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E THE ARIZONA CORPORATION COMMISSION

CARL J. KUNASEK
CHAIRMAN
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COMMISSIONER

IN THE MATTER OF THE JOINT APPLICATION OF SUN CITY WATER COMPANY AND SUN CITY WEST UTILITIES COMPANY FOR APPROVAL OF CENTRAL ARIZONA PROJECT WATER UTILITIZATION PLAN AND FOR AN ACCOUNTING ORDER AUTHORIZING A GROUNDWATER SAVINGS FEE AND RECOVER OF DEFERRED CENTRAL ARIZONA PROJECT EXPENSES.

DOCKET NO. W-01656A-98-0577
SW-02334A-98-0577

NOTICE OF FILING

Citizens Communications Company hereby provides Notice of Filing the Sun City/Sun City West/Youngtown Groundwater Savings Project, Preliminary Engineering Report and Technical Appendix in compliance with Decision No. 62293 dated February 1, 2000.

RESPECTFULLY SUBMITTED this August 1, 2000.

Craig A. Marks
Associate General Counsel
Citizens Utilities Company
2901 N. Central Avenue, Suite 1660
Phoenix, Arizona 85012

Original and ten copies filed this August 1, 2000, with:

Docket Control
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

Copies of the foregoing mailed/delivered this August 1, 2000, to:

Pat Williams
Compliance Section
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

Jerry Rudibaugh
Chief Hearing Officer
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

Lyn Farmer
Chief Counsel
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

Deborah R. Scott
Director, Utilities Division
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

Scott Wakefield
RUCO
2828 North Central Avenue
Suite 1200
Phoenix, Arizona 85004

Michael A. Curtis
William P. Sullivan
MARTINEZ & CURTIS
2712 N. 7th Street
Phoenix, Arizona 85006

Walter W. Meek
AUIA
2100 North Central Avenue
Suite 210
Phoenix, Arizona 85004

William G. Beyer
Beyer, McMahon & LaRue
10448 W. Coggins, Ste. C
Sun City, Arizona 85351

By: _____
Joann Zychlewicz

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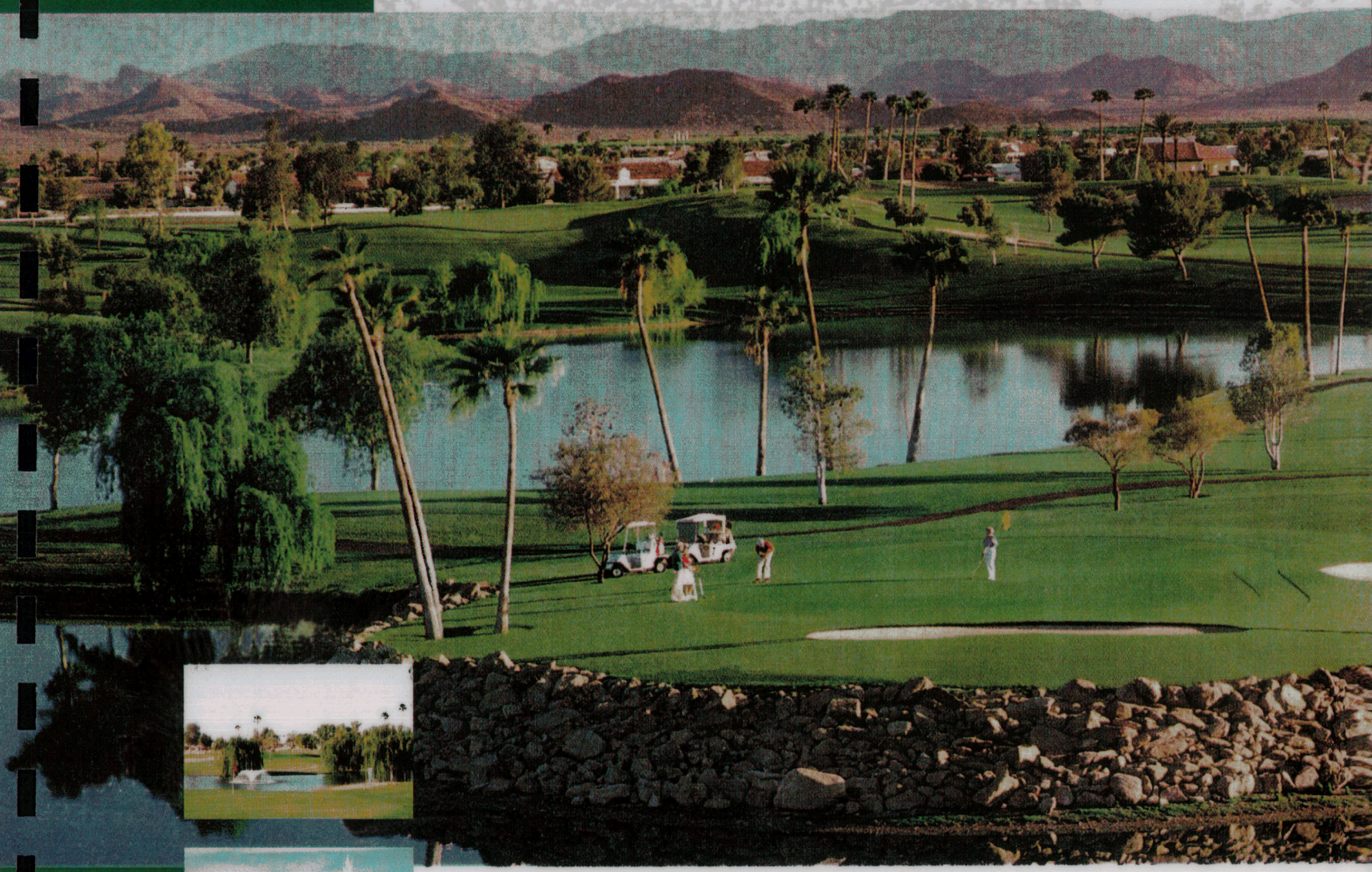
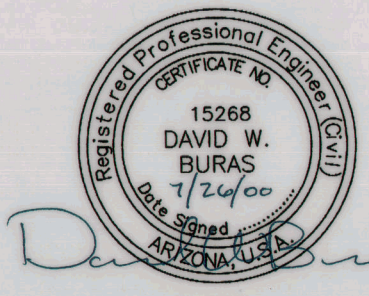


CITIZENS water resources

Sun City/Sun City West/Youngtown Groundwater Savings Project

Technical Appendix

July 2000



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Sun City / Sun City West / Youngtown Groundwater Savings Project

Technical Appendix

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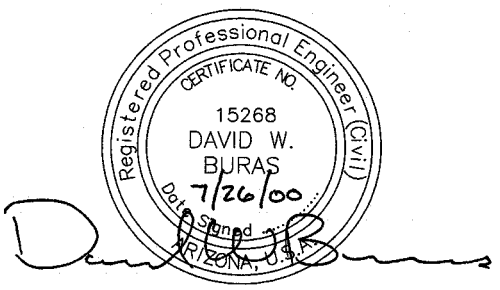

HDR

2141 E. Highland Avenue
Suite 250
Phoenix, AZ 85016
(602) 508-6600

SUN CITY / SUN CITY WEST / YOUNGTOWN GROUNDWATER SAVINGS PROJECT

PRELIMINARY ENGINEERING REPORT

TECHNICAL APPENDIX

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Appendix A
Arizona Corporation Commission
Decision 62293

Arizona Corporation Commission
DOCKETED
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BEFORE THE ARIZONA CORPORATION COMMISSION

CARL J. KUNASEK
CHAIRMAN
JIM IRVIN
COMMISSIONER
WILLIAM A. MUNDELL
COMMISSIONER

IN THE MATTER OF THE JOINT APPLICATION OF SUN CITY WATER COMPANY AND SUN CITY WEST UTILITIES COMPANY FOR APPROVAL OF CENTRAL ARIZONA PROJECT WATER UTILIZATION PLAN AND FOR AN ACCOUNTING ORDER AUTHORIZING A GROUNDWATER SAVINGS FEE AND RECOVERY OF DEFERRED CENTRAL ARIZONA PROJECT EXPENSES.	DOCKET NO. W-01656A-98-0577 DOCKET NO. SW-02334A-98-0577 DECISION NO. 62295 OPINION AND ORDER

DATES OF HEARING: October 14, 1999 (Pre-hearing conference), October 18 and 19, 1999.

PLACE OF HEARING: Phoenix, Arizona

PRESIDING OFFICER: Jerry L. Rudibaugh

APPEARANCES: Mr. Craig Marks, Associate General Counsel on behalf of Citizens Utilities Company;

Ms. Karen E. Nally on behalf of the Residential Utility Consumer Office;

Mr. William G. Beyer, BEYER, MCMAHON & LARUE, on behalf of the CAP Task Force;

Mr. Walter W. Meek, President, on behalf of the Arizona Utility Investors Association;

Mr. Paul R. Michaud, MARTINEZ & CURTIS, P.C., on behalf of the Sun City Taxpayers Association; and

Mr. Robert Metli, Staff Attorney, Legal Division, on behalf of the Utilities Division of the Arizona Corporation Commission.

BY THE COMMISSION:

On October 1; 1998, Sun City Water Company ("Sun City Water") and Sun City West Utilities Company ("Sun City West") (collectively "Companies") filed with the Arizona Corporation Commission ("Commission") an application for approval of a Central Arizona Project ("CAP") water utilization plan and for an accounting order authorizing a groundwater savings fee and recovery of

deferred CAP expenses. The Residential Utility Consumer Office ("RUCO"), the Arizona Utility Investors Association, Inc. ("AUIA"), the Sun City Taxpayers Association ("SCTA"), and the CAP Task Force ("Task Force") requested and were granted intervention in this matter.

Our June 17, 1999 Procedural Order set this matter for hearing commencing on October 13, 1999. Because SCTA had a scheduling conflict, the hearing was continued until October 18, 1999. The hearing was convened on October 18, 1999 with the Companies, RUCO, Task Force, SCTA, and the Commission's Utilities Division Staff ("Staff") appearing with counsel. AUIA was represented by its President. At the conclusion of the hearing, the parties were given an opportunity to submit closing briefs on or before November 5, 1999.

DISCUSSION

Citizens Utilities Company ("Citizens") is a Delaware corporation and diversified public utility which, through its operating divisions and subsidiaries, provides electric, natural gas, telecommunications, water and wastewater service to approximately 2 million customers in 20 states. Citizens is engaged in the business of providing public utility water service in Maricopa County pursuant to the Certificates of Convenience and Necessity granted by the Commission. This includes the Agua Fria Water Division ("Agua Fria Division"), as well as Citizens' wholly-owned subsidiaries, the Companies.

The CAP was designed to deliver surface water to replace mined groundwater. In 1985, Citizens entered into two CAP-water subcontracts, with a total CAP allocation of 17,274 acre-feet. One contract was for Sun City Water which included a 15,835 acre-feet CAP allocation and the other was for Agua Fria for a 1,439 acre-feet CAP allocation. In 1995, Sun City Water purchased the municipal water system of the Town of Youngtown resulting in Sun City Water obtaining an additional 380 acre-feet CAP allocation. This increased the total CAP allocation for Citizens to 17,654 acre-feet. In 1998, in response to criticism from intervenors in the rate case filed by Citizens in 1995, Citizens reassigned 9,654 acre-feet of Sun City Water's allocation to Agua Fria. This left Sun City Water with an allocation of 6,561 acre-feet. Citizens is proposing as part of the CAP water utilization plan to reassign 2,382 acre-feet to Sun City West resulting in an allocation of 4,189 acre-feet for Sun City Water.

In March, 1994, the Company completed a Water Resources Planning Study that concluded that continuous reliance solely on groundwater to meet the municipal and industrial demand could result in decreased water levels, increased pumping costs, well failures, diminished water quality, and land subsidence. The study recommended that the Company pursue the development of additional water resources to supplement its water supplies, and noted that the most technically and legally feasible alternative was the development and use of CAP water.

In August, 1995, Citizens completed a Water Use Feasibility Study which looked at three options for the use of CAP water. The study concluded that all three options were technically feasible, but selected the joint recharge project with the Central Arizona Water Conservation District ("CAWCD") along the Agua Fria River as the preferred option due to anticipated economies of scale, the advantage of having CAWCD as a partner, and the expected financial benefits from partial state financing.

On June 27, 1994, Sun City Water and Agua Fria filed a Joint Application with the Commission requesting an accounting order authorizing deferral of CAP water charges to allow the companies an opportunity to request recovery of the costs in a future rate proceeding. In Decision No. 58750, (August 31, 1994), the Commission approved the requested accounting order beginning with CAP water charges for 1995. The CAWCD assesses annual M & I Capital Charges based upon a per acre foot charge. The CAP water charges in 1995 were $21.00 per acre foot and have continued to escalate to $30.00 per acre foot in 1996, $39.00 per acre foot in 1997, $48.00 per acre foot for 1998-9, and $54.00 per acre foot in 2000 and thereafter.

In August, 1995, Citizens filed applications for rate increases for Sun City Water, Sun City West Water, and Agua Fria Water. As part of those applications, Citizens requested rate recognition for the deferred and on-going CAP water charges in the form of a surcharge mechanism. The Commission in Decision No. 60172, dated May 7, 1997, denied the request because Citizens was not utilizing CAP water in the provision of service to its customers. However, the Commission determined that the decision of Citizens to obtain allocations of CAP water was a prudent planning decision. It was also determined that the demand of existing customers was contributing to the groundwater depletion of the aquifer, land subsidence, and other environmental damage. Finally, the

Commission allowed Citizens to continue to defer CAP capital costs for future recovery from ratepayers when the CAP allocation has been put to beneficial use for Citizens' ratepayers. The continued deferral was subject to development of a plan and the date of implementation must be by December 31, 2000.

Task Force

Subsequent to Decision No. 60172, Citizens facilitated the creation of a community-based CAP Task Force to answer the question of how best to use CAP water. Citizens hired an independent professional facilitator ("Facilitator") to oversee the public planning process. The Facilitator interviewed various community leaders and as a result invited the following groups to each assign two individuals to represent their organization on the Task Force:

- Recreation Centers of Sun City
- Sun City Condominium Owners Association
- Sun City Homeowners Association
- Sun City Taxpayers Association
- Property Owners and Residents' Association
- Recreation Centers of Sun City West

Each group was to assign a current board member as well as a representative that was knowledgeable about water issues. Additionally, Citizens was permitted to appoint two members to the Task Force, the Town of Youngtown provided one representative, and four at-large members were selected to represent the general public. At their first meeting, the nineteen member Task Force unanimously agreed on the following mission statement:

> The underlying principle of this cooperative public planning process is that CAP water is needed to maintain the quality of life in Sun City, Sun City West and Youngtown. The mission of the Task Force is to develop consensus on the best plan for the use of CAP water that meets the Arizona Department of Water Resources' guidelines to achieve "safe yield", and that will be supported and paid for by the customers of Sun City Water Company and Sun City West Utilities Company.

According to Citizens, the Task Force used a number of means to solicit views and receive input from the residents of Sun City, Sun City West, and Youngtown, including advertisements, press

releases, bill inserts, board and personal communication, public comment periods and community open houses.

After considering the mission statement and information received during the planning process, the Task Force evaluated a number of options (including relinquishing the CAP allocations). The Task Force concluded as follows:

a. It was in the public interest to retain the CAP water allocation of 6,561 acre-feet.

b. The Interim Solution which recommended that the Sun Cities recharge its CAP allotment at the existing Maricopa Water District ("MWD") recharge facility, meets criteria of "used and useful".

c. The ratepayers would pay for the Deferred CAP Charges.

d. The ratepayers would pay for the Ongoing CAP Costs.

e. The Long-term Solution is to deliver CAP water to the Sun Cities through a non-potable pipeline, where the water would be used to irrigate golf courses that have historically used groundwater.

f. The Deferred CAP Charges and the On-going CAP Costs would be recovered on a per household, per month fee for the residential customer class.

g. The Deferred CAP Charges and the On-going CAP Costs for the commercial customer class would be recovered based on usage. The fee would be assessed per 1,000 gallons used.

Short-Term Solution

As an interim solution to resolve the issue of CAP water being "used and useful" until a long-term solution can be completed, the Task Force recommended Citizens deliver CAP water to the existing MWD groundwater savings project or, if capacity is unavailable, recharge the CAP water at the CAWCD Agua Fria Recharge Project ("Recharge Project"). The total cost to deliver CAP water to MWD's groundwater savings project in 2000 is $563,246. In 2001, the cost will increase to $636,417 because of an increase in the holding and delivery charges.

The MWD project would generate "water credits", but it would not increase the water levels in the Sun Cities' wells. Staff opined that the Recharge Project could provide a hydrological impact

in the Sun Cities' area. For that reason, Staff recommended Citizens utilize the Recharge Project as soon as it becomes operational. Staff also concurred with Citizens that the interim solution would resolve the "used and useful" criteria when CAP water is put to use.

SCTA hired an engineering consultant to review the long-term and short-term proposals as well as the proposed method to collect deferred costs. SCTA recommended the interim solution be rejected as a waste of ratepayers' money for the sole purpose of satisfying the "used" component of the "used and useful" test, where there has been no evidence to show such use of CAP water would benefit ratepayers. According to SCTA, such discharge of remote sites north of the Sun Cities may benefit the region as a whole, but will offer no benefit to the Sun Cities. As a result, SCTA concluded the remote discharges may put the CAP water "to use" but would not be "useful" to the Sun Cities. SCTA opined that the money would be better spent on paying a portion of the deferred obligation.

RUCO opined that the MWD exchange would allow the Companies to utilize their CAP allocations at the lowest cost possible for CAP usage. According to RUCO, it minimizes the cost of using CAP water with no investment in infrastructure. As a result, RUCO supported the short-term solution proposed by Citizens.

