CHAPTER 4

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Conjunctive use management strategies provide a more sustainable water supply by distributing stress across a number of available water resources.

The city of Albuquerque, faced with dwindling ground-water supplies and rapid population growth, will have to consider conjunctive use management to meet its future demand for water. The term "conjunctive use" refers to management strategies that are designed to provide a more sustainable water supply by distributing demand stress across a number of available water resources. Conjunctive use strategies seek to balance the advantages and strengths of each available water source against the disadvantages and weaknesses of others in order to avoid or mitigate the problems associated with relying entirely on a single limited source. To take maximum advantage of all of its resources, the City should integrate conjunctive use concepts into all aspects of water resource planning, management, and infrastructure development.

Conjunctive use strategies are generally more complex and costly than using a single source because of increased infrastructure requirements and the difficulty of managing a more complicated system. For these reasons, conjunctive use strategies are usually not considered to be necessary or justified until single-source supplies are stressed beyond comfortable limits.

The conjunctive use concept is not new. In New Mexico, the towns of Carrizozo and Alamogordo have relied on conjunctive use of water supplies since the early 1900's. Large metropolitan cities including Houston, San Antonio, El Paso, Tucson, Phoenix, and Los Angeles have adopted conjunctive use strategies to supplement diminishing or insufficient ground-water sources. Many other communities across the country have adopted conjunctive use strategies either because single reliable sources have never been available or because single sources were depleted or could not keep up with growth demands.

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Conjunctive use can also be used to meet water quality objectives. Waters from one source can be mixed to dilute the concentration of contaminants in another. Lower quality supplies can also be dedicated to uses not requiring high quality potable water as a means of conserving potable supplies.

A variety of management strategies can be included under the category of conjunctive uses. The types of conjunctive use methods that might be incorporated in a system would depend on such factors as the available alternative supplies, size of demand for various uses, specific characteristics of aquifers, existing infrastructure, economic considerations, etc. Conjunctive use methods available include:

- Utilization of multiple supply sources that may integrate the use of surface water, shallow ground water, and deep ground water.
- Building multiple delivery systems to supply water of differing quality for different uses.
- Reuse of waste water.
- Enhancing aquifer recharge using available surface supplies or other sources such as treated waste water.
- Management of flood water to enhance aquifer recharge.
- Water quality exchanges.
- Water banking.
- Land use management for protecting water quality, watershed yield, or recharge potential.

Conjunctive Use Concepts for Albuquerque

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The immediate water supply problems facing the City are not due to a lack of resources but to the fact that the existing water delivery infrastructure is not designed to use all available supplies. Albuquerque's water system was developed under the assumption that the Rio Grande would always provide adequate, good quality recharge to the deep aquifer beneath the City. Various evidence now clearly shows that this assumption is invalid and that relying entirely on the deep aquifer is not a sustainable resource use strategy for the City and surrounding communities.

There are a number of conjunctive use management concepts that would be well suited for use in the Albuquerque area to take advantage of a unique hydrologic system. The system has considerable untapped potential if it can be managed to utilize more of the available resources. A number of alternatives are available for direct use of surface and shallow ground water, water quality exchanges, and recharge protection or enhancement. Many of these alternatives could be implemented by using the capacity of existing infrastructure through operational changes or relatively minor structural modifications. Some or all of these alternatives could be integrated into an overall conjunctive use strategy.

The design of an overall conjunctive use management plan should assure that demands for diversions, withdrawals, and consumptive uses from the hydrologic system do not exceed the overall available water supply and that these demands can be met without overstressing and damaging any of the individual components or collective capabilities of the hydrologic system. In the Albuquerque area, these goals appear to be achievable for current demands and available resources. Accommodation of future growth will depend on a well-planned water resource and land use strategy.

There are a number of conjunctive use management concepts that would be well suited for use in the Albuquerque area. Many management alternatives could be implemented by using the capacity of existing infrastructure through operational changes or relatively minor structural modifications.

