# The Potential Economic Costs of a Gila River Diversion

## Meeting Future Water Supply Needs in Silver City and the Central Mining District

**Prepared for**

**The Gila Conservation Coalition**

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***From the Southwest Paddler web site (http://southwestpaddler.com):***

*[The Gila River from the East Fork confluence to Forest Road 809 at Mogollon Creek is about 42 miles] of very exciting Class II to III whitewater that has the added bonus of man-made hazards in the form of small diversion dams and barbed wire fences, just in case the near-continuous boulder gardens are not enough excitement. This tremendously scenic run, sometimes referred to as the "Wilderness Run", requires quick mental dexterity, effective control maneuvers and the good judgment to know when to run and when to portage. Dead-fall strainers are commonplace, and often take away good lines through rapids and drops.*

*However, this run is not only about avoiding disaster on the river. There are many places to explore along the banks and in side canyons, some of which provide views of petroglyphs dating to before Spaniards invaded this beautiful place that was the ancestral home to tribes of the Apache and Comanche Nations thousands of years ago. Wild animals and birds of many species far outnumber people, and the quantity of river hazards probably do, as well. The admonition about rattlesnakes given for the Cliff Dwellings to East Fork run applies here, and to all runs on the Gila River in New Mexico.*

*The river cuts through a geological wonderland of igneous, sedentary and metamorphic rock in mountains covered with beautiful pinon juniper, ponderosa pine and evergreen fir trees down to about 5,500 feet msl. Riverbanks are lined with equally gorgeous growths of sycamore, cottonwood, and alder trees, as well as indigenous grasses and brush. Leaving the "wilderness" area, the river flows through open ranchland and private property from the Little Burro Mountains down to the top of the "Middle Box" area, so please avoid unnecessary trespassing. Bring your best paddling skills, and don't forget to pack the camera, when winter snows begin to melt in the mountain forests of southwestern New Mexico.*

# TABLE OF CONTENTS

LIST OF ACRONYMS .......... ii
EXECUTIVE SUMMARY .......... iii
SECTION 1 – INTRODUCTION .......... 1-1
SECTION 2 – FUTURE MUNICIPAL WATER SUPPLY NEEDS .......... 2-1
Future Water Demand .......... 2-1
Future Supply from Current Sources .......... 2-5
Scenarios of Future Water Supply Needs .......... 2-7
SECTION 3 – PRELIMINARY ECONOMIC ANALYSIS OF WATER SUPPLY ALTERNATIVES AND CONSERVATION .......... 3-1
Cost-Effectiveness Methodology .......... 3-2
A Gila River Diversion Project Under CUFA .......... 3-2
New Well Fields .......... 3-5
Conjunctive Use .......... 3-11
Summary of Economic Analysis .......... 3-14
Municipal Conservation .......... 3-15
SECTION 4 – IMPACT OF AWSA SUBSIDIES .......... 4-1
Subsidy Allocation Scenario 1 – Grant County Bears Costs .......... 4-1
Subsidy Allocation Scenario 2 – Regional Cost Sharing .......... 4-3
SECTION 5 – POTENTIAL ECONOMIC COSTS DUE TO ECOLOGICAL IMPACTS OF A GILA RIVER DIVERSION PROJECT .......... 5-1
Environment-Economy Relationship .......... 5-2
Economic Values Derived from Water Resources .......... 5-4
Preliminary Estimates of Economic Costs due to the Ecological Impacts of a Gila River Diversion .......... 5-6
SECTION 6 – SUMMARY .......... 6-1
APPENDIX A – GROUNDWATER BUDGET FOR THE MIMBRES BASIN .......... A-1
APPENDIX B – PHELPS DODGE WATER RIGHTS, CONSUMPTION, AND UNUSED WATER RIGHTS .......... B-1
APPENDIX C – SUMMARY OF STUDIES OF ECONOMIC VALUES PROVIDED BY NATURAL RESOURCES .......... C-1
APPENDIX D – BIBLIOGRAPHY .......... D-1

# List of Acronyms

| | |
|---|---|
| acre-ft/yr | acre-foot per year |
| AWSA | Arizona Water Settlements Act |
| CAP | Central Arizona Project |
| cfs | cubic feet per second |
| CUFA | Consumptive Use and Forbearance Agreement |
| DBS&A | Daniel B. Stephens & Associates, Inc. |
| GCC | Gila Conservation Coalition |
| gpcd | gallons per capita per day |
| LCBDF | Lower Colorado River Basin Development Fund |
| NMISC | New Mexico Interstate Stream Commission |
| OSE | New Mexico Office of the State Engineer |
| USFWS | United States Fish and Wildlife Service |

# EXECUTIVE SUMMARY

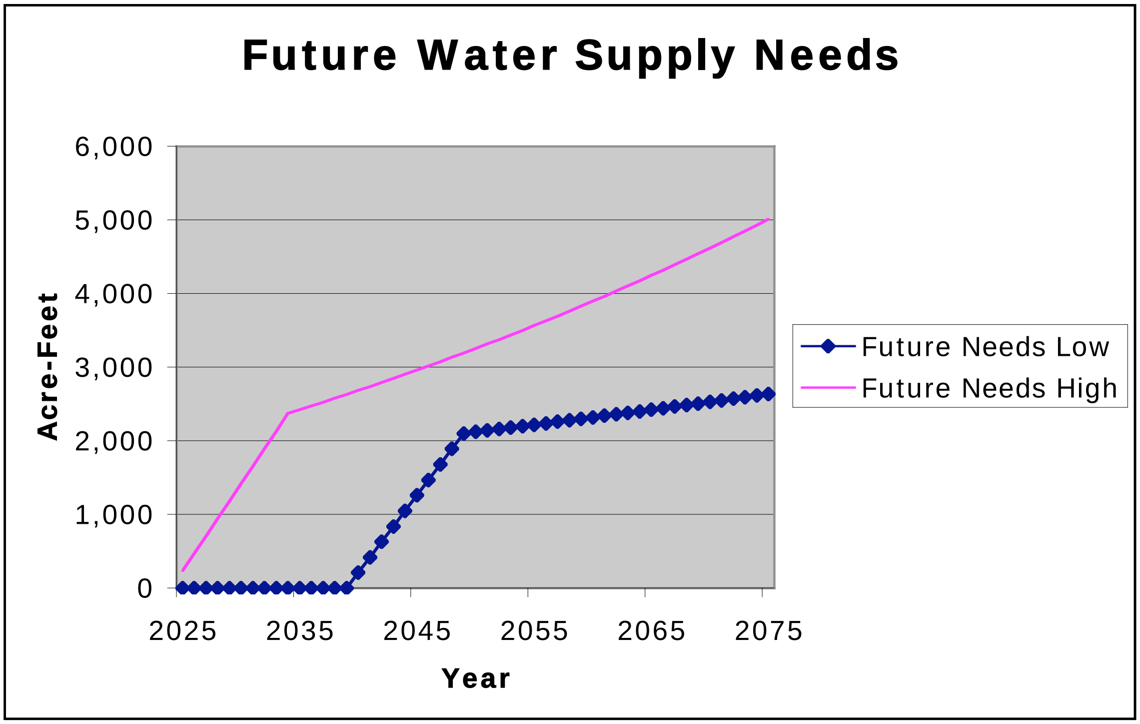
This report presents a preliminary economic analysis of a proposal to divert water from the Gila River in southwestern New Mexico. The proposed project is being discussed because the Arizona Water Settlements Act of 2004 (AWSA), a complex piece of legislation that addresses multiple disputes associated with the Central Arizona Project, provides $66 million of federal dollars for local and/or regional water supply projects, and up to an additional $62 million to subsidize the consumptive use of 14,000 acre-feet of water per year, on average, from the Gila River, its tributaries, or underground water sources. The most likely buyers of such water would be municipal water users in Grant County, New Mexico, specifically Silver City and the communities that make up the Central Mining District. Given the lack of current studies addressing the costs of water supply alternatives and demand in this market, this economic analysis provides a first step toward a more complete water plan for the region.

The analysis is necessarily preliminary. Detailed plans for the proposed diversion project have not been developed and, hence, it is possible to provide only a rough description of its potential economic costs by making assumptions regarding its location, scope, and ecological impacts. The available cost information regarding alternative sources of water is similarly limited and, hence, the analysis provides rough estimates based on multiple assumptions. The report describes each assumption as clearly as possible and examines the underlying uncertainty associated with major assumptions and how this uncertainty affects the analysis. The 2005 Southwestern New Mexico Regional Water Plan was the primary source of data for this economic analysis.

## Future Water Supply Needs

A forecast of future water supply needs is critical to gaining insight into the relative economics of various supply alternatives. The analysis developed two scenarios of future needs, low and high, to reflect demand growth uncertainty as well as uncertainty regarding the lifetime of current well fields in Silver City and the Central Mining District. Figure ES-1 illustrates the two scenarios for the period 2025-2075, the assumed lifetime of a Gila River diversion project. The low future needs scenario reflects low demand growth assumptions and that current well fields meet the region's needs through 2040, after which their pumping is reduced by 50 percent. The high future needs scenario reflects high demand growth assumptions and that current well fields meet the region's needs only until 2025 before pumping is reduced. The region's current water rights at or in the vicinity of its well fields are exceeded after 2054 in the high needs scenario.

**Figure ES-1.**




## Supply Alternatives

The alternatives evaluated are a new Gila River diversion project under the AWSA, drilling new well fields, and conjunctive use of groundwater water with a surface water diversion from the Gila River through existing facilities owned by Phelps Dodge Corporation. The assumption is that surface water rights would be purchased/leased from Phelps Dodge. The analysis also assumes that a regional water distribution system has been put in place by 2025, and therefore each supply alternative is expected to meet the future water needs of the entire region as defined by the scenarios in Figure ES-1. The costs of each alternative are evaluated and compared under the low and high scenarios of future water needs. In addition, given a least-cost supply alternative for each scenario, the maximum willingness to pay for municipal water conservation is then determined. This is based on the savings from delaying and/or avoiding supply-side investments due to demand reductions. Investments in conservation should be made prior to any supply-side investments if the costs of the conservation measures are less than this willingness to pay.

## Major Findings

The analysis yields these major findings and conclusions:

1. **Before investing in new supply sources, it is cost-effective for Silver City and the Central Mining District to spend $3 million to $21 million on conservation measures that can achieve a 20 percent reduction in demand by 2025. These conservation measures could include infrastructure improvements and/or efficiency improvements in indoor and outdoor water use.**

If Silver City and the Central Mining District experience the scenario of low future supply needs, the region should be willing to pay up to $164/acre-foot, or up to $3.3 million, for conservation measures providing an annual 20 percent reduction in demand between 2025 and 2075. If the region finds itself on the high needs path, then the willingness-to-pay for a 20 percent demand reduction increases to $832/acre-foot, or $21 million. Such conservation programs will be more economical than either drilling new well fields or conjunctive use, and much less expensive than a Gila River diversion project.

2. **Excluding potential federal subsidies, a Gila River diversion project's total construction and operation costs are at least 8 times greater than the costs for comparable alternatives and potentially as much as 34 times greater.**

Under the low future water supply needs scenario, a Gila River diversion costs at least $11,031/acre-foot and $287.2 million in present value.[1] The least-cost alternative for this scenario is drilling new well fields with a cost of $502/acre-foot and a total present value cost of $13.1 million, twenty-two times less expensive. If future water supply needs are high, a Gila River diversion would cost at least $4,153/acre-foot. The least-cost alternative in this case is conjunctive use of groundwater and surface water with costs of $492/acre-foot and $34.1 million, eight times less expensive than a Gila River diversion. Summary Tables 1 and 2 present the costs of the supply alternatives for the low and high scenarios of future supply needs, respectively.

[1] A "present value" is the one-time amount equivalent to a future stream of costs and/or benefits. Future values are converted to the present with a discount rate.

**Summary Table 1**

**Costs of Supply Alternatives for**
**Silver City and the Central Mining District**
***--Low Scenario of Future Water Supply Needs--***

| | | Cost-Effectiveness ($/acre-foot) | Total Cost ($ millions, present value) | Increase in Cost Relative to Least-Cost Alternative (multiplier) |
|---|---|---|---|---|
| New Well Fields | | 502 | 13.1 | -- |
| Conjunctive Use | | 565 | 14.7 | 1.12 |
| Gila River Diversion Under | | | | |
| CUFA, Cost Scenario* | (1) | 11,031 | 287.2 | 22 |
| | (2) | 13,985 | 364.1 | 28 |
| | (3) | 17,057 | 444.1 | 34 |

*Low, medium, and high capital cost scenarios were evaluated

**Summary Table 2**

**Costs of Supply Alternatives for**
**Silver City and the Central Mining District**
***--High Scenario of Future Water Supply Needs--***

| | | Cost-Effectiveness ($/acre-foot) | Total Cost ($ millions, present value) | Increase in Cost Relative to Least-Cost Alternative (multiplier) |
|---|---|---|---|---|
| Conjunctive Use | | 492 | 34.1 | -- |
| New Well Fields | | 533 | 36.9 | 1.08 |
| Gila River Diversion | | | | |
| under CUFA, Cost Scenario | (1) | 4,153 | 287.2 | 8 |
| | (2) | 5,265 | 364.1 | 11 |
| | (3) | 6,421 | 444.1 | 13 |

3. **After accounting for federal subsidies provided by the Arizona Water Settlements Act (AWSA), and assuming that Grant County would bear all remaining project costs, a Gila River diversion would cost at least 16 times more than drilling new well fields or conjunctive use. The diversion would increase the costs of meeting future demand in Silver City and the Central Mining District by at least $268 million.**

Summary Table 3 summarizes the impact of the AWSA subsidies on Silver City and the Central Mining District's costs to meet future demand.

**Summary Table 3**

**Silver City and Central Mining District Perspective with AWSA Subsidies**

| | (All costs in $ millions, present value) | | | | Cost-Effectiveness ($/acre-ft) | |
|---|---|---|---|---|---|---|
| Alternative | Total Cost Before Subsidies | Diversion Project Subsidy | Local Projects Subsidy | Net Cost | Low Future Needs | High Future Needs |
| Gila River Diversion | 364.1* | 62.0 | 16.5 | 285.5 | 10,969 | 4,129 |
| New Well Fields (for low scenario of future needs) | 13.1 | N/A | 16.5 | -3.4 | -132 | N/A |
| Conjunctive Use (for high scenario of future needs) | 34.1 | N/A | 16.5 | 17.6 | N/A | 254 |

***The middle capital cost scenario is used**

**4. From an individual county perspective, a Gila River diversion would impose substantial per capita costs, even after AWSA subsidies. Grant County's per capita costs for the diversion are $9,212 per person. Without the diversion, the county would be free to use its share of the $66 million local/regional project subsidy in the most cost-effective manner, and the per capita costs of meeting future supply needs would be at most $567 per person.**

Assuming Grant County bears all the costs of the diversion, the other counties in the region will benefit by the amount of the $66 million subsidy they receive. Note that the results presented above assume that the entire potential capital cost subsidy ($62 million) essentially goes to Grant County to defray the costs of a Gila River diversion.

**5. A Gila River diversion project could have significant negative ecological impacts due to stream flow reductions as well as from the construction of diversion and pumping facilities, pipelines, roads, and an intermediate storage reservoir. If the residents of New Mexico hold values for the Gila River's ecological attributes similar to those found in studies regarding similar natural resource amenities elsewhere, the economic costs due to ecological impacts could almost double the subsidized project costs.**

Insofar as a related analysis indicates that the proposed diversion project almost certainly would have adverse ecological impacts, it is reasonable to conclude that the economic costs associated with them also would be significant. These economic costs include the project's potential negative impacts on:

- The economic values of river-related aesthetics, recreation, and tourism.
- The economic values deriving from the quality of life provided by the river.
- The economic values associated with the river's relatively free-flowing status, unique in New Mexico.
- The economic values associated with the existence of specific species of native flora and fauna, especially species at-risk of extinction.
- The economic values of the ecosystem services—such as property values and scientific opportunities—provided by the riverine ecosystem.
- The economic values associated with the river's ability to provide high-quality water, which could materialize if reduced flows downstream of the point of diversion affect sediment loads or induce proliferation of tamarisk (saltcedar) that increase water salinity or reduce stream flow even further.

Summary Table 4 indicates the potential extent of economic costs due to the anticipated ecological impacts of a Gila River diversion project.

**Summary Table 4**

**Potential Economic Costs due to the Anticipated Ecological Impacts of a Gila River Diversion Project**

| | Flow Reduction | Diversion Facilities | Storage Reservoir | Pumping and Pipelines |
|---|---|---|---|---|
| Domestic Wells | X | | | |
| Mining | X | | | |
| Agriculture | X | | | |
| Water Quality | X | | X | X |
| Property Value | X | | X | X |
| Aesthetics | X | X | X | X |
| Recreation | X | X | X | X |
| Tourism | X | X | X | X |
| Scientific Opport. | X | | | |
| Existence Value | X | X | X | X |
| Bequest Value | X | X | X | X |

The information currently available for the Gila River ecosystem and for the proposed project is not sufficient to support an estimation of the project's potential negative impact on each category of value. However, if the results from studies conducted elsewhere regarding the existence value of free-flowing rivers are applicable to the Gila River, then the economic costs could be $218 million, almost doubling the monetary costs the project would impose on local residents after subsidies.

# Section 1

# INTRODUCTION

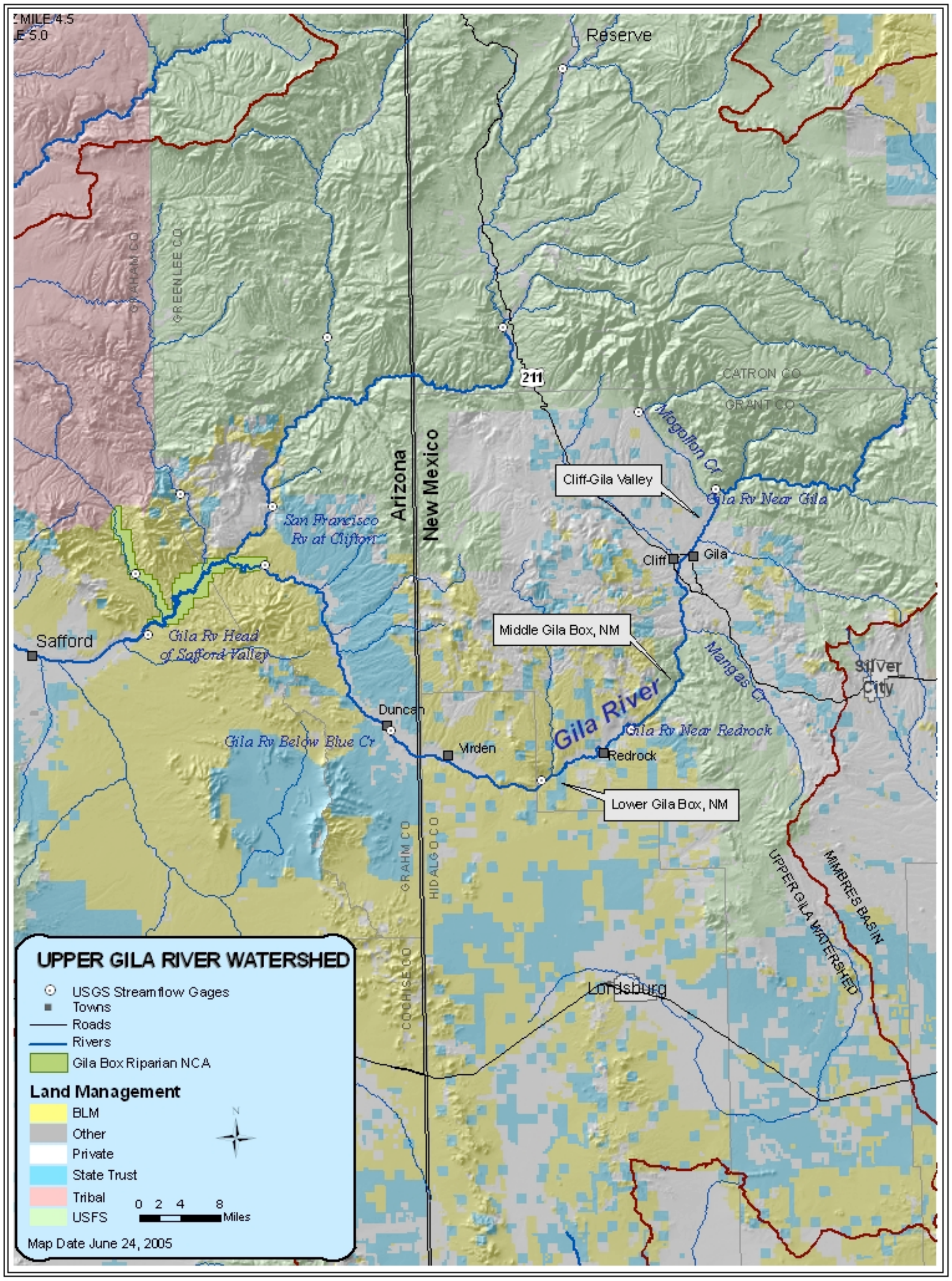
The Gila River is New Mexico's last main-stem river without a large dam or other major water development. Its headwaters are in the Gila Wilderness Area between the Mogollon Mountains and the Black Range north of Silver City, and it flows through Southwestern New Mexico for about 150 miles before entering Arizona near Virden (see map in Figure 1-1). Although it has several small irrigation diversions and one mining diversion, the Gila is one of the last relatively free-flowing rivers in the western United States. The river is largely perennial from its source to the New Mexico/Arizona state line. Its natural flow regime, characterized by its extreme variability, or "flashiness," due to late winter and early spring floods, preserves one of the best examples of native cottonwood-willow riparian habitat found anywhere in the Southwestern United States. This habitat supports a unique and diverse ecosystem created by the merging of the Chihuahuan, Sonoran, and Southern Rocky Mountain eco-regions and a vertical change from desert shrub to sub-alpine forest within the watershed.

