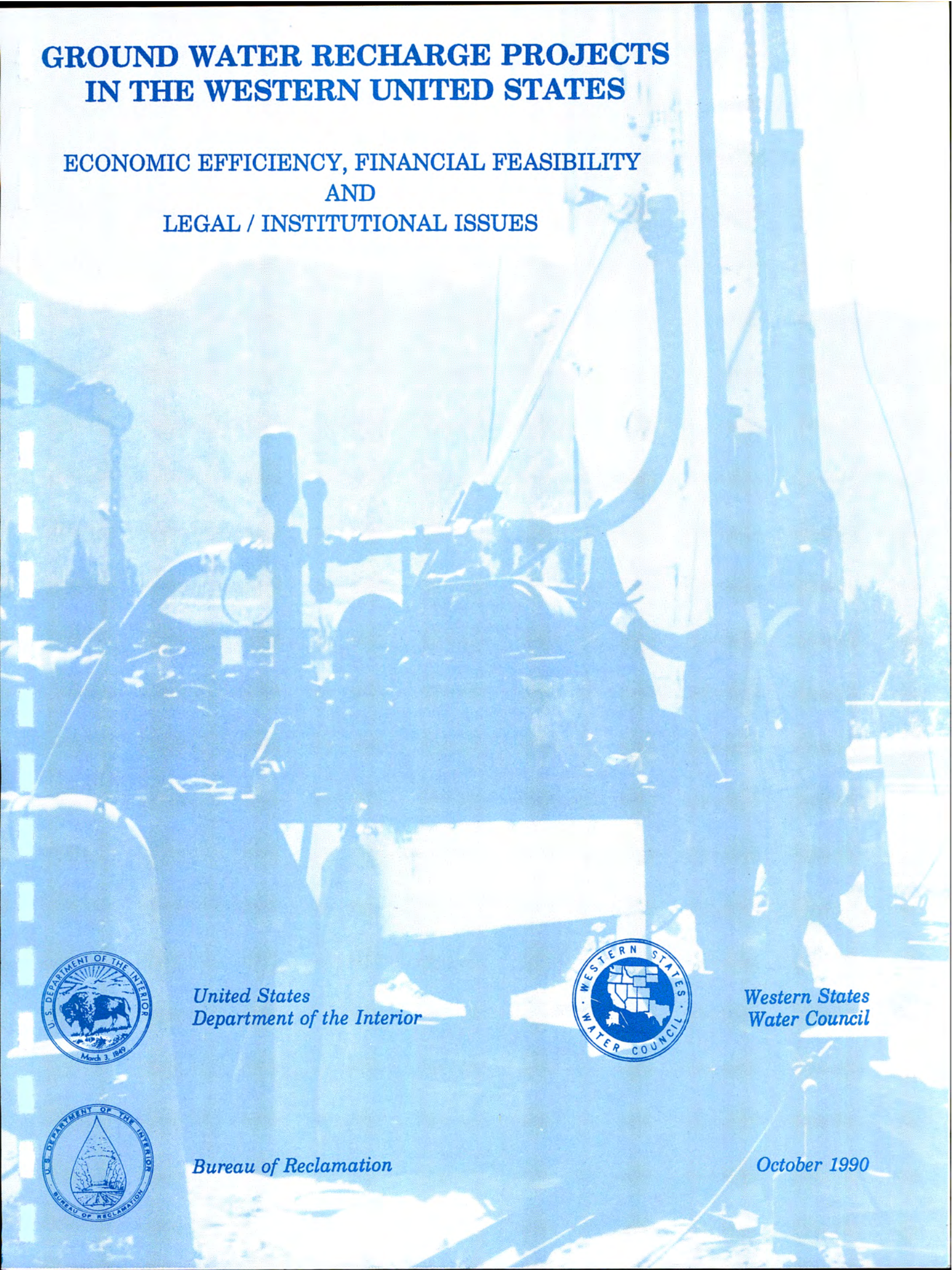
GROUND WATER RECHARGE PROJECTS IN THE WESTERN UNITED STATES

ECONOMIC EFFICIENCY, FINANCIAL FEASIBILITY AND LEGAL / INSTITUTIONAL ISSUES



United States
Department of the Interior

Western States
Water Council

Bureau of Reclamation

October 1990

United States Department of the Interior
BUREAU OF RECLAMATION
DENVER OFFICE
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DENVER, COLORADO 80225-0007

IN REPLY
REFER TO:
D-5190

1990

Mr. D. Craig Bell
Executive Director
Western States Water Council
Creek View Plaza, Suite A-201
942 East 7145 South
Midvale UT 84047

Subject: Western States Water Council's Report Transmitted to the Bureau of Reclamation (Groundwater Recharge)

Dear Mr. Bell:

The Bureau of Reclamation accepts the report, "Ground Water Recharge Projects in the Western United States: Economic Efficiency, Financial Feasibility and Legal/Institutional Issues," which the Western States Water Council prepared cooperatively with the Bureau of Reclamation under provisions of the High Plains States Groundwater Recharge Demonstration Program.

This document provides an important state perspective on issues regarding groundwater recharge in the Western States. The results will be included in the Bureau of Reclamation's summary report to Congress at the conclusion of the program. In the interim, it will be made available to all interested parties.

Sincerely,

Raymond W. Wilson

FOR J. William McDonald
Assistant Commissioner
Resources Management

GROUND WATER RECHARGE PROJECTS IN THE WESTERN UNITED STATES:

ECONOMIC EFFICIENCY, FINANCIAL FEASIBILITY AND LEGAL/INSTITUTIONAL ISSUES

A Report to the
Bureau of Reclamation and the Department of Interior
by the

Western States Water Council

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October 1990

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BACKGROUND

The High-Plains States Ground Water Demonstration Project Act of 1983 (Public Law 98-434) authorized and directed the Secretary of the Interior, acting through the Bureau of Reclamation (Reclamation), to engage in a special study of the potential for ground water recharge in the High-Plains States (Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming) and other Reclamation Act States (Arizona, California, Idaho, Montana, Nevada, North Dakota, Oregon, Utah, and Washington). Reclamation was directed to investigate and establish demonstration projects to recharge ground water aquifers in these states.

Reclamation's ground water recharge program involves two phases. Phase I was a two year process covering planning, development, and demonstration project site selection. The Phase I final report was sent to Congress on December 1, 1987. According to the report, the objective of the program "is to move from the research mode on ground water recharge to the pilot demonstration phase, and to lay the groundwork for larger operational programs in the future."[1] Forty-one proposals for ground water recharge demonstration projects were submitted by local sponsors. The Secretary of Interior and Reclamation recommended that 21 of these projects be constructed, twelve in the High-Plains States and nine projects in the remaining nine Western States.

Projects were selected based on technical and environmental factors and are intended to demonstrate new and innovative ground

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[1] High Plains States Ground Water Demonstration Program - Phase I Report, United States Department of the Interior, Bureau of Reclamation, December 1987, p. 5.

water recharge technology and also provide geographic diversity. In explaining the rationale for its selection, Reclamation's report states that "conditions of actual regional declining ground water levels on a long-term basis are considered to be at the heart of the program," but the underlying theme of the congressional debate regarding the scope of proposed projects was "small and local."

In the selection process, Reclamation asked each governor to designate a representative to work with Reclamation to review the concepts included in the site nomination and selection process, and to provide ideas and information that would be incorporated in the evaluation process. To insure that individual state policies and program priorities were recognized, the report notes, the governors prioritized the proposals from their states and submitted them to Reclamation. The Phase I report describes this process as a critical step to help insure that each state's recommendations were properly considered in the demonstration project site selection process.

Phase II of the program is the design, construction, and operation of approved demonstration projects over a five-year period. In most cases, each proposal is based on a full five-year construction and demonstration period. Construction of recommended projects depends on the appropriation of funds by Congress, and execution of required cost sharing agreements with non-federal sponsors. The Act requires a minimum 20 percent non-federal cost share, but actually non-federal project cost sharing agreements average about 28 percent. In fiscal year 1989, Congress appropriated $3 million dollars to initiate construction under cooperative agreements with non-federal sponsors.

Under Phase II, Section 4(b) of the Act also requires the Secretary, acting through the Bureau of Reclamation, to "contract

with the various High-Plains States and other Reclamation Act States to conduct a study to identify and evaluate alternative means by which the costs of ground water recharge projects could be allocated among the beneficiaries of the projects within the respective states and identify and evaluate the economic efficiency of and the legal authority for utilizing ground water recharge in water resource development projects." At the request of Reclamation, and with the support of the affected states, the Western States Water Council (WSWC) agreed to perform the economic, cost sharing and institutional analysis under Cooperative Agreement No. 9-FC-81-15970 (May 19, 1989).

The Western States Water Council was created by a resolution of the western governors is 1965 as a multi-state advisory group. Its purpose is to accomplish effective cooperation among member states in matters relating to the planning, conservation, development, management and protection of their water resources. Eighteen western states are members or associate members. Council membership includes all Reclamation states, with the exception of Kansas and Nebraska. To accomplish the work outlined in the cooperative agreement with the Bureau of Reclamation, the Council organized a Ground Water Recharge Work Group, which included representatives from Kansas and Nebraska (see Appendix A). Separately, a WSWC Ground Water Recharge Subcommitte was responsible for overseeing staff work.

Methodology

Following execution of the cooperative agreement, a questionnaire was prepared, reviewed and revised, and then sent to each Reclamation state to assess their experience with ground water recharge projects (see Appendix B). Work group members coordinated the various state agencies' answers and compiled a single state response. Next, Council staff reviewed the

responses and prepared an outline of project costs and benefits, as well as general observations regarding cost sharing and other areas of emphasis. States' legal and institutional approaches to ground water recharge issues were also summarized. This work was reviewed at the regular WSWC quarterly meetings in January 1990. Thereafter, the legal and institution summary for each state was completed, while work continued on other sections of the report.

In April 1990, the ground water recharge work group met in Salt Lake City to review the ongoing work. Fifteen seperate Reclamation states were represented. Discussions focused on the report's audience, scope, context and format, as well as the appropriate definition for ground water recharge. Specific comments were made regarding the preliminary document and expected study findings and recommendations were outlined. Also, the group reviewed important considerations in evaluating project feasibility, and discussed potential case studies. Following the meeting, the work group's comments were reviewed, summarized and circulated.

A draft report was completed in early June 1990. It was circulated among work group members and other western state representatives for their comment. It was discussed at the WSWC quarterly meetings in July 1990. Thereafter, a draft findings and recommendations section was completed and circulated for comment. During September, these additional state comments were reviewed and the economic efficiency section of the report was substantially expanded to include many illustrative case studies.

This report outlines western states experience with ground water recharge. Hopefully, it will be a useful tool in evaluating individual project feasibility in the context of comprehensive western water management. The information herein will be used by the Bureau of Reclamation in preparing its final program report to the Congress.

INTRODUCTION

This report addresses a broad audience, which includes federal, state and local decisionmakers, a diverse group with varying levels of interest and expertise. In part, it is intended for use in evaluating the feasibility of ground water recharge programs and projects, compared to other alternatives. It may be useful as a general guide for a lay audience (such as members of city councils, irrigation district boards, and others) to evaluate the potential feasibility of an artificial ground water recharge project as a solution to specific water resource management problems. It also presents a detailed state-by-state discussion of legal and institutional issues related to ground water recharge in the West. Both water quality and water quantity issues are identified and discussed.

Further, this report presents important economic principles to guide the development of appropriate cost sharing and financing policies. This part of the report may be useful as state and federal officials and legislators address new recharge project and program proposals. It discusses general principles related to economic efficiency, financial feasibility, cost sharing and cost recovery. A discussion of the allocation of project costs among project purposes is beyond the scope of this report. Federal water project cost allocation policies are well-established, according to accepted principles.

This report addresses appropriate cost sharing by all beneficiaries, both public and private, federal and non-federal, which is an issue that continues to be debated. While public and intergovernmental financing and cost sharing policies are largely political decisions, this report presents a few guidelines that

may serve to help establish appropriate roles for government participation in water resource management programs in general and ground water recharge projects in particular.

This study is not an economic or financial analysis of specific ground water recharge projects. It only presents an outline of important principles and alternative choices. However, reference is sometimes made to particular projects to illustrate specific points.

The general discussion of project feasibility that follows is intended to provide a sense of the variety and complexity of interrelated factors which need to be considered in evaluating any potential ground water recharge project or program. Project efficiency is site-specific, and must be analyzed as part of an overall water management plan. Compared to some other water management alternatives, little information is available regarding the general utility of ground water recharge westwide. Recharge activities are extensive in California and Colorado.[2] They are important in Arizona, Nebraska, Nevada, Texas and some other areas. However, in many parts of the West, ground water recharge remains largely an untried and untested alternative.

The findings and recommendations presented in this report may need to be revised in the future as experience grows with operational ground water recharge projects. In order to evaluate the utility of the general concepts presented herein, in the future a number of projects constructed under Reclamation's

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[2] According to California's and Colorado's responses to our questionnaire, there are over 70 projects in California and as many as 150 in Colorado, and the numbers are increasing.

demonstration program will be selected for a site-specific review. This report should be viewed as a general introduction to some important considerations in evaluating the feasibility of ground water recharge projects. Hopefully, it will help fill the need for more information regarding ground water recharge opportunities in the West.

"Ground Water Recharge"

As used in this report, unless otherwise indicated, the term "ground water recharge" refers to any active and artificial means of enhancing natural recharge. It includes spreading basins, recharge pits, injection wells and other direct means. Some state and local water management agencies recognize "incidental" ground water recharge. In the West, major surface water storage and distribution systems for irrigated agriculture are very significant sources of incidental recharge. On and off-farm losses from inefficient water delivery systems are generally recoverable and in many areas are recognized as an integral part of the local hydrologic system. Such incidental recharge of underground water sources may provide substantial economic or other benefits.

However, few state water codes explicitly recognize and take into account incidental recharge in water rights administration. Therefore, except as noted otherwise, such incidental recharge is not included within the use of the term "ground water recharge," in the legal and institutional issues section of this report. Further, some activities, such as oil and gas recovery, result in the purposeful reinjection of low quality water that is not intended for future beneficial use and is not included within the definition of ground water recharge.

Legally, two important factors define ground water recharge. First, there must be a controlled activity that enhances the natural replenishment of an underground aquifer. Second, the sponsor of the activity intends to use the recharged water in place for some beneficial purpose, or the water will be stored and available for withdrawl for some future beneficial use, as defined by state law. In some states, the recharge of ground water by itself is a beneficial water use, apart from any beneficial end use of the recharged water. In other states, the recharge of ground water by itself is not considered beneficial, but the ultimate use of the water may be.

At times, ground water recharge may enhance the beneficial use of water, or promote its optimal use, such as where a recharge project helps ameliorate aquifer contamination or prevent salt water intrusion into an aquifer with high quality water. This type of project is included within the legal definition of ground water recharge under a broad interpretation of the term "beneficial use as defined by state law."

Project Feasibility

In evaluating the potential feasibility of any ground water recharge project, it is important to recognize the project will usually be part of a broader, comprehensive water management plan or strategy. Federal, state and local needs and interests vary, and so will the purposes for ground water recharge. Generally, the primary problem to be addressed will be an inadequate water supply, given current demands. There are many important factors to be considered in evaluating any water project. There are economic, engineering, environmental, financial, geochemical, hydrogeologic, institutional, legal, political and social questions to be answered. Many of these factors are

interrelated, and there is generally no clear way to rank them by priority. However, in evaluating a potential ground water recharge project or program, the following questions should be considered.

What is the problem? This is the most basic question of all, but it is also the most important. It will define the purpose for the project and potential alternatives. Generally the primary problem will be an inadequate water supply, given current demands. However, there may be environmental, flood control, and water quality problems that need resolution. Ground water recharge may be an appropriate solution. There are important spatial and temporal advantages to ground water recharge that may make it a particularly appropriate solution.

What alternatives are available? Ground water recharge may or may not be an appropriate solution to the problem. There may be more effective and less costly alternatives available. However, in some areas of the West, less costly surface water and ground water supply and management alternatives have been exhausted. A cursory examination suggests ground water recharge may not be considered seriously until other water management alternatives have been exhausted. For example, appropriate water conservation measures should be considered to balance demands with water supplies. Further, other more traditional water storage and distribution alternatives will generally be considered first.

Historically, structural surface water impoundments that have often been the preferred conservation alternative in the West for addressing water supply and flood control problems. Some of the most important water conservation projects were built by the Bureau of Reclamation. Though they are still very

important, for many reasons, new surface water impoundments may not be feasible or otherwise desirable. Through the Bureau's ground water recharge demonstration program, Congress has provided a means to evaluate the potential of the technology as one alternative to address western water needs.

Can ground water be used to solve the problem? Surface water supplies have historically been the most likely water sources to be developed first. To the extent that they are now inadequate or their use is otherwise constrained, ground water resources are a very important alternative or supplemental supply. Moreover, ground water supplies offer unique advantages over surface water development.

According to the U.S. Geological Survey (USGS), 53% of the Nation's total population and nearly all the rural population's drinking water needs are now supplied from ground water.[3] Still, there may be areas where ground water resources are not now used effectively. USGS estimates fresh ground water withdrawals in the United States in 1985 at about 78.3 billion gallons per day, or less than 10% of the estimated natural flow through the ground water system. From a national perspective, this suggests the resource is not physically overdeveloped. However, locally the situation can vary widely, and a number of obstacles to utilizing ground water resources exist.[4]

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[3] National Water Summary 1987 - Hydrologic Events and Water Supply and Use, USGS Water-Supply Paper 2350, p.2.

[4] National Water Summary 1985 - Hydrologic Events and Issues, USGS Water Supply Paper 2250, p. 37.

Are long-term ground water tables or artesian water levels declining? In some parts of the West, both surface and ground water sources have been developed, but demands still exceed available long-term water supplies. Mining ground water reserves, i.e., withdrawls in excess of natural recharge, may lead to serious problems as ground water levels decline. Obviously, declining ground water levels are a good indication ground water recharge projects might be an appropriate and effective solution to some water management problems.

The extensive Ogallala Aquifer underlies parts of the High Plains states of South Dakota, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, New Mexico, and Texas. According to the USGS, ground water withdrawals in the southern and central High Plains have lead to widespread water level declines. More than half of the water in the underlying Ogallala aquifer has been removed from some 3,500 square miles in Kansas, New Mexico, and Texas.[5] Most of the declines are attributable to irrigation. Other areas where seriously declining ground water levels are evident are California's Central Valley and southern Arizona. In response, Congress authorized the Bureau of Reclamation's demonstration program to assess the potential for ground water recharge in the High Plains States and other Reclamation Act States.

Is adequate information available to evaluate recharge project effects? Where ground water tables or artesian water levels are declining due to mining, there is a high probability that information will be available on the hydrogeologic mechanics and geochemical properties of the aquifer. This information is critical in evaluating the quantity and quality of water available, and the engineering and hydrogeologic feasibility of

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[5] Ibid, p. 41.

recharge project opportunities. To the extent ground water resources remain largely undeveloped, the general lack of information may be a serious obstacle to evaluating recharge project feasibility. Without incurring substantial costs, it may be very difficult to determine whether a ground water recharge project is appropriate or whether there are other more desirable alternatives to resolving a specific problem.

Is there a source of water available for recharge? Ground water recharge does not provide an additional source of water, but rather the opportunity to use existing sources more efficiently and effectively. Conjunctive use takes advantage of both surface and ground water supplies. Ground water recharge is an important tool, but opportunities are limited by the availability of a source of water for recharge. Surface water is by far the most likely source of supply, although in some cases ground waters from another aquifer have been used for recharge. The most common sources include floodwaters, seasonally excess streamflows, and treated wastewaters.

Does state law address ground water recharge? Project feasibility is affected by the extent to which states recognize ground water recharge as a beneficial water use and provide some means of protecting the right of a recharge project sponsor to use the recharged water. Clearly defined water rights are important to a successful project. Virtually every western state has a system of law for allocating ground water rights. All western states also have or are in the process of developing and/or upgrading ground water quality protection strategies. A major portion of this report is an analysis of water law and policy in each of the Reclamation states as it relates to ground water recharge.

Is the project economically efficient? Or in other words, is the benefit/cost ratio favorable? Ground water recharge costs and benefits are discussed later in this report as a means of comparing project alternatives. However, the discussion is general and its utility is as a guide to be applied to specific problems or project proposals. Economic efficiency is an important consideration, but direct and indirect project impacts may be difficult to identify or quantify. Further, it is not possible to measure all of a potential project's costs and benefits in monetary terms. Evaluating project efficiency also requires evaluating non-monetary costs and benefits. An alternative that produces the maximum net economic benefit may not always be the best project.

Is the project financially feasible? Project benefits may outweigh costs, yet financially the project may not be feasible. It is important to determine whether or not the beneficiaries of a project can be identified, and whether or not they are willing and able to pay a project's costs. All project costs must be borne by someone, or the project will not be financially feasible. This report deals with the incidence of project costs and benefits and cost sharing, or the allocation of costs among beneficiaries, as well as the extent to which government (local, state or federal) should make a financial commitment to participate in ground water recharge projects. This report presents general principles of economic efficiency and equity for use in designing appropriate public financing and cost sharing agreements.

Is the project otherwise acceptable? Environmental, social, and political acceptability are major factors affecting project feasibility. In selecting projects for the current federal demonstration program, the Bureau of Reclamation followed a

technical evaluation and screening process. Successful projects had no serious environmental problems and were otherwise publicly acceptable (as evidenced by the support and priority given each project by the governor in each state).

Environmental factors have proven to be important considerations, particularly any effects on surface streamflows and the quality of ground water in the receiving aquifer. The water quality effects of ground water recharge projects are a major state concern and merit special consideration. There are problems associated with different types of aquifers and sources of recharge waters, and mixing waters with varying physical and geochemical properties. One simply example is the use of treated wastewater for recharge.

Given Reclamation's experience to date, it appears water quality related concerns, both state and federal, were underrated when the program began. The cost of gathering base-line ground water quality information and establishing monitoring systems to adequately protect receiving aquifers from potential contamination is a major emerging issue that has led to a significant increase in some demonstration project costs. The recognition and quantification of ground water quality protection requirements and related costs will be an important contribution of the federal demonstration program.

With respect to social and political acceptability, it is important to recognize that these concerns may transcend other considerations. Many of the impacts of ground water recharge projects and programs will not conform to political boundaries. Efficient and effective management will require new public and private organizational arrangements and agreements. While such interaction is beyond the scope of this study (with the exception

of the discussion of cost sharing), it is very important to the successful application of ground water recharge technology.

One emotional, social and political issue is the utilization of water transfers for recharge. To the extent that a community or region has depleted adjacent surface and ground water resources, water transfers may play an important role in balancing water supplies with demands. For example, the massive Central Arizona Project is bringing water from the Colorado River to major metropolitan areas. The primary purpose for the project is to alleviate serious ground water mining or overdrafting. However, this new surface water supply is being used to recharge depleted aquifers and store water for future use.

While in some sense the Central Arizona Project might be viewed as an example of the successful application of ground water recharge technology, it has only come about after decades of negotiation and compromise among myriad private interests and public agencies at the local, state, and federal levels. Regionally, it is an intrabasin transfer, and the necessary diversion, transportation and distribution works are intrastate. An even more divisive and explosive issue involves interbasin and interstate water transfer proposals.

Other appropriate and more specific questions might be asked, but these are sufficient to illustrate the breadth of an appropriate analysis of project and program feasibility. This report addresses only three of the above questions, economic efficiency, financial feasibility, and state legal/institutional issues.

What is the problem?

What alternatives are available?

Can ground water be used to solve the problem?

Are long-term ground water tables or artesian water levels declining?

Is adequate information available to evaluate recharge project effects?

Is there a source of water available for recharge?

Does state law address ground water recharge?

Is the project economically efficient?

Is the project financially feasible?

Is the project otherwise acceptable?

Economic Efficiency and Financial Feasibility

Ground water is a resource that is critical to the economic and public health of the West and the Nation. It is a principal source of supply for agricultural, municipal, and industrial uses. Further, it supports important environmental uses, given its interconnection with surface water resources. The conjunctive use of surface and ground water resources provide important opportunities to increase water use efficiency. Ground water recharge is an important tool in the conjunctive use of ground water and surface waters.

However, in some areas development and implementation of recharge projects has been slow, in part due to a lack of information on ground water recharge as a feasible water management alternative. Reclamation's demonstration program will provide valuable information for the future design and implementation of economically efficient and effective ground water recharge projects and program management policies.

The first two sections of this report focus on economic efficiency and financial feasibility issues. This report describes potential ground water recharge project costs and benefits in general, and briefly discusses other water management alternatives. Direct and indirect beneficiaries are also briefly discussed. Next, the report presents appropriate guidelines for maximizing economic efficiency and equity, in designing cost sharing and financing agreements, focusing on criteria for governmental participation. Lastly, this report briefly discusses potential cost recovery mechanisms and highlights special state and local authorities.

In the future, the general information and guidelines presented in this report will be applied to evaluate operational ground water recharge projects. A select number of case studies will be drawn from among the demonstration projects and perhaps other projects for review. Given the distinct nature of different aquifers, the different needs and concerns of project sponsors and various government entities, it is to be expected that each project will involve unique problems, issues and management approaches. The case studies will be used to highlight the available choices with respect to the use of ground water recharge technology. Further, the case studies will be analyzed and suggestions made towards improving economic efficiency, cost sharing agreements and cost recovery mechanisms for future recharge programs and projects. This later analysis will rely on the information available from project sponsors, related government agencies, and others.

Legal/Institutional Issues

Legal and institutional issues must also be considered in evaluating the potential for ground water recharge projects. Water law, which varies to some degree in each western state, is an important factor in evaluating project feasibility. Western water law defines and protects existing rights and determines the availability of water for new uses. Ground water recharge raises questions regarding beneficial use, water quality, the definition and protection of rights to recharged water, and any adverse effect on existing water rights.

This report contains a general explanation of water law and ground water management in the West. It documents and explains water quantity and water quality laws as they relate to ground water recharge in: Alaska, Arizona, California, Colorado,

Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. Every effort has been made to obtain and fairly reflect the views of state representatives with respect to laws governing ground water recharge in each state. This is particularly important in states with no ground water recharge statute, where general principles of state ground water law must be applied to recharge situations.

The legal and institutional issues portion of this report includes: (a) a brief description of federal environmental laws related to ground water recharge projects; (b) a general description of ground water laws and institutional authority in western states; (c) a general description of the characteristics and properties of ground water rights; (d) a detailed state-by-state examination of the law and institutional issues relating to ground water recharge, including consideration of any general principles that apply to recharge projects in states where no specific artificial recharge law currently exists; and (e) commentary on a number of important issues related to ground water recharge projects.

As many western states have had relatively little experience in this area, some questions may be answered only in general terms. It is also important to realize that the body of ground water recharge law is still evolving.

ECONOMIC EFFICIENCY

Economic efficiency, as used in this report, is a broad measurement of the effective application of resources to the solution of a specific water management problem. It is used as an ideal, integrated objective approach to evaluate and compare the social worth of alternative programs or projects.[1] Ground water recharge is an economically efficient alternative solution to certain water resource management problems. It has been practiced extensively in some areas of the West.

Recharge activities began in southern California in the late 1800's, and continue to be an important aspect of both state and local water management. Colorado is another state with widespread recharge activities, and there are several projects in Texas. It is also an increasingly important management alternative in Arizona, Nebraska and Nevada. However, outside of these states, there are only a few active artificial recharge projects. Ground water recharge activities follow a geographic pattern generally related to water availability and will likely increase in the future as demands on scarce western water supplies continue to grow and western water resource management becomes more intensive.

Economic efficiency is a function of a project's unique benefits and costs, and individual project feasibility is very

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[1] "Net social worth is the alegebraic sum of the total value of output of economic, social and environmental goods minus all costs incurred in the provision of those goods." Options for Planning Objectives: An Integrated Objective Approach to Multiple Objectives Planning, Planning and Cost Sharing Policy Options for Water and Related Land Programs, Part 3B, U.S. Water Resources Council, November 1975, p. 7.

site-specific. In some areas, ground water recharge is not now a cost effective alternative. For example, ground water recharge projects for irrigation of surplus federal program crops in the Midwest may not be economically efficient.[2] However, in California, about half the recharge projects qualifying for state assistance (based on benefit-cost ratios) are primarily for agriculture. Production of high value specialty crops for direct human consumption, as compared to lower value animal forage and feed crops, may produce sufficient benefits to outweigh project costs and justify construction.

Economics is a study of choices, and ground water recharge projects and programs must be considered as one alternative to address a particular problem, along with other means of increasing available water supplies, reducing or modifying demand, and transferring water from lower to higher economic uses. It is difficult to reach any general conclusions with respect to the utility of ground water recharge. Given the nature of different aquifers and the diverse needs and concerns of project sponsors and various government entities, each project will involve unique problems, issues and management approaches. However, ground water recharge and conjunctive use opportunities are a management alternative that should not to be overlooked.

In some areas of the West, surface water supplies simply are not sufficient to meet current demands. Ground water resources are an important supply alternative and a primary source of water for major metropolitan and agricultural areas. However, intensive development and continuing growth are stressing natural ground water systems in some places. Ground water use exceeds

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[2]Raymond J. Supalla and Dorthy A. Comer, "The Economic Value of Ground Water Recharge for Irrigation Use," Water Resources Bulletin, Vol. 18, No. 4, 1982, p. 685.

natural recharge to some important aquifers in the West. Overdrafting water in excess of the sustainable or safe yield has heretofore maintained and allowed for the growth of important western population and economic centers. Ground water mining may be in the public interest or at times the optimal use. However, such mining of ground water aquifers may result in serious long-term adverse impacts, as discussed later.

The conjunctive use of surface and ground waters is essential to the most hydrologically effective and efficient use of limited western water supplies. The integrated management of these naturally related resources can offer important hydrologic and economic advantages. Ground water recharge projects can create opportunities to maximize economic efficiency. For some existing water problems there may be important win-win recharge project opportunities (i.e., Pareto optimal economic solutions). In other words, ground water recharge may at times offer the most economically efficient and the most socially and environmentally advantageous solution. Everyone enjoys a net benefit!

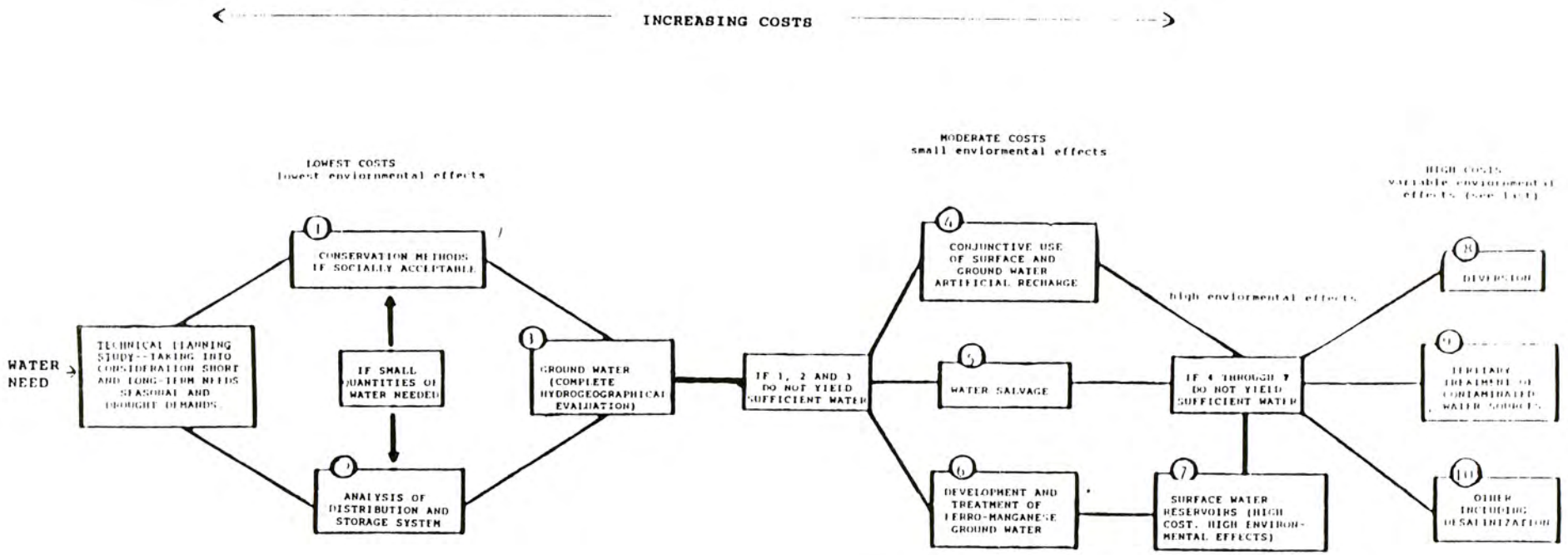
Ground water recharge is best viewed as an integral part of a long-term comprehensive water management plan. Artificial recharge opportunities must be considered in concert with other water management alternatives, including direct usage of surface or ground water resources. For example, California provides financial grants for ground water recharge projects, most of which are designed primarily to reverse declining water tables and ameliorate problems created by past mining of ground water aquifers. California also recognizes "in lieu" recharge project benefits from the secondary use of interruptible surface water supplies in order to conserve ground water resources, which are the primary source of supply.

