAGONER
CHEROKEE
ADAIR
ROGER MILLS
CUSTER
LOGAN
CANADIAN
OKLAHOMA
CREEK
OKMULGEE
MUSKOGEE
SEQUOYAH
OKFUSKEE
McINTOSH
BECKHAM
WASHITA
CLEVELAND
POTTAWATOMIE
SEMINOLE
HUGHES
HASKELL
GREER
KIOWA
CADDO
McCLAIN
PONTOTOC
PITTSBURG
LATIMER
LE FLORE
COMANCHE
GARVIN
GRADY
JACKSON
HARMON
STEPHENS
TILLMAN
COTTON
MURRAY
COAL
McCURTAIN
JEFFERSON
JOHNSTON
ATOKA
PUSHMATAHA
CARTER
MARSHALL
BRYAN
CHOCTAW
LOVE

Figure 4



SOURCE: State of Oklahoma Office of the Governor, Oklahoma City. State Heat Emergency Task Force Report to Governor Nigh, Subcommittee on Public Water Supply. Oklahoma Water Resources Board, August 24, 1984.

Figure 5

soon forgotten in times of abundant precipitation. Water users may not respond to the call for voluntary water conservation during the emergency shortages brought about by a heat wave or major pipeline rupture. This situation occurred during the summer of 1983 when the Saturday Oklahoman and Times reported that "Oklahoma City residents aren't responding to the call for voluntary conservation measures during the current heat wave."[40] On the same page of the newspaper, all residents were urged to comply with the voluntary conservation efforts.

Many municipalities across the state have suffered when their wells went dry, and they then encountered delays in obtaining funding for repairs to their water systems. Asher and Sasakwa are recent examples of what is going on in such small communities (water shortages and inadequate water facilities).[41] Problems of funding are frustrating to such small communities. Those small towns needing financial assistance for their water improvements had the choice of applying to the Oklahoma Department of Community Affairs or applying for a loan from the Farmers Home Administration (FHA) in more lengthy procedures.

More specifically, the financial situation of several municipalities across the state has been focused on by one water manager who is involved in the water management in small communities in Oklahoma. Don Morrison, a roving city manager for five Central Oklahoma towns, stated that:

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[40]The Saturday Oklahoman and Times, "Conserve or Face Rationing," (July 30, 1983), p. 18.

[41]The Sunday Oklahoman, (May 6, 1984), p. 7.

> "I would think the majority of towns in Oklahoma are facing some type of water problem. They simply have not had money in the past to make the improvements and they can't go for another sales tax hike to pay for things."[42]

Accordingly, water managers may shift their perspective away from the traditional water supply augmentation approach to the consideration of implementing water conservation/rationing measures. By and large, their attempts to modify the demand for water were generally made only when coping with drougnts and water distribution disruption. Such measures were designed and implemented to yield short term water use reductions pending a structural solution such as the development of new water sources and water treatment plant expansion.

Under these financial circumstances, one may conclude that developing a long-term water conservation program is a desirable option. Such long-term water conservation measures should not depend on private, voluntary action for success; but rather, conservation might be achieved by measures within municipal water management's control. Consequently, water conservation measures requiring the most intensive participation or habit changes by water users might be implemented during dry periods and non-drought conditions. Therefore, water managers who seek immediate action toward the formulation and implementation of long term conservation measures are making a major shift in thier water management philosophy at the municipal level. Thus, the stances and perspectives of water utility managers become critical in such water management decisions, in addition to the traditional factors of costs, technical feasibility, and environmental quality.

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[42] Ibid., p. 7.

Organization of the Study

The introductory chapter deals with the problem and its setting, and also gives ideas about objectives and significant of the study. Chapter Two examines previous research efforts, especially those related to municipal water conservation. The third chapter deals with the methodology of the study, data collection, field survey of the selected communities, and the statistical method employed in this study. Chapter Four presents the results and interpretation of the relationships existing between the dependent and independent variables. Chapter Five, presents a comparative discussion of water managers' attitudes and other elements of the study, focusing on the similarities and differences of managers' views on existing state policies on conservation. Chapter Six outlines major conclusions of the study and the recommended conservation measures.

CHAPTER II

PAST MUNICIPAL WATER CONSERVATION STUDIES

Introduction

This chapter is divided into two parts. In the first part the author will look back over the last decade or so of research on the planning and management of municipal water supplies in order to trace the main streams of development that have led to the present state of municipal water conservation and management research. The second part of this review is devoted to long-term municipal water conservation issues to which have been paid scant attention in published research.

Although the major studies concerning municipal water conservation frequently overlap, these types of studies can be classified and discussed in the following order:

1. Applications of economic concepts to municipal water use.
2. Water conservation as a new consideration to be incorporated into municipal water system planning.
3. New emphasis on problems of municipal water reuse.
4. New emphasis on the efficiency of implementing emergency water conservation programs at the municipal level.
5. New emphasis on local water officials views on municipal water conservation management strategies.

The above topics are not the only ones dealt with in the literature. The urban water demand and conservation topics were examined thoroughly by many scholars. Forecasting water use and analysis of water use patterns are some examples of studies considered outside the scope of this review. Instead, the emphasis is placed on issues more centrally related to this study. Therefore, the remainder of this chapter will focus on issues pertaining to the potentiality of implementing long-term water conservation measures at the local level.

Application of Economic Concepts to Municipal Water Use

During the late 1970s and early 1980s, several scholarly articles set out in detail the economic theory relevant to municipal water conservation and demonstrating it's applicability and significance by means of case studies. For example, Walski[1] addressed the issue of long run foregone water supply costs. He referred to long run foregone costs that may result from savings in capital, operation, and maintenance costs of existing water supply facilities due to implementing water conservation measures. The author's principal question is whether these costs are generally proportional to the reduction in water use. Although he outlined difficulties in applying economic theories to the water industry, his message is still clear in a way that water managers or planners need to quantify these foregone water supply costs of implementing conservation measures.

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(1) Thomas M. Walski, "The Nature of Long Run Cost Savings Due to Water Conservation," Water Resources Bulletin. Vol. 19, No. 3 (June, 1983), pp. 489-498.

The potential of promoting water conservation by taxing water users has been examined from the prospective of economic theory by Renshaw,[2] who proposed an excise tax for the purpose of promoting water conservation rather than generating additional funds to finance water facilities expansion. Furthermore, he suggested that excess revenues could be rebated to low income families and non-profit institutions against their water bills. However, refunding such revenues requires devising a fair system of rebating taxes to various low income households.

The estimation of the cost effectiveness of water saving devices to homeowners was examined from the perspective of economic theory by Lippiatt and Weber.[3] They based their estimation of dollar value of a unit of water conserved on the marginal price rather than on the average price. They found that the use of an average price for estimating a unit of conserved water leads to overinvestment in water saving devices. Therefore, they concluded that "the accurate indicator of a homeowner's benefit from saving a unit of water is a marginal price."[4] This is possibly true because they used the weighted average of more than one rate schedule from a national sample. But, if they were to have based their calculations on the local level, the results would have been different. The use of average prices as an indicator of the dollar value of a

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[2]Edward F. Renshaw, "Conserving Water Through Pricing." American Water Works Association Journal. Vol. 74, No. 1, January 1982. pp. 2-5.

[3]Barbara C. Lippiatt, and Stephen F. Weber, "Water Rates and Residential Water Conservation." American Water Works Association Journal, Vol. 74, No. 6, June 1982. pp. 278-281.

[4]Ibid., p. 281.

unit of conserved water will lead to underinvestment in water saving devices. To prove this point, one assumes that a water utility is charging its customers on the basis of an increasing block rate structure. Thus, the price of the first 3,000 gallons of water is $5; for the second block (3,001 to 5,000 gallons of water) the price is one dollar per 1,000 gallons; for the third block (5,001 to 6,000) the price is $1.25 per 1,000 gallons of water; for the fourth block (6,001 to 10,000) the utility charged $1.50 per 1,000 gallons of water. If one assumes that a family's monthly use of water is 7,000 gallons, according to the utility pricing policy, its total bill is $9.75, the average price per 1,000 gallons is $1.39, and the marginal price is $1.50 per 1,000 gallons. If one assumes also that in the next month he uses 6,000 gallons of water, the total bill will be $8.25. Therefore, when it consumes one unit of water (1,000 gallons) less, its bill decreased $1.50 which is equal to the marginal price, while the average price per 1,000 gallons of water is $1.39. Thus the average price is less than the actual bill reduction. Therefore, the average price in this case will lead to underinvestment rather than to overinvestment in water conservation.

The application of economic concepts in practice was illustrated by Griffith,[5] who reported that the Water Authority of Fairfax County, Virginia, developed a common sense water conservation and cost allocation policy. The Water Authority adopted several water conservation activities including informing the customers of unusually high consumption prior to billing; issuing flow restriction devices at no cost to the rate payer; submitting plumbing code revisions; and imposing utility peak use charges to lower the maximum peak

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[5]Fred P. Griffith, "Policing Demand Through Pricing," American Water Works Association Journal, Vol. 73, No. 6 (June, 1981), pp. 288-291.

demand. As a result of plumbing code revisions adopted by the Authority, it was expected that "about 10 percent" reduction in water use would be achieved over 50 years. Additionally, as a result of implementing the peak usage pricing option, the Authority attained a "six percent reduction in water sales which represents a potential of 14 percent reduction in (water) plant size and a 6 to 12 percent reduction in reservoir or supply capacity."[6]

The above reviewed articles are distinguished not only for their continuous contributions in bringing economic theory to bear on municipal water problems, but also because they made a crucial effort to communicate research results to persons involved in the decision making process, whatever their professional backgrounds might be.

There have been other contributions relating to the economic and management aspects of municipal water conservation. Perhaps the most important among them came not from the academic and research communities but from within federal and state government agencies. For instance, Sparks,[7] who is affiliated with the Oklahoma Water Resources Board, provided a brief description of various water rate structures. Sparks found that the decreasing block rate structure is imposed by about 75 percent of Oklahoma's rural water systems. A number of alternative rate structures have been suggested by Sparks for the purpose of promoting water conservation. Among these structures which have been used before in numerous areas throughout the United States are the

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[6]Ibid., pp. 289-290.

[7]Terri G. Sparks, Water Rates and Rate Structures in Oklahoma, (Oklahoma City, Oklahoma: Oklahoma Water Resources Board, October, 1981).

summer surcharge rate; excess water use charge; life line rate; marginal cost pricing; daily peak load; and increasing block rate. Although the author failed to indicate how a water utility can switch to any one of the suggested rate schedules, the implementation of the above mentioned rates is a reasonable step in using pricing to induce conservation.

Water Conservation as a New Consideration to be Incorporated into Municipal Water System Planning

The economic aspects of municipal water conservation were not the only concerns of previous research. Current investigations into the possibility of incorporating water conservation into the planning of municipal water systems are beginning to exert a significant influence on the future course of municipal water development. The major goal of this research is to assess the potential effects of integrating water conservation on traditional municipal water planning concepts. Such goals will lead to identifying ways that will minimize the potential stress of municipal water shortages and create new growth opportunities.

Sharpe[8] stressed the idea that water conservation should not be turned to only in times of shortages. Further, water conservation should be incorporated in municipal water plans as a long term option. But he did not offer enough information on how a water utility planner can incorporate water conservation measures as integral elements of urban water plans. Sharpe also foresaw that

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[8]William E. Sharpe, "Why Consider Water Conservation?" American Water Works Association Journal, Vol. 70, No. 9 (September, 1978), pp 475-479.

water utility managers someday will be forced to consider water conservation as "a management tool applicable to all times and all areas in the country."[9] This anticipated future course of municipal water planning will be realized by water managers because of the inflationary costs of expanding their water facilities. These costs may pose a threat to the revenue stability of a given utility.

Consideration of new alternatives, especially water conservation, have been deemed recently as integral elements of efficient management of urban water supply planning. Ellis[10] identified a number of new considerations that should be incorporated into the planning of municipal water systems. One of these new considerations is water conservation. The author assessed the potential effects of water conservation in a descriptive manner. Ellis reached a practical conclusion that the inclusion of water conservation in future municipal water plans depends upon the special needs and size of the community and the capability and expertise of the planning staff in each municipality. Baumann and Boland[11] developed an excellent methodology to assist the water planner in considering water conservation measures for possible integration into water supply plans. The same authors published a report sponsored by the Institute of Water Resources of the United States Army Corps of Engineers in which they developed a methodology[12] that evaluates the efficiency of certain water

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[9]Ibid., p. 478.

[10]Robert H. Ellis, "New consideration for Municipal Water System Planning." Water Resources Bulletin. Vol. 14, No. 3 (June 1978), pp. 542-553.

[11]Duane D. Baumann, and John J. Boland, "Urgan Water Supply Planning," Water Spectrum, Vol. 12, No. 3 (Fall 1980).

[12]Duane D. Baumann, John J. Boland and John H. Sims, The Evaluation of Water Conservation for Municipal and Industrial Water Supply: Illustrated Example, (I.W.R. Virginia: U.S. Army Corps of Engineers, February, 1981).

conservation measures. Also, their publication provides a means of determining the sector of water users that will be affected, how much it will cost, and whether or not it will be beneficial to implement a water conservation measure. Though the developed methodology provides an acceptable means of quantifying the effects of conservation measures on water use, still the user of their techniques many face the problem of quantifying the intangible effects of certain conservation measures.

New Emphasis on Problems of Municipal Water Reuse

Implementation of conservation programs is one alternative in tackling municipal water problems which is essential in order to strike a balance between demand and supply. Another alternative that may be considered by municipalities is water reuse. Research on aspects of water reuse, including costs and social acceptability, has been carried out recently by Horne,[13] McCarty and Polmer.[14] These investigators argued that reuse of municipal wastewater can be a valid solution in areas of water deficiency, especially when used for agricultural purposes. They ruled out the possibility of using reclaimed municipal water for domestic purpopses before evaluating the safety of reclaimed municipal wastewater. However, the Denver Water Supply Authority seriously considered this potential supply source after a great deal of research had been done on their one million gallon a day potable water reuse

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[13]F. Wiley Horne, et al "Water Reuse Projecting Markets and Costs," American Water Works Association Journal. Vol. 84, No. 2, February 1982, pp. 66-75.

[14]Perry L. McCarty and S. Polmer, "Working Toward Potable Reuse of Municipal Wastewater," Water & Sewage Works, Vol. 127, No. 11, November 1980, p. 14.

research had been done on their one million gallon a day potable water reuse demonstration plant.[15] The ultimate goal of the study will be "to obtain information on the feasibility of proceeding with the design and construction of a 100-mgd (million gallons per day) potable water reuse plant in the Denver area."[16]

New Emphasis on the Efficiency of Implementing Emergency Water Conservation Programs at the Municipal Level

Many municipalities across the United States have not adopted water reuse alternative because of its huge capital investment and because of fears concerning public acceptability of this treated water. Instead, municipalities which encountered frequent decline of their water supplies and could not afford building new reuse facilities chose the option of formulating emergency water conservation programs in order to minimize the stress of water shortages.

Reports and articles published in scientific journals document a range of successes of various emergency/rationing water conservation measures. Recent evaluations of water conservation programs implemented in Missouri were undertaken by Reed. The author concludes that "voluntary water conservation could not assure long-term reductions in water use during periods of extreme heat and drought."[17] because, during such conditions, the demand for water will increase

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[15] W. H. Miller, "Direct Potable Reuse: An Untapped Resource," Water and Sewage Works, Vol. 27, No. 11 (November, 1980), pp. 14 and 69.

[16] Ibid., p. 69.

[17] Gregory D. Reed, "Drought - Related Water Conservation Efforts in Missouri," American Water Works Association Journal, Vol. 74, No. 3 (March, 1982), p. 125.

in some types of domestic uses such as lawn watering and swimming.

Bruvold[18, 19] reached similar conclusions when he investigated the effectiveness of implementing emergency water conservation programs in San Francisco, California. He reported that a 20 percent reduction in water consumption has been attained because of implementing certain mandatory water conservation measures. He found that in areas suffering the most severe water shortages, one major incentive to conserve water was by way of penaity charges. Therefore, his recommendation was that water conservation should be mandatory rather than voluntary.

Unlike voluntary water conservation programs, mandatory water conservation programs are considered to be more likely to attain substantial water savings and to be more effective in achieving dramatic reductions during the water peak demand period. During the 1977 drought, two Iowa communities adopted voluntary conservation programs and ten communities adopted mandatory water conservation programs. Lee[20] found that although mandatory programs with per capita based restrictions were most effective in reducing water use, two communities achieved substantial reductions in water consumption while practicing voluntary measures. He explained this outcome by the

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[18] William H. Bruvold, Consumer Response to Urban Drought in Central California, Final Report, (California: June, 1978), pp. 58-66.