The supply available from Reclamation's San Juan-Chama Project is Albuquerque's greatest untapped water resource, and efficient utilization of this water is of critical importance to the City. This project imports water from tributaries of the San Juan River in southern Colorado into the Rio Grande Basin through a tunnel running under the Continental Divide. Water users, including the City and the District, and others contract with Reclamation for San Juan-Chama water. The City and other ground-water users now use or intend to use their San Juan-Chama water allocations to offset surface water depletions caused by their ground-water pumping. New understanding of the limits of aquifer recharge in the Albuquerque Basin have invalidated the formulas that are used to compute surface depletions due to ground-water pumping in the Basin. Water intended for recharge is probably flowing downstream and out of the Basin. Efficiency of using San Juan-Chama Project and other surface supplies can be increased by more directly using these sources. San Juan-Chama Project water could be treated and delivered directly to users, or it could be used to enhance aquifer recharge.

Maximizing the potential of the San Juan Chama water is an essential element in developing a conjunctive use strategy.

In the following discussion, we present some general concepts which would allow the City to make increased use of available surface and shallow ground-water resources and reduce dependence on the high quality deep aquifer source. The concepts presented include using lower quality water supplies for uses not requiring potable water and alternatives for enhancing aquifer recharge.

None of these concepts constitutes a full solution to Albuquerque's water supply problems. The full solution will require an approach that includes good planning and careful management to integrate a number of water resource development and management strategies that each address specific problem areas.

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Use of Surface and Shallow Ground Water for Irrigation and Nonpotable Use

Providing potable water at low cost for nonpotable uses is an undesirable allocation of a limited resource.

Providing potable water at low cost for nonpotable uses is an undesirable allocation of a limited resource. Use of surface water and shallow ground water for irrigation and nonpotable uses should be encouraged. These uses have been diminishing because of urbanization, availability of cheap potable water, and increasing shallow ground-water quality problems.

Incentives and regulatory measures could be applied to encourage use of surface water and shallow ground water for irrigation and other nonpotable uses. This option is most practical in valley areas where there is access to water from District ditches or shallow wells. There are political, management, and institutional challenges to be overcome before this strategy can be fully successful, but these obstacles are not insurmountable.

Irrigation with shallow ground water or surface water provides four important benefits:

- Appropriate use of either shallow ground water or surface water decreases withdrawals from the deep aquifer.
- Deep percolation from irrigation contributes to aquifer recharge.
- Irrigation with shallow ground water remediates septic tank and leach field pollution by making associated nitrogen compounds available as nutrients for vegetative growth.
- Irrigation with surface water would dilute septic tank contaminant concentrations in the shallow ground water and replace pumped use of contaminated shallow ground water with better quality water, thereby ultimately improving the quality of deeper recharge.

The key to effectiveness in this type of program would be to strike a balance between incentives for increasing appropriate use of surface and shallow ground water while not encouraging overuse or misuse.

Overuse of shallow ground water for irrigation in the valley is, to some extent, self-limiting. Cottonwood trees and other phreatophytes already satisfy their full demand from the shallow ground water. While some vegetative types, like alfalfa, may experience increases in consumption of water through luxury use (a biologically inefficient stage of evapotranspiration caused by excessive irrigation), most of the excess water will recharge the shallow ground water.

Misuse of contaminated shallow ground water for potable purposes is already a significant concern in many areas of the valley. Although this practice is discouraged, it continues because of ignorance or economic considerations. Strategies to encourage use of shallow ground water for nonpotable needs should incorporate elements to discourage improper and inappropriate use of this water. The overall strategy should include education, balanced economic incentives, plumbing code provisions, water quality monitoring, and integrated management.

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Dual Water Systems for Major Consumers of Irrigation Water or Nonpotable Supplies

Public and institutional use of potable supplies for irrigation should be eliminated where possible. Large amounts of high quality water from the deep aquifer are being used for irrigation of parks, golf courses, ball fields, cemeteries, and institutional, business, or industrial complex landscaping. Institutions having large irrigated acreage include universities, schools, airports, parks, and military installations.