Specific ecological attributes of the Gila River ecosystem include:

- The densest population of non-colonial breeding birds in the United States.
- Some of the best remaining bird habitat left in the lower Colorado River basin and the greatest diversity of raptors and the largest number of endangered, threatened, and peripheral bird species in the basin.
- It is the only watershed in New Mexico that still has all its native fish, a tribute to its relatively unmodified flow regime.
- The watershed sustains over twenty-five federal and state-listed threatened and endangered species, including the peregrine falcon, Mexican spotted owl, spikedace, and loach minnow.
- One of the largest populations of endangered southwestern willow flycatchers anywhere in the world is found in the Cliff-Gila Valley in the Upper Gila River Basin.

In addition to its unique ecological values, the Gila River provides many values derived from the direct and indirect use of its water by people. Recreation is popular all along the Gila River and includes rafting, canoeing, kayaking, hiking, fishing, and birding. Small agricultural communities have historically withdrawn and returned water to the river through a series of acequias whose riparian vegetation supports important components of the ecosystem. The Phelps Dodge Corporation diverts water from the Gila River downstream of the Cliff-Gila Valley to support its Tyrone copper mine operations. The town of Silver City is increasingly attracting retirees and tourists drawn to the area's environmental amenities, including river-related amenities.

**Figure 1-1.**
**Map of the Gila River**



These values are potentially threatened by the Arizona Water Settlements Act of 2004 (AWSA). This act settles long-standing disputes between the State of Arizona, Arizona tribes, and the State of New Mexico. In the part of the settlement related to New Mexico, the AWSA permits the Secretary of the Interior to contract with water users in New Mexico (the "NM CAP entity") for water from the Gila River, its tributaries, and underground water sources in an amount that may not exceed a consumptive use of 140,000 acre-feet in any ten consecutive years (Section 212). The AWSA guarantees Southwestern New Mexico at least $66 million in non-reimbursable federal funding from the Lower Colorado River Basin Development Fund (LCBDF), beginning in 2012 (Section 107). These funds may be used for a diversion project (the "New Mexico Unit") or for other "water utilization alternatives to meet water supply demands" (Section 212). If New Mexico elects to build the diversion project, additional funding of $34 million to $62 million will be available, depending on the rate of return in the LCBDF (Section 212).

An important part of the AWSA is the New Mexico Consumptive Use and Forbearance Agreement, or CUFA. The CUFA is a complex agreement among the states of New Mexico and Arizona, and Arizona water users, providing the details of how and when New Mexico Unit diversions may occur. Within the ten-year limit of 140,000 acre-feet, up to 64,000 acre-feet may be consumptively used within a single year. Of the average 14,000 acre-feet per year that may be diverted, up to 4,000 acre-feet per year may be taken from the San Francisco River, a Gila River tributary.

Due to issues of distance, topography, and therefore ultimate costs, a Gila River diversion project would most likely target the municipal needs of the closest, large demand center: northern Grant County, specifically Silver City and the nearby communities of Santa Clara, Bayard, Hurley, and Hanover (also known as the "Central Mining District"). According to the Southwestern New Mexico Regional Water Plan ("the regional water plan"), the remoteness of other demand centers in Southwestern New Mexico (e.g., in Luna and Hidalgo counties) will make them "impracticably costly to serve."[1] These areas are primarily concerned with agricultural water consumption as opposed to municipal. The price of water from a Gila River diversion is unlikely to be affordable for agricultural users. While Catron County could receive up to 4,000 acre-feet per year from the San Francisco River, this analysis assumes that the "Gila River diversion project" evaluated herein is located on the Gila River. This approach is consistent with the description and cost estimates of the potential diversion project in the regional water plan. [2]

Diverting water from the Gila River has been a very controversial issue in the past. The Hooker and Conner Dam projects that were proposed in the 1970s and 1980s generated significant opposition and inspired the formation of the Gila Conservation Coalition, a group dedicated to preserving the Gila River and its ecosystem. The dams were not built

[1] Daniel B. Stephens and Associates, Southwestern New Mexico Regional Water Plan, Draft, January 2005, p. 8-103. [Hereafter referred to as DBS&A.]

[2] DBS&A, Section 8.6.3.1.

due to findings of significant environmental impact by the Bureau of Reclamation and due to a cost-benefit analysis showing the purchase of unused water rights would cost about one-half that of a river project. The current plans for the New Mexico Unit have been characterized by public officials as an off-stream diversion project,[3] but nothing in the AWSA or CUFA specifies the type of project that could be built.

Implementation of the AWSA in New Mexico will be decided by the Southwest New Mexico Water Planning Group (a group of local government representatives) and the New Mexico Interstate Stream Commission. This group must notify the Secretary of the Interior by 2014 if it chooses to build a Gila River diversion project. As input to this decision process, the Gila Conservation Coalition (GCC) decided it was important to characterize the potential impacts of a diversion project on the ecological and economic values provided by the Gila River and to evaluate the cost-effectiveness of the diversion, compared to alternative sources of water, to meet the needs of Silver City and the Central Mining District. GCC's fiscal agent, the Gila Resources Information Project, contracted with ECONorthwest, an economics consulting firm specializing in natural resource issues, to perform this analysis. This remainder of this report is organized as follows:

- Section 2 – Future Municipal Water Supply Needs
- Section 3 – Preliminary Economic Analysis of Water Supply Alternatives and Conservation
- Section 4 – Impact of Arizona Water Settlements Act Subsidies
- Sections 5 – Potential Economic Costs due to Ecological Impacts of a Gila River Diversion Project
- Section 6 – Summary

[3] Soussan, Tania, "Stream Panel Backs Plan to Let New Mexico Tap Gila River," Albuquerque Journal, September 14, 2004.

# Section 2

# FUTURE MUNICIPAL WATER SUPPLY NEEDS

The future municipal water supply needs of Silver City and the Central Mining District are uncertain because future demand and the remaining lifetimes of current supply sources are uncertain. Since the Southwest New Mexico Water Planning Group decision on a Gila River diversion must be made by 2014, it will necessarily occur well before the demand that the project would meet is known. Because the Secretary of Interior's decision is due in 2019, this analysis assumes that the earliest date of operation for a Gila River diversion project is 2025. Assuming the typical 50-year life for such a project, it is therefore necessary to examine the period 2025-2075.

Two scenarios of future water supply needs (low and high) are developed from information in the regional water plan as well as from other publicly available sources and are described in detail below. To summarize, the low scenario of future water supply needs is based on an assumption of low demand growth and that current well fields are able to meet all demand cost-effectively through 2040. After 2040, new sources would be needed to prevent significant drawdowns, and, therefore, pumping from current well fields would be gradually reduced over time as new sources are brought online. In the high scenario, demand growth is assumed to be high, and this shortens the length of time that the current well fields are able to meet demand cost-effectively. In this high scenario, new sources would be needed beginning in 2025 as pumping from the current well fields is gradually reduced beginning in this year.

This section describes the detailed assumptions used for demand growth, the available data on the ability of the current well fields to meet future demands, and then presents the low and high scenarios of future water supply needs.

## Future Water Demand

Future water demand in Silver City and the Central Mining District depends on population growth and per capita demand. Due to the lack of a specific demand forecast for these communities in the regional water plan (the plan includes a demand forecast only for Grant County as a whole), this analysis bases its demand forecast on the population forecasts in the regional water plan and then applies per capita demand estimates that are based on the most recent usage data available.

**Population Growth.** The regional water plan provides low and high forecasts of population growth for Grant County as a whole as well as for Silver City and the Central Mining district separately through 2040. In both forecasts, Grant County's population is expected to decline in the near term and then recover and grow over the long term. Overall, Grant County is forecast to grow by 16 percent between 2000 and 2030. The plan's forecasts are based on data from the University of New Mexico's Bureau of Business and Economic Research (BBER). The BBER's growth rates for Grant County between 2000 and 2030 are consistent with the most recently released U.S. Census forecast for New Mexico as a whole, although it should be noted that the BBER's forecasts for Luna County are significantly greater than the U.S. Census.[1]

Tables 2-1 and 2-2 show the low and high forecasts developed for the population served by municipal water supplies in Silver City and the Central Mining District.[2] Note that the population figures for Silver City are estimates of its entire service area and are not based on the regional water plan. In 1990, the service area population was 15,365 according to the city's 40-yr plan,[3] and the population of Silver City was 10,683.[4] The figures shown below are based on U.S. Census data for Silver City in 2000 (10,545) plus an assumption of 12 percent growth in the service area population outside of Silver City since 1990 to reflect the growth of Grant County as a whole between 1990-2000.[5]

**Table 2-1. Low Forecast of Population Served by Municipal Water Supply**

| | 2000 | 2025 | 2040 | 2075 |
|---|---|---|---|---|
| Silver City | 15,789 | 16,458 | 17,789 | 21,108 |
| Santa Clara | 1,944 | 2,019 | 2,169 | 2,538 |
| Bayard | 2,536 | 2,634 | 2,829 | 3,311 |
| Hurley | 1,600 | 1,662 | 1,785 | 2,089 |
| Hanover | 300 | 312 | 335 | 392 |
| Total | 22,169 | 23,085 | 24,906 | 29,347 |

**Table 2-2. High Forecast of Population Served by Municipal Water Supply**

| | 2000 | 2025 | 2040 | 2075 |
|---|---|---|---|---|
| Silver City | 15,789 | 17,780 | 21,263 | 32,281 |
| Santa Clara | 1,944 | 2,168 | 2,554 | 3,746 |
| Bayard | 2,536 | 2,828 | 3,332 | 4,887 |
| Hurley | 1,600 | 1,784 | 2,102 | 3,083 |
| Hanover | 300 | 335 | 394 | 578 |
| Total | 22,169 | 24,894 | 29,647 | 44,575 |

[1] Associated Press, "Bureau projects slowdown in state population growth" 5/25/05.
[2] Population growth after 2040 is assumed to be at the same rate as from 2030 to 2040.
[3] Engineers Inc., "A 40-Year Water Plan for the Town of Silver City, New Mexico," October 1993, p. 27.
[4] U.S. Census Bureau.
[5] U.S. Census Bureau.

Note that the regional water plan forecasts the same negative growth between 2000 and 2010 in both the low and high forecasts. Growth resumes an overall positive trend after 2010, but the population does not recover to its 2000 level until almost 2020 in either scenario.

**Per Capita Demand.** Combining population estimates with per capita demand produces total demand. The regional water plan forecasts future demand using an average of 166 gallons per capita per day (gpcd) for Grant County.[6] This average value likely overestimates future consumption in the Silver City service area and the Central Mining District for two reasons.

First, the regional water plan's estimates for Silver City's service area population and gpcd are not consistent with the city's last 40-year water plan. The regional water plan assumes a service area population of 13,700 and a gpcd of 234 in 2000.[7] The city's 1993 plan estimated the 1990 service area population at 15,365 (10,683 of which was Silver City).[8] Applying the most recent U.S. Census data for Silver City versus Grant County as a whole produces an estimated service area population of 14,874 in 2004 (9,893 in Silver City).[9] Water pumped in 2004 was 2,724 acre-feet, resulting in 164 gpcd.

The analysis presented herein uses 164 gpcd for Silver City in order to be consistent with the prior approach taken by the city. Per capita demand for the other communities is based on the regional water plan.[10] The resulting average per capita demand for Silver City and the Central Mining District is about 148 gpcd, almost 20 gpcd less than the regional water plan assumption for Grant County. Table 2-3 summarizes the per capita demand for each community used in the analysis.

**Table 2-3. Per Capita Demand**

| Water System | Per Capita Demand (gpcd) |
|---|---|
| Silver City | 164 |
| Santa Clara | 105 |
| Bayard | 118 |
| Hanover | 61 |
| Hurley | 103 |
| *Weighted Average* | *148* |

[6] DBS&A, p. 6-9.
[7] DBS&A, p. 6-8.
[8] Engineers Inc., p. 27.
[9] U.S. Census Bureau
[10] DBS&A, Appendix E, Table E2-2.

The second problem with using 166 gpcd, or any fixed value for the forecast, is that it will not reflect the natural replacement of older plumbing fixtures with more water-efficient devices. Since all new residential construction since 1994 has utilized low flow toilets (i.e., 1.6 gallons per flush) per the Energy Policy Act of 1992, current average demand will overestimate future demand in the residential sector as new housing is built and pre-1994 toilets are replaced. The average savings from low flow toilets are estimated at 10 gpcd.[11]

Taking these issues into account, the forecast of demand in Silver City and the Central Mining District uses the values shown in Table 2-3 as the *initial* per capita demands but then assumes that they will decline by 10 gpcd by the year 2020 to reflect the natural replacement of pre-1994 toilets (average toilet lifetime is 20-25 years) and new construction. This is a conservative assumption, as low flow faucets and showerheads will also be used in new construction and will have replaced less efficient devices by then. From 2020 on, per capita demand is assumed to remain fixed at its 2020 level, approximately 138 gpcd. Note that the per capita demand assumptions do not assume any new conservation measures—the potential for conservation will be discussed in Section 3 along with the water supply alternatives.

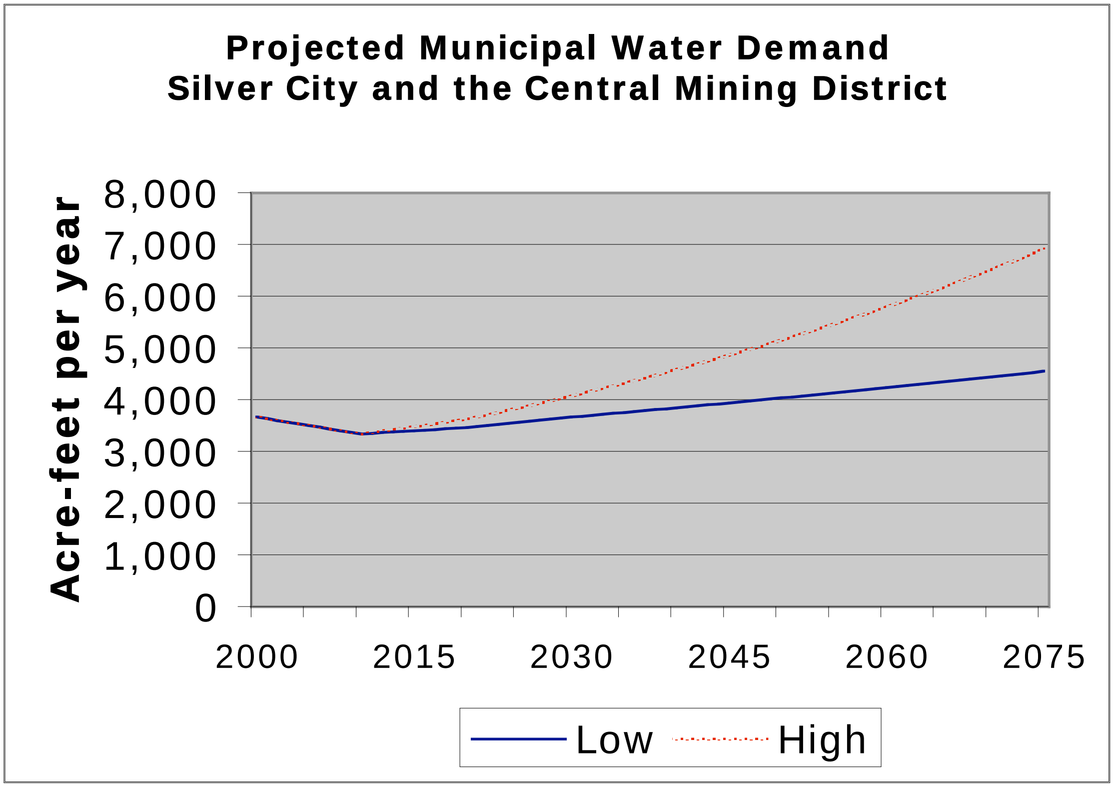
**Demand Forecast.** The demand forecast is calculated by multiplying the population in a given year by the per capita demand estimate for that year. Table 2-4 shows the low and high demand forecasts for selected years out to 2075. Figure 2-1 illustrates the demand scenarios graphically.

**Table 2-4. Municipal Water Demand Forecast for Silver City and the Central Mining District (acre-feet)**

| | 2000 | 2025 | 2040 | 2075 |
|---|---|---|---|---|
| Low Scenario | 3,669 | 3,563 | 3,847 | 4,552 |
| High Scenario | 3,669 | 3,845 | 4,584 | 6,913 |

[11] www.awwa.org

**Figure 2-1.**




## Future Supply from Current Sources

Municipal water supplies for Silver City and the Central Mining District are provided by well fields in the Mimbres and Gila Basins. Silver City's Woodward, Anderson, and Hayes well fields in the Mimbres Basin provide 70 percent of its needs. The remaining 30 percent is drawn from the Franks well field in the Gila Basin. The Central Mining District communities all draw their municipal water supply from the Mimbres Basin. Santa Clara and Bayard rely on the Lone Mountain and Bayard well fields, respectively. Hurley's water is purchased from wells owned by the Phelps Dodge Mining Company. Hanover has historically provided its own water from two local wells, although in May 2004 the town's wells ran dry due to mechanical problems. Hanover's wells are now providing limited supplies with the balance of water needs being met by water deliveries from the National Guard and from donated bottled water.