Ground water recharge projects may offer unique benefits particularly suited to a specific water management problem. However, recharge decisions must consider project purposes and weigh other water management alternatives as part of a comprehensive water management plan. Ground water recharge projects may only be a one response, perhaps a short-term response to a long-term problem, and should not preclude development of other alternative solutions.

For example, ground water recharge might be undertaken with other appropriate activities such as water conservation and public education. Other potential alternatives for addressing water scarcity include weather modification, vegetation management, dryland farming, and as a last resort the gradual voluntary relocation of people and related water uses.

The chart on the next page presents various water management alternatives ranked according to the lowest economic cost and least environmental impact. Based on a study of short and long-term water needs, including seasonal demands and drought events, it suggests first considering water conservation and then improvements to increase the efficiency of the current water storage and distribution system, particularly if only small quantities of water are needed. Next, the availability of ground water resources should be evaluated, followed by an analysis of conjunctive use, including artifical ground water recharge. Consideration of water salvage and treatment opportunities are listed next. New surface water storage is characterized as a high cost alternative with high environmental effects. Other high cost alternatives are interbasin diversions, tertiary treatment and reuse of contaminated waters, and desalinization. The alternatives might be ranked differently, depending on the specific water management problem.

DEVELOPMENT AND MANAGEMENT PROGRAM FOR OBTAINING A WATER SUPPLY OF LOWEST ECONOMIC COST AND LEAST NEGATIVE ENVIRONMENTAL EFFECTS



Source: Motts Wards., et., al., Feasibility of Increasing Water Supplies and Preventing Environmental Damage by Artificial Recharge in Massachusetts, pg. 19, Massachusetts University, Amherst, Water Resources Research Center, January 1983.

Benefit/Cost Ratios

In designing and justifying a project, the obective is to maximize benefits and minimize costs. By adding benefits until an additional unit of benefit is equal to its marginal or additional cost, you maxmize the net benefits and project efficiency. There are different ways to compare alternative projects. Net benefits is one measure. This report will assume the alternative or project with the greatest benefit/cost ratio is the most efficient. The following general discussion includes all costs and benefits, irrespective of their nature or incidence. In other words, it includes primary and secondary, private and public, federal, state and local, monetary and non-monetary, and environmental and social benefits and costs in analyzing economic efficiency.

A purely rational decision is made by reducing all benefits and costs to comparable terms, calculating their present value, determining alternative program or project benefits and costs, and selecting the alternative with the highest benefit/cost ratio greater than one. This integrated objective planning approach would ideally yield the project or non-structural management alternative with the greatest social worth (or as defined herein the most economically efficient alternative). While such an idealistic approach is useful for the purposes of this report, there are practical limitations.

Benefit/costs ratios are an imperfect tool to be used with skill and judgement in evaluating alternative solutions to a specific water management problem or problems. In reality, benefit/cost analysis is limited by the availablity and applicability of information. Not all project benefits and costs are easily identified and quantified. Further, various project

effects may not always be measurable in comparable common units (incommensurates). This is the case with monetarily measured economic effects (apples) and often non-monetarily measured evironmental impacts (oranges).

Traditionally benefit/cost analysis has been used for project justification, given a specific level of benefits and costs. For example, federal project justification purposefully excludes certain state and local economic benefits that at the national level may only represent a regional transfer or distributional change with no net national economic benefit. Federal project justification in the past has been based on certain principles and standards or guidelines for analyzing benefits and costs catagorized under four separate accounts: national economic development (NED), environmental quality (EQ), regional development (RD), and social well-being (SWB). Under recent Administrations, the focus has been on maximizing NED benefits. However, other effects can not be ignored. The project with the maximum national economic benefit may not be the best alternative solution to a specific problem.

Ground water recharge project costs and benefits, again as used herein, include all engineering, environmental, financial, legal, political, social and other costs. Many can be described and measured monetarily, but some can not. Benefit/cost ratios should be carefully calculated to include to the fullest extent possible all identifiable costs and benefits, particularly social opportunity costs, such as environmental values supported by instream uses. Economic analysis is an essential step in the decisionmaking process, but again any analysis of economic

efficiency is limited by the extent to which project costs and benefits can be identified, quantified and compared. Therefore, the project with the greatest benefit-cost ratio may or may not be the best solution to a specific water management problem.

As discussed later in this report, California provides loans for ground water recharge projects. Initially, under the program, projects were ranked in order of priority for funding using benefit/cost ratios, which could be adjusted upward by as much as 35% in order to include otherwise excluded secondary effects and other considerations. Given past experience, benefit/cost ratios are now only one of several considerations used in determining project priority. Further, the weight given the benefit/cost ratio has been reduced.

Ground Water Recharge Costs

Major cost components and related considerations for ground water recharge projects include: water supply, water quality (monitoring and protection), construction, operation and maintenance, legal and financial, and social opportunity or environmental and political costs. Some costs might fit appropriately in more than one category, but should not be counted twice. Recharge project costs should be carefully calculated and due weight should also be given risk and uncertainty. For example, under California's loan program, a contingency allowance of between 15%-20% of total capital costs is required in the benefit/cost analysis.

Water Supply

The primary constraint on ground water recharge in the West is simply the lack of unappropriated water.[3] Therefore, the very first consideration is the availability and cost of obtaining a source of water for artificial recharge. This usually involves finding and securing a right to the use of some surface water resource -- a river or stream, lake or reservoir. Generally, floodflows or seasonally excess streamflows are the most likely sources, but there are other potential sources, including the treatment and reuse of wastewater.

California state statutes specifically refer to the use of reclaimed water to supplement existing surface and ground water supplies.[4] Treated wastewaters are also used extensively in Colorado, and are important in El Paso, Texas. Recharge using reclaimed waters may be an effective alternative, but the costs are highly variable.[5]

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[3] Pilot Recharge Project Final Report, Northwest Kansas Groundwater Management District No.4, accompanying a letter to Gerald Hargadine, Kansas Water Office, August 19, 1988. The conclusions state, "Groundwater recharge in Northwest Kansas is seriously hampered by the lack of available surface water. While construction of certain structures can concentrate the intermittent storm run-off and make this water available for recharge, the total amounts of water recharged appear to be small. [S]tructures that have high surface area to depth ratios are subject to high evaporation losses. For these reasons, it appears that construction of impoundment[s] with a primary goal of ground water recharge will not be cost effective.

[4] Porter-Cologne Water Quality Control Act (Added by Stats. 1976, Chapter 1330; amended by Stats. 1977, Chapter 579).

[5] Vaux, H.J., "Economic Aspects of Groundwater Recharge," in Artificial Recharge of Groundwater, Butterworth Publishers, Boston, Massachusetts, 1985, pp. 703-718.

If unappropriated water is not available, western water markets and state water right transfer procedures are well established and offer a means to acquire the necessary water supplies, but at a price. To the extent that available surface water resources are substantially less expensive than the recovery of ground water, water users will be discouraged from pursuing artificial recharge opportunities.

Water Quality

A major concern with recharge projects is the potential degradation of ambient ground water quality.[6] Some of the biological and chemical constituents and processes and other concerns include viruses, total disolved solids (TDS), iron and manganese, calcite precipitation, and the mutagenicity of chlorinated artificially recharged waters. In order to protect ground water, recharge projects must be carefully designed, constructed and operated. Further, stringent and expensive state and federal data collection and monitoring requirements may be necessary to protect public health and the environment. Water treatment, with associated costs, may also be required prior to recharge.

Baseline information on ambient water quality for many ground water aquifers is unavailable or incomplete. Data collection activities can be expensive and materially affect recharge project feasibility. Monitoring recharge related water

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[6] Overwhelmingly, water quality was the major state concern raised in response to our ground water recharge questionnaire. Also of note, the potential deterioration of ground water quality due to depletion of the various intermontane alluvial basins in southern Arizona was an important factor prompting enactment of the Ground Water Management Act of 1980 and the Ground Water Recharge Act of 1986.

quality changes (within and without the mixing zone) may require an extensive test wellfield and can also be very expensive. Project-specific monitoring requirements must address the hydrogeologic framework, selection of contaminants to be monitored, monitoring frequency and the location of monitoring wells.

With regard to the current federal demonstration program, the Bureau of Reclamation and the Environmental Protection Agency (EPA) entered a memorandum of agreement (MOA) requiring project sponsors to monitor surface and ground water quality in order to assess any water quality impacts. Monitoring wells are required for most types of recharge projects. Periodic monitoring of recharge well injectate will be the primary mechanism for ensuring compliance with the requirements of the Safe Drinking Water Act's (SDWA) Underground Injection Control (UIC) Program. The extensive EPA water quality protection requirements have substantially increased the costs of some demonstration program projects and forced sponsors to reevaluate their feasibility.

UIC regulations are intended to prevent "endangerment" of underground sources of drinking water (USDWs). Under the Bureau/EPA memorandum of agreement, no endangerment will occur if: (1) constituent concentrations in the ground water at the point of injection do not exceed the National Primary Drinking Water Standards (i.e. EPA's maximum contaminant levels [MCLs]), or EPA recommended health based limits, such as health advisories (HAs); or (2) constituents in the injectate do not exceed ambient concentrations in the receiving ground waters.

To assure recharged waters will not have an adverse effect on ambient ground water quality, an effective recharge program may involve: (1) extensive sampling of ground and surface waters

(including water in areas adjacent to a project); (2) installation of a number of monitoring wells at and around the project site; (3) establishment of written protocol, standard operating procedures, and employee training programs; (4) intensive monitoring of surface waters for recharge, particularly urban stormwater, agricultural runoff, and reclaimed wastewaters; and (5) monitoring known potential sources of ground water contamination.[7]

Project sponsors should also be aware of any potential sources of ground water pollution that might threaten recharge opportunities, including septic tanks, mining tailings, hazardous waste dumps, oil brine pits, and sanitary landfills. Other potential non-point source pollution problems include urban stormwater and agricultural surface run-off contaminated by animal wastes, fertilizers, herbicides, and pesticides, etc. Natural leaching of salts, such as selenium, metals and other contaminates is another concern.

Construction

Most ground water recharge project investigation, design and construction costs will be similar to other water development projects, with perhaps some exceptions, such as data collection. For example, given a lack of hydrogeologic data for many aquifers, there may be substantial risk and uncertainty surrounding water quality parameters, and recharge and recovery rates. Without an adequate understanding of the spatial and

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[7] Nikkel, M., et al., "Assessment of the Adequacy of the Ground-Water Monitoring System for Artificial Recharge of Aquifers in the Los Angeles Area, California," in Proceedings of the FOCUS Conference on Southwestern Ground Water Issues, National Well Water Association, Dublin, Ohio, 1988, pp. 45-69.

temporal movement of water within an aquifer, and the chemical and other characteristics of the ground water, the suitability of an aquifer for storing surface waters, and the rate of recharge and recoverability can't be determined and the probability of a successful project can't be estimated.

Significant upfront research and development costs may be incurred even before recharge project benefits can be calculated. This problem is one substantial barrier to the widespread utilization of ground water recharge technology and may be an opportunity for appropriate continuing and future federal research and assistance programs and cooperative federal/state water resource investigations.

Land purchases for spreading basins or to protect wellhead areas may be another substantial cost for recharge projects. Sufficient land may not be available at an affordable cost. However, the Orange County Water District in California acquired an additional 270 acres of former sand and gravel pits in 1988 in order to increase its capacity to recharge waters from the Santa Ana River, which was a less costly than purchasing additional imported water supplies.[8] Organized in 1933 to protect the Orange County ground water basin, the district assumed additional water management responsibilities in 1955. The district now owns and operates 1600 acres for recharge. Over the years, the district has captured and recharged 4 million acre-feet (Maf) of water from the Santa Ana River, an ephemeral or seasonally intermittent stream, as well as another 3 Maf of imported water.[9]

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[8] Orange County Water District Annual Report, 1988.

[9] Groundwater Management Plan, Orange County Water District, February 1989, p. 3.

Operation and Maintenance

Some of the most important project operation and maintenance costs related to ground water recharge and storage systems involve the maintence of wells and pumps and the cost of pumping, which might be compared to the costs associated with the use of dead storage in surface water reservoirs. Energy costs related to recovery activities, power for pumping, are usually the major operating expense. Another major concern is the potential silting of the aquifer and any related loss of storage capacity or transmissivity. Silt also clogs injection wells and seals recharge basins, pits and ditches. Periodic cleaning and/or pretreatment of the surface water supply may be required to remove silt.

Near McPherson, Kansas a ground water recharge project was contructed in 1981, collecting surface water runoff from a small tract of land formed by the intersection of three highways. It consisted of three ponds within a sand and gravel pit. Water flowed through the first pond and then the second, which were connected by overflow pipes and were used for storage and desilting, before entering the third recharge pond through an inlet pipe with a valve to control and measure the flow. An outlet was also built from the recharge pond to an overflow pond. Six monitoring wells were built, one of which included a continuous water level recorder. Through the unconsolidated material, a total of 25.37 acre-feet of water was recharged into the Equus Beds Aquifer during two storm events in 1981-82. However, runoff from the gravel pit eroded and cut through the berm built for the recharge pond and deposited fine silt that

sealed the permeable bottom. Efforts to secure funds to effect repairs have been unsuccessful.[10]

As already mentioned, maintaining water quality is a major concern. Treatment of surface waters may be necessary prior to recharge by percolation or injection in order to meet state and federal water quality requirements. Poor project operation and maintence practices can otherwise have serious water quality and other impacts that impair the ability, capacity or suitability of an aquifer to store water. For example, excessive dewatering can lead to water quality degradation, due to salt water intrusion in coastal areas or migration of adjacent lower quality ground waters, as well as compaction with a loss of storage space and land subsidence.

Legal and Financial

Legal costs associated with securing a right to recharge and recover water may be significant, and sometimes prohibitive. Water rights may have to be adjudicated or otherwise perfected. Extensive and expensive recordkeeping requirements may be imposed by state water management agencies administering water rights. For example, metering of recharge and recovery wells, or measuring of surface water flows into recharge pits or basins may be necessary (operating costs). Further, contractual agreements may need to be drawn up in securing a water supply, land, and necessary rights-of-way for project facilities.

Costs related to legal and institutional uncertainty will be important in many states. Without the recognition of ground

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[10] McPherson Recharge Project Report, Equus Beds Groundwater Management District No. 2, accompanying a letter to Joseph Harkins, Director, Kansas Water Office, October 7, 1988.

water recharge as a beneficial use and a well defined means to protect recharged waters from extraction and use by other than project sponsors, there will be little incentive for potential sponsors to invest in recharge opportunities. Further, there may be unresolved questions of project liability for potential flooding and drainage problems, water quality degradation and any threats to public health.

Financing costs are a very important consideration in evaluating project feasibility. However, they should be distinguished from other costs and excluded from the benefit/cost analysis. Financial costs may distort the benefit/cost analysis, through, for example, reflecting the repayment of bonds over a 20-year period, while project costs and benefits are discounted over the life of the project (say 50 years).

Once economic efficiency has been determined and alternatives have been compared, financial costs must be evaluated as part of the financial feasibility analysis. Issuing bonds to finance a project requires the assistance of legal counsel, and there are other underwriting and marketing costs, which are common to any capital financing program. Of course interest costs are crucial. A complete discussion of financing considerations is beyond the scope of this study, which primarily addresses financial feasibility only as it relates to sharing project costs.

Federal financing opportunities are dwindling, but may offer some cost savings for state or local interests. However, there may be very real legal costs associated with additional federal regulatory requirements (related to social opportunity costs discussed below).

Social Opportunity Costs

There are important opportunity costs related to ground water recharge projects (including environmental and political costs). In other words, recharge project decisions may preclude other alternative land and surface water uses. These social costs may be difficult to identify and quantify, but must be considered. For example, increasing surface water diversions for recharge may have negative impacts on instream uses and recreation and aesthetic values, involving wild and scenic rivers, fish and wildlife habitat, endangered species, and wetlands.

Public awareness of environmental values continues to grow and opportunity costs associated with their loss are important. Dewatering streams or shallow aquifers can have significant negative impacts that must be carefully considered. Related environmental costs must be calculated. While imperfect, techniques are available to measure the economic value of foregone instream and other environmental benefits.[11]

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[11] Bonnie G. Colby, "Third Party Impacts of Water Transfers-Characterization and Economic Measurement," National Research Council, Water Science and Technology Board Committee on Western Water Management, Draft Paper, September 1989.

J. Loomis, "The Economic Value of Instream Flow: Methodology and Genefit Estimates For Optimum Flows," Journal of Environmental Management, Vol. 24, 1987a, p. 169-179.

Some non-market measures of recreation related values include the travel cost method and contingent valuation. Further, estimates can be made of non-users willingness to pay for "existence values," the satisfaction of knowing a resource will be preserved, "option values," assuring the opportunity for future use, and "bequest values," guaranteeing resource availability for future generations. The instream value of water measured in dollars per acre-foot may be comparable to the value of water for offstream uses such as irrigation.

To some extent, environmental and other social opportunity costs are not handled well by our free market system and have been otherwise institutionalized. Ground water recharge projects must comply with clean water requirements, statutes protecting fish and wildlife and endangered species, administrative directives designed to protect wetlands, and other rules and regulations. Complying with federal and state statutes and regulations designed to protect environmental values and other public uses may entail significant costs. California's ground water recharge project loan program (described later) provides examples of the some types of potential social and enironmental impacts and possible permit requirements (Appendices C and D).[12]

Ground water recharge may otherwise be a potentially divisive public and political issue. For example, it may require or promote new or increased water transfers. Many of the ground water recharge activities in California and Arizona rely on imported water as a major source of supply, though the water was originally intended for direct usage. The impacts of exporting water from any area for recharge elsewhere must be analyzed. In this respect, a project may be overwhelmed by the public debate regarding the highest and best use of water and the emotions surrounding many water transfers.

Underestimating or ignoring public concerns over social, environmental, political or other issues can lead to serious opposition and delays in project construction at substantial expense and inconvience.

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[12] "Loan Application for Ground Water Recharge Facilities Construction," California Department of Water Resources, Division of Local Assisstance, Water Conservation Bond Law of 1988, p. A-21 to A-27.

Ground Water Recharge Benefits

Ground water recharge project benefits may be grouped together as they relate to water supply, water quality, and other areas. As with project costs, some benefits may fit under more than one category, and care should be taken to avoid double counting. Ground water recharge benefits may be measured in a number of different ways, such as using an estimate of the least-costly alternative, avoided costs, changes in net income, or vendibility (such as the price at which additional water supplies might be sold).[13] Again, a full discussion of the techniques that are available for quantifying water project benefits is beyond the scope of this study.

Most recharge projects are justified on the basis of water supply benefits, related to enhancing resource management effiency by the conjunctive use of surface and groundwater, avoiding dewatering of ground water aquifers or extending their life, avoiding new surface water development, and promoting or maintaining economic development objectives. However, there are other important benefits, such as flood control, protecting or improving water quality, and enhancing environmental quality. A summary of the methodologies for quantifying water supply (and other) benefits is beyond the scope of this study, but is available elsewhere.[14] The following is a brief discussion of the various types of potential benefits.

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[13] Ibid, p. 38.

[14] U.S. Water Resources Council, "Methodologies and Assumptions for Socio-economic Characteristics and Patterns of Change and Water Use and Water Supply Data," The Nation's Water Resources: The Second National Water Assessment, Appendix B, April 1978.

Water Supply

Water supply augmentation is the primary purpose for most ground water recharge projects. Ground water recharge doesn't create water, but it may provide a means to enhance efficiency through conjunctive use. In other words, it may be possible to use existing water resources more efficiently (physically and economically) by taking advantage of differences in surface and ground water supplies and temporal and other differences in demand. Benefits related to water supply may also accrue through avoiding some of the costs associated with the development of new surface water supplies, the dewatering of ground water aquifers, or declining water tables.

Enhance Efficiency Through Conjunctive Use

Effective water management involves being able to exercise sufficient control to supply the right amount of water at the right time to the right place. Maintaining a balance between water supply and demands is a dynamic process. Too little water at critical times creates supply problems (while too much water causes flooding). Ground water recharge may offer opportunities to use the natural hydrologic system to enhance economic efficiency (at the least cost) through the conjunctive use of surface and ground water to improve water supply system flexibility, resiliency, and reliability.

For example, agriculture accounts for about 82.5% of total consumptive water use.[15] During the winter and at other times,

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[15] National Water Summary 1987 - Water Supply and Use, U.S. Geological Survey, Water Supply Paper 2350, 1987, p. 2.

surface water surplus to immediate demands may be available, often at a substantial cost savings. In California, the Rosedale-Rio Bravo Water Storage District in Kern County recharges large quantities of low cost surplus surface water, when available, at prices 25%-50% less than equivalent amounts delivered on an irrigation demand schedule.[16] This water may be subsequently put to beneficial use during periods of peak and seasonal demand (through out the growing season) or inadequate water supplies (drought).

In California, during the 1989-90 water year (October - September), precipitation has been about 60% of normal, runoff only 40%, and surface reservoir storage is at about 75%. This is the fourth consecutive critically dry year, and the Kern County Water Agency (KCWA) has declared a drought emergency. The KCWA collectively represents a number of water districts, which now face a cumulative water supply shortage of some 1.3 million acre-feet (Maf) or 60% less than normal. The estimated overdraft from ground water resources during 1990 will be 1 Maf, at an estimated additional cost to local farmers (for pumping water) in excess of $50 million.[17]

Since 1978, the KCWA has been able to store or bank a total of 161,490 acre-feet (af) of water through a recharge project operated by the City of Bakersfield. KWCA can withdraw up to 15,000 af annually from five wells, and has evaluated a joint project with the California Department of Water Resources (DWR) that would allow for the withdrawl of an additional 38,400 af at a cost to the agency of $294,000, plus nearly $1 million for pumping power. Typical agricultural water use in Kern County is

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[16] Western States Water, Issue #839, June 15, 1990.

[17] Ibid.

2.5-3.0 af/acre and gross crop revenues range from $1,000-$5,000/acre, depending on the type of crop. The potential value of the 38,400 af of additional water is estimated to be over $38 million, based on the potential avoided loss in gross farm revenue (without adding any loss of jobs and other effects on the local economy).[18] Obviously, augmenting water supplies during drought using waters recharged during wet periods can yield significant economic returns.

Conjunctive use and artifical recharge are important water management activities in Colorado. An estimated 150 recharge projects are operated by a number of municipalities, ditch companies, water supply districts, and other public agencies. For example, there are about 44 recharge sites in the South Platte River Basin that are operated primarily to augment streamflows depleted by pumping water from the alluvium along the river.[19] The Willows Water District in Englewood is experimenting with a 500 foot well to recharge 250 acre-feet of water into the Arapahoe Bedrock Aquifer in the Denver ground water basin. The South Adams County Water and Sanitation District uses recharge pits and former irrigation water, while the Central Colorado Conservancy District in Greely uses spreading basins and canals to recharge water for irrigation. Accurate records of the quantity of recharged waters are not available, but estimates range between 50,000 and 100,000 acre-feet per year.[20]

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[18] Ibid.

[19] Warner, J., et al., Recharge as Augmentation in the South Platte River Basin, Colorado State University, Water Resources Research Institute (Completion Report No. 144), November 1986.

[20] Colorado's response to WSWC questionnaire and notes from Robert Longenbaugh, Colorado State Engineer's Office.

Advantages over New Surface Water Development

Ground water recharge and storage may have several advantages when compared to new surface water development. In some areas, the potential for additional surface water development may be limited for various reasons, including a physical lack of feasible sites, environmental and recreationist opposition to inundating remaining free-flowing rivers and riparian areas, etc. Even where available, recharge projects may offer potential capital and operation and maintenance cost savings over new surface water storage and distribution systems. There is a substantial benefit (cost savings) if existing surface water storage and delivery systems can be used for recharge and existing wells can be used to withdraw the water. Ground water aquifers are storage reservoirs that cost nothing to construct. In addition, ground water basins may also serve as a substitute for a surface water distribution system.

In Arizona, the rapidly growing Phoenix metropolitan area covers much of the Salt River Valley and the underlying intermontane alluvial ground water basin. Surface streamflows are all ephemeral, and several dams regulate runoff from the mountains to the north in three major systems: the Salt River, the Verde River and the Agua Fria River. The potential for additional surface storage is limited and expensive. Ground water recharge is a cost-effective alternative for future water supply needs.[21]

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[21] Lluria, M.R., G.G. Small and R.B. Mack, The Granite Reef Underground Storage and Recovery Project, The Salt River Project, 1988.

In the Pheonix area, ground water has been the primary source of supply for most uses, and an estimated 105.5 billion cubic meters was mined from 1915-1984. The basin's once prolific upper alluvial unit has been dewatered, and together with the lower conglomerate unit now offers large storage capacity and considerable hydraulic conductivity. The Granite Reef Underground Storage and Recovery Project is a joint venture of various communities designed to use surplus water imported from the Colorado River by the Central Arizona Project, as well as occasional storm runoff and excess riverflows. An extimated annual supply of 250 million cubic meters is presently available.

In California, the Rosedale-Rio Bravo Water Storage District's ground water recharge project mentioned above provides tremendous capital cost and debt service savings, as well as project operation and maintenance cost savings. Construction and operation costs for an alternative surface water distribution system, to provide equivalent benefits, are estimated at $185.60 per acre annually. The district's actual cost of providing imported water using the recharge system is 28% less ($133.80).[22]

Some operation and maintence costs may be reduced or avoided. Unlike dams on surface streams, aquifers do not wear out (though poor management practices may impair an aquifers capacity and suitability for storage). Sedimentation and eutrophication problems are reduced (though recharge areas and wells may be subject to silting problems and aquifers may be susceptible to point and non-point pollution). Some

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[22] Maddock, T.S. and D.L. Hardan, "Groundwater Recharge Project Provides Economical Water Supply Plus Drought Protection," Boyle Engineering, paper presented at an American Society of Civil Engineers' conference in Las Vegas, Nevada on April 26-30, 1982 (Preprint 82-020).

irrecoverable water losses may be reduced, such as evaporative water losses from surface water systems. There will be some evaporative loss associated with recharge ponds, but generally no evaporative loss with underground water storage. Phreatophytes and evapotranspiration losses are only a problem with very shallow aquifers. However, care must be taken in evaluating project yields, as some of the recharged water will be irrecoverable.[23]

Ground water recharge and storage projects may use less land than surface water reservoirs or existing land uses may be compatible with ground water storage (but might exclude surface water development, such as in urbanized areas). For example, the Salt Lake County Water Conservancy District in Utah, with financial assistance from the Bureau of Reclamation's demonstration program, is developing a project to recharge an aquifer that underlies a large area of intense residential

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[23] While legal issues are discusses later, it is important to note that recharge may not be considered a beneficial use, or may be considered waste, to the extent that the recoverability of otherwise usable surface waters can not be proven.

In administering water rights, the state of Nevada requires recharge project applicants to estimate the amount of water that will be recoverable, while Arizona uses a complicated formula to determine the amount of water the state will allow to be recovered (based in part on public policy issues related to the source and nature of the water - effluent, imported water, etc.).

According to the U.S. Bureau of Reclamation's comments on a draft of this report, "Under natural recharge conditions, a rule of thumb is that only about 75 percent of ground water is recoverable using current technology. This would be no different with artificial recharge. A recharge program needs to recognize that up to 25 percent or more of the water recharged may not be directly recovered."

development.[24] In Southern California's densely populated coastal plain ground water basins are also effectively utilized for water storage through recharge. This advantage may be of particular importance in other heavily developed metropolitan areas.

Avoiding Dewatering Aquifers and Declining Water Tables

A major water supply benefit from recharge activities is the maintenance of underground water levels and artesian pressures. Recharge activities may actually create downgradient "reverse head water benefits."[25] This in turn helps reduce pumping costs, specifically power costs, and avoid well deepening costs. It may also help relieve stress on ground water systems and pumping equipment by moderating pumping demands. Such "lift benefits" are included here as they result from an increase in the water supply. However, these benefits will decline in proportion to the amount of recharged water that is subsequently extracted. Therefore, they might best be accounted for separately. Some lift benefits can be claimed along with water supply benefits if there is some delay between the time of recharge and extraction, or the amount of water extracted is less than that recharged.[26]

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[24] Project Development Plan for Southeast Salt Lake County Artifical Groundwater Recharge Demonstration Project, Salt Lake County Water Conservancy District, January 1990.

[25] Response to state ground water recharge questionairre in letter from Wayne Haas, Administrator, Planning and Policy Division, Idaho Department of Water Resources, October 2, 1989.

[26] Loan Application, CA DWR, ibid, p. 37.

Ground water recharge may help avoid land subsidence, caused by overstressing or dewatering aquifer systems.[27] Excessive dewatering can lead to compaction and irreparable harm to the acquifer with a loss of storage space, as well as serious disturbances of surface uses due to land subsidence. In the Santa Clara and San Joaquin Valleys of California the compaction of layers of clay, due to the loss of hydraulic pressure from the mining of a confined aquifer, has led to substantial subsidence (up to 28 feet in one small area). Some subsidence has also occurred in the Sacramento Valley.[28]

Since 1920, San Jose has dropped thirteen feet, while some bayland areas are now below sea level. Only a high levee keeps Alviso from being inundated. Land subsidence has caused many millions of dollars of damage to over 125 square miles of the Santa Clara Valley. Some of the consequences include reduced flood channel capacity, collapsed water well casings, poor drainage, and damage to water and sewer lines. The Santa Clara Valley Water District stopped subsidence between 1964-69 by recharging massive quantities of water imported from northern California via the State Water Project.[29] Recharge continues using imported and local sources of surface waters.[30]

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[27] Holzer, T.L. and M.R. Luria, "Selected Hydrogeologic Problems in Central Arizona," in Geologic Diversity of Arizona and Its Margins, Arizona Bureau of Geology and Mineral Technology, Special Paper 5, Tucson, Arizona, pp. 205-211.

[28] Final Report, Governor's Commission to Review California Water Rights Law, December 1978, p. 141.

[29] See chart in Appendix E.

[30] Discover Water, Santa Clara Valley Water District, January 1988, p. 20.

With regard to ground water flow, the artifical, but incidental, recharge from irrigation in eastern Idaho helps maintain a 7,000 to 8,000 cubic feet per second discharge from the Snake Plain Aquifer at Thousand Springs, a fifty mile reach along the Snake River. In effect, the aquifer serves as a giant reservoir. Without this incidental source of recharge, there would be much greater fluctuations in riverflows and the use of the much of the water would be lost downstream, due to the lack of surface water storage capacity.

Given the geohydrology of this area, in 1981 the legislature authorized and the Idaho Department of Water Resources created a Lower Snake River Aquifer Recharge District. During years when surplus floodwaters are available, the district operates a recharge project at a site north of Shoshone, Idaho where there is a depression within a finger of exposed fractured basalt that separates the Big and Little Wood Rivers. In 1983, the first 7,000 af of water was diverted and recharged, but in 1984 no water was recharged. Another 7,800 af was recharged in 1985, with 60,000 af available and recharged in 1986, and 4,200 af in 1987. The site has been inactive since, due to the continuing drought. Pumping lift benefits due to an elevated water table is the primary purpose of the project. Storage benefits are small because of the relatively short distance between the recharge and discharge sites. The direct beneficiaries of the project are those holding water rights to the ground water or spring water within the district. The district assesses a fee of up to $10 per cubic foot per second (cfs) of recorded water right, which provides approximately $25,000. There is no levy in dry years.[31]

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[31] Letter from R. Keith Higginson, Director, Idaho Department of Water Resources, to Tony Willardson, Associate Director, Western States Water Council, May 7, 1990.

Since 1985, treated municipal effluent has been injected in to the Hueco Bolson Aquifer in western Texas to supplement the dwindling municipal supplies of El Paso. This $30 million project includes ten injection wells ranging in depth from 632-881 feet and with an average recharge rate of between 3.5 to 4 million gallons per day. Prior to injection, the water is treated to standards set by the Texas Department of Health using federal Safe Drinking Water Act maximum containment levels (MCLs) under a wastewater discharge permit issued by the Texas Water Commission. Without augmentation, beyond 2030, the ground waters currently available to El Paso from the Hueco Bolson Aquifer are not expected to continue to be a viable municipal water supply due to declining yields and salinity problems. To date, El Paso has unsuccessfully pursued the use of other alternative sources of supply, including adjacent ground waters in New Mexico.[32]

In the long-run, ground water recharge may promote or help maintain economic development, by helping to ensure adequate water supplies for future use. This is perhaps the major concern that prompted Congress to authorize and fund the Bureau of Reclamation's Ground Water Recharge Demonstration Program. It's express purpose is to demonstrate the use of various recharge technologies under various geologic and hydrologic conditions. Eligible demonstration project sites were confined to areas with a declining water table. The major objective appears to be an assessment of the potential of recharge projects for meeting water supply needs in the Plains States and other Reclamation

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[32] Schenkkan, P. and L. Wilson, "Some Issues in Interstate Water Transfer: The El Paso Case," in Issues in Ground Water Management, Center for Research in Water Resources, University of Texas at Austin, 1985, pp. 97-99.

Kovis, J., Artificial Aquifer Recharge in Texas: Summary, Texas Water Commission (summary prepared for this study), 1990.