We find the proposed short-term solution satisfies the requirement in Decision No. 60172 that CAP water must be put to beneficial use prior to recovery from ratepayers. While there may not be a direct benefit to the Sun City Communities, we concur with Staff that the short-term proposal could provide a positive hydrological impact in the Sun Cities' area. Our approval is contingent upon any "water credits" not being utilized in a manner that would result in additional groundwater depletion in the Sun Cities' area.

Short-Term Costs

Citizens requested an order authorizing the recovery of the deferred CAP holding charges. Additionally, Citizens requested recovery of the on-going costs associated with payment of CAP holding and delivery charges, less an offset from participation in the MWD groundwater savings project. In the first year of implementation, the fee will be calculated based on the 2000 CAP holding and delivery charges, as approved by the CAP Board, and converted to residential and commercial

rates, using the forecasted year 2000 number of households and commercial volumes. In subsequent years, the fee will be determined using the difference between the actual amount of fees collected in the previous year, and the sum of the upcoming and the previous year's CAP holding and delivery charges. The fee will then be converted to residential and commercial rates using the forecasted number of households and commercial volumes for the subsequent year.

Cost Recovery

Deferred Costs

For Sun City Water, Citizens requested recovery of Deferred CAP charges of $762,320 (as of December 31, 1998) over a period of 42 months. The Company included an interest charge of $74,806 based on its currently approved cost of capital of 8.73 percent. Citizens proposed a monthly flat fee of $0.5502 per residential household and $0.0542 per 1,000 gallons for commercial customers. Staff updated the holding charges through 1999 and removed the interest charges to arrive at a deferred amount of $767,473. Since the balance of the Deferred CAP charges reflected five years of accumulated charges, Staff recommended an amortization period of 60 months. Staff proposed a monthly flat fee of $0.3437 per residential household and $0.0341 per 1,000 gallons for commercial customers.

For Sun City West, Citizens requested recovery of Deferred CAP charges of $433,195 (as of December 31, 1998) over a 42 month period with $42,371 due to the interest component of 8.73 percent. Citizens proposed a monthly flat fee of $0.5970 per residential household and $0.0709 per 1,000 gallons for the commercial customer class.

Staff updated the holding charges through 1999 and removed the interest charges to arrive at a deferred amount of $361,908. Utilizing Staff's proposed amortization period of 60 months, Staff proposed a monthly flat fee of $0.3761 per residential household and $0.0443 per 1,000 gallons for commercial customers.

RUCO opposed the recovery of $4,023 in late payment penalties as part of the deferral balance. Subsequently, Citizens agreed to remove any late payment penalties from the deferred amounts. As discussed below, RUCO also opposed the inclusion of carrying costs and the rate design proposed by Citizens.

The Company requested the inclusion of a carrying cost on the deferred CAP costs to be effective with the date of the decision in this matter. Both RUCO and Staff opposed the request to include a return on the deferred costs. RUCO relied on Decision No. 61831, dated July 20, 1999, in which the Commission denied Paradise Valley Water Company a return on its deferred CAP costs because such payments did not meet the "used-and-useful" test.

SCTA opposed any rate of return on the deferred holding cost balance. According to SCTA, the deferral balance was created by deliberate management decision and it would not be fair to have ratepayers pay any rate of return.

Staff characterized the CAP cost recovery as a pass-through and not subject to a rate of return. The Company disagreed with such characterization. Further, the Company asserted that cost recovery through most pass-through mechanisms occurs within a relatively short period of time which mitigates the time value of money issue.

Consistent with our determination that the CAP water will be put to beneficial use with commencement of the short-term solution, Citizens' request to begin recovery of deferred charges should be approved. Further, we find Staff's proposed 60 month collection period to be reasonable based on the period of deferral. As to the requested carrying charges going forward, we agree with Citizens that a certain rate of return is appropriate once the CAP water has been determined to be of beneficial use. Because it is not a direct benefit to the customers of the Companies, we find the appropriate rate of return should be reduced from the authorized rate of return. Accordingly, we shall approve a going-forward carrying cost of 50 percent of the authorized 8.73 percent cost of capital or 4.365 percent. Lastly, we concur with RUCO's removal of any late payment penalties.

On-Going Holding/Delivery Charges

Sun City Water proposed a monthly flat fee of $0.94 per residential household for the on-going CAP holding and delivery charges. The proposed rate for commercial customers was $0.0899 per 1,000 gallons. Similarly for Sun City West, the proposed monthly flat fee for residential customers is $1.04 and the rate for commercial customers was $0.1133 per 1,000 gallons.

Combined Monthly Impact

Sun City Water

Residential Month Fee	$1.35
Commercial (per 1,000 gallons)	$0.126

Sun City West

Residential Month Fee	$2.53
Commercial (per 1,000 gallons)	$0.1626

Staff concurred with the methodology set forth by Citizens for the on-going CAP holding and delivery charges. However, Staff modified those numbers to reflect updated charges and credits. Accordingly, Staff recommended for Sun City Water a monthly flat fee of $1.0036 per residential household and $0.0996 per 1,000 gallons for commercial customers. For Sun City West, Staff recommended a monthly flat fee of $1.1026 for residential households and $0.1299 per 1,000 gallons for commercial customers.

According to RUCO, both Sun City and Sun City West have exceeded their Groundwater Per Capita Day ("GPCD") limit established by the Arizona Department of Water Resources ("DWR") in each of the last four years. The current monthly allowance for Sun City and Sun City West is 15,000 and 11,000 gallons, respectively. As a result, RUCO recommended the proposed surcharge for the deferred and on-going CAP costs be applied to usage above the GPCD limits. RUCO's proposed CAP deferral surcharge for Sun City is $0.051 and for Sun City West is $0.089 per 1,000 gallons, respectively. RUCO recommended that the surcharge be applicable to all commercial consumption and to Sun City residential consumption above 15,000 gallons and Sun City West residential consumption above 11,000 gallons. RUCO's proposed surcharge for on-going CAP costs is $0.172 for Sun City and is $0.299 for Sun City West per 1,000 gallons, respectively. RUCO also recommended that the surcharge be applied to all commercial consumption and all residential consumption exceeding 15,000 gallons in Sun City and 11,000 gallons in Sun City West.

SCTA criticized the proposed CAP plan as being too expensive and opined that it would result in "rate shock" for the Sun City communities. According to SCTA, Citizens' proposal would result

in an annual increase to Sun City ratepayers of $688.695[1] or 12.6 percent increase before the impacts from any CAP related infrastructure. SCTA recommended that all CAP Deferred Costs should be denied because Citizens: a) initially agreed to take CAP water to protect its shareholders' investment by allowing additional development in its certificated areas; and b) made a management decision not to actively use CAP water.

Rate Design

Citizens proposed that CAP water be considered as the first water supply delivered to customers and be recovered on a pre-household charge. RUCO, on the other hand, proposed CAP charges be based upon incremental consumption above a threshold amount. SCTA proposed CAP charges be collected primarily from customers entering the system. Alternatively, SCTA supported RUCO's proposal that customers whose usage exceeds the GPCD limits should pay the incremental cost of using CAP water.

Citizens opposed the recommendations of SCTA and RUCO because they are: against the wishes of the communities; based upon a faulty understanding of water conservation requirements; and contrary to principles of cost causation. Citizens indicated that the Task Force has concluded that "CAP water should be considered as the first water supply delivered to customers, roughly the first 3,500 gallons, instead of making CAP water a portion of every gallon delivered. If the CAP water is assessed based on consumption, then the large water users will unfairly subsidize small water users . . ." Citizens further opined that the rate design should encourage CAP water consumption and discourage groundwater consumption. Citizens also criticized the RUCO proposal because 82 percent of all customers, those primarily with meters less than one-inch, would avoid paying any CAP charges. Finally, Citizens indicated that the deferred CAP charges are capital charges designed to recover the costs of constructing CAP facilities. Citizens opined that these charges as well as on-going CAP charges will not vary based on the consumption in the Sun Cities.

SCTA argued that using CAP water provides benefits of a regional nature and as such, the costs of using CAP water should be borne by the entire region. In response, Citizens indicated that

[1] This amount consists of $226,206 for on-going CAP holding charges, plus $247,151 in delivery charges, plus $215,338 in deferred costs.

the Board of the CAWCD establishes the balance between regional revenue sources and local revenue sources. The publicly elected Board establishes Citizens' appropriate fair share. Other entities that receive a regional benefit from Citizens' use of CAP water do not have to reimburse Citizens. Citizens opined that SCTA was challenging Decision No 60172 by now arguing that Citizens could have used CAP water as much as ten years ago. According to Citizens, the Commission has already determined in Decision No. 60172 that Citizens' stewardship of CAP water was prudent. Further, Citizens asserted that prudency should not be an issue anyway since Citizens is not seeking any return of the carrying costs of the CAP water.

We share some of RUCO's concerns that consumers who utilize water in excess of the allotted per capita amount should bear more of the burden of CAP water. However, because the Task Force supports the rate design proposed by Citizens as well as the fact that the deferred costs are for capital costs, we will approve Citizens' proposed rate design. The Commission wants to make it clear that it will review the rate design at the time Citizens comes in for rate consideration of its long-term solution to insure that cost allocations are appropriate.

Long-Term Solution

The Task Force determined that subsidence and earth fissures are becoming more and more common as a result of continued groundwater mining. As a result, the Task Force concluded that CAP water must be used in a manner which clearly and directly reduces the current amount of groundwater pumping. Brown and Caldwell were hired by Citizens to prepare a cost analysis of CAP water usage options. The six options and their relative incremental operating and capital costs are as follows:

Option	Capital Costs	Oper. Costs
Lease capacity at Agua Fria Recharge Proj.	$0	$132,000
Citizens' Recharge Project	11M	76,000
Exchange with MWD	0	(111,000)
Golf Course Usage	15M	187,000
CAP Water Treatment Plant	21M	679,000
Capacity at City of Glendale	10M	1,669,000

The Task Force recognized that the groundwater aquifer of the Communities of Youngtown, Sun City and Sun City West was being overused through groundwater pumping in excess of natural or incidental recharge. If CAP water is utilized on golf courses for turf irrigation, there would be an offsetting reduction in pumping of groundwater now being used on the golf courses. The use of CAP water on the golf courses would directly benefit the aquifer beneath the Communities of Youngtown, Sun City and Sun City West. Continued overdraft of the underground aquifer will give rise to serious problems from subsidence, degradation of water quality, increased pumping costs, and regulatory sanctions. The Task Force indicated there was overwhelming support in the Communities of Youngtown, Sun City and Sun City West.

As a result, the Task Force recommended that CAP water be delivered to the Sun Cities through a non-potable pipeline ("Groundwater Savings Project"). The CAP water would be used to irrigate golf courses that have historically pumped groundwater. The water would be conveyed from the aqueduct, be stored in reservoirs, and pumped to multiple golf courses for irrigation. The project would include an estimated 46,000-foot transmission line, storage reservoirs of 3.9 million gallons, and irrigation booster pumps with a capacity of 10,800 gallons per minute. The capital cost for the Groundwater Savings Project is estimated at approximately $15 million. Annual operating and maintenance costs for the project are estimated at $400,000. It is anticipated that these costs would be partially offset by annual water sales of approximately $221,000 to the Recreation Centers of Sun City and Sun City West ("Recreation Centers") for use on their golf courses. While the Company currently has no contracts for the golf course sales, the Recreation Centers have passed resolutions demonstrating their intent to enter into such contracts. Citizens estimates the Groundwater Savings Project would be operational sometime in 2003.

Staff supported the concept of using CAP water as proposed by the Task Force for a long-term solution in that utilization would constitute a direct use. According to the testimony of Ray Jones for Citizens, the next step in the process of implementing the CAP Task Force's water-use plan will be an extensive preliminary engineering and coordination phase. Although Staff believes that the concept of the Groundwater Savings Project appears to be reasonable, Staff opined that it would be imprudent to give a final recommendation as to the reasonableness and appropriateness of the costs

until the preliminary engineering plan is submitted and evaluated.

SCTA acknowledged that CAP water represents an important water source for central Arizona. SCTA also agreed that use of CAP water on existing golf courses in the Sun City communities is the only alternative that presents a potential for providing measurable benefits to equal the costs to ratepayers. SCTA reviewed the Groundwater Savings Project and concluded that the following three general changes could possibly be made to the Project:

- Elimination of a Storage Reservoir;
- Elimination of a Pumping Station; and
- Using existing Sun City West distribution facilities to use much of Sun City Water's CAP allocation in Sun City West.

According to SCTA, the aforementioned changes could reduce the cost of the Project by approximately $6 million. Citizens concurred that the first two suggestions should be considered during the completion of a preliminary design with a possible cost reduction of $2 million. Citizens opined that the majority of the potential cost reduction would result from the third suggestion, but Citizens asserted that Sun City Water's CAP water allocation cannot be used in Sun City West.

SCTA also recommended that Citizens should evaluate whether to proceed with a joint CAP water transmission project with the Agua Fria Division. SCTA indicated that Citizens is developing a separate plan for its 11,093 acre-feet allocated to the Agua Fria Division. SCTA recommended the plan for Agua Fria be combined with the plan for the Sun Cities whereby a joint transmission facility ("Joint Plan") could be built at a savings to the Sun Cities of $5,000,000. According to SCTA, the only reason Citizens gave for rejection of a Joint Plan was that it had decided to delay the bringing of CAP water to Agua Fria for a few years. SCTA noted that while Citizens hired the same engineering firm for the Agua Fria plan and the Sun Cities' plan, Citizens never requested the engineering firm to examine whether a joint project would be more cost effective. Citizens opposed this idea because; 1) Agua Fria will not need a CAP treatment plant before 2005; and 2) Agua Fria will likely be able to use the MWD's Beardsley Canal for water transportation.

Based on the above, SCTA made the following recommendations:

1. There should be no recovery of CAP-related costs from Citizens' ratepayers until

Citizens has, at a minimum: a) presented a viable, least-cost alternative for putting CAP water to use on the golf courses in Sun City; and b) demonstrated that the benefits to the ratepayers from implementation of the plan are equal to, or greater than, the costs associated therewith;

2. The Commission should require Citizens to further develop its proposed plan and return it within a specified period (e.g., 8 months) with all the elements of the proposed plan fully developed. Citizens should be required to address: a) the feasibility of a joint facility with the Agua Fria Division; b) maximizing use of existing infrastructure (e.g., the existing delivery system in Sun City West and the Beardsley Canal) by increasing deliveries in Sun City West; c) the need for all major elements of its proposed plan (e.g., storage and booster stations); d) binding commitments from golf courses, public and private, and the terms and conditions related thereto; e) the accrual and use of recharge credits; f) right-of-way issues; g) firm, not to exceed, costs; and h) financing.

3. If the recovery of CAP costs is allowed in the future, costs of CAP related infrastructure should be placed on new residents through connection fees and the on-going costs of CAP water should be recovered on a gallonage basis to recognize that it is the use of water that requires the importation of CAP water and to encourage conservation; and

4. If ratepayers pay for CAP water in order to protect their existing groundwater resources, the Commission must vigilantly monitor the accrual and use of recharge credits and groundwater to ensure the ratepayers' interests are protected.

According to RUCO, the Company's estimated CAP related construction costs of $15,000,000 would increase rate base by 40 percent and result in rate shock for residential ratepayers. RUCO opined it was premature to commit Citizens to such substantial investment at this time. RUCO asserted it would be more prudent to proceed with the interim plan and see how that works before committing the substantial investment for the golf course option. RUCO also expressed concern that it may not be in the public's best interest to commit to an expensive course of action

when Citizens has announced plans to sell its water utilities.

Citizens requested the Commission approve the general concept of the construction of a pipeline to the golf course as a reasonable and prudent approach for implementing the long-term solution for the utilization of CAP water in the Sun Cities. Citizens indicated it was unwilling to spend any more money to begin preliminary design work until the Commission finds the Project to be acceptable. According to Citizens, it needs an order from the Commission approving the Groundwater Savings Project before the Company can invest the necessary capital. Further, Citizens asserted that it is appropriate and reasonable for the CAP water costs to be paid for by the customers who benefit from the water. Once the Project is approved, Citizens opined that it would work with the Task Force and other interested parties to complete a preliminary design, obtain permits and right-of-way, complete a final design, and to finally construct the project. Citizens also indicated it would provide Staff with quarterly progress reports as well as submit the following for Staff review and approval:

1. Upon completion of the preliminary design, the final plan for the project as evidenced by the preliminary design and an updated cost estimate will be submitted.
2. Upon attaining all major permits, easements, right-of-ways, and completion of 50 percent design, a final cost estimate will be submitted.
3. Upon receipt of final bids, the bid with a comparison to the final cost estimate will be submitted.

Finally, in some future rate case, Citizens will ask the Commission to approve the completed Project for inclusion in rate base.

Staff opined that the Groundwater Savings Project with the golf courses for the long-term solution is the most favorable because, 1) the CAP water would directly be applied to the golf courses, 2) the high use consumption golf courses would stop pumping groundwater, and 3) the direct use of CAP water on the golf courses would eliminate any type of groundwater pumping in order to use this CAP water, even through the use of recharge wells. However, Staff indicated the cost estimates for the long-term project are very preliminary and conservative. As a result, Staff was unable to give a final opinion as to the reasonableness and appropriateness of the cost estimates.

According to SCTA, the foundation of Citizens' proposed plan is to preserve groundwater to avoid the harms associated with overdrafting an aquifer. However, SCTA opined that Citizens continues to encourage development within its certificated areas without any requirement that renewable resources are provided. SCTA recommended the Commission require Citizens to collect the cost of building CAP infrastructure to bring water to all new subdivisions.