[19] William H. Bruvold, "Perception Influences Water Conservation Success," Water and Sewage Works, Vol. 127, No. 2 (February, 1980), p. 34.

[20] Motokoy Lee, Mandatory or Voluntary Water Conservation?: A Case Study of Twelve Iowa Communities During Drought, (Ames, Iowa: Iowa State University, 1981).

extreme water shortages in these communities. Further, he concluded that "the key to successful water conservation seems to be the credibility of water shortages, rather than penalties per se."[21]

The effectiveness of both voluntary and mandatory conservation measures were explored by Abbott and others.[22] The authors obtained similar results, concluding that both voluntary and mandatory measures can be effective. Furthermore, they concluded that most water users are willing to conserve water in an emergency but, due to their ignorance of the local water supply situation, they lack the capability to reduce their water use during non-emergency conditions. An earlier study on the effectiveness of imposing stringent conservation measures was carried out by Bolman,[23] whose analysis showed that the 1976 imposed restrictions on outside water use, achieved a 25 percent reduction in total water use in Marin Municipal Water District, Marin County, California.

The degree of success of implemented emergency water conservation programs depends partly on consumer's awareness of an impending water crisis and the consumer's positive cooperation in cutting his or her water use.

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[21] Ibid., p. 12

[22] H. E. Abbott, K. G. Cook, and R. B. Sleight, Social Aspects of Urban Water Conservation, (Washington, D.C.: Office of Water Resources Research, United States Department of Interior, August, 1972).

[23] Frank Bolman, and Melinda A. Merritt, "Community Response and Change in Residential Rationing Measures: A Case Study - Marin Municipal Water District," In: Selected Works in Water Supply, Water Conservation and Water Quality Planning, Edited by James E. Crews, and James Tang, (Virginia: Water Resources Institute, U.S. Army Corps of Engineers, May, 1981), pp. 365-369.

However, water reduction may fail to be sustained for a prolonged time because water use may increase as soon as the dry period ends. In this regard, a report published by the New England River Basin Commission concludes that "water use reductions achieved during crisis do not usually continue once the drought has ended. Consumption will increase once the immediate crisis is over."[24]

New Emphasis on Local Water Officials' Views of Municipal Water Conservation Management Strategies

Whatever results are achieved from such emergency water conservation programs, the question lingers as to what is the best and most effective approach to attaining steady, long term water savings on a non-emergency basis. Changes in consumers' habits to eliminate water wastes and their attitudes toward water conservation are well investigated and documented in the literature.[25] However, a few recent investigations have analyzed the managerial

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[24]New England River Basin Commission, Before the Well Runs Dry: A Handbook for Designing a Local Water Conservation Plan, Sponsored by the U.S. Dept. of Interior, Geological Survey, Resource and Land Investigation Program, (Boston, Massachussets: October, 1980).

[25]For examples see: S. H. Hanke, and John J. Boland, "Water Requirements or Water Demand," The American Water Works Association Journal, Vol. 63, No. 11 (November, 1971), pp. 677-681: R. C. Camp, "The Inelastic Demand for Residential Water: New Findings," The American Water Works Association Journal, Vol. 70, No. 8 (August, 1978), pp. 453-458: Walter J. Primeaux, and Kenneth W. Hallman, "Factors Affecting Residential Water Consumption: The Managerial Viewpoint," Water and Sewage Works, Vol. 121, No. 3 (March, 1974), pp. 138-144: George A. Watkins, "A Sociological Perspective of Water Consumers in Southern Florida Households," Florida Water Resources Center, Publication No. 18 (Gainsville, Florida: University of Florida, 1972).

environment and the stance of water managers on following the course of conservation as an integral element in municipal water supply planning. For example, Sawyer[26] conducted a survey of 35 Maryland water utility managers to obtain insight into the prevailing attitudes toward water conservation. He found that most managers continue to view conservation only as a short-term option to temporary supply problems. The enumerated factors that contribute to Maryland water managers inaction are political, economical, institutional and time constraints. Attitudes of the water managers toward water conservation in general were found to be similar in the southwest and the arid west. For instance, Moomaw and Warner[27] tested the idea that water conservation practices that reduce water systems revenues are unlikely to be adopted. To do so, they examined the actual experience in five southwestern communities along the Red River. They suggested that to increase the likelihood of the adoption of certain water conservation measures that reduce revenues, federal and state subsidies should be obtained. Water use and water managers' attitudes toward implementing water conservation in 25 eastern slope communities of Northern Colorado were examined by White et al.[28] They found that water managers in

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[26]Stephen W. Sawyer, "Conservation Practices and Attitudes Among Maryland Water Supply Managers," Water Resources Bulletin, Vol. 28, No. 5 (October, 1982), pp. 791-796.

[27]Ronald L. Moomaw, and Larkin Warner, "The Adoption of Municipal Water Conservation: An Unlikely Event," Water Resources Bulletin, Vol. 17, No. 6 (December, 1981), pp. 1029-1034.

[28]Anne U. White, A. N. Dinatale, Joanne Greenberg, and J. Ernest Flack, Municipal Water Use in Northern Colorado: Development of Efficiency of Use Criterion, Completion Report, Office of Water Resources and Technology, Colorado State University, (Ft. Collins, Colorado: Colorado Water Resources Institute, 1980).

their study area are not prepared to implement water conservation measures to reduce water use unless their communities are facing severe and prolonged drought conditions. They suggested implementing comprehensive metering, restricting lawn size, imposing new plumbing codes, and creating new changes in the prices of water by local water managers.

Summary

The issue of municipal water conservation has received much attention in recent years in a number of countries, particularly in the United States. Current research has investigated and reported on recent conservation and rationing efforts as a result of severe droughts and increased demand for water. Various articles reported rates of water use reduction from implementing water conservation measures under specific circumstances. In other words, different water conservation methods were designed and implemented for the needs of particular municipalities. Therefore, water reductions vary as a function of the manager's skill, commitment, his/her perceived need to save water, and the water users' cooperation. Thus, an attempt to transfer the experience of one municipality to another will be unsuccessful in the absence of very similar baseline circumstances.

Moreover, current water conservation programs already implemented throughout the United States mainly pertain to emergency circumstances requiring immediate and major short term reductions in water use. Water conservation in Oklahoma follows this national pattern but problems in some Oklahoma municipalities differ from these emergency situations. Some municipalities across the state of Oklahoma have substantial water storage capacity and even in a

relatively dry period water utilities could meet their customers' prudent needs comfortably. However, during prolonged dry periods demands for water may increase to the point of bringing on problems of water transfer and treatment facilities inadequacy.

By and large, some of the reported reductions in water use have been achieved through changes in the water users' habits. However, such savings are never sustained over a long period of time. Long term (permanent) reductions in water use have been accomplished in a few places as a result of the installation of water saving devices and water distribution system improvements.[29,30] In this regard, William Bruvold, in his analysis of policy lessons from the California drought, reached the following conclusions:

> The best and most effective approach to residential use may come from steady, long-range, methodical programs carried out in a non-emergency atmosphere. This idea augers well for long-term residential conservation of water . . . In fact, an approach that focuses on a short-term crisis may not be as effective as preparing for long-term reductions.[31]

Bruvold's view regarding the limitations of a short-term water conservation approach is valid because short-term water conservation programs were guided by trial and error approaches. Therefore, in order to avoid the pitfalls of a trial and error approach to implementing water conservation methods, municipalities may need to develop effective long-term water conservation programs. Such

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[29]Seattle Water Department, Seattle Comprehensive Regional Water Plan, Vol. XI: Summary: Water Conservation Program, (Seattle WA: March, 1980).

[30]East Bay Municipal Utility District, Some Rather Unusual Ideas for Saving Water, (Oakland, California: 1977), 18 pgs.

[31]William H. Bruvold, "Residential Water Conservation: Policy Lessons from the California Drought," Public Affairs Report (California: December 1978).

programs will yield continuous reductions in water use in accordance with selected water conservation measures.

Water conservation efforts that have attained the most visibility in the United States have generally been in major metropolitan areas. For example, major conservation practices were implemented in Washington, D. C.; Boulder, Colorado; Los Angeles, California; Dallas, Texas; and Tulsa, Oklahoma.[32,33,34,35,36] The consistent implementation of long-term water conservation measures have been tailored to major urban users and large water utility districts. In most small and medium sized cities and towns, the staff does not have the expertise and time to formulate and implement permanent or long-term water conservation measures. Originally, such towns and cities have responded to increased demand for water by expanding existing water facilities with intensive capital expenditures. The rising cost of extending water supply capacities to serve their new customers may necessitate the consideration of a number of water policy options in municipal water supply planning.

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[32]Arthur P. Brigham, "A Public Education Campaign to Conserve Water," American Water Works Association Journal, Vol. 68, No. 12 (December, 1976), pp. 665-668.

[33]S. H. Hanke, "Some Behavioral Characteristics Associated with Residential Water Price Changes," Water Resources Research, Vol. 6, No. 5 (October, 1970), pp. 1383-1386.

[34]F. I. Griffith, Jr., "An Equitable Rate Structure Relation to Conservation and Wastewater Flow Reduction," American Water Works Association Journal, Vol. 72, No. 11 (November, 1978).

[35]I. M. Rice, and L. G. Shaw, "Water Conservation: A Practical Approach," American Water Works Association Journal, Vol. 70, No. 9 (September, 1978).

[36]U. S. Army Corps of Engineers, Tulsa Urban Study, Draft Water Supply, Stage II Study, (Tulsa, Oklahoma: 1981).

This review of the literature on municipal water conservation reveals the following major findings:

1. Municipal water conservation can be a cheap or cost-effective approach to water management. This implies that creating a unit of water by eliminating waste can be less expensive than creating a unit of water by expanding the existing water supply system.
2. Water conservation elements can be relatively easily incorporated into the planning process of municipal water suppliers.
3. Emergency water conservation efforts (mandatory and/or voluntary conservation programs) may not generate long-term reductions in water use.
4. Water managers are not prepared to implement permanent water conservation programs unless their communities are facing severe and frequent drought and major water shortages.
5. Water conservation options that may reduce net revenues are unlikely to be adopted.

Until the early 1970s, studies regarding the basic determinants of adopting conservation as a long range strategy by municipal officials were conspicuously absent from the literature. More specifically, research efforts concerning the specific incentives and disincentives of implementing and adopting certain water management strategies by water managers have lagged well behind the rapidly changing supply and demand scenarios. Investigations were of a very broad nature and were concerned mostly with incentives which influence the adoption of specific conservation measures by water users. What is clearly absent in the literature are studies of management attitudes

influencing adoption of long-term water conservation policies. This study examines such attitudes and is a first step in filling this research gap.

If the major goal of water managers is to reduce water waste and ameliorate the need for future water supply projects, it may be crucial to adopt long-term water conservation practices with full consideration of the factors that influence their implementation. Such factors could be institutional, political and economical. Knowledge of water policy makers' attitudes toward considering conservation as a long range strategy in municipal water supply planning may direct the investment planning decision and may increase the overall equity and efficiency in the coordination of short and long range water supply and demand planning objectives.

CHAPTER III

METHODOLOGY

Introduction

This chapter is devoted to the discussion of data collection procedures and methods of statistical analysis. The basic research method consisted of a questionnaire which was mailed to each water manager in the selected 60 communities in Oklahoma. The questionnaire, which was designed especially for the purposes of this study, was completed by 49 of the 60 water managers employed by the selected communities. Data obtained from the completed questionnaires were analyzed using a cross-tabulation statistical procedure to produce a clear understanding of factors influencing water managers' attitudes toward adopting or rejecting certain water conservation options. Due to the paucity of past water conservation studies, especially those concerning water officials' attitudes toward the adoption of water policy options, this study sought such information needed in order to carry out the objective set forth in Chapter I. Knowledge of local water policy makers' attitudes toward considering conservation as a long range strategy in municipal water supply planning will direct the investment planning decisions and will increase the overall equity and efficiency in the coordination of short and long range water supply and demand objectives.

Data Collection

Data about the selected cities have been acquired from different sources such as The Oklahoma Water Resources Board, municipalities themselves, Farmers Home Administration, Oklahoma Water Coalition, Department of Economic Affairs (DECA) of Oklahoma, and the Oklahoma Municipal League. Water managers or water officials in each municipality were contacted by either telephone or pre-questionnaire letter. When the preliminary work was completed, written contacts were made with water managers included in the selected towns and cities. The contacted manager in each case was identified as the person responsible for water allocation, facilities construction and conservation or rationing activities. A preliminary inspection of the Oklahoma League of Municipalities Directory[1,2] showed that, in small and medium sized water systems, the likely responsible water official is frequently the town manager or mayor. In the larger municipalities, the key water official is usually a full time employee whose professional responsibilities relate entirely to water system operations. These people were informed about the purpose of the study and called to participate in the study. In those cases where the respondent failed to respond in the first round, a follow-up questionnaire and more detailed letter were mailed to the water manager (Appendix II).

The content of the questionnaire (Appendix II) cosisted of four sections.

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[1]Oklahoma Municipal League, 1984-1985 Directory of Oklahoma's City and Town Officials, (Oklahoma City, Oklahoma: July, 1984).

[2]Oklahoma Municipal League, 1985-1986 Directory of Oklahoma's City and Town Officials, (Oklahoma City, Oklahoma: July, 1985).

The content of the questionnaire (Appendix II) consisted of four sections. The first section sought general information regarding the respondents' professional experience, educational level, his perceived water supply adequacy, current water related problems encountered by the studied municipalities, past and current water conservation measures implemented regularly at the municipal level, and information on who should undertake research responsibility for dealing with water supply and demand problems in the selected municipalities.

The respondent's professional experience was believed to be a good indicator of the nature, breadth, and depth of conservation activities in which he or she is engaged. The length of the manager's experience may also reflect the degree of his or her exposure to pro-conservation policies during his or her professional career. Further, the respondent's educational level and his or her training background may reflect his or her stance on the issue of adopting water conservation in the future. For instance, a water manager who had previous training which emphasized structural solutions in dealing with water supply conditions may give little attention to certain water conservation policy options

The reason behind asking the respondent about his judgement of the adequacy of water supplies is that it was felt that one's water conservation attitude may be a function of how he perceived the water supply conditions prevalent in his or her municipality. Water managers were questioned about current water-related problems because the experience of such problems was considered to be important in determining varying sorts of water-related problems (such as adjusting water rates, capital funding, water quality, water leakage, problems in obtaining federal and state assistance to promote water conservation, and recent water shortages, if any, experienced by the studied

water systems) were considered to be important in determining future water conservation recent water shortages, if any, experienced by the studied water systems) were considered to be important in determining future water conservation directions by a given municipality. Specifically, it was intended to tap what type of water problems of certain intensity are salient to future conservation action. For example, it might be the case that simply having experienced a capital funding problem is insufficient to bring about long-term changes in water conservation strategies. But perhaps capital funding of a certain intensity is sufficient to determine whether or not a connection exists between noteworthy water problems experienced by the water management in Oklahoma and its water conservation efforts.

Knowledge of on-going water conservation activities was considered to be essential in identifying which municipalities are already involved in implementing some type of conservation policy options. Having been involved in implementing temporary water conservation during recent years may influence potential adoption of long-term water conservation measures. Likewise, respondents' views on who should hold primary responsibility for research in dealing with their municipal water demand and supply problems was considered to be a good indicator of the potentiality of adopting certain water management policies. For instance, adoption and implementation of a pressure reduction program in a given community should be preceded by a feasibility study to determine its costs-benefits outcome and its social acceptability. If the given municipality happened to be at a disadvantage in terms of its financial situation in carrying out the study, the chance of adopting the pressure reduction measure might be minimal or even nonexistent.

The second section of the questionnaire sought to measure the degree of water officials' support for a number of water management options. These options were: development of new water supply sources, implementing water conservation on a regular basis, limiting the number of water users, using treated wastewater for drinking and non-drinking purposes, transferring water from nearby communities, and implementing temporary (rationing) water conservation programs. The reason for presenting the respondents with more water policy options than simply water conservation is to eliminate or reduce bias from the questionnaire. These were considered later on as the dependent variables in the analysis. Therefore, they need minimum justification since the objective of the study was set to identify the determinants of their adoption.

The third section emphasizes the degree of effectiveness and political acceptability of certain water saving measures for a particular community. The reason behind this line of questioning is that when a certain measure (such as water reuse) was perceived to be ineffective and politically unacceptable, the probability its adoption would be small.

Finally, the fourth section of the questionnaire explored the anticipated difficulties in adopting water conservation and the types of state assistance that would be most needed in planning for a balance between demand and supply.

The first, second, and third rounds of the questionnaires were mailed in July, 1985. Of 60 questionnaires mailed, 54 were returned. Of these, three were incomplete and two were returned during the data analysis. This left a total of 49 completed questionnaires employed in the data analysis.

