# LONG-TERM STORAGE THROUGH INDIRECT RECHARGE

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## ABSTRACT

The Central Arizona Project is nearing completion and is currently operating in partial capability. Central Arizona finds itself with a plentiful water supply available from the Colorado River but without the physical or economic resources to fully use the supply. The state of agricultural economics is such that irrigation is not profitable using the high cost CAP supply. Yet as we look toward the future, central Arizona can expect shortages of Colorado River supplies 25 to 50 years in the future and short term loss of supply from system outages due to maintenance or unplanned failures.

The Central Arizona Water Conservation District, working with the Arizona Department of Water Resources and local irrigation districts, is developing indirect recharge programs to promote present day use of available Colorado River supplies instead of groundwater pumping. At the same time, the programs provide long-term storage for protection against temporary system outages and shortages in long-term supply. While 1992 will be the first year for such programs by CAWCD or anyone in Arizona, we hope it will demonstrate a win-win program for all.

## BACKGROUND

As the Central Arizona Project (CAP) is nearing completion of construction, the Central Arizona Water Conservation District (CAWCD)[3] is planning ahead to enhance operational capability. In 1992, the CAP was capable of making deliveries through approximately 90% of the 330 mile long system. With the full pump diversion capability of 3000 $ft^3/sec$ and a "normal" water supply available from the Colorado River, the CAP has the

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[3]CAWCD is the agency created by the Arizona state legislature to operate the CAP and repay the United States for reimbursable construction costs associated with the project.

opportunity to use 1.5 million acre-feet (MAF) per year. However, in 1992, actual use is expected to be only about one-half of that amount. Water available to CAP, but not used, most likely will not remain in storage in the Colorado River system but will be used by California.

Many CAP allottees will not be taking their full allocation for several years. The CAP was planned to meet the future growth needs of municipal and industrial (M&I) and Indian users. In the interim, it was to replace current groundwater use for agriculture and, to some degree, for M&I purposes. Growth in the M&I sector has slowed. With the current depressed agricultural economic conditions in central Arizona, the irrigated acreage is probably less than one-half of the potential maximum. In many instances, the cost to pump groundwater is less than one-half the cost of CAP water; consequently, groundwater is often used instead of CAP water. The result is, although we have the capability to deliver all of the Colorado River water available to CAP, there will be a significant amount of water available to Arizona that will not be used or stored for future use unless something is done. These current conditions of supplies exceeding demand will not last. In fact, municipalities in the Phoenix and Tucson areas are currently seeking to acquire additional water supplies for use in the future as populations continue to increase. One logical source of water to satisfy future needs is today's excess water.

A primary objective of the CAP was to replace the current use of pumped groundwater by agriculture with the use of renewable surface water supplies from the Colorado River. The conserved groundwater supply would then be available for use during critical periods in the future when Colorado River supplies are short due to drought. Yet it is the availability and use of that groundwater which plays a major role in today's demands for CAP water by the agricultural entities served by the CAP. A number of the irrigation districts (IDs) have an allocation of federal hydropower which can be used to pump groundwater at a relatively low price. In order to maintain the allocations to federal hydropower, the IDs must use it to provide water to lands within their service areas, otherwise they face the threat of losing the allocation due to non-use. The agricultural entities need to maintain their hydropower allocations for two reasons: (1) CAP cannot deliver all of the water that the agricultural subcontractors use during peak months due to CAP aqueduct capacity constraints, and (2) the CAP supply available to agriculture declines as M&I uses grow. Because groundwater is less costly than CAP water, and because the IDs want to exercise the right to all of their hydropower allocation, groundwater is used as the basic water supply and CAP water serves as a secondary source. Therefore, a significant amount of the agricultural water demand is still being served by groundwater despite the availability of CAP water.

CAWCD has continually sought ways to maximize the use of the CAP system, to effectively use Arizona's share of the Colorado River supplies, and to reduce Arizona water users' reliance on groundwater. As such, we have been involved in plans to directly recharge the excess CAP water supplies. Yet, increasing direct use in lieu of groundwater pumping appeared to be a less costly and more readily available alternative. Therefore, in 1991, we began to earnestly pursue opportunities for indirect recharge.

## RECHARGE CONCEPTS AND OPPORTUNITIES

Arizona has a strong framework for management of groundwater resources. The 1980 Groundwater Management Act (GMA) provides the basis for management and accounting of the use of groundwater. A subsequent amendment to the GMA provided for the underground storage and recovery of water supplies through direct recharge projects. A later amendment made provisions for underground storage through reduction in groundwater pumping.