SCTA opined that Citizens plans to have each golf course designated as a Recharge Facility to accept CAP water in lieu of groundwater. According to SCTA, this will make Citizens eligible to receive recharge credits which allow the storer of CAP water to recover the water at a later time. According to SCTA, recharge credits create the potential for the entire benefit to be consumed at a later date. As a result, SCTA asserted the Commission must restrict Citizens' right to dispose of or recover such credits without express authority of the Commission.

The Task Force requested the Decision in this matter include the following:

1. A requirement for Citizens to provide final cost estimates for the infrastructure required for the long-term plan;
2. A requirement for Citizens to provide detailed engineering and construction schedules for the completion of the long-term plan and to provide quarterly progress reports; and
3. An express sanction against Citizens if it fails to complete the long-term plan within a reasonable time (e.g., 42 months).

While there are clearly less costly options, the Task Force has represented there is general agreement in the Sun City areas for the Groundwater Savings Project. As a result, we will approve the concept of the Groundwater Savings Project and approve the reasonable and prudent costs associated with the completion of the preliminary design/updated cost estimate. As part of that design/cost estimate, we will require Citizens to address: a) the feasibility of a joint facility with the Agua Fria Division including the timeframe for any such joint facility; b) the need for all major elements of its proposed plan (e.g., storage and booster stations); and c) binding commitments from golf courses, public and private, and the terms and conditions related thereto. Further, we shall require Citizens to file the preliminary designed/updated cost estimate with the Commission within six months of the effective date of this Decision.

* * * * * * * * * *

Having considered the entire record herein and being fully advised in the premises, the Commission finds, concludes, and orders that:

FINDINGS OF FACT

1. On October 1, 1998, the Companies filed with the Commission an application for approval of a CAP water utilization plan and for an accounting order authorizing a groundwater savings fee and recovery of deferred CAP expenses.

2. Citizens is a Delaware corporation engaged in providing water and wastewater utility service to the public in certain portions of Mohave and Santa Cruz Counties, Arizona.

3. Citizens is in the business of providing public utility water service in Maricopa County through its Agua Fria Division and the Companies.

4. CAP was designed to deliver surface water to replace mined groundwater.

5. In 1985, Citizens entered into two CAP-water subcontracts, with a total CAP allocation of 17,274 acre-feet.

6. One contract was for Sun City Water which included a 15,835 acre-feet CAP allocation and the other was for Agua Fri for a 1,439 acre-feet CAP allocation.

7. In 1995, Sun City Water purchased the municipal water system of the Town of Youngtown resulting in Sun City Water obtaining an additional 380 acre-feet CAP allocation for a total CAP allocation for Citizens of 17,654 acre-feet.

8. The Commission in Decision No. 58750 approved a request by Sun City Water and Agua Fria for an accounting order authorizing deferral of CAP water charges for possible recovery of the costs in a future rate proceeding.

9. In August 1995, Citizens filed applications for rate increases for the Companies and Agua Fria.

10. As part of the August 1995 rate applications, Citizens requested rate recognition for the deferred and on-going CAP water charges in the form of a surcharge mechanism.

11. In 1998, Citizens re-assigned 9,654 acre-feet of Sun City Water's allocation to Agua Fria.

12. The Commission in Decision No. 60172 denied the request for the CAP surcharge mechanism because Citizens was not utilizing CAP water in the provision of service to its customers.

13. The Commission in Decision No. 60172 determined that the decision of Citizens to obtain allocations of CAP water was a prudent planning decision.

14. The Commission in Decision No. 60172 allowed Citizens to continue to defer CAP capital costs for future recovery from ratepayers when the CAP allocation has been put to beneficial use for Citizens' ratepayers.

15. The demand of existing customers is contributing to the groundwater depletion of the aquifer, land subsidence, and other environmental damage.

16. The consequences of excessive groundwater withdrawal include decreased water levels, diminished water quality, well failures, increased pumping costs, and more land subsidence.

17. The continued deferral of CAP capital costs was subject to a development of a plan and date of implementation by December 31, 2000.

18. Subsequent to Decision No. 60172, Citizens facilitated the creation of a community-based CAP Task Force to answer the question of how best to use CAP water.

19. At their first meeting, the Task Force unanimously agreed on the following mission statement:

> The underlying principle of this cooperative public planning process is that CAP water is needed to maintain the quality of life in Sun City, Sun City West and Youngtown. The mission of the Task Force is to develop consensus on the best plan for the use of CAP water that meets the Arizona Department of Water Resources' guidelines to achieve "safe yield", and that will be supported and paid for by the customers of Sun City Water Company and Sun City West Utilities Company.

20. After considering the mission statement and information received during the planning process, the Task Force evaluated a number of options (including relinquishing CAP allocations) and concluded as follows:

a. It was in the public interest to retain the CAP water allocation of 6,561 acre-feet.

b. The Interim Solution which recommended that the Sun Cities' recharge its CAP allotment at the existing Maricopa Water District ("MWD") recharge facility, meets the

criteria of "used and useful".

c. The ratepayers would pay for the Deferred CAP Charges.

d. The ratepayers would pay for the Ongoing CAP Costs.

e. The Long-term Solution to deliver CAP water to the Sun Cities through a non-potable pipeline, where the water would be used to irrigate golf courses that have historically used groundwater.

f. The Deferred CAP Charges and the On-going CAP Costs would be recovered on a per household, per month fee for the residential customer class.

g. The Deferred CAP Charges and the On-going CAP Costs for the commercial customer class would be recovered based on usage. The fee would be assessed per 1,000 gallons used.

21. The current monthly allowance established by DWR for Sun City and Sun City West is 15,000 and 11,000, respectively.

22. The MWD groundwater savings project and Recharge Project satisfy the requirement in Decision No. 60172 that CAP water must be put to beneficial use prior to recovery from ratepayers.

23. The Groundwater Savings Project will provide direct benefits to the Sun City areas.

24. While the use of CAP water will support the State's water policy goals, CAP water at any cost is not necessarily a prudent decision.

CONCLUSIONS OF LAW

1. Citizens is a public service corporation within the meaning of Article XV of the Arizona Constitution and A.R.S. §§ 40-250 and 40-251.

2. The Commission has jurisdiction over Citizens and of the subject matter of the applications.

3. Notice of the application was given in accordance with the law.

4. Citizens' decision to obtain allocations of CAP water was a prudent planning decision.

5. The approval of rate recovery for the deferred CAP costs as well as the on-going capital and delivery costs should be subject to the conditions that any "water credits" will not be utilized in a manner that would result in additional groundwater depletion in the Sun City areas.

6. The requirements of Decision No. 60172 have been satisfied and rate recovery should

be approved for the previously approved deferred CAP costs as well as the on-going capital and delivery costs.

ORDER

IT IS THEREFORE ORDERED that Citizens Utilities Company shall file, within 15 days from the effective date of this Decision, a tariff setting forth the rates and charges as approved herein, subject to the following conditions:

- The deferred CAP costs for both Sun City and Sun City West shall be updated up through January 31, 2000;
- The deferred CAP costs shall be collected utilizing Citizens proposed rate design over a 60 month period;
- The deferred CAP costs shall include a going-forward carrying cost of 4.365 percent;
- The deferred CAP costs shall not include any late payment penalties;
- The on-going CAP costs shall be estimated based on costs of February 1, 2000; and
- The on-going CAP costs shall be collected utilizing Citizens proposed rate design.

IT IS FURTHER ORDERED that Staff shall review and approve Citizens Utilities Company's tariff in order to determine whether it meets the criteria set forth herein and file a memorandum in this Docket within five days from the date Sun City Water Company and Sun City West Utilities Company files the tariffs in this Docket indicating Staff's approval of the tariffs.

IT IS FURTHER ORDERED that Citizens Utilities Company shall notify its customers of the rates and charges authorized herein and the effective date of same by means of an insert in its next regular monthly billing.

IT IS FURTHER ORDERED that Sun City Water Company and Sun City West Utilities Company shall file with the Commission within 60 days from the effective date of this Decision a copy of the notice it sends to its customers of the new rates and charges.

IT IS FURTHER ORDERED that approval of the use of CAP water is conditional upon any "water credits" not being utilized in a manner that would result in additional groundwater depletion in the Sun Cities' area.

IT IS FURTHER ORDERED that Citizens Utilities Company shall file the results of the completion of the preliminary design/updated cost estimate within six months of the effective date of this Decision including: a) the feasibility of a joint facility with the Agua Fria Division including the

timeframe for any such joint facility; b) the need for all major elements of its proposed plan (e.g., storage and booster stations); and c) binding commitments from golf courses, public and private, and the terms and conditions related thereto.

IT IS FURTHER ORDERED that within 60 days of the filing of the preliminary design/updated cost estimates by Citizens Utilities Company, the Commission's Utilities Division as well as the remaining parties shall have 60 days in which to file any comments/objections/recommendations regarding the preliminary design/updated cost estimates.

IT IS FURTHER ORDERED that Citizens Utilities Company shall within 30 additional days file any response to the filings of Staff and other parties.

IT IS FURTHER ORDERED that the Hearing Division shall within another 30 days set the matter for hearing or submit a recommended Opinion and Order for Commission consideration.

IT IS FURTHER ORDERED that this Decision shall become effective immediately.

BY ORDER OF THE ARIZONA CORPORATION COMMISSION.

CHAIRMAN COMMISSIONER COMMISSIONER

IN WITNESS WHEREOF, I, BRIAN C. McNEIL, Executive Secretary of the Arizona Corporation Commission, have hereunto set my hand and caused the official seal of the Commission to be affixed at the Capitol, in the City of Phoenix, this 1st day of February, 2000.

BRIAN C. McNEIL
EXECUTIVE SECRETARY

DISSENT _____

JLR:dap

SERVICE LIST FOR: SUN CITY WATER COMPANY and SUN CITY WEST UTILITIES COMPANY

DOCKET NOS.: W-01656A-98-0577 and SW-02334A-98-0577

Craig Marks
CITIZENS UTILITIES COMPANY
2901 N. Central Avenue, Suite 1660
Phoenix, Arizona 85012

Scott S. Wakefield
RUCO
2828 N. Central Ave., Suite 1200
Phoenix, Arizona 85004

Paul R. Michaud
MARTINEZ & CURTIS
2712 N. Seventh Street
Phoenix, Arizona 85006-1090
Attorneys for Sun City Taxpayers Association

Walter W. Meek
AUIA
2100 N. Central Avenue, Suite 210
Phoenix, Arizona 85004

William G. Beyer
BEYER, McMAHON & LaRUE
10448 W. Coggins, Suite C
Sun City, Arizona 85351
Attorneys for CAP Task Force

Lyn Farmer, Chief Counsel
Robert Metli, Staff Attorney
LEGAL DIVISION
1200 W. Washington Street
Phoenix, Arizona 85007

Deborah Scott, Director
UTILITIES DIVISION
1200 W. Washington Street
Phoenix, Arizona 85007

Appendix B
Technical Advisory Committee Meeting Minutes and Notes

CENTRAL ARIZONA PROJECT
TECHNICAL ADVISORY COMMITTEE

MEETING HIGHLIGHTS

JUNE 5, 2000

TAC Members in attendance:

Jim Sander, Briarwood Country Club
Ernie Miller, Palmbrook Country Club
Jerry Swintek, Recreation Centers of Sun City
John Powell, Recreation Centers of Sun City
Dess Chappelear, Recreation Centers of Sun City West
Bob Jones, Recreation Centers of Sun City West
Paul White, Sun City Homeowners Association
Jay Blackburn, Sun City Country Club
Raymond Dare, Sun City Taxpayers Association
Bob McCurdy, Property Owners and Residents Association

TAC members not in attendance:

Donald Needham, Town of Youngtown
Jeff Schuld, Hillcrest Golf Club

Others in attendance:

Jim Irvin, Arizona Corporation Commission
Bruce Ellinson, Daily News Sun
Patrick Black, Arizona Corporation Commission

After asking for a moment of silence to remember fallen soldiers in World War II, Ron Jackson, Engineering Project Manager for the Sun Cities/Youngtown Groundwater Savings Project, briefly summarized Commission Order No. 62293. Specific to the TAC, the Order requires Citizens to prepare a preliminary design/updated cost estimate for the Groundwater Savings Project. The study is required to (1) analyze whether or not a joint project with the Agua Fria Division is feasible, and (2) assess the need for all the major components identified in the Task Force's original cost estimate.

After explaining the parts of the Order applicable to the TAC, Mr. Jackson described the roles of the various parties involved in the TAC process.

Citizens Water Resources. Citizens is responsible for the final study. As a part of the study, Citizens is responsible for managing and paying for the consultants used to prepare the study. Citizens is also responsible for managing the TAC process.

HDR Engineering, Inc. HDR is the engineering firm hired by Citizens to conduct the analysis required by the Commission Order. HDR is responsible for presenting its findings at TAC meetings. HDR is also responsible for preparing the final report and meeting summaries.

BJ Communications. BJC is responsible for planning and organizing the TAC meetings. BJC is also responsible for preparing and distributing meeting agendas, as well as distributing meeting summaries.

TAC Members. TAC members are representatives of community organizations and golf courses. These individuals were selected by their respective organizations and are expected to attend TAC meetings, review the materials provided to the TAC, make comments and communicate information back to their respective organizations.

In addition to these parties, the public is invited to share thoughts and ask questions.

Mr. Jackson told the TAC that future meetings will be held in the same room, Hoover Room, at the Bell Recreation Center Library starting at 2:00 p.m. on the following days:

Monday, June 19, 2000
Friday, July 7, 2000
Monday, July 17, 2000

Mr. Jackson then turned the meeting over Mr. Dave Buras, Project Manager with HDR Engineering, Inc. Mr. Buras began by explaining how this and future meetings will address the engineering aspects of the project. He explained that today's meeting will focus on the work affecting the north area. This work includes the conveyance of the water from the CAP aqueduct to the Sun Cities/Youngtown area. Mr. Buras explained that at the second meeting, the TAC would discuss the Sun City West distribution system and at the third meeting the TAC would discuss the Sun City distribution system. The TAC is planned to meet one additional time to conclude the work product.

Mr. Buras explained the structure of this meeting indicating that he would present the information in a logical manner. He would pause at appropriate times and take comments from TAC members. At the end of the meeting, he would then open the meeting up for public comment.

Mr. Buras began by describing the purpose of the north area part of the project. He told the TAC that the distribution system in the north area was strictly to convey the CAP water from the CAP aqueduct to the Sun Cities/Youngtown area. He described three alternatives for bringing the water from the CAP aqueduct to the Sun Cities/Youngtown area.

1. Divert the CAP water using an existing turn-out structure at Lake Pleasant Road, convey the water through a pipeline down existing right-of-way along Lake Pleasant Road to a point roughly adjacent to the existing waste water treatment plant. The pipeline would then turn due west until it reached the water campus.

2. Divert the CAP water using an existing turn-out structure at the confluence of the Beardsley Canal and the CAP aqueduct. From here, the water will be conveyed through an open canal to one of two locations directly north of the water campus. From this point, the water would be piped from the Beardsley Canal to the water campus.

3. Divert the CAP water using an existing turn-out structure at the confluence of the Beardsley Canal and the CAP aqueduct. The water would be diverted from the Beardsley Canal at a turn out to Sun City West's non-potable distribution system. From here the water would be conveyed either through a dedicated pipeline across Sun City West to the water or campus or through Sun City West's existing non-potable distribution system.

In total, Mr. Buras presented five routes for bringing the CAP water to the Sun Cities/Youngtown area. Mr. Bob Jones with the Recreation Centers of Sun City West indicated that he was aware that Citizens was considering using the Recreation Centers' non-potable distribution system to convey the CAP water to the water campus. He indicated that this would not be possible for operational reasons. Moreover, he indicated that he had sent a letter to Ray Jones informing Citizens that the Recreation Centers' facilities could only be used to convey CAP water and effluent from east to west and not the other way around.

Mr. Buras then opened the discussion up for specific comments from TAC members. One TAC member wanted to know what purpose the waste water treatment facility played in the project and what benefit is derived. Mr. Buras responded saying that the treatment plant is not a part of the project. The treatment plant is simply a large property already owned by Citizens where the Groundwater Savings Project could bring the CAP water temporarily before it would be fed further south and west to the communities. Any storage, booster pumps or other equipment or facilities can be located at the water campus. The advantage of doing this is that the project would not have to incur the expense of buying additional property.

Another TAC member asked about evaporation on the options requiring the use of the Beardsley Canal. Mr. Buras indicated that there are significant losses on the Beardsley Canal and the cost of those losses is incorporated into the analysis for determining which alternative is best. Mr. Buras indicated that he would addresses this issue later in the presentation. Mr. Buras also indicated that in addition to losses, the project would also incur wheeling charges from the Maricopa Water District, the irrigation district that owns the Beardsley Canal.

Another issue raised by several TAC members was whether or not the pipeline would be constructed to include surplus capacity that could be used in the future if additional CAP water is acquired. Mr. Buras responded that the pipeline is being designed to convey the 6,561 acre-feet of CAP water currently under subcontract by Citizens. The pipeline will, however, be operated to meet certain peak demands. Mr. Buras indicated that it might be possible to move additional amounts of water during shoulder months assuming demand existed to receive the supply.

One TAC member asked if we considered an option that included sharing facilities with Agua Fria. Mr. Buras indicated that the last two options that would bring the CAP water to the intersection of the Beardsley Canal and Grand Avenue essentially represent the "shared" alternative since Agua Fria would take its CAP water through the Beardsley Canal to at least this point. Under these alternatives, none of the costs incurred by Sun City or Sun City West could be placed onto Agua Fria.