Data Processing

The justification of variables to be considered in this analysis (Table I) should include a suitable explanation of why more variables were not chosen. The following paragraphs offer evidence in support of the selected variables and reasons for not obtaining more.

The dependent variables such as water officials' attitudes toward adopting a number of water policy options (such as developing new water supply sources, implementing long term water conservation measures, limiting the number of water users, treated water reuse for drinking and non-drinking purposes, transferring water from nearby communities, and implementing temporary water conservation) need only minimum explanation. The task originally set forth was to investigate the change in the prospects of adopting and implementing long-term water management options by Oklahoma water managers. By observing the change of such prospects throughout the selected municipalities in Oklahoma, a pattern may emerge to indicate what municipalities will follow the course of a particular type of water management approach and those who follow some other course. Such an observation may also indicate preferred water policy option patterns among the selected municipalities. Here then, lies the root of the problem. The degree of preferability in the prospect of adopting and implementing a long-term water conservation option as a parameter, for instance, will allow one to demonstrate that a variability will take place.

A number of potential explanatory or independent variables have been considered in this study. The perceived adequacy of water supply conditions by respondents in the given municipality is the first independent variable to be justified. Justification of this parameter could be stated according to one's

TABLE 1

A LIST OF VARIABLES INCLUDED IN THE ANALYSIS

A:	Independent Variables

1. Length of the respondent's service in the community
2. Education level
3. The perceived water supply adequacy
4. Whether or not a given water utility has experienced increased water rate problem
5. Capital funding problem
6. Water quality
7. Water quantity
8. Water losses in the system
9. Problems in obtaining federal assistance to promote comprehensive water conservation programs.
10. Problems in obtaining state assistance in promoting water conservation
11. The availability of trained staff
12. Water shortages
13. Changes in rate structure option
14. The perceived degree of effectiveness of adjustment in water rate structures option
15. The perceived degree of effectiveness of comprehensive metering option
16. The perceived degree of effectiveness of pressure reduction option
17. The degree of perceived effectiveness of leak detection and repair option
18. The degree of perceived effectiveness of water reuse option
19. The degree of effectiveness of education
20. The degree of political acceptability of increased water rates option
21. The degree of political acceptability of comprehensive metering option

(Table 1, continued)

22. The degree of political acceptability of pressure reduction option
23. The degree of political acceptability of leak detection and repair option
24. The degree of political acceptability of water reuse option
25. The degree of political acceptability of education
26. The degree of political acceptability of changes in water rate structure
27. Lack of sufficient funds as a difficulty in adopting water conservation measures
28. Inability/lack of planning staff to design and implement water conservation programs
29. Lack of data base as an difficulty in adopting water conservation measures
30. Potential reduction in water systems net revenue as a difficulty in promoting water conservation measures
31. Legal constraints as a difficulty in adopting water conservation measures
32. Political constraints as a difficulty in adopting water conservation

B:	**Dependent Variables**

1. The respondent's attitude toward development of new water supply sources option
2. The respondent's attitude toward implementing water conservation practices on a regular basis
3. The respondent's attitude toward limiting the number of water users in the service area
4. The respondent's attitude toward adopting treated water for drinking purposes
5. The respondent's attitude toward water transfer option
6. The respondent's attitude toward implementing temporary/rationing conservation option

common sense. One may assume that water officials who live in communities that depend upon ground water as a major source of supply and located in semi-arid areas where the average precipitation, of which the ground water replenishment rate is less than the quantity of water withdrawn in a given year, tend to implement more long-term conservation strategies than do those in humid areas. This justification may confirm one's expectations that those water managers with a scarce water supply tend to be more supportive of the water conservation approach.

The length of the water manager's experience is the second independent variable to be considered. This variable will be measured by the number of years the respondent held his position in the water utility. The reason for including this parameter as an independent variable is because it may reflect any given water manager's views of conservation activities in which he engaged. In more general terms, it also may reflect the water manager's attitude and values toward the whole philosophy of implementing water conservation alternatives.

The third independent variable to be viewed is the education level of the water manager. Reasons for inclusion of this parameter are strong. Analysis of this variable might give a fairly complete idea of whether the respondent is committed to a pro-conservation stance or not. Also, the importance of this variable will serve as a check on the quality of the decision making process regarding water conservation issues.

The perceived effectiveness and political acceptability of certain water conservation measures (such as increased water rates, leak detection and repair, pressure reduction, metering, water reuse, and education) were considered as

independent variables to be employed in this study. The perceived degree of effectiveness and political acceptability may indicate the complexity and structure of particular options for the water decision-making entity. One may assume that if a certain measure happened to be perceived as both inefficient and politically unacceptable, the chance of its adoption would be slim. It is contended always that developing robust conservation strategies requires a positive perception of the local feasibility of certain measures in order to adopt and implement such strategies.

Finally, other independent variables to be considered in this study are the number of related water problems, especially those related to both water quality and quantity aspects, faced by municipalities. The importance of each as an independent variable can be realized because it has important spatial variations that will make for a clearer interpretation of the likelihood of implementing conservation as a long range strategy in municipal water supply planning in Oklahoma. It has been demonstrated, therefore, that justification exists for the variables selected.

One might reasonably ask at this point, however, why are not more variables chosen. The answer that must be given does not excuse the researcher from the problem, but only gives him a rain check to add other variables later in the case of future analysis. The answer to the above question is known to anyone who has tried to collect detailed information for a research study from public officials. One may realize that because of the always busy schedules of such officials, it is not always easy to obtain the required information when it is requested. A lengthy questionnaire and prearranged interview seeking excessive information may discourage the full attention of such public figures.

In this case, the researcher will be forced to collect limited, but necessary, information to achieve the goal of the investigation.

Having identified and justified the dependent and independent variables included in the study, the next phase of analysis was to explore the major determinants influencing the likelihood of adopting a given water policy option as dependent variables. Since the questionnaire items or variables form distributions, in other words, they are distributed across some range of values or options, the first step in processing the obtained data is to describe the distributions of each variable. Frequency tables were used to actually show the entire distribution. The distribution was described by indicating the number and percent of respondents who answered each item on the questionnaire. The use of frequency tables provided a very complete picture of the distribution of data for the variables. The percentages of distribution were employed in the data analysis chapter because they are more easily interpreted and can be compared from one item on the questionnaire to the next even though they may be based on different total frequencies. The statistical tool (single frequency) and analysis discussed earlier allowed us only to portray or to describe individual items. By doing so, it satisfied the information needed in the analysis phase; but also, it was of interest to explore the relationship between the independent and dependent variables. The two-way cross-tabulation tables were employed to indicate the relationship between the dependent and independent variables. Therefore, tables were generated by statistical analysis system computer program[3] for analysis of the obtained data. The purpose of employing this

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[3]SAS Institute, Inc., SAS User's Guide: Basics, Version 5 Edition, (Cary, North Carolina: 1985).

statistical procedure was to show whether or not the distributions of one variable differ significantly for each value or level of other variables. Assessment of the relationship between variables was accomplished by the use of cross-tabs.

Analysis of the open-ended questions can be conceptualized as involving two phases. First, water officials' statements and views were abstracted and ordered. A number of views were expressed by water officials. The state's role in encouraging and fostering water conservation and type of resistance to or resentment of higher government levels of authority (county, state, and federal government) in handling water conservation issues were analyzed because this helped in the identification of philosophical attitudes of water managers regarding the implementation of certain conservation measures at municipal levels.

Having identified who holds which attitudes and having a sense of what attitudes prevail among the water managers, each and every specific water management policy option has been examined in the next chapter. For example, who would be in favor of implementing leak detection and why; who would be opposed to it and why; and what incentive could be offered to change water managers' minds. Are the water managers in any agreement on implementing long-term conservation alternatives? If not, what options do they plan to adopt in their communities? These are the kinds of questions to be asked and the data obtained can at least begin to help us answer in the next chapter.

CHAPTER IV

DATA ANALYSIS

Introduction

The purpose of this chapter is to analyze attitudes of the water management officials in the selected municipalities in Oklahoma on a number of water policy options that can be considered in dealing with future water demands. This analysis was based on the information obtained from a detailed questionnaire completed by water managers in 49 municipalities. The questionnaire covered general information such as the respondent's education level, water management experience, recent water related problems encountered by the selected communities, and research responsibilities for related water problems. The questionnaire also covered current water conservation practices employed, the perceived degree of efficiency and political acceptability of certain water conservation options, and the anticipated difficulties in adopting water conservation. This chapter is divided into three major sections. The first section examines a number of personal characteristics of respondents and how they are related to water management's attitudes toward adopting water conservation policies. The same section also explores factors that are most important in determining water officials' attitudes in dealing with water supply problems.

The second part of this chapter examines how the respondents' attitudes toward a given water policy option vary with location. The final part of this chapter examines whether or not the water officials' attitudes are a function of certain factors (problems) such as lack of funds and the extent of perceived efficiency and political unacceptability of certain water policy options.

Analysis of Single Frequencies

Respondent's Personal Characteristics

Water managers were asked about their experience and education. The respondents had served at their water utility positions for up to 37 years. The mean level of experience was 9.5 years, but 33 of 49 water officials had less than 10 years experience, and 18 had less than 5 years experience. Statistical analysis indicated that length of experience had little impact on attitudes toward water conservation practices.

One-half of the respondents have graduated from college (Bachelor of Arts or Bachelor of Science) and nearly one-fourth of the respondents have received graduate training. Again, statistical analysis indicated a lack of relationships between the respondents' education levels and their attitudes toward water conservation. This might be due in part to the fact that the majority of respondents were probably trained in educational systems that were not committed to a pro-conservation stance. Further, the lack of relationship between education and water management attitudes on conservation policies may be due to the possibility that water officials are not receptive to the logic that it is government that should bring about water conservation because of anticipated minimum cooperation of customers.

Respondents were also asked to characterize the quantity of the local water supply as "inadequate", "adequate", or "abundant." Almost two-thirds of the respondents viewed their water supplies as adequate or abundant, while only one water official in three viewed them as inadequate (Table 2).

TABLE 2

DISTRIBUTION OF RESPONDENT'S PERCEPTION OF WATER ADEQUACY

Perception of Water Quantity	Percent of Respondents	Number of Respondents
Inadequate	32.7	16
Adequate	53.0	26
Abundant	14.3	7
	100%	49

The Perceived Adequacy of Water Supply Conditions

Simple correlations indicate that the perception of water supply adequacy is significantly related to three major options the water management may consider for future policies (Table 3). These measures are developing new water supplies, implementing water conservation on a regular basis, and limiting the number of water users. Those who describe their water supply as less than adequate tend to implement limiting the number of water users, to feel more favorable toward developing new water supplies and to favor implementing long term water conservation strategies. These results suggest that such perceptions of current water supply inadequacy act as powerful levers in setting activities in motion, at least for the short run.

TABLE 3

ASSOCIATION BETWEEN MANAGERS' PERCEPTION OF THE ADEQUACY OF WATER SUPPLIES AND THREE POLICY VARIABLES

Variable Name	r
Developing New water supplies	0.37*
Implementing long term water conservation	0.29*
Limiting the number of water users	0.59*

*Significant Statistically at 0.05 level.

The Extent of Water Problems Currently Encountered by the Selected Communities

Water officials were asked whether they had experienced recently any noteworthy problems related closely to the perceived adequacy of their water supplies. Specifically, they were presented with problems such as increased water rates, capital funding, water quality, water quantity, water losses in the system, the extent of federal and state assistance in implementing water conservation programs, the availability of trained staff capable in designing and implementing water conservation alternatives, water shortages, and changes in rate structure.

Three major water-related problems were indicated by a majority of respondents that they have recently faced in their respective communities. Data revealed that 79 percent of water the managers who completed the questionnaire had experienced difficulties in changing water rates. In general it is

difficult to change water rates not justified by cost increases. Even if such change occurs, a major surplus in net revenues might be generated. In this case, the water utility would be viewed by the public as a profit maker leading to immediate pressure for rate reduction. In conclusion, resistance to water rate hikes at the local level is quite likely, and water officials probably perceived price induced water use reductions might only be temporary. On the other hand, it is not surprising that 75 percent of respondents have faced capital funds problems in recent years, and 75 percent have experienced water systems leakage problems. That a large percentage of water officials were exposed to such problems lends added importance to any relationship that might be discovered between such experience and subsequent water conservation activities.

Research Responsibilities of Water Supply Problems

The next item on the questionnaire attempted to explore who should hold the major responsibility for research efforts dealing with water supply and demand problems in the selected municipalities. The data revealed that two-thirds of the respondents indicated that local government should take this responsibility. Thus, local government was ranked first as an appropriate authority in conducting water supply management research. One may imply that the majority of communities favored doing such research locally rather than with federal or state assistance. However, 65 percent of respondents believed that state water agencies should also bear major responsibility for researching water supply matters. Moreover, state involvement in researching water supply and demand problems was favored by those water managers who declared themselves in need of state financial, technical, and legal assistance.

Water Officials' Attitude Toward a Number of Water Management Policies

Identification of current water related problems experienced by the selected municipalities and the perceived future research efforts dealing with such problems may shed some light on water management attitudes toward future adoption of certain water policy options. In general, developing new water supplies seems to be an attractive option. Fifty-three percent of water managers were strongly in favor of developing new water supplies. The preferred method of meeting future water demands for the selected municipalities seemed to be to acquire additional water supplies. Whenever such options were perceived as impossible, or the inadedquacy of their water supplies was perceived as a short run problem, then local water utilities would consider other options. Water conservation on a regular basis was strongly favored by 43 percent of the water officials. Interestingly, a majority of water officials were not in favor of limiting the number of water users, and resorting to water reuse for drinking and water reuse for non-drinking purposes as potential options in dealing with future water needs under any circumstances.

Ninety-eight percent of the respondents considered limiting the number of water users to be an unrealistic option. This, for them, is a question of the benefits of conservation versus the cost of losing revenues and they may then conclude that benefits do not exceed costs. Another potential explanation is that water management resisted favoring this option on the grounds of not violating the policy of providing a low cost water supply as a universal right to all who move to a community and that growth should not be retarded due to limited water resources. Treating wastewater for drinking and non-drinking

purposes was also opposed as an option by an overwhelming majority (94%) of water officials. Such results were expected because it was seen as an unfeasible course of action by respondents who have neither the technology nor evidence of the acceptability of water reuse on the part of the general public.

Current Water Conservation Practices in the Selected Communities

In order to understand the extent of existing water conservation practices, respondents were presented with a number of water conservation measures (water rate adjustment, comprehensive metering, pressure reduction, leak detection and repair, water-saving devices, education, and water reuse) and asked whether these measures have been implemented on a regular basis. Data indicated that metering was employed by nearly three-quarters of the communities. Comprehensive metering, though not in itself a water conservation option, is linked to water rates that might affect consumption levels, and to detection of leaks. Those respondents (28%) who have not employed metering regularly might feel that it is too costly and difficult to install meters in older buildings. Also, it was probably as politically dangerous to try to force customers to pay installation costs; and, it is likely that those who currently have not employed metering regularly have a concern that the system's revenues were likely to drop.

The leak detection measure was ranked second to metering in terms of its frequency of implementation by water managers. Almost two-thirds of the water officials indicated that they have implemented leak detection and repair measures regularly. It seems that water managers were in favor of implementing

water conservation measures (metering and leakage reductions) under their own department control, which would not require any burdensome lifestyle changes among the water consumers.

Measures that were implemented regularly by a few communities were education (4%), installing water saving devices (8%), adjusting water rate structures (12%), pressure reduction (16%), and increasing water rates (24%). One should bear in mind that all of these measures required water users' approval and their cooperation. Further, most of these measures could be perceived to have direct costs to the water system. Previous figures suggested that the majority of municipalities have been using water conservation measures (metering and leak detection and repair) which require little effort to implement. On the other hand, municipalities with limited supplies, practiced more of the water conservation measures such as adjusting water rate structures, pressure reduction, and increasing water rates. Further, one may speculate that municipalities that do not practice more of conservation techniques may have peculiar evaluations regarding the degree of efficiency and political acceptability of such water conservation techniques.

The Perceived Efficiency and Political Acceptability of Certain Water Conservation Measures

Two items in the questionaire were designed to emphasize major dimensions of selected water conservation measures, namely efficiency and political acceptability. Interestingly, water conservation measures that currently are employed regularly by the majority of water officials were usually judged as

efficient by the majority of respondents. For example, 81 and 68 percent of water officials judged leak detection and metering respectively as efficient management tools. As expected, water pressure reduction and water reuse measures were evaluated by more than one-half of the respondents as ineffective measures in achieving substantial water savings. One may speculate that pressure reduction was judged to be an inefficient measure because water officials probably thought the same amount of water would be used regardless of pressure level. Also, probably pressure reduction was perceived as unfair to a few customers having locational disadvantage served by a given utility. Water reuse was evaluated by 63 percent of respondents as an inefficient management tool. This was not a surprising result when one bears in mind that it was likely to have been evaluated from the perspective of costs involved, technological availability, and public acceptability. The degree of public acceptability is likely to be determined by the perceived amenity loss by the customers through knowledge of what they were drinking.