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The benefits accruing from private use of the surface and shallow ground water systems are also applicable here, but to an even greater degree. The Assessment's "Land-Use Trends and Their Effect on Water Use and the Hydrologic Budget" report illustrates that in 1994, irrigation of parks and golf courses consumed about 8,000 acre-feet of water, while domestic irrigation consumed about 1,900 acre-feet (Bell et al., 1993; Summers, 1995).

In many cases, large acreages could be irrigated with less than potable quality water. Depending on location, irrigation water could be economically obtained from surface water diversions, treated waste water, or shallow ground-water wells. High density industrial and business complex areas could be efficiently served by dual water systems.

If parks and golf courses could be converted to alternative water supplies for irrigation, the benefits would be substantial. These savings could be approximately equivalent to one-fourth of the annual recharge from the river and riverside drains (Hansen, in press[a]), enough water to serve more than 35,000 people at a per capita use rate of 200 gallons per day.

A delivery system for nonpotable water would be needed to take full advantage of the shallow ground-water resource. In some water-short communities, separate dual water systems for potable and nonpotable water supplies were encouraged through U.S. Environmental Protection Agency funding grants during the late 1970's and early 1980's as a means to relieve stress on municipal supplies. In Emery County, Utah, for example, several small communities developed gravity fed pipeline systems for nonpotable water which diverted surface water from irrigation canals. These systems supplied untreated surface water for "outside use only" during the irrigation season. They were drained and unused during the winter months.

Development, operation, and maintenance costs associated with dual system infrastructure can be lower than development of new potable supplies from the deep aquifer or other sources.

Combined Use of Deep Ground Water and Bureau of Reclamation San Juan-Chama Project Surface Water Supplies

Diversion of river water would allow the City to make direct use of its available supply from the San Juan-Chama Project.

The Assessment identifies several alternatives for diverting surface water from the Rio Grande. Diversion of river water would allow the City to make direct use of its available supply from the San Juan-Chama Project. Surface water, once treated, could be pumped into the existing municipal water system and used directly or used to recharge resting wells. Surface water could be mixed with ground water to augment supplies or to mitigate water quality problems. The city of Wichita, Kansas, uses surface water to remediate ground-water salinity problems, as do the New Mexico towns of Alamogordo and Carrizozo.

In most conjunctive use schemes, renewable surface water supplies are used to provide as much "base load" capacity as possible, while limited ground-water supplies are reserved for meeting "peak load" requirements. This allows the aquifer to rest and recharge between periods of heavy pumping. During periods when surface water availability exceeds demand, excess capacity can be used to recharge resting wells by pumping treated water down into the aquifer. Combined use can also be used to redistribute load patterns for purposes such as well rehabilitation, rotating pumped areas of the aquifer for passive enhancement of natural recharge, or control migrating contaminants.

Water Banking

Better balancing supplies and demand on the hydrologic system is becoming increasingly necessary as water resources approach full utilization. Water banking provides one of the means for achieving this balance.

Sharing benefits between water users by better balancing supplies and demand on the hydrologic system is becoming increasingly necessary as water resources approach full utilization. Water banking provides one of the means for achieving this balance. Water banking is an old concept which is now gaining more attention and is being applied on many scales. Dams and reservoirs are the most obvious examples of water banks. Reservoirs generally provide regional storage of water for time periods extending over months or years. Municipal water tanks are smaller reservoirs designed to provide storage for attenuation of daily demand variations so that production facilities do not have to be sized for peak demands. The banking concept even applies to rural domestic wells where a small banked supply in a pressure tank keeps the pump from cycling on and off with each use. Magnitude, frequency, and duration of peak demands impacting a water supply dictate the amount of banked storage needed.

The water banking concept also includes loaning and borrowing water resources between water users having different use patterns or peak demand periods. An example of this would be alternating water use between a ski area for snowmaking and a nearby town for summer irrigation. This arrangement would help to meet both seasonal demand peaks without the need for investing in storage facilities. Another example might be rotating contributions from various regional water users, as their peak demands subside, toward instream flow requirements for meeting waste water return flow dilution requirements or endangered species protection and recovery needs.