Another issue raised by TAC members was the quality of the CAP water and what would need to be done to treat the CAP water before it could be used to irrigate the turf on the golf courses. Mr. Buras indicated that this issue will be addressed by Chip Howard, who is a turf irrigation specialist. These issues will be addressed at future meetings.

After taking comments and questions from TAC members, Mr. Buras then explained the criteria used by the engineers to evaluate the alternatives. The following criteria was considered:

Major Cost (Capital and Annual)
Right-of-Way availability
Environmental Issues
Gravity Flow (Pumping and Storage requirements)
Ownership and Control
Achieving the Goal of Groundwater Savings

One TAC member asked if the project would require the construction of a pipeline under the Agua Fria River. Mr. Buras explained that the existing Sun City West non-potable distribution system would be used to cross the Agua Fria.

TAC members asked how HDR decided on the size of the pipeline. Mr. Buras explained that the pipe must be sized to carry the needed volume of water at an acceptable velocity, ideally around 5 feet per second for a project like this. He explained that the water will move at higher volumes in the summer than in the winter. The engineers are attempting to model optimum continuous flows to smooth out the demand curves in order to make the pipeline smaller. In running their analyses, they determined that a 30-inch pipe was too large and a 21-inch was too small. As such, they settled on a 24-inch pipe.

One TAC member asked whether the losses charged by the Maricopa Water District (MWD) would vary over time. Mr. Buras indicated that MWD could change its policy on losses. This number could increase or it could decrease based on a number of factors.

Another TAC member commented that he was concerned that the Arizona Corporation Commission is mandating this study. He indicated that the work seemed to be repetitive of the work already conducted by the CAP Task Force.

A TAC member asked how much water would be delivered to the water campus each day. Mr. Buras responded saying 34 acre-feet per day would be delivered.

Another TAC member asked out of what type of material the pipeline would be constructed since the type of material would dictate whether the pipeline could be used for potable or non-potable purposes. Mr. Buras responded saying that the pipeline will likely be either ductile iron or concrete. They are still looking at the advantages and disadvantages of each. As to the end use, Mr. Buras indicated that since the pipeline will be pressurized, the material selected will be suitable for potable and non-potable purposes.

One TAC member asked about holding pond capacity for emergencies. Mr. Buras indicated that the golf courses have holding capacity as part of their normal operations. Some courses have more holding capacity than others. The engineers have not assumed additional emergency holding capacity.

After the second question and answer period, Mr. Buras compared each of the five alternatives with the criteria used to evaluate each option. This analysis showed the alternative where the CAP water would be conveyed from west to east in Sun City West non-potable pipeline was not feasible from an operational perspective. The other options were ranked and the first alternative, the pipeline running down Lake Pleasant Road (also the option recommended by the CAP Task Force), prevailed.

One TAC member questioned the costs presented by HDR indicating that the costs seemed too low. Mr. Buras indicated that the costs presented today just included the costs to bring the CAP water to the water campus. The next two meetings with address the additional costs.

Another TAC member asked at what point the golf courses take control of the CAP water. Citizens indicated that the courses will take control of the water when the water is discharged into the location specified by the golf course operators primarily where the wells currently discharge water into the irrigation system.

After the TAC members had completed their questions and comments, Mr. Buras then opened the meeting up to public comment.

One member of the audience asked if the pipeline would be cement lined and provide for cathodic protection. Mr. Buras responded saying that ductile iron pipes are lined to protect against corrosion. He indicated that the engineers were still evaluating the need for cathodic protection.

Another member of the audience asked what the difference in elevation is from the CAP canal to the water campus. Mr. Buras indicated that it was approximately 300 feet.

A member of the public questioned the costs associated with wheeling CAP water through the Beardsley Canal asking if the costs should be adjusted to take into account inflation. Mr. Buras indicated that the engineers used a simplistic approach to determining the cost of wheeling. They assumed a conservative $30 per acre-foot but did not include inflation or present value. Mr. Buras indicated that they expect the figure to change, but in today's dollars it would be roughly $200,000 per year.

Another member of the public asked why the pipeline is not constructed to take into account all the growth that is planned along Lake Pleasant Road. If it was, then perhaps the project could be commonly shared cost.

A member of the public explained his desire to have some guarantee from Citizens that golf course grass would continue to remain green and would not be killed by the CAP water.

Commissioner Jim Irvin elected to make comments during the public comment period. Mr. Irvin complimented the engineers on the quality of their presentation and offered the following suggestions. In estimating the cost to wheel water from MWD, the analysis uses the highest possible costs. This is not realistic. Mr. Irvin suggested that more realistic values be used. In addition, Mr. Irvin cautioned the engineers to review the Commission's order. The Commission did not mandate that Citizens consider alternatives to bringing the CAP water to Sun City and Sun City West. The Commission instead ordered Citizens to consider a joint project with Agua Fria. Mr. Irvin suggested that the analysis at a minimum must consider a joint project. Finally, Mr. Irvin suggested that the engineers consider a broader view and consider the possibility of a regional project that would serve the entire west valley.

In addition to these comments, Mr. Irvin took exception to comments made by TAC member, John Powell, regarding the Commission requiring additional study of the option recommended by the CAP Task Force. Mr. Irvin commented that the Commission's job is to protect the residents of Sun City, Sun City West and Youngtown, not the golf courses. Mr. Irvin cited, as an example, that the Task Force's recommendation was originally estimated to cost $30 million. Due to Commission efforts, this cost was reduced to $15 million. When Citizens presented this concept to the Commission, according to Mr. Irvin, there were no hard costs presented. The purpose of the study required by the Commission is to prepare more realistic costs before construction begins.

Mr. Irvin also raised some concerns about the continuing lack of contracts between Citizens and the Recreation Centers. Finally, Mr. Irvin expressed concern about Citizens' water properties being sold to American Water Works Company. He indicated that new ownership can raise numerous issues that may affect the project.

When Mr. Irvin concluded, Mr. Powell commented that the Sun Cities/Youngtown Groundwater Savings Project was estimated at $15 million by the Task Force and the Commission did not decrease the cost of the project by 50%.

Concluding these remarks, Mr. Jackson thanked everyone for attending and adjourned the meeting at 3:20 p.m.

CITIZENS WATER RESOURCES
GROUNDWATER SAVINGS PROJECT
TECHNICAL ADVISORY COMMITTEE

Meeting No. 2 Summary

Meeting Date: June 19, 2000
Meeting Time: 2:00 p.m.
Meeting Location: Bell Recreation Center Library, Hoover Room

TAC Members in attendance:

Ernie Miller, Palmbrook Country Club
Jerry Swintek, Recreation Centers of Sun City
John Powell, Recreation Centers of Sun City
Dess Chappelear, Recreation Centers of Sun City West
Bob Jones, Recreation Centers of Sun City West
Gene Zylstra (for Paul White), Sun City Homeowners Association
Raymond Dare, Sun City Taxpayers Association
Bob McCurdy, Property Owners and Residents Association
Donald Needham, Town of Youngtown
Jim Trikoff (for Jay Blackburn), Sun City Country Club

TAC Members not in attendance:

Jim Sander, Briarwood Country Club
Jeff Schuld, Hillcrest Country Club

Others in attendance:

Bruce Ellinson, Daily News Sun

1. Ron Jackson (Citizens Water Resources) provided a brief project overview and introduce the project team members in attendance. The Technical Advisory Committee (TAC) members in attendance introduced themselves. A sign-in sheet was routed and the general public was asked to sign in but was informed it was not mandatory. The list is attached.

2. Terri Sue Rossi (Citizens Water Resources) provided an update on the status of the Golf Course Agreements. Draft Agreements developed and reviewed by the various golf courses. Initial comments were received from the golf courses and those comments are currently being discussed and addressed.

3. Dave Buras (HDR Engineering, Inc.) provided an overview of the presentation. This presentation/meeting was the second of four scheduled meetings. **The purpose of the meeting was to address those aspects of the Sun City West (SCW) Area Distribution System.**

4. Chip Howard (TurfScience, Inc.) presented issues related to the delivery of CAP water to the golf course lakes and the quality of CAP water as it relates to turf irrigation and maintenance.

   a. To meet the objective of the GSP, the complete system should be capable of delivering the full CAP allocation to Sun City and Sun City West.

   b. The SCW allotment is 2372 acre-feet/year.

   c. Irrigation demand varies widely throughout the year. For SCW, the ratio of peak month (Jul) to minimum month (Dec or Jan) is approximately 9.0. The peak daily SCW demand is 33 acre-feet/day.

   d. During high demand months, groundwater pumped from wells will have to be used to supplement the CAP allocation.

   e. Design objectives for proper lake management includes:

      - System should deliver a portion of the capacity to each facility.
      - System should maximize operational efficiencies.
      - System should allow lake levels to be maintained within acceptable limits.

   f. To maximize system efficiency during peak demand periods, requires continuous flow in the transmission main at the maximum rate throughout a 24-hour period. Under this maximum flow scenario, there are several issues worth noting:

      - Delivery must be pre-planned and coordinated.
      - Not all facilities will receive flow simultaneously.
      - A system coordinator must ensure the successful integration for the various separate deliveries.

g. Several delivery categories were presented:

- Nighttime Delivery/High Priority – This includes those courses with large lake areas.
- Nighttime Delivery/Lower Priority – This includes those courses with lake areas not as large.
- Daytime Delivery/High Priority – This includes those courses that have decorative water features (creeks) that currently use well water and must have a supply of water during the day for the water feature.
- Daytime Delivery/Lower Priority –
- Buffer Delivery – This includes large lake areas and can be used to fill in the flow gaps in the integrated delivery program.

h. Flow to the lakes will be controlled via an electronic flow control valve installed in a buried vault. A flow meter will also be installed in the vault. SCADA (Supervisory Control and Data Acquisition) equipment will be installed adjacent to the vault.

i. Average pH levels of groundwater and CAP water are as follows:

- SCW Groundwater = 9.3
- CAP Water = 8.5

The pH of 8.5 is preferable for turf irrigation.

j. Salinity in the CAP water is higher than that of groundwater. While salinity is undesirable in most cases, it is relatively easy to manage. This is done through the application of excess water to leach salts out the bottom of the root zone. If only CAP water was used to irrigate the turf throughout the year, approximately 1.8 inches/year of excess CAP water would have to be applied (when compared to groundwater). In this case, since groundwater will be used to supplement the demand, approximately 1 inch/year of excess water will be required.

k. The City of Scottsdale has been irrigating golf course turf with raw CAP water in the north Scottsdale area for approximately eight years. Seven courses that receive the CAP water were contacted to discuss their experience. All seven reported neutral or favorable experience.

5. Mike Heaton (HDR Engineering, Inc.) presented the results of evaluating the SCW delivery system.

   a. The existing pipeline network in SCW was constructed in the early 1980s. Ranging in size from 12 to 20 inches, its general system capacity is between 5 and 7 CFS. Originally, the piping network was intended to deliver effluent from the SCW WWTP to the various golf courses. However, since the golf courses have always used groundwater, the piping network has historically been used to move groundwater between courses.

   b. To evaluate the existing piping system's ability to convey the CAP water, HDR incorporated a computer model (Kentucky Pipe). The model is "built" based on existing as-built plans and considers such things as golf course demands and flow input to the network. The computer model can generate output that shows the flow rate in each pipeline as well as the pressure at various locations of the piping network.

   c. The results of the modeling effort showed that the existing SCW system could be used to deliver the CAP water.

6. During the question and answer period, questions were first fielded from the TAC, after which it was open to the floor. The following summarizes the questions and answers.

   a. Q: During the low demand winter months, will all irrigation water be CAP water?
      A: Yes

   b. Q: What impact will this have on the turf?
      A: The project team responded in accordance with Items 4j and 4k of these meeting notes.

   c. Q: Will the CAP water (salinity) kill fish in the golf course lakes?
      A: No

   d. Q: How can the system accomplish the delivery of reclaimed water and CAP water?
      A: Will require further investigation. The project team will report back.

   e. Q: Will the antenna be an eye sore and will it be subject to vandalism?
      A: No

f. Q: If CAP water must still be supplemented with groundwater, what happens if groundwater supply goes away in the future?
A: That consideration is not a part of the project scope.

g. Q: Why were the expansion courses not included for consideration in receiving CAP water?
A: Maricopa County requires that they use effluent only (in lieu of groundwater).

h. Q: Why not oversize the pipe so all flow can be delivered during the night?
A: Not cost effective

i. Q: Was the SCW delivery system originally sized for five courses?
A: It was sized to deliver the maximum expected effluent, which was 5 to 7 CFS.

j. Q: Will operation costs consider the lower electrical costs of delivering flow at night or in the winter months?
A: Yes, whenever feasible.

k. Q: Will the computer model allow for the flow of effluent from the SCW WWTP to the expansion courses along with the CAP water (i.e. co-mingling)?
A: This requires further investigation. The model will allow but the existing system may not.

l. Q: Why not oversize the pipe in the event that additional allocations become available in the future?
A: This is not consistent with the ACC order and there are no apparent allocations available.

m. Q: Can the project team investigate the possibility of over-sizing the pipe?
A: See above Q and A.

n. Q: Who controls flow at the CAP turnout structure?
A: System control will be downstream of turnout structure and will be by Citizens Water Resources.

o. Q: Does the system consider any storage capacity at the SCW WWTP?
A: System delivers entire allocation without requiring storage.

CITIZENS WATER RESOURCES
GROUNDWATER SAVINGS PROJECT
TECHNICAL ADVISORY COMMITTEE

Meeting No. 3 Summary

Meeting Date: July 7, 2000
Meeting Time: 2:00 p.m.
Meeting Location: Bell Recreation Center Library, Hoover Room

TAC Members in attendance:

Ernie Miller, Palmbrook Country Club
Jerry Swintek, Recreation Centers of Sun City
John Powell, Recreation Centers of Sun City
Bob Jones, Recreation Centers of Sun City West
Gene Zylstra (for Paul White), Sun City Homeowners Association
Raymond Dare, Sun City Taxpayers Association
Bob McCurdy, Property Owners and Residents Association
Donald Needham, Town of Youngtown

TAC Members not in attendance:

Jim Sander, Briarwood Country Club
Jeff Schuld, Hillcrest Country Club
Dess Chappelear, Recreation Centers of Sun City West

Others in attendance:

Bruce Ellinson, Daily News Sun
Bill Mundell, Arizona Corporation Commission

1. Ron Jackson (Citizens Water Resources) provided a brief project overview of the project. A sign-in sheet was routed and the general public was asked to sign in but was informed it was not mandatory.

2. Dave Buras (HDR Engineering, Inc.) provided an overview of the presentation. This presentation/meeting was the third of four scheduled meetings. **The purpose of the**

meeting was to address those aspects of the Sun City (SC) Area Distribution System.

3. Mike Heaton (HDR Engineering, Inc.) presented information on the Cybernet model, pipe sizes, CAP flows and distribution system costs.

   a. The Sun City distribution system delivers to Recreation Center courses with pipes ranging from 12"-24" with a capacity of 4,000-5,000 gpm.

   b. Maps showing approximate delivery routes through streets and golf courses were presented.

   c. The system was designed using Cybernet which is based on the Kentucky Pipe Model. It models multiple pipe and node systems and allows for varying demands over a 24 hour period. Input for the model included golf course demands, available CAP allotment and proposed system geometry. The output provided delivery rates at reservoirs, pressures at the delivery points and flow in each pipeline. The pipeline was designed to accommodate 20% overflow.

   d. Results so far indicate the allotted water for Sun City can be completely used by the Recreation Center courses. The preliminary estimate for the pipe system is $8,230,000, the control system is $720,000 for a total of $8,950,000.

   e During the question and answer period, questions were fielded from the TAC. The following summarizes the questions and answers.

   Q: Is there a delivery to North Golf Course?
   A: Yes. A 12" pipe is provided.

   Q: Should Quail Run golf course be included since it is desert landscaped and has a small lake?
   A: The size of the lake is not as important as the acreage that it feeds to use all the allotted water. Quail Run will be investigated to determine if to be included in the system.

   Q: Should Maricopa Lake be included in the system?
   A: Since the demand is low and the water replaces evaporated water the lake will be removed from the system.

   Q: Is CAP water ok for wildlife in the golf course lakes?
   A: The CAP water will not hurt the wildlife.

Q: Will gravity flow work for the system?
A: The elevation at the tie to the CAP is high enough that a gravity system will work.

Q: Why is there such a difference in going from the 24" pipe to the 16" pipe? Why can't you use a 20" pipe?
A: The pipes were sized based on the demands for the golf courses and the elevation at which each has to be delivered. Downsizing to a 20" pipe at the beginning of the system will increase flow velocity and friction losses and decrease the hydraulic grade line. It may lead to increasing pipe sizes at the end of the system to allow for delivery. The design team will investigate to determine if the pipe size can be reduced.

Q: The cost is for the whole project predicted to be over $15,000,000? What is being down to reduce costs?
A: The system is required to optimize CAP usage in Sun City/Youngtown and cost. Optimal pipe routes and sized are being investigated to distribute the allotted CAP water. The costs presented are preliminary and include contingencies that will be removed as the cost becomes further refined.