While adjusting water rates was considered by 58 percent of water officials as an efficient tool in achieving water savings, 62 percent of the respondents assessed this measure as unacceptable politically. Probably it was felt by water management that it would be politically dangerous to try to force customers to pay more. Further, adjusting water rates might hurt large water users such as major industrial and commercial establishments.

The pattern of responses regarding the efficiency evaluation mirrors the pattern of responses of political acceptability of the measures. Put another way, those measures that were judged to be effective were judged also to be acceptable politically. For example, data indicated that comprehensive metering

and leak detection and repair measures were judged by 75 and 85 percent, respectively, as politically acceptable, while water reuse was evaluated to be politically unacceptable by 74 percent. This implies that respondents are linking efficiency with political acceptability of water reuse because they are expected not to try to force the public to use treated wastewater or to pay the costs. Consistently, adjustments in water rates were judged by 58 percent of respondents as an efficient management tool and, at the same time, 38 percent of respondents assessed this measure as politically unacceptable.

One may conclude that a water conservation technique perceived as inefficient and politically unacceptable is unlikely to be favored by water managers. However, the perceived efficiency and political acceptability were not the only two aspects which lead to their adoption and implementation; certainly, some sort of anticipated difficulties in adopting such measures may preclude their implementation in practice.

The Perception of Anticipated Difficulties in Promoting Water Conservation

Water officials were also presented with obstacles that they may encounter in their attempts to adopt water conservation policies. Pinpointing major difficulties they may face in adopting water conservation is of great value in justifying what of conservation strategies will be adopted in the near future. Moreover, knowledge of perceived difficulties by water managers may help in eliminating them for the purpose of promoting water conservation programs at state level.

Information obtained from the questionnaire indicated that capital funding

was considered as a major obstacle in adopting water conservation policies. Fifty-nine percent of responses indicated that capital funding will definitely be a difficulty in adopting water conservation. This result confirms the expectation that it is easier to issue municipal bonds for developing new water supplies than to design and implement water conservation alternatives. Short-run water supply considerations might dominate long-run conservation considerations. A water conservation strategy will pay off its costs in the long run by delaying expanding the original water supply facilities.

Another major concern indicated by water management is the potential loss of revenues in time of conservation. Sixty-one percent of respondents stated that loss of revenue will definitely be a major difficulty in adopting water conservation. Water officials clearly prefer increasing, or at least stabilizing, the system's net revenues. This is an important concern in the face of decreased state and federal spending on water related projects.

Accordingly, measures which were perceived by water managers as likely to affect a water system's net revenues adversely are unlikely to be adopted. Political constraints were stated by 22 percent of the respondents as a major difficulty in adopting water conservation programs; lack of planning staff (16%), lack of data base (14%), and legal constraints (12%) were considered by water officials as definite obstacles in terms of their impact on promoting water conservation policies. Some of these difficulties might be related to the capital funding problem mentioned earlier. Funds are needed to hire capable experts whose major expertise lies in the domain of designing and implementing water conservation policies. Also, funds are important in building a reliable data base that will serve the process of implementing water conservation programs.

Demonstrating the magnitude of funding problems in facilitating water conservation policies, more than half of the water officials (57%) stated that state financial assistance would be very helpful in planning for a well established water conservation strategy. However, nearly one-third of the respondents indicated that state technical assistance in the form of planning staff and consulting services is also very helpful in planning for water conservation policies.

Summary

In spite of facing increased water rates, capital funding, and water loss problems in recent years, the majority of water utility managers who completed the questionnaire felt the development of new water supplies was still the favored option in meeting future water needs. Implementing water conservation on a regular basis was supported by less than one-half of those who completed the questionnaire. On the other hand, limiting the number of water users and water reuse options were considered by the majority of water officials as unfeasible options to dwell upon, probably because of their perceived efficiency and political acceptability.

In general, it is reasonable to conclude that water conservation options are viewed primarily by water officials as short-run solutions for dealing with a temporary inadequacy of water supply rather than as long-run adjustment mechanisms for reducing the demand for water. The reason for the lack of water management enthusiasm toward implementing water conservation on a regular basis is that water officials were more concerned with satisfying water users' needs than in reducing those needs.

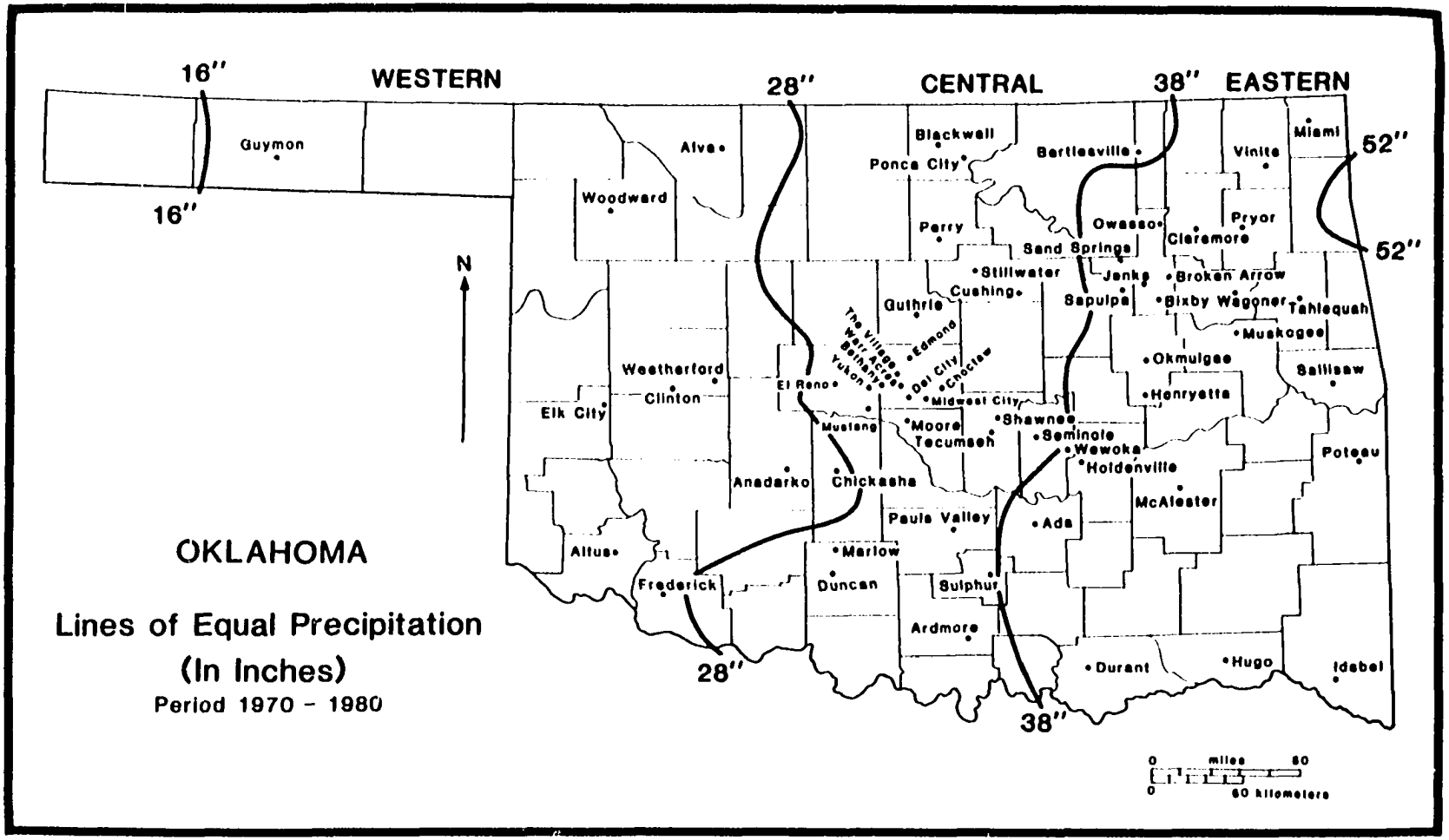
Analysis of the Results by Region

The first section of this analysis addressed perceived current and future water conservation related problems, and water management assessment of the degree of efficiency and political acceptability of certain water conservation options. The analysis in this second section will address the following question: Do these attitudes and problems vary with location of municipalities? One may hypothesize that since there are rainfall variations in various parts of the state, then it is expected one would find significant regional differences in water officials' attitudes toward water management policies.

The first step was to code the responses obtained on a locational basis. Cities located in areas with an average annual precipitation of more than 38 inches were coded as eastern cities; cities located in the areas with 28 to 38 inches average annual precipitation were coded as central cities; and cities located within the zone of less than 28 inches of average rainfall were coded as western cities (map, Fig. 6).

Variations of Water Officials' Perception of their Water Supply Adequacy

Data revealed that there is no significant difference between communities located in the eastern, central, and western parts of the state on perceived adequacy of water supply, adjusting water rates, water quality adequacy, limiting the number of water users served by municipalities, ongoing conservation activities, and the perceived degree of efficiency of leak detection measures. Regarding the extent to which water supplies were perceived as inadequate, 30 percent of municipalities located in the east indicated they have inadequate water supplies, 42 percent of municipalities in the central part of the state


16"
WESTERN
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CENTRAL
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EASTERN
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Guymon
Alva
Woodward
Blackwell
Ponca City
Bartlesville
Vinita
Miami
Perry
Owasso
Pryor
Claremore
Sand Springs
Stillwater
Jenks
Broken Arrow
Cushing
Sapulpa
Bixby
Wagoner
Tahlequah
Muskogee
Guthrie
Edmond
Okmulgee
Weatherford
El Reno
Del City
Choctaw
Midwest City
Henryetta
Sallisaw
Clinton
Elk City
Mustang
Moore
Tecumseh
Shawnee
Seminole
Wewoka
Holdenville
Poteau
Anadarko
Chickasha
McAlester
Paula Valley
Ada
Altus
Marlow
Frederick
Duncan
Sulphur
Ardmore
Durant
Hugo
Idabel
N
OKLAHOMA
Lines of Equal Precipitation
(In Inches)
Period 1970 - 1980
28"
38"
0 miles 50
0 50 kilometers

Figure 6

perceived their water supplies as inadequate, and 30 percent of municipalities located in the western part of the state stated that their water supplies have been inadequate. These results did not confirm the hypothesis that more western municipalities were suffering water supply inadequacy, and few if any eastern municipalities will declare their water supplies inadequate. This may be so because some communities in the western part of the state are more capable financially of developing new water supplies than those located in the eastern section of the state. On the other hand, the high percentage (42%) of communities who perceived their water supply situation as inadequate could be explained by the fact that a number of communities (such as Bethany, Choctaw, Del City, Edmond, Midwest City, Moore, Guthrie, Mustang, and Yukon) depend mainly on the Garber-Wellington aquifer as the major source of city water which is an unreliable source in the long run. According to water experts, although "there is no regional depletion, there may be some problems if too much water is drawn in one location. There can be a local drop in water level that could cause problems since the aquifer which contains fresh water sits atop salt water."[1]

Variations in Current Water Related Problems with Location of Communities

In contrast, regional variation was clearly the case in terms of capital funds availability, water losses problems, problems of obtaining federal and state assistance, the perceived responsibility for research efforts in dealing

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[1] Saturday Oklahoman and Times, "Mysterious Aquifer Supplies Water to Central Oklahoma," (December 22, 1984), p. 28.

with water supply planning, water management attitude on certain future water policy options, the perceived degree of efficiency and political acceptability of certain water conservation options, the anticipated difficulties in promoting water conservation programs, and the preferred state assistance that would likely be most beneficial in promoting water conservation policies.

Results indicated that there is a significant difference in the problem of capital funding in the east as opposed to the western and central parts of the state. One-third of municipalities located in each the east and the central compared to one-fifth of the municipalities located in the west indicated that they have experienced a major problem of capital funding. These results were expected because western communities are better off financially than those communities located in the eastern part of the state. The west has been endowed with a stronger economic base supported by oil and other mineral resources than the eastern part of the state.

In the east, 81 percent of municipalities have experienced overall water line losses as opposed to the central or the western part of the state (66% and 70%, respectively). Water distribution systems in the east are very old, thus the probability of having this sort of problem is high. Alleviation of this problem places the burden of raising funds on eastern municipalities. That is another reason why capital funds were perceived as a major problem in the east.

Variations in the Perceived Research Responsibility of Water Programs by Region

Because the western communities are in better financial condition and have fewer problems with old, leaky systems, it was expected that western

municipalities would be in favor of placing major responsibility for research efforts on local governments in dealing with water supply problems, while the eastern municipalities were expected to prefer state responsibility. Eighty percent of western water managers were in favor of local responsibility and 63% of eastern water managers were in favor of state responsibility. Western water management recognizes that it is capable financially to undertake any future research regarding water resources management; thus, it would like to be left alone.

Variations in Water Managers' Attitudes Toward a Number of Water Policies by Region

Results indicated that there is a significant difference between regions in attitudes toward developing new water supplies. Forty-four percent of eastern municipalities were strongly in favor of developing new water supplies, 60 percent of western municipalities were also strongly in favor of the new water supplies option, and 66 percent of central municipalities were strongly in favor of the new water supplies option. The reason for this significant difference between regions may be that eastern municipalities had sufficient water and would prefer not to plan for further expansion due to the limitations of their financial capabilities. In contrast, western communities were looking for water transfer possibilities and new water sources because they felt they have adequate financial capabilities to initiate new water projects.

It was expected also that more communities in the west would be strongly in favor of implementing water conservation on a regular basis. Local governments in this part of the state need water badly, but probably neighboring

towns and eastern counties would turn down pleas for help. Therefore, it is not surprising to find that 60 percent of western municipalities were strongly in favor of water conservation on a regular basis, while only one-third of eastern municipalities were strongly in favor of water conservation on a regular basis. In eastern Oklahoma, some municipalities may not have either the money or the borrowing power to finance improvements in related water projects. However, the majority of eastern communities, especially the larger ones, have their own reservoirs, transmission lines, and treatment plants.

In case western municipalities were turned down and did not get the needed water, they might tend to adopt the water reuse option for non-drinking purposes. Indeed, one-half of western water officials were strongly in favor of treated water for non-drinking purposes, while only 30 percent of eastern water officials were in favor of water reuse for non-drinking purposes. The reason why more western municipalities were expected to prefer water reuse for non-drinking purposes is that treated wastewater will be directed toward irrigation and public use.

Data revealed that there is no significant difference between regions in regard to favoring water transfer from nearby communities. The overall approval of this alternative was the same among the majority of the selected communities regardless of their location in the state (73% east, 70% central, and 75% west). At least, in the short run, these municipalities will spend their energies in order to bring in water and meet their needs regardless of location.

It was expected that the western towns and cities would be more in favor of implementing water rationing measures than the central and east because of frequency of droughts. Data supported this contention when 90% of the western

Oklahoma water managers, 67 percent of central Oklahoma water managers, and 66 percent of eastern Oklahoma water managers indicated their overall approval of implementing water rationing measures policy.

Variations in Ongoing Water Conservation Practices by Region

Adjusting water rates has been practiced by almost one-third of western and central water utilities in Oklahoma, but only one-fifth of eastern municipalities were practicing adjusting water rates on a regular basis. From these results it would seem that there is no significant difference among regions in terms of the current implementation of this measure. A majority of the water managers perceived this alternative as unrealistic and politically unacceptable regardless of location.

Unlike adjusting water rates, comprehensive metering has been employed on a regular basis more in the west (90%) than in the east (63%) or the central (75%). These results confirm the expectation that western communities consider the water they treated and transmitted to their perspective customers as a valuable commodity that should be used wisely. On the other hand, some eastern municipalities perceived their water supplies as in excellent shape, and thus they did not bother to install water meters in their service areas.

Realizing that many water utilities in the eastern part of the state have outdated and undersized water lines and are unable to carry sufficient amounts of water to local customers, more eastern water utilities were expected to employ leak detection measures regularly. Information obtained from the questionnaire indicated that 70 percent of eastern water managers, 60 percent

of western water managers, and 42 percent of central water managers have already been implementing the water leak detection alternative regularly. Again, it is reasonable to conclude that water management shows immediate response to specific problems as they occur. Few ongoing water conservation measures were reported by respondents in certain parts of the state. The perceived degree of efficiency of other water conservation options by water management might preclude their implementation on a regular basis.