States, particularly areas above the declining Ogallala Aquifer, which is a major regional resource of national concern.[33]

Flood Control

Ground water recharge by spreading floodflows and using retention basins, dry wells, or injection wells can be a cost effective and a very efficient means of flood control. On regulated streams, flood control benefits may also accrue from transferring a portion of the surface water supply storage to local ground water aquifers and thereby leave more reservoir space available for flood control. In many areas of the arid West, recharge projects may be designed to provide flood control benefits, while also augmenting existing ground water supplies.

For example, the Rillito Creek Project is a joint recharge and flood control project (that also provides open space and recreation benefits). It is a cooperative effort of the Arizona Department of Water Resources, the City of Tucson, and the Pima County Flood Control District, with assistance from the Bureau of Reclamation. The primary purpose is to evaluate opportunities for enhancing infiltration and recharge of floodwaters or surplus surface runoff, using a diversion structure, sedimentation and recharge basins, and in-channel "T" levees. Other features include wildlife ponds, walking and riding trails, playing fields and a water education center.

Water Quality

Ground water recharge projects are one alternative for protecting existing ground water supplies from contamination and

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[33] Public Law 98-434, September 28, 1984.

thus produce water quality benefits (and water supply benefits). Excessive dewatering of an aquifer may lead to water quality degradation, due to salt water intrusion in coastal areas or the migration of adjacent lower quality ground waters. Recharged waters may serve as a physcial barrier to pollution, and help avoid the negative impacts of water quality degradation on people, crops and livestock.[34] Similarly, recharging waters of higher quality than ambient levels may help attenuate or dilute ground water polluted by human practices or natural conditions. This may result in agricultural benefits due to increased crop yields or lower water requirements, or reduced damages to appliances, plumbing, and equipment related to municipal and industrial use (or reduced maintenance requirements).

In some areas, surface water resources have been recharged to form a hydraulic barrier to prevent salt water intrusion into coastal aquifers,[35] or contain the movement of underground pollution plumes or the encroachment of poorer quality waters. In California, the Orange County ground water basin is largely protected by the Newport-Inglewood fault, which effectively seals deeper aquifers from seawater intrusion. However, the ancestral Santa Ana and San Gabriel Rivers eroded four geologic gaps that expose an alluvial aquifer. Seawater intrusion first became a problem in the early 1930s due to ground water overdraft. The Orange County Water District injects surface water, ground water,

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[34] Atkinson, S.F., "Ground Water Contamination from Saltwater Intrusion and Limitations on Agricultural Activities," in Ground Water Quality and Agricultural Practices, Lewis Publishers, Chelsea, Michigan, 1987, pp. 57-72.

[35] Hartman, G.C., et al., "Prevention of Saltwater Intrusion Through Artificial Recharge of Ground Water in East Orange County, Florida," in Proceedings of the NWWA Conference on Solving Ground Water Problems with Models, National Well Water Association, Dublin, Ohio, 1987, pp. 541-575.

and highly treated wastewater into two of the gaps to control seawater intrusion.[36] District studies indicate substantial additional dewatering of the underground water basin would require construction of more seawater intrusion control facilities in all four gaps. The Orange County Water District's Water Factory 21, one of the world's most advanced treatment plants, uses a reverse osmosis process to produce water recharged by injection to the Orange County ground water basin (primarily to control seawater intrusion).

Recharging treated wastewater through injection or infiltration may also be an effective means of meeting some state and federal drinking water and water quality requirements and avoiding treatment costs. Ground water recharged using infiltration through sand and gravel may biologically renovate waters and remove bacteria and viruses, as well as some chemical pollutants. It may also provide an effective and superior method of odor control.[37] Recharge may otherwise have water quality benefits, such as helping improve color and avoiding temperature pollution from discharges to surface waters. Further, in addition to avoiding variable water treatment costs, such as chemical purchases, capital cost savings may be possible if construction of additional treatment capacity can be avoided.

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[36] Groundwater Management Plan, Orange County Water District, February 1989, pp. 3 and 23-24.

[37] Savenhed, R., et al., "Odour Control by Artificial Groundwater Recharge," in Pretreatment in Chemical Water and Wastewater Treatment, Springer-Verlag, New York, 1988, pp. 113-122.

Environmental and Recreation

It is important to note that there may be important environmental benefits from conjunctive use and recharge activities due to the possible conservation or augmentation of surface waters for instream uses, particularly along critical stream reaches during times of stress. For example, surface water diversions might be curtailed during drought and ground water withdrawls increased from supplies stored during wet years by artificial ground water recharge. As a result, more water might be left in the stream to protect important fish and wildlife habitat, such as wetlands, as well as maintain recreation opportunities.

In addition to the benefits possible from conjunctive use, recharge activities may help restore or maintain water levels in shallow aquifers or discharges to streams that support wetlands and other riparian areas. Playa lakes and other natural or artificial impoundments used for recharge may also sustain or create wetlands. Similarly, recharge project impoundments may offer opportunities for recreation, including fishing, sailing, boating, and picnicing. As previously described, the Rillito Creek Project in Tucson, Arizona is designed to enhance recreation and provide water education opportunities.

In Texas, decling ground water levels due to mining of the Edwards Aquifer threaten the flow of San Marcos Springs, a popular tourist attraction and the home of different endangered species. The Blanco River loses water to the Edwards Aquifer through the highly fractured rock that makes up the river bottom and directly recharges San Marcos Springs. In order to enhance recharge and maintain springflows, various projects have been suggested, including damming the river, drilling into the

riverbed, and/or diverting river water to adjacent bedrock sinkholes.[38]

In summary, ground water recharge projects may involve a variety of costs amd benefits, many of which are common to other water management alternatives, but which vary by degree from project to project. Substantial risk may surround the feasibility of some recharge projects. Therefore, early in the economic analysis allowances should be budgeted for anticipated and unanticipated costs. Further, the benefits that result from recharge activities may be uncertain, though perhaps substantial, (and uncertainty may increase with time and distance).

Therefore, throughout recharge project investigation, construction and testing, estimated project costs and benefits should be carefully monitored. If project costs rise significantly, or estimated benefits fall substantially, the benefit/cost ratio should be recalculated.

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[38] Ogden, A.E., and R.A. Quirk, "Delineation of Separate Flow Regimes in the Edwards Aquifer: A Means of Sustaining the San Marcos Springs Discharge," in Proceedings of the Association of Ground Water Scientists and Engineers, Southern Regional Ground Water Conference, National Water Well Association, Worthington, Ohio, 1986, pp. 14-32.

FINANCIAL FEASIBILITY

Economic efficiency and financial feasibility are not the same. Once project costs and benefits have been identified and quantified, if the benefit/cost ratio is greater than one, the project is economically efficient. Again, as used in this report, the benefit/cost ratio is presented as an all inclusive measure of social worth in an ideal, purely rational decision-making model. The next step is to determine financial feasibility by appropriately matching beneficiaries with costs and benefits, to the extent possible, and then negotiating cost sharing and financing agreements. There are major differences between direct and indirect beneficiaries, and their ability and willingness to finance and repay project costs, which circumscribe financial feasibility. Therefore, a project may not be financially feasible, even though it is economically efficient.

The complex provisions of financial agreements are beyond the scope of this study, though some financing considerations will be discussed briefly in the context of designing appropriate cost sharing agreements and cost recovery mechanisms. It is important to recognize that cost sharing involves both financing and repayment agreements. Further, due to the divergent and sometimes unique costs and benefits ground water recharge projects and programs may produce, cost sharing agreements must be addressed on a case-by-case basis. Effective and efficient cost sharing agreements must recognize and employ these differences. While some general principles are applicable, few hard and fast rules are suitable or very useful. Flexibility is the key, though policy and process must be carefully considered.

Program and Project Beneficiaries

Ground water recharge projects and water resource management programs, in general, provide important benefits to numerous entities. Often, it is difficult to identify individual or specific groups of beneficiaries. Any particular project may affect a wide range of individuals or groups, either directly or indirectly. Beneficiaries may be categorized as: (1) individuals, cooperatives, companies or other private entities; (2) local governments and agencies; (3) states and state agencies; and (4) the federal government.

Each of these have varying interests in ground water recharge projects and programs, and a benefit to one may or may not represent a benefit to another. An example is a project's indirect benefits, such as the multiplying benefits of a major construction project on the economic welfare of a community. While an economic boon to that community, on a state or federal level the benefit, if any, may not be significant. If funded by state or federal grants, it may simply represent a transfer of wealth from one area to another.

In the past, many large water resource development projects and programs were federally designed, financed, constructed and operated. Federal guidelines defined benefits, determined beneficiaries, allocated costs among those beneficiaries, and established repayment policies (by project purposes). This federal process primarily reflected federal objectives and priorities. However, the continuing decline in federal water resource development expenditures is evidence of changing federal priorities (due in part to the growing federal budget deficit), and more and more non-federal interests are expected to bear a

greater share of federal project costs and financing responsibilities. As a result, non-federal interests now play a greater role in designing federal projects, defining their benefits and determining whether or not a project is built by their willingness to finance and/or share federal project costs.

With respect to ground water recharge projects, there may be many direct and indirect beneficiaries. Obviously, individual farmers benefit from the increased availability of water and rising water levels that reduced pumping lifts, or increasing artesian water pressure and resulting energy savings, which directly affect net farm income. Similar benefits accrue to an individual homeowner with a domestic well. Private companies may benefit directly from the greater availability of water, or indirectly, perhaps due to greater net farm income and a related increase in disposable income. Further, a company might find injection of treated process waters to be of benefit as an environmentally sound and responsible means of disposal (which may also be a local, state, and/or federal benefit).

The benefits to a community or irrigation district from ground water recharge are generally related to both water and cost savings associated with replacing or augmenting surface water supplies. In areas with declining water tables, ground water recharge may prove to be the least-cost solution to a specific problem. If an alternative water source is available, recharge activities may effectively be used to extend supplies by increasing the efficiency and effective yield of the hydrologic system. Some municipalities may benefit from the ability to better manage the existing resources to meet demands and avoid, at least temporarily, developing new surface water resources.

For some western communities greater water supply and water use efficiency are particularly important as growth pushes consumptive use up, while dependable supplies dwindle. In the furture, some western communities and irrigation districts may face major economic disruptions due to the dewatering of some aquifers. In some areas, falling water tables and rising energy costs will likely contribute to a decline in irrigated agriculture. Extending aquifer life and avoiding dewatering may lead to direct and indirect benefits to a community or irrigation district related to avoiding financial hardship, bankruptcy, and geographic dislocation.

The development of a workable methodology for estimating the costs and economic losses associated with the disruption caused by the loss of a water supply was not part of this study. However, some work has been done in estimating drought related losses that might be usefully applied to calculating the benefits of ground water recharge. Some research has been done in developing relationships between water shortage and economic losses. The California Department of Water Resources has sponsored work on input/output models, which require a substantial investment in data gathering. Others have suggested comparing the value added by anticipated economic activity with and without a shortage (or perhaps a potential project), estimating willingness to pay to avoid shortages, or the use of general equilibrium models to measure losses.[1]

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[1] Ben Dziegielewski, "Designing a Framework for Assessing the Impacts of Drought," Southern Illinois University, draft paper presented at a research conference sponsored by the U.S. Army Corps of Engineers' Institute for Water Resources in Pheonix, Arizona on January 22-24, 1990.

At the state level the benefits of maintaining the water supply upon which the state economy is based can be tremendous. Again, referring to the 1976-77 drought in California, the direct losses were estimated at almost $1.3 billion, or adding indirect and induced losses, a $1.8 billion loss in gross output, $490 million in lost income and 51,000 foregone job opportunities.[2] Similarly, on a smaller or more long-term scale, dwindling ground water supplies may effect state economies by reducing tax revenues, increasing relief expenditures, etc. Moreover, the state as the trustee of state lands and resources may find other benefits from increasing the availability of surface or ground waters, through recharge, for a myriad number of purposes ranging from water supply to environmental enhancement and recreation. It may be in the best interest of a state and its people to use ground water recharge as a means to stabalize ground water resources and maintain economic activity.[3]

The federal government, representing the national interest, may similarly benefit. Recharged waters are available to increase federal project yields, maintain streamflows for the protection of endangered species, meet national water quality goals, fulfill international agreements, and meet many other needs where a federal or national interest has been defined, as part of the political process. Ground water recharge may be an effective means of protecting or rehabilitating wetlands to meet the nation's new "no-net loss" goal. Estimating the economic

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[2] Ibid.

See also, The 1976-1977 California Drought: A Review, California Department of Water Resources, May 1978.

[3] R. K. Thomas, "Ground Water Recharge for Oklahoma: An Analysis of Past and Future Methodology," Ground Water Quality and Agriculture Practices, Lewis Publishers, Chelsea, Michigan, 1987.

benefit to the nation of ground water recharge would be a long and complicated process. However, estimating the federal or national interest in a particular proposed project is a more manageable task, with established principles and guidelines.

Congress' authorization and funding of the Bureau of Reclamation's current ground water recharge demonstration program, focusing on the High Plains and other Reclamation Act States, is evidence of a perceived national benefit to be derived from this alternative means of extending the life of the ground water resources upon which major regional economies have developed. Again, drawing on the drought analogy, serious water shortages may lead to financial hardships, food shortages, population migration, health problems, economic disruption, massive government relief, and even international problems. There is a federal or national interest in each of these areas.

The varying beneficiaries of recharge projects and the role of the government (local, state and federal) in promoting or participating in recharge activities will be discussed further in regard to designing appropriate cost sharing agreements.

Cost Sharing

With respect to cost sharing, the following general principles are important: **(1) beneficiaries should usually pay project and program costs; and (2) cost sharing should encourage economic efficiency and equity.** The application of these principles can be difficult, in view of the complex nature of ground water recharge projects and the problems of risk and uncertainty.

Beneficiaries should usually pay project costs. This concept is essential to economically efficient resource allocation. A free market system relies upon cost (or price) to promote the wise development and efficient use of our natural resources. Unless the costs of a project or the use of a resource fall on those that benefit, there will be no incentive to conserve the resource and it will be used inefficiently. Therefore, to the extent that beneficiaries can be identified, it is important that they somehow assume responsibility for project costs.

However, water is a particularly complex mixed economic good with both private and public benefits. While its private or exclusive use is possible, and it may be bought and sold as many other commodities, the benefits of its development and use are as fluid as its physical nature and stop at no particular social or political boundaries. There are major public benefits from uses that are non-exclusive and non-competitive, or in other words, that are available to everyone and are not diminished by any particular individual's use and enjoyment. For example, navigation, flood control, and recreation are uses that are considered public benefits. Hydroelectric power and agricultural, municipal and industrial water supply are viewed as private benefits. While it may be difficult to imagine navigating or recreating in ground water, the integral hydrologic connection between surface and ground waters makes the potential benefits of recharge projects almost all inclusive.

Multipurpose water resource development, including ground water recharge, is very complex because it provides both public and private goods and services (or benefits), sometimes simultaneously. The benefits and costs of development may literally "spillover," and thus result in important economic

externalities. While a free market economy generally allocates resources efficiently among direct beneficiaries, it fails to equitably handle spillover effects (economic externalities) and indirect costs and benefits. Government participation may be necessary to help remedy the market's inability to allocate all project costs efficiently and equitably.

With respect to ground water recharge projects, the private development of a new or supplemental water supply for domestic, municipal or agricultural use, may at the same time create public flood control and recreation benefits. However, the private developer may not be able to recover a proportionate share of the project's costs, due to the potential difficulty in excluding the public from the benefits of the project, and therefore has no incentive to design or operate the project to maximize efficiency and opportunities to enhance public benefits.

Often, exclusion is not possible or practical, and the free market alone can not maximize project efficiency. For example, an irrigation district sponsoring a ground water recharge project may only have jurisdiction to limit subsequent withdrawals within its boundaries by its members. However, the benefits may be exploited by ground water users outside the district, without the constraints imposed by project costs. Similarly, all of the individual beneficiaries of a project may not always be easily identifiable and separable from each other, which consequently makes project cost allocation problematic. In such instances, the efficient allocation of the resource requires some broader collective action. A county wide ad valorem tax or levee assessed in proportion to the indirect benefits of the project outside the districts boundaries would be a way to raise revenue to share project costs and improve efficiency.

Government Participation

The purpose of this subsection is to suggest an appropriate role for government participation in water projects or programs generally, and then to discuss the appropriate federal role in ground water recharge project or program financing and cost sharing. Government financing and cost sharing are essential tools that can be used to promote economic efficiency. Government participation in projects can correct market failures that result in inefficiencies and inequities by carefully matching project costs with beneficiaries through broad taxing and spending powers.

Over the last decade, considerable discussion has centered on appropriate federal and non-federal roles with respect to federal water project financing and cost sharing. All ground water recharge project costs must be born by someone: direct and indirect beneficiaries, state and local governments, and/or the federal government. Normative economics suggests that three legitimate objectives of government participation in a free market-oriented economy are to promote:

(1) **the efficient allocation of resources;**
(2) **a just and equitable distribution of income and wealth;** and (3) **a reasonably healthy economy,** through the use of countercyclical stabilization measures.[4]

Generally, intervention should be undertaken by the lowest level of government capable of achieving the desired objective.

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[4] Richard and Peggy Musgrave, Public Finance in Theory and Practice, 3rd Ed., McGraw-Hill, New York, New York, 1980.

Public works projects or governmental participation in private projects can be an appropriate means of achieving the above objectives. Generally, economic stabilization and wealth redistribution are are beyond the scope of this study, which focuses on the role of government in promoting economically efficient resource allocation as it relates to ground water recharge projects.

Benefit-cost analysis determines whether or not potential project benefits are greater than potential project costs. Normative economic analysis suggests how best to allocate costs in order to maximize efficiency and equity. Benefit-cost analysis addresses project effects. Normative economic analysis focuses on the incidence or distribution of those effects, which may then form the basis for designing appropriate cost sharing agreements and cost recovery mechanisms that promote the most efficient allocation of costs (and resources), within any constraints imposed by principles of equity.

To promote economic efficiency, government participation (financing and cost sharing) in ground water recharge projects should be based on affirmative answers to the following six questions:[5]

(1) Is the government a direct or indirect project beneficiary?

(2) Is the government in the best position to finance and recover direct project costs?

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[5] Willardson, A.G., Federal Water Resource Development Financing and Cost Sharing: A Western State Perspective, University of Utah, Institute of Government (MPA Policy Paper), June 1983, p. 53

(3) Is the government in the best position to finance and recover, or bear, indirect project costs?

Further, with respect primarily to the federal government, these additional questions should also be addressed:

(4) Does the project promote objectives associated with economic stabilization and income or wealth redistribution?

(5) Has the government created a statutory or other right to some good or service (such as safe drinking water)?

(6) Has the government made previous commitments or promises?

By way of explanation, government (collectively representing individuals) may be a direct beneficiary of a ground water recharge project. If a city initiates a project to enhance or ensure the yield or its municipal water system, the city should assume responsibility for project costs associated with these benefits. At the federal level, there may be a direct benefit from a recharge project supplying a military, Indian or other reservation or federal lands. There may be a direct federal benefit associated with possible fish and wildlife habitat improvements, particularly any positive effect on endangered species. To the extent that a government benefits directly from a recharge project, that government should share its costs.

In addition, governments may benefit indirectly, perhaps from the water supply benefits of a ground water recharge project. For example, a state may benefit from increased or

prolonged economic activity related to the greater assurance of an adequate water supply. Increased tax revenue can be a definite state and local benefit, though it is not usually appropriately considered a federal benefit, as it may merely results in an interregional transfer. Whether or not government benefits are direct or indirect, they are evidence of a need for government participation in the project to promote economic efficiency.

Direct and indirect project benefits may or may not be easily identified. Moreover, even where project benefits are apparent, cost recovery can be difficult. Government participation is sometimes the best and perhaps the only way to effectively recover costs. As noted, an irrigation district can recover project costs from it members by way of various assessments, but direct and indirect benefits that occur outside district boundaries and jurisdiction can not be charged to the beneficiaries without government participation, perhaps through the use of specific or general taxing authority.

Certain benefits may be so diverse or widespread as to justify state or federal assumption of responsibility for project costs, which to the extent practical, would then be recovered from beneficiaries. It might also be appropriate for the state or federal government to simply bear the cost of the project. For example, the administrative costs associated with identifying each individual beneficiary, quantifying minor monetary gains and determining appropriate charges, and then recovering related assessments may be prohibitively expensive and impractical. In such instances, governments may appropriately financing the project and recover its costs, using its taxing and spending authorities.

Governments may also promote development of economicially efficiency projects that otherwise might not be financially feasibile, given the free markets inability to require all beneficiaries to share project costs. An individual, private company, irrigation district, or small community may not be in a position to finance an economically efficient ground water recharge project (due to limited access to capital resources, or a limited ability to control subsequent ground water withdrawls and recover costs from project beneficiaries). The federal Reclamation program helped settle and the West, and now federal participation is helping determine the future role of ground water recharge projects. Clearly, government financing is an important means of realizing economically efficient resource development and allocation.

Federal Financing and Cost Sharing

Abraham Lincoln once said, "The legitimate object of government is to do for a community of people whatever they need to have done, but cannot do at all or cannot do well for themselves in their separate and individual capacities."[6] Upfront financing can be a significant problem for many state and local sponsors, given limited capital resources and limited access to private capital markets. Even if there is little or no federal benefit from a ground water recharge project, federal financing may be appropriate. While recognizing there are limitations imposed by federal budgetary constraints, the federal governments may often still be in the best position to finance some ground water recharge projects where important needs can not be met otherwise.

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[6] Waldo, Dwight, The Enterprise of Public Administration, Chandler & Sharp, Novato, California, 1980, p. 17.

In such instances, to promote economic efficiency, the federal government should finance projects and subsequently recover costs, as appropriate, from direct and indirect beneficiaries over a reasonable repayment period and at an appropriate interest rate that reflects the federal government's cost of borrowing. The federal government has an obligation to help meet necessary water resource development needs, but should not actually share the costs or provide any subsidy unless there is a legitimate federal objective and benefit. This can be done through the careful design of repayment contracts and appropriate cost recovery mechanisms.

Federal cost sharing of ground water recharge projects may be important to promote national economic and social objectives, as defined by Congress and pursued by various federal agencies. For example, the enactment of the High-Plains States Ground Water Demonstration Project Act is evidence of Congress interest in the potential benefit to the nation of recharge projects. Obviously, the collective importance of smaller local and regional economies (dependent on ground water use) to the national economy should not be underestimated.

Federal cost sharing is also appropriate to help provide certain goods or services to which legal rights have been created and defined by Congress or the courts. For example, Congress has enacted broad mandates to ensure the quality of public water supplies under the Safe Drinking Water Act. When Congress creates a public right, such as to safe drinking water, there is an accompanying federal obligation to share the cost of providing what may then be considered as a type of welfare floor based on public health.

The federal government also has a self-evident ethical obligation to keep prior promises. In many areas, Congress has by statute or otherwise made specific commitments, often as part of political compromises, which should be honored. Where federal promises have been made regarding water resource development, ground water recharge projects may provide opportunities to fulfill these promises.

At present, there is no clear and concise definition of the federal or national interest in water resources management generally, and ground water recharge in particular. However, something may be divined about federal cost sharing policy from current national objectives -- the state of the economy, the federal budget and the deficit -- and recent laws and congressional findings. Past precedent should also be considered.

In 1978, President Jimmy Carter issued a number of specific directives addressing federal water policy changes. With respect to cost sharing, the Administration proposed a modest upfront state financing requirement of five to ten percent of federal project costs.[7] Issued as a mandate without prior consultation with Congress or the states, the proposed changes began a heated discussion of appropriate intergovernmental responsibility for water resource development and federal project financing and cost sharing.

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[7] Water Policy Message: Detailed Background, Office of the White House Press Secretary, June 6, 1978, p. 9.

In 1982, under the Reagan Administration, Interior Secretary James Watt sent a memorandum to the President recommending a new cost sharing policy for federal water projects, based on the following specific principles:[8]

(1) non-federal cost sharing is necessary due to federal budgetary constraints to provide for needed development;

(2) non-federal "up-front" contributions are preferable and should be presumed in all cases, with limited exceptions;

(3) in general, beneficiaries should pay for the cost of services;

(4) above-cost-pricing should be considered where the value of water is higher than its cost; and

(5) agricultural water supply and flood control services require more flexible cost sharing, though they should pay a significant portion of the cost.

The memo further suggested specific non-federal capital financing requirements as a percentage of project costs based on project purposes. Beneficiaries or project sponsors would be responsible for operation and maintenance costs.

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[8] "What kind of cost sharing arrangements should the Administration require for federal water projects?" Memorandum for the President, from James G. Watt, Chairman and Pro Tempore, Cabinet Council on Natural Resources and Environment, June 15, 1982.

In 1986, Congress passed the Water Resources Development Act (P.L. 99-662), authorizing the first new federal water project starts for the U.S. Army Corps of Engineers in over a decade. Comprehensive cost sharing revisions were included. Although the debate continues over appropriate federal and non-federal cost sharing requirements, these may represent the best indication of current federal cost sharing policy. Generally, non-federal cost sharing requirements were as follows:

(1) Harbors - 10%-50% of project costs, depending on depth;

(2) Inland Waterways Navigation - 50% to be paid from the Inland Waterways Trust Fund, financed by fuel taxes;

(3) Flood Control - 25%-50% depending on the cost of lands, easements, and rights-of-way provided by non-federal interests, with a minimum 5% upfront cash contribution;

(4) Hydropower - 100%;

(5) Municipal and Industrial Water Supply - 100%;

(6) Agricultural Water Supply - 35%;

(7) Recreation - 50%;

(8) Hurricane and Storm Damage Reduction - 35%;

(9) Aquatic Plant Control - 50%; and

(10) Beach erosion control, water quality enhancement, and fish and wildlife mitigation as assigned to other project purposes and shared at the same percentages.

While the Department of Interior and Bureau of Reclamation have no similar explicit statutory mandates, past project proposals have generally included similar non-federal cost sharing requirements, determined on a case-by-case basis. With respect to future federal participation in ground water recharge projects, an acceptable cost share might be approximated by applying the above guidelines to the project's purposes.

Lastly, it is important to recognize that in promoting economic efficiency, the federal share of project costs would be the same whether or not it is a federal or non-federal project. In addition to financing and constructing federal projects with non-federal sponsors sharing the costs, the federal government should participate financially and share the cost of non-federal projects, public or private, where there are federal or national benefits. Greater attention needs to be directed towards realizing such joint ventures and establishing true federal/non-federal partnership arrangements.

While the above discussion focuses on the financing and cost sharing role of the federal government, the three legitimate objectives of government participation and six analytical questions presented above may be usefully applied to all levels of government. Many western states already finance major water resource development projects,[9] and a few states specifically promote ground water recharge.

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[9] State/Federal Financing and Western Water Resource Development, Western States Water Council, 1984 Update.

State Ground Water Recharge Project Financing

In the past, California and Kansas have established programs to provide financial assistance for ground water recharge projects. In the early 1980's, Kansas appropriated $400,000 for "aid to groundwater management districts for groundwater recharge pilot projects." The local sponsors were required to provide 20% cost sharing.[10] Construction began on one or more projects in each of the five Kansas groundwater management districts, and included pits, ponds, terracing, and stream channel recharge enhancement. The authorized program could have funded $1 million in projects, but it was eventually curtailed due to a lack of support. None of the projects funded by Kansas are now active.

California's Ground Water Recharge Project Loans

In California, the Water Conservation and Water Quality Bond Law on 1986 provided the means for the state to finance ground water recharge projects through low interest loans financed by state general obligation bonds. The Act stated that local agencies have the primary responsibility for water management, including ground water recharge, but rising construction prices had pushed the costs of ground water recharge facilities "beyond the ability of local agencies to pay." Moreover, ground water recharge is "an effective way to maximize the availability of scarce water supplies throughout the state...."

The 1986 Act, outlined specific procedural requirements for determining economic and financial feasibility, which focused on the determination of a benefit-cost ratio over the life of the

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[10] 1979 Kansas Legislature Session Law Chapter 20, Section 9(a).

project. The life of the project was determined to be 50 years. Various adjustments were made to the base benefit-cost ratio, which then determined project priorities for funding. Only primary benefits and costs were considered in the base benefit-cost analysis, but project benefits could be increased up to 35% with the following justification:

(1) the project was located in an overdrafted ground water basin (10%);
(2) project sponsors had existing water management programs (5%);
(3) there was a critical need (10%); and
(4) the proposed project offered the greatest engineering and hydrogeologic feasibility (5-10%, moderate-high).

Initially, project benefit-cost ratios varied from 1.09 to 14.07, but given the limited availability of state funds, the cut-off benefit-cost ratio was around 4.5 to 6.0.

The Water Conservation Bond Law of 1988 authorized issuing additional bonds to continue the ground water recharge program, and it is anticipated that a similar bond-financed program will be on the November 1990 state ballot. The Department of Water Resources is currently in the process of amending its regulations to more effectively administer the program. Less weight is given project benefit-cost ratios, and they are no longer adjusted and then used exclusively to determine project funding priorities.

The criteria the Department now considers in ranking projects in order of priority for construction loan funding include:

(1) the degree of overdraft reduction and alleviation of related problems;

(2) the engineering and hydrogeologic feasibility of the project;

(3) the economic justification for the project;

(4) the critical need for the project in the community;

(5) the project's consistency with water management programs; and

(6) other local and regional environmental, social and economic impacts.

A ground water recharge project is defined as a "project involving captial outlay expenditures to construct, expand, renovate or restructure land and facilities for artificial ground water recharge or in-lieu recharge, and may include the purchase of land or easements, but not the purchase of surface waters for use in lieu of puming groundwater." In-lieu recharge is defined as "accomplishing increased storage of ground water by providing interruptible surface water to a user, who relies on ground water as a primary supply, to accomplish ground water storage through the direct use of that surface water in lieu of pumping ground water." However, bond proceeds may not be used to purchase surface water for use in lieu of pumping ground water.

A Water Conservation and Water Quality Bond Fund in the state treasury and Ground Water Recharge Account are administered by a committee under the state's general obligation bond law. The committee may, as authorized by the statute and approved by the voters, incur debt in the form of general obligation bonds to finance eligible projects. The 1986 Act authorized $75 million in general obligation bonds for the water conservation and ground water recharge account, and approximately half of that amount has been committed to ground water recharge projects. The 1988 Act authorized the issuance of an additional $40 million in general

ofligation bonds. The Department of Water Resources reports annually to the legislature on the status of the loan program.

With respect to ground water recharge facilities, the law requires that the Department of Water Resources must find the project is economically justified, the sponsoring agency has the ability to repay the requested loan, and the project is feasible from an engineering and hydrogeologic viewpoint. Contracts include a feasibility report setting forth the economic justification and the engineering, hydrogeologic, and financial feasibility of the project, along with an estimate of reasonable project benefits and costs. DWR may provide a feasibility study loan of up to $100,000.

Regarding economic efficiency, applicants are provided a worksheet for estimating and discounting project benefits and costs and computing the benefit/cost ratio. Project benefits are categorized under water supply, lift, water quality, flood control, and sea water intrusion. Project costs are grouped in relation to capital construction costs, operating costs, replacement costs, and water purchase costs. Third party or out-of-agency benefits and costs, particularly any change in water availability, must also be described (but only significant impacts must be included which are defined as more than $100,000 per year or equal to 2% of total discounted project costs).

With respect to water quality, a loan applicant must address how the recharge waters relate to regional water quality plans and determine if the recharged waters will change significantly in quality as it percolates through the soils or if the recharge water will impact the receiving aquifer or its water quality. Major considerations are silt load and mineral constituents, as well as any chemical contamination. If reclaimed water is used,

a description of the status of necessary Department of Health Services approval and regional water quality control board permits.

Project applicants must submit hydrogeological information, including regional geologic cross-sections to substantiate that water placed in the artificial recharge facility will percolate to the intended aquifer from which benefits will be calculated, and that sufficient storage space is available for the recharged water. The hydrogeology and hydrology section requires a description of the source of water for recharge and the status of rights to the water. It also addresses the type and duration of rights, including an estimate of the frequency and amount of recharge water available. The report also requires an explanation of the proposed facilities and any relation to other water-related facilities in the basin or region.

Applicants must submit financial data and take any actions necessary to demonstrate their ability to repay and legal capacity to incur the loan. Project loans are limited to a total of $5 million, to be repaid at an interest rate determined annually at one-half the interest charged for general obligation bonds issued under the Act during the previous year. The term of the loan shall be as short as possible, considering the ability of the applicant to repay the loan, up to twenty years.

Except as authorized by the Department of Water Resources, when project costs exceed the requested loan amount, no state funds shall be dispersed until the applicant demonstrates the ability to otherwise acquire sufficient funds to complete the project, and such funds have been exhausted. The Department of Water Resources will issue a letter of commitment of funds, which may be withdrawn or revised if a contract is not executed within

one year. All project costs are included in the state's analysis, regardless of the proposed sources of financial assistance.

Lastly, the loan application specifically includes a section on the method of repayment (or cost recovery) and description of the repayment plan over the term requested. If standby charges, flat rate payments, user fees, or assessments are to be used to repay the loan, the method for dividing costs among system users is to be included.

While California currently has the only state-financed program specifically designed to encourage ground water recharge projects, every western state provides some means of financing water projects which could possibly be used to finance and share the cost of ground water recharge.