According to the regional water plan, Silver City owns 4,739 acre-feet per year in water rights, with 4,431 acre-feet per year at or in the vicinity of its current well fields, while Bayard and Santa Clara own water rights of 467 and 515 acre-feet per year, respectively, in the vicinity of their well fields.[12] Thus, total water rights in the vicinity of the well fields for these communities are 5,413 acre-feet per year. These water rights exceed projected demand throughout the entire time horizon in the low demand growth scenario,

[12] DBS&A, Appendix E, Table E2-2.

and are exceeded only after 2054 in the high demand growth scenario. The remainder of this subsection presents the currently available data regarding the ability of existing well fields to keep pace with demand.

**Existing Well Fields.** Recent studies indicate that Silver City's current well fields will continue to be able to meet demand at least until 2040. A 2002 study by Balleau Groundwater Inc. for Silver City concludes " each operating city well has more than 40 years of remaining service at projected rates with or without additional effects of a 575 acre-foot per year transfer to the Franks well field."[13] The regional water plan relies on a report prepared for the Office of the State Engineer by Johnson et al. (2002). This report states "with careful management and distribution of pumping it may be possible to meet Silver City's demands alone with its existing well field locations until the year 2040.[14] By 2060, however, the Johnson study indicates that drawdowns at Silver City's well fields range from 56 percent to 100 percent.

It is important to note that the Johnson study is based on a demand forecast (Wilson, 2001) even higher than the high forecast in the regional water plan. The Wilson study used per capita demands of 208, 126, and 117 for Silver City, Bayard, and Santa Clara, respectively, and assumed these per capita demands rise to 230 (for Silver City) and 130 (for Bayard and Santa Clara) by 2020.[15] Projected demand in 2040 for Silver City, Bayard, and Santa Clara is 5,574 acre-feet according to Wilson,[16] while the forecast in the regional water plan for all of Grant County in 2040 is 5,324 acre-feet.[17] The high demand forecast for 2040 in Silver City and the Central Mining District developed for this analysis is 4,584 acre-feet. Thus, the drawdowns predicted by Johnson would appear to be more dramatic than what would be indicated by more recent demand forecasts.

As for Santa Clara and Bayard, the most recent information comes from the Johnson study, again with very high demand assumptions. It modeled drawdowns at the Lone Mountain and Bayard well fields ranging from 75 to 83 percent by 2040 and almost 100 percent by 2060.[18] If a regional water system were put in place so that Silver City's well fields would be used to meet demand in Santa Clara and Bayard, the Johnson analysis indicates that Silver City's wells would experience drawdowns ranging from 52 percent

[13] Balleau Groundwater, Inc., Technical Memorandum, BGW Field Survey of Silver City Supply Wells - August 27, 2002.
[14] Johnson, et al., "Analysis of Effects of Groundwater Development to Meet Projected Demands in Regional Planning District 4, Southwest New Mexico," New Mexico Office of the State Engineer, Draft Hydrology Report 02-X, March 2002, p. 22.
[15] Wilson, Brian C. "Projected Water Demands in Grant, Hidalgo, and Luna Counties, New Mexico, 2000 to 2040," New Mexico Office of the State Engineer, December 16, 2001, Tables 3-5.
[16] Wilson, Table 6.
[17] DBS&A, p. 6-29.
[18] Johnson, p. 53.

to 100 percent by 2040, while the Lone Mountain and Bayard well fields would recover to about 70 percent of their initial water column due to cessation of pumping.[19]

According to Johnson, large drawdowns do not necessarily mean that wells cannot continue to be pumped.[20] Many well-specific physical issues determine the amount of water that may be produced. For example, well pumps could be lowered and well production could continue with higher energy costs. It is also a mistake to assume that the forecasted drawdowns imply a lack of water in the aquifer. While cones of depression will occur in the vicinity of the affected wells, Johnson states that:

> *Additional wells in other locations could reduce drawdowns by spreading pumping laterally, replacing existing sources or extending their productive lives. This option is available primarily in the Mimbres Basin to the southeast of the Anderson and Hayes wells, and perhaps also northwest of the Franks well field. New well fields in the Mimbres Basin are another option, and 53 specific potential well sites have been identified.*[21]

Additional discussion of the availability of groundwater in the Mimbres Basin appears in Section 3 regarding the water supply alternative of drilling new wells.

To summarize, the information reviewed in this subsection indicates that meeting the combined demands of Silver City and the Central Mining District will cause significant drawdowns by 2040 in the region's existing well fields under a very high demand growth scenario. If Silver City's well fields only need to supply the Silver City service area, then significant drawdowns in its well fields would not occur until 2060.

## Scenarios of Future Water Supply Needs

Future water supply needs are defined as the difference between future demand and future supply from current sources. This subsection develops the low and high scenarios of future water supply needs that will be used in the analysis of water supply alternatives presented in Section 3. Table 2-4 and Figure 2-1 illustrate the low and high scenarios developed for future demand. To develop scenarios of future supply from current sources, it is necessary to make certain assumptions regarding how the current well fields would be operated in the face of pending drawdown and new sources coming online. Based on information provided by Balleau Groundwater Inc.,[22] the analysis assumes a reasonable operating plan is that well pumping would be cut back gradually at the rate of 5 percent per year until a 50 percent reduction is achieved (i.e., that pumping is reduced to 50 percent over a ten-year period). Such an approach would minimize potential

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[19] Johnson, p. 21, p. 54.
[20] Personal communication with Mike Johnson, hydrologist, New Mexico Office of State Engineer, May 18, 2005.
[21] Johnson, p. 22.
[22] Personal communication with Dave Romero, hydrologist, Balleau Groundwater, Inc., June 6, 2005.

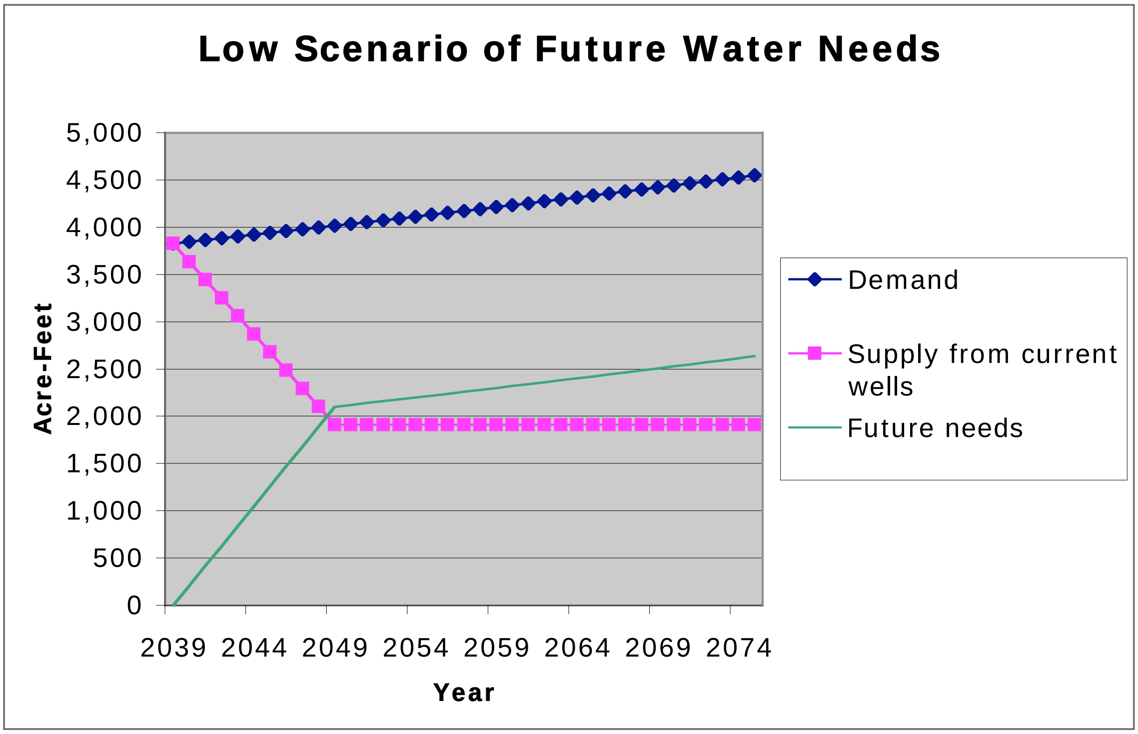
impacts on nearby surface water flows that could be negatively affected by adding the lagged surface water depletion associated with rapid reduction in pumping to any new surface water depletion caused by alternative source water use. Clearly, if such a step were taken in the future, a more specific plan for well operations would be developed based on additional information from updated hydrologic modeling and from current well field performance.

As indicated at the beginning of this section, the low scenario of future water supply needs is based on the low demand forecast presented in Table 2-4 and Figure 2-1 and on the assumption that the current well fields in Silver City and the Central Mining District would not face significant drawdowns until after 2040. Furthermore, the low scenario assumes that pumping from current wells would be reduced according to the plan outlined above beginning in 2040. Future water supply needs would begin in 2040 as pumping is reduced and increase over time as demand grows and pumping declines to 50 percent of its pre-2040 levels by 2050. Pumping in 2039 is 3,828 acre-feet, and so pumping is reduced about 191 acre-feet per year for ten years until a level of 1,914 acre-feet is reached. Table 2-5 and Figure 2-2 illustrate the low scenario of future water supply needs.

**Table 2-5. Low Scenario of Future Water Supply Needs (acre-feet)**

| | 2040 | 2050 | 2060 | 2075 |
|---|---|---|---|---|
| Demand | 3,847 | 4,036 | 4,235 | 4,552 |
| Supply from Current Wells | 3,647 | 1,914 | 1,914 | 1,914 |
| Future Needs | 210 | 2,122 | 2,321 | 2,638 |

**Figure 2-2.**

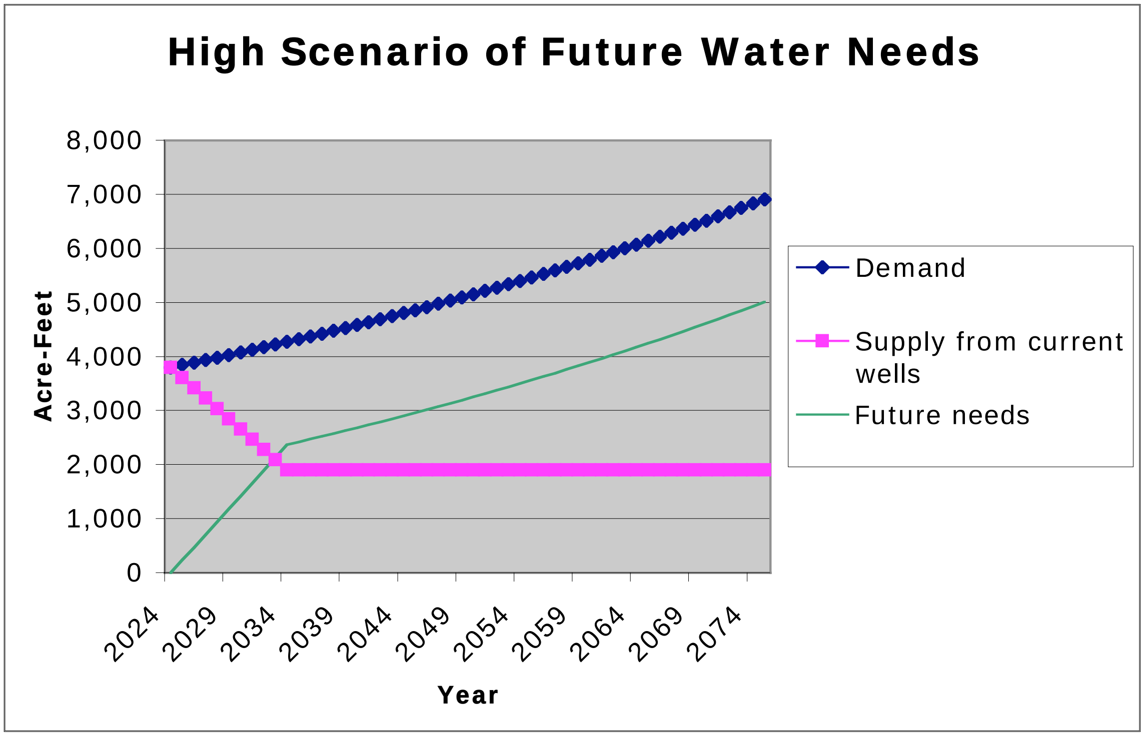



In the high scenario of future water supply needs, demand is assumed to follow the high forecast shown in Table 2-4 and Figure 2-1, and the current well fields are assumed to face significant drawdowns by 2040. In response, well field production is reduced according to the operating plan beginning in 2025 and reaches 50 percent of pre-2025 levels by 2035. The high demand forecast in 2024 is 3,800 acre-feet and therefore pumping is reduced by about 190 acre-feet per year for ten years until it reaches 1,900 acre-feet per year. Pumping from current well fields is assumed to remain at this level through 2075 even though the well fields would likely recover substantially during this period. Table 2-6 and Figure 2-3 illustrate the high scenario of future water supply needs.

**Table 2-6. High Scenario of Future Water Supply Needs (acre-feet)**

| | 2025 | 2035 | 2045 | 2055 | 2065 | 2075 |
|---|---|---|---|---|---|---|
| Demand | 3,845 | 4,323 | 4,861 | 5,467 | 6,147 | 6,913 |
| Supply from Current Wells | 3,610 | 1,900 | 1,900 | 1,900 | 1,900 | 1,900 |
| Future Needs | 235 | 2,423 | 2,961 | 3,567 | 4,247 | 5,013 |

**Figure 2-3.**




In summary, the low scenario of future water supply needs starts at 210 acre-feet per year in 2040 and increases over time so that by 2075, future water needs are 2,638 acre-feet. In the high scenario, future water supply needs begin in 2025 with 235 acre-feet per year, reach 2,423 acre-feet per year by 2035, and increase to 5,013 acre-feet per year by 2075.

# Section 3

## PRELIMINARY ECONOMIC ANALYSIS OF WATER SUPPLY ALTERNATIVES AND CONSERVATION

This section provides a preliminary economic analysis of the following water supply alternatives for Silver City and the Central Mining District: a Gila River diversion project under CUFA, drilling new well fields, and conjunctive use of groundwater with a Gila River surface water diversion through Phelps Dodge's existing facilities as part of its Tyrone mine operations. The costs of each alternative are evaluated and compared under the low and high scenarios of future water needs presented in Section 2. Given a least-cost supply alternative for each scenario, the maximum willingness to pay for municipal water conservation is then determined. This is based on the savings from delaying and/or avoiding supply-side investments due to demand reductions. Investments in conservation should be made prior to any supply-side investments if the costs of the conservation measures are less than this willingness to pay.

The analysis assumes that a regional water distribution system has been put in place by 2025, and therefore each supply alternative is expected to meet the future water needs of the entire region as defined by the scenarios. Note that the costs presented in this section do not reflect any federal subsidies available under AWSA or any potential economic costs of the diversion due to its ecological impacts (e.g., loss of recreational opportunities).[1] Section 4 revisits the results of this section to show the effect of the federal subsidies on the relative economics, while Section 5 describes the potential additional costs due to ecological impacts.

The comparison here is in terms of the total construction and operating costs per acre-foot of water over the project lifetime (i.e., cost-effectiveness). The goal is to determine if the decision between the alternatives is clear on the basis of these traditional costs alone. The results show the costs per acre-foot of water produced by a Gila River diversion project under CUFA are at least twenty-two times the costs of the least-cost alternative under the low scenario of future water needs and eight times the costs under the high water needs scenario. The results are necessarily preliminary because of the lack of specific project definitions, especially for a Gila River diversion, but the large difference in costs indicates there is a high likelihood that additional investigation will confirm that the costs for the diversion project greatly exceed those of the alternatives.

This section provides an overview of the methodology for determining cost-effectiveness, the results of applying the methodology to each water supply alternative, and concludes with the analysis of conservation potential.

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[1] While drilling new well fields and conjunctive use may have ecological impacts, they would be much smaller than those of the Gila River diversion, and so we do not address them in this scoping analysis.

## Cost-Effectiveness Methodology

Cost-effectiveness is a measure of the cost of securing a specific good or service via alternative means. When comparing water supply alternatives, cost-effectiveness is expressed in dollars spent per acre-foot of water obtained ($/acre-ft). The lower the cost in dollars per acre-foot, the more cost-effective. Ideally, the costs included in the calculation would include all capital and operating costs as well as any costs due to ecological impacts (e.g., loss of recreation opportunities) or other indirect impacts, such as litigation, that occur over the useful life of the alternative. As mentioned, however, this section focuses on capital and operating costs only.

Mathematically, the cost-effectiveness ($/acre-ft) of a water supply alternative is defined as:

(1) Present Value of Total Cost ($) / Present Value of Water Supplied[2] (acre-ft)

The "present value" is the total cost (or amount of water) today that is equivalent to a stream of costs (or water) occurring over a number of years in the future. Future annual costs (or water) are converted to the present using a discount rate. The discount rate reflects the time value of an asset. The time horizon for this analysis is from 2025 to 2075 and the discount rate used is 3 percent. All costs are assumed to be in 2003 dollars and all annually occurring costs (e.g., operating and maintenance costs) are assumed to have a zero rate of escalation in real dollars unless otherwise specified. All capital investments are assumed to have a 50-year life. For the low and high scenarios of future water supply needs developed in Section 2, the present values of the water supplied are 26,035 acre-feet and 69,158 acre-feet, respectively.

The remainder of this section estimates the cost-effectiveness of the following alternatives:

- A Gila River Diversion Project under CUFA
- New Well Fields
- Conjunctive Use
- Municipal Conservation

## A Gila River Diversion Project under CUFA

As described in Section 1, a Gila River diversion project is authorized under the Arizona Water Settlements Act (AWSA) to divert up to 14,000 acre-feet per year on a ten-year average basis. The project has been characterized as an off-stream diversion utilizing an infiltration gallery with a gravity feed to a new storage reservoir. From there, the water would then be pumped to recharge the Silver City well fields. A major challenge in

[2] Or saved, as in the case of conservation.

estimating the costs of this alternative is the lack of detailed project definition at the current time. The analysis will review the cost estimates currently available based on the Congressional testimony by the New Mexico Interstate Stream Commission (NMISC) and the State Engineer's office during the AWSA hearings as well as on information presented in the Southwestern New Mexico regional water plan.

During the AWSA hearings, both Estevan Lopez, Director, NMISC and John D'Antonio, New Mexico State Engineer, testified before House and Senate subcommittees that the capital costs of the project could be as high as $300 million, but that they believed the project could be built for $220 million:

> *As originally contemplated in the 1968 Act, funding for the New Mexico unit is authorized as part of the CAP. While the original New Mexico project cost estimate was approximately seventy million dollars, that estimate inflated according to the Consumer Price Index results in a cost total over three hundred million in today's dollars. However, we believe we can build a suitable project for approximately two hundred twenty million dollars, including increased costs to accommodate federal environmental mandates.*

The regional water plan provides a much lower capital cost estimate, $164.5 million, and estimates operating costs at $5.6 million per year.[3] The capital costs are stated to include the diversion facilities as well aquifer recharge and a $21.4 million regional distribution system. Since the regional water plan is an official document with wide distribution, its cost estimate for a Gila diversion project bears careful examination.