4. Chip Howard (TurfScience, Inc.) presented issues related to the delivery of CAP water to the golf course lakes and the quality of CAP water as it relates to turf irrigation and maintenance.

   a. To meet the objective of the GSP, the complete system should be capable of delivering the full CAP allocation to Sun City and Sun City West.

   b. The SC allotment is 4,189 acre-feet/year.

   c. Irrigation demand varies widely throughout the year. The peak daily SC demand is 41 acre-feet/day. CAP can deliver approximately 47% of the to demand.

   d. During high demand months, groundwater pumped from wells will have to be used to supplement the CAP allocation.

   e. Design objectives for proper lake management includes:

      - System should deliver a portion of the capacity to each facility.
      - System should maximize operational efficiencies.
      - System should allow lake levels to be maintained within acceptable limits.

f. To maximize system efficiency during peak demand periods, requires continuous flow in the transmission main at the maximum rate throughout a 24-hour period. Under this maximum flow scenario, there are several issues worth noting:

- Delivery must be pre-planned and coordinated.
- Not all facilities will receive flow simultaneously.
- A system coordinator must ensure the successful integration for the various separate deliveries.

g. Several delivery categories were presented:

- Nighttime Delivery/High Priority – This includes those courses with large lake areas.
- Nighttime Delivery/Lower Priority – This includes those courses with lake areas not as large.
- Daytime Delivery/High Priority – This includes those courses that have decorative water features (creeks) that currently use well water and must have a supply of water during the day for the water feature.
- Daytime Delivery/Lower Priority –
- Buffer Delivery –This includes large lake areas and can be used to fill in the flow gaps in the integrated delivery program. (Dawn Lake and Viewpoint Lake)

h. Flow to the lakes will be controlled via an electronic flow control valve installed in a buried vault. A flow meter will also be installed in the vault. SCADA (Supervisory Control and Data Acquisition) equipment will be installed adjacent to the vault.

i. Salinity in the CAP water is higher than that of groundwater. While salinity is undesirable in most cases, it is relatively easy to manage. This is done through the application of excess water to leach salts out the bottom of the root zone. If only CAP water was used to irrigate the turf throughout the year, approximately 1.8 inches/year of excess CAP water would have to be applied (when compared to groundwater). In this case, since groundwater will be used to supplement the demand, approximately 1 inch/year of excess water will be required.

j. The City of Scottsdale has been irrigating golf course turf with raw CAP water in the north Scottsdale area for approximately eight years. Seven courses that receive the CAP water were contacted to discuss their experience. All seven reported neutral or favorable experience.

k. During the question and answer period, questions were fielded from the TAC. The following summarizes the questions and answers.

Q: During the low demand winter months, will all irrigation water be CAP water? What impact will this have on the wildlife?
A: Yes. There will be no effect on wildlife.

Q: How was the water budget for each course derived?
A: The historical annual demand for the past 6 years was averaged and then broken down by a computer program to determine the water usage for each month.

Q: What is needed for control of the system?
A: An operator will be needed to supervise the system and to provide for override control. Assumed at this time to be a Citizens Utility employee.

Q: US Agriculture Department states 7" is to be used for leaching. Why are you suggesting 1"-2"?
A: 7" is an overestimate and previous experience in Phoenix area provides data showing 1"-2" will solve problem. The design team will check with agriculture department.

Q: Will there need to be treatment for the CAP water?
A: No treatment is necessary. A trash rack / screen will be provided at the tie to the CAP to remove large obstacles.

Q: Will you look at the overall system to remove Quail Run and Maricopa Lake to reduce pipe costs?
A: Yes. The design team will investigate.

5. Ron Jackson announced the next TAC meeting will be postponed to August and the committee will be informed of the new date.

6. Questions were opened to the floor. The following summarizes the questions and answers.

Q: Were the alternatives for using just the courses north of Grand Avenue or including all courses (Recreation Center and Country Club) investigated?
A: Yes those were considered however, the system is to use the allotted CAP water in all of Sun City and not just north of Grand Avenue to protect from subsidence. The second alternative was also investigated however, the system

will not work without the Recreation Center usage and they have requested a exclusive contract.

Q: Who is paying for the CAP water?
A: The Citizens Utilities customers are paying for the CAP equally. The cost of the pipeline will be assessed to the Citizens Utilities customers of the community for which it serves. The final determination will be made by the ACC after operational.

Q: What will happen if there is a power failure?
A: The valves used for delivery have a fail-safe mode and will close if required.

Q: Is there to be effluent in this system?
A: No.

Q: If effluent was added in the future what would need to be done?
A: No change to the distribution system would be required.

Q: How will the CAP salt content affect the courses?
A: If the salt content is increased it is a deficit that must be managed. Leaching will need to occur however, the CAP water will not be much more of a deficit that the groundwater already is.

Q: Concern about the postponing of the next TAC meeting until after the report has been submitted to the ACC.
A: The meeting was postponed to provide time to the engineers to complete the report. After the ACC receives the report there will be a 6 month review period for the community to voice concerns and make changes.

Q: Can you release facts before the report is submitted?
A: Citizens can not release the report prior to the ACC review. Dr. Howard or Mr. Buras may be contacted for information prior to that time.

Q: Use of CAP water south of Grand Avenue is important since it helps Youngtown's drinking water, prevents future subsidence and fissures. A pipe could be constructed to dump water in the Agua Fria at less cost but that would not use the CAP water as effectively.

8. The meeting adjourned at 4pm.

Appendix C
Letter from Recreation Centers of Sun City West

RECREATION CENTERS OF SUN CITY WEST, INC.

19803 R.H. JOHNSON BOULEVARD SUN CITY WEST, ARIZONA 85375-4498 602-584-2050 FAX 602-584-2349

RM 5/8/00

copy Blaine
Terri Sue
Ron Fuches

May 5, 2000

RECEIVED
MAY 08 2000

Mr. Ray Jones
General Manager
Citizens Water Resources
P.O. Box 1687
Sun City, AZ 85372

RE: Citizens use of existing distribution piping

Dear Mr. Jones:

In response to your inquiry regarding the use of existing pipes that connect our golf courses Desert Trails and Deer Valley to the sewage treatments for the purpose of moving CAP water eastward toward Sun City, we, the Governing Board of Sun City West Recreation Centers object to this use.

This objection is based on the need to use effluent water for the above named golf courses. We believe ADWR will require this in the near future. Also, we have four golf course wells that have GIU permits that expire in 2005. This expiration will further increase the need for effluent water which must move from east to west and not west to east, the proposed direction movement of the CAP water.

Sincerely,

Richard A. Catlin, President
Governing Board of Sun City West

Cc: Sun City West Water Committee

Jones/5-4-00

Appendix D
Raw Data from Golf Course Investigations

Sun Cities Golf Course Water Use 1993 - 1998

Location	Facility	1993	1994	1995	1996	1997	1998
Sun City	Lakes East/Viewpoint Lake	466.46	580.25	627.81	905.43	832.11	617.97
	Lakes West/Dawn Lake	864.75	906.59	823.76	653.00	1130.00	799.86
	North Golf Course	592.99	592.17	668.45	597.30	642.77	644.31
	Palmbrook Country Club	589.48	561.99	585.74	659.85	666.42	611.57
	Quail Run Golf Course	230.88	253.17	259.55	268.65	250.47	121.84
	Riverview Golf Course	572.51	630.93	217.77	444.97	227.16	587.08
	South Golf Course	787.93	854.87	807.23	902.24	826.86	735.72
	Sun City Country Club	525.00	552.00	573.00	600.00	511.00	439.00
	Sunland Memorial Park	105.81	104.77	108.12	123.94	154.00	120.56
	Union Hills Country Club	680.21	729.99	670.66	805.60	793.23	692.66
	Willowcreek Golf Course and Willowbrook Golf Club	1071.64	1246.74	1195.02	1444.33	1263.45	1750.81
Sun City West	Briarwood Country Club	716.40	722.19	706.08	772.58	747.78	683.64
	Deer Valley Golf Course*	345.47	215.15	557.76	569.27	488.00	569.87
	Desert Trails Golf Course*				544.14	457.00	405.60
	Echo Mesa Golf Course	222.00	320.00	530.09	619.38	628.30	589.22
	Grandview Golf Club	682.90	704.50	753.64	858.61	839.00	728.55
	Hillcrest Golf Club	807.80	775.60	733.50	835.00	780.70	683.11
	Pebblebrook Golf Course	656.00	695.00	715.00	702.55	728.90	633.70
	Stardust Golf Course	493.00	386.00	411.00	423.71	449.10	409.60
	Trail Ridge Golf Course	491.00	526.00	532.00	634.53	599.00	450.93
	TOTAL	11357.91	11476.18	13365.08	13015.25	12275.60	12275.60

*Switched to recovered effluent in 1997. Use given is actual amount used - does not include effluent adjustment.

APPENDEX 1

Appendix 2
Phoenix Greenway AZMET Station
Estimated Monthly and Annual Turf Water Use

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUM
1988	1.7"	2.6"	4.8"	5.2"	7.3"	7.2"	7.5"	6.8"	6.0"	4.3"	2.5"	1.8"	57.7"
1989	1.8	2.6	4.6	6.7	7.5	7.6	8.0	7.7	6.1	4.3	3.1	2.1	62.2
1990	2.1	2.4	4.1	5.7	7.5	7.8	7.3	7.1	5.1	4.7	2.9	1.7	58.3
1991	1.7	3.0	3.2	6.0	7.7	6.9	8.1	7.4	5.5	4.4	2.4	1.2	57.7
1992	1.8	2.2	3.1	5.9	6.4	7.4	7.5	6.8	5.8	4.5	2.9	1.1	55.3
1993	1.3	1.8	3.7	6.3	7.9	7.8	8.4	7.4	6.3	4.1	2.3	1.9	59.3
1994	2.1	2.5	3.9	6.2	7.1	7.7	8.3	8.1	5.4	4.2	2.3	1.4	59.2
1995	1.2	2.3	3.9	5.4	6.8	7.4	8.2		6.2	4.6	2.5	1.8	
1996	2.2	2.4	4.6	6.6	7.6	7.4	7.5	7.9	5.2	4.3	2.7	1.9	60.2
1997	1.6	2.6	5.0	5.7	7.5	7.4	8.0	6.9	5.3	4.5	2.5	1.4	58.4
1998	1.7	1.6	3.4	5.5	6.7	7.5	7.6	7.8	5.5	4.3	2.6	1.8	56.1
1999	2.3	2.9	4.4	5.4	7.6	7.6	7.1	7.4	5.5	4.9	3.0	2.2	60.2
AVG	1.8"	2.4"	4.1"	5.9"	7.3"	7.5"	7.8"	7.4"	5.6"	4.4"	2.6"	1.7"	58.5"

Appendix 3
Phoenix Greenway
ETo : Reference EvapoTranspiration (inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Total
1988	2.48	3.78	6.64	6.77	9.63	9.95	9.58	8.22	7.79	5.54	3.28	2.59	76.25
1989	2.69	3.76	6.34	8.64	9.81	10.61	10.28	9.29	7.96	5.63	4.02	2.98	82.01
1990	3.02	3.37	5.61	7.46	9.87	10.81	9.32	8.59	6.59	6.15	3.83	2.39	77.01
1991	2.57	4.33	4.39	7.84	10.15	9.65	10.35	8.91	7.09	5.76	3.21	1.77	76.02
1992	2.59	3.11	4.18	7.72	8.37	10.21	9.63	8.19	7.59	5.83	3.82	1.62	72.86
1993	1.84	2.50	5.08	8.22	10.44	10.83	10.83	8.92	8.17	5.38	3.09	2.75	78.05
1994	3.11	3.56	5.41	8.06	9.39	10.70	10.61	9.79	6.96	5.50	3.01	1.94	78.04
1995	1.83	3.27	5.32	7.03	9.00	10.25	10.52	0.00	8.02	6.00	3.30	2.51	67.05
1996	3.19	3.44	6.24	8.54	10.03	10.32	9.61	9.47	6.79	5.63	3.50	2.71	79.47
1997	2.31	3.70	6.83	7.44	9.93	10.22	10.30	8.33	6.83	5.79	3.28	2.06	77.02
1998	2.49	2.35	4.68	7.15	8.87	10.48	9.77	9.39	7.13	5.57	3.38	2.57	73.83
1999	3.36	4.10	6.00	7.06	9.94	10.56	9.09	8.91	7.13	6.39	3.94	3.10	79.58
Ave.	2.62	3.44	5.56	7.66	9.62	10.38	9.99	8.17	7.34	5.76	3.47	2.42	76.43

Appendix 4
Phoenix Greenway
Rainfall (inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Total
1988	1.42	0.24	0.83	1.46	0.00	0.20	4.37	2.72	0.00	3.01	0.68	0.10	15.03
1989	1.26	0.00	0.65	0.00	0.00	0.00	1.44	0.55	0.50	0.73	0.10	0.11	5.34
1990	0.75	0.52	0.25	0.12	0.12	0.00	1.48	3.12	2.01	0.37	0.45	0.30	9.49
1991	0.82	0.50	2.21	0.25	0.00	0.00	0.08	0.62	0.15	0.77	1.02	2.38	8.80
1992	1.62	1.78	2.39	0.36	0.87	0.25	2.66	2.02	0.67	0.05	0.00	3.03	15.70
1993	5.20	2.33	1.11	0.00	0.04	0.00	0.00	0.56	0.06	0.76	2.67	0.04	12.77
1994	0.08	0.51	1.72	0.15	0.34	0.08	0.66	0.10	2.38	0.40	0.49	2.42	9.33
1995	1.57	0.70	1.68	0.33	0.12	0.00	0.10	0.00	1.62	0.00	1.52	0.01	7.65
1996	0.16	1.04	0.41	0.01	0.00	0.00	2.64	0.54	0.97	0.02	0.04	0.00	5.83
1997	0.04	0.93	0.00	0.25	0.00	0.06	0.02	0.67	0.53	0.13	0.07	1.51	4.21
1998	0.46	5.07	1.66	0.29	0.08	0.00	1.51	0.20	1.22	0.71	0.22	0.85	12.27
1999	0.02	0.38	0.11	1.06	0.00	0.23	2.83	0.12	0.14	0.00	0.00	0.00	4.89
Ave.	1.12	1.17	1.08	0.36	0.13	0.07	1.48	0.94	0.85	0.58	0.60	0.90	9.28

Appendix 5
DWR Information (Source ADWR)

1999 Golf - Allotment Facility Name	Management Plan Classifications		Total Holes	Planted Acres	Turfed Acres	Water Acres	LWUP Acres	UNADJUSTED Conservation Allotment	
								FMP	SMP
Briarwood Country Club	EXIST	Reg	18	90.00	152.10	4.10		785.92	714.82
Palmbrook Country Club	EXIST	Reg	18	90.00	141.50	5.80		743.46	682.96
Sun City Country Club	EXIST	Reg	18	90.00	123.30	2.70		633.24	590.94
Sun City Rec: Lakes East	EXIST	Non-Reg	18	57.90	57.90	37.50		522.00	516.21
Sun City Rec: Lakes West	EXIST	Non-Reg	18	90.00	140.70	37.50		936.00	876.30
Sun City Rec: North	EXIST	Reg	18	90.00	139.60	5.90		734.58	675.98
Sun City Rec: Quail Run	EXIST	Non-Reg	9	45.00	50.80	1.40		307.00	252.38
Sun City Rec: Riverview	EXIST	Reg	18	90.00	143.20	7.60		763.12	700.92
Sun City Rec: South	EXIST	Reg	18	90.00	199.50	4.30		1024.16	905.66
Sun City Rec: Willowbrook/Creek	EXIST	Reg	36	180.00	238.50	8.50		1245.20	1168.70
Sun City West Deer Valley	NEW	Reg	18	90.00	101.37	7.64	50.22	0.00	546.62
Sun City West Desert Trails	NEW	Non-Reg	18						
Sun City West Echo Mesa	NEW	Non-Reg	18	90.00	100.80	7.60		432.00	456.62
Sun City West Grandview	EXIST	Reg	18	90.00	163.70	7.80		866.86	784.16
Sun City West Hillcrest	EXIST	Reg	18	90.00	154.00	23.70		916.94	843.94
Sun City West Pebblebrook	EXIST	Reg	18	90.00	142.50	6.40		752.18	690.68
Sun City West Stardust	EXIST	Non-Reg	18	90.00	96.30	2.30		495.76	480.46
Sun City West Trail Ridge	NEW	Reg	18	90.00	81.60	14.87	81.44	463.06	546.62
Union Hills Country Club	EXIST	Reg	18	90.00	141.00	5.60		739.72	679.72

Appendix 6
Theoretical Irrigation Requirements

	------Acres of Turf-------		Acres	Acres	----------Acrefeet for each component----------				
	OS	Non-OS	Water	Desert	OS	Non-OS	Water	Desert	Total
Lakes East	26	31.9	37.5	0	161.15	180.06	223.13	0	564
Lakes West	27	113.7	37.5	0	167.35	641.78	223.13	0	1032
North	31	108.6	5.9	0	192.14	612.99	35.11	0	840
Quail Run	14	36.8	1.4	0	86.77	207.72	8.33	0	303
Riverview	50	93.2	7.6	0	309.90	526.07	45.22	0	881
South	52	147.5	4.3	0	322.30	832.56	25.59	0	1180
WB/WC	70	168.5	8.5	0	433.86	951.10	50.58	0	1436
Palmbrook CC	65	76.5	5.8	0	402.87	431.80	34.51	0	869
Sun City CC	90	33.3	2.7	0	557.82	187.96	16.07	0	762
Union Hills CC	90	51	5.6	0	557.82	287.87	33.32	0	879
Maricopa Lake	0	0	2.43	0	0.00	0.00	14.46	0	14
Deer Valley	52	49.37	7.64	50.22	322.30	278.67	45.46	30.63	677
Desert Trails	35	44	5	19	216.93	248.36	29.75	11.59	507
Echo Mesa	33	67.8	7.6	0	204.53	382.70	45.22	0	632
Grandview	67	96.7	7.8	0	415.27	545.82	46.41	0	1007
Pebblebrook	57	85.5	6.4	0	353.29	482.60	38.08	0	874
Stardust	33	63.3	2.3	0	204.53	357.30	13.69	0	576
Trail Ridge	50	31.6	14.87	81.44	309.90	178.37	88.48	49.68	626
Briarwood CC	106	46.1	4.1	0	656.99	260.21	24.40	0	942
Hillcrest GC	68	86	23.7	0	421.46	485.43	141.02	0	1048
								TOTAL	15650

Spectron Laboratories
PLANT NUTRIENT MONITORING

Water Analysis

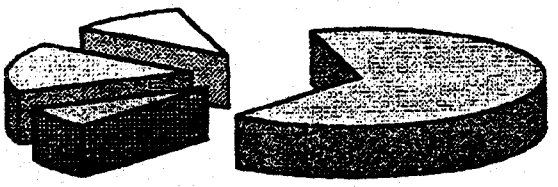
Irrigation Water

Client :	Sun City West	Sample No. :	4103-20
Contact :	Dan Maurer	Location :	Pebble Brook
Date :	7-Jun-99	Sample ID :	Fairway # 11 Lake

pH :	9.5	Carbonates :	28 mg/l
ECs :	0.356 mS/cm	Bicarbonates :	38 mg/l
T. D. S. :	178 (ppm)	Total hardness :	181 (ppm) CaCO3
Suspended Solids :	41 mg/l	S.A.R. :	3.2 meq/l
Turbidity :	36 NTU	R.S.C. :	0.0 meq/l

Element	Test Results		*Lbs. per acre ft. of water used.*	*lbs per 1,000*
Ammonia N :	2.6 (ppm)		7.0	*0.2*
Nitrate N :	2.0 (ppm)		5.4	*0.1*
Sulfate S :	16.0 (ppm)		43.2	*1.0*
Phosphate :	6.8 (ppm)		18.4	*0.4*
Potassium :	8.0 (ppm)	*7.6%*	21.6	*0.5*
Calcium :	17.0 (ppm)	*16.2%*	45.9	*1.1*
Magnesium :	11.0 (ppm)	*10.5%*	29.7	*0.7*
Sodium :	69.0 (ppm)	*65.7%*	186.3	*4.3*
Chloride :	22.0 (ppm)		59.4	*1.4*

n.d. = *element was not detectable in sample*



■ Potassium ▨ Calcium □ Magnesium ▣ Sodium

Please note: All test results are reported based on the sample received. Any target values, suggestions and suggested rates are for reference only.