Variations by Region in the Perceived Degree of Efficiency and Political Acceptability of Certain Water Conservation Measures

The pattern of responses concerning the overall efficiency of certain water conservation options indicates that the majority (70%) of western water managers perceived pressure reduction, water reuse, and increased water rates as inefficient management tools. On the other hand, eastern water managers (60%) perceived pressure reduction and water reuse as inefficient water management tools. Water officials who perceived the pressure reduction measure as an inefficient management tool may have thought that is implementation would produce little water savings because customers would use the same amount of water regardless of water pressure established by a given water utility. Water reuse measures were also perceived by both western and eastern communities as inefficient. One may interpret their perception as a reflection of their concern about the availability of technology and the probability of citizens' acceptance of treated wastewater even for non-drinking purposes.

Few water officials in the eastern part of the state judged educational measures, for the purpose of stimulating water conservation ethics and behavior

among water users, as an efficient option. This finding may imply that implementing education programs may confuse residents of the eastern part of the state who perceived their water supplies as adequate. Indeed, one-half of the water managers in the east perceived educational measures as ineffective. One possible explanation is that residents of the eastern communities have been taking water for granted.

Results indicated that there are differences between municipalities located in the eastern part of Oklahoma and those municipalities located in the western part of the state in terms of perceived political acceptability of increased water rates, pressure reduction, and water reuse options.

Probably the perceived adequacy of water supplies by the majority of water officials in the eastern part of the state (29 percent of eastern water utilities stated that their water supply was inadequate) was the deciding factor behind their assessment of increased water rates, pressure reduction, and water reuse options as unacceptable politically. In contrast, less than one-half of western water management perceived the same options as politically unacceptable--probably because of their perception of the inadequacy of their water supplies. On the other hand, few water utilities viewed leak detection and comprehensive metering options as unacceptable politically.

One might conclude that water conservation options thought to be under control of water managers and whose implementation will not require the water users' conscious cooperation and approval and considered to be ineffective and politically unacceptable are unlikely to be adopted because of the anticipation of certain difficulties which will be discussed in the following section.

Variations in the Perceived Anticipated Difficulties in Promoting Water Conservation by Region

The obtained data indicated that there are significant differences between the regions in regard to three major difficulties in adopting water conservation programs. These difficulties were capital funds, data base, and political constraints. However, there were no significant differences between regions in terms of the anticipated staffing and legal difficulties.

A little more than one-fourth of eastern managers stated that financial problems would definitely be an obstacle in any attempt to adopt water conservation; however, just 10 percent of municipalities in the west had a major concern about financial difficulties. Potential reduction in the system's net revenues was a major concern of 19.5 percent of eastern water utilities and to 32 percent of western water utilities. This illustrates that western water utilities are concerned about loss of revenues that might delay any future improvements in the existing water systems. Water officials who anticipated lack of funds as a difficulty in promoting water conservation policies are still concerned about potential reductions in net revenues resulting from future water conservation policies.

When respondents were asked about the most beneficial state assistance that could help and encourage water conservation efforts, 75 percent of central water management and 62 percent of eastern water management indicated financial assistance was needed. Sixty percent of western managers were in need of state technical assistance. State subsidies and technical assistance were needed by the majority of the selected municipalities across the state.

Summary

In summary, water officials' attitudes toward certain water policy options were influenced by the locational factors. On the other hand, their attitudes toward other options (such as water transfer) were found not to be a function of the municipality location. As expected, a majority of the communities surveyed in the central and western parts of the state preferred developing new water supplies as a first priority in meeting future water demands. Our analysis suggested that whenever new water supplies could not be acquired, water conservation and water rationing activities were preferred as options by the majority of central and western municipalities. In contrast, respondents' attitudes toward limiting the number of water users, treated water for non-drinking purposes, and water transfer options were found not to be a function of location but might be a function of other factors. These factors will be explored in the following section of this chapter.

Determinants of the Water Management Attitude Toward Water Policy Options

The purpose of this section is to explain water management attitudes on a number of future water policy options (such as developing new water supplies, implementing water conservation on a regular basis, limiting the number of water users, implementing water reuse for drinking purposes, transferring water from others, and implementing temporary water conservation measures as dependent variables). Water officials' perceptions of the degree of efficiency, political acceptability of certain measures, the extent of water related problems faced by them recently, and the anticipated difficulties in adopting water conservation programs were considered as independent variables.

Developing New Water Supplies

Development of new water sources may involve complex legal and financial problems. But the obtained results (Table 4) indicate that the degree of political unacceptability of water pressure reduction, and the degree of inefficiency of water reuse were found to be major determinants of water management attitudes toward developing new water sources option.

Nearly three-fourths of water officials who were in favor of developing new water supplies perceived water pressure reduction as a politically unacceptable management tool. On the other hand, 44 percent of those opposing the development of new water supplies perceived pressure reduction as a politically unacceptable management option. Although water managers may realize the fact that reducing the overall water distribution pressure could produce substantial water savings, especially in leaky systems, they still considered implementation of this measure unrealistic and might generate public opposition and dissatisfaction. As an alternative to a water conservation option (pressure reduction), water managers preferred developing new water supplies.

Adopting water reuse policies could alleviate the problem of inadequacy of water supply. However, 67 percent of those who favored developing new water supplies perceived this option as an inefficient management tool as compared with 44 percent of those who opposed developing new water supplies, perceiving water reuse as an inefficient management tool. The considerations that probably appear to be crucial from the perspective of water officials are those of cost and health. If it can be shown that the cost of recycled water is equal to or less than the costs of developing new water supplies, developing new water sources will not be adopted to replace more water reuse. And, if it

TABLE 4

MAJOR DETERMINANTS OF WATER MANAGEMENT ATTITUDES ON DEVELOPING NEW WATER SUPPLIES OPTION

Independent Variable	% in Favor who agree that:	% Opposed who agree that:
Political unacceptability of water pressure reduction	71	44
Lack of funds as a difficulty in adopting water conservation	55	88
Legal constraints as a difficulty in adopting water conservation	33	55
The degree of inefficiency of water reuse	67	44
Adjusting water rates as a major problem encountered by water officials recently	38	56
Water quality as a major problem encountered by water management officials recently	28	11
Problems in obtaining state assistance	33	50
Water shortage problems	26	65

can be proven to water users that treated water is not a source of danger to health, the chance of adopting new water supplies will be slim.

Table 4 shows that lack of funds and legal constraints as anticipated difficulties in adopting water conservation, the extent of adjusting water rates, the extent of water quality problems, and the extent of state assistance problems were weak determinants of water management attitudes on adopting new water supplies development. One-third of those in favor of new water supply development perceived legal constraints as a difficulty in adopting water conservation. On the other hand, 55 percent of those opposing new water supplies anticipated legal constraints as a difficulty in adopting water conservation. Possibly, though, the most difficult problem facing the water authority is enforcement of new construction and plumbing codes: more than one-half of those opposing development of new water supplies perceived legal constraints as an obstacle in promoting water conservation. This implies that having been faced with lack of funds and encountering legal problems associated with water conservation implementation, the water management in the selected municipalities might well consider additional water supplies as the easiest choice to make.

Adjusting water rates was a problem encountered by some water utilities in Oklahoma. Fifty-six percent of those opposing new water supplies indicated that they have had water rate adjustment problems. Thirty-eight percent of those favoring new water supplies have had the same problem. Probably, respondents realized it as a problem because there are social and political impacts, as well as some legal impediments, that must be considered prior to implementing new water rate adjustments.

Water officials faced with periodic water shortage problems do not expect to deal with this type of problem by developing new water supplies. It appeared that water officials realized that water shortages are short-run problems that cannot be solved by long range solutions such as developing new water supplies. Results in Table Four confirmed this contention. Sixty-five percent of those opposing the new water supplies stated they had encountered water shortages recently. However, only 26 percent of total respondents favoring new water supplies have had the same problem.

Some communities cannot execute major water projects and water conservation programs without receiving financial and technical help. It was found that one-half of those opposing the new water supply option were experiencing problems in obtaining state assistance needed to promote water conservation, while only one-fourth of those favoring the new water supply option were also experiencing problems in obtaining state financial assistance. These results indicated that some water officials may have wanted to get away from state government interference and to be left alone. Water officials who opposed new water supply development probably did so because they lacked the financial capability needed to invest in developing in new supplies.

Implementing Long-term Water Conservation

The degree of political unacceptability of adjusting water rates, water reuse, lack of funds, lack of planning staff and data base, the degree of inefficiency of pressure reduction and leak detection, and the extent of water quality and water loss problems experienced by water utilities in recent years were found to have an impact on water management attitudes toward

implementing water conservation on a regular basis. Table 5 showed additional determinants of local water management's attitudes regarding implementing water conservation on a regular basis. Among these are potential reduction in net revenues and legal constraints as difficulties in adopting water conservation; political acceptability of changing water rate structures; the degree of inefficiency of changing water rates, water reuse, and education; and problems in obtaining federal and state financial assistance to promote water conservation.

Passing extra costs onto water users by increasing water rates was not an attractive course of action. Seventy percent of those water officials favoring implementation of water conservation on a regular basis perceived adjusting water rates as unacceptable politically. On the other hand, 54 percent of those opposing water conservation on a regular basis were found to perceive changing water rates as unacceptable politically. One possible conclusion is that when a given water utility plans to curb water use, it will do so by using management tools other than measures to which water users may react negatively.

It was mentioned earlier that water reuse was considered an ineffective measure by water management. All of those opposing implementing water conservation on a regular basis thought that water reuse was unacceptable politically, while 64 percent of those favoring water conservation considered the water reuse option as politically unacceptable. This implies that the perceived political acceptability of the water reuse option has no impact on attitudes of those water officials who opposed implementing water conservation regularly.

TABLE 5

MAJOR DETERMINANTS OF WATER MANAGEMENT ATTITUDES ON IMPLEMENTING WATER CONSERVATION ON A REGULAR BASIS OPTION

Independent Variable Name	% in Favor who agree that:	% Opposed who agree that:
The degree of political unacceptability of changing water rates	70	54
The degree of political unacceptability of water reuse	64	100
Lack of funds as a difficulty in adopting water conservation	65	38
Lack of planning staff as a difficulty in adopting water conservation	59	25
Lack of data base as a difficulty in adopting water conservation	63	12
Potential reduction of revenues as a difficulty in adopting water conservation	58	75
Legal constraints as a difficulty in adopting water conservation	34	50
The degree of inefficiency of adjusting water rates	39	63
The degree of inefficiency of pressure reduction	63	25
The degree of inefficiency of leak detection measures	22	0
The degree of inefficiency of water reuse	56	100
The degree of inefficiency of education	34	50
Water quality as a major problem face water management recently	34	13
Water losses as a major problem experienced by water utilities recently	33	13
Problems in obtaining federal assistance	42	75
Problems in obtaining state assistance	32	60

Lack of funds, lack of planning staff, and lack of data base as difficulties in adopting water conservation were expected to be major influences on water officials' attitudes toward implementing water conservation on a regular basis. However, the results showed the opposite, although there were significant differences between those in favor of and those opposed to the measure. For instance, 65 percent of those favoring water conservation on a regular basis stated that they would anticipate lack of funds as a problem in adopting water conservation. On the other hand, only 38 percent of those opposing water conservation anticipated lack of funds as a difficulty in adopting water conservation. Likewise, 59 percent of those in favor of water conservation on a regular basis considered lack of trained staff as an obstacle, while 25 percent of those opposing water conservation anticipated lack of planning staff as a difficulty. Sixty-three percent of those in favor of water conservation on a regular basis expected the lack of a data base to be a difficulty in adopting water conservation, while 12 percent of those opposing water conservation anticipated data base problems. These figures imply that other factors rather than lack of trained staff, lack of data base, and lack of funds would affect water management attitudes on implementing water conservation regularly.

Results indicated also that potential reduction in the water system's net revenue and legal constraints were the major deciding factors of implementing water conservation on a regular basis. Seventy-five percent of those opposing water conservation stated that they have a significant concern about the potential reduction of the systems' net revenue, while 58 percent of those in favor of water conservation anticipated potential net revenue losses as an obstacle in adopting water conservation. Fifty percent of those opposing water conservation

stated legal complexities as a major difficulty, while 34 percent of those favoring water conservation still expect legal problems will be encountered sooner or later. Potential reduction in revenues appeared as a major concern of those opposing implementing water conservation on a regular basis. Similarly, three-fourths of those opposing long-term water conservation perceived changing rate structures as politically unacceptable. One major concern over significant changes in water rate structures might be its effect on the large water users (industrial and commercial customers) and the potential fluctuations of water revenues due to implementing such policy.

Water officials who perceived certain conservation options as effective in saving water tended to favor water conservation. Those who perceived the same measures as ineffective in attaining sustained water savings were not in favor of long term water conservation. For instance, 63 percent of those opposing water conservation have perceived increasing water rates as an inefficient measure in achieving significant water savings. On the other hand, 39 percent of those in favor of water conservation considered increasing water rates as an inefficient measure of saving water. Evidently, because of the perceived political unacceptability of adjusting water rates, coupled with its perceived ineffectiveness, water management may implement long-term water conservation only through methods that large water users may react to positively. This illustrates the awareness and political nature of water management process.

One weak determinant of water management attitudes toward implementing water conservation was the degree of water reuse efficiency. One hundred percent of those opposing long term water conservation considered a water reuse option inefficient. On the other hand, only 56 percent of those in favor

of long term water conservation perceived water reuse as an inefficient management alternative. One possible conclusion is that implementing water conservation alternatives (changing water rates and water reuse) that would require consumer cooperation have been evaluated by water officials as unworkable options.

Results in Table 5 revealed additional major determinants of implementing water conservation regularly. These were the extent of federal and state assistance. Those who were not in favor of implementing long-term water conservation were more likely faced with problems of obtaining financial assistance from the federal and state governments. Seventy-five percent of those opposing water conservation indicated that they had been faced with federal assistance problems. On the other hand, 60 percent of those opposed to water conservation have complained about lack of state assistance. These figures imply that unless financial assistance can be obtained from either state or federal governments in order to implement, administer, and monitor long-term water conservation policies, water conservation is less likely to be adopted. And, until water management is assured with considerable subsidies equal to anticipated revenue losses, water conservation on a regular basis will be limited or even nonexistent.

Major Determinants of the Water Managers' Attitudes Toward Limiting the Number of Water Customers Served by Their Utilities

If water supply sources cannot be developed at reasonable costs and federal and state assistance cannot be obtained, water management may consider service area restrictions (limiting the number of water users) in order

to protect existing water users. The following paragraphs outline under what conditions water management will be expected to impose service area restrictions.

Table 6 revealed that several independent variables turned out to be good predictors of the water officials' attitudes on limiting the number of water users in the service area. Of those who preferred limiting the number of water users in their service area perceived pressure reduction (88%), water reuse (80%), and changing water rate structures (66%) by water managers as unacceptable politically. These results suggest that water officials would rather implement service area limitations rather than implement alternative policy options (such as pressure reduction). Water pressure reduction implementation may generate more political opposition from existing water users than limiting the number of water users.

Water officials who have been faced with lack of funds, lack of planning staff, and potential reduction in the system's net revenues as difficulties in adopting water conservation tend to be in favor of limiting water users. For example, 80 percent of those in favor of limiting the number of water users stated that they would anticipate financial difficulty if water conservation policy should be adopted. Also, respondent's evaluation of the degree of efficiency of certain measures may be relevant to some extent to their attitude toward considering the policy of limiting the number of water users. For Instance, nearly 90 percent of those leaning toward limiting the number of water users have judged water reuse measures inefficient. While 58 percent of those opposing the option of limiting the number of water users perceived water reuse as an inefficient measure.

TABLE 6

MAJOR DETERMINANTS OF WATER MANAGEMENT ATTITUDES ON LIMITING THE NUMBER OF WATER USERS OPTION

Independent Variables	% in Favor who agreed that:	% Opposed who agree that:
Political unacceptability of comprehensive metering	34	18
Political unacceptability of pressure reduction	88	62
Political unacceptability of water reuse	88	64
Political unacceptability of adjusting water rate structure	66	40
Lack of funds as a difficulty in adopting water conservation	80	56
Lack of planning staff as a difficulty in adopting water conservation	66	50
Potential reduction in net revenues as a difficulty in adopting water conservation	77	58
Legal constraints as a difficulty in adopting water conservation	11	42
The degree of inefficiency of metering measure	56	28
The degree of inefficiency of pressure reduction	100	48
The degree of inefficiency of leak detection measure	44	13
The degree of inefficiency of water reuse measure	89	58
The degree of inefficiency of education measure	66	30
The extent of increasing water rates problems	56	38
The extent of capital funding problem	78	62
The availability of trained staff to promote water conservation	50	37

In summary, there are four major determinants of water officials' attitudes toward adopting a limitation on the number of water users option. Among these are the perceived inefficiency of water reuse, lack of funds, lack of planning staff, and potential revenue losses. If a given water utility is offered the choice between the options implementing water conservation and service area restriction, it may adopt a policy of restricting new water taps to the number it can adequately serve because of the enumerated difficulties it may anticipate in implementing water conservation.