The plan states its estimates are based on the Bureau of Reclamation's Upper Gila Water Supply Study from the mid-1980s. However, the Bureau's study evaluated several conjunctive use-recharge/recovery alternatives that diverted at the rate of 15-25 cfs, not at 350 cfs as would be likely under CUFA. The October 1987 Upper Gila Water Supply Study-Special Report on Alternatives specifically states that the costs for its conjunctive use-recharge/recovery alternative would be "prohibitive" with higher volume pipelines:

> *This alternative provides an adequate supply only when combined with a conjunctive use operation because the costs would be prohibitive to provide a full water supply through high volume pipelines.*[4]

The regional water plan states its assumption that the capacity of the conveyance system above the intermediate storage facility is 15 cfs,[5] but its estimates do not appear to address the costs of diverting 350 cfs from the river to storage. In fact, the plan states: "Because of the pumping and conveyance costs associated with moving 350 cfs, it would be highly desirable from an economic standpoint to locate the intermediate storage

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[3] DBS&A, p. 8-111.

[4] Bureau of Reclamation, "Upper Gila Water Supply Study: Special Report on Alternatives," U.S. Department of Interior, October 1987, p. 9.

[5] DBS&A, p. 8-109.

facility as close to the diversion point as possible."[6] Finally, the plan provides a strong caveat regarding its own cost estimates, stating they are "very preliminary and could be vastly different from a thorough cost estimate using up-to-date prices and well defined facilities."[7]

Given this information, it appears that the regional water plan's cost estimate seriously underestimates the cost of a Gila River diversion project diverting at 350 cfs. The cost-effectiveness results presented below in Table 3-1 include it, however, as one of the scenarios to show the results for an extreme lower bound on the potential costs. The other capital cost scenarios of $220 million and $300 million are also evaluated. The calculations assume that the diversion project begins operation in 2025 and supplies the entire needs of the region for the next 50 years as defined by the low and high scenarios of future water needs.

**Table 3-1. Cost-Effectiveness of Gila River Diversion**

| | Capital Cost Scenarios | | |
|---|---|---|---|
| **Assumptions** | **1** | **2** | **3** |
| Capital Costs ($ millions, present value) | 143.1[8] | 220.0 | 300.0 |
| Operating Cost ($ millions/year)[9] | 5.6 | 5.6 | 5.6 |
| **Calculated Values** | | | |
| Operating Costs ($ millions, present value) | 144.1 | 144.1 | 144.1 |
| Total Costs ($ millions, present value) | 287.2 | 364.1 | 444.1 |
| **Cost-Effectiveness ($/acre-ft)** | | | |
| Low Scenario of Future Water Supply Needs | 11,031 | 13,985 | 17,057 |
| High Scenario of Future Water Supply Needs | 4,153 | 5,265 | 6,421 |

As these results show, Gila River diversion costs range from $11,031/acre-foot to $17,057/acre-foot for the low scenario of future water supply needs, depending on the capital cost scenario. For the high scenario of future water supply needs, its costs range from $4,153/acre-foot to $6,421/acre-foot. The following subsections will explore the costs of alternative approaches to meet future water supply needs.

[6] DBS&A, p. 8-110.
[7] DBS&A, p. 8-112.
[8] Reflects the $164.5 million total capital cost less $21.4 million for the regional water system that is assumed to already be in place.
[9] The estimate from the regional water plan is used for each scenario.

## New Well Fields

Another alternative for meeting future supply needs is the drilling of new well fields in the Mimbres or Gila Basins utilizing existing water rights and/or through the purchase and transfer of new water rights. This subsection reviews the available information about the availability and sustainability of groundwater supplies in the Mimbres Basin, the potential for water rights purchases and transfer, and determines the cost-effectiveness of drilling new well fields according to the scenarios described above.

**Mimbres Basin Groundwater Supplies.** According to the regional water plan, the Mimbres Basin covers an immense area of approximately 4,300 square miles, of which 3,651 square miles fall within the Southwestern New Mexico planning region.[10] The Continental Divide is the northern and western border of the basin, while Mexico and the Lower Rio Grande Basin provide its border to the south and east, respectively. Silver City and the Central Mining District lie in the northern section of the Mimbres Basin aquifer, while the other major demand centers of Southwestern New Mexico (Deming, Lordsburg, and Columbus) are in the southern section.

The regional water plan states that Silver City is one of the areas where "additional groundwater resource development is most likely to be economically feasible."[11] And, as cited in Section 2 of this report, the Johnson study states that new well fields in the Mimbres Basin are an option for the region and that 53 specific potential well sites have been identified.[12] The drawdown contour lines produced by the Johnson study for the Mimbres Basin in 2040 show a significant reduction in drawdown as the distance from Silver City is increased. Moving southeast from Silver City's well fields toward Hurley, the drawdown is only 60 feet by 2040.[13] Recall that this drawdown is based on a significantly higher demand scenario than current estimates, and so the aquifer could experience much smaller drawdowns, especially near the major well fields.

Estimates for the amount of good quality water stored in the Mimbres Basin range from about 30 million acre-feet[14] to 70 million acre-feet.[15] Critical issues for regional water planning include (a) whether the aquifer is being significantly depleted over time, (b) the relative availability of water in the northern versus southern sections, and (c) the costs of extraction, conveyance, and treatment. According to the Mimbres Basin groundwater budget in the regional water plan, Grant County is depleting the aquifer at the rate of about 3,000 acre-feet per year, while Luna County's depletion rate is about 31,000 acre-

[10] DBS&A, p. 5-53.
[11] DBS&A, p. 8-130.
[12] Johnson, p. 22.
[13] Johnson, Plate 4.
[14] DBS&A, p. 5-56.
[15] Reynolds, S.E., Technical Memo, State Engineer Office, State of New Mexico, September 1, 1983, p. 4.

feet per year.[16] Using the low estimate of water in storage, the basin's water supply would last 882 years at this depletion rate of 34,000 acre-feet per year. The plan acknowledges, however, "in order to develop quantitative estimates of sustainable yields for all the basins in the region, additional field studies and modeling efforts are required."[17]

Since the Mimbres Basin is the primary source of water supply for Silver City and the Central Mining district, the assumptions in the regional water plan's Mimbres Basin groundwater budget are worth examining in some detail. As detailed in Appendix A, using more recent data on mining outflows shows that Grant County is not mining its section of the aquifer, and that inflows actually exceed outflows by almost 6,000 acre-feet per year. While significant depletions may be occurring in Luna County in the southern portion of the aquifer, the significant distance between the demand centers (about 50 miles) and the Johnson study's results showing small drawdowns southeast of Silver City appear to indicate that the northern part of the aquifer can sustain additional groundwater development.

**Water Rights Purchase and Transfer.** New groundwater development may not be necessary, however, given declining mining operations and the likelihood of the mines closing prior to the need for additional supplies. According to the Wilson study on water demands previously mentioned in Section 2, demand for water from mining operations is projected to decline to zero by 2035.[18] This is almost 20 years before new water rights would be needed under the high future needs scenario. Current water consumption by the mines could be shifted to municipal use through the purchase or lease of water rights. These rights could be transferred to a more convenient location for the regional water system and new well fields developed.

The most likely potential seller/leaser of water rights in the Gila and Mimbres Basins is the Phelps Dodge Corporation. Phelps Dodge currently operates the Tyrone, Chino, and Cobre mines in the Silver City/Central Mining District region and retains water rights in the Gila and Mimbres Basins for these facilities. The Tyrone mine diverts surface waters from the Gila River and pumps groundwater in the Gila and Mimbres Basins. The Chino and Cobre mines pump groundwater from wells in the Mimbres Basin.

Even without considering recent declines in mining operations, a significant amount of these water rights go unused every year and represent a potential source of future water supply for Silver City and the Central Mining District. Table 3-2 summarizes Phelps Dodge's water rights, average water consumption, and average unused water rights based on reports provided by the State Engineer's office. Appendix B provides the yearly detail supporting Table 3-2. The sale or lease of these water rights by Phelps Dodge represents a potential "win-win" solution for all parties: Phelps Dodge can receive compensation

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[16] DBS&A, Appendix F, Table F-6
[17] DBS&A, p. 5-76
[18] Wilson, Table 12.

for an underutilized asset, and the Silver City region can meet its water supply needs for significantly lower cost and ecological impact than with a Gila River diversion project.

**Table 3-2. Phelps Dodge Water Rights, Usage, Unused Water Rights** (1997-2003, all values in acre-feet per year, irrigation rights excluded)

| | Total Consumptive Rights | Average Usage | Average Unused Consumptive Rights |
|---|---|---|---|
| Tyrone-Gila Diversion | 5,309 | 2,888 | 2,421 |
| Mimbres Basin Wells | 25,584 | 14,558 | 11,026 |
| Total | 30,893 | 17,446 | 13,447 |

Inspection of the yearly data (see Appendix B) show that water consumption at the Phelps Dodge Chino mine averaged over 17,000 acre-feet per year between 1993 and 2000, but has dropped off to about 5,000 acre-feet per year since then. The total amount of water pumped by Phelps Dodge's mine operations in the Mimbres Basin was 6,249 acre-feet in 2003. This is almost 1,250 acre-feet per year more than the region would need in 2075 under the high scenario. Since the Mimbres Basin groundwater budget for Grant County shows net inflows with this most recent mining data (see Appendix A), it appears reasonable to consider that mining consumption could be converted to municipal use without negative effects on the aquifer.

**Cost-Effectiveness of New Well Fields.** This subsection examines the cost of new well fields (including water rights purchase and transfer costs for the high scenario of future water supply needs). The cost of each new well field and pipeline is based on the estimate in the regional water plan for a well in the Animas Basin producing 1,000 acre-feet per year,[19] with modifications to reflect a location southeast of Silver City. Table 3-3 summarizes the cost assumptions and results. Note that the costs include $300,000 for studies to address potential impairment issues, the high end of the range suggested in the regional water plan.[20]

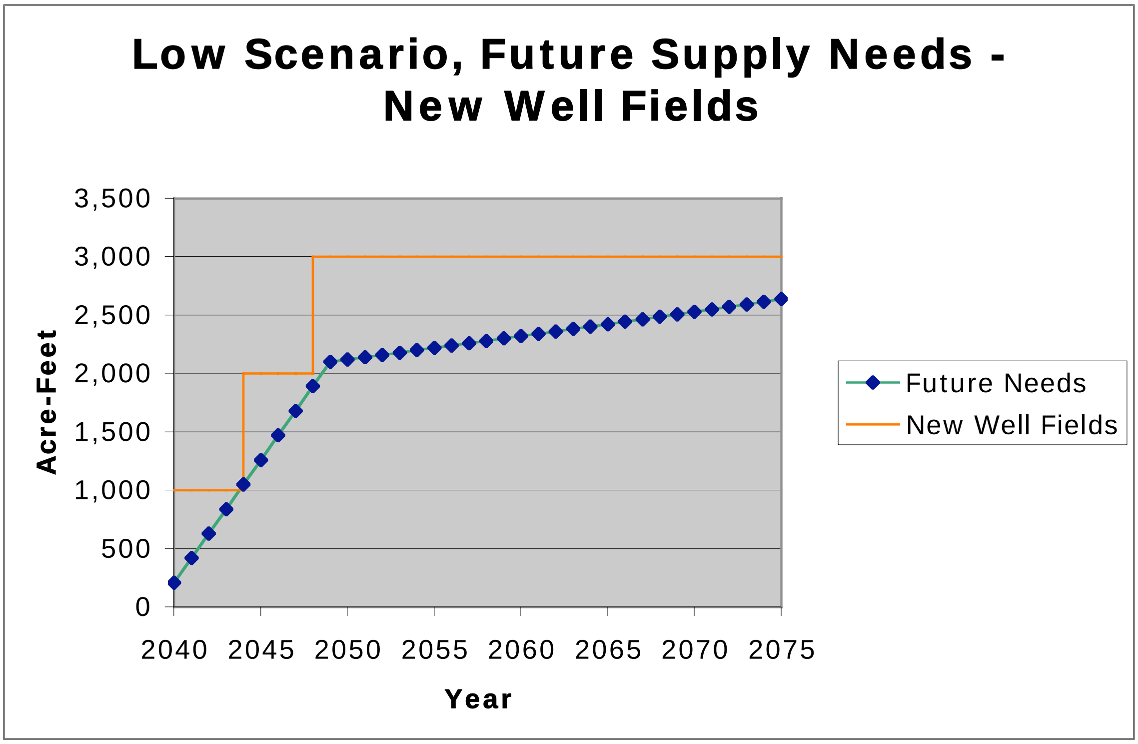
[19] DBS&A, p. 8-138.
[20] DBS&A, p. 8-137.

**Table 3-3. Costs of New Well Field and Pipeline Producing 1,000 acre-feet per year**

| | | |
|---|---|---|
| **Capital Costs** | | |
| Land purchase (40 acres) | | $200,000 |
| Well field design and permitting | | $40,000 |
| Supply wells (5) | | $750,000 |
| Pipeline design and permitting | | $100,000 |
| Easement purchase/lease (10 miles) | | $20,000 |
| Pipeline (10 miles) | | $2,250,000 |
| Booster station (1) | | $400,000 |
| Additional studies re impairment | | $300,000 |
| | **Total** | **$4,060,000** |
| **Operating Costs** | | |
| Well field O&M | | $100,000/year |
| Pipeline O&M | | $37,500/year |
| | **Total** | **$137,500/year** |
| **Calculated Values** | | |
| Operating Costs ($ millions, present value) | | 3.5 |
| Total Costs ($ millions, present value) | | 7.6 |

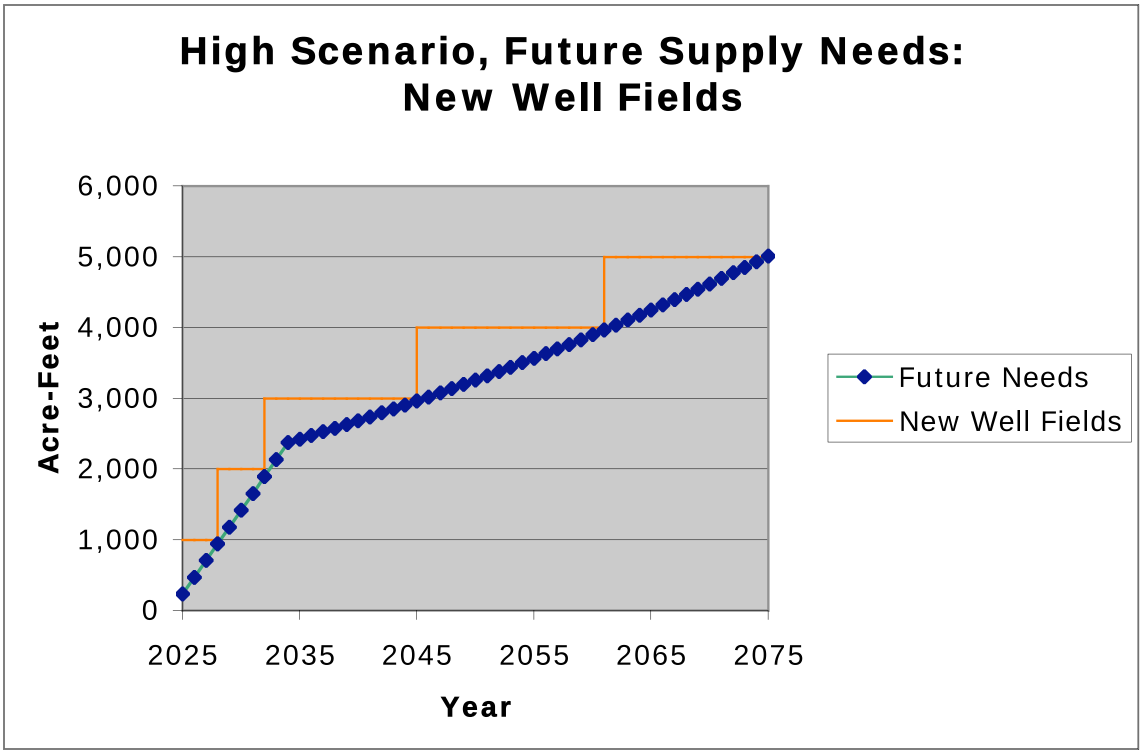
The analysis assumes new well fields are brought online as 1,000 acre-foot blocks of supply are needed. As was shown in Table 2-5, under the low scenario of future water supply needs, an additional 2,638 acre-feet is needed by 2075. Figure 3-1 shows that three new well fields are brought online in 2040, 2044, and 2048 in the low scenario of future supply needs. Thus, the $7.6 million individual well field cost would occur three times: in 2040, 2044, and 2048. Discounting each of these costs back to the beginning of the planning horizon (2025) produces a total present value cost of $13.1 million. As stated previously, in 2025, the present value of the water supplied in this case is 26,035 acre-feet, and so the cost-effectiveness is $502 per acre-foot. Drilling new well fields is less costly by a factor of 22 when compared to the Gila Diversion’s capital cost scenario (1), and by factors of about 28 and 34 when compared to cost scenarios (2) and (3)

**Figure 3-1.**




In the high scenario, future water supply needs increase to 5,013 acre-feet by 2075, and demand exceeds current water rights beginning in about 2054, resulting in the need for five new wells and 1,500 acre-feet in new water rights by 2075. Referring to Figure 3-2, the well fields would be brought online in 2025, 2028, 2032, 2045, and 2061. The purchase of water rights is assumed to occur in 2025.

**Figure 3-2.**




Discounting the costs of the well fields to 2025 produces a total present value cost of $27.6 million. In addition to these costs, it is necessary to include the costs of purchasing 1,500 acre-feet of water rights. To estimate these costs, the analysis reviewed recent water rights sales in New Mexico, Arizona, and Nevada over the past year, the annual review of market trends in the periodical *Water Strategist*, and the recent appraisal of Phelps Dodge Tyrone water rights. According to *Water Strategist*, the average price paid by the city of Albuquerque in 2004 was $4,750 per acre-foot.[21] Other recent water purchases for municipal and industrial use in the region have ranged from about $1,700 to $3,750 per acre-foot. The appraised value of Phelps Dodge's water rights is $6,210 per acre-foot.[22]

Even though the Phelps Dodge appraised value is more than 30 percent greater than the current water market in Albuquerque, the analysis uses $6,210 per acre-foot to represent a conservative estimate for the total costs involved in purchasing and transferring the location of the water rights. A further assumption is that these water rights would be purchased in the near-term to lock in this price, a common practice. The water rights purchase and transfer costs are therefore estimated at $9.3 million. Adding this to the present value costs of the well fields results in a total present value cost of $36.9 million.

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[21] Water Strategist, February 2005, p. 23.

[22] Brown, F. Lee. Economic Considerations Pertinent to the Appraisal of the Phelps Dodge Tyrone Water Rights. Memorandum Report prepared for the New Mexico Energy Minerals and Natural Resources and Environment Departments, April 2, 2004, p. 2.

Dividing by the present value of the water supplied in the high scenario (69,158 acre-feet) produces a cost-effectiveness of $533/acre-foot. This is less expensive by a factor of about 8 when compared to the Gila Diversion's capital cost scenario (1), and by factors of 10 and 12 when compared to cost scenarios (2) and (3). Table 3-4 summarizes the costs of new well fields for the low and high scenarios of future water supply needs.

**Table 3-4. Cost-Effectiveness of New Well Fields**

| | Future Water Supply Needs | |
|---|---|---|
| | Low | High |
| Total Cost ($ millions, present value) | 13.1 | 36.9 |
| Cost-Effectiveness ($/acre-ft) | 502 | 533 |

## Conjunctive Use

This alternative explores the conjunctive use of surface water and groundwater to meet the region's needs. According to the regional water plan, preliminary discussions with Phelps Dodge have taken place regarding their possible interest in leasing some of their Tyrone water rights and/or the use of any excess capacity in their Gila River diversion and pumping facilities.[23] Since 1,500 acre-feet of new water rights would be needed under the high future supply needs scenario, this alternative assumes that these rights are purchased/leased and the water diverted from the Phelps Dodge Tyrone Gila River diversion facility, and that the remaining supply needs are provided through new well fields.