663 West 6th Ave., Mesa, AZ 85210-2309 USA ph (602) 969-8741 fax (602) 969-8158

Spectron Laboratories
PLANT NUTRIENT MONITORING

Water Analysis

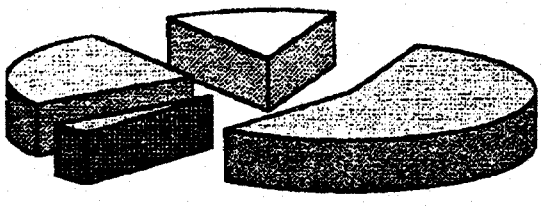
Irrigation Water

Client:	Sun City West	Sample No.	4103-13
Contact:	Pete Sagasta	Location:	Star Dust
Date:	7-Jun-99	Sample ID:	Tee # 16 Pump Station

pH:	8.2	Carbonates:	0 mg/l
ECs	0.425 mS/cm	Bicarbonates:	78 mg/l
T. D. S. :	212 (ppm)	Total hardness:	362 (ppm) CaCO3
Suspended Solids	10 mg/l	S.A.R.:	2.1 meq/l
Turbidity:	7 NTU	R.S.C.:	0.0 meq/l

Element	Test Results		*Lbs. per acre ft. of water used.*	*lbs per 1,000*
Ammonia N:	3.3 (ppm)		8.9	0.2
Nitrate N:	2.0 (ppm)		5.4	0.1
Sulfate S:	18.0 (ppm)		48.6	1.1
Phosphate:	10.3 (ppm)		27.8	0.6
Potassium:	4.0 (ppm)	4.2%	10.8	0.2
Calcium:	24.0 (ppm)	25.3%	64.8	1.5
Magnesium:	14.0 (ppm)	14.7%	37.8	0.9
Sodium:	53.0 (ppm)	55.8%	143.1	3.3
Chloride:	23.0 (ppm)		62.1	1.4

n.d. = *element was not detectable in sample*



■ Potassium □ Calcium □ Magnesium □ Sodium

Please note: All test results are reported based on the sample received. Any target values, suggestions and suggested rates are for reference only.

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Spectron Laboratories
PLANT NUTRIENT MONITORING

Water Analysis

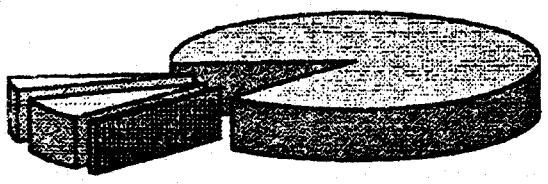
Irrigation Water

Client :	Sun City West	Sample No. :	4103-4
Contact :	Patrick Burgess	Location :	Grandview
Date :	7-Jun-99	Sample ID :	Pump Station

pH :	9.2	Carbonates :	8 mg/l
ECs :	490.000 mS/cm	Bicarbonates :	52 mg/l
T. D. S. :	245 (ppm)	Total hardness :	121 (ppm) CaCO3
Suspended Solids :	8 mg/l	S.A.R. :	6.5 meq/l
Turbidity :	9 NTU	R.S.C. :	0.3 meq/l

Element	Test Results		*Lbs. per acre ft. of water used.*	*lbs per 1,000*
Ammonia N :	2.4 (ppm)		6.5	0.1
Nitrate N :	4.0 (ppm)		10.8	0.2
Sulfate S :	27.0 (ppm)		72.9	1.7
Phosphate :	5.9 (ppm)		15.9	0.4
Potassium :	1.0 (ppm)	0.9%	2.7	0.1
Calcium :	8.0 (ppm)	7.3%	21.6	0.5
Magnesium :	5.0 (ppm)	4.6%	13.5	0.3
Sodium :	95.0 (ppm)	87.2%	256.5	5.9
Chloride :	48.0 (ppm)		129.6	3.0

n.d. = *element was not detectable in sample*



■ Potassium □ Calcium □ Magnesium □ Sodium

Please note: All test results are reported based on the sample received. Any target values, suggestions and suggested rates are for reference only.

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Spectron Laboratories
PLANT NUTRIENT MONITORING

Water Analysis

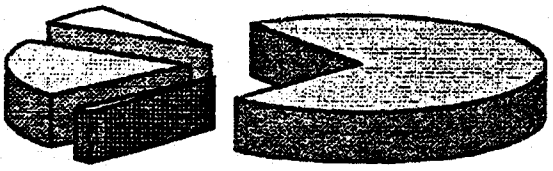
Irrigation Water

Client :	Sun City West	Sample No. :	4096-13
Contact :	Patrick Burgess	Location :	Echo Mesa
Date :	3-Jun-99	Sample ID :	Green # 12 Pump Station

pH :	8.2	Carbonates :	8 mg/l
ECs :	0.616 mS/cm	Bicarbonates :	68 mg/l
T. D. S. :	308 (ppm)	Total hardness :	362 (ppm) CaCO3
Suspended Solids :	15 mg/l	S.A.R. :	4.4 meq/l
Turbidity :	14 NTU	R.S.C. :	0.0 meq/l

Element	Test Results		*Lbs. per acre ft. of water used.*	*lbs per 1,000*
Ammonia N :	2.4 (ppm)		6.5	0.1
Nitrate N :	7.0 (ppm)		18.9	0.4
Sulfate S :	41.0 (ppm)		110.7	2.5
Phosphate :	6.5 (ppm)		17.6	0.4
Potassium :	3.0 (ppm)	1.9%	8.1	0.2
Calcium :	30.0 (ppm)	19.2%	81.0	1.9
Magnesium :	11.0 (ppm)	7.1%	29.7	0.7
Sodium :	112.0 (ppm)	71.8%	302.4	6.9
Chloride :	64.0 (ppm)		172.8	4.0

n.d. = *element was not detectable in sample*



■ Potassium □ Calcium □ Magnesium ⊡ Sodium

Please note: All test results are reported based on the sample received. Any target values, suggestions and suggested rates are for reference only.

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Spectron Laboratories
PLANT NUTRIENT MONITORING

Water Analysis

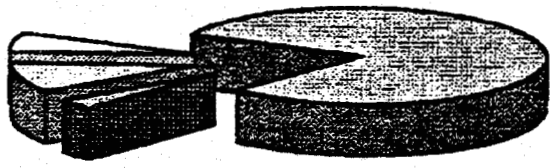
Irrigation Water

Client:	4096-15	Sample No.	4096-15
Contact:	Brad Ackerman	Location:	Trail Ridge
Date:	3-Jun-99	Sample ID:	# 18 Pump Station

pH:	9.9	Carbonates:	24 mg/l
ECs:	0.506 mS/cm	Bicarbonates:	42 mg/l
T. D. S.:	253 (ppm)	Total hardness:	121 (ppm) CaCO3
Suspended Solids:	39 mg/l	S.A.R.:	6.0 meq/l
Turbidity:	42 NTU	R.S.C.:	0.0 meq/l

Element	Test Results		*Lbs. per acre ft. of water used.*	*lbs per 1,000*
Ammonia N:	2.6 (ppm)		7.0	0.2
Nitrate N:	2.0 (ppm)		5.4	0.1
Sulfate S:	31.0 (ppm)		83.7	1.9
Phosphate:	10.0 (ppm)		27.0	0.6
Potassium:	5.0 (ppm)	3.4%	13.5	0.3
Calcium:	15.0 (ppm)	10.1%	40.5	0.9
Magnesium:	9.0 (ppm)	6.1%	24.3	0.6
Sodium:	119.0 (ppm)	80.4%	321.3	7.4
Chloride:	31.0 (ppm)		83.7	1.9

n.d. = *element was not detectable in sample*



■ Potassium ■ Calcium □ Magnesium ■ Sodium

Please note: All test results are reported based on the sample received. Any target values, suggestions and suggested rates are for reference only.

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Spectron Laboratories
PLANT NUTRIENT MONITORING

Water Analysis

REVENGE - CALCIUM.

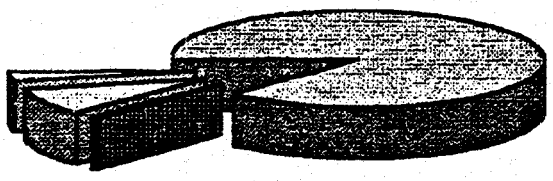
Irrigation Water 5.5 ACRE FEET.

Client :	Sun City West	Sample No. :	4103-18
Contact :	Brad Ackerman	Location :	Deer Valley
Date :	7-Jun-99	Sample ID :	Green # 12 Pump Station

pH :	9.8	Carbonates :	28 mg/l
ECs :	0.566 mS/cm	Bicarbonates :	38 mg/l
T. D. S. :	283 (ppm)	Total hardness :	121 (ppm) CaCO3
Suspended Solids :	60 mg/l	S.A.R. :	7.8 meq/l *
Turbidity :	51 NTU	R.S.C. :	0.5 meq/l

Element	Test Results		Lbs. per acre ft. of water used.	lbs per 1,000	
Ammonia N :	3.2 (ppm)		8.6	0.2	
Nitrate N :	2.0 (ppm)		5.4	0.1	
Sulfate S :	36.0 (ppm)		97.2	2.2	
Phosphate :	9.6 (ppm)		25.9	0.6	
Potassium :	1.0 (ppm)	0.7%	2.7	0.1	
Calcium :	* 13.0 (ppm)	8.7%	35.1	0.8	193 lbs / YEAR — APPROX 2 TONS CALCIUM
Magnesium :	5.0 (ppm)	3.3%	13.5	0.3	
Sodium :	* 131.0 (ppm)	87.3%	353.7	8.1	1,945 lbs / YEAR.
Chloride :	57.0 (ppm)		153.9	3.5	

n.d. = element was not detectable in sample



■ Potassium ⊡ Calcium □ Magnesium ⊡ Sodium

350 lbs CA / MONTH APPROX.

GYPSUM

Please note: All test results are reported based on the sample received. Any target values, suggestions and suggested rates are for reference only.

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Spectron Laboratories
PLANT NUTRIENT MONITORING

Water Analysis

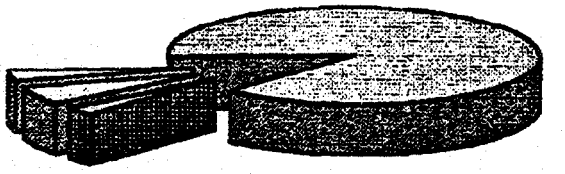
Irrigation Water

Client :	Sun City West	Sample No. :	4096-14
Contact :	Dan Maurer	Location :	Desert Trails
Date :	3-Jun-99	Sample ID :	Green # 6 Pump House

pH :	10.2	Carbonates :	28 mg/l
ECs :	0.450 mS/cm	Bicarbonates :	38 mg/l
T. D. S. :	225 (ppm)	Total hardness :	81 (ppm) CaCO3
Suspended Solids :	28 mg/l	S.A.R. :	7.2 meq/l
Turbidity :	22 NTU	R.S.C. :	0.9 meq/l

Element	Test Results		*Lbs. per acre ft. of water used.*	*lbs per 1,000*
Ammonia N :	2.7 (ppm)		7.3	0.2
Nitrate N :	2.0 (ppm)		5.4	0.1
Sulfate S :	26.0 (ppm)		70.2	1.6
Phosphate :	7.3 (ppm)		19.7	0.5
Potassium :	3.0 (ppm)	2.8%	8.1	0.2
Calcium :	6.0 (ppm)	5.7%	16.2	0.4
Magnesium :	4.0 (ppm)	3.8%	10.8	0.2
Sodium :	93.0 (ppm)	87.7%	251.1	5.8
Chloride :	40.0 (ppm)		108.0	2.5

n.d. = *element was not detectable in sample*



■ Potassium ◻ Calcium ◻ Magnesium ◻ Sodium

Please note: All test results are reported based on the sample received. Any target values, suggestions and suggested rates are for reference only.

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Appendix E
Miscellaneous CAP Plans & Related Items

CENTRAL ARIZONA PROJECT
P.O. Box 43020 • Phoenix, Arizona 85080-3020 • 23636 North Seventh Street (85024)
(623) 869-2333 • www.cap-az.com

April 26, 2000

<<< OPERATING PROCEDURES >> >

WATER PROJECTIONS

By June 1st - BOR advises CAWCD of Colorado River water availability for following year.

At June CAWCD Board Meeting - Board adopts water pricing for next calendar year.

By July 1st - CAWCD advises customers of water rates and availability for next calendar year, and requests annual water delivery schedules for the next three calendar years.

By October 1st - Annual water delivery schedules are due from customers.

By November 15th - CAWCD advises customers of their approved delivery schedules, and distributes the Annual Operating Plan for the next year. If necessary, subcontractors will be limited to 11% of their annual allocation for any month where system demands cannot be met.

Last week of month - CAWCD calls customers for revised forecast data for next two months.

WATER SCHEDULING

Before 9:00 A.M. each day - Customer will call flow changes into Control Center personnel for the next day. Changes must be in CFS, with the date and time they are to take effect. Limit of two changes per 24 hour period. During times of limited system capacity, CAP will contact customers after all orders are in to inform them that curtailment procedures have begun.

In Emergencies - (when possible) customer will give CAP two hours notice for flow reductions due to weather conditions. Otherwise, notice must be given as soon as possible for immediate closure of gate(s) due to damage or threat of damage to user's system.

WATER BILLING AND PAYMENT POLICIES

By 15th of each month - Water use accounting reports for the previous month's deliveries are mailed.

By 20th of each month - Billing invoices for the second following month are mailed. Example: Invoice dated January 20th, is for the March prepayment, which is due by February 20th.

By 20th of each month - Monthly water prepayments are due.

By 25th of each month - Electronic Fund Transfer (EFT) payments are posted to CAP account. This due date applies (only) to those customers who have an established EFT account with CAP.

Close of business on last working day of the month - Grace period for late payments ends. Late payment penalties will take effect, and water deliveries may be restricted, interrupted or terminated.

By August 20 - Tax Levy invoices are mailed to subcontractors.

By December 1st and June 1st - Capital charge payments are due.

January 1st and July 1st - Grace period for late capital charge payments end. Late payment penalties will take effect, and water deliveries may be restricted, interrupted or terminated.

By February 20th - CAWCD will furnish customer account reconciliations for previous calendar year. Reconciliation statements will accompany regular monthly invoices mailed on this date. Regular monthly invoices will reflect the appropriate credit or debit to reconcile the account. Invoices mailed on this date are for the April prepayment. Customers receiving a credit can request in writing that a refund check be processed. Mail or fax request for refund check to Jodi Gould.

ADMINISTRATIVE CONTACTS

Annual Water Delivery Schedules/ - Jodi Gould ———— (623)869-2565
Monthly Water Use Accounting
Reports/Monthly Delivery Reports/
Temporary Water Use Permits
Two Month Forecast Projections/ - Dianna Mantzey ——— (623)869-2573
Temporary Water Use Permits
System Operational Plan (water/power) - Tim Kacerek —— (623)869-2563
Waddell Accounting/Water Quality - Brian Henning ——— (623)869-2567
Monthly Water Service Invoices/ - Tina Brown/Finance —— (623)869-2149
Semi-Annual Capital Charge Invoices
Fax ———————————————————— (623)869-2376

WATER OPERATIONS CONTACTS

Day Shift Scheduling - Bob Navigato/Mark Rhodes	(623)869 -2562
Flow Reduction	(623)869 -2562
Emergencies	(623)869 -2530
Dispatch Desk	(623)869 -2531
24-hour Toll Free	1-800-847-2303
Water Quality Monitor	(623)869 -2182
Cellular Phone/Control Center	(602)319-9296
Backup Analog Line/Control Center	(623)581-9375
Fax/Control Center	(623)869 -2399

PAYMENT OPTIONS

*** *Wire Transfer of Funds:*

Central Arizona Water Conservation District
Account Number - 6010000471064
Bank Routing Number - 122100024
Bank One
1735 W. Bell Road
Phoenix, AZ 85023
NOTE: include your company name and invoice number your paying so your account can be credited promptly

*** *Direct Deposit into CAWCD Account:*

Bank One (any branch)
Central Arizona Water Conservation District
Account Number - 6010000471064
NOTE: after making deposit, fax copy of deposit receipt to Jodi Gould at (623)869-2399, and mail original

*** *U.S. Mail:*

Central Arizona Project
P.O. Box 43020
Phoenix, AZ 85080-3020
ATTN: Jodi Gould
NOTE: overnight/next day delivery is required on all past due payments

*** *Courier/Hand Delivery:*

Central Arizona Project
23636 N. 7th Street
Phoenix, AZ 85024
ATTN: Jodi Gould
NOTE: no later than 5:00 p.m.