Since withdrawal of the right to receive water service might be accompanied with social and political impacts, as well as some legal impediments, some water managers might be led to consider other policy options such as the possibility of adopting treated wastewater for non-drinking purposes.

Water Management Attitude on Adopting Treated Wastewater for Non-Drinking Purposes

Turning next to how water officials viewed the possibility of adopting treated wastewater for non-drinking purposes, the relevant information is presented in Table 7.

In general, the considerations that appeared to be crucial in regard to treated water use are costs and health. However, the obtained data revealed that other major determinants may influence water managers' attitudes toward adopting a treated wastewater option. These determinants are political unacceptability and inefficiency of pressure reduction, lack of funds, lack of planning staff, lack of data base, and the extent of federal and state assistance. For instance, three-quarters of water managers favoring water reuse for

TABLE 7

MAJOR DETERMINANTS OF WATER MANAGEMENT ATTITUDES
ON ADOPTING TREATED WASTEWATER OPTION
FOR NON-DRINKING PURPOSES

Independent Variable	% in Favor who agree that:	% Opposed who agree that:
Political unacceptability of metering	14	42
Political unacceptability of pressure reduction	74	46
Political unacceptability of leak detection	6	31
Political unacceptability of education	9	31
Political unacceptability of changing rate structure	47	31
Lack of funds as a difficulty in adopting water conservation	65	50
Lack of planning staff as a difficulty in adopting water conservation	58	38
Lack of data base as a difficulty in adopting water conservation	61	38
Legal constraints as a difficulty in adopting water conservation	28	62
The degree of inefficiency of adjusting water rates	39	54
The degree of inefficiency of pressure reduction	76	31
The degree of inefficiency of education measure	31	54
The extent of federal assistance problem	41	63
The extent of state assistance problem	29	63
The extent of water shortages problem	28	8
The extent of changing rate structure	26	50

non-drinking purposes perceived pressure reduction as politically unacceptable and inefficient conservation measures.

Also, water managers who anticipated difficulties in adopting water conservation tended to feel favorable toward implementation of treated wastewater for non-drinking purposes. For example, 65 percent of water officials who favored treated wastewater perceived lack of funds as an anticipated difficulty in adopting water conservation. Consistently, 63 percent of water managers who favored treated water experienced some sort of difficulty in obtaining federal and state assistance for implementation of water conservation programs.

One may conclude that unless it can be shown that the costs of treated water are less than the costs of implementing water conservation measures, treated water is less likely to be adopted. Until treated water can be proven that it is more efficient and politically acceptable than other policy options (such as pressure reduction) it is unlikely to be implemented.

Major Determinants of Water Management Attitude Toward Transferring Water Option

Water transfer projects, particularly those which transfer water from one municipality to another, may involve complex legal problems, and protection of the exporting company.[2] The exporting municipality may face the risk of relinquishing what may currently be a surplus, but is potentially a useful or

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[2]For an excellent treatment of the dimensions of the local public's opposition to the transfer of water supplies in Oklahoma, see: Fred M. Shelley, and Chandrasiri Wijeyawickrema, "Local Water Opposition to the Transfer of Water Supplies: An Oklahoma Case Study," Water Resources Bulletin, Vol. 20 (5), (October, 1984), pp. 721-727.

necessary future supply of water. Political opposition almost always is generated whenever it is proposed or adopted.

The purpose of this section is to outline the conditions under which water transfer attitudes become transformed into action. In order to identify such conditions, Table 8 summarized the detailed information obtained from the questionnaire.

The percentages in the table confirm the common expectation that those who evaluated certain measures as unacceptable politically tended to be in favor of the policy of transferring water. For example, 69 percent of those who were in favor of the transfer water option perceived changing water rates as politically unacceptable, 76 percent of water officials who were in favor of transferring water stated that a water reuse policy is unacceptable politically, and water pressure reduction option was perceived by 74 percent of respondents as politically unacceptable; thus, they are likely to adopt a transfer option. These percentages illustrate that the perceived political unacceptability of the above measures exerted some sort of influences on water managers' attitudes toward adopting water conservation. However, one must bear in mind that adopting the water transfer option involves political complexities in itself.

Table 8 indicated also that managers who perceived water pressure reduction (64%) and water reuse measure (72%) as inefficient options were in favor of policies of transferring water. These figures imply that water management will continue to be in favor of the policy of water transfer as long of water transfer as long as pressure reduction and water reuse were perceived as inefficient options.

TABLE 8

MAJOR DETERMINANTS OF WATER MANAGEMENT
ATTITUDE ON WATER TRANSFER OPTION

Independent Variables	% in Favor who agree that:	% Opposed who agree that:
The extent of political acceptability of changing water rates	69	38
The extent of political unacceptability of pressure reduction measure	74	42
The extent of political unacceptability of water reuse measure	76	50
The extent of political unacceptability of changing water rate structure	53	18
The degree of inefficiency of adjusting water rates	47	41
The degree of inefficiency of pressure reduction	64	38
The degree of inefficiency of water reuse measures	72	38
Lack of data base as a difficulty in adopting water conservation	50	69
Potential reduction in revenues	78	15
The extent of increasing water rate problem	46	31
The extent of capital funding problem	69	50

Again, potential losses of revenues (78%) and capital funds (69%) were perceived as major difficulties in adopting water conservation. At the same time, the same respondents were in favor of transferring water from nearby communities.

Water Management Attitude Toward Implementing Water Rationing Measures

Various levels of temporary water conservation measures can be imposed when a water utility experiences water shortage. The goal is always to immediately curtail water use. However, implementing such policy may encounter various problems. Beyond gaining public acceptance of these temporary water conservation measures, possibly the most difficult problem facing the given water utility is enforcement of these measures. In addition, industries and businesses using large amounts of water could be severely affected.

To determine under what circumstances water management may feel favorable toward a water rationing option, one should inspect the data obtained from the survey. It appeared that the potential revenue loss variable could not be considered as a major influence on the water officials' attitude toward implementing water rationing. Results revealed that 66 percent of those in favor of rationing water indicated that they would anticipate potential reduction in the net revenues, while 50 percent of those opposing rationing water anticipated the same difficulty. However, the variable of legal constraints still hold the prediction power as a major determinant of adopting water rationing practices. sixty-four percent of those favoring water rationing indicated that they would face legal problems once water rationing measures

TABLE 9

MAJOR DETERMINANTS OF WATER MANAGEMENT ATTITUDE TOWARD IMPLEMENTING WATER RATIONING MEASURES

Independent Variables	% in Favor who agree that:	% Opposed who agree that:
Potential reduction in net revenues as a difficulty in adopting water conservation	66	50
Legal constraints as a difficulty in adopting water conservation	31	50
Political constraints as a difficulty in adopting water conservation	71	50
The degree of inefficiency of adjusting water rates	34	64
The degree of inefficiency of pressure reduction	66	36
The degree of inefficiency of leak detection	23	7
The degree of inefficiency of education	31	50
Problems in obtaining capitol funds recently	74	38
Problems in adjusting water rates recently	47	29
Problems in attaining adequate water quality recently	34	0
Problems in attaining adequate water quantity recently	40	7
Problems of experiencing water shortages recently	29	8

were imposed. On the other hand, one-half of those opposing water rationing stated that education was inefficient, and 31 percent indicated that although the education measure is inefficient, they still favor water rationing. This may be so because water officials may realize the fact that educational awareness methods can effectively instill the water conservation ethic in the long run.

Results indicated also that there is ample evidence that respondents who perceived certain alternatives as inefficient adjust their conservation policies accordingly. For example, adjusting water rates was perceived to be an inefficient management tool by 64 percent of those water officials who opposed water rationing, while 34 percent of those in favor of water rationing perceived such an option as an inefficient management tool.

Summary

The primary purpose of this chapter has been to explore the distribution of attitudes and perceptions of water management officials in 49 communities throughout the State of Oklahoma as they relate to their evaluation of water supply problems. The analysis involves water management's views on kinds of alternatives that may be adopted and implemented at the local level.

The data indicated (not surprisingly) that there is a strikingly high level of interest in water matters among water officials. Specifically, water officials were aware of a wide range of conservation measures; that is, local water management in Oklahoma is well informed as to what to do to effect water conservation. Water officials from western municipalities evidenced a greater interest in water conservation adoption than did respondents from eastern communities.

There is general agreement among water officials that the primary alternative in planning municipal water supplies is the development of new and existing water supplies. This implies a strong support for increased planning to increase water supplies. However, it was found that two major factors have had some sort of impact on water official's attitudes toward developing new supply options. These are: the political unacceptability of water reuse alternatives and the perceived inefficiency of pressure reduction. In general, developing the new water supplies option represented a long-run desirable solution for the majority of respondents. Water officials would rather have development of new water sources than implement water reuse and pressure reduction options because of the expected social and political acceptability of the former as compared to the latter.

Of those municipalities who considered implementing water conservation practices on a regular basis, five factors were found to have impacts on their decision of adopting water conservation strategies on a regular basis. These functions are: concerns about losses of revenues, legal constraints, the perceived political unacceptability of changing water rate structures, and the perceived inefficiency of water rates and water reuse. The adoption and implementation of water conservation measures on a regular basis may generate instability of the system's net revenues.

Limiting the number of water users was favored by those municipalities when certain difficulties may preclude them from implementing water conservation programs. These difficulties represent lack of funds, lack of planning staff and revenue loss. Water utilities which favored this policy option also

considered pressure reduction and water reuse politically unacceptable and inefficient tools.

Respondents who perceived water reuse as a viable option in alleviating future water supplies, probably did so because they perceived pressure reduction as politically unacceptable and an inefficient tool in stretching the community water supplies. They would not choose water conservation because they anticipated a number of difficulties in implementing such strategy. Among these difficulties were lack of funds, lack of planning staff, lack of data base, federal assistance, and state assistance in promoting water conservation programs.

The water utility managers who considered the water transfer option did so because they perceived changing water rate structure, water reuse, and pressure reduction as politically unacceptable and inefficient management tools in alleviating water supply problems. Further, they would not consider conservation practices because they were anticipating loss of revenues and lack of funds as major obstacles in promoting water conservation.

Results also revealed that the temporary water rationing conservation measures option was favored by those who perceived water quantity problems. Legal constraints were also found to be deciding factors in whether or not to implement water conservation.

In evaluating attitudes of water management officials in Oklahoma regarding a number of water management policies, several of the factors noted in the above discussion must be considered. Since attitude comes before behavior and affects the way the water official will act, water management attitudes are becoming more important in the successful implementation of water policy options. But what is more important is to attain some sort of

compatibility between local and state views toward successful implementation of water management policies. The evaluation of the existing State water conservation programs and planning for comparability with local perspectives on water conservation policy will be discussed in the following chapter.

CHAPTER V

INTERPRETATION OF ATTITUDES OF WATER OFFICIALS TOWARD IMPLEMENTING WATER POLICY OPTIONS

Introduction

The primary purpose of this chapter is to interpret water officials's attitudes toward adopting a number of water policy options. The perceived social and political considerations regarding the acceptance of each alternative are also discussed. Results of this study are then compared with those obtained in the literature. The next two sections of this chapter evaluate the existing state water conservation programs and their compatibility with the local perspective on water conservation policy.

Synthesis of Managers' Attitudes

The preferred option for meeting future water needs, as stated by water officials in this study, is the development of new water supplies. Even more favorable to management are those structural solutions to increase the supply at minimal costs to local residents. A number of respondents (14%) who answered the last open-ended question in the questionnaire expressed their desire to adopt the water supply augmentation option by getting someone else (state or

federal agencies) to finance it. The most obvious methods for development of new water supplies, as indicated by respondents, are construction of dams and reservoirs and ground water development. One report showed that a number of communities declared their water supply as inadequate. Table 10 lists names of each community and the estimated costs of developing new supplies.[1]

TABLE 10

COMMUNITIES FACING INADEQUACY OF WATER SUPPLY AND THE ESTIMATED COSTS OF DEVELOPING NEW SUPPLIES

Community Name	Problem	Estimated Costs
Yukon	Inadequate Supply	$ 900,000
Moore	Inadequate Supply	$5,500,000
Edmond	Inadequate Supply	$ 800,000
Sapulpa	Inadequate Supply	$6,000,000
Guthrie	Inadequate Supply	$1,000,000
Idabel	Inadequate Treatment Capacity	$1,000,000
Ada	Need Water Pump Repairs	$ 114,000
Mustang	Inadequate Storage	$1,600,000

[1]Oklahoma Water Resources Board, Planning and Development Division, Report to Governor George Nigh on Community Problems and Funding Needs, (Oklahoma City, Oklahoma: January, 1982).

The problems in obtaining sufficient funds for acquiring new water supply sources remained unchanged, some water utilities will not be able to obtain sufficient water through development of new water supply sources.

Implementing long-term water conservation measures to stretch out the available water supplies is viewed less favorably than the development of new water supplies. Water managers appear to perceive long-range water conservation strategies as procedures that involve additional expense, additional regulations, additional enforcement, and additional supervision.

Some communities in Oklahoma are faced with the reality that the gap between demand and supply is rapidly widening. In this context, water management will be driven to implement some of the strategies included in the "preferable" category of options. For example, few respondents indicated (when they answered the open-ended question) that since irrigation is the largest user of water and by far the largest consumptive user, conservation measures (if successful) should have the greatest payoff in irrigated agriculture; then, conserved water could be transferred for municipal use.

Some cities, because of their size or financial condition, may find it not only impractical but prohibitively expensive to acquire sufficient water to meet their projected needs or to develop comprehensive water conservation programs because of time constraints and planning staff limitations. In either case, it may be necessary or desirable to reduce per capita water use or, in some other way, reduce total water requirements by means of rationing measures.

The majority of water management officials indicated their approval of adopting temporary water conservation measures. The imposition of rationing measures is essentially a short-term method of conserving water. Water

managers usually institute either voluntary or mandatory measures when water supplies reach a level where there might not be enough water to meet the growing demand during drought periods.

Adopting and implementing temporary water conservation may be the most costly conservation measures socially and politically. It is perceived by Oklahoma water officials that such measures may or may not work and may create undesirable lifestyle changes in the short-run. As one water official put it: "After installing a iow flow shower device, his teenage boy took fifteen minutes to finish his shower when it had taken only two minutes to finish before the installation of the new low flow device." Further, water rationing measures could create problems for water utility public relations programs. For example, imposing restrictions on car washing may generate anger and frustration in those who own high value cars. Since such measures are taken on an emergency basis, some frustration or hostility should scarcely be much of a surprise to water utility managers.

The political costs of adopting water rationing measures may be large. For instance, imposing water restriction measures may foster distrust of local water officials by their customers. Prolonged and subsequent implementation of certain water rationing measures could conceivably give rise to protest by water users if the measures are severe enough and the water users perceive that water management is at fault.

From the water utility's viewpoint, one of the hazards of water rationing measures are that they <u>will</u> be effective (achieves substantial water savings). Then the drop in the system's revenues when water use is reduced can place the given water utility in the position of either raising water rates to make up for

the loss of revenues or to encourage some additional water usage. Both of these courses of action are very likely to generate an adverse reaction from water customers and water officials. For the purpose of elaboration, let us take a hypothetical community and set its goal of reducing water use by ten percent (from 1,000,000 to 900,000 gallons per day) through a rationing program due to the perceived water system capacity limitations. Then, later, it is determined that the community's water use dropped by 200,000 gallons daily instead of the projected 100,000. Therefore, a drop in the total water sales might affect the water utility's payment receipts at the end of the month ($50,000 if it is assumed that the utility charged $.50 for each 1,000 gallon). This also implies that total revenues might decline in response to the notable drop of monthly water sales.

One is likely to conclude that unless Oklahoma's municipalities obtain more water or implement long-term water conservation strategies to alleviate water supply problems, water shortages during dry summers will become common and so will efforts to ration water. But, the question is, how often will water users cooperate and respond positively to calls for rationing?

Nevertheless, when the preferred alternatives dealing with municipal water supply problems have been substantially exhausted, water management may be forced to move in the direction of less preferred category of alternatives such as water reuse and limiting the number of water users. Results revealed that few water officials gave a high priority to the water reuse option. A number of explanations could be provided for this attitude. Water officials who expressed a lack of desire to adopt water reuse probably have a major concern over the operation of the wastewater treatment facilities, especially if they suspect the

facility does not have safe controls to ensure constant water quality.