Western states, local agencies and the federal government have used different sources to finance water development and management. General fund appropriations are a major source of funding. Special funds, with dedicated revenue from various sources, are another important financing mechanism. In the West, both the federal government and the states have dedicated royalties and severance taxes from the development of non-renewable mineral resources to special funds for the management and development of water resources. Specific examples are the Federal Reclamation Fund, Montana's Renewable Resources Development Program and Wyoming's Water Development Account.[11]

Bonded indebtedness, usually general obligation bonds and revenue bonds, are another major means of financing water

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[11] Ibid.

projects. Similarly, warrants may be used to dedicate future taxes or other revenue to repay debts incurred to cover project costs. Further, to the extent project revenues might be generated by the sale of water, revenue bonds could be issued. Once initial capital requirements are met and construction is at least partially complete, project revenues may also be used to finance further development on a "pay as you go" basis.

Cost Recovery Mechanisms

Cost recovery mechanisms are an important aspect of financial feasibility and economic efficiency. They are the means by which to match ground water recharge project cost with project beneficiaries. Again, to encourage economic efficiency, it is important that beneficiaries pay for the cost of project-related goods and services. To the extent that there are costs associated with some project benefits that can not otherwise be recovered, government participation may be appropriate to encourage economic efficiency and promote equity. Appropriate cost recovery is a major factor in determining financial feasibility.

In the private sector, profit is the measure of success. Prices are set to maximize profits, and individual consumers determine what they are willing to pay for goods and services. In the public sector, profit is not the primary objective and prices are usually set to recover the cost of providing essential public services, such as municipal water supplies and wastewater treatment. Government spending priorities are determined through the political process, which approximates voters' willingness to pay for public goods and services.

With respect to cost recovery, to the extent that water development meets some governmental objective or provides a specific service to government, it is appropriate that government finance and bear an appropriate share of project costs. Other project costs should be reimbursable, but appropriate government participation may include financing the project and/or designing and implementing cost recovery mechanisms that effectively place the burden of project costs on beneficiaries.

Government participation in cost recovery usually involves the use of two mechanisms, user fees and taxes. User fees are most often appropriate to recover the costs of direct benefits, while taxes are a more appropriate means of covering costs associated with indirect benefits. To promote efficient resource allocation, government participation should match user fees and taxes as closely as practical to those actually benefitting from the project. Usually, this will best de done at the lowest level of government possible.

The use of appropriate cost recovery mechanisms will vary by level of government. User fees, such as water service charges, may be appropriate at all levels of government, but property taxes and/or similar assessments are strictly a local cost recovery option (that may be tailored to specific geographic areas to most closely match project costs with beneficiaries). To the extent a project provides a particular state or federal benefit, the appropriation of general funds or issuing general obligation bonds is acceptable. Cost recovery mechanisms include general income taxes and to some extent sales taxes.

The following examples are presented to illustrate possible state and local government user fees and taxes related to ground water recharge.

Arizona's Ground Water Withdrawal Fee

Under Arizona's Ground Water Management Act, the Director of the Department of Water Resources is authorized to levy a fee of up to $5.00 per acre-foot for the withdrawal and beneficial use of ground water in an active management area.[12] Up to $1.00 per acre-foot may be used for program management and administration. Beginning in 1990, up to $2.00 per acre-foot may be assessed as a fee for augmentation in the first year in which the program is developed and implemented as part of an augmentation plan for an active management area (AMA).

Augmentation projects may include, but are not limited to, artificial ground water recharge. The law establishes an augmentation fund and ground water withdrawal fees, excess administration and enforcement funds, as well as application and surcharge fees for temporary ground water use by lakes are deposited in the fund. Revenues must be used to finance augmentation programs to benefit the AMA within which the fees are collected.

The augmentation fund may be used for projects and studies initiated by the Arizona Department of Water Resources or to provide state cost sharing for augmentation project grants and studies. At present, the Department has no provisions or guidelines for cost sharing, which would be negotiated on a project-by-project basis through intergovernmental agreements.

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[12] Arizona Revised Statutes Annotated Section 45-611.

Nevada's Ground Water Recharge Fees

Nevada is one of the few states with specific statutes relating to ground water recharge, storage and recovery.[13] In order to fund the state's administration of the law, the legislature approved a one-time application fee for a ground water recharge permit of $2,500. In addition, the law requires permit holders to annually submit a report covering recharge operations. The state engineer may assess and collect a penalty of $500 per month that the required report is delinquent, up to a total of $5,000.

Further, the state engineer sets an annual fee, due with the annual report, earmarked for administration of the ground water recharge law. Once set by the state engineer, permit holders are notified by mail of the amount of the fee and when it is due. Late fees may be assessed at 10% of the unpaid fee per month, up to a maximum 60% penalty. The annual fees are deposited with the State Treasurer and credited to the "account for projects for recharge, underground storage and recovery of water" in the state general fund. Any interest or other income earned on such funds is also credited to the account, after deducting any applicable charges. In addition to incurring general administrative expenses, the state engineer may employ special consultants to assist him in fulfilling his ground water recharge management responsibilities.

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[13] Nevada Revised Statutes § 534.250 to .340.

Nebraska's Special Local Authorities

The State of Nebraska has created an array of special districts across the state with authority to construct or contract for the construction of specific conservation projects, including ground water recharge projects. These different districts have authority to issue bonds and warrants (for project construction, operation and maintenance,) that are backed by general specific taxing authority, or authority to levy assessments on real property or other taxable tangible property. Local natural resources districts have built some small ground water recharge projects using local taxing authority and state and federal cost sharing funds.

Natural Resources Districts

In 1972, Nebraska divided the entire state into natural resources districts (NRDs) to provide more effective conservation, protection, coordination, planning, development and general management of natural resources.[14] Now 23 in number, the districts' boundaries generally coincide with river basin boundaries.

The legislature transferred to the new natural resources districts those functions previously performed by soil and water conservation districts, watershed conservancy districts, watershed districts, advisory watershed improvement boards, and watershed planning boards. The legislature further encouraged other special purpose districts, including rural water districts, ground water conservation districts, drainage districts, reclamation districts, and irrigation districts, to cooperate,

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[14] Revised Statutes of Nebraska § 2-3201 to 2-32,101.

and where appropriate, merge with natural resources districts. The districts are governed by boards of directors elected at the state general election.

Natural resource districts (NRDs) may annually levy a tax of up to four and one-half cents on each $100 of the actual valuation on all of the tangible property within the district.[15] A higher levy may be authorized by a majority vote at a regular election. The tax proceeds are available to the district to support general operations and to develop projects. The NRDs are specifically authorized to undertake flood control, water supply, and pollution control projects, as well as the general development, management, utilization and conservation of ground water and surface water resources.

Natural resource districts may acquire water rights, and develop and furnish water for any beneficial use at rates and terms as set by the district board. The conservation and development of ground water storage areas is specifically authorized.[16] Natural resource districts also may be divided into separate units of land susceptible to irrigation and water furnished and assessments levied for service "on the basis of the value per acre-foot of water...."[17] NRDs have specific authority to contract with the state and the United States to construct projects.

Projects "...which the board determines to be of general benefit to the district, shall be carried out with any available

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[15] Id. § 2-3225.

[16] Id. § 2-3238.

[17] Id. § 2-3239.

funds..., including proceeds from the district's tax levy...." Similarly, "projects of a predominantly general benefit to a district with only an incidental special benefit, as determined by the board, may be developed and executed using any available funds...."[18] A district may establish "improvement project areas," where projects result in special benefits, i.e., when the benefits are limited to a certain area and the beneficiaries are identifiable.

An improvement project area may be created by petition of landowners or by the district board itself.[19] An extensive public participation process is used in part to define politically whether or not the project benefits exceed its costs. Before proceeding with detailed plans, cost estimates and a determination of total benefits, the NRD board must provide notice and hold a public hearing. If the project produces revenue through continuing services such as water supply for domestic or other purposes, the board shall "...determine, by circulation of petitions or by some other appropriate method, if such project can be reasonably expected to generate sufficient revenue to recover the reimbursable costs thereof."[20] The board estimates and divides project benefits into units, and "...each landowner within the improvement project area shall..., subscribe to a number of benefit units in proportion to the extent he or she desires to participate in the benefits of the special project...."[21] The district fixes unit fees for such revenue producing projects, and service may be withheld for non-payment.

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[18] Id. § 2-3252.

[19] Id. § 2-3253.

[20] Id. § 2-3254(2).

[21] Id.

Delinquencies may accumulate and are a lien on the land which cannot be cleared, nor service resumed, until all past due payments have been made in full.

For any revenue producing project, whether or not it involves an improvement project area, NRDs are authorized to issue revenue bonds.[22] A two-thirds vote of the board is required to approve such action.

If a project implemented through an improvement project area is non-revenue producing, such as a drainage project, the board "shall apportion the benefits...on a system of units. The land least benefitted shall be apportioned one unit...and each tract receiving a greater benefit shall be apportioned a greater number of units or fraction thereof, according to the benefits received."[23] Further, sub-areas may be created within a project improvement area, "...to permit future allocation of costs for particular portions of the work to specific sub-areas."[24] Such action is referred to as the sub-area method of cost allocation.

Again, the NRD board is required to publish notice and hold when total costs have been estimated a public hearing and when proposed units of benefit are assigned to lands and the proposed assessments have been determined after the hearing, the board makes a final decision on benefits and assessments. Thereafter, if landowners representing over 50% of the estimated total assessments for benefits file an objection, further project work

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[22] Id. § 2-3226.

[23] Id. § 2-3254(3).

[24] Id.

will be suspended.[25] However, assessments can be levied and collected to cover project expenses prior to suspension. The board's apportionment of benefits is conclusive, unless appealed, and establishes "the authority of the district to levy special assessments and issue bonds and warrants for such projects."[26] The board's determination of benefits may be appealed to the local district court for review.

The district may issue negotiable "improvement project area bonds" repayable from an established sinking fund for non-revenue producing projects.[27] Of note, general district funds may be used to insure prompt payment of principal and interest on bonds. By definition, bonds and warrants are: "issued for an essential public and governmental purpose and to be public instruments."[28] As such, they are tax-exempt. Bonds and warrants are issued by a majority vote of the NRD board. The board may only issue bonds and levy assessments after a public hearing. Any principal and interest payments are generally made from a sinking fund created with proceeds from special assessments. The board may also issue warrants at rates and terms fixed by the board, but due and payable within five years. Such warrants may be repaid from bond proceeds, the proceeds of special assessments, or other available funds, including the NRD's general taxing authority.[29]

As discussed further below and later in more detail in the Nebraska section of the Legal/Institutional Issues section of

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[25] Id. § 2-3254(4).

[26] Id. § 2-3254.01.

[27] Id. § 2-3254.02 to 54.05.

[28] Id. § 2-3254.07.

[29] Id. § 2-3254.05.

this report, Nebraska also has a ground water recharge statute that allows sponsors of ground water recharge projects to recover the costs of those projects from the beneficiaries. NRDs are among the potential sponsors that could use the provisions of that act.

At least three small ground water recharge projects have been built by NRDs and another is now being constructed as one of the projects under the High Plains States Ground Water Demonstration Project Act of 1983. A larger scale project planned by the Bureau of Reclamation is also being proposed by a natural resource district for construction after the year 2000. For the three built thus far, no cost recovery from beneficiaries has been attempted. Financing has been through a combination of local tax dollars and state Resources Development Fund dollars. The local cost-share for the P.L. 98-434 demonstration project will be all from local property tax dollars, with no special assessments or state assistance plan.

The proposed Bureau project in central Nebraska, called the Prairie Bend Project, is much larger in scope and is projected to keep 61,300 acres of existing irrigated land from reverting to dryland. It would also provide pumplift benefits to other lands. The financing/cost recovery issues for that project have not yet been resolved but charges to the direct beneficiaries are expected using either the NRD improvement project are authorities or the special ground water recharge statutes described later in this report.

Nebraska's NRDs are also the local entity for any regulatory management of ground water that is needed. The regulatory authorities granted can be important to managing recharge as well as naturally occurring ground water. They are also described in

more detail in the Nebraska section of the Institutional Authorities portion of this report. Districts have the power to ensure that ground water, whatever its source, is used efficiently and within the capability of the aquifer.

Reclamation Districts

Nebraska law also provides for the organization of reclamation districts (RDs) since 1947.[30] Designed primarily to complement an irrigation district in the sponsorship of federal reclamation projects, there are currently only five RDs in Nebraska. New RDs can still be formed but that is less likely since the creation of natural resources districts.

Under Nebraska law, reclamation districts are authorized to levy and collect the following taxes and special assessments to meet district obligations and operating expenses: (1) Class A general property tax levy; (2) Class B assessment for special benefits accruing to property within municipalities receiving water service; (3) Class C assessments for special benefits accruing to lands within irrigation districts for water service; and (4) Class D assessments for special benefits accruing to other lands for which water service is furnished.[31]

Of particular interest is the provision for an additional special assessment on any lands within the district not included within Classes B, C, and D, "which receive special direct benefits from recharging of the ground water reservoirs by water

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[30] Id. § 46-501 to 587.

[31] Id. § 46-542.

originating from district works...."[32] The board can levy a fixed amount on such tangible property as in its opinion will compensate the district for providing the special benefits that accrue. This special ground water recharge assessment, together with the Class A general tax levy, may not exceed 14 cents per $100 of actual valuation. Landowners are entitled to notice, a hearing, and the right of appeal, including review by the district court and appeal to the Nebraska Supreme Court. In the absence of an appeal, the findings of the board are accepted as conclusive evidence that the assessments have been made in proportion to the benefits conferred upon the property in the district by reason of the improvements to be constructed, and the assessment constitutes a perpetual tax lien on the property until paid.

No reclamation district has attempted to use this special assessment authority for lands receiving recharge benefits, but it remains a potential tool for the future.

Nebraska's Ground Water Recharge Law

Nebraska's surface water law recognizes the intentional and incidental storage of water underground and, "the propriety of all beneficiaries proportionately sharing to the extent of the potential benefit..., in the financial obligations necessary for construction, operation, and maintenance of water projects which...."[33] Ground water storage is a beneficial use, and anyone with an approved unperfected appropriation may apply for a

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[32] Id. § 46-544.

[33] Id. § 46-295.

permit to include intentional underground water storage.[34] Having obtained a permit for the storage and recovery of recharged water, a permittee may "levy a fee or assessment against any person for the right or probable right to withdraw or otherwise use such stored water. Such fee or assessment may be levied against any land in connection with which such underground water storage has occurred or probably will occur.... No fee or assessment shall represent more than the fair market value of such recharge, except that a fee or assessment may include a sum sufficient to amortize the operation, maintenance, repair, and capital costs of the project, apportioned on the degree to which recharge has occurred or is likely to occur, and on the degree to which any surface water is delivered."[35]

These provisions of Nebraska's ground water law are described in more detail in the Nebraska section of the Legal/Institutional Issues section of this report.

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[34] Id. § 46-295 and 297.

[35] Id. § 46-299.

LEGAL/INSTITUTIONAL ISSUES

All western states have a legal system for allocating rights to use ground water. Most do so under the appropriation doctrine. Also, all western states have developed or are developing and/or upgrading ground water quality protection strategies. Federal laws also protect ground water quality. These legal systems and protection strategies come into play with respect to ground water recharge projects. Local ordinances and other requirements may also play a part. Ground water recharge projects may create situations that require flexibility in state ground water legal institutions. Some western states have enacted statutory law to specifically facilitate permitting of ground water recharge projects and protection of the right to withdraw recharged water. Others have successfully adapted existing laws and administrative procedures to accommodate recharge activities. A detailed state-by-state summary of ground water recharge law is included below.

Primary Legal Issues

Assuming water is physically available to a recharge area with appropriate geologic characteristics and that a sponsoring entity with sufficient funds wishes to develop and maintain a ground water recharge project, three primary legal issues are critical. First, can the entity obtain the right from the state where the project is located to use an available water supply to recharge an aquifer? Put another way, is the recharge of an aquifer a "beneficial use" of water under state law?

Once the storage of recharged water is authorized, the second basic legal issue becomes critical. It is, can the entity expending funds and energy to recharge an aquifer obtain an

exclusive right to withdraw the water being recharged. In the alternative, can the entity or individual that already has a right to withdraw water from an aquifer adequately benefit from recharge efforts in the face of continued use of the aquifer by others? In other words, will state law protect the project sponsor in the use of the recharged water from encroachment by third parties?

A third basic legal issue is more broad; namely, how do state water quality laws or federal environmental laws affect a ground water recharge project? That is, what must a recharge project sponsor do to comply with state ground water quality laws and federal environmental statutes?

Where the ground water quantity questions may be clearly answered positively under state law, recharge projects are more likely to succeed. Uncertainty, however, may not necessarily preclude the viability of a recharge project. For example, where ground water recharge is not specifically recognized as a beneficial use under state law, perhaps the use to which the recharged water will be put may be recognized as beneficial, thus allowing the project to proceed. There may also be instances where a sponsoring entity may not receive protection to withdraw recharged ground water, per se, but may be able to protect its right to control the use of the water by some indirect method, such as taxing users of the recharged water, assessing them a "user fee," or requiring that its written permission be granted before the recharged water may be used. In any case, for a ground water recharge project to be successful, ground water quality issues must be adequately addressed.

The bulk of this section of the report is on how state law addresses these primary issues. However, there are other legal issues related to ground water recharge. These have arisen with

varying frequency in states depending on the amount of ground water recharge that has occurred. Some are discussed in the state-by-state information below. Before turning to that information, however, a brief discussion of federal environmental laws that affect ground water recharge projects is included.

Federal Environmental Laws

Although the focus of the this report is state law relating to ground water recharge, some mention of potential federal legal constraints is also necessary. There are a number of federal laws that may affect a ground water recharge project. The most important are the Safe Drinking Water Act,[1] particularly the Underground Injection Control program[2], the Clean Water Act[3], particularly Section 404[4], the Endangered Species Act[5], the National Environmental Policy Act[6], and the reserved rights doctrine.

A substantial number of ground water recharge projects use injection wells. Generally, such wells are considered Class V injection wells under federal Underground Injection Control (UIC) program regulations and must comply with all applicable UIC requirements.[7] This may be difficult in some instances. UIC programs are carried out by states that have been delegated

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[1] 42 U.S.C. §§ 300f-j(11).

[2] Id. § 300h-3.

[3] 33 U.S.C. §§ 1251-1376.

[4] Id. § 1344.

[5] 16 U.S.C. §§ 1531-1543.

[6] 42 U.S.C. §§ 4321-4361.

[7] See 40 C.F.R. § 144.1 to .55.

primary UIC authority or by the U.S. Environmental Protection Agency in states that have not been delegated primacy. The focus of the UIC program is to protect underground sources of drinking water from contamination or potential contamination caused by the injection of polluting substances. Underground sources of drinking water, known as USDWs, are defined in federal regulations as aquifers or portions of aquifers that supply or are capable of supplying a public water system and that currently supply potable water or contain less than 10,000 mg/l of total dissolved solids.[8] There are few exceptions to this broad definition.

After an aquifer has been designated as a USDW, no federal funds may be expended for activities that may contaminate the aquifer so as to create a public health hazard.[9] Regulations protect USDWs by restricting the movement of fluid containing contaminants introduced by underground injection. If the contaminant could cause a violation of any primary drinking water regulation, then the underground injection into the USDWS is not allowed.[10] Generally, agricultural recharge wells are allowed to operate without being permitted as long as they do not endanger USDWs. The UIC program director, however, can require that such wells be permitted under certain conditions.[11] States that have been delegated primary UIC authority, in some instances, have more complex regulations governing UIC wells generally.

The Safe Drinking Water Act was amended in 1986 to require states to establish programs to protect from contaminants areas

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[8] Id. § 146.3.

[9] 42 U.S.C. § 300h-3(e).

[10] Id. 40 C.F.R. § 144.12.

[11] Id.

around public water supply system wells.[12] These programs, known as wellhead protection programs, are designed to protect public drinking water from health hazards. They were intended to be underwritten by federal grants, but have not been funded by Congress. Even without funding, many states are establishing wellhead protection programs.[13] The specifics of the programs vary. Where a state has instituted a program, ground water recharge projects, carried out by private sponsors or federal agencies, must adhere to the requirements of the program.[14]

A more narrow section of the Safe Drinking Water Act could affect some ground water recharge projects. It allows the EPA Administrator to take emergency actions deemed necessary to protect public health. Whenever a contaminant that is present in or likely to enter a public water system or a USDW may present an imminent and substantial danger to human health, the Administrator may take necessary action to protect the public health.[15] Similar authority is provided under the Clean Water Act.[16]

Another provision of the Clean Water Act that may apply to ground water recharge projects is Section 404.[17] This section requires a permit from the U.S. Army Corps of Engineers for the discharge of dredge or fill material into the waters of the

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[12] Pub. L. No. 99-339, 42 U.S.C. §§ 300f-j(11).

[13] 20 ENVT'L REP. 513 (1989).

[14] See generally 42 U.S.C. § 300h-1.

[15] Id. § 300i.

[16] 33 U.S.C. § 1364.

[17] 33 U.S.C. § 1344.

United States.[18] The broad jurisdiction of the law includes not only waters navigable in fact, but other water bodies, adjacent wetlands, and other wet areas, as well.[19] Section 404 can affect recharge projects because a federal permit is often required for construction of water diversion or impoundment structures. Denial of such a permit, or issuance of a permit with certain conditions, may increase the difficulty of constructing and maintaining a recharge project.

Another federal law that may impact ground water recharge projects, often in conjunction with Clean Water Act Section 404, is the Endangered Species Act,[20] which prohibits the "taking" of listed species and requires the Secretary of Interior to insure that any action "...authorized, funded, or carried out by any [federal]...agency...is not likely to jeopardize the continued existence of any endangered... or threatened species or result in the destruction or adverse modification of habitat of such species...."[21] The Act has been interpreted to require the Secretary of Interior to devote the entire yield of a project authorized for agricultural uses to the restoration of an endangered species.[22] The Act has also served as the basis for denial of a Section 404 permit where the diversion would

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[18] States may assume authority to issue individuals and general Section 404 permits, 33 U.S.C. § 1344g-1. Only one state, Michigan, has assumed this authority.

[19] See United States v. Riverside Bay View Homes, Inc., 474 U.S. 121 (1985); Barley v. United States 647 F. Supp. 44 (D. Idaho 1986); Quirva Mining Co. v. United States, 765 F.2d 126 (10th Cir. 1985).

[20] 16 U.S.C. §§ 1531-1543.

[21] Id. § 1536(a)(2).

[22] Carson-Truckee Water Conservancy Dist. v. Clark, 741 F.2d 257 (9th Cir. 1984).

negatively impact endangered species habitat located some 250 miles downstream.[23] Thus, the general difficulty of assuring an available surface water supply to recharge an aquifer may be further complicated under federal law by the need to assure that diversion of the water does not adversely affect the endangered species habitat that exists throughout much of the West.

The National Environmental Policy Act (NEPA)[24] provides that federal agencies must prepare an Environmental Impact Statement for any "major federal action significantly affecting the quality of the human environment...."[25] Where a federal agency is involved in the construction, operation, or maintenance of a recharge project, and the project is determined to have a significant impact on the environment, a NEPA review may be required, with potential delay and additional expenditure of funds.

Another body of federal law that may affect ground water recharge projects in the West is known as the reserved rights doctrine.[26] It is judicial, rather than statutory, law which provides that when Congress reserved lands for specific purposes from the federal public domain, a corresponding, implied reserved water right was set aside as well. This applies to Indian and non-Indian reservations. Because of the size of federal land holdings in the West, many implied reserved rights exist. Very

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[23] Riverside Irrigation Dist. v. Andrews, 758 F.2d 508 (10th Cir. 1985).

[24] 42 U.S.C. §§ 4321-4361.

[25] Id. § 4332(C).

[26] See Winters v. United States, 207 U.S. 564 (1908); Arizona v. California, 373 U.S. 546 (1963); Cappaert v. United States 426 U.S. 128 (1978); United States v. New Mexico, 438 U.S. 696 (1978).

few, however, have been quantified. This situation complicates water resource management generally, and will complicate the process of securing a surface water supply for ground water recharge projects as well. On the other hand, there are a number of proceedings pending to quantify reserved rights claims. In some instances, ground water recharge projects may be used to optimize water resource management and thereby provide increased supplies where they are needed to satisfy reserved rights claims.

At the other end of the spectrum from federal laws that affect or may affect ground water recharge projects are local laws, ordinances, and regulations. These vary widely from county to county, and municipality to municipality. In general, they take the form of land use controls and other zoning regulations. For each recharge project such controls and regulations may create an additional level of legal requirements that a project sponsor may have to meet, along with state and federal requirements.

Ground Water Law in the West

Before proceeding to a state by state analysis of laws relating to ground water recharge, a synopsis of certain aspects of ground water law is appropriate. Ground water, in the broadest sense, includes all subsurface water as distinct from surface water. As the term is more commonly used, it refers to that portion of subsurface water located in the saturated zone of the earth. Another definition might be water located underground that is available for extraction and beneficial use under state water law.

The importance of ground water in the West is illustrated by a few observations. First, on average citizens in western states depend on ground water for some 50% or more of their municipal

water needs. In some states, the figure is as high as 90%. Municipal treatment costs for ground water are relatively low because ground water quality is generally high. Second, ground water is essential to irrigated agriculture in the West. It is a principle source of supply in many important agricultural areas. Third, ground water is an important source of industrial process and cooling water and is potentially important to the development of alternative energy sources.

Population and development trends in the West indicate dependence on ground water will likely increase in the future. While demands are generally expanding, however, supplies are generally replenished slowly. This creates an important responsibility to carefully manage ground water resources. In some instances, ground water recharge projects may play an important role in "stretching" the use of available ground water concurrently and conjunctively with similar efforts to "stretch" the use of surface water. At the same time, protection must be given to the constitutionally protected private property rights to use ground and surface water that are ubiquitous in the West. Rights to use ground water are created under four basic legal doctrines or theories.

The doctrine of absolute ownership provides that ground water is appurtenant to land and owned as an incident of land ownership. As such, a land owner can, essentially, withdraw and use as much water as he can extract, without regard to the effect of the withdrawal on others. The second legal doctrine is a variation of the absolute ownership doctrine known as the reasonable use rule. It provides that while a landowner controls water under his land as an incident of land ownership, he may only use the amount of water that can be reasonably applied to benefit the land from which the water is taken. Another variation of the absolute ownership doctrine is known as the

correlative rights doctrine, which is similar to the reasonable use doctrine. Under the correlative rights doctrine, the reasonable use rule is extended to require the equitable sharing of ground water among overlying land owners. When a land owner has correlative ground water rights he may withdraw a "fair and just portion" of ground water from a common pool. The overlying owners have no right to a specified pump lift level, and there is no priority among right holders. Non-overlying owners may obtain rights to use ground water under the correlative rights doctrine, but only if surplus water is available.

The doctrine of prior appropriation, used in most western states to allocate ground water rights, is unlike the other legal theories.[27] It is not founded upon a proprietary interest in overlying land, but is based upon beneficial use of water. Under the appropriation doctrine, the first user to put water to a beneficial use is protected in that use and a chronological hierarchy among appropriators is established whereby initial users receive priority rights over subsequent users. The limit of the right is legislatively defined beneficial use, which may occur on or off overlying land.

Under the appropriation doctrine, a permit to use ground water should not issue if it will interfere with existing ground or surface water rights. It is much more difficult, however, for a senior ground water right holder to ensure the continued enjoyment of his right than for a senior surface water right holder to do the same. All use of water from an aquifer contributes to the drawdown of the aquifer and, thus, affects the rights of other users. But, for a number of technical reasons,

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[27] In the state-by-state legal summaries contained later in this section of the report, where a state's ground water law is based on a legal theory other than the appropriation doctrine, that fact is explained.

it is difficult to determine the precise effect of one use upon another's rights. This difficulty complicates ground water management generally, and ground water recharge project management in particular.

A different problem is that ground water aquifers seldom "run dry." Water is usually available at some depth. Thus, a central issue is who should pay the cost of pumping water from a well deeper than the well originally drilled by an early appropriator. In this regard, aquifer depletion is a question not only of the amount of ground water use and natural replenishment, but also the type of use, well spacing, geohydrology, transmisivity, and aquifer size, shape, and storage capacity. Officials in states where the appropriation doctrine governs ground water use take these and other factors into account, determine whether to manage an aquifer as a renewable or non-renewable water source, and then take administrative, judicial, or regulatory action to regulate use. The states have taken different approaches to determine what use should be allowed.

Early appropriators in a ground water basin may have enjoyed artesian pressure, or some other beneficial hydrologic condition, that allowed them to extract ground water with minimal expense for well drilling and energy to pump water. Since any additional use reduces the amount of water in an aquifer, and thus increases the difficulty in extracting ground water, they may have argued that additional use should not be allowed, or that subsequent users should have to compensate initial appropriators for increased pump lift costs. A few early court decisions went along with some of these arguments.[28] Critics countered that

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[28] See, e.g., Noh v. Stoner, 53 Idaho 651, 26 P.2d 12 (1933).

requiring such compensation impeded efficient ground water use.[29] They pointed out that a surface water right holder may "call" his appropriated water right, but that he may not demand the streamflow at a rate that provides the least costly method of diverting that right. Courts began to require a "reasonable" rather than a "convenient" pump lift.[30]

Some states address the issue of a pump lift through administrative regulation. For example, a section of the Idaho Water Code says that "early appropriators of under ground water should be protected in the maintenance of reasonable ground water pumping levels as may be established by the Director of the Department of Water Resources" to assure optimum economic use of the state's ground water.[31] Other states have addressed the issue through well spacing regulations.[32] Still others create ground water use control areas where ground water use is strictly regulated or precluded under certain conditions.[33]

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[29] See, e.g., Bagley, Water Rights Law and Public Policies Relating to Ground Water "Mining" in the Southwestern States, 4 J.L. ECON. 144 (1961).

[30] See City of Colorado Springs v. Bender, 148 Colo. 458, 363 P.2d 552 (1961); Wayman v. Murray City Corp., 23 Utah 2d 97, 458 P.2d 861 (1969), Baker v. Ore-Ida Foods Inc. 95 Idaho 575, 513 P.2d 627 (1973), Mathers v. Texaco Inc. 77 N.M. 239, 421 P.2d 771 (1966).

[31] IDAHO CODE § 42-226.

[32] See Aiken and Suppalla, Ground Water Mining and Western Water Rights; the Nebraska Experience, 24 S. DAKOTA L. REV. 607, 628-45 (1979).

[33] See, e.g., KAN. STAT. ANN. §§ 82a-1020-1035; MONT. CODE ANN. § 85-2-506; NEV. REV. STAT. §§ 534.0-187; N.M. STAT. ANN. § 72-12-20; and ORE. REV. STAT. 537.730. See also TARLOCK, LAW OF WATER RIGHTS AND RESOURCES § 6.04 (1988); WESTERN STATES WATER COUNCIL, WESTERN STATE GROUND WATER MANAGEMENT 10-79 (1986).

The critical issue with respect to pump lift is protecting the rights of third parties. Under the appropriation doctrine these rights receive general protection. The methods of protection vary from state to state. Ground water recharge projects may afford an appropriate means to allow continued pumping of a heavily used aquifer without detrimental impacts to established ground water rights. The affect of such projects on third party surface water rights, however, must also be considered and mitigated. Again, the methods of protecting these third party rights vary.

State-By-State Legal Analysis

To provide the state-by-state analysis below, the Western States Water Council staff circulated a "State Ground Water Recharge Questionnaire" to each reclamation state, and/or Council member state. The survey responses, with accompanying attachments, varied in length and detail. The survey was designed to help states summarize their body of ground water recharge law, whether that amounted to describing a statute and accompanying administrative regulations or theorizing about how a general body of ground water law would apply to a recharge project. Each survey response was written by the state agency with primary responsibility to regulate ground water recharge projects, with input from other state agencies as appropriate.

Some states have substantial practical legal and institutional experience related to ground water recharge. Others do not. Often, responses to the Council's questionnaire reflected the experience of the responding state. Council staff attempted to supplement questionnaire responses where appropriate and feasible. The state-by-state information that follows, however, is based primarily on survey responses.

The law of ground water recharge varies significantly from one western state to another. What some states describe as issues or solutions to problems, however, may be applicable in other states as well. Generally, the more use of ground water in a state, the greater the body of recharge law that has developed.

A few states have enacted ground water recharge statutes. Others have a portion of their ground water law devoted to ground water recharge. In some states the law relating specifically to ground water recharge is meager, or non-existent. Every state, however, has legal mechanisms to govern ground water use. Thus, in some instances, state ground water recharge laws are specific, comprehensive, and detailed. In other instances, general principles of state ground water law must be theoretically applied to a recharge situation, or hypothetical situation, with resulting questions and ambiguities. Where appropriate, the summaries below comment on the adequacy of a state's ground water recharge law.