The Phelps Dodge Gila River diversion has the ability to pump at the rate of 40 cfs and is only operated at low flows to avoid sedimentation problems. The infrastructure includes pumping facilities to store water in Bill Evans Lake (capacity 2,100 acre-feet), and additional pumps and pipelines deliver water to storage tanks at the Tyrone mine. The regional water plan states that with some additional pumping and transmission (40,000 feet) it could be a source for recharge of the Silver City well fields and a regional distribution system.[24]

Approximately 20 days of diversions at 40 cfs could deliver about 1,500 acre-feet per year and would not require expensive reconfiguration of the existing system or a new storage facility as would be the case with Gila River diversions under CUFA at 350 cfs. In addition, since the Phelps Dodge diversion facility is downstream of the ecologically sensitive Cliff-Gila Valley, diverting water from this location will avoid the significant ecological impacts that are likely from any upstream diversion. The use of the Phelps Dodge conveyance system would also preclude the need for a new storage reservoir and its associated ecological impacts.

[23] DBS&A, pp. 8-100, 8-101.
[24] DBS&A, pp. 8-100, 8-101.

Table 3-5 shows that the present value cost for the purchase of 1,500 acre-feet of Phelps Dodge Gila River water rights and the additional pumping and transmission needed to convey the water to the regional distribution system is $16.6 million in 2025.

### Table 3-5. Costs to Purchase 1,500 acre-feet of Phelps Dodge Gila River Water Rights and Conveyance to Regional Distribution System in 2025

| | | |
|---|---|---|
| **Capital Costs** | | |
| Water Rights Purchase ($) | | $9,315,000 |
| New Pipeline (40,000 feet) ($) | | $1,700,000 |
| Booster Station ($) | | $400,000 |
| | **Total** | $11,415,000 |
| **Operating Costs ($/yr)** | **Total** | $200,000 |
| | | |
| **Calculated Values** | | |
| Operating Costs ($ millions, present value) | | 5.1 |
| Total Costs ($ millions, present value) | | 16.6 |

In addition to the cost of the surface water component, the conjunctive use alternative also needs to include the costs of supplying the remaining needs from groundwater. Assuming that the surface water diversion occurs in 2040 for the low scenario of future water needs, Figure 3-3 shows that one additional well field would be needed in 2046.[25] Table 3-6 shows that after discounting to 2025 the present value cost of conjunctive use totals $14.7 million for the low needs scenario. The cost-effectiveness is $565/acre-foot. In the high needs scenario, the surface water diversion is assumed to occur in 2025, and four additional wells are needed in 2030, 2036, 2053, and 2068 as shown in Figure 3-4. The present value cost in 2025 of these wells is $17.5 million. Adding the present value cost of the diversion ($16.6 million) produces a total present value cost of $34.1 million. The cost-effectiveness is $492/acre-foot. Table 3-6 summarizes these results.

[25] The analysis assumes that one new well field can produce the additional 1,138 acre-feet needed by 2075.

**Figure 3-3.**

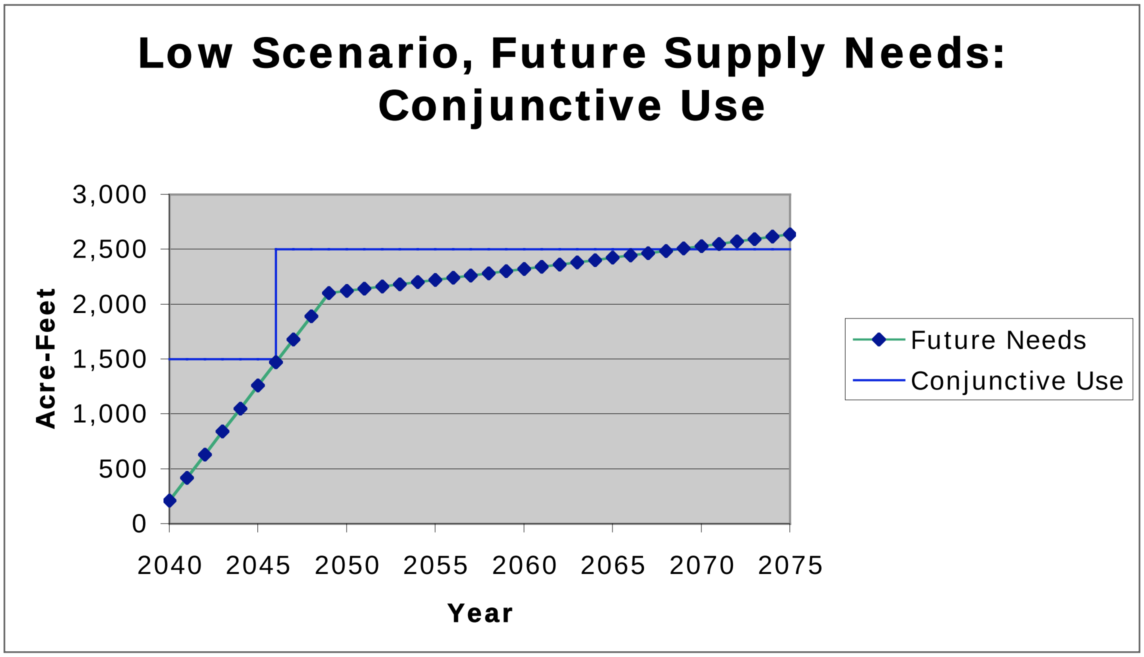



**Figure 3-4.**

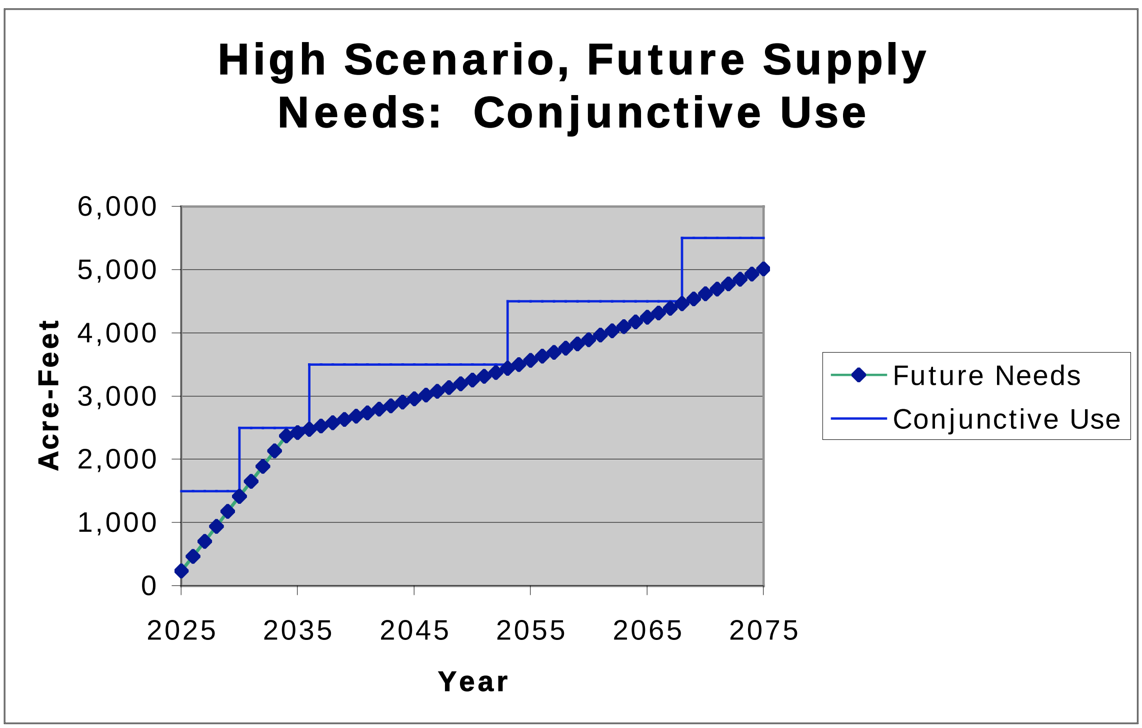


**Table 3-6. Cost-Effectiveness of Conjunctive Use**

| | Future Water Supply Needs | |
|---|---|---|
| | Low | High |
| Surface Water Diversion Costs ($ millions, present value) | 10.6 | 16.6 |
| New Well Fields ($ millions, present value) | 4.1 | 17.5 |
| Total Cost ($ millions, present value) | 14.7 | 34.1 |
| Cost-Effectiveness ($/acre-ft) | 565 | 492 |

The cost-effectiveness results show that conjunctive use is similar in cost to drilling new well fields. When compared to the Gila diversion alternative under the low scenario of future needs, it is less expensive by a factor of 20 when compared to cost scenario (1), and by factors of 25 and 30 for cost scenarios (2) and (3). Under the high scenario of future needs, conjunctive use is less expensive by factors of 8, 11, and 13 for the three cost scenarios, respectively.

## Summary of Economic Analysis

Tables 3-7 and 3-8 summarize the economic analysis results for the low and high scenarios of future water supply needs. In the low scenario, the least-cost alternative is new well fields, followed by conjunctive use and then the Gila River diversion project under CUFA. Conjunctive use is just 12 percent more expensive than new well fields, whereas the Gila diversion project is at least 22 to 34 times more expensive than new well fields, depending on the capital cost assumption. In the high scenario, the least-cost alternative is conjunctive use, followed by new well fields and then the Gila River diversion project under CUFA. New well fields are just 8 percent more expensive than conjunctive use, whereas the Gila diversion project is at least 8 to 13 times more expensive than conjunctive use, depending on the capital cost assumption.

**Table 3-7. Ranking of Supply Alternatives *Low Scenario of Future Water Supply Needs***

| | Cost-Effectiveness ($/acre-foot) | Total Cost ($ millions, present value) | Increase in Cost Relative to Least-Cost Alternative (multiplier) |
|---|---|---|---|
| New Well Fields | 502 | 13.1 | -- |
| Conjunctive Use | 565 | 14.7 | 1.12 |
| Gila River Diversion | | | |
| under CUFA, Cost Scenario (1) | 11,031 | 287.2 | 22 |
| (2) | 13,985 | 364.1 | 28 |
| (3) | 17,057 | 444.1 | 34 |

**Table 3-8. Ranking of Supply Alternatives *High Scenario of Future Water Supply Needs***

| | Cost-Effectiveness ($/acre-foot) | Total Cost ($ millions, present value) | Increase in Cost Relative to Least-Cost Alternative (multiplier) |
|---|---|---|---|
| Conjunctive Use | 492 | 34.1 | -- |
| New Well Fields | 533 | 36.9 | 1.08 |
| Gila River Diversion | | | |
| under CUFA, Cost Scenario (1) | 4,153 | 287.2 | 8 |
| (2) | 5,265 | 364.1 | 11 |
| (3) | 6,421 | 444.1 | 13 |

While these results are preliminary due to the lack of specific project definitions, the dramatic, order-of-magnitude difference between the cost of the Gila River diversion and the other alternatives is compelling. Regardless of whether demand growth turns out to be high or low, a Gila River diversion under CUFA is the most expensive alternative for Silver City and the Central Mining District. New well fields and conjunctive use have much lower capital and operating costs, and their smaller capacity (e.g., 1,000 acre-feet per year per well field) means that they can better match demand over time. The region saves money by adding supply sources as needed, rather than committing to a big project up-front. The relatively huge capacity of a Gila River diversion (i.e., 14,000 acre-feet per year) carries with it very large capital and operating costs that render it uneconomic given that the future supply needs of the region are only expected to reach 5,000 acre-feet per year in 2075 at the most.

Finally, recall that these results are based on capital and operating costs alone. Including the negative economic and ecological impacts of the diversion as described in Section 5 puts the costs of the diversion project even higher. This section concludes with an analysis of the economic potential for additional municipal conservation programs in the region.

## Municipal Conservation

According to the American Water Works Association (AWWA), if the average household replaced all major indoor appliances with water-efficient fixtures, indoor water savings of 35 percent are possible.[26] Reductions of up to 30 percent of *overall* water use are possible if outdoor watering conservation measures are also employed.[27] The economics of conservation depend on the costs of the supply alternatives that can be avoided or delayed due to reductions in demand as well as on the direct costs of implementing the conservation measures themselves.

According to the Environmental Protection Agency, water conservation also "helps to maintain aquatic habitats; restore wetlands and fisheries; protect groundwater from depletion and contamination; and reduce the amount of energy used to pump, heat, and treat drinking water and to pump and treat wastewater."[28] Including these impacts is beyond the scope of this analysis, but they serve to increase the cost-effectiveness of conservation. This subsection examines the potential for conservation in Silver City and the Central Mining District, evaluates the benefits of a specific level of conservation in the low and high demand growth scenarios, and determines the maximum willingness-to-pay for conservation in each case.

Silver City and the Central Mining District currently have several conservation measures in place, including inverted block pricing, water waste ordinances, and drought restrictions. According to the regional water plan, however, no region-wide programs to replace inefficient plumbing fixtures or improve the efficiency of outdoor watering have been instituted. Such programs represent a significant source of conservation potential and may delay or avoid the need to develop new supply sources.

A water efficiency study performed for Silver City in 1991 estimated that the installation of water-efficient fixtures indoors could save 10 to 20 percent of peak demand and that the water savings would completely pay for the costs of the fixtures if the town were to provide them. This study also estimated an additional 20 to 25 percent savings from the use of water-efficient landscaping and watering practices.[29] Thus, the study estimated that conservation measures could produce total demand reductions of 30 to 45 percent, consistent with the AWWA statistics. Such measures have not yet been implemented because, according to the last 40-year water plan, funds were limited and there were competing demands for funds to address unaccounted-for-water and leak detection.[30]

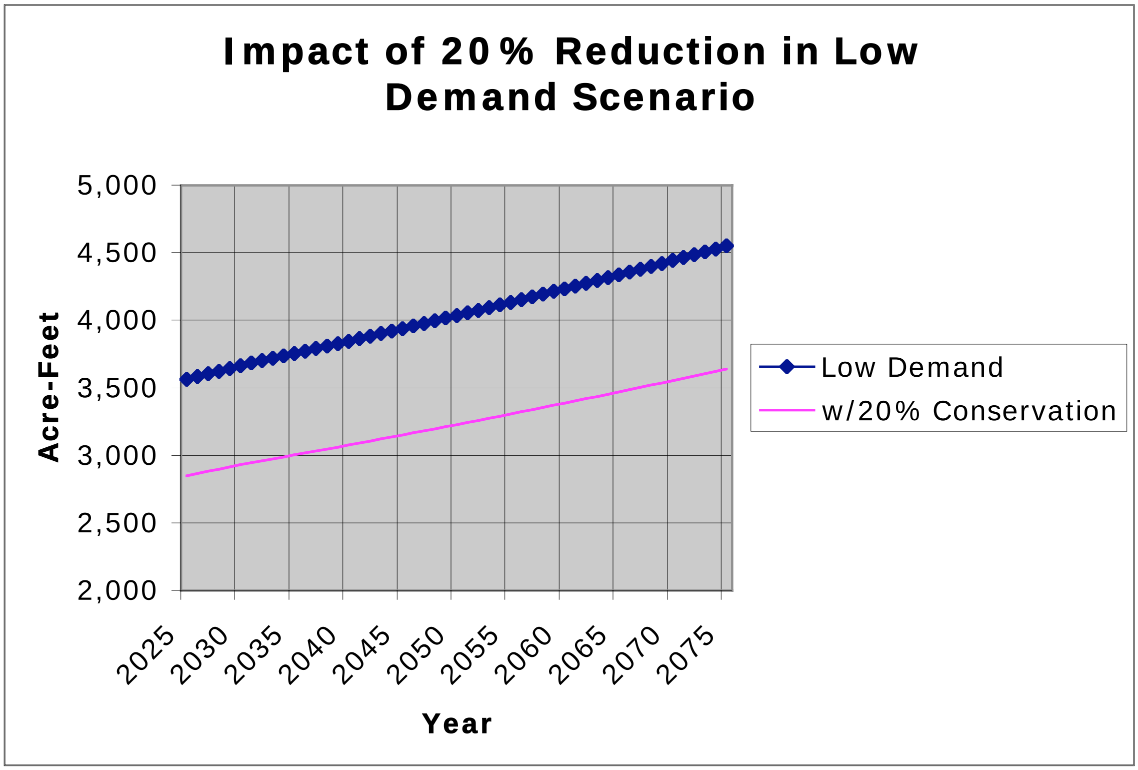
[26] Mayer, et al, 1999
[27] Mayer, et al, 1999.
[28] www.epa.gov
[29] Engineers, Inc., p. 44.
[30] Engineers, Inc., p. 44.

Now, however, the federal funds available to Grant County as part of the AWSA provide a potential means to implement these programs, and, as shown below, cost-effective investments in conservation should be made before investments in new supply.

The potential impact of conservation in Silver City and the Central Mining District is significant, both in terms of acre-feet saved as well as avoided costs from delaying the need for new supply sources. Based on the previously mentioned study for Silver City, a 20 percent reduction in future demand beginning in 2025 is assumed to be an achievable conservation level, even considering the 10 gpcd reduction already assumed due to the replacement of pre-1994 toilets. The following analysis determines the maximum price in dollars per acre-foot that the region should be willing to pay to achieve this target for the low and high scenarios of future demand growth. This maximum price is applicable to decisions on leak repairs as well as the retrofitting of inefficient plumbing devices or outdoor watering retrofits such as drip irrigation and rainwater harvesting—any investment that reduces water consumption. In other words, before investing in new supply sources, the region should invest in conservation up to this maximum price, assuming a 20 percent reduction in demand is achieved with the investments.

**Low Demand Growth.** Figure 3-5 illustrates the impact of a 20 percent reduction in demand on the low demand growth scenario. Demand is reduced by about 700 acre-feet beginning in 2025 and by about 900 acre-feet in 2075. The present value of the acre-feet saved is 20,374 acre-feet. To estimate the economic benefits of conservation, it is necessary to estimate how the reduced demand would affect the need for future supply sources. Recall from the original low scenario of future supply needs that new supplies would need to come online beginning in 2040, when demand is about 3,800 acre-feet. Figure 3-5 shows that, with conservation, a demand of 3,800 acre-feet does not occur until after 2075. Thus, it is reasonable to assume that some delay of investment in new supplies would occur. As shown in Table 3-7, the least-cost alternative for the low scenario of future needs was drilling new well fields, with a present value cost of $13.1 million. If the drilling of new well fields could be delayed 10 years (i.e., to 2050), then the savings due to conservation are approximately $3.3 million, or $164 per acre-foot saved.