Indirect recharge operates on the basis of surplus CAP water being used in place of groundwater. Upon demonstrating that a substitution has taken place, in-lieu recharge credits, which enable the holder of such credits to remove groundwater for subsequent use, are created. The opportunity to purchase excess CAP water and to create, hold, and use in-lieu credits is available to CAWCD and other individual entities.

The CAP is currently delivering water to 10 IDs, nine of which are located within the boundaries of the state's three groundwater Active Management Areas (AMAs). All of these IDs are pumping some groundwater and offer an opportunity for development of indirect recharge projects. Initial efforts focused on the two largest IDs (about 85,000 acres each) within CAWCD's service area, the Maricopa-Stanfield Irrigation and Drainage District (MSIDD) and Central Arizona Irrigation and Drainage District (CAIDD). Success of developing these two projects cleared the way for subsequent projects involving the seven remaining IDs located within the AMA boundaries, Roosevelt Water Conservation District (RWCD), Tonopah Irrigation District (TID), Queen Creek Irrigation District (QCID), San Tan Irrigation District (STID), Chandler Heights Citrus Irrigation District (CHCID), Hohokam Irrigation and Drainage District (HIDD), and New Magma Irrigation and Drainage District (NMIDD).

Background

IDs served by CAWCD fall generally in two categories: (1) Those which control all water deliveries to the individual farmers (including groundwater), and (2) those which deliver only CAP water to farmers upon specific request by the farmer. CAIDD, MSIDD, RWCD, STID, and CHCID fall into the first category, while TID, QCID, HIDD, and NMIDD fall into the second category. Those IDs in category one above are steadily improving their capability to operate as conjunctive use districts, where both surface water and groundwater sources are commingled to optimize operations. Water is delivered to the individual farms through a district owned distribution system. The irrigation district controls the water wells within its boundaries and pumps groundwater for delivery directly to an adjacent farm or into the distribution system for use elsewhere in the district. Water orders from the individual farmers are satisfied from any source available to the district and the farmers pay for it on a "postage stamp" price schedule that is independent of the source.

Those IDs in the second category above do not maintain control of the wells within the district. The individual farmers own and operate the wells and, therefore, decide whether to pump groundwater or use CAP water. If the farmer chooses to use CAP water, an order is given to the ID, and the ID delivers the CAP water through a district-owned distribution center.

Several IDs are operationally integrated with one or more Electrical Districts (EDs). For example, MSIDD is the primary customer of Electrical District No. 3 and CAIDD is the primary customer of Electrical Districts Nos. 4 and 5. Some of the EDs have contracts with the United States for hydropower generated by the Hoover, CRSP, and Parker-Davis projects. Groundwater pumped with federal hydropower is the least expensive source of water available to these IDs.

The IDs are also contractors for CAP water under both interim and long term subcontracts. Some IDs also have other sources of surface water. The IDs can also purchase steam generated electrical power from Arizona Public Service or Salt River Project either through the Arizona Power Authority (APA) or directly. Groundwater pumped with such power may be more expensive than CAP water. Steam power is sold to the EDs and subsequently to the IDs at rates which include a monthly capacity charge based on the irrigation districts' peak use.

Generally, any water needs which exceed available surface water supplies and hydropower-pumped groundwater supplies are met with CAP water or groundwater pumped with steam power. IDs with relatively shallow

groundwater levels find groundwater pumped with steam power less expensive than CAP water, while other IDs with greater pumping depths use steam power only as a last resort when CAP outages or capacity constraints limit the availability of CAP water. Since steam power is sold with both energy and capacity rate components, the IDs will try to schedule the CAP water during peak water demand periods to reduce the payment for capacity to the most expensive pumping power supplier.

Operations During the Recharge Period

Under current policy, surplus CAP water is available for recharge at a reduced price. The ID participating in the recharge project (the "recipient") must agree to reduce groundwater pumping on a gallon for gallon basis in exchange for the indirect recharge water provided to it. The entity who purchases the indirect recharge water (the "permittee") accrues the recharge credits.

Indirect recharge requires that there is both adequate capacity in the CAP canal and adequate demand by the recipient. As a practical matter, these conditions will most often occur simultaneously in the shoulder months on either side of the peak summer demand months. Day-to-day CAP operations will be minimally affected, as recharge water will only be delivered on a space-available basis after all orders for CAP water for direct use have been met.