Alaska

Alaska has no ground water recharge projects, and no permits for such projects have been sought. Likewise, the state has no ground water recharge statute. The issue of whether ground water recharge qualifies as a beneficial use of water in Alaska has not been raised. Currently, state officials are unsure of how the Alaska Water Use Act would apply to a ground water recharge situation. Hence, it is unclear whether a proponent of ground water recharge could receive any legal protection in the use of recharged water, or even obtain authorization to use water to

recharge an aquifer. It is also unclear how state ground water quality laws would apply to a recharge project.[34]

Arizona

Arizona has enacted laws regulating both artificial ground water recharge[35] and underground water storage and recovery.[36] These laws provide for development of two types of recharge projects. One is undertaken under a simple recharge permit and has no provision for recovery. Such a permit may be issued to help a basin reach the goal of safe yield, and all ground water users in a basin benefit from the recharge. Such projects are likely to be undertaken by regional authorities and the costs borne by the entire region. For the other type of project, designed to allow individual entities to recharge and recover a specific amount of water, both a recharge and a recovery permit must issue. Here, the recharging entity is the beneficiary and is expected to pay the project costs. The provisions became effective in 1986. They enumerate minimum qualifications for both types of projects. These requirements relate to the permitting process, restrictions on recharge, storage and recovery of water, use of stored water, storage accounting, effect on service areas and assured water supplies, protection of stored waters, measuring and annual reporting, and withdrawal fee requirements. Because they are regulated by different statutes,

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[34] Alaska response to WSWC State Ground Water Recharge Questionnaire, September 25, 1989.

[35] ARIZ. REV. STAT. Ann. §§ 45-651 to 655 (West, Cum. Supp. 1988).

[36] Id. §§ 45-801 to 818 (West, Cum. Supp. 1988).

there are different applications and permits for a recharge project than for an underground storage and recovery project.[37]

To implement the statutory permitting requirements for underground storage and recovery project permits, the Arizona Departments of Water Resources (DWR) and Environmental Quality (DEQ) have developed an application form and packet and have developed a pilot scale application packet for projects of 10,000 acre-feet or less of storage and duration of two years or less. DWR anticipates drafting general storage and recovery rule concepts in 1990.[38]

The Arizona underground water storage statute declares as the policy of the legislature that:

> "It is in the best interest of the general economy and welfare of the people of this state to establish a framework for regulating the underground storage and recovery of waters of this state in order to assist in using this state's maximum entitlement to the waters of the Colorado River, to further the conjunctive management of the water resources of this state which will help to reduce the overdraft and achieve the management goals of the active management areas, to store water underground for seasonal peak demand use and for use during years of storage, and to augment the water supply for future growth and development."[39]

Arizona law allows the Department of Water Resources director to issue an underground storage and recovery project permit if: (1) the applicant has the technical and financial capability to construct and operate the project; (2) the applicant has a right to use the proposed source of water; (3) the project is hydrologically feasible; (4) the project will not

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[37] Arizona response to WSWC State Ground Water Recharge Questionnaire, September 25, 1989.

[38] Id.

[39] ARIZ. REV. STAT. ANN. § 45-801.

cause unreasonable harm to land or other water users within the area of hydrologic impact of the project; and (5) the applicant has applied for any water quality permit required by the DEQ.[40] Permits are issued for a period of 50 years or less, with provisions for permit renewal if certain requirements are met.[41] Permits may be conveyed to another person upon approval of the director.[42] The DWR director must, upon receipt of a complete underground storage and recovery project application, provide notice of the application in a newspaper of general circulation in the county or counties where persons reside who could be affected by the project and provide a hearing and an appeal process for such individuals before an application receives final approval.[43]

A separate permit is needed to recover the stored water. The permittee may recover recharged water only after obtaining a recovery well permit.[44] The Director may require certain information from a permittee before approving such a permit, and must give notice to third parties that may be affected by the recovery of stored water.[45] A permittee may use or exchange stored water recovered under a permit only as it was permissible for the permittee to use or exchange the water before it was stored underground.[46]

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[40] Id. § 45-804(B).

[41] Id. § 45-804(D).

[42] Id. § 45-804(E).

[43] Id. § 45-806.

[44] Id. § 45-807.

[45] Id. § 48-807(E).

[46] Id. § 45-808.

The permittee is protected in the recovery of the amount of water held in his "storage account."[47] This amount is based on credits and debits to the account as calculated by the DWR Director. The Arizona statute contains a detailed formula for calculating the recoverable amount,[48] and provides specific protection for the stored water.[49] A person who recovers stored water under a recovery well permit must use a water measuring device approved by the director and must comply with rules setting forth requirements and specifications for water measuring devices.[50] The director levies and collects an annual stored water recovery fee from each permittee who recovers stored water. The amount of the fee is based on recovery of administration and enforcement costs.[51]

Controversy has arisen where agricultural interests filed objections to the issuance of an underground storage and recovery permit to the cities of Phoenix and Scottsdale. The controversy involved conjunctive use of water that is not owned or controlled solely by one entity. The municipalities proposed to store and recover municipal and industrial (M&I) Central Arizona Project (CAP) sub-contract water. The irrigation district's objection to the permits was not the storage and recovery of CAP water per se, but the ranking of CAP water's direct use versus underground storage. The districts asserted that an "applicant has no legal right to use CAP surface water for non-consumptive use purposes

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[47] Id. § 45-809.

[48] Id.

[49] See id. § 45-812.

[50] Id. § 45-813.

[51] Id. § 45-814.

[such as underground storage] if such water could be put to direct beneficial use by other CAP subcontractors."[52]

The controversy has centered on whether ground water underground storage is a beneficial use under Arizona law and the interpretation of the definition of M&I water use. The districts do not interpret the definition to include storage as M&I use, and therefore believe they should be given the opportunity to directly use the water before it is recharged. The districts have noted that they "do not object to storage and recovery of CAP water once such water has been declined for direct consumptive uses by all CAP subcontractors."[53] In addition to the district's claim that the cities do not have a legal right to store CAP water, they objected to the use on the basis of unreasonable harm to the district water users. The result, they contend, may be to force districts to pump ground water in lieu of using CAP water.[54]

The Department of Water Resources conducted hearings on the objections of the districts to the underground storage permits issued to municipalities in November, 1988, and March, 1989. The director issued a decision affirming the hearing officer's determination, and ordering that permits be granted to the cities.[55] The districts filed an administrative appeal to the decision, which was denied. The districts did not appeal the

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[52] Arizona response to WSWC State Ground Water Recharge Questionnaire, September 25, 1989.

[53] Id.

[54] Id.

[55] In the matter of the Application for Underground Storage and Recovery Project Permit Nos. 64-520080, 455, Arizona Department of Water Resources Findings of Fact, Conclusions of law, Decision and Order, June 28, 1989.

final decision to state Superior Court for judicial review. During the Department's hearing on the cities' permits, the districts also filed a complaint in federal court on the same grounds.[56] The hearings and appeals process has slowed the permitting process for storage and recovery of CAP M&I water. It is unknown what effect the federal district court suit will have on CAP recharge, but any resulting, additional delays in recharging CAP water will slow Arizona's augmentation and recharge program. Arizona is not currently using its full CAP allocation under the laws that govern the Colorado River.[57]

Future conjunctive use conflicts may arise related to the recharge of effluent, other surface water sources, and transfer waters. Legislation may be needed to identify the extent of the Department of Water Resources' jurisdiction over effluent and to establish water transfer regulations. This is particularly true given an Arizona Supreme Court ruling that sewage effluent is neither ground water, nor surface water, but a separate category of water under Arizona law.[58]

Other legal issues related to recharge activities in Arizona center on interstate water compacts and federal reserved water

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[56] Central Arizona Irrigation and Drainage District v. Lujan, No. 89-0767 (D-AZ., filed April 11, 1989).

[57] Arizona response to WSWC State Ground Water Recharge Questionnaire, September 25, 1989.

[58] Arizona Public Service Co. v. John F. Long 773 P.2d 988 (Ariz. 1989). The Arizona Supreme Court held that "before sewage ...is returned to the ground as either ground water or surface water, it is nothing more than sewage effluent...." The court refused to recognize right of downstream water users who may have depended upon treated sewage effluent to continue to receive the effluent, and found that cities may apply treated effluent to whatever use they choose, including, by implication, ground water recharge. Id.

rights. As noted, Arizona views ground water recharge and storage and recovery as a method of insuring the state's ability to put to use its full compacted share of the Colorado River. Recharge is affected by the terms of the agreements for compacts, such as the Colorado River Compact, as demonstrated by the controversy created by Phoenix and Scottsdale attempting to recharge CAP subcontract water. The definition of M&I water use as cited in the subcontract was one of the pivotal arguments in the irrigation district's objections.[59]

Storage and ground water recharge activities in Arizona also have the potential to affect agreements to settle Indian reserved water rights claims. According to state officials, guidelines should be written into such agreements to clearly describe their relationship to recharge and storage activities.[60] For example, Arizona's Salt River Pima Indian community has expressed interest in a joint storage venture with several cities and the Salt River Project. The storage site is located within the Indian reservation. The community, however, may be interested in recovering and selling the stored water outside of the reservation boundaries. Under water rights agreements for the Indian community it is unclear whether the water can be stored and whether the recovered water can be used off-reservation. Storage and recharge issues such as these are forcing agencies to interpret and/or amend existing agreements to directly address recharge activities. A better approach, according to the state, would be to include in the original agreement language addressing

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[59] See Central Arizona Irrigation and Drainage District v. Lujan, Civ. Action No. 89-0767, (D. AZ., filed April 11, 1989).

[60] Arizona response to WSWC State Ground Water Recharge Questionnaire, September 25, 1989.

activities and potential activities related to underground storage and ground water recharge.[61]

The Arizona Department of Environmental Quality's aquifer protection program protects aquifers of the state that are potential drinking water sources. This includes nearly all aquifers. All discharges must meet drinking water standards unless the ambient ground water quality exceeds the drinking water standards, in which case there is a non-degradation standard. These standards maintain a level of ground water quality that may not degrade below drinking water standards or current quality levels, hence "preserving" the quality of aquifers for recharge.[62] Additional protection is provided by prohibiting storage and recharge projects that would adversely impact aquifers.[63]

In addition to the general concerns of ambient ground water quality in the aquifer in which the water will be introduced and the quality of the water to be added, the department is concerned with the movement of existing contaminants as a result of introducing even the purest water into an aquifer. In cases where storage or recharge projects are near an area of contamination, additional monitoring is required. If a recharge or storage project is aggravating an area of contamination, the project must be discontinued or modified to avoid affecting the area.[64]

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[61] Id.

[62] Id.

[63] See ARIZ. REV. STAT. ANN. §§ 45-652 and 45-804.

[64] Arizona response to WSWC State Ground Water Recharge Questionnaire, September 25, 1989.

California

In California, ground water recharge is not generally regulated by the state, but is the responsibility of local agencies. The state does not sponsor specific ground water recharge programs, although it is the general policy of the State Department of Water Resources and the State Water Resources Control Board to encourage ground water recharge wherever possible. There is no specific ground water management legislation directing the state with respect to ground water recharge, although the enabling legislation for many districts includes language that either encourages or explicitly allows intentional ground water recharge. The state has left land use decisions relating to recharge areas to land-use agencies or other local entities with limited expertise in ground water resources.[65]

California state officials believe that full-scale conjunctive use programs, including extensive ground water recharge, would maximize the use of all of the state's water resources. However, the hydrogeologic characteristics of each proposed conjunctive use program must be carefully evaluated to ensure that conjunctive use is a viable management alternative in that area. Potential constraints on conjunctive use programs include the possibility of land surface subsidence as the result of ground water extraction, a significant decline in water level that would result in increased lift and higher energy costs, limited or low recharge potential, and complex institutional negotiations. Where these constraints allow conjunctive use,

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[65] California response to WSWC State Ground Water Recharge Questionnaire, February 21, 1990.

such programs would reduce the need for expensive and complex surface distribution systems.[66]

The Department of Water Resources is undertaking a major conjunctive use project, the Kern Water Bank, in cooperation with the Kern County Water Agency. The Kern Fan Element, a project which is a portion of the Kern Water Bank, is located along the Kern River near Bakersfield. This ground water basin will be directly recharged with state Water Project water. The Kern Fan Element will be operated by the Kern County Water Agency. It will increase the amount of water provided by the state Water Project during dry years by up to 140,000 acre feet. Additional phases of the program could provide much more storage. Many ground water recharge projects that can be called conjunctive use programs are currently functioning. Some agencies have the authority to regulate extraction of ground water.[67]

California recognizes ground water recharge as an important component of good water management, but unless reclaimed water is being recharged, no ground water recharge permits are required.[68] If treated sewage effluent or other waste discharge is recharged, the Department of Health Services and the Regional Water Quality Control Board must issue a water quality permit. And, where reclaimed surface water is recharged, the recharging party must have a statement on file with the state Water Resources Control Board, Division of Water Rights.[69]

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[66] Id.

[67] Id.

[68] CAL. WATER CODE. § 1242.

[69] California response to WSWC State Ground Water Recharge Questionnaire, February 21, 1990.

With respect to ground water rights, the State of California does not follow the appropriation doctrine. Rather, the state follows the overlying rights doctrine.[70] State law does not differentiate between artificially versus naturally recharged ground water. The California Supreme Court, however, in Los Angeles v. San Fernando, concluded that the first right to water in a ground water basin belongs to the party that has imported and recharged the water for storage in the basin, as long as there is room for the storage of imported water.[71] In contrast, ground water that is recharged as the result of the natural storm event is water available to an overlying landowner as a part of his correlative right to extract the ground water or, in an adjudicated ground water basin, his adjudicated right. The same decision also affirmed an entity's right to recapture recharged ground water under certain conditions.[72] Generally, there must be space in an aquifer and the sponsoring entity must be able to demonstrate that its recharge activities have increased the level of water in the aquifer. Also, the quality of the aquifer must not be degraded. Thus, case law provides protection for the sponsor or sponsors of a ground water recharge project to recover recharged water.[73]

California officials report that the amount of information available on ground water resources to support state administrative decisions regarding recharge projects varies considerably from case to case. The burden of proof on the project sponsor is to collect sufficient data and keep suitable records to demonstrate: (1) the amount of water recharged; (2)

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[70] Katz v. Waklinshaw, 141 Cal. 116, 74 P. 766 (1903).

[71] 14 Cal.3d 199 (1975); 537 P.2d 1250 (1975).

[72] Id.

[73] Id.

change in the ground water level in the basin because of the recharge activity; (3) the amount of ground water extracted; (4) the water quality parameters before and after the project is implemented; and (5) the point of use of the extracted water.[74]

Extensive ground water recharge in California would provide the opportunity to maximize use of the state's water resources by storing water in ground water reservoirs when excess surface water and storage capacity in an aquifer are both available. State law neither regulates, except in the case of reclaimed water and with regard to public health concerns, nor requires, recharge. State agencies concerned with water resources generally encourage ground water recharge to the extent possible. This encouragement was underscored by passage of two state-wide propositions to provide funding for ground water recharge projects.[75]

California law does not prohibit ground water mining, colloquially referred to as "long-term overdraft," or "critical overdraft," unless a basin has been adjudicated or is managed by a local agency with authority to regulate extraction. Overdraft is defined differently in various water management agency acts, or ground water management district acts, but generally is "a condition of the ground water basin or aquifer where the average annual amount of water extracted exceeds the average annual supply of water to a basin or aquifer."[76] Section 2100 of the California Water Code authorizes the State Water Resources

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[74] California response to WSWC State Ground Water Recharge Questionnaire, February 21, 1990.

[75] Cal. Water Code §§ 13450-13469 and 12879-12879.17.

[76] Section 121-318 in Fox Canyon Ground Water Management Agency Act, Water Code Appendix Sections 121-102 to 121-1008 (West, 1990); Stats. 1982, C. 1023.

Control Board to reach a determination, after public hearings, that a ground water basin is in a condition of critical overdraft and that the overdraft is endangering the quantity and/or quality of the ground water in the basin. Such a determination requires that the parties in the basin enter a court proceeding in which the rights to ground water extraction will be adjudicated by the court. Ground water extractors in one overdrafted basin initiated a detailed study when it appeared the State Board would invoke Section 2100. However, Section 2100 has never been invoked to initiate an adjudication proceeding. The twelve ground water basins in California where the rights to extract ground water have been adjudicated all resulted from one or more parties in the basin bringing suit.[77]

The California Department of Health services and/or one of the Regional Water Quality Control Boards can prohibit recharge with sewage plant effluent, or other waste discharge, if such recharge is considered a threat to public health. In addition, the Regional Water Quality Control Boards can prohibit recharge with any surface water that the Board considers will degrade the state's waters.[78] The State Water Resources Control Board retains primacy for control of all injection wells, including ground water recharge injection wells, except for injection wells for petroleum-associated waste liquids. These wells are regulated by the Department of Conservation, Division of Oil and Gas. Any ground water recharge accomplished by injection well must meet applicable underground injection control statutory requirements.[79]

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[77] California response to WSWC State Ground Water Recharge Questionnaire, February 21, 1990.

[78] State Water Resources Control Board Resolution 68-16.

[79] CAL. WATER CODE. § 13260(a)(3).

Any person discharging waste that could affect the quality of the waters of the state is required to submit a "report of waste discharge."[80] Submission of this report begins the permitting process. Any one of the nine Regional Water Quality Control Boards, after a hearing, may issue waste discharge requirements for a discharge in their region. Those requirements include standards for the quality of water that can be discharged and consider the impact of the discharged water on the receiving water. "Proposed Guidelines for Ground Water Recharge with Reclaimed Municipal Wastewater" have been formulated by an interagency committee, and are being considered for distribution to the staffs of the nine regional boards.[81]

In the case where reclaimed water is being used for "ground water recharge of domestic water supply aquifers by surface spreading," the California Department of Health Services is required to hold a public hearing prior to determining the public health aspects of the ground water recharge project.[82] Recommendations from the department are forwarded to the regional board issuing the waste discharge permit that delineates the standards that must be met. The comments are generally incorporated into the waste discharge permit, even though the board is not required by law to do so. In practice, the staffs of the board and department work together closely on the details of a permit until it is agreeable to both parties. The permit is

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[80] CAL. WATER CODE. § 13260(a)(1).

[81] California response to WSWC State Ground Water Recharge Questionnaire, February 21, 1990.

[82] California Code of Regulations, Title 22, Section 60320.

then presented to the regional board in a public hearing for approval.[83]

Discharges from sewage treatment plants may constitute 80% to 95% of the surface flow in some drainages during the summer. In some cases, these flows are recharged downstream through alteration of the streambed to enhance the natural recharge. While waste discharge requirements are issued on discharges into the drainages at the outfalls, such requirements do not necessarily consider that the wastewater is being recharged into a drinking water aquifer downstream. In at least one such Southern California river, municipal use is not even considered as a beneficial use for the drainage, although the water is recharged to an aquifer used for municipal supplies.[84]

The California Environmental Quality Act requires all local agencies which carry out or approve a project that may have a significant effect on the environment to prepare and certify an environmental impact report. Whether or not a ground water recharge project impacts ground water quality, other environmental issues will probably come up which will lead to the preparation of such a report. Water quality impacts of the recharge project may be the subject of comment during the public review period. Project sponsors may be required to mitigate the water quality impacts of the proposed project, if they are shown to be a threat to water quality. The Environmental Quality Act requires that the information be made available to local planning agencies and decision-making political bodies. These entities decide what mitigating conditions, if any, will be required and may or may not include provisions for enforcement. Thus, some

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[83] California response to WSWC State Ground Water Questionnaire, February 21, 1990.

[84] Id.

projects that impact water quality may be approved and constructed.[85]

While California water quality laws can be used to protect recharge areas, there is no specific statutory authority directed at recharge areas. In addition to the water quality laws protection of recharge areas frequently relies on land-use decisions made by local governments.[86]

California officials view ground water recharge as good management practice and as one potential tool available to help clean up a ground water basin contaminated with organic compounds, heavy metals, or nitrates. Combined management of the location and the amount of recharge and the location and amount of extraction would help prevent the spread of contaminants and would play a large role in ultimate basin clean up. Management for such cleanup would also require a wellhead protection program and a wellhead treatment program.[87]

California officials believe comprehensive ground water recharge legislation would solve some problems but would raise many others. There is already a large body of judicial law providing specific local authority to manage ground water, including recharge. Imposition of state authority would involve significant changes that would likely be opposed at the local institutional level. Such opposition would almost certainly result in the defeat of any such legislation that might be proposed.[88]

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[85] Id.

[86] Id.

[87] Id.

[88] Id.

Colorado

The Colorado Division of Water Resources has jurisdiction over water quantity aspects of ground water recharge in the state. The Department of Health has jurisdiction over water quality issues. Recharge projects were first undertaken in the early 1960's. There are over 150 existing, active artificial recharge facilities in Colorado operated by municipalities, ditch companies, water supply districts, and other public agencies. This number appears to be increasing.[89]

Some recharge facilities are elaborate. For example, Willows Water District recharges the Arapaho Bedrock aquifer through a 1500 foot well. South Adams County Water and Sanitation District recharges through a specially constructed pit using water that has been changed from its previous irrigation use. The Central Colorado Conservancy District recharges through spreading ponds and basins to augment the many irrigation wells covered by their plan. Several cities are using artificial recharge pits or land application plots to recharge their sewage effluents to the underlying alluvial aquifers from which they pump a like amount of water from alluvial wells. There are many sites where local farmers or ditch companies will spread excess surface water so as to artificially recharge the underlying alluvium. This directly benefits their pumping of alluvial ground water through one or more of their wells. The amount of water artificially recharged each year is a function of water availability.[90]

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[89] Colorado response to WSWC State Ground Water Recharge Questionnaire, March 15, 1990.

[90] Id.

Accurate records of the quantities artificially recharged do not exist, but the amount is estimated to average over 50,000 acre-feet per year and could exceed 100,000 acre-feet in a wet year. The State Engineer's Office strongly encourages artificial recharge to maximize the use of the state's water resources, including underground storage.[91]

Conjunctive use is recognized by statute in Colorado.[92] The statute requires the state and the Division of Water Engineers to maximize the beneficial use of the state's water resources. State officials believe the existing and future artificial recharge projects are consistent with maximizing beneficial use.[93]

Colorado recognizes ground water recharge as a beneficial water use[94] and use of surface water for recharge purposes must be carried out under a valid water right. The state issues no recharge permits, but issues well permits for withdrawal of recharged water, and in this way can protect a recharge project sponsor's right to withdraw recharged water. Before a well permit may be issued, the operator must demonstrate that he has retained dominion and control over the recharged water and that withdrawal will not injure any other well or water right.[95]

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[91] Id.

[92] COLO. REV. STAT. §§ 37-92-102(1) and (2).

[93] Colorado response to WSWC State Ground Water Recharge Questionnaire, March 15, 1990.

[94] COLO. REV. STAT. § 37-92-103(10.5).

[95] Colorado response to WSWC State Ground Water Recharge Questionnaire, March 15, 1990.

In addition to the administrative protection of the right to withdraw recharged water, the Colorado water courts have decreed underground storage rights. Many of the decrees contain specific limitations and retain jurisdiction to prevent injury to other water rights and to allow revision or modification of the terms and conditions. In this way, a proponent of ground water recharge is protected in the exclusive use of the recharged water. The volume of recharged water is measured by various devices depending on the type of recharge. Sometimes, depending on the type of recharge project, evaporation losses must be assessed and subtracted from the amount of water being recharged. Recovery of recharged water is also measured. Information on recharge projects generally must be developed and maintained by a project operator. He carries a burden to prove that: (1) water has been recharged; (2) he has maintained dominion and control over the water; and (3) that the operating terms and conditions will not cause injury to other vested water rights. Colorado, then, regulates: (1) diversion of water for artificial recharge, according to decreed priorities; (2) the entry of storage decrees; (3) the calculation of timing, location, and amount of return flow credits; and (4) based on appropriate data, limits the amount of recharged water that can be recovered.[96]

Colorado allows ground water mining in some aquifers. A statutory 100-year minimum aquifer life is used for administration of some aquifers, while a 40% depletion in 25 years is allowed in others. Both of these mining provisions, however, exclude artificially recharged ground water, and an over-appropriated ground water system will usually have declining ground water levels on an infrequent or continuous basis. Colorado's ground water permit statutes allow new permits to be issued if there is unappropriated water available and if issuance

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[96] Id.

of such permits and the associated use of water would not injure other vested water rights.[97]

Colorado officials are concerned that the quality of recharged water must not contaminate a receiving aquifer. The specific provisions to accomplish this goal, however, are not defined by statute and now rest with the individual or entity carrying out the recharge. Any recharge accomplished by injection well must be accompanied by a permit from the U.S. Environmental Protection Agency. It is not yet clear in Colorado whether either the Health Department or the State Engineer have the power to override an EPA permit decision. The State Department of Health has control over entities that discharge water to both the surface streams and ground water. Colorado is also concerned about whether permits should be required for all recharge activities, including those accomplished by other than injection wells, and which state or local agency should be responsible for issuing such permits. State officials also believe, however, that any permitting regulations that are developed not be so restrictive as to prevent artificial recharge as a viable water management tool. Overly restrictive controls and/or costs for ground water quality monitoring, and data collection could preclude many artificial recharge projects.[98]

Colorado officials do not believe the state needs comprehensive ground water legislation. Because of the success that has been enjoyed by many ground water recharge projects, state officials believe that any new legislation would be helpful only if it is "reasonable, based upon factual concerns, and addresses those topics where new statutes would benefit state

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[97] Id.

[98] Id.

water interests. There is great concern that improper legislation could seriously prevent the use of artificial recharge."[99]

Hawaii

Neither technical nor legal ground water recharge issues have been given a high priority for evaluation by state officials in Hawaii. Such recharge, however, is viewed as a possible future alternative water management option that "needs to be studied more closely."[100]

Hawaii has no specific ground water recharge statute and state officials are uncertain how general state ground water laws would apply to a recharge situation. Ground water recharge is not recognized as a beneficial water use in the state and the state issues no ground water recharge permits. General water use permits might apply to a recharge situation, but the state could offer no legal protection to a recharge project sponsor to recover recharged ground water. Generally, insufficient information is available on ground water resources in Hawaii to support administrative decisions relating to recharge projects. The state does not believe comprehensive ground water recharge legislation is currently needed, but, as noted, believes technical and institutional issues related to ground water recharge need careful study.[101]

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[99] Id.

[100] Hawaii response to WSWC State Ground Water Recharge Questionnaire, November 27, 1989.

[101] Id.

Idaho

Idaho has a ground water recharge law[102] that authorizes the organization of aquifer recharge districts and provides that use of water for district purposes is a beneficial use for which the Idaho Department of Water Resources may grant an appropriative water right. In a statement of policy, the law says:

> In the view of the public betterment to be achieved by the completion of aquifer recharge projects, the legislature hereby declares that the appropriation and underground storage of water by an aquifer recharge district hereinafter created and operated pursuant to the provisions of Chapter 42, Title 42, Idaho Code, for purposes of ground water recharge or by an irrigation district organized and operated pursuant to Title 43, Idaho Code, shall constitute a beneficial use and hereby authorizes the Department of Water Resources to issue to the aquifer recharge district, or the irrigation district, a permit...for the appropriation and underground storage of the unappropriated waters of the state.[103]

Thus, ground water recharge is recognized as a beneficial use in organized water districts and irrigation districts.[104] The Department of Water Resources has also approved as a beneficial use recharge involving specific intentional actions outside of an organized district, but has refused to recognize ground water recharge as a beneficial use when claimed as an incidental benefit from some other water use, such as irrigation.[105] A recharge permit must be issued for all recharge wells. All water currently being recharged in Idaho is by injection wells. Where

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[102] IDAHO CODE §§ 42-201 to 4231.

[103] Id. § 42-4201A(a)(2).

[104] Id.

[105] Idaho response to WSWC State Ground Water Recharge Questionnaire, September, 1989.

an injection well greater than 18 feet deep is used, an injection well permit is also needed.[106]

In general, Idaho encourages conjunctive use of ground and surface water supplies. The state water plan says:

> It is the policy of Idaho that, when public interest criteria are met, optimum beneficial use of a water resource shall be encouraged. Optimum beneficial use shall be achieved through the integration and coordination of use of water and by augmentation of specifically existing supplies.[107]

The Idaho Department of Water Resources encourages conjunctive use, including ground water recharge activities, where the department considers a project to be beneficial under the criteria of the state water plan. Similarly, such projects would be discouraged if considered non-beneficial.[108]

The major use of ground water recharge in Idaho is to enhance water supply in areas where all existing water right holders benefit from the recharge project. Often such benefit is in the form of assuring a continued, reasonable pumping level in an aquifer. The Idaho Department of Water Resources treats recharged water as part of the overall supply in an aquifer. In this sense it is allocated between existing ground water right holders by priority of right. The department has no experience in differentiating under state law between artificially versus naturally recharged ground water. Applications for permission to withdraw recharged ground water for "new" appropriations have been received by the department. State officials, however, have so far refused to issue permits to such applicants. The state

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[106]IDAHO CODE § 42-3909.

[107]Idaho State Water Plan, Policy 4L (1986).

[108]Idaho response to WSWC State Ground Water Recharge Questionnaire, September, 1989.

views these applicants as attempting to "leap-frog" over existing priorities. Thus, ground water recharge is considered a beneficial use of water under Idaho law, but the recharging entity cannot obtain a "new" right to use recharged water.[109]

Before a recharge project can be approved, an aquifer recharge district must usually be formed. The burden of proof on the sponsors of a recharge project is to demonstrate the need for the district and the ability of the district to benefit the water users in the area.[110] A number of other criteria must be met, including answers to questions such as: (1) will the diversion used for recharge reduce the quantity of water under existing water rights; (2) is the water supply sufficient for the purpose for which it is sought; (3) was the application made in good faith, or simply for speculative purposes; (4) does the applicant have sufficient financial resources to complete the work involved; and (5) would the function of the recharge district conflict with the local public interest, which is broadly defined under state law.[111] The quality of the recharged water and the effect of the recharge on aquifer quality are critical issues in these determinations.[112] The burden of proof on what Idaho would consider to be an applicant for a "new" right to recharged ground water (a proponent of a recharge project with no connection to existing users), trying to establish a right in preference to senior existing rights in an aquifer, would be much more severe. Thus far, Idaho has granted no such "new" rights.[113]

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[109] Id.

[110] IDAHO CODE § 42-4203.

[111] Id. § 42-203A.

[112] Idaho response to WSWC State Ground Water Recharge Questionnaire, September, 1989.

[113] Id.

Idaho provides that ground water may not be available to fill a right if withdrawal would negatively affect "the present or future use of any prior surface or ground water supply at a rate beyond the reasonably anticipated average rate of future natural recharge."[114] Recent amendments to the law allow diversions beyond the rate of natural recharge if the Department of Water Resources determines that such diversions are in the public interest and: (1) a program exists or is proposed to bring withdrawals into balance with recharge; and (2) holders of prior rights will not be required to pump from below the established reasonable pumping level.[115] Administratively, the total recharge to an aquifer (natural and artificial) has been considered as the natural water supply of the aquifer.[116] Hence, there is direct relationship under Idaho law between ground water recharge and optimum use of ground water resources.

No ground water recharge may occur in Idaho unless all applicable water quality standards are met, including those established under Idaho's ground water protection law generally,[117] and those created under the Idaho Underground Injection Control Program,[118] which regulates injection of any fluids by injection wells, including ground water recharge wells.

Changes in irrigation practices from gravity to sprinkler diversions are reducing the recharge to the Snake Plain Aquifer.

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[114] Id. § 42-237a(g).

[115] Id.

[116] Idaho response to WSWC State Ground Water Recharge Questionnaire, September, 1989.

[117] IDAHO CODE § 39-3601.

[118] Id. §§ A2-3901 to 3919.

Idaho has identified the effect on irrigation practices of new water quality laws on controlling pesticide use as an unresolved, but important, issue related generally to ground water recharge.[119] Further, state officials believe that public awareness of and support for protecting ground water resources will cause a change in water use and ground water quality protection and management in the future.[120]

The Water Committee of the Idaho Bar Association is evaluating the need for recodifying the state's ground water appropriation statutes. State officials believe that some of the unresolved issues concerning recharge and appropriation based upon recharge may be addressed in draft legislation prepared by the Committee. This is expected to be done in the near future.[121]

Kansas

Kansas does not have a specific ground water recharge statute. Ground water recharge, however, is defined in the State Division of Water Resources' administrative regulations,[122] and the Kansas Water Appropriation Act,[123] as a beneficial use of water. Further, the State Water Resources Planning Act[124] contains several sections that are written broadly enough to apply to

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[119] Idaho response to WSWC State Ground Water Recharge Questionnaire, September 1989.

[120] Id.

[121] Id.

[122] Kansas Division of Water Resources' Administrative Regulation 5-1-1(F).

[123] KAN. STAT. §§ 82a-701 et seq.

[124] Id. §§ 82a-901 et seq.

ground water recharge.[125] Kansas' Ground Water Management District Act also contains sections that infer that ground water recharge is a beneficial use of water under Kansas law.[126]

The Division of Water Resources issues ground water recharge permits for structures and diversions. A permit is required to divert the natural flow of a stream in any quantity for the purpose of recharging an aquifer, and such recharge qualifies as a beneficial use under Kansas law. But where runoff water is trapped and recharged via level terraces, or in ponds, no permit is required.[127]

Recharged ground water was indirectly measured in early work with recharge research in Kansas. The amount of recharge was quantified specifically for short periods of time. With recharge dams, the measurement of recharge was quantified by identifiable changes in the water table. For terraces, moisture enhancement was measured and some quantification was made, based upon certain assumptions.[128]

While recharged ground water can be measured in Kansas, the individual or entity responsible for the recharge is not currently provided legal protection to recover the recharged ground water. Once recharged to the aquifer, the water is available for appropriation through normal procedures. Indeed, once the water is in the aquifer, there is no differentiation

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[125] See, e.g., id. §§ 82a-907(g), 82a-927(d), and 82a-928(k)(e).