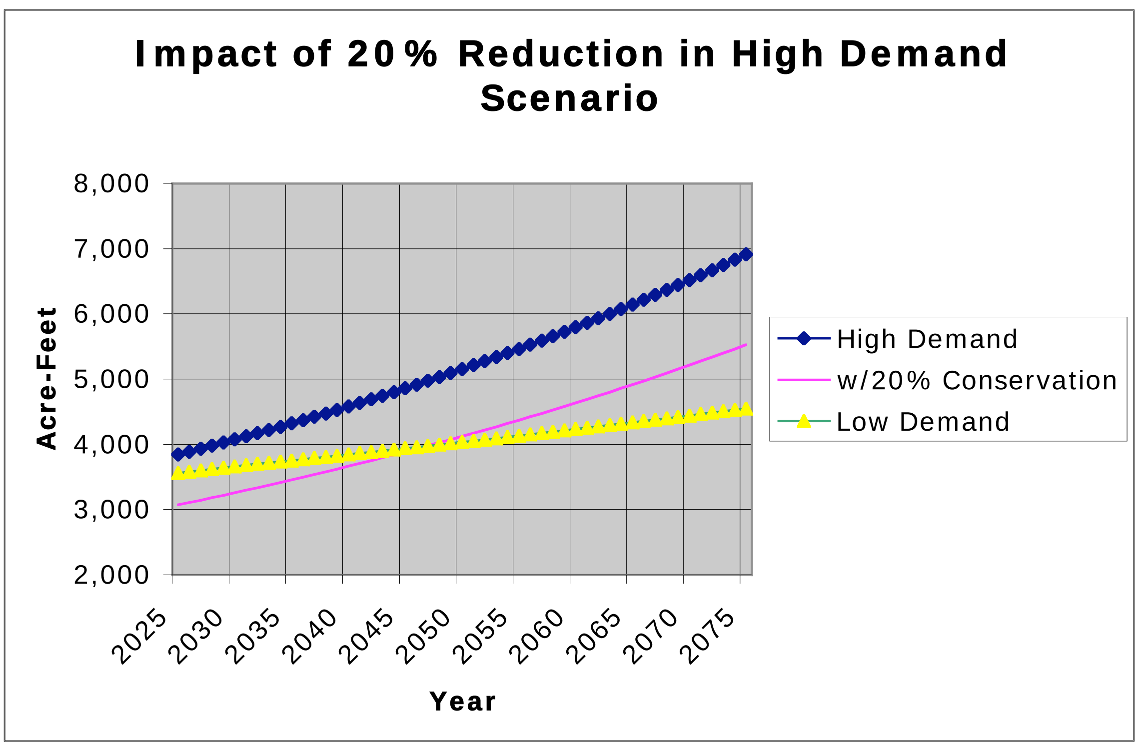
**Figure 3-5.**


Impact of 20% Reduction in Low Demand Scenario
5,000
4,500
4,000
3,500
3,000
2,500
2,000
Acre-Feet
2025
2030
2035
2040
2045
2050
2055
2060
2065
2070
2075
Year
Low Demand
w/20% Conservation

**High Demand Growth.** Figure 3-6 illustrates the impact of a 20 percent reduction in demand on the high demand growth scenario. For comparison, the low demand growth trajectory (without conservation) is also shown. With conservation, demand is reduced by about 770 acre-feet in 2025 and by about 1,400 acre-feet by 2075. The present value of the water saved is 25,231 acre-feet. The impact of conservation in this case is to bring demand below the low demand growth scenario until about 2050. Recall from the original high future supply needs scenario that new well fields were needed beginning in 2025 (when demand was about 3,800 acre-feet) and that 1,500 acre-feet of water rights would need to be purchased because demand would exceed 5,400 acre-feet. Figure 3-6 shows that a demand of 3,800 acre-feet is not reached until about 2043 and that additional water rights would not be needed until practically the last year of the time horizon.

To estimate the economic benefits of conservation in this case, the assumption is that a 20 percent demand reduction by 2025 essentially moves the region from the high needs scenario to the low needs scenario where new wells are not needed until 2040. The savings due to conservation are therefore the difference between the least-cost alternatives in each case. In the high needs scenario, as shown in Table 3-8, the least-cost alternative is conjunctive use, with a present value cost of $34.1 million. The least-cost alternative in the low needs case is drilling new well fields with a cost of $13.1 million. The resulting savings are $21 million, or $832 per acre-foot saved.

**Figure 3-6.**



In summary, if Silver City and the Central Mining District believe they are on the low future needs path, the region should be willing to pay up to $164/acre-foot, or up to $3.3 million, for conservation measures providing an annual 20 percent reduction in demand between 2025 and 2075. If the region finds itself on the high growth path, then the willingness-to-pay for conservation increases to $832/acre-foot, or $21 million. These conservation programs will be more economical than either drilling new well fields or conjunctive use, and certainly much less expensive than a Gila diversion project.

# Section 4

# IMPACT OF AWSA SUBSIDIES

The Arizona Water Settlements Act (AWSA) provides the counties of Southwestern New Mexico with a $66 million subsidy for local or regional water supply projects. It also presents a major decision: whether or not to pursue building a Gila River diversion project. If the decision is made to go forward, an additional subsidy of $34 million to $62 million will be made available (depending on the rate of return of the LCBDF), but the region must bear any additional construction costs as well as annual operating costs.

This section describes the potential subsidies available from the AWSA and how these monies and the remaining costs of a Gila River diversion project could be shared among the four counties of Southwestern New Mexico: Grant, Catron, Hidalgo and Luna. Two subsidy allocation scenarios are examined: (1) Each county receives one-fourth, $16.5 million, of the $66 million subsidy for local/regional projects, and Grant County bears all incremental Gila River diversion project costs remaining after the capital cost subsidy (assumed to be the $62 million maximum), and (2) the entire potential subsidy of $128 million is applied to the diversion project (i.e., no monies are available for separate, local projects), and the incremental project costs are borne by the residents of all four counties. This latter scenario is intended to illustrate the potential financial impact to the region's residents if the project scope is expanded to deliver water beyond Grant County. The financial impact is considered a lower bound because current project cost estimates do not include pumping or conveyance beyond Grant County. The middle cost scenario for the diversion project's capital costs is used for this analysis. As shown in Section 3, this results in a present value total cost (capital plus operating costs) of $364.1 million before subsidies. Results for each subsidy allocation scenario are presented in terms of total net costs and net costs per capita for each county and are compared to the financial outcomes if the diversion project is not pursued.

Note that this section does not address any potential projects to consume up to 4,000 acre-feet per year from the San Francisco, as currently allowed under the CUFA. Such projects would benefit Catron County, the closest demand center. It is certainly possible that some of the AWSA capital cost subsidy could be made available to Catron County in addition to the subsidy it could receive for local/regional projects. The effect of this would be to increase the net costs of any diversion on the Gila River. The analysis of impacts on Southwestern New Mexico residents should be updated once the costs of a San Francisco project are better understood and the subsidy allocation decided.

## Subsidy Allocation Scenario 1 – Grant County Bears Costs

In this scenario, each county receives $16.5 million of the $66 million available for local/regional water supply projects. In addition, the analysis assumes the full $62 million is available to defray the capital costs of a Gila River diversion project. Finally, Grant County is assumed to apply its $16.5 million subsidy to the costs of a diversion project and to bear any incremental capital and operating costs. Table 4-1 shows the results of this scenario for the four counties. In Grant County, the net cost of the diversion is $285.6 million, resulting in a cost of $9,212 per person. In the other three counties, the net costs are negative, meaning each county receives a net benefit equal to the full $16.5 million. On a per capita basis, this benefit ranges from $655 per person in Luna County, to $2,783 per person in Hidalgo County, and to $4,626 per person in Catron County.

**Table 4-1. Subsidy Allocation Scenario 1**(Each county receives $16.5 million; $62 million capital cost subsidy for Gila River diversion; Grant County bears all incremental costs)

| | Net Cost of a Gila River Diversion Project | |
|---|---|---|
| **County** | **Total, $M** | **$/capita** |
| Grant | 285.6 | 9,212 |
| Catron | -16.5* | -4,626* |
| Hidalgo | -16.5* | -2,783* |
| Luna | -16.5* | -655* |

*Note: negative costs are equivalent to <u>benefits</u>

Table 4-2 compares Grant County's costs for meeting its future needs with and without a Gila River diversion project for this subsidy allocation scenario. Without a diversion project, the analysis assumes Grant County would apply its $16.5 million toward its other supply alternatives. The results show that a Gila River diversion project increases the costs of meeting the area's future needs by at least $268 million. A Gila River diversion project is at least 16 times more expensive than conjunctive use or new well fields. The diversion is relatively more expensive with subsidies than without, because the subsidy defrays a greater percentage of the costs of the other (lower-cost) alternatives than for a Gila River diversion. Without a Gila River diversion project, the per capita costs of meeting future supply needs in Grant County range from a <u>benefit</u> of $110 per person (if future needs are low the $16.5 million subsidy more than pays for new well fields) to a cost of $567 per person (if future needs are high), as compared to a cost of $9,212 with a diversion project.

**Table 4-2. Grant County Perspective – Subsidy Allocation Scenario 1**

| | | Net Cost of Meeting Future Supply Needs | | | |
|---|---|---|---|---|---|
| | | Total, $M | $/capita | Low Future Needs ($/acre-ft) | High Future Needs ($/acre-ft) |
| | Gila River Diversion | 285.6 | 9,212 | 10,969 | 4,129 |
| Least-Cost Alternative | Low Future Needs | -3.4 | -110 | -132 | -- |
| Least-Cost Alternative | High Future Needs | 17.6 | 567 | -- | 254 |

## Subsidy Allocation Scenario 2 – Regional Cost Sharing

This scenario is intended to reflect the possibility that the scope of a Gila River diversion project could be expanded to provide water beyond Grant County. As such, the assumptions are that the entire potential $128 million subsidy is applied to the costs of a diversion project, and that each county bears the incremental costs proportional to its population. As mentioned previously, the pre-subsidy, total cost estimate of $364.1 million represents a lower bound on the ultimate costs of such an expanded project and the results herein should be viewed as such. Table 4-3 shows the costs borne by each county both in total and on a per capita basis. Grant and Luna counties would bear the highest total costs due to their larger populations, but the per capita cost is the same in all counties: $3,594 per person.

**Table 4-3. Subsidy Allocation Scenario 2** (Entire potential $128 million subsidy used for Gila River diversion; each county bears incremental costs proportional to population)

| | Net Cost of a Gila River Diversion Project | |
|---|---|---|
| **County** | **Total, $M** | **$/capita** |
| Grant | 111.4 | 3,594 |
| Catron | 12.8 | 3,594 |
| Hidalgo | 21.3 | 3,594 |
| Luna | 90.5 | 3,594 |
| **Total** | **236.1** | |

The regional cost sharing approach of Scenario 2 significantly increases the costs borne by Catron, Hidalgo, and Luna counties while it decreases the costs borne by Grant County. Table 4-4 shows the change in cost for each county caused by Scenario 2 versus Scenario 1, in which Grant County would bear the costs of the project. The regional approach increases per capita costs in Catron, Hidalgo, and Luna counties by $8,200,

$6,377, and $4,249, respectively, as compared to Scenario 1. This reflects the lost subsidy of $16.5 million for local projects plus the costs due to a Gila River diversion. Recall these are the minimum cost impacts of Scenario 2, as a regional cost-sharing approach would likely only be undertaken if Gila River water were to be transported beyond Grant County and this would involve substantially higher costs for pumping and conveyance. Grant County's total costs are reduced by $174.2 million, corresponding to a savings of $5,618.

### Table 4-4. Change in Costs due to Regional Cost Sharing of a Gila River Diversion Project (Scenario 2 vs. Scenario 1)

| County | Total, $M | $/capita |
|---|---|---|
| Grant | -174.2 | -5,618 |
| Catron | 29.3 | 8,220 |
| Hidalgo | 37.8 | 6,377 |
| Luna | 107.0 | 4,249 |

Table 4-5 shows Grant County's perspective as a result of regional cost sharing for a Gila River diversion project. Grant County's costs are reduced by more than half, but a Gila River diversion project still costs $94 million more and is at least 6 times more expensive than conjunctive use or new well fields. The lower costs per acre-foot reflect the cost sharing by the other counties, who are, in fact, subsidizing the costs of water in Grant County by $124.7 million under this scenario (see Table 4-3). Note that, absent additional demand to bring costs down, the true regional costs of meeting demand in Grant County in this scenario range from $3,414/acre-foot to $9,068/acre-foot, depending on future needs.

### Table 4-5. Grant County Perspective – Subsidy Allocation Scenario 2

| | | Net Cost of Meeting Future Supply Needs | | | |
|---|---|---|---|---|---|
| | | Total, $M | $/capita | Low Future Needs ($/acre-ft) | High Future Needs ($/acre-ft) |
| | Gila River Diversion | 111.4 | 3,594 | 4,280* | 1,611* |
| Least-Cost Alternative | Low Future Needs | -3.4 | -110 | -132 | -- |
| Least-Cost Alternative | High Future Needs | 17.6 | 567 | -- | 254 |

*Reflects costs borne by other counties, true regional costs are $9,068/acre-ft and $3,414/acre-ft

This analysis shows that, even with a $128 million subsidy, a Gila River diversion project is by far the most costly alternative for Grant County. Even if an annual demand of 14,000 acre-feet per year could somehow be found, the cost of water from the diversion project would be a minimum of $655/acre-foot, more than double that of the least-cost alternative in Grant County ($254/acre-foot), and this does not include the significant additional costs that would be needed to transport water beyond Grant County. In fact, the annual demand met by the project would have to exceed 36,000 acre-feet per year, more than double what the project could provide, to bring the regional cost per acre-foot down to about $250/acre-ft.

Southwestern New Mexico should focus its efforts on the best utilization of the $66 million for local/regional projects and investigate any other means for utilizing the incremental $34 million to $62 million while avoiding a Gila River diversion.

# Section 5

# POTENTIAL ECONOMIC COSTS DUE TO THE ECOLOGICAL IMPACTS OF A GILA RIVER DIVERSION

Water resources provide economic value as a function of their ecological attributes. For example, fish and wildlife populations are valued for their existence as well as the recreational opportunities they provide. Streamside vegetation provides aesthetic value in addition to habitat support. Free-flowing rivers are valued for their uniqueness and wildness. This section focuses on the potential economic costs stemming from a Gila River diversion project's negative impacts on the surrounding ecosystem. Economic costs will occur to the extent that the diversion project damages the Gila River's ecological attributes.

Many of the Gila River's ecological attributes are summarized in a recent study by The Nature Conservancy (Haney, 2005):

- As New Mexico's last major river without dams or other major water development, the Gila's natural flow regime supports a unique ecosystem that includes outstanding examples of riparian (streamside) forest, a remarkable abundance of wildlife, and the densest population of non-colonial breeding birds in the United States.
- The Gila River has the largest complement of native fish, eight species, in the lower Colorado River Basin.
- Three of the species (spikedace, loach minnow, and roundtail chub) are protected under New Mexico law, while the spikedace and loach minnow are listed as threatened species under federal law.
- For birds, the Gila River Valley provides some of the best remaining habitat left in the lower Colorado River basin and supports the greatest diversity of raptors and the largest number of endangered, threatened, and peripheral bird species in the basin.
- Some of the largest known populations of the federally endangered southwestern willow flycatcher are found in the Cliff-Gila Valley.
- The mature cottonwood-willow riparian forest supported by the Gila River also provides important habitat for the yellow-billed cuckoo. Biologists estimate that more than 90 percent of the bird's riparian habitat in the West has been lost or degraded.

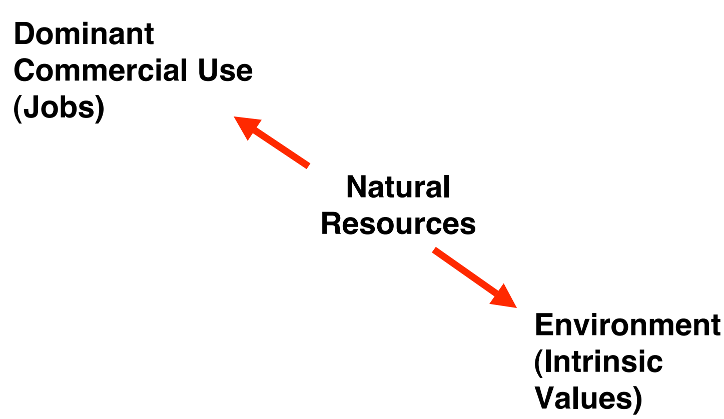
According to Haney, due to stream flow reductions, a Gila River diversion project is expected to have impacts in two major categories: 1) native fish, as well as other aquatic vertebrate and invertebrate species; and 2) riparian habitat and associated wildlife. In other words, a diversion may affect the entire list above. The extent of impacts is unknown at the current time due to the lack of specific project definition and lack of associated scientific studies on the ecosystems of the upper Gila River. As a result, the economic analysis is limited and focuses on a few categories of *potential* economic costs due to ecological impacts. The underlying assumptions are clearly stated.

The remainder of this section first describes how the economy has evolved to depend on preserving pristine natural resources as opposed to consuming them. Next is a description of the many types of economic values that are derived from water resources. Then, using the (limited) data available, rough, preliminary estimates of potential economic costs due to the potential ecological impacts of a Gila River diversion are developed.

## Environment-Economy Relationship

In the not so distant past, natural resources were perceived to be abundant, and a proposal to divert the Gila River for municipal water supply would have been characterized as a decision to protect either the environment or the economy—a zero sum game. The thinking went like this: When natural resources are abundant, extractive uses should prosper and claim their priority in the economy. Figure 5-1 illustrates this concept.

**Figure 5-1.**
**Competition for Natural Resources with Abundance: Old View**



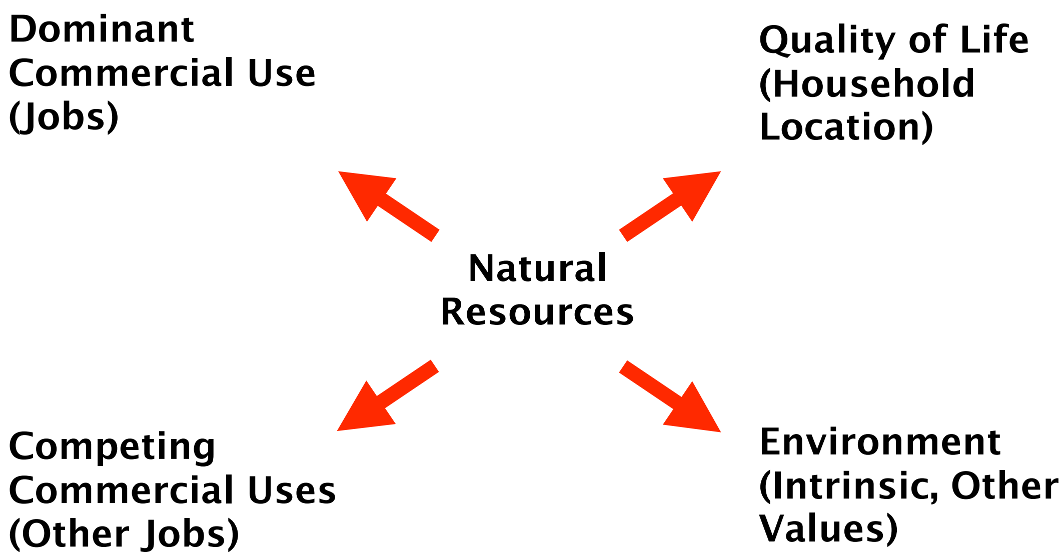

In today's economy, however, natural resources have become scarce, as the growing population and expanding economy place additional demands on these resources, many of which have already been degraded. The result is growing competition for natural resources throughout the West, including competition for the water and related resources of the Gila River. The Gila River is the last major river in New Mexico without dams or other significant water development and one of the last in the American Southwest. The competition for pristine natural resources is more intense and more complex than in the past. Four types of demand now compete for the use of our natural resources:

- The dominant commercial use (e.g., agriculture, mining, logging)
- Other commercial uses (e.g., municipal water supply, recreation, tourism)

- The consumer desire for quality of life affecting household location decisions
- The desire to preserve the intrinsic values of natural resources.

This new reality of the competition for natural resources is shown in Figure 5-2. The economic impacts of a Gila River diversion must take all four of these factors into account.

**Figure 5-2.**
**Competition for Natural Resources with Scarcity: Current Reality**




The left-hand side of Figure 5-2 illustrates the competition for jobs and profits between different commercial uses. As a general example (not necessarily for the Gila), consider the situation in which otherwise potable river water receives polluting discharges from an upstream industry (e.g., mining, agriculture) before it reaches a downstream diversion point for a public water system. Once there, it must be treated before it enters the drinking water supply. The upstream and downstream water users are competing for unpolluted, potable water. Another example of competition between commercial uses is between upstream water uses, such as hydropower and irrigation, that rely on fluctuations in daily or seasonal stream flows and downstream recreational uses such as kayak parks that desire consistently high flows.