The District is presently proposing to establish a water bank to allow more flexible allocation of water in the District. While Reclamation recognizes the potential benefits of the proposed water bank, there are various legal and institutional obstacles to be overcome before it can become operational. Specifically, the contractual relationship between the District and Reclamation imposes restrictions on some provisions of the District's proposal.

Aquifer Recharge Protection and Enhancement

Previous discussions in this report showed that the river, riverside drains, irrigation canals, irrigated lands, interior drains, and flood control facilities are all important features affecting ground-water recharge. This existing infrastructure offers many relatively inexpensive and low-tech opportunities for protection or artificial enhancement of ground-water recharge.

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Ground-water recharge has been an unintended beneficial byproduct of irrigation in the valley for centuries. Percolation from farm fields and seepage from canals and ditches are important contributors to shallow ground water and to deeper aquifer recharge. Assessment studies indicate that these contributions account for about half of the current ground-water recharge in the Albuquerque metropolitan area with the riparian corridor providing the other half (Hansen, in press[a]). Recharge from irrigated agriculture is not a natural process, and it will continue to diminish or disappear with continued urbanization.

The riverside drains are important elements in the overall recharge picture. The riverside drains were originally designed to reduce high ground-water problems by intercepting and draining seepage from the river. In many areas, the riverside drains no longer serve this function and, in fact, are inhibiting ground-water recharge (Hansen, in press[b]). In these areas, the riverside drains could be easily modified and managed to increase ground-water recharge. Essentially, the necessary modifications would involve building relatively simple and inexpensive structures in the drains to raise their water surface elevations. This would allow more water to move horizontally away from the riparian corridor and into the ground-water system. In some places, the potential recharge may be even greater than recharge that existed naturally.

Existing flood control facilities are designed to move water away from the City and into the Rio Grande as quickly as possible. Potential exists for better management of flood water to increase its contribution to aquifer recharge. Because flood water is available at a high elevation, the costs associated with pumping can often be reduced or eliminated. Slowly releasing floodwater from detention dams through unlined channels or capturing it in special recharge basins are possible ways of benefiting aquifer recharge. Fault zones and recharge windows running along the foot of the Sandia Mountains are important natural recharge areas. Managing flood waters that originate in the Sandias in this zone could be an effective means of enhancing recharge.

Albuquerque's existing ground-water production and delivery infrastructure could be adapted for water banking by injection of water into the deep aquifer. Possible sources of water for injection are the San Juan-Chama Project or treated waste water.

The Salt Lake County Water Conservancy District in Utah provides an example of water banking by injection into an aquifer that is used as part of a conjunctive surface water/ground-water use strategy. The system historically relied on water stored in Deer Creek Reservoir for a substantial portion of its supply. Urbanization resulted in a growing municipal water demand for a population of 500,000 people which could no longer be met by the combined delivery capacity of the Salt Lake Aqueduct and the available ground water. In January 1992, the District ran a pilot project to bank water by artificial aquifer recharge. In the winter, excess delivery capacity in the Salt Lake Aqueduct was used to deliver water to two injection sites. In the pilot project, 1,430 acre-feet of water was injected via wells into an unconfined basin-fill aquifer beneath the east bench of the Salt Lake Valley. In the summer, this water was recovered to meet peak seasonal demand. The pilot project is now moving toward permanent implementation on a larger scale. Institutional constraints associated with this project required the State Engineer to create special authorizing legislation.

Treated waste water has been used for aquifer recharge in El Paso and other cities. The cost of treating waste water to allow this practice is high. However, increasing cost of developing other new sources or meeting more stringent waste water discharge standards may make waste water recharge a viable and economical option.

Storing water by injecting it into the aquifer requires careful consideration of aquifer characteristics and water quality. Clearly, the aquifer must be physically capable of absorbing the injected water. Problems can result if the injected water is not chemically compatible with the native ground water or the aquifer materials. Preliminary findings have indicated that these would not be problems in the Albuquerque area if water from the Rio Grande were used. (Hawley, Haneberg, Whitworth, and Detmer, 1996).