[126] Id. §§ 82(a)-1020 et. seq.

[127] Kansas response to WSWC State Ground Water Recharge Questionnaire, October 3, 1989.

[128] Id. and additional information supplied by Kansas April 16, 1990.

under Kansas law between water that is artificially or naturally recharged. However, where water is ponded for ground water recharge and an individual pays for the structure, the Division of Water Resources could give consideration for additional quantity on his water right.[129]

Kansas has compiled substantial information concerning ground water resources, especially those available at shallow depths. The state is currently updating and collecting more information on the Dakota and Roubidoux aquifers, particularly related to protection of aquifers from pollution. A recharge project in Kansas would most likely be located in the Ogallala aquifer or some alluvial material of younger age in the western one-third of the state where the rate of recharge is less than the rate of withdrawal, and where water from other sources is not economically available. Some areas in central Kansas, however, where use is very heavy, may also consider recharge alternatives. For water to be used as a source for recharge, an individual or entity would have to prove the availability of water and demonstrate the benefits to be derived from the recharge activity.[130]

The opportunities related to conjunctive use by a recharge project in Kansas would be to enhance the quantity of water available for uses such as domestic, municipal, and irrigation by way of the recharge projects. Problems associated with recharge could relate to ground water quality deterioration of the aquifer associated with the recharge of poor quality water.[131] The Kansas Department of Health and Environment, however, does not allow the

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[129] Id.

[130] Id.

[131] Id.

quality of ground water aquifers to be degraded. In areas of extremely good quality ground water, such as the Ogallala formations, the Equus Beds, parts of the Great Bend Prairie, and some other alluvial material, even good quality recharge water may deteriorate the quality of an aquifer. The Department of Health and Environment's policy essentially eliminates use of sewage effluent for recharge, even though the effluent has been treated to a fresh and usable condition.[132]

Kansas has four surface water interstate compacts covering the Arkansas River with the states of Colorado and Oklahoma and the Republican and Big Blue Rivers with the state of Nebraska. The surface water base flow associated with ground water flow is affected by ground water withdrawal, especially close to the river. Ground water recharge could help replenish surface water streamflow. Unless such recharge were very substantial, however, the increase in flow most likely could not be realized. Conversely, diversions to recharge ground water cannot reduce compliance of the flow delivery required by the compacts. Currently, effects of any recharge activity on compact requirements must be addressed on a case-by-case basis.[133]

Presently Kansas, through its ground water management districts, has initiated protection of ground water recharge areas for some wells on a pilot-program basis. The city of Oakley in western Kansas was the first such wellhead protection study. Although ground water recharge injection wells are used in many states, no such wells have been installed in Kansas. Quality of injection water and degradation of an aquifer by sediment, chemicals, and bacteria has always been an issue in

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[132] Id.

[133] Id.

Kansas, and thus the state has not encouraged injection as a method of recharge. With respect to water quality issues related to ground water recharge, concerns have been expressed about fertilizers, herbicides, and bacteria in agricultural runoff recharging some underlying aquifers.[134]

The primary state water quality regulations that affect ground water recharge projects in Kansas require that water may not be recharged if it will degrade the ambient quality of an aquifer.[135] These state regulations comply with the federal Clean Water Act.[136] If the quality of recharge water is not equal to or better than the quality of water in an aquifer, regardless of how pristine that water may be, the project may not proceed.[137]

In the late 1970's, funds were appropriated by the Kansas legislature for ground water recharge pilot projects. Up to $1M could have been spent. The funding, however, ceased after $400,000 was appropriated. The cessation of funding by the legislature indicated lack of total support for recharge programs. In general, Kansas officials believe the state has sufficient ground water recharge legislation in place, but more funding may be necessary if projects with local support are to be constructed.[138]

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[134] Id.

[135] Kansas Dept. of Health and Environment Administrative Regulation §§ 28-16-57 and 28-16-28e.

[136] 33 U.S.C. §§ 1251-1376.

[137] Information supplied by Kansas April 16, 1990.

[138] Id.

Montana

State officials in Montana have yet to see any real interest in ground water recharge. The state has not specifically developed statutes to regulate this type of use. State administrators believe the spectrum of consumptive users (public, private domestic, irrigation) and, conceivably, those interested in preservation of instream flows (in cases where ground water storage might provide an economical option for seasonable augmentation of streamflows) would be the most likely sponsors of future ground water recharge projects.[139]

Montana has one small designated ground water management area where recharge augmentation is a requirement of an applicant seeking to obtain or expand a ground water right. In this sense, the state has, in a limited fashion, recognized recharge augmentation as a valid approach to increasing ground water availability. Such augmentation, however, has been investigated at only a few Montana sites and its feasibility has not been demonstrated at any of them. However, the concept of such augmentation is "worth considering in certain Montana settings," according to state officials.[140]

Montana has no specific ground water recharge statute and has only defined in a limited fashion the potential application of Montana water law to future recharge situations. State officials believe that legal action with respect to ground water recharge would be most directly related to the issuance of a right to divert water intended for recharge. However, Montana does not specifically recognize ground water recharge as a

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[139]Montana response to WSWC State Ground Water Recharge Questionnaire, August 29, 1989.

[140]Id.

beneficial use of water and does not issue ground water recharge permits. Further, the state could offer no legal protection to the sponsor of a potential recharge project. The state has made no effort to differentiate between naturally and artificially or intentionally recharged water.[141]

Ground water "mining" is not defined by statute in Montana, and the state has made no effort to determine if there is a relationship under state law between ground water mining and ground water recharge. Also, because there is no ground water recharge activity in Montana, the state has made no effort to determine the effect, if any, that ground water recharge might have on interstate water compacts or allocations, or federal or Indian reserved water rights.[142]

The Montana Water Quality Bureau of the Department of Health and Environmental Sciences regulates underground injection wells under the state's underground injection control program.[143] Recharge activities by injection well would have to be carried out in conformity with this program and in harmony with Montana general ground water quality laws and programs.[144] Currently, there are no problems in the state related to ground water quality and ground water recharge.[145]

Montana, at the present time, is trying to establish policies to promote conjunctive use of ground and surface water,

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[141] Id.

[142] Id.

[143] Id.

[144] MONT. REV. CODES ANN. §§ 75-5-101 to 1122.

[145] Montana response to WSWC State Ground Water Recharge Questionnaire, August 29, 1989.

and thereby enhance the state's ability to manage its water resources. Montana officials view ground water recharge as a future, further step in promoting water use efficiency. Thus, at some future time, ground water recharge legislation may be an appropriate consideration.[146]

Nebraska

Nebraska's general ground water law is based on a combination of the reasonable use and correlative rights doctrines. Originating in case law and now codified in statute, it allows that "Every land owner shall be entitled to a reasonable and beneficial use of the ground water underlying his or her land subject to [statutory requirements]...and the correlative rights of other landowners when the ground water supply is insufficient for all uses."[147] The statutes require state registration of non-domestic wells, include well-spacing restrictions, and permit, with conditions, transportation of ground water off the overlying land for municipal, rural domestic, industrial, and out-of-state uses.

The statutes also authorize three different types of special areas where use restrictions may be imposed. These are respectively called control areas, management areas, and special protection areas. Local natural resources districts are the only entity authorized to request designations of a control area. Such an area can be created by the State Director of Water Resources:

> "if it shall be determined, following evaluation of relevant hydrologic and water quality data, history of developments, and projection of effects of current and new development, that development and utilization of

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[146] Id.

[147] NEB. REV. STAT. § 46-656.

> the ground water supply has caused or is likely to cause within the reasonably foreseeable future the existence of either of the following conditions:
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> > (a) An inadequate ground water supply to meet present or reasonably foreseeable needs for beneficial use of such water supply; or
> >
> > (b) Dewatering of an aquifer, resulting in a deterioration of the quality of such ground water sufficient to make such ground water unsuitable for the present purposes for which it is being utilized.[148]

If a control area is formed, the natural resources district board can adopt rules to allocate water, require measuring devices, require stricter spacing of wells, adopt a system of rotation of use, and if necessary set up a one year moratorium on wells. Three control areas exist in the state; they were all formed for quantity reasons.

Natural resources districts are also authorized to create ground water management areas. State approval is not required, but the districts must first prepare a ground water management plan that is reviewed by the state.[149] For ground water quantity management, the districts have less authority than in a control area. Moratoriums are not allowed and the ability to regulate well-spacing is limited. Emphasis is placed on allocation by acre-inch. One natural resources district has formed water management areas for quantity reasons.

Management areas may also be formed for water quality reasons, especially if water quality problems are created by non-point contaminant sources. In such event, landowners, both rural and urban, can be required to use best management practices in

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[148] Id. § 46-658.

[149] Id. § 46-673.01.

applying chemicals.[150] Water use can also be restricted if the district concludes that leaching could be thus reduced.[151] Two natural resources districts have created water management areas specifically for water quality reasons and several others are considering such action.

Within a control or management area, permits are required prior to well drilling.[152] The control and management area laws in effect would appear to apply to both naturally occurring ground water and recharged ground water.

Nebraska law also allows for creation of another type of area for quality protection. Called special protection areas, these can be created by the State Department of Environmental Control when non-point sources of ground water contamination are identified.[153] After an area is created, the appropriate natural resources district is required to prepare an action plan that relies on best management practices and education for addressing the problem.[154]

Concerning recharge specifically, Nebraska law recognizes that:

> As a result of water project operations, surface water in some areas of the state has been, is, and will be in the future intentionally and incidentally stored in and withdrawn from underground strata. The legislature acknowledges that rights to water intentionally or unintentionally stored underground and rights to withdrawal of such water should be formally recognized

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[150] Id. § 46-673.09.

[151] Id.

[152] Id. § 46-659.

[153] Id. §§ 46-674.02 to 46-674.20.

[154] Id. §§ 46-674.08 to 46-674.11.

> and quantified and recognizes the propriety of all beneficiaries proportionately sharing, to the extent of potential benefit from intentional underground water storage, in the financial obligations necessary for construction, operation, and maintenance of water projects which cause intentional underground water storage.[155]

The legislature has declared that uses of water for incidental and intentional underground water storage are beneficial uses of water that contribute to the recharge of Nebraska's aquifers.[156] Further, the legislature has declared that:

> ...Comprehensive, conjunctive management of surface water and intentional or incidental underground water storage is essential for the continued economic prosperity and well-being of the state, serves the public interest by providing an element of certainty essential for investment in water resources development, and will improve Nebraska's standing in the event of interstate dispute.
>
> To facilitate optimum beneficial use of water by the people of Nebraska, the legislature recognizes the need for authorizing the recognition of incidental underground water storage, for authorizing intentional underground water storage, and for authorizing the levying and collection of fees and assessments on persons who withdraw or otherwise use or benefit from intentional underground water storage...[157]

Nebraska law defines intentional ground water storage to mean "underground water storage which is an intended purpose or result of a water project or use."[158] Such storage may be accomplished "by any lawful means such as injection wells, infiltration basins, canals, reservoirs, and other reasonable

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[155] Id. § 46-295.

[156] Id.

[157] Id.

[158] Id. § 46-296.

methods..."[159] The source of a permit for intentional underground water storage must be surface water.[160] Incidental underground water storage is defined as "underground water storage which occurs as an indirect result, rather than an intended or planned purpose, of a water project or use and shall include, but shall not be limited to, seepage from reservoirs, canals, and laterals, and deep percolation from irrigated lands."[161] Nebraska law allows an individual who holds an approved, unperfected appropriation to apply for a modification of the permit to include intentional underground water storage associated with the appropriation.[162]

Concerning rights to the water after it has been stored, Nebraska law provides that:

> Any person who has obtained a permit for intentional underground water storage associated with a project not existing on August 26, 1983...may...levy a fee or assessment against any person for the right or probable right to withdraw or otherwise use such stored water.[163]

Wells with a capacity of less than 100 gallons per minute used solely for domestic purposes are exempt from any fee or assessment.[164] Before an entity can levy fees or assessments, it must receive approval from the Nebraska Department of Water Resources. Requirements for approval are specified by statute.[165]

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[159] Id.

[160] Nebraska response to WSWC State Ground Water Recharge Questionnaire, September 27, 1989.

[161] NEB. REV. STAT. § 46-296.

[162] Id. § 46-297.

[163] Id. § 46-299.

[164] Id. § 46-2,100.

[165] See id. § 46-2,101.

An individual who obtains approval for fees or assessments may commence an action to enjoin a person from withdrawing or otherwise using stored water if the person has not entered into an agreement to pay or has not paid applicable fees and assessments.[166] However, this appears to be the only basis upon which use of intentionally recharged ground water can be prevented if the use is consistent with other ground water laws and regulations.

Nebraska law also still allows water users with perfected water rights to receive approval for incidental underground water storage associated with some kinds of water use.[167] The Director of the Department of Water Resources may approve an application subject to the following conditions: (1) the use of surface waters will not be increased from that proved in the original right; (2) if the water to be stored underground from incidental recharge is to be used on lands different from lands included under the original appropriation, the Director must determine that the change is in the public interest; (3) the appropriation date shall remain the same as that of the original appropriation; and (4) the incidentally recharged water must be used for beneficial purposes.[168] The burden of proof with respect to incidental recharge is on the applicant for a permit. The Director may grant an application in a modified or reduced form.[169]

A provision in the original law passed in 1983 allowed the holder of a water right for incidental recharge to collect up to

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[166] Id. § 46-2,103.

[167] Id. § 46-226.01.

[168] Id. § 46-225.02.

[169] Id.

fifty cents per acre per year from ground water irrigators benefitting from that recharge. However, as a result of landowner opposition that authority was repealed in 1989. As explained in more detail later, the most likely motivation for now obtaining a water right for incidental recharge is to protect the surface water diversion upon which that recharge depends.

With respect to intentionally recharged underground water storage, a permit may be obtained from the Department of Water Resources to appropriate public waters for intentional storage and recovery of such water. Further, an unapproved application pending on August 26, 1983, may be amended to include an appropriation for intentional underground water storage and recovery.[170] In many respects, applications to withdraw intentionally recharged water are treated the same as applications to appropriate water from a lake or a reservoir.[171] An application for storage and recovery of water intentionally stored underground may be made only by an appropriator of record who shows, by documentary evidence, sufficient interest in the underground water storage facility to entitle him to the water requested.[172]

Although the state has recognized incidental underground water storage for a number of projects, none of the projects are currently withdrawing the stored water. This has been identified as a problem relating to conjunctive use of water in Nebraska, created by ground water recharge activities. State officials opine that Nebraska law does not contain enough specific language on ground water recovery because ground water is not subject to

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[170] Id. § 46-233.

[171] See id. § 46-242.

[172] Id. § 46-241(3).

appropriation in Nebraska and because the proponents of the recharge law were not interested in recovery, but in assessing beneficiaries and protecting water diversion quantities. Controversy could arise if projects attempt to withdraw stored water or prevent others from doing so. Before then, NDWR feels more legislation is needed to clarify the rights of interested parties to recovery of recharged water.[173]

As alluded to earlier, the incidental underground water storage permit allows existing projects to "firm up" their rights to divert water at historic diversion rates. State statutes set a maximum diversion rate for irrigation at 1 cubic foot per second for every 70 acres.[174] Over the last 15 years the Department of Water Resources has had an aggressive adjudication program. Several districts have filed applications for recognition of incidental underground water storage prior to or simultaneously with the adjudication of their water rights. By so doing, and proving incidental recharge from operation of projects, the districts were able to retain a diversion rate and priority date on the basis of recharge for a portion of the water historically diverted.

The following simplified hypothetical situation helps explain. District X has an 1898 priority date water right to divert 300 cubic feet per second for irrigation of 21,000 acres of land. Since the right was granted, neighboring towns have grown, wells have been drilled, farming practices have changed, and the district now only provides direct service to 14,000 acres of land. Historically, the district has diverted approximately 250 cubic feet per second, and the ground water table under the

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[173]Nebraska response to WSWC State Ground Water Recharge Questionnaire, September 27, 1989.

[174]NEB. REV. STAT. § 46-231.

project has risen. Following a hearing and adjudication, the district could be recognized as having the right to divert 200 cfs to irrigate 14,000 acres and 50 cfs for incidental underground water storage.[175]

The water quality effects of ground water recharge in Nebraska are regulated by various laws. Most activities designed to recharge ground water directly would require a permit from both the Department of Water Resources and the Department of Environmental Control. Intentional ground water recharge using injection wells is regulated under the Nebraska Environmental Protection Act[176] and by Nebraska rules and regulations for underground injection and mineral production.[177] The limits on contaminant levels and injectate are based on the Nebraska ground water quality standards and use classifications.[178] These controls, in turn, are based in part on the federal Safe Drinking Water Act.[179] Further, Nebraska is developing a wellhead protection program that will be used to allow public water suppliers to protect recharge areas of a public supply well.[180]

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[175]Nebraska response to WSWC State Ground Water Recharge Questionnaire, September 27, 1989.

[176]NEB. REV. STAT. §§ 81-1501 to 1533.

[177]Nebraska Department of Environmental Control, Title 122 - Rules and Regulations for Underground Injection and Mineral Production Wells, January 2, 1989.

[178]Nebraska Department of Environmental Control, Title 118 - Ground Water Quality Standards and Use Classification, May 29, 1988.

[179]42 U.S.C. §§ 300f - j(11).

[180]Nebraska response to WSWC State Ground Water Recharge Questionnaire, September 27, 1989.

Nebraska is concerned that some ground water resources could be degraded through ground water recharge projects. Where the source water contains nitrates, pesticides, or other substances that could cause contamination, some ground water resources may be in jeopardy. However, the state has little control over a recharge project based on water quality concerns unless injection wells are used. Two programs described earlier could be used to protect ground water recharge from non-point source contamination. As noted, the natural resource districts in the state may designate ground water quality management areas, where the districts can require best management practices with respect to certain agricultural practices to limit non-point source contamination. Further, the Department of Environmental Control may create special protection areas designed to achieve the same goal.[181]

State officials in Nebraska view ground water recharge as an area of the law where some change is necessary. More legislation on recovery of recharged water, as mentioned previously, may be needed. Also, natural recharge of municipal water supplies by surface water sources, such as rivers, is not adequately recognized and protected. Ground water, which supplies most municipalities, and surface water, the source of ground water recharge, are managed as two distinct water systems, even when the ground water is derived directly from induced recharge in an alluvial aquifer. Several municipalities including Lincoln and Omaha rely on Platte River island or streambank well fields for their water supply. Hence, more legislation is needed with respect to these and other conjunctive uses. However, chances

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[181] Id.

for enactment of new laws, according to Nebraska officials, depend on certain "major players" seeing the need for change.[182]

Nevada

In 1987, Nevada enacted a ground water recharge statute and gave the State Engineer specific authority over recharge/recovery projects.[183] The Nevada Division of Environmental Protection has authority over the quality of recharged water under Nevada statutes[184]and administrative regulations.[185] The Nevada Department of Conservation and Natural Resources actively supported the passage of the Nevada recharge law and has encouraged water purveyors and users to explore ground water recharge as an option to enhance the state's ability to manage water resources.[186] Department officials feel that ground water recharge projects are viable water management tools, and the Division of Water Planning has identified ground water recharge as an important water management option to explore in future studies. The state seeks to provide an incentive for use of ground water recharge by recognizing the increase in efficiency of water management generally when ground water recharge plays a significant role. This could allow future reliance on recharge to support additional growth in the state. Although only

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[182]Nebraska response to WSWC State Ground Water Recharge Questionnaire, September 27, 1989.

[183]NEV. REV. STAT. §§ 534.250 to .340.

[184]Id. § 445.

[185]NEV. ADMIN. CODE §§ 45.422 to .4278.

[186]Nevada response to WSWC State Ground Water Recharge Questionnaire, November 9, 1989.

preliminary analysis has been done, the Department believes ground water recharge is cost effective.[187]

Nevada's recharge legislation established procedures and requirements to develop and operate a project both to store and recover water for beneficial use. The source of recharged ground water must be water held under existing water rights and the amount of water that may be recovered cannot exceed the recharged amount. The applicant is required to demonstrate the amount of recoverable water that remains in a recharge area. Significant penalties may be imposed by the State Engineer for mismanagement of a recharge project.[188]

Recharge of water is not specifically defined as a beneficial use under Nevada law. The uses that will be made of the recharged water when it is recovered, however, may be considered beneficial under Nevada's recharge legislation, and may serve as a legal basis for the recharge project. To date, recharge applicants have all intended to use ground water basins as storage facilities for future use of water for a defined beneficial use. There are, however, projects being considered by local entities where the recharged water would relieve overdrafting of a ground water basin. In these instances, the beneficial use would likely be deemed an adequate water supply for domestic use, which is considered a beneficial use under Nevada law.[189]

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[187] Id.

[188] See NEV. REV. STAT. §§ 534.250 to .340; Nevada response to WSWC State Ground Water Recharge Questionnaire, November 9, 1989.

[189] Nevada response to WSWC State Ground Water Recharge Questionnaire, November 9, 1989.

Operation of all ground water recharge projects in Nevada requires a permit from the Department of Conservation and Natural Resources. Recharged water must be monitored by the permittee and an annual report must be filed with the State Engineer, including information on the quantity and quality of recharged water. Nevada differentiates between artificially and naturally recharged ground water. With respect to artificially, or intentionally stored water, an applicant must have a valid right to use water from the proposed source. Where the source of recharge is derived from a storm event, an applicant would have to first obtain from the State Engineer a permit to appropriate the stormwater. In making a determination of whether to issue such a permit, the State Engineer would have to consider whether or not the stormwater was part of the perennial yield of the ground water basin, or part of the surface water system already appropriated, and then determine whether a permit could issue.[190] Nevada finds that sufficient information is available in most instances to determine the amount of water recoverable from a recharge project. A project sponsor is required to perform hydrologic studies in sufficient detail to determine if the project is hydrologically feasible, and then is being operated in a hydrologically sound manner, to assure the amount of recoverable water.[191]

The State Engineer must set up a storage account for each project. The amount of water that may be recovered from the storage account is the portion of the recharged water defined as "recoverable." The permittee is required to submit to the State Engineer a detailed analysis of the recoverability of recharged water. The State Engineer utilizes the information in the

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[190] Id.

[191] Id.

analysis, along with any additional information available to him, to determine the amount of water the permittee may recover. In no instance would the permittee be allowed to recover an amount exceeding the amount recharged. Domestic wells are exempt from the appropriation process, and the recharge/recovery process. The permittee has the right to operate a recharge project, and no entity or individual may recover recharged water unless designated by the permittee and approved by the State Engineer.[192]

No recharge project may be permitted in Nevada if it affects existing water rights.[193] If, after a permit has been issued for a recharge project, the State Engineer determines that the project is adversely effecting existing rights, the State Engineer can modify the conditions of the recharge project permit so as to discontinue its effect on existing rights. Any recharge activity not permitted is considered a violation of Nevada water law. No recharge projects are allowed to adversely affect interstate water compacts or allocations, or Indian reserved water rights.[194] To date, the Nevada Division of Water Resources has received 7 applications for ground water recharge projects, and two permits have been granted, both to the Las Vegas Valley Water District.[195]

Nevada law does not allow ground water mining.[196] State policy defines available ground water as the perennial yield of the ground water basin. There is little direct relationship

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[192] Id.

[193] Id.

[194] Nevada response to WSWC State Ground Water Recharge Questionnaire, November 9, 1989.

[195] Information provided by Nevada, May 3, 1990.

[196] NEV. REV. STAT. § 533.370(3).

under the law between ground water mining and recharge projects because recharge projects are only allowed if the source of water to be recharged has already been appropriated by the applicant. Also, since Nevada law does not allow ground water mining, a recharge project may not mine ground water. As mentioned previously, recovery of recharged water from a recharge project is limited to the demonstrated amount of recharged water.[197]

The Nevada Division of Environmental Protection may regulate ground water recharge injection wells under the state Underground Injection Control Program to assure that the quality of recharged water meets applicable standards.[198] State water pollution control laws, which also regulate contamination of ground water, provide the state with adequate tools to protect ground water quality that might be affected by recharge projects.[199] This includes the authority to regulate rapid infiltration basins and other means of ground water recharge and require such projects to comply with all applicable state water quality laws.[200]

New Mexico

Ground water recharge is a possible method of water conservation in New Mexico, and the state has a general interest in any ground water recharge activity. The state's specific interests include preventing contamination of aquifers, assuring the chemical compatibility of the recharged water with that of

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[197]Nevada response to WSWC State Ground Water Recharge Questionnaire, November 9, 1989.

[198]See NEV. REV. STAT. §§ 445.221 to .241.

[199]See generally id. §§ 445.015 to .399.

[200]Nevada response to WSWC State Ground Water Recharge Questionnaire, November 9, 1989.

the aquifer, protecting existing water rights from impairment, and insuring that recharge is not contrary to the conservation of water in the state or detrimental to the state's public welfare. However, there has been very little ground water recharge activity in New Mexico except the "recharge" of "produced" water from oil and gas operations, primarily into brine or saline aquifers. This activity occurs only in oil and gas producing areas in the state.[201]

In New Mexico, water in underground streams, channels, reservoirs, or lakes is public water subject to appropriation for beneficial use. The state has no specific ground water recharge statute. With respect to the application of water law generally to a ground water recharge situation, the New Mexico State Engineer office views the cases interpreting applicable statutes as discouraging ground water recharge activity.[202]

In State Ex Rel. Reynolds v. King,[203] the New Mexico Supreme Court faced a situation where a landowner claimed the right to use water recharged into an underground basin below a private lake located on his land. The waters flowed intermittently into the lake with the permission of the landowner. A portion of the water percolated downward and contributed to the quantity of water in the aquifer below the lake. When the landowner claimed the right to use this recharged water without applying for permit from the State Engineer, he was enjoined for failure to make an application to appropriate the public waters from an underground source. In upholding the injunction, the New Mexico Supreme

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[201] New Mexico response to WSWC State Ground Water Recharge Questionnaire, October 5, 1989.

[202] Id.

[203] 63 N.M. 425, 321 P.2d 200 (1958).

Court found no law "permitting the storing of private waters in established underground water basins."[204] The court said, "When waters, either artificial surface waters or natural surface waters, reach an established underground water basin by percolation, seepage or otherwise, they become public waters...."[205] The court held that the water in question was public water, subject to appropriation under New Mexico law. Thus, the court refused to recognize the right of a land owner to "recharged" ground water and found the landowner was properly required to obtain an appropriative permit, subject to the priorities of other existing water rights, to use the water to irrigate his land.[206]

In Kelley v. Carlsbad Irrigation District,[207] The same court faced a situation where an appropriator attempted to change his point of diversion from an intermittent stream to a downstream, fully appropriated, aquifer. The court upheld the State Engineer's refusal to make the transfer. Although the case was not really a ground water recharge case, the court made the following statements that are applicable to ground water recharge under New Mexico law. The court said:

> When an artificial or natural flow of surface water, through percolation, seepage or otherwise, reaches an underground reservoir and thereby loses its identity as surface water, such waters become public...and are subject to appropriation in accordance with applicable statutes...
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> ...The transfer of a surface right to water, which has lost its identity as surface water because it has reached an

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[204] Id. 63 N.M. at 428.

[205] Id.

[206] Id.

[207] 76 N.M. 466, 415 P.2d 983 (1966).

> underground reservoir,...would constitute a new appropriation in the underground reservoir.
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> * * *
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> It is clear from the evidence the appellee's surface water, through percolation, reached the underground basin. Upon this occurring, it immediately lost its identity as appellee's water and became public water, subject to appropriation.[208]

New Mexico does not specifically recognize ground water recharge as a beneficial use of water and does not issue ground water recharge permits, per se. Still, if an individual or entity were to attempt to use public water in New Mexico for ground water recharge, that individual or entity would have to make an application to the State Engineer. The State Engineer might grant the application upon finding that: (1) there is water available for the benefit of the applicant; (2) the appropriation would not impair or be detrimental to existing rights; and (3) the use would not be detrimental to the public welfare or contrary to conservation of water in the state. An individual promoting ground water recharge, however, would be given no deferential treatment in the permitting process, and could not be protected in the right to recover the recharged ground water. There is no differentiation under New Mexico law between ground water artificially recharged by diverting water from another source for injection and ground water naturally recharged.[209]

New Mexico case law and statutes appear to discourage ground water recharge except, perhaps, in an instance where existing appropriations and aquifer characteristics ensure that the recharged water could be available only to known appropriators.

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[208] Id. 76 N.M. at 472-3.

[209] New Mexico response to WSWC State Ground Water Recharge Questionnaire, October 5, 1989.

Also, in New Mexico there is a very limited amount of excess surface water, most of which is held under contract by municipalities for future municipal and industrial use. Thus, in view of state officials, there is very little water available that might be used for ground water recharge. There is "essentially no unappropriated surface water in the state."[210]

New Mexico allows some "ground water mining," not as defined by statute, but as defined by case law.[211] According to state officials, however, there is no relationship under New Mexico law between "ground water mining" and ground water recharge.[212] Officials are uncertain as to what effect ground water recharge might have on reserved water rights for federal or Indian lands or on interstate compacts. The state has opined that if ground water recharge did occur it would "have to be carefully scrutinized to determine its effect on water apportioned by the compacts and decrees or on delivery obligations. The other states affected might not be willing to agree to theoretical determinations of returns to the stream from ground water recharge and "the problems raised would likely outweigh the opportunities."[213]

The New Mexico Water Quality Control Commission, with the Environmental Improvement Division as the enforcement agency, regulates the disposal of water onto or below the surface of the ground in New Mexico. Where recharge would affect the quality of

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[210] Id.

[211] Mathers v. Texaco, Inc., 77 N.M. 239, 421 P.2d 771 (1966).

[212] New Mexico response to WSWC State Ground Water Recharge Questionnaire, October 5, 1989.

[213] Id.

the water in aquifers, it would have to be regulated by the State Water Quality Control Commission. Numerous problems could be created by recharge including plugging of a recharge well by chemical, biological, or physical factors, the potential chemical incompatibility of injected water with that of the natural ground water, and possible contamination of the aquifer injected and adjacent aquifers, especially those from which potable waters are drawn.[214]

New Mexico has primary enforcement authority for administration of the federal underground injection control program.[215] Enforcement is carried out partly under the authority of the New Mexico Oil and Gas Act[216] and partly under the authority of the New Mexico Water Quality Act.[217] If ground water recharge were accomplished by injection wells, the requirement of these acts would have to be met.

State officials in New Mexico do not see the need for comprehensive ground water recharge legislation. No demonstration of such need has yet been made primarily because of lack of opportunity for and little interest in ground water recharge in the state.[218]

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[214] Id.

[215] Water Quality and Water Pollution Control in New Mexico, 1988; New Mexico Water Quality Control Commission Clean Water Act § 305(b) Report.

[216] N.M. STAT. ANN. §§ 70-2-1 to 38 (1978).

[217] Id. §§ 74-6-1 to 13.

[218] New Mexico response to WSWC State Ground Water Recharge Questionnaire, October 5, 1989.

North Dakota

Approximately two-thirds of North Dakota is glaciated. Much of the state's population resides in small, rural towns and villages. Many of these obtain their water supply from aquifers of glacial origin. Although glacial aquifers are relatively limited in areal extent, they provide dependable municipal water supplies for most rural communities in some areas of the state.[219]

North Dakota advocates and promotes innovative water development and management, which includes ground water recharge. Such recharge is viewed as a viable alternative for ground water supply enhancement, depending on the type of use, demand, technical and economic feasibility, and political acceptability. The North Dakota State Engineer is required to regulate the development of artificial recharge under general water appropriation statutes. The state has no ground water recharge statute. The state encourages ground water recharge to enhance the availability of water for beneficial use.[220]

Ground water recharge is not specifically recognized as a beneficial use in North Dakota. The ultimate use of recharged water, however, may be a beneficial use that would allow surface water to be used for a recharge project.[221] In North Dakota the term "beneficial use" is broadly construed as any purpose consistent with the best interests of the people of the state.[222]

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[219]North Dakota response to WSWC State Ground Water Recharge Questionnaire, October 4, 1989.

[220]N.D. CENT. CODE §§ 61-04-01 to 31.

[221]North Dakota response to WSWC State Ground Water Recharge Questionnaire, October 4, 1989.

[222]See N.D. CENT. CODE § 61-04-01.1.

North Dakota does not issue ground water recharge permits, per se. The diversion of surface water for artificial recharge would require a water permit from the State Engineer. The permit would define quantity, point of diversion, and source and type of use water.[223] The porous underground media (the aquifer) would be viewed as a storage reservoir under North Dakota law and legal issues related to the project would be handled in much the same way as if the aquifer were a surface water storage reservoir.[224] The quantity of water diverted for recharge would be measured by a metering device. The amount of water recoverable by the project sponsor would depend upon the hydraulic characteristics of the aquifer. In settings where the quantity of water diverted for artificial recharge cannot be accurately measured, the water "credits" subject to recovery could be based upon monitoring the water level in the receiving aquifer and allocating benefits accordingly.[225]

North Dakota does not differentiate between ground water that is artificially recharged by diverting water from a surface water source, versus naturally recharged ground water. Further, apparently North Dakota statutes do not provide specific protection for the sponsors of a recharge project to recover intentionally recharged ground water. The North Dakota State Engineer believes that the general body of water law in the state as it is currently administered, however, would provide necessary protection to a recharge project sponsor. The state would be required to issue a water permit for diversion of water for

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[223] Id. § 61-04-02.