LAND USE APPLICATION

00-031

Central Arizona Project
Land Administration Program
P.O. Box 43020 Phoenix, AZ 85080-3020

Phone: (623) 869-2265
Fax: (623) 869-2249
Email: scibik@cap-az.com

CAP will consider your request to use CAP property, but applicants should realize that some land use applications are not approved. Our foremost responsibility is to make careful and competent land use decisions for CAP property. Before CAP will begin review of land use requests, we need a complete application package. This includes:

____ (A) This application with all requested information, signed by the applicant.

____ (B) Initial $500 nonrefundable fee/deposit.

____ (C) Written legal description (in the western grid system of Township, Range, Section) and a drawing of the applicable area of CAP property. These must be of a high enough quality for use as exhibits to the land use documents.

____ (D) Design plans (4 sets). CAP land boundaries should be clearly marked. Plans submitted should be limited only to those drawings which affect CAP property (with the associated legend and explanation pages).

Concurrently with our review of your application package, we suggest that applicants arrange for the required insurance certificate and collect any documents they will need to show the authority of the party who will sign the CAP land use agreement.

Most approved projects will be granted a Construction Period Land Use License, to be followed by a longer term license or easement. As-built drawings shall be delivered to CAP, and administrative costs paid to CAP, before the longer term land uses will be granted.

CAP works on land use applications in the order in which we receive a complete application. Applicants can best cooperate with us for fastest service by providing us all the information requested in the initial application package. Status calls about your application are usually not necessary and do not result in a faster processing of your application over another's. CAP should be contacted early in your project's planning phase.

1. **Applicant Legal Name:** .....

   Type of Applicant (example, *a Delaware corporation*): .....

2. **Project Contact Names**

   Application Coordination (R/W Agent): ..... Phone: .....

   Address: ..... Fax: .....

   Field Representative (Construction): ..... Phone: .....

   Emergency Contact (After Hours): ..... Phone: .....

   Finance/Account Contact: ..... Phone: .....

   Address: ..... Fax: .....

3. Applicant Representatives for Purposes of CAP Document Preparation

These are persons the applicant will designate in the land use document as its representatives in matters of (A.) safety, (B.) environmental and hazardous waste issues, and (C.) official receipt of notices concerning the land use agreement. CAP also requests (D.) the name and title of the individual who has authority to sign the land use document on behalf of the applicant.

A. Safety Representative: .....

Address: .....

Phone: .....

B. Environmental Representative: .....

Address: .....

Phone: .....

C. Document Contact for Official Notices: .....

Address: .....

D. Signature Authority Name: .....

Title: .....

Project Information

4. Location: Township: _____ Range: _____ Section: _____ G&SRB&M

Cross Streets/ Other Reference: .....

5. Acres of CAP Land (to 1/100): ..... **6. Term Needed** (in months or years): .....

7. Project Description (examples, *12 KV Overhead Powerline, 24" Underground Water Line*):

.....

Applicant understands that all administrative costs (including overhead) of CAP's review, inspection, and processing of this application are to be paid by the applicant, and the applicant agrees to pay those costs.

_____	_____	_____
Signature	**Title**	**Date**

Central Arizona Project, Land Use License Information

Signature Authority Checklist

Type of Applicant (individual, corporation, municipality): _____

Name of Person who will sign the License for Applicant: _____

Title of Person signing License for Applicant: _____

CAP requires documentation of the signature authority of the person who will be signing CAP land use licenses on behalf of the applicant. Applicants are encouraged to collect and submit the requested documents early in the review process. The following standard business documents (or appropriate equivalents) are normally required, categorized by the type of applicant:

Municipality or Political Subdivision: An original resolution of the governing board authorizing the municipality or political subdivision to execute and perform the CAP license, and authorizing the appropriate official to sign the license on behalf of the municipality or political subdivision.

Corporation: 1. Copy of filed articles of incorporation, 2. Copy of current by-laws, 3. Original certificate of good standing from the Arizona Corporation Commission, and a similar one from state of incorporation, if not Arizona, 4. Original corporate resolution, authorizing the corporation to execute and perform the license , and naming an officer or agent to sign the license on behalf of the corporation, and 5. For a foreign corporation, the filed application and certificate of disclosure of a foreign corporation.

Limited Liability Company: 1. Copy of filed articles of organization, 2. Copy of current operating agreement, 3. Original certificate of existence from the Arizona Corporation Commission, and a similar document from state of organization, if not Arizona, 4. Original consent to action by members or managers of the company authorizing the company to execute and perform the license, and 5. For a foreign limited liability company, a copy of the filed application for registration as a foreign limited liability company and certificate of registration.

General Partnership or Joint Venture: 1. Copy of the current partnership agreement authorizing a partner or agent to sign on behalf of the partnership or joint venture, 2. Copy of the recorded certificate of fictitious name from the county recorder, 3. Original certificate of partners authorizing the partnership or joint venture to execute and perform the license.

Limited Partnership: 1. Copy of the current limited partnership agreement authorizing a general partner or agent to sign on behalf of the limited partnership, 2. Copy of filed certificate of limited partnership, 3. Original certificate of existence from the Arizona Secretary of State, and if a foreign limited partnership, a similar certificate from the domicile state, 4. Original certificate of general partners authorizing the limited partnership to execute and perform the license, 5. If a foreign limited partnership, a copy of the filed application for registration as a foreign limited partnership and certificate of registration.

Limited Liability Partnership: 1. Copy of current partnership agreement authorizing a partner or agent to sign on behalf of the partnership, 2. Copy of filed application for registration and most recently filed renewal of registration, 3. Original certificate of existence from Arizona Secretary of State, and if a foreign limited liability partnership, a similar certificate from domicile state, 4. Original certificate of partners authorizing the partnership to execute and perform the license, 5. If a foreign limited liability partnership, a copy of the filed application for registration as a foreign limited liability partnership and certificate of registration.

Trust: Trust agreement. Beneficiaries of the trust, as specifically named in the trust agreement, will also be asked to sign for the trust (in addition to the trust officer). The beneficiaries , depending on what type of entity (individual, corporation, partnership) will be asked for signature authority documents also.

CAP LAND USE APPLICATION INFORMATION

Central Arizona Project
Land Administration Program
P.O. Box 43020; Phoenix, AZ 85080-3020

Phone: (623) 869-2265
FAX: (623) 869-2249
E Mail: scibik@cap-az.com

1. Applicant Information

CAP requests an application with a general description of the proposed project, a legal description and an initial $500 fee/deposit. The applicant is responsible for all CAP administrative costs relating to their project. The application should not be made by the applicant's contractors. We will work with your contractors, but we prefer to set up only one file and account for each project. The applicant is also asked to designate a Safety Representative and an Environmental Representative for their project.

CAP requires information to qualify the signature authority of the person signing the CAP land use documents on behalf of the applicant. We have a checklist that describes the documents needed. Applicants who regularly apply for CAP land uses may establish one set of signature authority documents that can be used for all their projects for as long as the designated signature authority remains the same.

2. Property Identification, Legal Description

The applicant must describe the CAP land that they want to use. A legal description (in grid system of township, range, and section) of sufficient quality to be used for the license or easement document should be submitted with the application. Please mark CAP boundaries on design plans. We have CAP surveys and drawings that may assist you in determining CAP boundaries.

3. Insurance Checklist

CAP requires proof of liability insurance before execution of licenses or easements, or access to CAP property. Some land uses would require insurance amounts higher than those described below. Evidence of insurance of contractors may be requested. Most applicants must provide a Certificate of Insurance from an "A" rated or better company that names, as additional insured, *both* the United States and the Central Arizona Water Conservation District. Required amounts are:

____ Workers Compensation and Employers' Liability, as required by Arizona Law
____ Commercial General Liability
(with Bodily Injury, Property Damage) -- $1,000,000 Per Occurrence
____ Business Automobile Liability Insurance -- $1,000,000 Per Occurrence

4. Fees

A nonrefundable initial fee/deposit of $500 is required for most land use applications. Make checks payable to Central Arizona Water Conservation District. We may request a larger initial deposit if we expect that administrative fees will be greater than average. Land use license fees include all costs incurred by CAP relating to your project starting from your application. These costs include, but are not limited to, employee labor and salary (with overhead) for engineering plan reviews, document processing and preparation, appraisals, and construction inspections. In addition to administrative costs, longer-term land use licenses and easements normally have annual use fees that are based on an appraisal. CAP may request an additional deposit prior to an appraisal.

5. Access to CAP Property

An executed license is required prior to beginning construction on CAP property. Licensees and their contractors and subcontractors should all sign "Hold Harmless" agreements with CAP Security. Call Mr. Abe Sahli, Civil Engineer, (623) 869-2126, at least two weeks before projects begin to arrange for the hold harmless agreements and site access. Applicants are responsible for informing their contractors regarding this requirement, and other requirements of CAP land use agreements, including specific hazardous waste and construction safety standards.

The Central Arizona Project will be a collaborative, innovative leader in the management and delivery of water to central Arizona. It will enhance the state's economy and quality of life and ensure sustainable growth for current and future populations of Arizonans.

CENTRAL ARIZONA PROJECT
23636 North Seventh Street • Phoenix, Arizona 85024
www.cap-az.com

DAVID W. GUNN, P.E.
Engineering Manager

(623) 869-2233
(623) 869-2249 Fax
(602) 289-4516 Pager
dgunn@cap-az.com

P.O. Box 43020 • Phoenix, Arizona 85080-3020

CENTRAL ARIZONA PROJECT
23636 North Seventh Street • Phoenix, Arizona 85024
www.cap-az.com

TIMOTHY F. KACEREK, P.E.
Water Control Manager

(623) 869-2563
(623) 869-2376 Fax
tkacerek@cap-az.com

P.O. Box 43020 • Phoenix, Arizona 85080-3020

CENTRAL ARIZONA PROJECT
23636 North Seventh Street • Phoenix, Arizona 85024
www.cap-az.com

SANDRA L. CIBIK
Land Administration Assistant

(623) 869-2265
(623) 869-2249 Fax
scibik@cap-az.com

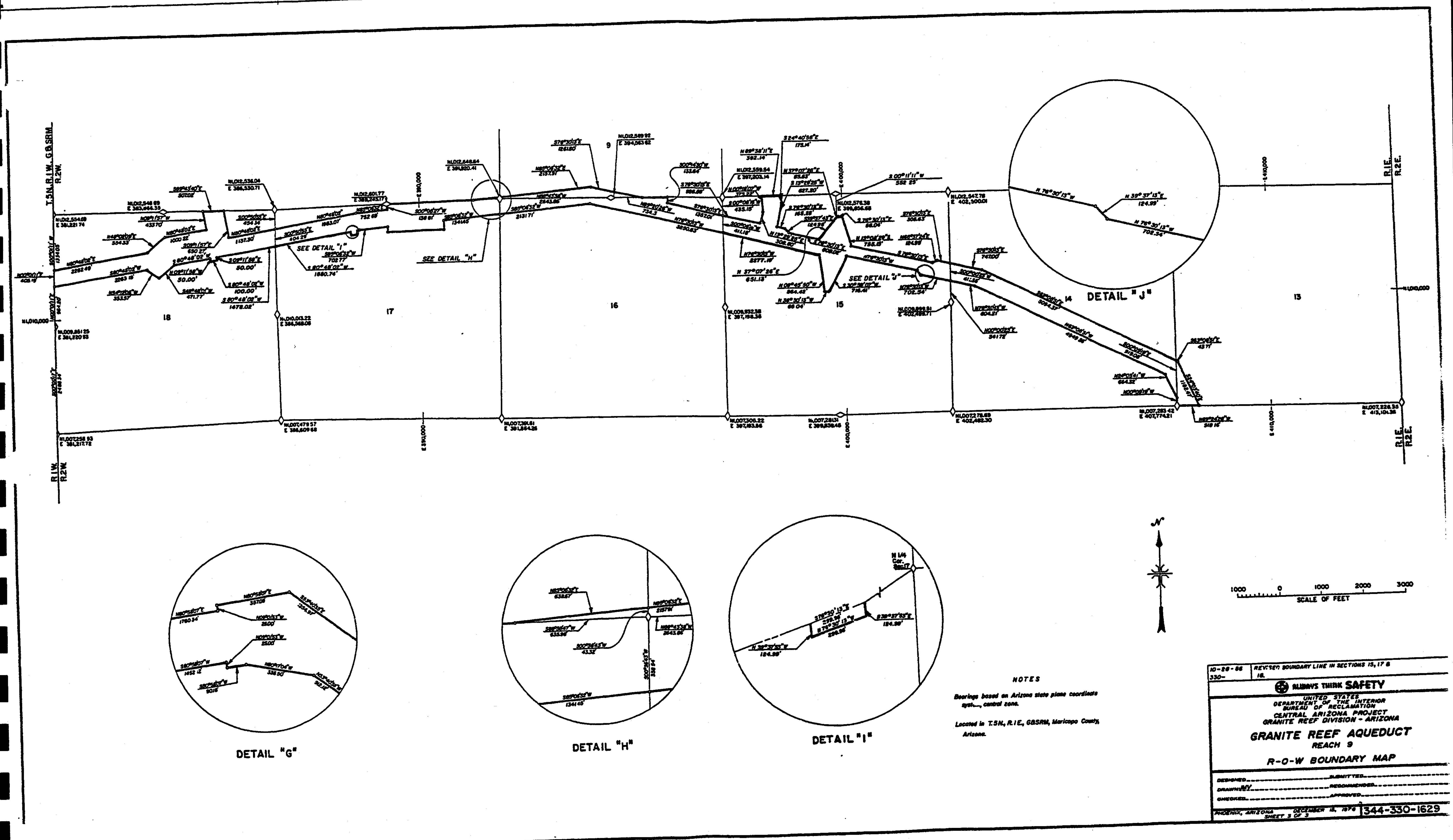
P.O. Box 43020 • Phoenix, Arizona 85080-3020

CENTRAL ARIZONA PROJECT
23636 North Seventh Street • Phoenix, Arizona 85024
www.cap-az.com

SHARON R. HOOD
Land Administrator

(623) 869-2387
(623) 869-2249 Fax
shood@cap-az.com

P.O. Box 43020 • Phoenix, Arizona 85080-3020



NOTES

Bearings based on Arizona state plane coordinate system, central zone.

Located in T.5N., R.1E., G&SRM, Maricopa County, Arizona.

10-29-86 330- REVISED BOUNDARY LINE IN SECTIONS 15, 17 & 18.