There are contrasting views concerning a water reuse option. Some viewed water reuse as a major solution to water problems; while others expressed major concern.[2] For instance, water management officials representing the American Water Works Association and health authorities representing the Water Pollution Control Federation viewed wastewater reuse as "a potential water supply option but they expressed considerable concern for the possible health hazards involved."[3] Their attitudes arise from their responsibilities for protecting public health. Furthermore, water officials often view a water reuse option as too costly. Therefore, they favor plans for increasing total water supply or focus on other more socially acceptable strategies.

Comparison of Oklahoma Water Managers' Attitudes to Those Found in Other Studies

The results of this study can be compared with those obtained from recent studies conducted outside Oklahoma. Sawyer[4] interviewed 35 local water supply managers in 35 municipal water systems in Maryland. The main objective of his survey was to find out how local water supply managers view conservation as "an integral element of water supply planning."

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[2]A.D. Phillips, "New Directions for Wastewater Collection and Disposal," Journal of American Water Works Association, Vol. 66, No. 4, (April, 1974), pp. 231-237.

[3]Water Polution Control Federation, "Water Polution Control Federation Adopts Water Reuse Policy," Journal of Water Polution Control Federation, Vol. 45, No. 3, (March, 1974), p. 2404.

[4]Stephen W. Sawyer, "Conservation Practices and Attitudes Among Maryland Water Supply Managers," Water Resources Bulletin, Vol. 18, No. 6 (1982).

Of the 35 managers interviewed, only two considered conservation as a high priority while the remaining respondents considered conservation as a temporary action generated by occasional shortages. Further, the majority of local water supply managers expressed "no need for nor interest in any type of conservation measures beyond leak detection." This did not contrast with the views of Oklahoma water managers who were strongly in favor of development of the new water supply option rather than embarking on adopting and implementing long-term water conservation alternatives.

Both Maryland and Oklahoma local water supply managers differed fundamentally in their perceptions of reasons for not giving conservation a high priority. Water managers in Maryland did not accept the overall concept of water conservation as an essential element of urban water supply planning for a number of reasons. Reasons included the fear of losing credibility with local water users. Water conservation may generate the water users' unfounded concerns over the extent of the adequacy of their water systems which are located in this "relatively water rich" area of the country. Finally, many managers have a variety of non-water related job assignments, especially in the smaller systems, causing them to give conservation planning a very low priority for their limited time and energy. On the other hand, Oklahoma water managers considered legal constraints and problems in obtaining state and federal financial and technical assistance as major determinants of their rejection of the long-term water conservation option. Both Oklahoma's and Maryland's water managers associated conservation with revenue loss. This perceptual similarity

(revenue loss) has been the case in the study undertaken by Moomaw and Warner.[5]

Moomaw and Warner suggested that certain water conservation measures--overall rate increase, summer surcharges, changing rate structure, metering, and leak control--are likely to increase net revenues of a given water utility, while plumbing code revisions, education and retrofitting are likely to reduce revenues. The authors tested these ideas by examining the actual water conservation experience in five communities along the Red River—three in Texas and two in Louisiana. Of these five communities, one community has taken "conservation for the sake of conservation;"[6] while in four others, water officials were more concerned with satisfying water needs. These water officials also increased water rates only in response to the pressure of increased water costs. This implies that water managers in the five communities have had profound concern about revenue loss through reduced water usage. Likewise, Maryland and Oklahoma water managers were strongly aware of the potential revenue loss associated with a water conservation program. However, both the Sawyer and Moomaw-Warner studies did not explore the full range of potential factors influencing water managers' attitudes toward adoption or rejection of water conservation measures as was done in this study in Oklahoma.

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[5]Ronald L. Moomaw, and Larkin Warner, "The Adoption of Municipal Water Conservation: Unlikely Event," Water Resources Bulletin, Vol. 17, No. 6 (December, 1981), pp. 1029-1034.

[6]That is, the idea of eliminating waste was attractive even though the community was not facing immediate water shortages or severe limitations.

In the questionnaire mailed to Oklahoma water managers, the respondents were presented with other potential factors (political and legal constraints, revenue losses, state and federal assistance, lack of planning staff, and lack of data base) that could have considerable impact on the likelihood of adopting a water conservation program. Moomaw and Warner concluded that in order to achieve widespread adoption of certain conservation measures (education, retrofitting, and plumbing codes) that are likely to generate revenue loss, "subsidies" from state or federal agencies should be offered tolocal water systems. The authors also concluded that "the adoption of conservation pricing is a reasonable step in using rates to induce conservation."[7]

Three major pricing mechanisms (overall rate increase, summer surcharges, and changing rate structure) were suggested because of their potential for increasing the given water system revenues not only to the pre-conservation level but to excess revenues above that level. Results of this study revealed that, based on their social and political acceptibility and technical and economic feasibility criteria, leak detection and repair and metering measures were found to be most favored by water managers in Oklahoma. Pricing measures were found to be decidedly less attractive in the study, casting some doubt on Moomaw and Warner's enthusiasm for such measures.

Other studies assessed both water officials' and water users' attitudes toward adopting certain water conservation programs (voluntary and mandatory water conservation). For instance, Davis and Haines investigated attitudes of

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[7] Ibid., p. 1034

water users and state water officials toward Washington State's water policy.[8] Washington state officials were found to be most supportive of imposing voluntary water conservation programs. They also were supportive of imposing penalties on users who waste water. Both Washington state water officials and Oklahoma water managers were aware of the inadequacy of their water supplies; thus, they perceived conservation as only a temporary solution to the problem as long as they face long-term urban demand growth. In contrast to this study of Oklahoma water managers attitudes, Davis and Haines did not examine attitudes toward permanent conservation measures.

In an earlier stdy, Abbott, Cook, and Sleight[9] examined water managers' and customers' attitudes toward voluntary water conservation measures in 17 eastern water utilities. Most managers surveyed were willing to adopt and implement water conservation in an emergency situation. Water managers of these eastern water utilities approached the problem on an emergency basis which seems a common response of many officials in our study in Oklahoma. But, in the case of Oklahoma, water managers expressed the view that they will be forced to consider water conservation as a permanent management tool in meeting future water needs. This, no doubt, is partially related to the climatic

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[8]Dale Davis, and Bruce Haines, Some Political-Institutional Factors Affecting Efforts to Conserve Water in Washington State, (Seattle, Washington: Washington State University, Water Research Center and Department of Political Science, June, 1978), 71 pages.

[9]H. E. Abbott, K. G. Cook, and R. B. Sleight, Social Aspects of Urban Water Conservation, Century Research Corp., Prepared for the Office of Water Resources Research, (August, 1972).

differences between the two regions. Dryer areas are more likely to be conscious of the limitations of their supply and the need to avoid waste. Even in Oklahoma, the western communities studied favored long-term conservation to a greater degree than did communities in the more humid eastern sections of the state.

Evaluation of Existing Oklahoma State Water Conservation Policies

The purpose of this section is to reveal characteristics of state level water conservation efforts in Oklahoma as well as current attitudes about the need for water conservation activities. The emphasis on water conservation and water management activities at the state level was not only a result of changing federal policy (federal cuts in both loans and grants) but was a result of dramatic escalation in costs of planning and construction of new water supply sources.

Some of the best efforts of the State of Oklahoma come through the Oklahoma Water Resources Board. Chapter I included a detailed section on state responsibility for initiating water conservation policies. The Water Resources Board has concentrated on such studies as conducting an inventory of agricultural and municipal water use, administering the state's financial assistance program, identifying water supply problems, and developing plans for emergency situations.[10] The Board also has initiated a speaker bureau to

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[10]Oklahoma Water Resources Board, "Summary of Oklahoma Water Resources Board Contribution to the Governor's Task Force on Water Supply," (Oklahoma City, Oklahoma: Summer, 1983), 3 pages.

disseminate water conservation related information to interested cities and towns across the state. In cooperation with the Oklahoma Rural Water Association, the Board instituted a leak detection and repair program and has provided the Association with "a leak detection device which is being utilized to assist communities in identifying leaks so corrective actions may be taken."[11]

Due to the ominous water shortage problems facing Oklahoma during the summer of 1980, Governor George Nigh created the State Contingency Review Board to help communities across the state in dealing with their water problems. The major responsibility of the committee was the development and implementation of a water conservation education program under the auspices of the Oklahoma Department of Health and Oklahoma Water Resources Board.[12] The purpose of that emergency plan was first to generate community and individual awareness of water conservation alternatives and, second, to provide technical assistance by the personnel of the Oklahoma Department of Health.

The importance of the issue of water conservation to the state is shown, not only by the existence of an emergency program, but by the authority given to the administering agencies (the Oklahoma Water Resources Board and the Oklahoma Department of Health) and the funds available to the program. However, centralization of implementation authority can be an important aspect of a water conservation program. When more than one agency is responsible for

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[11] Ibid., p. 2.

[12] Oklahoma Water Resources Board, "Final Report to Governor George Nigh on Water Supply Conditions in Oklahoma," (Oklahoma City: October 2, 1980).

enforcing policies, there is often a lack of coordination. One agency such as the Oklahoma Water Resources Board may be responsible for quantity control measures and the Oklahoma Department of Health for quality control measures. As a result, the general public in the State of Oklahoma does not often have a clear understanding of water issues and who has control.

Technical assistance, as proposed to the Governor in 1981, is one of the other services provided by the Oklahoma Water Resources Board. This service allows communities, especially middle and smaller sized ones, access to specialists they could not otherwise afford. Indeed, the Oklahoma Water Resources Board recommended to Governor Nigh the approval of "a comprehensive water conservation program to help municipalities and farmers in dealing with water problems.[13] Therefore, developing conservation materials, providing technical assistance, and coordinating research are three areas in which the Oklahoma state government is able to be effective in promoting water conservation. But recommending a program is one thing and implementing it is quite another due to problems in obtaining money to finance such programs. As a case in point, the Oklahoma Water Resources Board, Planning and Development Division, submitted in September, 1980, an application for funding for a water conservation program. Its major objective was "to educate and inform citizens of the need to utilize water in a wise manner.[14] The total amount of funds requested by the Board from the State was $62,276.00"[15] but, it was not funded.

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[13] Ibid, p. 36

[14] Ibid., p. 2

[15] Ibid., p. 3

Compatibility of Managers' Views with Existing State Policy on Conservation

The State's existing policy regarding water conservation was expressed clearly in the context of the Oklahoma Comprehensive Water Plan and in the context of the new amended state water law. In the context of general state water policies, water conservation was considered as an "essential to future well being of all Oklahomans."[16] It was also stated in the plan that though "conservation offers, at least in part, one realistic means of alleviating Oklahoma's water supply problems, new water source development and the conservation of existing water must be considered jointly in any plan for supplying the entire state with adequate water."[17]

While the State of Oklahoma, as stated in the plan, is in a position of supporting and approving a conservation program, the main thrust of state water resources planning emphasized increasing water supply option as did the water officials in our survey. Governor George Nigh, in his keynote address at the Second Annual Water Conference in 1982, stated that:

> In the process of balancing the federal budget and in the light of new federal policy, there will be less federal funds available to local government for water project construction and maintenance. We need to create a water development fund so the state can more adequately and appropriately assist local government in financing needed water development.[18]

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[16]Oklahoma Water Resources Board, Oklahoma Comprehensive Water Plan, Publication No. 94, (April 1, 1980), p. 38.

[17]Ibid., p. 38

[18]Oklahoma Water Resources Board, "Water: A Time for Action. Conference Summary," The Governor's Second Annual Water Conference (Oklahoma City: 1982), p. 1.

Indeed, an underlying obstacle anticipated by water managers who were in favor of developing a new water supplies option is the financial inability of municipalities to adequately fund their water projects. This means that although water may be plentiful, it is not available to water users because large capital expenditures will be necessary to improve and construct new reservoirs and distribution systems. In this regard, seven water officials representing seven municipalities stated their desire for structural solutions (dams and reservoirs) to be financed almost totally by federal and state water agencies.

According to the Emergency Grant Priority System devised by the Oklahoma Water Resources Board, it must be determined for any community to be eligible for a grant whether or not the applicant has taken all reasonable measures to limit waste and conserve water.[19] The Emergency Grant Priority System is based on awarding points for individual water projects according to the following formula:[20]

$$P = E+WR+I+L+MHI+FF-AN$$

Where:

P = Priority Ranking

E = Emergency Ranking

WR = Water Rate Structure

I = Indebtedness by Customers

L = Amount of Local Contribution Toward Project

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[19]Okla. Sta. 82: 1085.39 (supp. 1982).

[20]Oklahoma Water Resources Board, "Emergency Grant Priority System," Unpublished Guidelines. Rev. (Oklahoma City: 1985), p. 2

MHI = Median Household Income

FP = Applicant's Ability to Finance Project

AN = Application Number

Emergency water projects are only likely to be funded under certain conditions: the total loss of the supply system of a given community, extension of a water system, and improvement of the water supply system to meet additional needs of users. All the above conditions are assigned high points. Therefore, the emphasis of the Emergency Grant Priority System is on structural solutions to local water supply problems. However, a maximum of ten points will be awarded to the applicant (community) that employs increasing block rate in charging their water users.[21]

In conclusion, providing adequate water supplies when and where they are needed is a growing challenge for the state and municipalities. The underlying factor of lack of funds makes it impossible for the state and some communities to finance new water supply facilities. In considering what the needs are, the state government must determine if a water conservation program is needed and, if so, at what level it should operate. By examining both current and future water usage levels, the staff of the Oklahoma Water Resources Board can further establish evidence of the need for a strong water conservation program across the state.

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[21] Ibid., p. 5.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter is divided into three sections. The first section presents the major findings of the study, considers implications of these findings, and outlines several important conclusions. The second section presents particular recommended conservation alternatives that can be adopted by Oklahoma's water management officials. Finally, the third section outlines means of implementation for those recommended water conservation alternatives.

Findings

The "hard path" of municipal water supply planning calls for developing new water supplies through the options of water transfer, sinking new wells, or building new reservoirs to meet the ever increasing demands. This particular approach presupposes a continued expansion of water use. Proponents of this approach tend to continue to adopt and implement new supply sources because that is the way the imbalance between demand and supply have always been handled.

Such future implementation of developing new water supply options may be accompanied by economic, legal, social, and political ramifications. A municipality which contemplates the development of new water sources must first obtain rights to the water through purchase or by any other legal means. This can be a complex process, involving negotiations with landowners, over the value of water and the damage caused by its diversion to the given municipality for domestic use. If the same community acquired a new water supply source in a different watershed, then the process may involve legal ramifications of water rights, compensation, and protection for the watershed of origin. To complicate the problems more, environmental effects of storage reservoir construction include clearing of trees and disruption of scenic amenities.

Even transferring water from nearby communities may involve inter-jurisdictional problems. Many water supply problems generated by implementing this policy option may often be considered impossible for either legal or political reasons. Since municipal government officials are often concerned about their short-term political futures, the political impact of a bond issue for financing a given conveyance system may be of more concern to such officials than a technical problem affecting a water supply alternative.

Consideration of the water reuse option by water officials in Oklahoma was hindered by financial, political, and technical problems. Therefore, the possibility of considering this alternative as a viable option in future water management policy formulation is remote. This is so because it requires economic studies, research on public acceptance, and research on effects to health. Even less practical is the possibility of considering such wastewater treatment plants in small communities which not only lack the financial means

to pay for the cost of initial research and construction, but also do not have the money for the operation and maintenance of such a plant once it has been built.[1]

Water management officials were also reluctant to limit the number of water users in the service area. The expected implications of limiting the number of water users are: new development may continue outside the service area, private water wells may be drilled, and new water supply companies may be established as a result of the adopted policy. Furthermore, in assessing policy implications of adopting the service area limitation option, water officials in such localities must take into account the economic consequences of such a policy. Withdrawal of the right to receive water service will probably lower property values in the affect area which will, in turn, lower tax revenues, creating a chain of additional financial considerations for the municipality.

The unlikelihood of adopting the previous options--water transfer, water reuse, and limiting the number of water users--by Oklahoma water officials will then result in implementation of water rationing programs in response to emergency situations. But, the question is, how often can such water rationing measures be called for? Dramatic reductions of water delivered to customers under drought conditions do not represent a permanent panacea of water supply problems experienced by a particular community.

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[1] An indication of the expected costs of the water reuse option might be those experienced by Denver, Colorado, whose potable water reuse demonstration plant was expected to cost $30 million and tc take a minimum of ten years to complete the design, construction, operation, and health effects research. See: William C. Lauer, Stephen E. Rogers, and Jean M. Ray, "The Current Status of Denver's Potable Water Reuse Project," Journal of American Water Works Association, Vol. 77, No. 7 (July, 1985), pp. 52-59.