[224] North Dakota response to WSWC State Ground Water Recharge Questionnaire, October 4, 1989.

[225] Id.

intentional recharge of an aquifer based upon the beneficial use to which the water would eventually be put. Generally, a water permit is required prior to construction of facilities for diversion of water. In the case of a recharge project, the same would hold true. The demonstration of beneficial use would be required for issuance of a permit for diversion. Such a permit is required prior to the construction of facilities for the diversion of water. Thus, the water would be allocated. The state believes it is unlikely that after such a permit was issued, and facilities to utilize it constructed, the state would subsequently allocate intentionally recharged water to a different beneficial user.[226]

Historically, activities in North Dakota have, in some instances, resulted in some mining of a select few ground water sources. While there is no definition in North Dakota statutes for ground water mining, contemporary ground water management policy avoids sustained mining of a ground water aquifer. The state has not defined any relationship between ground water mining and ground water recharge. With respect to the conjunctive use of surface and ground water generally, as noted previously, the use of surface water for artificial recharge can be permitted under existing statutes. This could result in some competitive problems between surface and ground water users, but would be dealt with under existing statutes, based upon the prior appropriation doctrine.[227]

North Dakota officials believe there is sufficient information concerning the geometry and general hydraulic characteristics of the state's aquifers to support administrative

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[226] Id.

[227] Id.

decisions concerning recharge projects. Because a water permit is required for a recharge project, the project sponsor must provide to the State Engineer the data necessary to determine water availability, beneficial use, water quality effects, and the safety of the project works. Sufficient information in each of these categories would be required for a project sponsor to carry his burden of proof regarding withdrawal of recharged water.[228]

A ground water recharge project in North Dakota would be required to meet all applicable state and federal water quality laws, and the state could prohibit a project on the basis of harm to other water rights or degradation of water quality. North Dakota regulates all injection wells under a state Underground Injection Control Program. While the state has a program for such regulation, injection wells are defined by federal law. Ground water recharge by injection well would have to comply with all state and federal regulations.[229] No critical aquifer protection areas or sole source aquifers have been designated in North Dakota. There is, however, a wellhead protection program being implemented to protect water supplies and any ground water recharge project would have to conform with requirements of this program.[230]

The North Dakota State Water Commission considers artificial ground water recharge a viable water management practice. Widespread application of artificial recharge, however, does not seems likely in the near future. Prerequisites for artificial recharge include community growth and development resulting in

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[228] Id.

[229] Id.

[230] Id.

sustained ground water mining and a dependable high quality water source, generally surface water, close to the ground water reservoir. Many rural communities in North Dakota are experiencing a net population decline. Thus, sustained ground water mining is not a significant water management problem. In addition many rural communities are not in close proximity to a dependable surface water source for artificial recharge. Moreover, the population of these communities generally is too small to absorb the cost of a lengthy conveyance system.[231] Finally, some rural communities may receive Missouri River Water for their municipal water supplies as is stipulated under the Garrison Diversion Unit Reformulation Act of 1986.[232]

North Dakota officials believe the state probably does not need comprehensive ground water recharge legislation. However, some enhancement or strengthening of present statutes relative to ground water recharge would be desireable. State officials believe such legislation would have a reasonably good chance of enactment.[233]

Oklahoma

The Oklahoma Water Resources Board has statutory authority over appropriation of surface and ground water rights, as well as surface and ground water quality. While Oklahoma has no specific ground water recharge statute, ground water recharge is considered a beneficial use under Oklahoma ground water law.[234]

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[231] Id.

[232] Pub. L. 99-294, § 5, 100 Stat. 418 (1986).

[233] Id.

[234] OKLA. STAT. tit. 82, §§ 1020.1-1020.22.

The Oklahoma Water Resources Board has statutory authority over appropriation of surface or stream water rights and allocation of ground water as well as authority over various aspects of surface and ground water quality. While Oklahoma has no specific statute regarding artificial recharge, applicants must comply with the basic system of water rights administration.[235]

The basis for the ground water law and the system of water rights administration and regulation in Oklahoma originates in a statute that reads in part:

> "The owner of the land owns water standing thereon, or flowing over or under its surface but not forming a definite stream. The use of ground water shall be governed by the Oklahoma Ground Water Law..."[236]

It is apparent that the entire system of ground water law administration and regulation is based upon the premise that the owner of the land owns the water thereunder. However, further reading of this section indicates that this "ownership" is not an unqualified right, because the "use of ground water is to be controlled, governed and managed according to the provisions of the Oklahoma Ground Water Law."[237]

Oklahoma ground water law may be considered somewhere between a correlative rights doctrine and an absolute ownership doctrine. The policy declarations of the Oklahoma legislature make it clear that the ground water resources of the state are to be put to beneficial use including but not limited to agriculture, domestic, municipal and industrial uses. The policy

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[235]Oklahoma response to WSWC State Ground Water Recharge Questionnaire, November 20, 1989.

[236]OKLA. STAT. tit. 60, § 60.

[237]Id.

also states that reasonable regulations restricting production are in the interest of the general economy and health and welfare of the state and its citizens. The legislature encouraged use of ground water resources in the state, yet realized that some restriction of production was necessary, and provided mechanisms to set restrictions on the use of the ground water.[238]

In order to place ground water to beneficial use, the applicant must make an application for use permit to the Oklahoma Water Resources Board. The application must meet general permitting requirements[239] and conditions[240] for the Board to grant a ground water permit. Paraphrased, these statutory conditions are: (1) That the lands dedicated to the application are owned or leased by the applicant; (2) That the lands dedicated overlie the fresh ground water basin or subbasin; (3) That the applicant's intended use is a "beneficial use"; and (4) "...that waste will not occur..." by virtue of the intended use.[241]

The allocation system of the Oklahoma Ground Water Law and the amount of ground water that can be withdrawn from a ground water basin by permit depends on the number of acres of land the applicant owns or leases overlying the basin. Once a hydrologic survey is completed for a basin, a "maximum annual yield" of the basin is determined. The landowner may take his equal, proportionate part of the yield of the basin depending on the number of acres he owns or leases overlying the basin. Until such a survey is completed, a legislative allocation of two

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[238] See generally the Sections of id., tit. 82 discussed in the immediately following paragraphs.

[239] Id. tit. 82, §§ 1020.7-1020.11.

[240] Id. § 1020.9

[241] Id.

acre-feet per surface acre owned or leased is the amount authorized by a "temporary" permit.[242]

The process by which hydrologic surveys and investigations are made and conducted and the maximum annual yield determined is quite complex and involves considerable time and expense.[243] The determination of maximum annual yield of fresh water to be produced from a ground water basin must be based upon the following: (1) the total land area overlying the basin or subbasin; (2) the amount of water in storage in the basin or subbasin; (3) the rate of natural recharge to the basin or subbasin and total discharge from the basin or subbasin; (4) transmissibility of the basin or subbasin; and (5) the possibility of pollution of the basin or subbasin from natural sources.[244]

The maximum annual yield of fresh ground water to be allocated to each acre of land overlying the basin is then determined and is based on a minimum basin life of twenty years. This means that at the end of twenty years, ground water wells on fifty percent of the land area overlying the basin would not be able to pump the equal proportionate share.[245]

As can be seen, the rate of natural recharge is a factor in setting the maximum annual yield of a ground water basin. It could be inferred then that amounts of artificial recharge water should not be included in the yield and therefore not allocated under the permit system. However, the definition of "ground

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[242]Information supplied by Oklahoma May 1, 1990.

[243]Id.

[244]OKLA. STAT. tit. 82, § 1020.5.

[245]Information supplied by Oklahoma May 1, 1990.

water" and "fresh water" as used in the Ground Water Law does not distinguish between artificial and natural water. At least until the yield determination is made, it appears that the Board should issue permits to withdraw the ground water, whether the basin has been artificially recharged or not.[246]

Legally in Oklahoma, ground and stream water are separate types of water with respect to appropriation and management. Oklahoma officials recognize artificial recharge as a beneficial use of surface water, and the Board may issue permits to use surface water for artificial recharge underground. At least one surface water appropriation permit for recharge has been issued in Oklahoma. The usual requirements to obtain an appropriation permit were followed.[247] The only protection for the recovery of recharged ground water is by the normal permitting process under state law.[248]

In making an application to appropriate recharged water, the individual or entity that has initiated the recharge may request a permit to withdraw the amount "believed to be reasonably recharged."[249] This estimate is made by the permit holder and reported annually to the Water Resources Board. The Board believes that generally there is adequate information regarding ground water resources in Oklahoma for the state to rule on applications to withdraw recharged water. The permit applicant must provide adequate evidence to demonstrate he is capable of recharging the amount of water he wishes to withdraw and that the

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[246] Id.

[247] Id.

[248] Oklahoma response to WSWC State Ground Water Recharge Questionnaire, November 20, 1989.

[249] Id.

water is both available from a surface water source (to support the initial appropriation) and that the water has been recharged to an underground source and is now available for withdrawal. Upon an adequate showing, the Board could grant the sponsor a recharge project a permit to withdraw the recharged ground water.[250]

The Water Resource Board's interest in protecting the quality of the ground water in the state is accomplished under the Pollution Remedies Act.[251] Any recharge project in Oklahoma would have to comply with the requirements of this Act. The Oklahoma State Health Department regulates Class V injection wells under the state underground injection control program. Ground water recharge wells are classified as Class V injection wells, and must meet all applicable regulatory requirements.[252]

Oklahoma state officials do not believe the federal critical aquifer protection area program provides any significant added protection to ground water recharge areas. Also, water quality monitoring of recharged wells is generally not required. In some instances a minimal amount of monitoring is mandated by state statutes and regulations. There is no evidence of the need for any additional monitoring.[253]

Oklahoma officials view their authority under existing statutes and regulations as sufficient to deal effectively with issues related to ground water recharge. Comprehensive ground

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[250] Id.

[251] OKLA. STAT. tit. 82, §§ 926.1-926.10.

[252] Oklahoma response to WSWC State Ground Water Recharge Questionnaire, November 20, 1989.

[253] Id.

water recharge legislation, they believe, is probably not needed at the present, and there would probably be little chance of enacting such legislation.[254]

Oregon

A section of Oregon's water laws pertains specifically to ground water recharge.[255] The law requires a permit to appropriate water for the purpose of artificially recharging a ground water aquifer. Such recharge is considered a beneficial use of water.[256] The law also requires the proponent of a recharge project to obtain a "secondary permit" to withdraw the artificially recharged water. Some measure of protection is afforded the recharger in that no one may make appropriation of artificially recharged water without first getting the recharger's written approval. According to state officials Oregon's ability to protect the recharged water, however, is not foolproof.[257]

There is no requirement that artificial recharge be conducted only in areas closed to new development of naturally occurring ground water. Where there is naturally available ground water in an artificially recharged aquifer, the state continues to issue rights to the naturally available water. In the view of state officials, it may be difficult to determine exactly when that supply is fully appropriated, with the result

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[254] Id.

[255] OR. REV. STAT. § 537.135.

[256] Technically, such recharge is considered an appropriation for a beneficial purpose, which some state officials would argue is synonymous with "appropriation for beneficial use."

[257] Oregon response to WSWC State Ground Water Recharge Questionnaire, October 2, 1989.

that the permitting process may proceed and permits may be issued that result in inadvertent consumption of artificially recharged water. Of course, in areas where further development of naturally occurring ground water has been prohibited, the problem would not exist.[258]

Before the recharge permit may be issued, the Oregon Water Resources Commission must determine whether the project would prejudicially affect the public interest in the state. Further, the Commission may not issue a recharge permit unless the surface water source has a minimum perennial streamflow established for the protection of aquatic and fish life. The state Department of Fish and Wildlife may waive this requirement if it decides that the minimum perennial streamflow for protection of aquatic and fish life is not needed in the supplying stream.[259]

Oregon law directs the Water Resources Commission to develop standards that an applicant must meet before the Commission may approve a ground water recharge permit.[260] The Water Resources Department has issued accompanying administrative rules.[261] These rules require an applicant to submit information to assist the commission in making public interest determinations concerning a proposed project. Also, certain attachments must accompany a permit application. They include: (1) proof that the supplying stream has a minimum perennial stream flow; (2) a copy of necessary water quality permits; (3) a description of the ultimate use or value of the ground water recharge; (4) a

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[258]OR. REV. STAT. § 537.135.

[259]Id.

[260]Id.

[261]Oregon Water Resources Department Administrative Rules, Chapter 690, Division 11, § 690-11-085.

description of the volume of water expected to be stored; (5) if the recharged diversion is for 5 cfs or more, proof of financial capability to construct and operate the project; (6) proof that the proposed recharge project is hydrologically feasible; (7) a copy of plans for recharge project construction, operation, and costs; and (8) any additional information that would assist the Commission in making its public interest determination regarding the project.[262]

Any permit that is issued must address the following: (1) the maximum diversion rate and annual maximum diversion volume; (2) metering of recharged water from the diversion source and at the place of recharge; (3) requirement of accurate and current records of metered values, water levels, and other pertinent information; and (4) the response of water levels in wells.[263] The administrative rules also require a permit to specify the formula to determine the availability of artificially recharged ground water for appropriation based upon negotiations between the applicant and the department or a definitive ground water investigation. The department must record its final determinations on stored recharged water in a storage account ledger. The permittee must submit the annual report to both the department and any secondary permittee. If, under the actual operating conditions of a recharge project, the director notifies the permittee that the director has reason to believe there are adverse ground water quantity or quality effects of a project, the permittee is required to cease recharge activities and make no further diversions until measures to prevent, correct, or

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[262] Id.

[263] Id.

monitor the adverse effects have been agreed to and implemented.[264]

With respect to "secondary ground water permits," the following must be provided: (1) identification of an artificially recharged ground water reservoir as a source of supply; (2) written consent of the holder of the recharge permit or certificate; (3) proof that the proposed use will actually be from the recharged reservoir; and (4) a copy of the valid recharge certificate or permit.[265] The rules require limitations on secondary ground water permit approval as follows. During the first five years of recharge cumulative secondary permits to no more than 85% of a project's permitted annual recharge volume may be issued. Subsequent permits may exceed 85% in some instances. A secondary ground water permit must address the following: (1) maximum diversion rate; (2) metered withdrawal; (3) measured water levels; (4) current and accurate records of withdrawals and water levels; (5) an annual report noting withdrawals, dated water levels, and other data pertinent to the storage account; and (6) any other conditions specified by the director.[266]

In Oregon, artificial recharge can be used to store water in times of "surplus" for later use. This form of conjunctive use, according to state officials, increases the total quantity of water available for beneficial use. However, it may do so at the expense of surface flows when direct use of those flows may be more efficient. Permit conditioning may mitigate this concern. Artificial recharge using winter "surplus" water may result in the delayed and slow movement of runoff out of drainage basin.

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[264] Id.

[265] Id.

[266] Id.

This, in turn, may result in streamflows later in the year that are somewhat enhanced over what would otherwise be present as some of the artificial recharge discharges to surface waters. This aspect of conjunctive water management is attractive and beneficial, at least with respect to the surface waters, as long as the recharge project is in operation. However, if the project ceases for any reason, the parties and interests that have become accustomed to or dependant upon the resultant enhanced surface flows will be adversely impacted. In Oregon, there is no legal means to require continued project operation on behalf of those who have so benefited.[267] Similarly, some artificial recharge occurs incidentally by way of leaky canals and distribution systems. Those who have become the beneficiaries of that recharge are also without recourse, state officials note, when the leakage is reduced or eliminated.[268]

The potential exists in Oregon, according to state administrators, for using artificial recharge to improve the supplies of water available for beneficial use. Storing surface water for later use under a secondary ground water right could improve the lot of several surface and ground water appropriators in at least one region of the state. To take advantage of available technology, however, state officials believe there needs to be a statutory change to allow a water right holder in Oregon to shift from appropriating surface water to appropriating ground water, without losing priority. Such a statutory change has not yet been seriously considered in Oregon. In other areas of the state, the concept of storing water for a later appropriation as ground water can be used to good advantage

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[267]Oregon response to WSWC State Ground Water Recharge Questionnaire, October 2, 1989.

[268]Id.

without any statutory change.[269] Unresolved impediments to recharge include funding, public perceptions about the ultimate fate of recharged water, and the relative merits of ground water recharge versus instream values. Also, in Oregon there is a need to better educate the public concerning ground water. According to state administrators, much of the public still views ground water as something mysterious, or otherwise unknowable. This breeds distrust of artificial ground water recharge and accusations of waste whenever recharge is mentioned as a water supply alternative.[270]

Oregon law does not define "ground water mining." The state's ground water management philosophy as expressed and implied in statute, however, is contrary to the concept of mining ground water. Statutory policy states that ground water should be "...beneficial(ly) use(d) without waste, within the capacity of available sources..."[271] Additionally, Oregon statues clearly authorize, or require, corrective action when overdraft of ground water impends or occurs. Overdraft has been defined in administrative rule as production of water at a rate faster than recharge occurs. Under certain circumstances, ground water recharge offers an opportunity to avoid ground water mining while at the same time pursuing optimum ground water use.[272]

Ground water recharge has not affected interstate agreements in Oregon, nor is it likely to be a factor with respect to those agreements in the future. Some issues have arisen concerning

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[269] Id.

[270] Id.

[271] OR. REV. STAT. § 537.525(3).

[272] Oregon response to WSWC State Ground Water Recharge Questionnaire, October 2, 1989.

federal reserved rights for Indian reservations. State officials report that the Confederated Tribes of the Umatilla Indian Reservation have expressed concern over the two current recharge projects in Oregon. They are also concerned with the recently modified Umatilla Basin Plan, which classifies much of the Basin's water as available for, among other things, artificial ground water recharge.[273]

The Oregon Department of Environmental Quality administers the underground injection control program in the state. By memo of understanding with the Department of Water Resources, the Department of Environmental Quality controls recharge in accordance with the Underground Injection Control program. This is done through permit conditions developed by the Department of Environmental Quality for inclusion in water rights and/or permits necessary for a recharge project. This arrangement results in the issuance of permits with conditions agreeable to both departments. The Department of Water Resources then regulates the project to assure compliance with Department of Environmental Quality's water quality conditions.[274]

In 1989 the Oregon Department of Environmental Quality adopted a ground water protection policy.[275] That policy declares the need to protect ground water from degradation, although the policy is not based strictly upon non-degradation. The policy requires use of best practicable technology and best management practices wherever ground water quality is at risk. It guides the department's decisions, practices, and permits related to any

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[273] Id.

[274] Id.

[275] Oregon Administrative Rules 340.40.

activities affecting air, land, or water quality, that in turn impact ground water quality.

Also, Oregon's land use goals target ground water protection. They require land use planning at the local (county) level to inventory and protect ground water.[276] Oregon officials expect that improvement in its interagency coordination may provide a vehicle for generating ground water recharge protection by way of land use plans or zoning. Further, some forest plans currently under review in Oregon take into account ground water recharge[277]generally. They provide some protection in terms of restrictions on land use and forest management activities.[278]

In Oregon, the quality of the water used to recharge an aquifer must not degrade ambient ground water quality. In most cases, natural ground water quality is superior to surface water quality. Recharge permits may contain a permit condition requiring the treatment of artificial recharge water to bring it to ambient ground water quality. This could create a burden on recharge permittees such as to effectively prevent artificial recharge. State officials believe that potential, future advances in technology may allow large volumes of water to be treated at a cost low enough that recharge permittees can still afford to operate recharge projects.[279]

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[276]OR. REV. STAT. §§ 197.225 et seq.; Oregon Administrative Rules 660.

[277]This is accomplished under authority of Oregon Governor's Executive Order EO-87-09 and OR. REV. STAT. §§ 536.450 and .460.

[278]Oregon response to WSWC State Ground Water Recharge Questionnaire, October 2, 1989.

[279]Id.

Oregon state administrators do not believe that a comprehensive ground water recharge statute is necessary. Current statutes allow artificial recharge and protect use of recharged water through the surface water rights system.[280]

South Dakota

South Dakota is in its infancy in using artificial means of recharge to augment ground water resources. The Department of Water and Natural Resources has jurisdiction over the few ground water recharge activities that have occurred. The state has no ground water recharge statutes. However, ground water recharge is recognized as a beneficial use[281] of water in South Dakota providing the recharge activity does not degrade existing ground water quality.[282] Generally, state appropriation and water quality laws would be applied by the State Water Management Board to regulate any ground water recharge project in the state.[283] The state, however, does not issue ground water recharge permits. Rather, a permit to use surface water for recharge would be issued under the general appropriation statutes.[284] South Dakota does not have any measuring or reporting mechanism for recharged waters. The state can offer protection to a recharge project sponsor to retain an exclusive right to withdraw recharged ground

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[280] Id.

[281] S.D. COMPILED LAWS ANN. § 46-1-6(6).

[282] Administrative Rules of South Dakota (hereafter referred to as ARSD) Chapter 74:03:15, Ground Water Quality Standards adopted pursuant to S.D. COMPILED LAWS ANN. §§ 34A-2-93, 34A-2-10 and 34A-2-11.

[283] S.D. COMPILED LAWS ANN. § 34A-2, Water Pollution Control; § 34A-3A, Safe Drinking Water; and §§ 46-1, 46-2A and 46-5, Water Rights Laws.

[284] Id. §§ 46-1-15, 46-2-9, 46-5-9, and 46-5-10.

water as part of the approval and qualification of a permit to appropriate surface water for the recharge project.[285]

South Dakota law addresses ground water "mining" in the following manner:

> No application to appropriate ground water may be approved if according to the best information reasonably available, it is probable that the quantity of water withdrawn annually from the ground water source will exceed the quantity of the average estimated annual recharge of water to the ground water source...[286]

Although South Dakota Law prohibits "mining" there is no legal or hydrological reason that a quantity of water equal to the amount recharged could not be withdrawn from an aquifer that the Board determines is being "mined." However, any recharge project would probably be conducted in an aquifer that was not being "mined," but rather when lower water levels resulted from drought pumping and lack of normal recharge. For example, one city in South Dakota has been issued a permit to pump surface water into an old by-pass channel to recharge a shallow sand and gravel aquifer that has low water levels due to drought condition pumping. Normally, the aquifer receives recharge each spring from flood flows.[287]

There is no differentiation under South Dakota law between ground water artificially recharged and ground water recharged from a natural storm event. There is no case law on artificially recharged or "developed water". Notwithstanding this paucity of law, there appears to be sufficient information to make

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[285] Id. § 46-1-14.

[286] Id. § 46-6-3.1.

[287] Information supplied by South Dakota April 20, 1990.

administrative decisions with respect to aquifer recharge projects in South Dakota.[288]

The South Dakota Division of Water Rights does not expect that interstate water compacts or allocations nor federal reserved rights would affect or be affected by ground water recharge activities.[289]

There may be some problems of water availability and water quality relating to conjunctive use of recharged water in South Dakota. The state could prohibit any ground water recharge activity that includes the injection of hazardous waste or degrades the existing water quality so it could no longer support the beneficial use for which it was classified.[290]

South Dakota has underground injection control regulations but does not have delegation of the federal underground injection control program.[291] Any injection of recharged ground water made in violation of state regulations would be prohibited by the state. The state has wellhead protection legislation that allows local units of government to develop wellhead protection areas.[292] The state has prioritized those areas for its regulatory efforts. The department must develop procedures to safeguard public health and welfare and prevent pollution of public water supply systems

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[288]South Dakota response to WSWC State Ground Water Recharge Questionnaire, October 1, 1989.

[289]Id.

[290]ARSD Chapters 74:03:15 and 74:03:16, adopted pursuant to S.D. COMPILED LAWS ANN. § 34A-2.

[291]ARSD Chapter 74:03:12, adopted pursuant to S.D. COMPILED LAWS ANN. § 34A-3A.

[292]S.D. COMPILED LAWS ANN. § 34A-3A-17.

and must develop a voluntary wellhead protection program specifying the guidelines for the general program, the duties of the department and local governments, the method for determining the extent of wellhead protection areas, and all potential and actual pollution sources to those areas. It must take into consideration potential sources of pollution when siting new wells and develop contingency plans for pollution release containment and cleanup. Any ground water recharge activity would be required to comply with these rules, protect the beneficial use of existing water, and the appropriation permit would have to assure that recharge activities are in the public interest.[293]

Except for the example cited, South Dakota state officials believe artificial ground water recharge efforts may not be understood by many residents and may be viewed a potential cause of contamination. Because of this, other water supply management alternatives are seen as more favorable. Ground water recharge, however, may be necessary in the future as ground water resources become fully appropriated. For this reason research is necessary to closely monitor the effects of artificial recharge. This could lead to an education process that will likely make recharge more acceptable in certain situations, when accompanied by close monitoring.[294]

Currently, South Dakota officials do not see the need for comprehensive ground water recharge legislation. They believe the present ground water protection laws provide the state regulatory authority to prohibit activities that constitute a

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[293]ARSD 74:03:15 and 74:08:16; and S.D. COMPILED LAWS ANN. § 46-2A-9.

[294]South Dakota response to WSWC State Ground Water Recharge Questionnaire, October 1, 1989.

menace to public health, welfare, or the environment. State officials believe it is premature to speculate on the chance of enactment of comprehensive legislation.[295]

Texas

The law governing ground water resources in Texas is different from the other western states. Texas basically follows a common law ground water doctrine known as the absolute ownership rule. This doctrine provides that ownership of ground water is incident to ownership of overlying land. Thus, ground water is considered a privately owned resource, subject to disposition at the unfettered will of the owner. However, there are some exceptions to the absolute ownership rule.[296]

Under the authority of the 1917 Conservation Easement,[297] the Texas Legislature enacted Chapter 52 of the Texas Water Code.[298] The code authorizes and establishes the procedures for the creation of underground water conservation districts. It also sets forth the various powers of a district to regulate, conserve, or manage the ground water supply.

In addition to the creation of districts under Chapter 52 for the management of ground water, districts may be created by special acts of the Texas Legislature, and they may include powers of Chapters 50 and 51 of the Texas Water Code.

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[295] Id.

[296] Texas response to WSWC State Ground Water Recharge Questionnaire, October 31, 1989.

[297] See TEXAS CONST. art. XVI, § 59.

[298] See TEXAS WATER CODE ANN. ch. 50, 51, & 52 (Vernon Supp. 1988).

In 1975 the Texas Legislature created the Harris-Galveston Coastal Subsidence District[299] to regulate ground water withdrawal to control subsidence. The statute requires a well owner to obtain a permit from the district before a well can be operated. Necessary restriction can be imposed on the well owner and a fee collected for the permit.

Texas has no ground water recharge or conjunctive use statutes. However, the state recognizes ground water recharge as a beneficial use of surface water.[300] Texas believes that any artificial ground water recharge that might occur within the state would be by sediment beds, on-channel impoundment (in place or subsequent release) or underground injection of surface water or wastewater. In any case, a permit from the Texas Water Commission would be required. A diversion permit would be necessary in the case of surface water and a wastewater discharge permit in the case of wastewater.[301] Special regulations would apply to any recharge activity in the Edwards Underground Aquifer.[302]

Recharged waters in Texas are gauged and/or metered. Since ground water is privately owned, there would be no limit on the amount an individual could withdraw, as long as the water pumped was not wasted and the pumpage caused no water quality deterioration. Texas does not require a permit to appropriate

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[299] See Act of May 22, 1975, ch. 284, 1975 Texas Gen. Laws.

[300] Texas response to WSWC State Ground Water Recharge Questionnaire, October 31, 1989.

[301] See TEXAS WATER CODE ANN., Ch. 11 and 26 (Vernon Supp. 1988).

[302] See id. § 11.023 (ctd.) (Vernon Supp. 1988).

artificially stored ground water and, as noted, would provide no legal protection to a project sponsor to recover recharged ground water. Nevertheless, the state encourages the recharge of surface water into aquifers because it affords opportunities to save considerable water that would normally evaporate. Since ground water is privately owned in Texas, a recharge project sponsor must obtain ownership of overlying land or contractually obtain water rights from the owner of the land in order to recover recharged ground water.[303]

To obtain the right to use surface water to recharge an aquifer, a project sponsor would be expected to prove that his recharge project was feasible, that water is available for appropriation, that there would be no impact on existing water right holders, that it would not create a public nuisance, and that it would cause no deterioration of ground water quality.[304] The major problem which has surfaced in Texas when surface water has been used for ground water recharge is that surface water usually contains silt, which has a tendency to clog the pores of a ground water aquifer. This problem could be solved by requiring surface water to be filtered before it is injected into aquifers. Injection recharge activities in Texas are regulated by the state's underground injection control statute, which requires the state to govern the underground injection of all types of fluid.[305] Any ground water recharge project involving injection wells would have to conform to this statute.

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[303]Texas response to WSWC State Ground Water Recharge Questionnaire, October 31, 1989.

[304]Id.

[305]See TEXAS WATER CODE ANN. § 27.011 (Vernon Supp. 1988).

Texas encourages the formation of underground water conservation districts to protect and conserve ground water. Ground water withdrawal may be regulated by underground water conservation districts or special law districts. Texas law does not differentiate between naturally and artificially recharged ground water and state officials have defined no direct relationship between ground water mining and ground water recharge.[306]

Texas views ground water recharge wells as Class V injection wells and regulates the wells accordingly. Where ground water recharge would degrade ground water quality, the state could refuse to issue an injection permit or approval. There are currently no controls related specifically to ground water recharge other than the UIC regulations.[307]

Texas officials do not believe that comprehensive ground water recharge legislation is necessary at the present time. They see chances of enactment of such legislation as very slim in the foreseeable future.[308]

Utah

Utah has little practical experience with ground water recharge projects, and therefore the body of law related specifically to ground water recharge is meager. A 1984 Executive Order affirms:

> The Division of Water Resources and the State Engineer shall encourage conjunctive use operations where more

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[306]Texas response to WSWC State Ground Water Recharge Questionnaire, October 31, 1989.

[307]Id.

[308]Id.

> efficient use of the water resource can be demonstrated and the natural stream environment will not be unreasonably impaired, and the Board of Water Resources shall promote such operations through technical and financial assistance.[309]

In the view of state officials, extensive implementation of conjunctive use, including ground water recharge, would have positive benefits. It would extend, in many instances, the water supply by allowing an entity to use surface water during high water years to recharge ground water so that the recharged water could be used in times of drought. There could be some localized negative effects related to excessive drawdowns during drought periods and perhaps some mitigation would have to be provided in those instances. Utah has an interest in regulating and promoting ground water recharge to ensure such activities are conducted in accordance with state law and do not adversely impact other rights, with regard to either quantity of quality. Also, the state wants to encourage and promote projects that can have a positive impact on the future availability and management of water supplies in the state.[310]

Utah law does not specifically recognize ground water recharge as a beneficial use of water. State officials, however, believe that it could likely be included by implication within the statute that defines beneficial water use as any public use.[311] Further, state officials believe that water that is

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[309]Executive Order on Utah Ground-Water Policy, October 4, 1984.

[310]Utah response to WSWC State Ground Water Recharge Questionnaire, October 14, 1989.

[311]UTAH CODE ANN. § 73-1-5.

recharged is likely to be put to some beneficial use that would be recognized under Utah law.[312]

Utah has issued no ground water recharge permits, and has established no mechanism to measure or account for recharged ground waters. The means exists to issue permits for recharge projects under the state underground injection control program and the state ground water protection programs. Although the state has established no process to appropriate artificially stored ground water, it appears to state officials that ground water recharge projects must have valid water rights to recover recharged waters, and that water might be recharged under existing water rights or from unappropriated sources in some instances. Any effort to recharge water would have to be evaluated on a case-by-case basis. Once a water right has been established to use surface water for recharge purposes, the permit for regulating recharged water would be similar in either case. Utah does not differentiate between naturally and intentionally recharged ground water.[313]

For the majority of ground water basins in Utah there is sufficient information available to make sound decisions concerning the administration of ground water recharge activities. The state has computer models for most of the major ground water basins. These would assist in the analysis of the effects of recharge projects. Undoubtedly, additional site specific data would be required from some project sponsors.[314]

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[312]Utah response to WSWC State Ground Water Recharge Questionnaire, October 14, 1989.

[313]Id.

[314]Id.

There is no law in Utah defining or prohibiting ground water mining. In 1984, the state adopted a ground water policy that indicated ground water mining could be allowed in certain instances when it is determined to be in the best interest of the state.[315] Generally, Utah does not encourage or allow ground water mining, and currently mining has not necessarily led to construction of artificial ground water recharge projects to augment supplies. Utah believes that the interstate compacts to which it is a party would, under appropriate circumstances, allow recharge projects within their present framework.[316]

Utah regulates all injection wells in the state, and any ground water recharge accomplished by injection would be regulated under the state underground injection control program. Injection wells are regulated by different state agencies depending on the type of well. For example, the Division of Oil, Gas and Mining regulates oil and gas injection wells, the Division of Water Rights regulates geothermal injection wells, and all other injection wells are regulated by the Division of Environmental Health. Ground water recharge wells would be regulated as Class V injection wells by the Bureau of Water Pollution Control.[317]

Also, other ground water quality statutes and regulations could apply to a ground water recharge project. Utah could prohibit a recharge project, through state ground water or UIC

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[315]Executive Order on Utah Ground-Water Policy, October 4, 1984.