In an effort to make indirect recharge a viable operating option for IDs with federal hydropower allocations, a method was developed to ensure that the hydropower allocations would be maintained even if the associated power was not used to pump groundwater within the affected ID's service area. In such a case, the participating ID agrees to take delivery of indirect recharge water and forego pumping an equivalent amount of groundwater with its hydropower. The "unused" hydropower is paid for by the participating ID and scheduled to CAWCD for use in delivering all or a portion of the ID's regular CAP water order. The ID is required to pay CAWCD only the non-energy component of the current CAP price for CAP water delivered with the ID's hydropower. Under this plan, the participating ID does not risk losing its hydropower allocation because the power is still being used to deliver water to lands within its service area.

Where CAWCD participates in indirect recharge projects within the Phoenix or Tucson AMAs, recovery is not expected to be a serious concern. Cooperating entities will take future CAP deliveries from our recharge credits using their service area wells as long as we pay the pumping cost. In this case, the CAP customer will continue to pay the

current postage stamp rate for any CAP water recovered and delivered as part of their CAP allocation.

Outside the urban AMAs, a recovery method must be identified and provisions for recovery made in the recharge agreement. CAWCD proposes to recover its underground storage credit by exchange. Essentially, the IDs will submit their water schedules in the usual manner. CAWCD would exercise options obtained via agreement to require them, to the extent that pump capacity is available, to use the CAP underground storage credits to meet some or all of their CAP water orders as well as the orders of Indians and the small M&I entities reachable through their distribution systems. This will leave an equal amount of water in the canal for other users.

Recharge credits may be recovered during times of Colorado River water supply shortages, during planned or unplanned system outages when scheduled CAP deliveries cannot otherwise be made, or at any other time when recovery is beneficial to overall operation of the project. If, in the future, we decide that we have accrued more recharge credits than are needed, we may sell those in excess of our needs.

Financial Arrangement and Ongoing Projects

The CAWCD has nine projects on-going in 1992 with two different financial arrangements. The established price for CAP water to be used for recharge in 1992 is $38/ac-ft which represents the incremental cost of $36/ac-ft for energy to pump the water from the Colorado River to the delivery point and $2/ac-ft for an administrative cost. This price does not include the related fixed operation and maintenance cost of $16/ac-ft. In the most straightforward arrangements, the IDs have identified that their incremental savings for not pumping groundwater is about $13/ac-ft. Consequently, CAWCD pays $25 and the ID pays $13 of the $38 cost. The ID receives CAP water for use at approximately the same out of pocket cost as groundwater and enjoys the benefits of less pump use and a generally raised groundwater table when pumping is required. The CAWCD gains groundwater recharge credits for the cost of $25 ac-ft with no capital cost outlay for recharge or recovery facilities.

In some more complicated arrangements that involve hydropower exchanges, the CAWCD pays the full $38/ac-ft cost and delivers water to the ID at no cost. In turn, the ID purchases the hydropower equivalent to what would have been needed to pump groundwater and directs that hydropower to CAWCD. CAP water delivered to the ID using the ID's hydropower is paid for at $16/ac-ft, the fixed O&M component of the CAP

water price. The CAWCD then markets the additional project power made available as a result of the exchange to enhance the overall revenue available to the CAWCD. One complicating factor for both parties is that the CAP requires about 1600 Kwhr to deliver one acre-foot and the participating IDs use about 850-1000 Kwhr to pump an acre-foot of groundwater. Careful recordkeeping is necessary to demonstrate that the proper amount of energy is scheduled to CAP and only that amount is credited to the ID for subsequent delivery of CAP water.

Table 1 provides a summary of the active projects in 1992, the expected water recharged through each project, and the cost to CAWCD.