In evaluating policy implications, water officials should consider each water policy option, determining whether legal and political obstacles exist and the appropriate means by which they can be overcome. For instance, in the case that a given alternative is expected to generate technical obstacles, the solution may be determined through research and experimentation. Social acceptability problems often can be solved by public officials, but it will often take time to educate water users as to the desirability of initiating a given alternative such as treated water reuse. Careful preparation and time spent in planning may help reduce any public tensions.

In summary, a tendency toward single-minded options (i. e., development of new water supplies or expansion of the existing systems' capacity) costs local, state, and federal governments millions of dollars which are difficult to obtain at the present time. The tendency of water planners in Oklahoma to continue to do things in a certain way, regardless of whether or not there are new water conservation options, prevents such options from being given adequate consideration. For example, due to inadequate treatment capacity in Idabel, the estimated cost of expanding the existing treatment plant was one million dollars in 1982. It was reported on the city's application that though the project's feasibility study had been done about three years ago, problems in obtaining funds had prevented the project's start up.[2]

The crux of the matter lies in simply identifying what can be done to promote and articulate the concepts of long-term water conservation to water

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[2]Oklahoma Water Resource Board, Planning and Development Division, Report to Governor George Nigh on Community Water Problems and Funding Needs, (Oklahoma City, Oklahoma: January, 1982).

officials so that they become part of their planning procedures. But one may conclude that the interest in water conservation is very high at an academic and philosophical level. However, the rising costs of acquiring new water sources and installing new water treatment facilities may still not spur water planners to actions of adopting and implementing water conservation.

In the light of increasing difficulties communities face by following a traditional policy of increasing water supplies, the question is, what actions can be taken by local governments that will promote some type of balance between water demand and supply? This question is addressed in the following section.

Recommendations of Water Conservation Alternatives and Their Implications

Recommending particular conservation alternatives to be implemented by Oklahoma's water officials who believed in a myth of abundant water would be a matter of dispelling such myth. Further, it is difficult to determine what kind of conservation alternative is realistic and acceptable in the absence of water planners' perception of shortage or crisis situation. But, before the recommended water conservation can be adopted as a realistic, long-term demand management tool, such alternatives should be articulated to water management officials in terms of costs versus benefits.

Therefore, in recommending water conservation alternatives for a given municipality, several factors are of importance. Among these factors are costs of implementing a given alternative, the achievement of continuous water savings from the implemented alternative, the time frame in which sustained water savings could be achieved, and whether or not the recommended measure is within the control of water management.

Two long-term water conservation measures are recommended for implementation by Oklahoma water utilities because they fit the criteria mentioned above. These alternatives are leakage detection and repair and comprehensive metering. The recommendation of adopting and implementing a leak detection option by the studied communities was based on our survey results. Information obtained from the questionnaire indicated that 75 percent of water officials have experienced water loss problems in recent years. Also, the majority of of respondents perceived leak detection and repair programs and metering as efficient and politically acceptable. Therefore, the chance of adopting and implementing these two alternatives is expected to be high.

Estimates of the magnitude of water losses from leakage in Oklahoma are not available as, in general, it is difficult to determine because of other unaccounted-for water losses. However, a number of past studies gave different estimates of the water system leakage in different areas in the United States. In one recent study, Gagon reported results of implementing leakage control programs in six communities located in the Great Lakes region. The amount of water savings reported ranged from 12 to 75 percent of the average daily pumpage.[3] Another study reported that the loss from any given water system ranged from two to 27 percent.[4] Finally, in an earlier survey of 91 cities carried out by Howe, the reported mean loss due to leakage was 12 percent of

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[3]Gary A. Gagon, "The Role of Water Audits in Water Conservation," Journal of Water Resources Planning and Management, Vol. 110, No. 2 (April, 1984), p. 133

[4]C. W. Keller, "Analysis of Unaccounted-for Water," American Water Works Association Journal, Vol. 68, No. 3 (March, 1976), p. 160.

total water delivery.[5] The above figures imply that the amount of water savings as a result of leak detection and repair for a given utility depends on how old the distribution system is. Furthermore, to achieve higher percentages of water savings, leak detection and repair programs should be incorporated into maintenance of meters in the given community. One survey showed that "at least 20 percent of meters with more than seven years of service would not register flows below 0.7 gpm (gallons per minute)."[6]

Costs involved in implementing this alternative consist of the purchase of leak detection equipment and labor. The costs of leak repair vary with the type and location of the leak.

Another long-term water conservation measure that can be recommended for water officials is metering. This measure is largely within the control of a particular local government. Further, its implementation implies assigning a positive value to each unit of water used. A given municipality which still has an unmetered system implies that this community based its charges on a flat rate basis. Therefore, the water users have no economic incentive to conserve water because each customer pays the same monthly bill no matter how much water he uses.

Earlier studies demonstrated various effects of metering. For example, Hanke studied the impacts of universal metering on water use in Boulder,

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[5]C. W. Howe, "Savings Recommendations with Regard to Water System Losses," American Water Works Association Journal, Vol. 56, No. 2 (February, 1964), p. 145.

[6]W. D. Hudson, "Reduction of Unaccounted-for Water," American Water Works Association Journal, Vol. 56, No. 2 (February, 1964), p. 145.

Colorado. This study reported a 36 percent reduction in residential water use.[7] In an earlier study, Howe and Linaweaver concluded that residential water use was basically the same in metered and flat rate cities.[8]

It is expected that comprehensive metering, if implemented in the studied communities in Oklahoma, may generate long-run benefits such as savings in the cost of water treatment facilities expansion and new water development services, because of the metering potentiality in increasing the efficiency in water use. Results of this present study confirmed the majority of water officials in the selected cities and towns in Oklahoma perceived metering as an effective and politically acceptable measure. This probably is so because they might consider metering as an equitable way of charging their customers. Therefore, this recommended measure may not be opposed by water officials who view it as a socially acceptable option.

As was mentioned earlier, the leak detection and repair option and comprehensive metering option are highly acceptable politically to the water officials in the selected communities. Therefore, the likelihood of adopting these options is high. But, how and who is going to hold primary responsibility for implementing and monitoring the recommended alternatives (metering and detection and repair programs)? This question will be addressed in the following section.

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[7] S. H. Hanke, "Demand for Water Under Dynamic Conditions," Water Resources Research, Vol. 6, No. 5 (March, 1970), pp. 1253-1261.

[8] C. W. Howe, and F. P. Linaweaver, Jr., "The Impact of Price on Residential Water Demand and its Relation to System Design and Price Structure," Water Resources Research, Vol. 3, No. 1 (January, 1970), p. 13.

Means of Implementing the Recommended Measure by the Local Government

Due to the perceived failure of the state and federal governments to design and implement a workable water conservation policy, local governments, according to our findings in Chapter IV, considered themselves to have the authority and the means to adopt and enforce policies that promote water conservation. What follows is a procedure for action (by implementing a leak detection and repair program) that local governments can take to reduce the future growth of water requirements from conventional water resources.

The first phase of the procedure is to place the water conservation issue on the local agenda. In general, water conservation issues may not be on the agenda of many local communities. Without a perception of the need for a local water conservation program and without a clearly defined benefit to the given community, both elected and appointed officials may be reluctant to carve out a local role in water conservation management.[9] It is a well known fact that local government activities such as police and fire services may be though to have a higher political pay-off. Long-term water conservation strategies are not as highly visible or as publicly acceptable as these more traditional local government activities.

To demonstrate that water conservation and management strategies can work smoothly and result in substantial water savings, water conservation

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[9]It could be argued only partially at this point that experience is still the best teacher. It would be hard to fault the frustrated manager who decides that allowing the community to experience the severe drought is a more effective water conservation education than endless pamphlets and public information meetings about hypothetical shortages in a dim future.

options can be created by water utilities themselves. Examples are leak detection and repair programs and comprehensive metering installation and maintenance programs. The adoption and implementation of these policy options require the following actions:

1. A philosophical statement that calls attention to a policy of water efficiency;
2. A plan of action with goals and measurable objectives;
3. An investment plan using general funds to carry out these options.
4. Monitoring, evaluation, and refinement of the recommended options.

Probably the best way to achieve these results is to form a task force composed of water officials because of their close connection to the water system and their expertise in having the job done. The task force must evaluate ways of implementing leak detection and repair measures. The task force should try to monitor the recommended measures that will improve the efficiency of the water system. Greater water system efficiency brings immediate savings. But, if the long range water conservation strategy is to achieve its basic goals, it must seek long-term benefits that can be achieved only by basic changes and continuous improvements in the system.

Once local officials have directed the task force to devise a leak detection and repair program to be integrated with water supplies plans, and the task force has studied various water supply and demand scenarios and established criteria to be used as guidelines for various policies, what accomplishments can be expected? What policy levers can local governments use to reduce

future needs of conventional water resources? There are many. Local governments can control the growth of water requirements in a particular community through system improvements and information programs as well as other municipal operations. Each of these areas has several elements that either directly or significantly affect future water needs in a particular community.

It should not be assumed that this discussion has addressed all possible elements of local community actions striving to achieve long-term water savings or that every community will adopt all of the steps that have been outlined. Each community is unique, which is why a comprehensive water conservation policy at state level will not be as effective as a local level approach. Local leaders best know the particulars of their community's situation and they are best able to reflect local interests and attitudes so that the long range water conservation strategy will be acceptable to the community. Through the combined actions of communities across the state, state water objectives will thus be achieved.

APPENDIX I

APPENDIX I

Cities and Towns to be Investigated

City Name	Population[1]	City Name	Population
Ada	15,902	Altus	23,689
Ardmore	23,689	Bartlesville	34,568
Bethany	22,130	Broken Arrow	35,761
Chickasha	15,828	Claremore	12,085
Del City	28,424	Duncan	22,517
Durant	11,972	Edmond	34,637
El Reno	15,486	Guthrie	10,312
McAlester	17,255	Miami	14,237
Midwest City	49,559	Moore	35,063
Muskogee	40,011	Okmulgee	16,263
Ponca City	26,238	Sand Springs	13,246
Sapulpa	15,853	Shawnee	26,506
Stillwater	38,268	The Village	11,049
Woodward	13,610	Yukon	17,112
Alva	6,416	Anadarko	6,378
Bixby	8,400	Blackwell	8,400
Choctaw	8,059	Clinton	8,796
Cushing	7,172	Elk City	9,579
Frederick	6,153	Guymon	8,492

[1]U. S. Department of Commerce, Bureau of the Census 1980 Census of the Population and Housing - Oklahoma (Washington, D. C.: 1982).

City Name	Population	City Name	Population
Henryetta	6,432	Holdenville	5,469
Hugo	7,172	Idabel	7,622
Jenks	5,876	Marlow	5,017
Mustang	7,496	Owasso	6,149
Pauls Valley	5,664	Perry	5,796
Poteau	7,089	Pryor	8,483
Sallisaw	6,403	Seminole	8,590
Sulphur	5,516	Talaquah	9,708
Vinita	6,740	Wagoner	6.191
Warr Acres	9,940	Weatherford	9,640
Wewoka	5,480		

APPENDIX II

July 11, 1985

Dear Sir:

As a graduate student at the University of Oklahoma, Department of Geography, I am interested, as a part of my doctoral researach, in investigating the views of water managers on municipal water conservation and management in Oklahoma.

I would appreciate it if you would help me by filling out the enclosed questionaire and returning it in the enclosed stamped envelope. It is not necessary to sign your name. It should take no more than fifteen minutes of your time. This information will be useful to your community and the state in planning future water needs. I will be grateful for your cooperation with the survey.

Sincerely yours,

ABDEL L. ABDALLAH
Ph. D. Candidate

jnm/ALA

Enclosure

I. How many years have you been employed as a water management official?

a. In this community _____ years.

b. Total experience - all localities _____ years.

II. What is your education level?

a. ___ High school

b. ___ Some college

c. ___ B.A., B.S.

d. ___ Graduate work

III. How can you describe the adequacy of your municipal water supply?

a. ___ Inadequate (current water supplies may not meet future needs).

b. ___ Adequate (current supplies will meet future needs).

c. ___ Abundant.

IV. What does the concept "water conservation" mean from your professional perspective?

_____

_____

_____

_____

V. Are there any alternative definitions of the concept of water conservation which have been discussed by your community's government? If so, please describe briefly.

_____

_____

_____

_____

_____

(PLEASE ANSWER BOTH SIDES OF EACH PAGE.)

VI. During recent years water utilities have experienced varying sorts of problems. Please indicate the extent to which the following problems have been encountered by your water utility.

Major Problem	Moderate Problem	Minor Problem	No Problem	Not Certain
a. Increased water rates.				
1	2	3	4	5
b. Capital funding.				
1	2	3	4	5
c. Water quality.				
1	2	3	4	5
d. Water quantity.				
1	2	3	4	5
e. Water losses in the system.				
1	2	3	4	5
f. The extent of Federal assistance in implementing comprehensive water conservation programs.				
1	2	3	4	5
g. The extent of State assistance in promoting water conservation programs.				
1	2	3	4	5
h. The availability of trained staff capable in designing and implementing water conservation alternatives.				
1	2	3	4	5
i. Water shortages.				
1	2	3	4	5
j. Changes in rate structures.				
1	2	3	4	5

VII. How much primary responsibility for research efforts to deal with municipal water supply problems should be taken by the following organizations?

Major Responsibility	Mild Responsibility	Minor Responsibility	No Responsibility	Not Certain
a. Universities				
1	2	3	4	5
b. Local Water Utilities				
1	2	3	4	5
c. State and Local Government water resource agencies				
1	2	3	4	5
d. Federal Water Agencies				
1	2	3	4	5
e. Private Consultants hired by municipalities				
1	2	3	4	5

VIII. Which of the following measures you may consider for the future?

strongly in favor	mildly in favor	slightly in favor	slightly not in favor	mildly not in favor
a. Develop new water supply sources (surface, ground, or both).				
1	2	3	4	5
b. Implement water conservation practices on a regular basis.				
1	2	3	4	5
c. Limit the number of water users applying for new water service.				
1	2	3	4	5
d. Treated wastewater reuse for non-drinking purposes.				
1	2	3	4	5

e. Reusing treated wastewater for drinking purposes.

1 2 3 4 5

f. Transferring water from other water suppliers by establishing some type of agreement between your community or nearby communities.

1 2 3 4 5

g. Implementation of temporary water conservation measures to reduce water use.

1 2 3 4 5

IX. How frequently does your water utility currently employ the following measures?

	employ regularly	employ occasionally	do not employ
a. Adjustments in water rate schedules.	1	2	3
b. Comprehensive system metering.	1	2	3
c. Pressure reduction measure.	1	2	3
d. Promoting continuous leak detection and repair program.	1	2	3
e. Installation of water saving devices.	1	2	3
f. Intensive educational information program dessemination on water conservation.	1	2	3
g. Water reuse/recycling.	1	2	3

X. How do you rate the degree of water saving effectiveness of the following measures for your municipality?

very ineffective	moderately ineffective	mildly ineffective	mildly effective	moderately effective	very effective
a. Adjustment in water rate structures.					
1	2	3	4	5	6
b. Comprehensive metering.					
1	2	3	4	5	6
c. Pressure reduction.					
1	2	3	4	5	6
d. Leak detection and repair.					
1	2	3	4	5	6
e. Water reuse.					
1	2	3	4	5	6
f. Education.					
1	2	3	4	5	6

XI. How do you rate the degree of political acceptability of the following water saving measures for your municipality?

very unacceptable	moderately unacceptable	mildly unacceptable	mildly acceptable	moderately acceptable	very acceptable	not certain
a. Increase water rates.						
1	2	3	4	5	6	7
b. Comprehensive metering.						
1	2	3	4	5	6	7
c. Pressure reduction.						
1	2	3	4	5	6	7

d. Leak detection and repair.

1 2 3 4 5 6 7

e. Water reuse.

1 2 3 4 5 6 7

f. Education.

1 2 3 4 5 6 7

g. Changes in rate structure.

1 2 3 4 5 6 7

XII. Would you anticipate difficulty in adopting water conservation measures in your community for the following reasons?

definitely yes	probably yes	probably no	definitely no

a. Lack of sufficient funds.

1 2 3 4

b. Inability/lack of planning staff to design and implement water conservation programs.

1 2 3 4

c. Lack of data base necessary for formulating water conservation programs.

1 2 3 4

d. Potential reduction in the water system's net revenues.

1 2 3 4

e. Legal constraints.

1 2 3 4

f. Political constraints.

1 2 3 4

XIII. What type of assistance would be most beneficial to assist you in planning for a balance between water demand and supply in your municipality?

a. ___ Financial assistance in the form of loans and grants.

b. ___ Technical assistance in the form of planning staff and consulting.

c. ___ Legal: revisions of existing laws and regulations.

d. ___ Others, please specify.

_____

_____

_____

_____

XIV. Please indicate actions you would like to see initiated on a statewide basis in Oklahoma to promote water conservation.

_____

_____

_____

_____

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