[316]Utah response to WSWC State Ground Water Recharge Questionnaire, October 14, 1989.

[317]The underground injection control program is carried out under the authority of the Utah Water Pollution Control Act, UTAH CODE ANN. §§ 26-11-6(9) and 8(2).

regulations, if the project had the potential to cause water quality problems. Water quality issues and the compatibility of ambient ground water and injected surface water are regulated by UIC and ground water programs.[318]

The Utah water pollution control committee recently adopted regulations to protect the quality of ground water in the state. The regulations would apply to recharge projects and land use activities related to the projects. In the ground water regulations there are several provisions that regulate ground water recharge based upon criteria intended to protect the quality of the aquifers in the state. Where these criteria are not met, a recharge project would be prohibited. Any recharged water would have to meet water quality criteria before it could be recharged.[319]

Utah has identified three significant obstacles affecting implementation of ground water recharge projects in the state. They are water quality concerns, legal control of recharged water, and economic feasibility. Currently the relatively low cost of alternative supplies in most areas of the state precludes consideration of artificial recharge as a viable water supply alternative.[320]

Utah has several ongoing studies in conjunction with the U.S. Geological Survey to identify ground water recharge areas in the four most populous counties of the state. Utah is interested in ground water recharge, but no legislation specifically

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[318]Utah response to WSWC State Ground Water Recharge Questionnaire, October 14, 1989.

[319]Id.

[320]Id.

regulates such activity. The state supports the water quantity aspects of ground water recharge projects and believes they can have positive impact on the future availability and management of water supplies in the state. Utah has actively participated in the High Plains States Ground Water Recharge Program because it believed that the program was an opportunity to develop the necessary experience, background, and institutional structure to address artificial ground water recharge.[321]

In the opinion of state water officials, Utah needs to enact legislation to regulate and promote ground water recharge. Such legislation would have a good chance of passage.[322]

Washington

Washington does not have specific ground water recharge legislation, but the state has authority to regulate ground waters of the state, including recharge activities.[323] The law makes a clear distinction between naturally occurring ground waters and artificially stored ground water. The latter is defined as "water that is made available in underground storage artificially, either intentionally, or incidentally to irrigation and that otherwise would have been dissipated by natural waste."[324]

This definition specifically refers to water occurring "incidentally to irrigation." It is not clear how the law should be interpreted to address waters artificially stored but

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[321] Id.

[322] Id.

[323] WASH. REV. CODE § 90.44.060.

[324] Id. § 90.44.035 (5).

incidental to non-agricultural activities. This could pose problems for municipal recharge projects in the future and may require statutory changes.

Washington law allows for conjunctive use of surface and ground waters. Although there is no specific statutory reference to conjunctive use, the ground water code clearly allows for use of waters which are artificially stored in aquifers and declares that all such waters which have been abandoned or forfeited are public ground waters and are subject to appropriation for beneficial use.[325]

In order to administer the waters of a given area, the state, through the Department of Ecology (Ecology), may designate ground water areas or subareas. The establishment of such areas provides administrative control over ground water withdrawals for the purpose of controlling overdraft. Ecology may establish depth zones to enclose a single and distinct body of public ground water.[326]

The creation of a ground water area or subarea may be proposed by Ecology or by one-fourth of the water users in the proposed area, whichever is less and is accomplished through a process including public notice and culminating with a written order by Ecology establishing the area or subarea.

Once established, priorities of rights are established separately for each area. Within 90-days of designation, any claims for ownership of artificially stored water then stored must be submitted to Ecology. Thereafter, claims for waters

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[325] Id. § 90.44.040.

[326] Id. § 90.44.130.

being stored must be made within 3 years of the earliest artificial storage. These claims must include information about the water use, including evidence of storage due to action by the claimant. Ecology must then either accept or reject the declaration. Acceptance does not convey any right to the claimant to withdraw public ground waters nor to impair any existing rights to such public waters.[327] Any subsequent withdrawals must have a declaration of ownership for the waters to be withdrawn.[328]

Ecology may convene a public hearing (or may be petitioned to do so) to determine whether the water supply in the area is adequate for the current needs of all such holders. If the department finds supplies are not adequate, it may order the aggregate withdrawal decreased so it does not exceed the available supply. This decrease shall conform to the priority of rights established within the area (i.e. first in time, first in right) except that, by mutual consent of the water users and the Department, the reduction in aggregate water use may be accomplished by the waiving of all or some specified part of a senior right in favor of a junior right. However, when such agreements are reached, the relative priorities of such rights are unchanged.[329]

In order to properly manage the ground waters in a designated area, the department may appoint ground water area

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[327]"Public Ground Waters" are defined, generally, as all natural ground water and all artificial ground water that has been abandoned or forfeited. Id. § 90.44.040.

[328]Id. § 90.44.130.

[329]Id. § 90.44.180.

supervisors to supervise the withdrawal of ground waters within that area.[330]

The state requires a water right for all surface water diversions and for the storage of water in reservoirs. A water right permit is also required for the diversion of stored water from a reservoir.[331] Generally, the state requires a water right permit for all withdrawals of ground water. Washington allows the recharge of ground water for subsequent withdrawal for beneficial uses. For a ground water recharge project involving the diversion of surface water to be stored in an aquifer, the following water right permits would be required: (1) a permit for the diversion of the surface waters; and (2) a permit for the withdrawal of the stored ground water.

Any permit issued would contain provisions to provide for measuring and reporting artificially recharged waters. This would be accomplished under existing ground water law.[332] Additionally, authority is contained in a separate regulation adopted by Ecology,[333] which establishes a permit system for the withdrawal and use of ground waters consisting of commingled artificially stored ground water and public waters located in established ground water area, subareas, or zones.

In addition to the concerns related to water quantity, there are a number of water quality considerations associated with ground water recharge projects. Under the state Water Pollution

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[330] Id. §§ 90.44.200, 90.03.060, and 90.03.070.

[331] Id. § 90.03.260.

[332] Id. § 90.44.050.

[333] WASH. ADMIN. CODE Chs. 173-136.

Control Act,[334] it is unlawful to pollute waters of the state, including ground water. Pollution or contamination means the physical or chemical alteration of the receiving water which results in impingement of the beneficial uses of the waters.[335] Any party injecting or recharging ground water must notify Ecology.[336] Recharge of ground water with potable surface water would not be subject to the water pollution control laws if the recharge water has no adverse physical or chemical effects on ground water.

Injection of waste fluids into ground water is prohibited.[337] Injection of uncontaminated stormwater is allowed.[338] Injection well owners are required to notify Ecology.[339]

Physical or chemical changes to the ground water quality will be measured against Washington's draft proposed ground water quality standards.[340] The standards will be used to determine compliance with water pollution control laws. Such an assessment would also be used to determine whether stormwaters are considered to be contaminated.

If the injectate (fluid) does not change the water quality and does not violate the ground water quality stands, Ecology may

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[334] WASH. REV. CODE § 90.48.080.

[335] Id. § 90.48.020.

[336] WASH. ADMIN. CODE Ch. 173-218-090(3).

[337] Id. Chs. 218-050(1) and 173-218-090(1).

[338] Id. Ch. 173-218-030(17)(b).

[339] Id. Ch. 173-218-090(3).

[340] Id. Ch. 173-200.

require the discharger to obtain a state waste discharge permit.[341]

Washington officials believe that sufficient information is generally available to support administrative actions relating to ground water recharge projects although conditions vary on a case-by-case basis. Washington could prohibit such projects if they adversely affect: (1) existing water rights; (2) instream flows; (3) quality of the receiving waters; (4) in situations where water withdrawals exceed permitted recharge volume; or (5) if, for any reason, a water right permit is denied.[342]

A recharge project sponsor is expected to demonstrate: (1) recharge effects on basin hydrology (2) availability water for recharge; and (3) impacts, or lack of impacts, on other beneficial uses and water quality.[343]

Wyoming

Wyoming has little practical experience with ground water recharge projects, but is nevertheless interested in ground water recharge as a potential alternative to traditional water development projects.[344]

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[341] Id. Ch. 173-216.

[342] Washington response to WSWC State Ground Water Recharge Questionnaire, September 18, 1989.

[343] Id.

[344] Wyoming response to WSWC State Ground Water Recharge Questionnaire, September 15, 1989.

There are no recharge projects currently functioning in Wyoming. Hence, the state has issued no permits and taken no formal action regarding ground water recharge. Currently, ground water recharge is not considered a beneficial use of water. However, when faced with a viable project, Wyoming would probably recognize ground water recharge as a beneficial use subject to a permitting procedure that would involve testing, measuring, and reporting recharge of ground water. There would also likely be some accounting procedures, along with requiring a project sponsor to collect physical data from observation wells and water sources to be utilized as the basis for allocation. The differentiation between recharge from water sources derived from existing facilities, reservoirs, and streams, and storm water events, would probably be required to ensure that prior appropriators were not injured.[345]

In areas of Wyoming where large quantities of ground water are used for irrigation, adequate information on ground water systems exists and would support administrative decisions regarding ground water recharge projects. Wyoming law is unclear concerning whether a ground water recharge project sponsor could be protected in the exclusive right to use recharged ground water.[346]

Wyoming water law does not specifically prohibit mining of ground water. According to state officials, however, such a prohibition may be inferred from state law.[347] There is no statutory definition of mining. With respect to conjunctive use,

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[345] Id.

[346] Id.

[347] Wyoming response to WSWC State Ground Water Recharge Questionnaire, September 15, 1989.

Wyoming law dictates that priority of appropriation is the measure by which water is apportioned in areas where "underground waters and the waters of surface streams are so interconnected as to constitute in fact one source of supply."[348]

In most areas in Wyoming where large-scale ground water pumping occurs, there is little surface water available. Thus, conjunctive use considerations offer few opportunities for success with respect to ground water recharge, while ground water recharge might be available, in some instances, to help alleviate problems with ground water mining.[349]

Water quality parameters under Wyoming water pollution control statutes[350] could preclude the use of poor quality ground water for recharge activities. The Water Quality Division of the Wyoming Department of Environmental Quality would make such determination. Further, if ground water recharge were to be accomplished by injection wells, the Water Quality Division would also have to issue an underground injection control program permit.[351]

Wyoming state officials believe the state needs comprehensive ground water recharge legislation and that current conditions may be favorable for its enactment.[352]

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[348] WYO. STAT. § 41-3-916.

[349] Wyoming response to WSWC State Ground Water Recharge Questionnaire, September 15, 1989.

[350] See WYO. STAT. §§ 35-11-301 to 304.

[351] Wyoming response to WSWC State Ground Water Recharge Questionnaire, September 15, 1989.

[352] Id.

FINDINGS AND RECOMMENDATIONS

In conclusion, the following findings and recommendations have been drawn from the state responses to our questionnaire, the work group review meeting, state comments on the draft report, and our observations regarding ground water recharge in the West.

1. Conjunctive use of surface and ground water resources is essential to efficient water management and maximum beneficial use. Ground water recharge projects and programs should be considered as part of a comprehensive water management plan.

2. Ground water recharge project effects are very site-specific. Therefore, management decisions must be based on a careful analysis of a particular problem and a specific project's purposes. Augmenting water supplies, which is mainly a private or local government responsibility, is the primary purpose for most recharge projects.

3. Ground water recharge activities in the West will increase in response to increasing water demands, particularly given their advantages in addressing some specific problems. In some states, such as Arizona, California, Colorado, Nevada and Texas, ground water recharge is already an important means of maximizing water use efficiency.

Elsewhere, there are few recharge projects, in part due to the availability and success of other water management alternatives. The increased level of interest in recharge activities (in these areas) generated by the Bureau of Reclamation's demonstration program is unlikely to continue in the absence of further federal program support.

4. In evaluating alternative water projects, including ground water recharge projects, benefit/cost ratios should be carefully calculated to include (to the fullest extent practical) all costs and benefits, particularly social opportunity costs and benefits, such as environmental values and instream water uses. The development of accepted standards of measurement for such costs and benefits would facilitate public and private decisionmaking.

5. Substantial uncertainty surrounds the feasibility of some ground water recharge projects. Therefore, early in the project analysis, allowances should be budgeted for anticipated and unanticipated costs. Costs and anticipated benefits must be carefully monitored throughout project investigation, construction, testing, and operation. If either change substantially, the benefit/cost ratio should be reevaluated. Then, a decision can be made on whether or not to proceed with the project, or seek another alternative.

6. There is an appropriate role for the federal government in ground water recharge activities that involves technical and financial support, particularly with respect to water resources research and data collection programs. The federal government should continue to fund cooperative ground water resource investigations and research that focuses on specific problems in order to facilitate decisionmaking.

7. Further, upfront capital financing is a problem for many ground water recharge project sponsors. This may be an appropriate area for reimbursable federal financial assistance. However, non-reimbursable federal cost sharing or subsidies are only appropriate when there is a legitimate federal interest in a specific project or program purpose. The Small Reclamation Projects Act loan program and Reclamation Fund might be an appropriate means and source for federal financing.

8. Project purposes or benefits which may justify federal cost sharing include flood control, environmental and fish and wildlife enhancement, reserved rights uses, public health, water quality improvements, endangered species recovery, and international treaties. Non-federal cost sharing requirements have been defined politically, by statute, for some federal project purposes. These requirements may serve as a guide for federal participation in future ground water recharge projects.

9. In order to promote economic efficiency and equity, cost sharing and financing agreements should be designed so that beneficiaries pay project costs. Cost recovery mechanisms include taxes and user fees. Where user fees are impractical, the use of local, state and federal taxing and spending authorities may be appropriate.

10. Federal oversight and regulatory requirements have substantially increased the cost of some projects under the Bureau of Reclamation's demonstration program. Excessive federal regulation should be avoided, and project sponsors should have greater input in the development of federal interagency cooperative agreements and memoranda of understanding.

11. Two primary state concerns associated with ground water recharge are: (a) the potential degradation of ambient ground water quality and adverse effects on the current or future use of an aquifer; and (b) the potential waste of water given the hydrogeologic uncertainty surrounding some proposed projects. Without unnecessarily adding to the cost or complexity of recharge projects, states should ensure that water quality standards protect beneficial uses of groundwater and water is not wasted.

12. There is a need for greater public awareness of ground water use and recharge opportunities, such as the reuse of reclaimed

waters. Networking and information exchange among various groups and interests working on ground water recharge is also important. This is an area that the states and the Bureau of Reclamation might profitably explore, perhaps by establishing a public education and information clearinghouse, or by sponsoring conferences or workshops on recharge opportunities.

13. Most states have only recently begun to define how their legal and institutional systems will govern ground water recharge and recovery activities. Some states have adapted general legal principles and administrative procedures to address recharge activities. A few western states have enacted specific ground water recharge statutes, or revised their ground water laws to accomodate recharge activities. On the other hand, a few states have not yet found it necessary to decide how to apply their legal systems to ground water recharge, due to a lack of interest in recharge projects.

14. Some of the legal and institutional questions that have arisen regarding ground water recharge activities include:

(a) Is ground water recharge recognized as a beneficial use of surface water?

(b) Is the right to withdraw recharged ground water protected, and is adequate information available to define the recoverable amount?

(c) Are third parties with ground and surface water rights, as well as public interest values, adequately protected? and

(d) Should ground water protection be based on ambient quality, which may preclude the recharge of potable surface water and other waters, or present and future beneficial uses?

In addition to these general issues, some states have experienced state-specific legal or institutional questions related to ground water recharge as a water management tool.

15. As interest in ground water recharge and recovery increases, state legal and institutional mechanisms will likely be further refined and better adapted to facilitate increased ground water recharge activities. Each state should examine its own legal and institutional systems to assure they adequately address ground water recharge.

Hopefully, this report and these findings and recommendations, will prove helpful in evaluating project and program feasibility and appropriate intergovernmental roles in promoting and regulating ground water recharge.

APPENDIX A

Ground Water Recharge Study

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APPENDIX B

revised August 7, 1989

STATE GROUND WATER RECHARGE QUESTIONNAIRE

General

1. Which state agencies have or might have jurisdiction over ground water recharge?

2. Does the state sponsor any state ground water recharge program, such as an artificial ground water recharge storage program? Please include any statutory language, with citations.

3. Has the state undertaken or considered any projects specifically for ground water recharge (including participation in federal projects)? If so, for what purpose?

4. How are state ground water recharge projects or programs financed?

5. How are or might costs be allocated among beneficiaries? What if any cost sharing guidelines, requirements, or provisions are included?

6. How might or do other state federally funded water projects affect ground water recharge?

7. Does the state monitor other public and private ground water recharge activities, which may not otherwise be subject to state jurisdiction?

8. How extensive are other public and private ground water recharge activities in your state? Please give specific examples.

9. Does the state in any way promote and/or discourage ground water recharge?

10. What is or might be the state's interest in regulating or promoting ground water recharge?

11. What incentives might the state or federal government provide?

12. What do you perceive as the problems or costs, and benefits or beneficiaries, of ground water recharge projects?

13. How do you view ground water recharge -- compared to other water supply management alternatives?

Legal and Water Quality

14. Does your state have a ground water recharge statute? If so, please provide a copy and summary of the statute, as well as copies of any relevant case law with citations.

15. If your state does not have a specific ground water recharge statute, how has or would your state laws and procedures for water and ground water generally, be applied to a ground water recharge project (statutory law, case law, and administrative decisions, such as these changes that would apply to the nature of use or point of diversion, etc.)?

Please ensure that you address the following related questions:

a. Does your state recognize ground water recharge as a beneficial use of water?

b. Does the state issue ground water recharge permits?

c. How are recharged waters measured and reported? (for what amount of recharged water may a project sponsor receive "credit" to appropriate)?

d. What process does or might the state use to appropriate artificially stored ground water?

e. What legal protection does the state provide a project sponsor or sponsors to recover recharged ground water?

f. Is there any differentiation under your state law between ground water which is artificially recharged by diverting water from another water body, versus enhancing recharge from, for example, a natural storm-event?

g. Is sufficient information generally available on ground water resources in the state to support administrative decisions regarding recharge projects? What "burden of proof" might the project sponsor be expected to bear?

16. What problems or opportunities related to conjunctive use might be created by ground water recharge activities in your state, and how are or might they be addressed under state law?

17. Does your state allow or prohibit ground water "mining?" How is "ground water mining" defined under your state law? Is there any relationship under state law between ground water mining and ground water recharge?

18. What if any effect would interstate water compacts or allocations, and federal or Indian water reserved rights or lands have on ground water recharge activities? Conversely, what effect might recharge activities have on compacts, reserved rights, etc.?

19. Can the state prohibit ground water recharge activities, and if so, under what circumstance?

20. Can and does the state regulate ground water recharge injection wells under state or federal law, such as the Safe Drinking Water Act's Underground Injection Control Program?

21. What, if any, protection may be afforded ground water recharge areas by the state under state or federal law, such as EPA's Critical Aquifer Protection Area Program?

22. Are there any other state water quality concerns or controls related to ground water recharge?

23. In your opinion, does the state need comprehensive ground water recharge legislation? What would be the chances of enactment?

Is there anything else, with regard to ground water recharge in your state, that is not addressed in the above questions, but is important in understanding your state's position?

APPENDIX C

Appendix VI
Summary of environmental impacts

.. Earth. Will the proposal result in:	Yes	Maybe	No
a. Unstable earth conditions or changes in geologic substructures?	—	—	—
b. Disruptions, displacements, compaction or overcovering of the soil?	—	—	—
c. Change in topography or ground surface relief features?	—	—	—
d. The destruction, covering or modification of any unique geologic or physical features?	—	—	—
e. Any increase in wind or water erosion of soils, either on or off the site?	—	—	—
f. Changes in deposition or erosion of beach sands, or changes in siltation, deposition or erosion which may modify the channel of a river or stream or the bed of the ocean or any bay, inlet or lake?	—	—	—
g. Exposure of people or property to geologic hazards such as earthquakes, landslides, mudslides, ground failure, or similar hazards?	—	—	—
2. Air. Will the proposal result in:			
a. Substantial air emissions or deterioration of ambient air quality?	—	—	—
b. The creation of objectionable odors?	—	—	—
c. Alteration of air movement, moisture, or temperature, or any change in climate, either locally or regionally?	—	—	—
3. Water. Will the proposal result in:			
a. Changes in currents, or the course or direction of water movements, in either marine or fresh waters?	—	—	—
b. Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?	—	—	—
c. Alterations to the course or flow of flood waters?	—	—	—
d. Change in the amount of surface water in any water body?	—	—	—
e. Discharge into surface waters, or in any alteration of surface water quality, including but not limited to temperature, dissolved oxygen or turbidity?	—	—	—
7. Light and Glare. Will the proposal produce new light or glare?	—	—	—

	Yes	Maybe	No
8. Land Use. Will the proposal result in a substantial alteration of the present or planned land use of an area?	—	—	—
9. Natural Resources. Will the proposal result in:			
a. Increase in the rate of use of any natural resources?	—	—	—
b. Substantial depletion of any nonrenewable natural resource?	—	—	—
10. Risk of Upset. Will the proposal involve:			
a. A risk of an explosion or the release of hazardous substances including, but not limited to, oil, pesticides, chemicals or radiation) in the event of an accident or upset conditions?	—	—	—
b. Possible interference with an emergency response plan or an emergency evacuation plan?	—	—	—
11. Population. Will the proposal alter the location, distribution, density, or growth rate of the human population of an area?	—	—	—
12. Housing. Will the proposal affect existing housing, or create a demand for additional housing?	—	—	—
13. Transportation/Circulation. Will the proposal result in:			
a. Generation of substantial additional vehicular movement?	—	—	—
b. Effects on existing parking facilities, or demand for new parking?	—	—	—
c. Substantial impact upon existing transportation systems?	—	—	—
d. Alterations to present patterns of circulation or movement of people and/or goods?	—	—	—
e. Alterations to waterborne, rail or air traffic?	—	—	—
f. Increase in traffic hazards to motor vehicles, bicyclists or pedestrians?	—	—	—
14. Public Services. Will the proposal have an effect upon, or result in a need for new or altered governmental services in any of the following areas:	—	—	—
a. Fire protection?	—	—	—
b. Police protection?	—	—	—

14. Public Services (cont)	Yes	Maybe	No
c. Schools?	—	—	—
d. Parks or other recreational facilities?	—	—	—
e. Maintenance of public facilities, including roads?	—	—	—
f. Other governmental services?	—	—	—
15. Energy. Will the proposal result in:			
a. Use of substantial amounts of fuel or energy?	—	—	—
b. Substantial increase in demand upon existing sources of energy, or require development of new sources of energy?	—	—	—
16. Utilities. Will the proposal result in a need for new systems, or substantial alterations to the following utilities?			
a. Power or natural gas?	—	—	—
b. Communications systems?	—	—	—
c. Water?	—	—	—
d. Sewer or septic tanks?	—	—	—
e. Storm water drainage?	—	—	—
f. Solid waste and disposal?	—	—	—
17. Human Health. Will the proposal result in:			
a. Creation of any health hazard or potential health hazard (excluding mental health)?	—	—	—
b. Exposure of people to potential health hazards?	—	—	—
18. Aesthetics. Will the proposal result in the obstruction of any scenic vista or view open to the public, or will the proposal result in the creation of an aesthetically offensive site open to public view?	—	—	—
19. Recreation. Will the proposal result in an impact upon the quality or quantity of existing recreational opportunities?	—	—	—
20. Cultural Resources.			
a. Will the proposal result in the alteration of or the destruction of a prehistoric or historic archaeological site?	—	—	—
b. Will the proposal result in adverse physical or aesthetic effects to a prehistoric or historic building, structure or object?	—	—	—

20. Cultural Resources (cont)	Yes	Maybe	No
c. Does the proposal have the potential to cause a physical change which would affect unique ethnic cultural values?	—	—	—
d. Will the proposal restrict existing religious or sacred uses within the potential impact area?	—	—	—
21. Mandatory Findings of Significance.			
a. Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlifespecies, cause a fish or wildlife population to drop below self sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	—	—	—
b. Does the project have the potential to achieve short-term, to the disadvantage of of long-term, environmental goals? (A short -term impact on the environment is one which occurs in a relatively brief, definitive period of time, while long-term impacts will endure well into the future.)	—	—	—
c. Does the project have impacts which are individually limited, but cumulatively considerable? (A project may impact on two or more separate resources where the impact on each resource is relatively small, but where the effect of the total of those impacts on the environment is significant.)	—	—	—
d. Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	—	—	—

APPENDIX D

Appendix VII
Permit Checklist

Consider whether any of the permits listed in this Appendix are needed for construction of your project. Discuss in Section G.

Type I: Is the project located in the areas listed?

Geographic Area	**Agency**	**Permit**
From 3 miles offshore to 1,000 yards inland	Coastal Commission	Coastal Development Permit
San Francisco, San Pablo, and Suisun bays from high water to 100 feet inland	San Francisco Bay Conservation and Development Commission	Development Permit
Suisun Marsh	San Francisco Bay Conservation and Development Commission	Marsh Development Permit
Lake Tahoe Watershed	Tahoe Regional Planning Agency	Development Permit
Floodways in the Central Valley	The Reclamation Board	Encroachment Permit
Navigable waterways or streams affecting navigable waterways	US Army Corps of Engineers	Section 10 Permit
Wetlands, including coastal and inland waters, lakes,	US Army Corps of Engineers	Permit for dredging or disposal of rivers, tributaries,dredged material or swamps and marshes placement of any fill material or structure in the waters of the US
Wild and Scenic Rivers	Resources Agency	Approval of diversions; Finding of Compatibility

Type II: Does the project affect any of the resources listed?

Resource	**Agency**	**Permit**
Air	Air Pollution Control Districts	Authority to Construct and Permit to Operate for Activities emitting pollutants to the atmosphere
Fish and Wildlife Habitat	Department of Fish and Game	Stream or Lake Alteration Agreements for Activities in streams or lakes and channels, and crossings spawning gravel protection
Water Rights	State Water Resources Control Board, Regional Boards	Permit to Appropriate and Statement of Diversion and Use for Activities diverting surface water not previously appropriated
Water Quality	State Water Resources Control Board, Regional Boards	National Pollutant Discharge Permit or Waste Discharge Requirements for discharges to surface water
Wetlands. including coastal and inland waters, lakes, rivers,	US Army Corps of Engineers	Permit for disposal of dredged material or tributaries, swamps or placement of any and marshes fill material
Or, Navigable waters and and tributaries to them	US Army Corps of Engineers	Permit for dredging, filling, dock, groins, land jetties or for any obstruction or effect on the capacity of navigable waters
Navigable waters and and tributaries to them	Federal Energy Regulatory Comm.	FERC License

Type II: Continued

Resource	Agency	Permit
Beds of navigable waters	State Lands Comm.	Land Use Lease for encroachments and docks
Endangered Species	US Fish and Wildlife Service	Incidental Take Permits
Drinking Water	Department of Health Services	Title 22 Drinking Water Standards

Type III: Does the project involve any of the following activities?

Activity	Agency	Permit
Power plants and transmission lines for Certification	California Energy Comm.	Notice of Intention and Application
Generation of electrical power	Federal Energy Regulatory Comm.	F.E.R.C. Permit
Conversion of timberland to other uses	Department of Forestry	Timberland Conversion Permit
Cancellation of a Williamson Act Open Space Contract	Resources Agency Waiver of a Cancellation Fee	Approval of the
Bridge Construction causeways over navigable waters	US Coast Guard	Permit for bridges and
Mineral prospecting and extraction on State lands	State Lands Comm. and Extraction Lease	Prospecting Permit
Oil or gas well	Department of Conservation, Division of Oil and Gas	Oil or Gas Well Permit
Geothermal well	Department of Conservation, Division of Oil and Gas	Geothermal well
Geothermal prospecting and development on State lands	State Lands Comm.	Geothermal Prospecting Permit and Extraction Lease
Encroachment on or across a State highway	Department of Transportation	Encroachment Permit; Utility Encroachment Permit
Construction, alteration, maintenance, operation, and removal of dams or reservoirs	Department of Resources, Division of Safety of Dams	Approval of Plans

Type III: Continued

Activity	Agency	Permit
Construction or alteration of dams	Federal Energy Regulatory Comm.	F.E.R.C. License
Dredging	Department of Fish and Game	Standard or Special Suction
Removal of sand, gravel, and dredge spoils from State-owned lands	State Lands Comm.	Grant or Privilege
Dredging or placement of fill or other materials or structure in wetlands	US Army Corps of Engineers	Permit 404
Water diversion from a State wild or scenic river	Resources Agency	Determination of Need and No Adverse Effect
Surface mining	City or county	Reclamation Plan

Type IV: Property rights

Considerations
Who owns or controls the land?

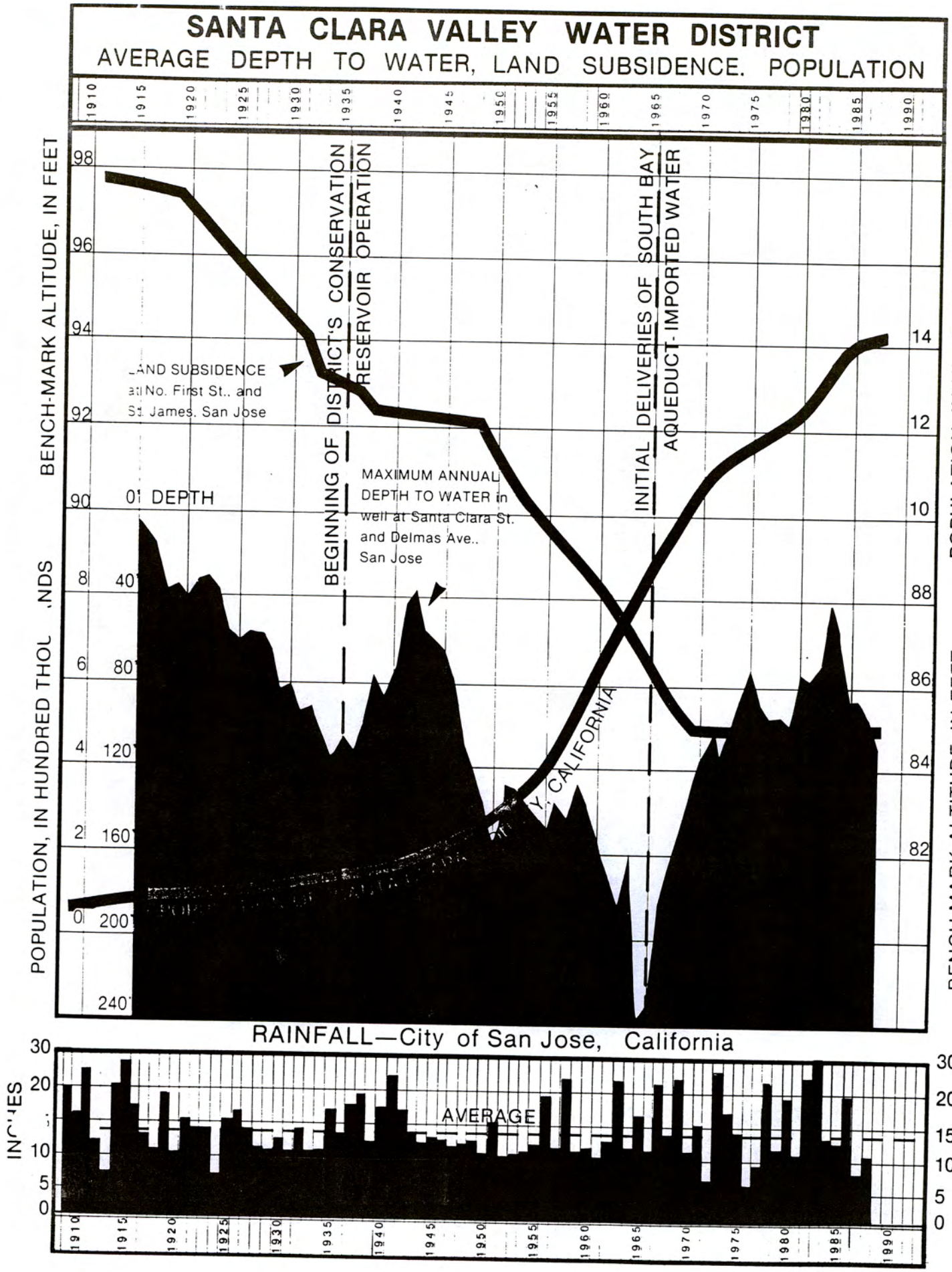
Do we have the landowner's permission?

Private Owner?

Lessee?

Public Agency Owner?

APPENDIX E


SANTA CLARA VALLEY WATER DISTRICT
AVERAGE DEPTH TO WATER, LAND SUBSIDENCE. POPULATION
BENCH-MARK ALTITUDE, IN FEET
POPULATION, IN HUNDRED THOUSANDS
LAND SUBSIDENCE at No. First St., and St. James, San Jose
DEPTH
MAXIMUM ANNUAL DEPTH TO WATER in well at Santa Clara St. and Delmas Ave., San Jose
BEGINNING OF DISTRICT'S CONSERVATION RESERVOIR OPERATION
INITIAL DELIVERIES OF SOUTH BAY AQUEDUCT-IMPORTED WATER
RAINFALL—City of San Jose, California
AVERAGE
INCHES

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