The upper right hand side of the diagram shows that in today's economy the amenities provided by natural resources exert a powerful influence on household location decisions. This is called quality-of-life demand. For example, many households prefer to live where there are ample opportunities for kayaking/ canoeing, fishing, and hiking and are willing to give up some income in exchange for these amenities. This is called the *second paycheck effect* (Whitelaw and Niemi, 1989). If enough households locate near such amenities, they exert a real impact on the local economy by providing labor for and spending money in local businesses. Increasingly, firms are seeking to locate in areas providing quality of life amenities for their employees. Numerous studies confirm that environmental amenities influence location decisions and economic growth.[1]

The lower right hand side of the diagram represents the intrinsic values provided by natural resources. These are nonuse values, but they are real nonetheless. They include the value of wildness, biodiversity, the preservation of species, and the value of passing on such attributes to future generations. Since these values are not commodities traded in a marketplace, they are not commonly observed, although they may become observable in some settings, as when people take action to protect the values of wild areas and free-flowing rivers from destruction.

## Economic Values Derived from Water Resources

A recent report by the National Research Council of the National Academy of Sciences reinforces the concepts of evolving, competing demands, as shown in Figure 5-2. The report distills several decades of research into the different ways society derives value from or assigns value to water resources. The report provides a useful classification (Table 5-1) of these many facets of water's economic value.

The Council's classification system has several important features. It recognizes that water by itself sometimes has economic values, as when it irrigates crops, waters livestock, or provides domestic drinking water. It also recognizes that water generates economic values not by itself but as an inseparable element of an aquatic system, as when entire stream systems provide habitat for fish and wildlife, or when stream banks and streamside vegetation attenuate flooding. The classification system seeks to identify and quantify the full set of values, many of which are provided by the Gila River ecosystem.

[1] See, for example, research performed by the USDA Economic Research Service (Vias, 1999, and Cromartie and Wardwell, 1999). Also see Helvoigt, 1999; Rudzitis and Johnson, 2000; Southwick Associates, 2000.

**Table 5-1.**
**Classification of Total Economic Value Provided by Water Resource Ecosystems**

| Use Values | | Nonuse Values |
|---|---|---|
| **Consumptive** | **Non-Consumptive** | **Existence and Bequest Values** |
| Irrigation | Ecosystem Services | Cultural heritage |
| Municipal and domestic use | *Flood control and storm protection* | Resources for future generations |
| Industrial processing | *River bank stabilization* | Existence of resources |
| Livestock watering | *Habitat function* | *Species* |
| Genetic and medicinal resource | *Nutrient retention, cycling* | *Wild places* |
| Harvesting of food, timber, etc. from streamside zones | *Enhanced property values* | *Free-flowing rivers* |
| Other consumptive uses | Aesthetics | Biodiversity |
| | Recreation and Tourism | Other nonuse values |
| | Transportation | |
| | Scientific and educational opportunities | |
| | Other non-consumptive uses | |

Adapted by ECONorthwest from: National Research Council, 2004. *Valuing Ecosystem Services: Toward Better Environmental Decision-Making*.

The classification system distinguishes between "Use Values" derived from the direct use of the ecosystem and "Nonuse Values" derived from its existence. Use values include both consumptive uses, such as irrigation, and non-consumptive uses such as recreation and transportation. Non-consumptive values also materialize as an aquatic ecosystem provides services, such as mitigating flooding, protecting against storms, or stabilizing a riverbank. Use values encompass the commercial use and quality of life components of Figure 5-2 (i.e., the entire left-hand side and upper right-hand side).

The "Nonuse Values" are less recognizable, but not necessarily less important. These were referred to as intrinsic values earlier, and they constitute the fourth component of demand for natural resources shown in the lower right-hand section of Figure 5-2. In general, they refer to an important economic reality: most Americans place a value on knowing that some water resources exist in a more-or-less wild state (existence value) and will be passed on to future generations in this condition (bequest value). Numerous studies have found they express this value whether or not they intend to use the water themselves. According to the Research Council's report, "in some cases, this 'nonuse value' may be the primary source of an ecosystem's value to humans."[2]

The Gila River's ecosystem is capable of producing many of the values shown in Table 5-1, if not today then sometime in the foreseeable future. Hence, to understand the full costs of the proposed diversion project, it is necessary to account for the diversion

[2] National Research Council. *Valuing Ecosystem Services: Toward Better Environmental Decision-Making*, National Academies Press, 2004, p. 206.

project's potential impacts on each category of value.  This task is addressed in the following discussion.

## Preliminary Estimates of Economic Costs due to the Ecological Impacts of a Gila River Diversion

The regional water plan provides the most current discussion of the potential project.[3] At least three points of diversion are under consideration: (1) from just below the Gila Wilderness boundary at the head of the Cliff-Gila Valley; (2) from just above the entry point of Mangas Creek at the Phelps Dodge diversion facility; and (3) from the Gila "Middle Box" (see Figure 1-1).  According to the diversion rules in the CUFA, the facilities could be designed to deliver up to an average of 14,000 acre-feet of water per year (with a maximum potential of 64,000 acre-feet per year).  The project would likely include the construction and operation of the following facilities:

- Road to diversion point for installation of diversion facilities (e.g., the potential location at the head of the Cliff-Gila Valley has minimal access on the north/west side of the river and no access on the south/east side))
- Diversion facilities (e.g., direct pumping of surface water or underground infiltration gallery)
- Large diameter pipeline (350 cfs capacity) from diversion point to intermediate storage reservoir (e.g., approximately 25 miles through Cliff-Gila Valley)
- Impoundment of Mangas Creek (or Schoolhouse Canyon) to create intermediate storage reservoir holding 50,000 acre-feet[4] (i.e., 25 times the volume of Bill Evans Lake)
- Pumping station to deliver water from storage to Silver City well fields
- Pipeline from storage reservoir to Silver City well fields
- Power lines.

Following the approach described in the previous subsections, Table 5-2 provides a preliminary framework for organizing the discussion of the potential economic costs due to the ecological impacts of a Gila River diversion.  The columns of the table represent categories of the likely physical changes associated with the construction and operation of the project: flow reduction, diversion facilities, the storage reservoir, and the pumping station(s) and pipeline facilities.  The rows represent the likely economic values affected by the diversion based on Table 5-1.  The "X"s in the table show the potential linkages between physical changes and economic values.

[3] DBS&A, Section 8.6

[4] DBS&A, p. 8-109

**Table 5-2. Potential Economic Costs due to the Anticipated Ecological Impacts of a Gila River Diversion Project**

| | Flow Reduction | Diversion Facilities | Storage Reservoir | Pumping and Pipelines |
|---|---|---|---|---|
| Domestic Wells | X | | | |
| Mining | X | | | |
| Agriculture | X | | | |
| Water Quality | X | | X | X |
| Property Value | X | | X | X |
| Aesthetics | X | X | X | X |
| Recreation | X | X | X | X |
| Tourism | X | X | X | X |
| Scientific Opport. | X | | | |
| Existence Value | X | X | X | X |
| Bequest Value | X | X | X | X |

Currently, the dominant commercial uses of the Gila River are for agriculture and mining; domestic wells also draw from the basin. It is possible that the proposed diversion project could diminish these uses by degrading water quality and/or quantity. For example, if the project were to encourage the establishment of tamarisk along the river due to reduced flows, tamarisk's potential for increased consumption of water relative to cottonwood/willow habitat would diminish flows even further and increase the salinity of water remaining in the river. Impacts on sediment loads could also have potentially negative impacts on mining, agriculture, and domestic wells.

Other commercial values derived from the river include various types of recreation (boating, fishing, birding) by locals and tourists. Impacts on recreational use and tourism are likely to occur if the changes in flows and/or the construction of the various facilities affect habitat for fish and wildlife and their ultimate population size and diversity. Ecosystem services such as property values are also likely to be affected due to road building, pipelines, power lines, and pumping stations.

Scientific and educational opportunities could also be diminished if the diversion negatively affects the uniqueness of the Gila River and its ecosystem. Existence and bequest values will be reduced to the extent that the diversion noticeably alters the river's relatively free-flowing nature or negatively affects its relative wildness, species existence, or natural Southwestern riparian habitat.

In addition to the specific values outlined in Table 5-2, it also seems reasonable to anticipate that the accumulation of the diversion project's potential ecological impacts could have negative impacts on overall quality of life in the area and therefore its attractiveness as a household location. If households decide not to live in the area because of the changes, growth of jobs and incomes in the area will be reduced. These impacts would arise insofar as the project resulted in:

- A reduction in quality or availability of recreational opportunities such as boating, fishing, hiking, or birding.

- A reduction in the aesthetics of the river.
- Elimination of the river's relatively free-flowing character.
- Diminution of the river's unique characteristics, so that it more closely resembles other rivers with altered flows in the Southwest.
- The loss of biodiversity and/or certain species from the area.

As stated previously, it is beyond the scope of this effort to comprehensively link each of the potential ecological impacts individually to specific economic impacts. Extensive data gathering and additional environmental and economic modeling would be needed. The goal of this effort is to use currently available data to estimate general categories of potential economic costs due to ecological impacts. Appendix C contains a summary of recent studies on the wide range of benefits resulting from the conservation of natural resources. The remainder of this section refers to these studies and others referenced herein to estimate potential economic costs of the diversion in the following areas:[5]

- Property Values
- Quality of Life
- Existence and Bequest Values

**Property Values.** The literature summarized in Appendix C provides evidence that property values increase with proximity to natural areas like rivers. The specific amenities cited in these studies include:

- Proximity to a river
- Health of surrounding vegetation and presence of mature trees
- Proximity to protected riparian areas
- Undeveloped land near riparian areas
- Opportunities for wildlife viewing
- Open space
- Higher water table to maintain existing wells
- Proximity to a greenbelt
- Proximity to hiking and biking

Two of these studies found that land near a greenbelt could be worth over $1,000 per acre more than land that was not. A Boulder, Colorado study found homes adjacent to a greenbelt are valued 32 percent higher than comparable houses 3,000 feet away. A 2002 study in Tucson, Arizona found that homes located within one-half mile of riparian areas proposed for protection commanded three to six percent higher sales prices. Another study in Yavapai County, Arizona (2002) found that the closer a home was to a river, the more the property value would increase ($118.87/mile).

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[5] While the recreational opportunities derived from the Gila River ecosystem clearly provide significant value to each participant, the number of recreational users is relatively small, and so economic impacts would be expected to be small as well. This analysis assumes the impact of lost recreational opportunities is largely felt in terms of impacts on property values and quality of life.

**Quality of Life.** As described earlier, quality of life affects household location decisions. If Grant County's environmental amenities are negatively affected by the diversion, then economic growth could be affected due to fewer new households and businesses locating in the area. It is also possible that some current households and businesses could relocate. Estimating the potential economic impact in dollar terms is difficult, however, because of the lack of precision in the location and extent of ecological impacts, and the lack of local studies linking river-related amenities (as distinct from climate, etc.) to quality of life.

Examining economic and population trends in Grant County provides some insight into the importance of quality of life for the region's economy. For example, employment in Grant County's services-related industries has grown over time while it has declined in the mining sector (see Table 5-3). Between 1970 and 2000, general service industry employment grew over 200%, while mining employment declined by almost 50 percent. In terms of growth rates, over the last ten years, service jobs have increased at the rate of 3 percent per year, while mining has declined 1 percent per year. Some of this is certainly due to increased tourism, but during this same period from 1970-2000, Grant County's population grew from 22,030 to 31,002, a total increase of 40 percent.[6] While growth clearly has costs and benefits, these data show that households are locating in Grant County for reasons other than mining jobs.

## Table 5-3. Grant County Employment Trends

| | Mining | Services | Agric. Services, Forestry, Fishing, Other | Finance, Insurance, Real Estate | Construction | Retail Trade | Government & Govt. Enterprises |
|---|---|---|---|---|---|---|---|
| **Total Growth** | | | | | | | |
| **1970-2000** | -49% | 233% | 342% | 148% | 153% | 168% | 100% |
| **Average Annual Growth** | | | | | | | |
| **1990-2000** | -1% | 3% | 4% | 3% | 1% | 3% | 2% |

Source: Bureau of Economic Analysis

This result is consistent with recent research on rural America from the USDA's Economic Research Service:

> Lack of natural amenities, rather than the presence of agriculture per se, creates barriers to renewed population growth in many rural and small town settings. Indeed, population loss is noticeably absent in the intermountain West and coastal settings, where recreation and retirement economies prevail.[7]

[6] U.S. Census Bureau

[7] Cromartie, J. "Population Loss Counties Lack Natural Amenities and Metro Proximity," Amber Waves, April 2005.

And,

> Natural amenities though, will be the trump card for some rural areas. Rural counties with varied topography, relatively large lakes or coastal areas, warm and sunny winters, and temperate summers have tended to reap huge benefits from tourism and recreation, one of the fastest growing rural industries. Recent ERS research finds that tourism and recreational development in rural areas leads to increases in local employment, income, and wage levels, and improvements in social conditions, such as poverty, education, and health. These strategies have drawbacks, however, particularly in the form of higher housing costs in these nonmetro recreation counties.[8]

According to the regional water plan, "growth of the residential, municipal, and commercial sectors in Grant County will most likely be driven by increased tourism and in-migration of residents seeking quality of life, including retirees." The plan goes on to observe that increased tourism is currently shifting and will continue to shift commercial development toward services for visitors to the area, and that businesses that serve county residents will continue to locate in the Silver City area. The plan's high growth scenario for Grant County forecasts a 1 percent annual growth for total population, 1 percent annual growth for the residential, municipal, and commercial sectors, and zero percent annual growth for the mining industry.[9]

To the extent that river-related amenities contribute to the tourism economy, then any degradation in those amenities will affect revenues from tourism. According to the New Mexico Department of Tourism, tourism contributed $48 million to the economy of Grant County in 2002. Hypothetically, if the negative ecological impacts of a Gila River diversion cause a one percent decline in those revenues, and this $480,000 loss occurred every year over the life of the project, the present value cost would be $12.4 million.

**Existence and Bequest Values.** Another potential category of economic impact due to the ecological effects of the diversion is intrinsic, or nonuse, values, otherwise known as existence and bequest values. As shown in Table 5-2, the nonuse values of the Gila River include wildness/free-flowing nature, biodiversity, species existence, cultural heritage, and bequest value. The potential ecological impacts could negatively affect all of these values. This subsection addresses values for species existence, values for free-flowing rivers, and concludes with an estimate of riparian restoration costs to provide perspective on these values.

> Species Existence Values. A study referenced in Appendix C indicates that the willingness to pay by New Mexico residents for minimum instream flows for at-risk fish in all the state's major rivers is $79 per household per year for five years. The same study found a willingness to pay of $30 per year for five years to provide minimum instream flows in the Rio Grande to prevent the extinction of

[8] Whitener, L. "Policy Options for a Changing Rural America," Amber Waves, April 2005.
[9] DBS&A, Appendix E4, pp. 9, 12.

one fish species. Another study found that U.S. households were willing to pay $50-$330 per year to protect habitat critical to the survival of at-risk fish in the Southwest, including habitat along the Gila River.
Compared to the information on property value and quality of life impacts, the research on instream flow values is more directly linked to New Mexico and the Gila River, although none of the research is for willingness to pay solely for Gila River instream flows. Assuming that the willingness to pay for instream flows on the Gila is less than on the Rio Grande may provide a reasonable estimate for the Gila. If a lower-bound on the value for the Gila is $5 per household per year, then the total willingness to pay by New Mexico households (677,971 in 2000) is at least $3.4 million per year, or a present value of $15.5 million over 5 years.

Free-Flowing River Values. For the value of free-flowing rivers, the studies reviewed in Appendix C show a range in value from about $0.25/mile/household to $1.20/mile/household (in today's dollars). These studies are for rivers in Colorado and Oregon. If the residents of New Mexico value the free-flowing character of the Gila River to the same extent as the residents of these states, then an estimate can be made for the loss in nonuse value if the diversion project markedly alters the river's free-flowing character. Assuming that approximately 50 river miles could be affected, from the Cliff-Gila Valley through the Lower Box, and the low end of the value range is used ($0.25/mile/household), the annual value that could be lost to New Mexico is $8.5 million. Over 50 years, the present value is $218 million.

Riparian Restoration Costs. As a check on these results for potentially lost existence and bequest values, it is useful to calculate what it might cost to recreate the lost habitat and ecosystem, if it were destroyed by the diversion project. If people were willing to pay this amount, then this would be a lower bound on total willingness to pay. Economic analyses of the costs of riparian restoration due to tamarisk damage provide a starting point. Tamarisk have clogged the banks and destroyed natural riparian habitat in most of the Southwest's rivers with non-natural flows. On the San Pedro River, for example, as flow becomes increasingly intermittent and groundwater deepens, conditions become less suitable for cottonwood and willow and more suitable for tamarisk.[10] According to Haney, a shift from cottonwood-willow dominance to tamarisk dominance along drier reaches of the Gila River is a potential outcome of a reduction in stream flow.

The cost to remove tamarisk with hand cutting (as opposed to bulldozers) and foliar application of herbicide is estimated at $5,000 per acre.[11] Planting of

[10] Lite, S.J. and J.C. Stromberg. 2005. Ground-water and surface water thresholds for maintaining *Populus-Salix* forests, San Pedro River, Arizona. Biological Conservation. In Press.
[11] Tamarisk Coalition, "Impact of Tamarisk Infestation on the Water Resources of Colorado," Prepared for the Colorado Department of Natural Resources, Colorado Water Conservation Board, May 30, 2003.

natural vegetation is an additional cost, estimated at $250 per acre. Without restoration of a natural flow regime, however, tamarisk would be expected to return and so these costs could be experienced every few years. To estimate the cost of riparian restoration along the Gila, the assumptions are a one-time cost of $5,250 an acre and annual costs of $250 per acre. If 50 miles would be affected and if there are 25 acres per river mile, then the present value costs are $14.6 million.

In summary, the potential economic costs due to ecological impacts explored in this section range from $12.4 million for potential lost tourist dollars to $218 million for the value that New Mexico residents might place on the loss of the free-flowing characteristics of the Gila River. Table 5-4 summarizes these results. Clearly, additional study is needed to refine these estimates. Since it produces the largest value, further research is especially important regarding how New Mexico residents' valuation of the Gila River's relatively free-flowing nature would change with a Gila River diversion.

**Table 5-4. Summary of Potential Economic Costs due to Ecological Impacts**

| Type of Value | Estimated Present Value |
|---|---|
| Tourism | $12.4 million |
| Species Existence | $15.5 million |
| Free-Flowing River Values | $218 million |

# Section 6

# SUMMARY

While it is understandable that some in the region believe New Mexico must secure its right to Gila River water through consumptive use, this preliminary analysis has shown that the water in the Gila River actually has much greater value to the region if it remains instream. On the basis of direct capital and operating costs and including federal subsidies under AWSA, a diversion project under CUFA will increase the costs of meeting future water supply needs in Grant County by at least $268 million. The demand for the water is simply not there. Significantly less expensive alternatives exist (one-sixteenth the costs of a diversion) that better match the region's supply needs, including conservation, new well fields, and conjunctive use of groundwater with surface water diverted through the existing Phelps Dodge Tyrone facilities.