Table 1 - CAWCD 1992 Actual and Projected Indirect Recharge Deliveries and Costs

| Indirect Recharge Water Recipient | Max Annual Volume (AF/Yr) | Involves Power Exchange | CAWCD Cost | 1992 Actual and Projected Indirect Recharge Deliveries (Acre-feet) | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| CAIDD | 110,000 | Yes | $38 | 0 | 123 | 1,659 | 4,174 | 4,208 | 7,916 | 11,982 | 0 | 0 | 0 | 0 | 0 | 30,062 |
| | | No | $25 | 0 | 0 | 0 | 0 | 0 | 0 | 14,429 | 28,000 | 14,000 | 1,500 | 1,000 | 1,000 | 59,929 |
| MSIDD | 120,000 | Yes | $38 | 0 | 1,062 | 5,677 | 4,191 | 9,127 | 8,768 | 9,531 | 9,100 | 7,800 | 1,100 | 1,000 | 1,000 | 58,356 |
| | | No | $25 | 0 | 0 | 0 | 0 | 0 | 0 | 14,185 | 11,200 | 12,200 | 4,400 | 1,500 | 1,000 | 44,485 |
| RWCD | 50,000 | No | $25 | 0 | 0 | 0 | 0 | 0 | 0 | 3,561 | 3,000 | 2,000 | 2,000 | 2,000 | 2,000 | 14,561 |
| San Tan | 5,000 | No | $25 | 0 | 0 | 42 | 58 | 367 | 549 | 516 | 850 | 625 | 300 | 250 | 100 | 3,657 |
| Tonopah | 15,000 | No | $25 | 0 | 0 | 0 | 1,142 | 2,373 | 2,417 | 2,838 | 2,750 | 1,000 | 500 | 0 | 0 | 13,020 |
| Hohokam | 40,000 | No | $25 | 0 | 0 | 1,919 | 1,849 | 1,960 | 4,609 | 7,113 | 10,000 | 2,400 | 0 | 0 | 680 | 30,530 |
| Queen Creek | 28,000 | Yes | $38 | 0 | 0 | 0 | 699 | 539 | 676 | 857 | 1,000 | 500 | 0 | 0 | 0 | 4,271 |
| | | No | $25 | 0 | 0 | 1,794 | 1,976 | 3,442 | 4,094 | 4,040 | 5,000 | 1,500 | 200 | 100 | 100 | 22,246 |
| Chandler Hts | 3,000 | Yes | $38 | 0 | 0 | 0 | 120 | 134 | 142 | 160 | 140 | 130 | 140 | 100 | 50 | 1,116 |
| | | No | $25 | 0 | 0 | 0 | 212 | 284 | 202 | 104 | 100 | 60 | 30 | 10 | 0 | 1,002 |
| New Magma | 40,000 | Yes | $38 | 0 | 0 | 0 | 0 | 1,971 | 2,429 | 0 | 3,100 | 2,400 | 0 | 0 | 0 | 9,900 |
| | | No | $25 | 0 | 0 | 0 | 0 | 1,669 | 0 | 2,876 | 3,500 | 1,500 | 500 | 0 | 0 | 10,045 |
| Total | 411,000 | -- | -- | 0 | 1,185 | 11,091 | 14,421 | 26,074 | 31,802 | 72,192 | 77,740 | 46,115 | 10,670 | 5,960 | 5,930 | 303,180 |
| Total CAWCD Costs | | | | $0 | $45,030 | $372,643 | $479,917 | $859,577 | $1,054,153 | $2,097,690 | $2,116,920 | $1,293,665 | $282,870 | $163,300 | $161,900 | $8,927,665 |

Includes actual deliveries through July 1992.

## INSTITUTIONAL REQUIREMENTS

Prior to implementing an indirect recharge program, several institutional arrangements are necessary. After initial agreement with an ID, the first step is the state permitting process administered by the Arizona Department of Water Resources (DWR). The heart of this process is a sound engineering and operational plan that demonstrates that groundwater would have been pumped if the in-lieu project were not in operation. The plan must outline an accounting process which demonstrates the anticipated reduction in groundwater pumping. Some tools in this process include historic groundwater pumping records, cropping pattern, cropped acreage, crop consumptive use, electrical use records, and contracts for electrical power. Each project has its own unique arrangement. The DWR process includes a public notice process which provides opportunity for protest and for resolution of any controversy.

Where hydropower exchange is part of the project, it is necessary to develop an agreement with the supplier and scheduler of the hydropower. In the projects that CAWCD is operating, the Western Area Power Administration is the contractor for the hydropower to the IDs and is the power management agency for CAWCD. This agreement is necessary to ensure that the power allocation is not lost because the power is still being used to pump water to the land.

Appropriate agreements identifying the operating plan, recovery plan, costs, and accounting procedures must be developed between the indirect recharge project permittee and the water recipient.

## CONCLUSIONS

Indirect recharge provides a comparatively low cost method of increasing the short term utilization of the CAP and providing long-term storage of available Colorado River supplies that would otherwise be lost to Arizona. An evaluation of current and projected economic conditions, water supply conditions, and anticipated water demand indicates that excess water supplies may be available for 10 to 15 years, but additional water supplies will be needed in 25 to 40 years. With the passage of legislation enabling the establishment of indirect recharge programs in 1990, CAWCD moved aggressively to implement a number of such projects in 1992. Nonetheless, water supplies and opportunities still exist. The main question is: "How much long-term storage can be justified (at what cost) in consideration of today's economic conditions?"

At whatever level determined to be justified, indirect recharge provides storage for long-term water supply, operational flexibility, and increased project utilization at the lowest cost when compared to surface storage, direct recharge, and development of new alternative water supplies.