In addition, the potential economic costs produced by the ecological impacts of a Gila River diversion could be very large, perhaps doubling total project costs. A Gila River diversion's stream flow reductions are expected to impact the very features that define the uniqueness and wildness of the ecosystem: its native fish and other aquatic species, and its riparian habitat and associated wildlife, many of which are threatened or endangered. Additional research would certainly be needed to ascertain specific impacts, but given the overwhelming lack of cost-effectiveness for a diversion project and the potentially large value placed by New Mexico residents on preserving the Gila, funds for ecological studies would be much better spent protecting and enhancing the ecosystem of the Gila River.

Finally, while the capital cost subsidy of up to $62 million provided by the AWSA for the diversion appears very attractive, the estimates for the total costs of a diversion are so large ($287 million to $444 million, present value of capital plus operating costs), that the region would still have to bear significant costs. If Grant County is expected to bear the costs of a diversion project, its per capita costs are $9,212 versus $567 per person for the conjunctive use alternative. If the other counties in the region were to share the project costs, assuming some demand for the water is found beyond Grant County, then the per capita cost across the region is at least $3,594. This must be compared to the situation without a Gila River diversion in which each county would potentially receive $16.5 million without any commitment to the costs of a larger project.

As this report has shown, the local/regional subsidy should be spent first on cost-effective conservation measures, followed by lower cost supply-side investments. The region should explore alternatives to a Gila River diversion as a means to secure the additional $34 million to $62 million made available by AWSA.

# Appendix A

# Groundwater Budget for the Mimbres Basin

This appendix examines the regional water plan's Mimbres Basin groundwater budget for Grant and Luna counties.[1]

## Grant County

The data show the projected storage loss in the Mimbres Basin in Grant County is only about 3,000 acre-feet per year. The groundwater budget also shows that most of the basin's recharge occurs in the Grant County area of the basin: about 22,000 acre-feet out of a total recharge of 25,000 acre-feet. In addition, the Grant County portion looks even healthier when the most recent mining water use data are used. The regional water plan uses data from 2000 showing about 19,000 acre-feet per year for Grant County mining outflows, whereas more recent mining outflows (in 2002 and 2003) have been only about 6,000 acre-feet per year (see Appendix B. Updating the groundwater budget with this more current data shows that there is a positive net change in storage in the Grant County section of almost 6,000 acre-feet per year. It would appear that the Grant County section of aquifer is in relatively good shape.

## Luna County

Luna County is responsible for the loss of 31,000 of the aquifer's 34,000 acre-feet per year. Most of the loss in Luna County is due to irrigation (30,000 acre-feet). But the Luna County portion may be better off than indicated by the groundwater budget. For example, the regional water plan acknowledges that the estimates of evapotranspiration and recharge are highly uncertain, and that, specifically, evapotranspiration may be overestimated by 10,000 acre-feet per year.[2]

Table A-1 revises the Mimbres Basin groundwater budget incorporating the up-to-date mining data for Grant County and the potential for zero evapotranspiration (ET) loss in Luna County. The water budget for Grant County's portion of the Mimbres Basin now has net inflows of about 6,000 acre-feet per year, and Luna County's net losses decline to about 21,000 acre-feet per year. Overall, these assumptions reduce basin-wide net outflows to about 15,000 acre-feet per year, a 60 percent reduction compared to the figure reported in the regional water plan. Given these results and the general uncertainty due to the lack of regional modeling studies, the regional water plan's broad assertion that the Mimbres Basin aquifer is under stress appears unsubstantiated, especially for the Grant County portion.

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[1] DBS&A, Appendix F, Table F-6

[2] DBS&A, p. 7-15; Appendix F, Table F-6

**Table A-1. Mimbres Basin Groundwater Budget (all flows in acre-ft/yr)**

| | **Luna County** | | **Grant County** | | **Total Basin Flow** | |
|---|---|---|---|---|---|---|
| Component | Regional Water Plan | If ET is zero | Regional Water Plan | Using 2003 Mining Data | Regional Water Plan | With ET=0, and 2003 Mining Data |
| Total Inflow | 59,994 | 59,994 | 31,196 | 27,392 | 91,190 | 87,386 |
| Total Outflow | 90,784 | 80,784 | 34,161 | 21,447 | 124,945 | 102,231 |
| Net Inflow | -30,790 | -20,790 | -2,965 | 5,945 | -33,755 | -14,845 |

# Appendix B

## Phelps Dodge Water Rights, Consumption, and Unused Water Rights

Tables B-1, B-2, and B-3 detail the consumptive use rights, actual consumptive use, and unused water rights for Phelps Dodge mining operations in the Gila and Mimbres Basins for the last five or more years, excluding all irrigation rights. This information was obtained from monthly water reports on file at the State Engineer's Office in Deming. As the data show, unused consumptive rights average about 3,000 acre-feet per year from the Tyrone mine, and 7,400 acre-feet per year for a five-year average from the Chino mine. The Chino results bear further examination, however, because pumping there has dropped off significantly since the year 2000 due to low copper prices. If this trend continues, unused consumptive rights will be closer to 12,000 acre-feet per year for a five-year average. If the copper market improves, water use is expected to return to 1999 levels,[1] when unused consumptive rights were about 5,400 acre-feet. Total unused consumptive rights from the Tyrone and Chino mines therefore range from 8,400 to 15,000 acre-feet per year. Regardless of market trends, it is clear that Phelps Dodge's unused water rights are more than sufficient to meet the future needs of Silver City and the Central Mining District.

**Table B-1. Tyrone Mine Water Consumption - Gila River Diversion (License 02260, excluding irrigation rights) Total Consumptive Use Right: 5309 acre-ft/yr** ***All amounts in acre-feet***

| Year | Total Consumptive Use | Unused Consumptive Right |
|---|---|---|
| 1997 | 3,726 | 1,582 |
| 1998 | 2,629 | 2,680 |
| 1999 | 2,380 | 2,929 |
| 2000 | 2,714 | 2,594 |
| 2001 | 2,553 | 2,756 |
| 2002 | 3,174 | 2,135 |
| 2003 | 3,042 | 2,267 |
| Average | 2,888 | 2,422 |

[1] DBS&A, p. 6-12.

**Table B-2. Tyrone Mine Water Consumption – Mimbres Basin Wells (M4980, M4979, M2680, M4978, M8748)Total Consumptive Use Right: 2,090 acre-ft/yr** ***All amounts in acre-feet***

| Year | Total Pumped | Unused Consumptive Right |
|---|---|---|
| 1990 | 2,050 | 40 |
| 1991 | 2,053 | 37 |
| 1992 | 1,227 | 863 |
| 1993 | 1,460 | 630 |
| 1994 | 1,842 | 248 |
| 1995 | 1,829 | 261 |
| 1996 | 1,912 | 178 |
| 1997 | 1,480 | 610 |
| 1998 | 1,443 | 647 |
| 1999 | 1,393 | 697 |
| 2000 | 1,438 | 652 |
| 2001 | 817 | 1,273 |
| 2002 | 1,229 | 861 |
| 2003 | 1,018 | 1,072 |
| Average | 1,514 | 576 |

**Table B-3. Chino Mine Water Consumption – Mimbres Basin Wells (M5010-5019, M3527, M5068, M4425, M6724; excludes irrigation well fields) Total Consumptive Use Right: 27,656 acre-ft/yr; 5 year average: 23,494 acre-ft/yr**
***All amounts in acre-feet***

| Year | Annual Amount Pumped | Unused Consumptive Right | 5-yr Average Annual Pumped | 5-yr Average Annual Unused |
|---|---|---|---|---|
| 1993 | 15,849 | 11,807 | | |
| 1994 | 16,157 | 11,499 | | |
| 1995 | 16,634 | 11,022 | | |
| 1996 | 18,875 | 8,781 | | |
| 1997 | 18,376 | 9,280 | 17,178 | 6,316 |
| 1998 | 17,319 | 10,337 | 17,472 | 6,022 |
| 1999 | 19,085 | 8,571 | 18,058 | 5,436 |
| 2000 | 17,200 | 10,456 | 18,171 | 5,323 |
| 2001 | 11,037 | 16,619 | 16,603 | 6,891 |
| 2002 | 4,835 | 22,821 | 13,895 | 9,599 |
| 2003 | 5,231 | 22,425 | 11,478 | 12,016 |
| Average | 13,383 | 11,968 | 14,107 | 6,450 |

# Appendix C

## Summary of Studies of Economic Values Provided by Natural Resources

| Potential Economic Benefits | Study and Explanation |
|---|---|
| **Intrinsic Values:** | |
| Instream flows necessary for fish survival | A study in New Mexico found that the state's residents were willing to pay:<br>• $30/yr (1995 dollars) for 5 years to provide the minimum instream flows in the Rio Grande River to prevent extinction of one fish species, and<br>• $79/yr (1995 dollars) for 5 years to provide minimum instream flows in all the state's major rivers (Berrens et al., 1995).<br>Over 80% of the respondents in another survey were willing to pay $80/yr (1996 dollars) to increase the streamflows in New Mexico rivers and streams (Berrens et al., 1998). These results are indicative of the economic benefits of protecting instream flows in the Sonoran Deserts, assuming that Arizonans and New Mexicans hold similar values.<br>A study showed that households along 45 miles of the South Platte river were willing to pay $21 (1998 dollars) per month in a higher water bill to receive or maintain five ecosystem services, such as dilution of wastewater, natural purification of water, erosion control, habitat for fish and wildlife, and recreation. This translated into an investment ranging between $18 million and $71 million (1998 dollars), depending on how many households would participate (Loomis et al., 2000).<br>A study found that people living in close proximity to the Little Tennessee River in North Carolina valued the benefits of a full restoration program that included all the small streams and 6 miles of LTR at $2,835,373. This is equivalent to benefits of $472,560/mile ($89.50/ft) of restoration, or $4.54/household/mile (Holmes et al., 2004). All values are reported in 2000 dollars. |
| Free-flowing rivers | A survey of Colorado residents in 1990 found a willingness-to-pay of 21 cents/mile/household (1996 dollars) for the combined option, existence, and bequest values of the Yampa, Dolores, and Green Rivers.<br>A contingent valuation study found that the willingness to pay to preserve the Black Canyon of the Upper Snake River from development was 92 cents/mile/household (1996 dollars).<br>These studies are summarized in (Loomis, 1999). |
| Habitat for at-risk species | A study found that U.S. households were willing to pay $50-$330/yr to protect habitat critical to the survival of at-risk fish in the Southwest, including habitat along the Gila River (Ekstrand and Loomis, 1998). Some portion of this value, still unquantified, would derive from habitat protection in the Sonoran Desert.<br>Researchers studying the protection of the Mexican Spotted Owl found that U.S. households were willing to pay an average of $40.49 to protect the owl and its 4.6 million acres of critical habitat in Arizona, New Mexico, Colorado, and Utah. A conservative estimate places the benefits at $1.8 billion to $2.6 billion. (Loomis and Ekstrand, 1997).<br>A study estimated households located close to south-central Florida's Lake Okeechobee watershed would pay $30.24-71.17/year (2002 dollars) for 5 years for environmental services, such as limiting phosphorus runoff, sequestering atmospheric carbon dioxide, and improving habitat for wildlife (Shrestha and Alavalapati, 2004). |

| Potential Economic Benefits | Study and Explanation |
|---|---|
| Native ecosystems and landscapes of the desert | California residents indicated they were willing to spend $177 million to $448 million per year (1993 dollars) to support legislation to protect 6.9 million acres of the state's desert lands (Richer, 1995). |
| **Recreation and Aesthetic Values:** | |
| Bird-watching and nature-related tourism | Nature-based tourism, and especially visitors to Ramsey Canyon, generated $1 million (1992 dollars) in value-added activity in the Sierra Vista, AZ area during one year (Leones and Colby, 1998). |
| Recreational fishing | An acre-foot of water left in a stream rather than used for irrigation in central and southern Arizona would generate 150 angler-days of recreational fishing with an economic value of about $3000 (Hansen and Hallam, 1990). |
| Wilderness recreation and intrinsic value | Studies of increasing the amount of wilderness in Colorado and Utah found that the recreational and intrinsic value benefits would be roughly $402/acre (1990 dollars) for the first 2.7 million acres in Utah and $1,250/acre (1980 dollars) for the first 1.2 million acres in Colorado. (Loomis, 2000, based on Pope et al., 1990, and Walsh et al., 1982). |
| **Increased Property Values:** | |
| Increased property values near protected riparian corridors | A 1999 study in Tucson, Arizona found that homes located within one-half mile of riparian areas proposed for protection commanded three to six percent higher sales prices than comparable homes that were not located near riparian areas. In addition, the study found that undeveloped land near these riparian areas was valued 10 to 27 percent higher than other undeveloped land (Colby and Wishart, 2002). The researchers attributed these results, in part, to landowner benefits from natural amenities associated with riparian areas. These amenities include opportunities for wildlife viewing and enjoying open space as well shading, which lowers cooling costs, and a higher water table, which maintains existing well levels. |
| Increases in property values near open space and natural lands. | A 1987 study in Seattle found that houses near a bike/hiking trail sell for 6 percent more than more distant, similar houses.<br><br>A 1975 Boulder, Colorado study found that houses adjacent to a greenbelt were valued 32 percent higher than comparable houses 3,000 feet away.<br><br>A 1986 study in Salem, Oregon, found that urban land adjacent to a greenbelt was worth $1,200 more per acre than similar land 1,000 feet away.<br><br>These studies, summarized in Brabec (1992), provide more evidence that protecting natural areas provides economic benefits to property owners.<br><br>A study by Sengupta and Odgood (2002) found that the closer a ranchette property in the Yavapai County, Arizona, was to a river, the more the property value would increase ($118.87/mile in 2000 dollars). The same study estimated that a one percent increase in the greenness index was equivalent to an increase in property values of $1,415.84/acre (2000 dollars). The greenness index was indicative of the health of the surrounding vegetation, the area climate, the presence of trees and their height/age. |

## References


Berrens, R.P., A.K. Bohara, H. Jenkins-Smith, C.L. Silva, P. Ganderton, and D. Brookshire. 1998. "A Joint Investigation of Public Support and Public Values: Case of Instream Flows in New Mexico." *Ecological Economics* 27: 189-203.

Berrens, R.P.,, P. Ganderton, and C. Silva. 1995. *Valuing the Protection of Minimum Instream Flows in New Mexico*. Presented at the annual conference of the New Mexico Riparian Council, September 18, 1995, in Albuquerque.

Brabec, E. 1992. *On the Value of Open Spaces*. Scenic America.

Colby, B. and S. Wishart. 2002. *Riparian Areas Generate Property Value Premium for Landowners*. College of Agriculture and Life Sciences. January.

Ekstrand, E.R. and J. Loomis. 1998. "Incorporating Respondent Uncertainty When Estimating Willingness to Pay for Protecting Critical Habitat for Threatened and Endangered Fish." *Water Resources Research* 34 (11): 3149-3155.

Hansen, L.T. and A. Hallam. 1991. "National Estimates of the Recreational Value of Streamflow." *Water Resources Research* 27 (2): 167-175.

Holmes, T.P., J.C. Bergstrom, E. Huszar, S.B. Kask, and F. Orr III. 2004. "Contingent Valuation, Net Marginal Benefits, and the Scale of Riparian Ecosystem Restoration." *Ecological Economics* 49: 19-30.

Leones, J. and B. Colby. 1998. "Tracking Expenditures of the Elusive Nature Tourists of Southeastern Arizona." *Journal of Travel Research* 36 (3): 56-64.

Loomis, J. 2000. "Economic Values Of Wilderness Recreation and Passive Use: What We Think We Know at the Beginning of the 21st Century." In *Wilderness Science in a Time of Change*. Edited by S. McCool. 2. U.S. Department of Agriculture, Forest Service.

Loomis, J. and E. Ekstrand. 1997. "Economic Benefits of Critical Habitat for the Mexican Spotted Owl: A Scope Test Using a Multiple-Bounded Contingent Valuation Survey." *Journal of Agricultural and Resource Economics* 22 (2): 356-366.

Loomis, J., P. Kent, L. Strange, K. Fausch, and A. Covich. 2000. "Measuring the Total Economic Value of Restoring Ecosystem Services in an Impaired River Basin: Results from a Contingent Valuation Survey." *Ecological Economics* 33: 103-107.

Loomis, John. 1999. "Passive Use Values of Wild Salmon and Free-Flowing Rivers." Agricultural Enterprises Inc. (October).

Pope, C.A. and J.W. Jones. 1990. "Value of Wilderness Designation in Utah." *Journal of Environmental Management* 39: 157-174.

# Appendix D

## Bibliography

Balleau Groundwater, Inc. 2002. *BGW Field Survey of Silver City Supply Wells*. Technical Memorandum. August 27.

Brown, F. L. 2004. *Economic Considerations Pertinent to the Appraisal of the Phelps Dodge Tyrone Water Rights*. Memorandum Report prepared for the New Mexico Energy Minerals and Natural Resources and Environment Departments. April 2.

Bureau of Reclamation. 1987. *Upper Gila Water Supply Study: Special Report on Alternatives*. U.S. Department of Interior. October.

Cromartie, J. 2005. "Population Loss Counties Lack Natural Amenities and Metro Proximity." *Amber Waves*. April.

Cromartie, J. and J. Wardwell. 1999. "Migrants Settling Far and Wide in the Rural West." *Rural Development Perspectives* 14 (2): 2-8.

Daniel B. Stephens and Associates. 2005. *Southwestern New Mexico Regional Water Plan*. Draft. January.

Engineers Inc. 1993. *A 40-Year Water Plan for the Town of Silver City, New Mexico*. October.

Haney, J.A. 2005. *Preliminary Assessment of the Potential Hydro-ecological Impacts to the Gila River Ecosystem from a Proposed Diversion in New Mexico*. The Nature Conservancy, Tucson, Arizona. Internal Publication. Working Paper.

Helvoigt, T. 1999. "1998 In-Migration Study: Quality of Life." *Oregon Labor Trends* (March) : 11-12.

Johnson, M.S., L.M. Logan and D.H. Rappuhn. 2002. *Analysis of Effects of Groundwater Development to Meet Projected Demands in Regional Planning District 4, Southwest New Mexico*. New Mexico Office of the State Engineer, Draft Hydrology Report 02-X. March.

Lite, S.J. and J.C. Stromberg. 2005. *Ground-water and Surface Water Thresholds for Maintaining Populus-Salix Forests*, *San Pedro River, Arizona*. Biological Conservation. In Press.

National Research Council. 2004. *Valuing Ecosystem Services: Toward Better Environmental Decision-Making*. National Academies Press.

Reynolds, S.E. 1983. Technical Memo, State Engineer Office, State of New Mexico, September 1.

Rudzitis, G. and R. Johnson. 2000. “The Impact of Wilderness and Other Wildlands on Local Economies and Regional Development Trends.” In *Wilderness Science in a Time of Change—Volume 2: Wilderness Within the Context of Larger Systems*. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Soussan, T. 2004. “Stream Panel Backs Plan to Let New Mexico Tap Gila River.” *Albuquerque Journal*, September 14.

Southwick Associates. 2000. *Historical Economic Performance of Oregon and Eastern Counties Associated with Roadless and Wilderness Areas*. Oregon Natural Resources Council and World Wildlife Fund. August 15.

Tamarisk Coalition. 2003. *Impact of Tamarisk Infestation on the Water Resources of Colorado*. Prepared for the Colorado Department of Natural Resources, Colorado Water Conservation Board. May 30.

Vias, A. 1999. “Jobs Follow People in the Rural Rocky Mountain West.” *Rural Development Perspectives* 14 (2): 14-23.

*Water Strategist*, February 2005.

Whitener, L. 2005. “Policy Options for a Changing Rural America.” *Amber Waves*. April.

Wilson, B. C. 2001. *Projected Water Demands in Grant, Hidalgo, and Luna Counties, New Mexico, 2000 to 2040*. New Mexico Office of the State Engineer. December 16.