ALWAYS THINK SAFETY

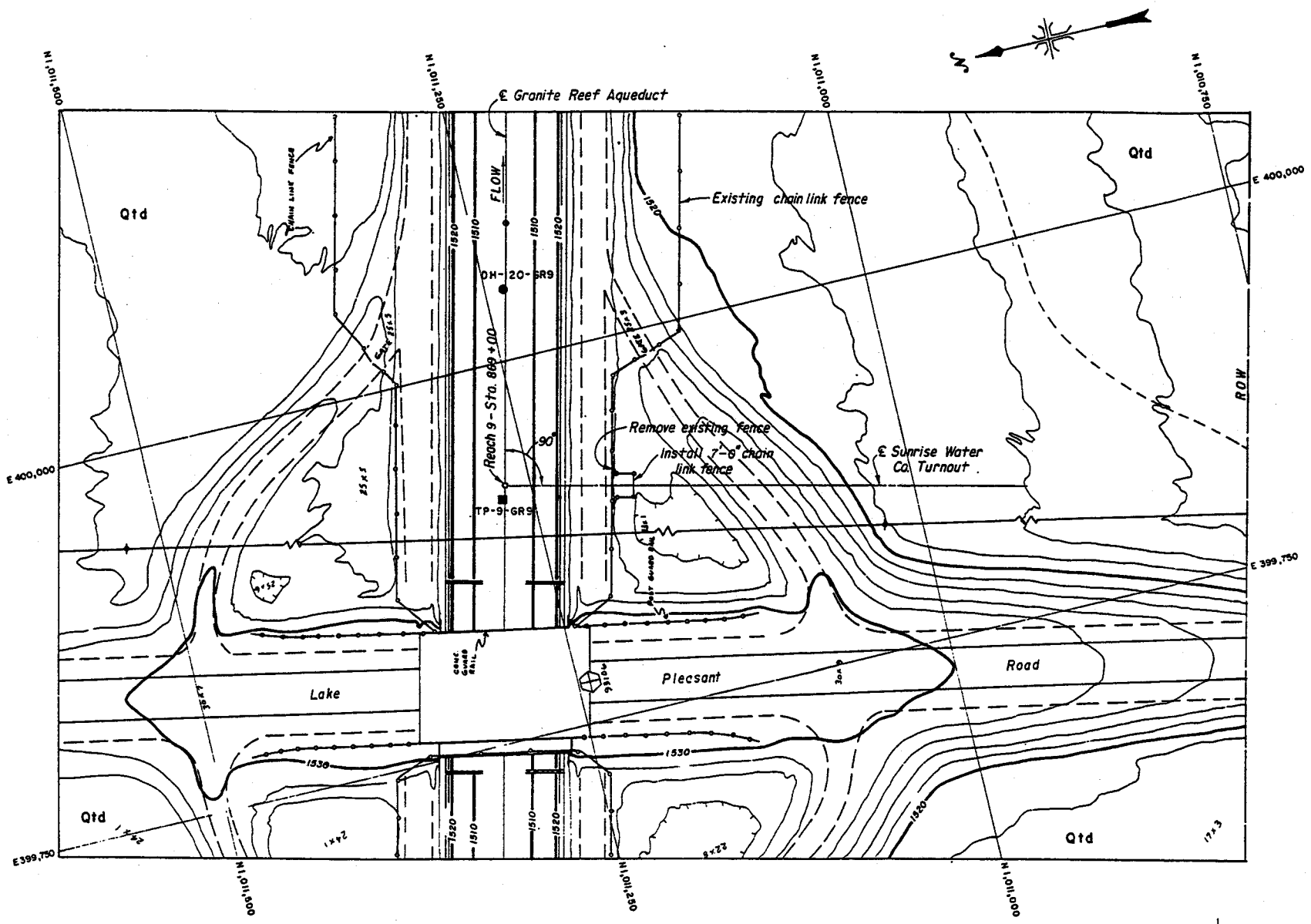
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GRANITE REEF DIVISION - ARIZONA

GRANITE REEF AQUEDUCT
REACH 9

R-O-W BOUNDARY MAP

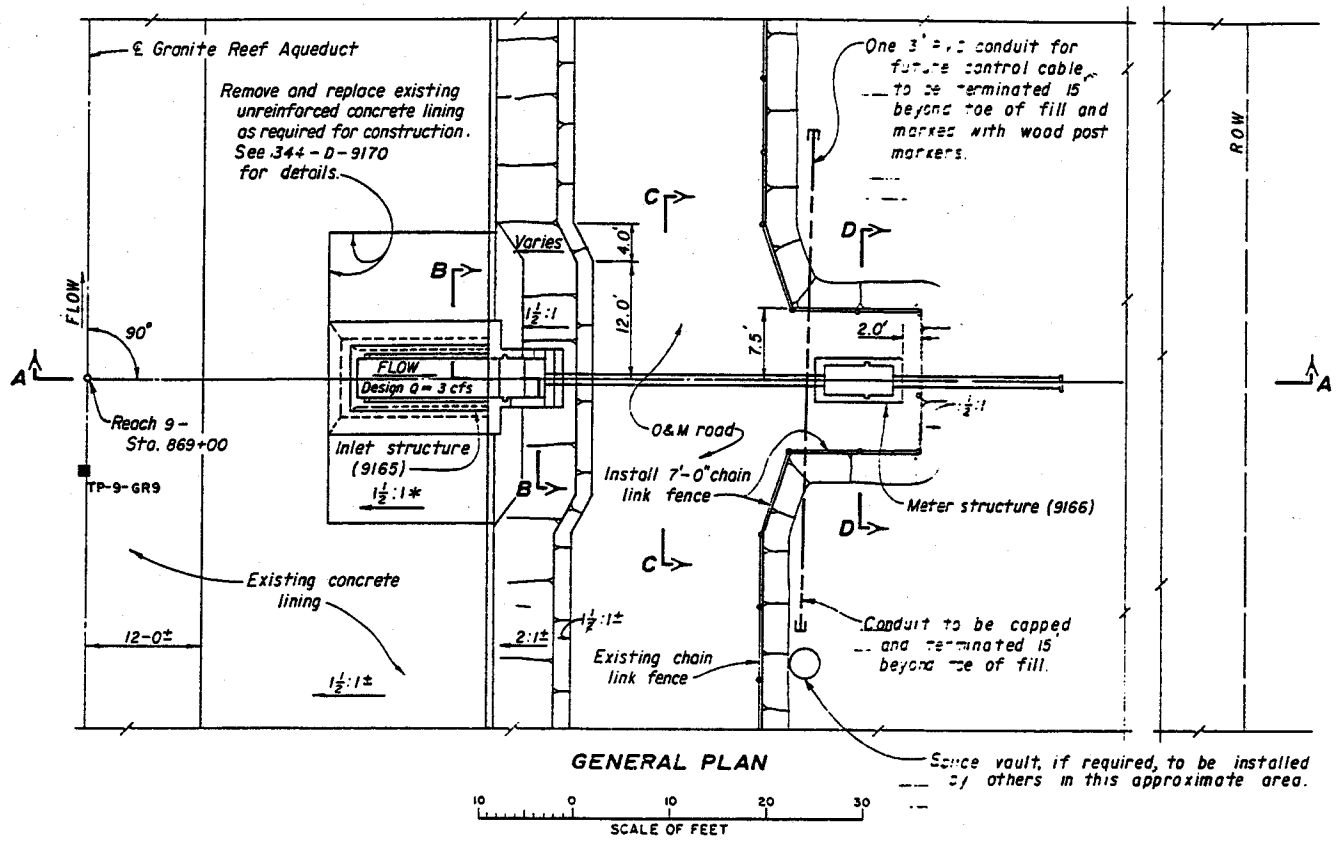
DESIGNED..... SUBMITTED.....
DRAWN..... RECOMMENDED.....
CHECKED..... APPROVED.....

PHOENIX, ARIZONA DECEMBER 18, 1974 SHEET 3 OF 3 | 344-330-1629



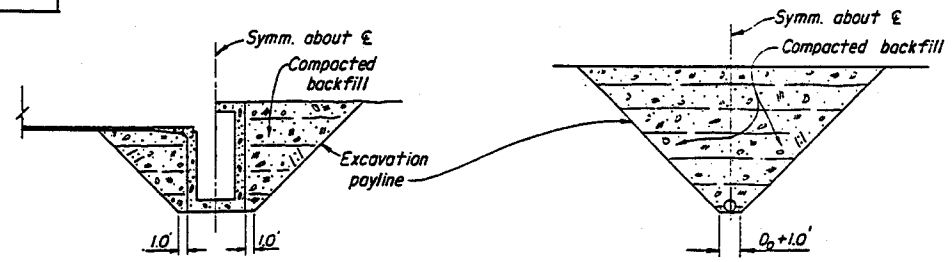
SITE TOPOGRAPHY
(AS OF APRIL, 1982)

50 0 50 100 150
SCALE OF FEET



GENERAL PLAN

10 0 10 20 30
SCALE OF FEET

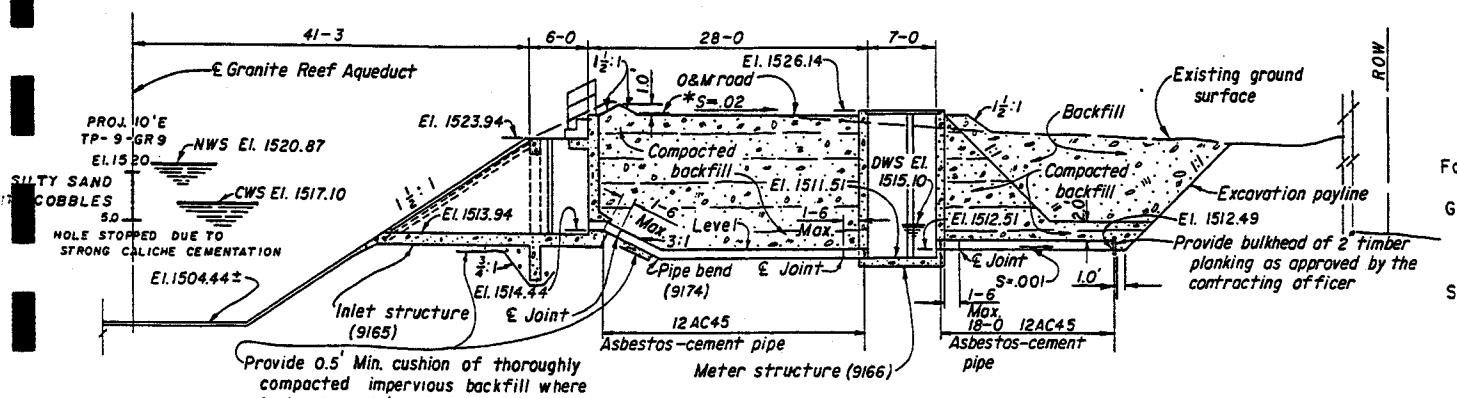


SECTION B-B

SECTION C-C

NOTES

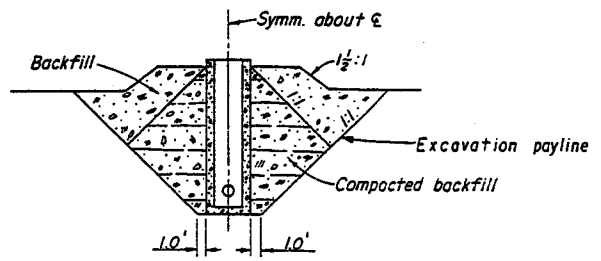
For general notes, see 344-D-9170.
Chain link fence to be relocated as shown or as directed.
For fencing details, see 40-D-6268.
* Match existing



SECTION A-A

GEOLOGIC NOTES

For General Geologic Legend, Explanation and Notes, see Dwg. 344-D-9289A.
Geology shown is before excavation and does not delineate embankment areas.
Logs of TP-9-GR9 and DH-120-GR9 are included in these specifications.
See Dwg. 344-330-3342A for additional geology in the vicinity of this turnout.



SECTION D-D

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GRANITE REEF DIVISION - ARIZONA

GRANITE REEF AQUEDUCT
TURNOUTS
REACH 9 - STA. 869+00 RT.
SUNRISE WATER CO. TURNOUT
SITE TOPOGRAPHY, GENERAL PLAN & SECTIONS

DESIGNED K.E. TECHNICAL APPROVAL T.C. Fisher
DRAWN Mark C. Mohr SUBMITTED W.A. Long
CHECKED A.L. Nelson APPROVED C.O. Dunsley
CHIEF, WATER CONVEYANCE BRANCH

GEOLOGY
TECH. APPROVAL
SUBMITTED - NOT REQUIRED
APPROVED

DENVER, COLORADO FEB. 22, 1983

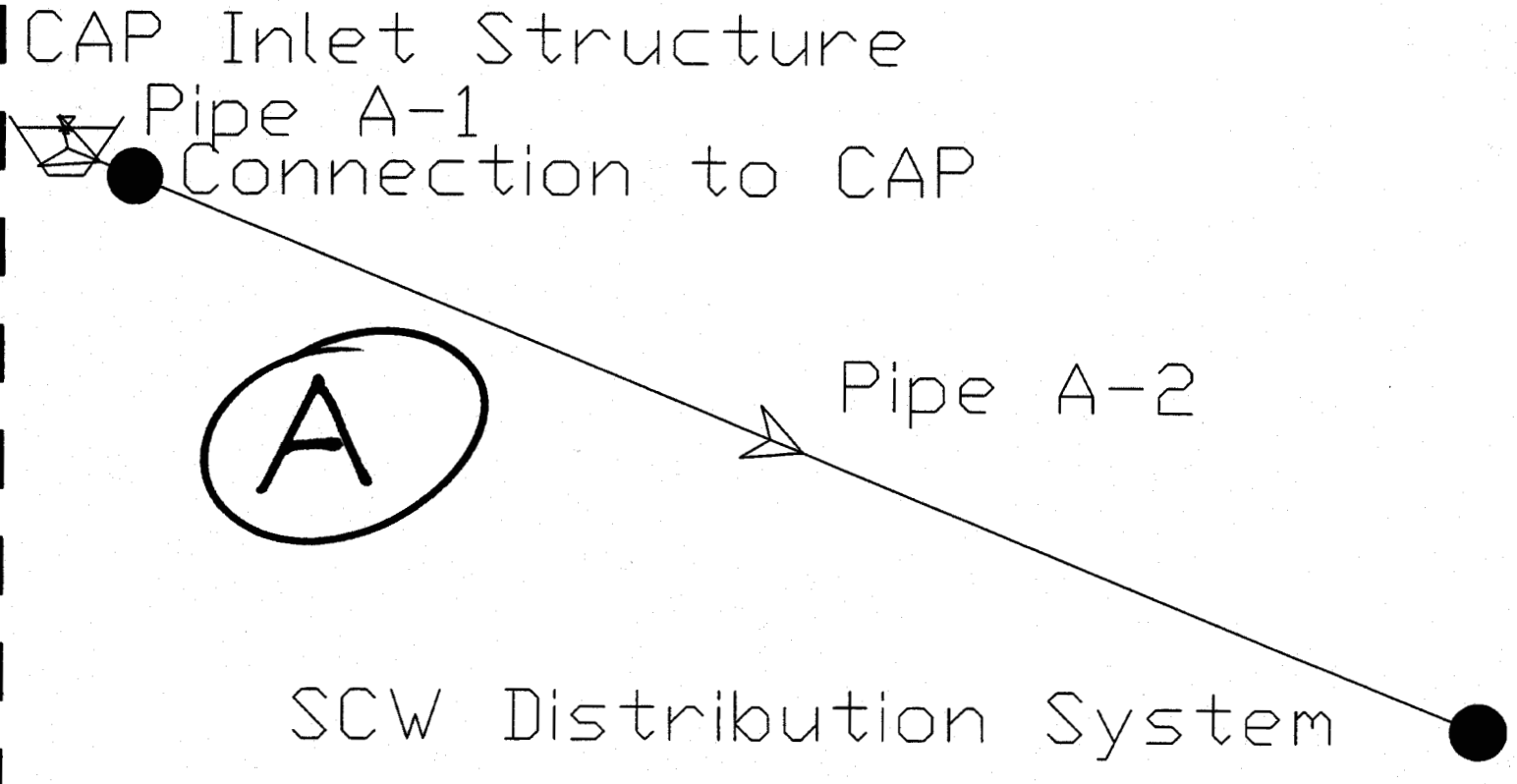
344-D-9145

Appendix F
Cybernet Hydraulic Calculations

Pipe Size (in)	Flow Rate (cfs)	Head @ End (ft)	Pressure @ End (psi)
24	9.1	1461.68	106.67
24	15	1377.40	70.23
30	15		
30	37	1271.95	24.63

CWS = 1517.10
Elev. @ End = 1215.0

Static Pressure = 130psi



Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipe A-2

Demand Summary

Type	Demand (cfs)	Pattern
Demand	9.10000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,461.68	106.67	9.10000	246.68

24-9.1

Detailed Report for Pipe: Pipe A-2

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Connection to CAP	Diameter	24 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	46,000.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	9.10000	2.90	1,515.90	1,461.68	54.21	0.00	54.21	1.18

24-9.1

Detailed Report for Junction: Connection to CAP

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-52.32 ft	Elevation	1,512.51 ft
Y	41.66 ft	Zone	Zone-1

Connecting Pipes
Pipe A-1
Pipe A-2

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,515.90	1.47	0.00000	3.39

24-9.1

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HDR Engineering
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Detailed Report for Pipe: Pipe A-1

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	CAP Inlet Structure	Diameter	12 in
To Node	Connection to CAP	Material	Asbestos Cement
Check Valve	No	Roughness	140.0
Length	40.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	9.10000	11.59	1,517.10	1,515.90	1.20	0.00	1.20	30.05

24-9.1

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HDR Engineering
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Detailed Report for Reservoir: CAP Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,517.10 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipe A-1

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,517.10	N/A	9.10000

24-91

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes

Pipe A-2

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,377.40	70.23	15.00000	162.40

24-15

Detailed Report for Pipe: Pipe A-2

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Connection to CAP	Diameter	24 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	46,000.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	4.77	1,514.07	1,377.40	136.67	0.00	136.67	2.97

24-15

Detailed Report for Junction: Connection to CAP

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-52.32 ft	Elevation	1,512.51 ft
Y	41.66 ft	Zone	Zone-1

Connecting Pipes
Pipe A-1
Pipe A-2

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,514.07	0.67	0.00000	1.56

24-15

Detailed Report for Pipe: Pipe A-1

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	CAP Inlet Structure	Diameter	12 in
To Node	Connection to CAP	Material	Asbestos Cement
Check Valve	No	Roughness	140.0
Length	40.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	19.10	1,517.10	1,514.07	3.03	0.00	3.03	75.75

24-15

Detailed Report for Reservoir: CAP Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,517.10 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipe A-1

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,517.10	N/A	15.00000

24-15

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipe A-2

Demand Summary

Type	Demand (cfs)	Pattern
Demand	37.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,271.95	24.63	37.00000	56.95

30-37

Detailed Report for Pipe: Pipe A-2

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Connection to CAP	Diameter	30 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	46,000.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	37.00000	7.54	1,516.91	1,271.95	244.97	0.00	244.97	5.33

30-37

Detailed Report for Junction: Connection to CAP

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-52.32 ft	Elevation	1,512.51 ft
Y	41.66 ft	Zone	Zone-1

Connecting Pipes
Pipe A-1
Pipe A-2

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,516.91	1.90	0.00000	4.40

30-3

Detailed Report for Pipe: Pipe A-1

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	CAP Inlet Structure	Diameter	30 in
To Node	Connection to CAP	Material	Asbestos Cement
Check Valve	No	Roughness	140.0
Length	40.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	37.00000	7.54	1,517.10	1,516.91	0.19	0.00	0.19	4.64

30-37

Detailed Report for Reservoir: CAP Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,517.10 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipe A-1

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,517.10	N/A	37.00000

30-37

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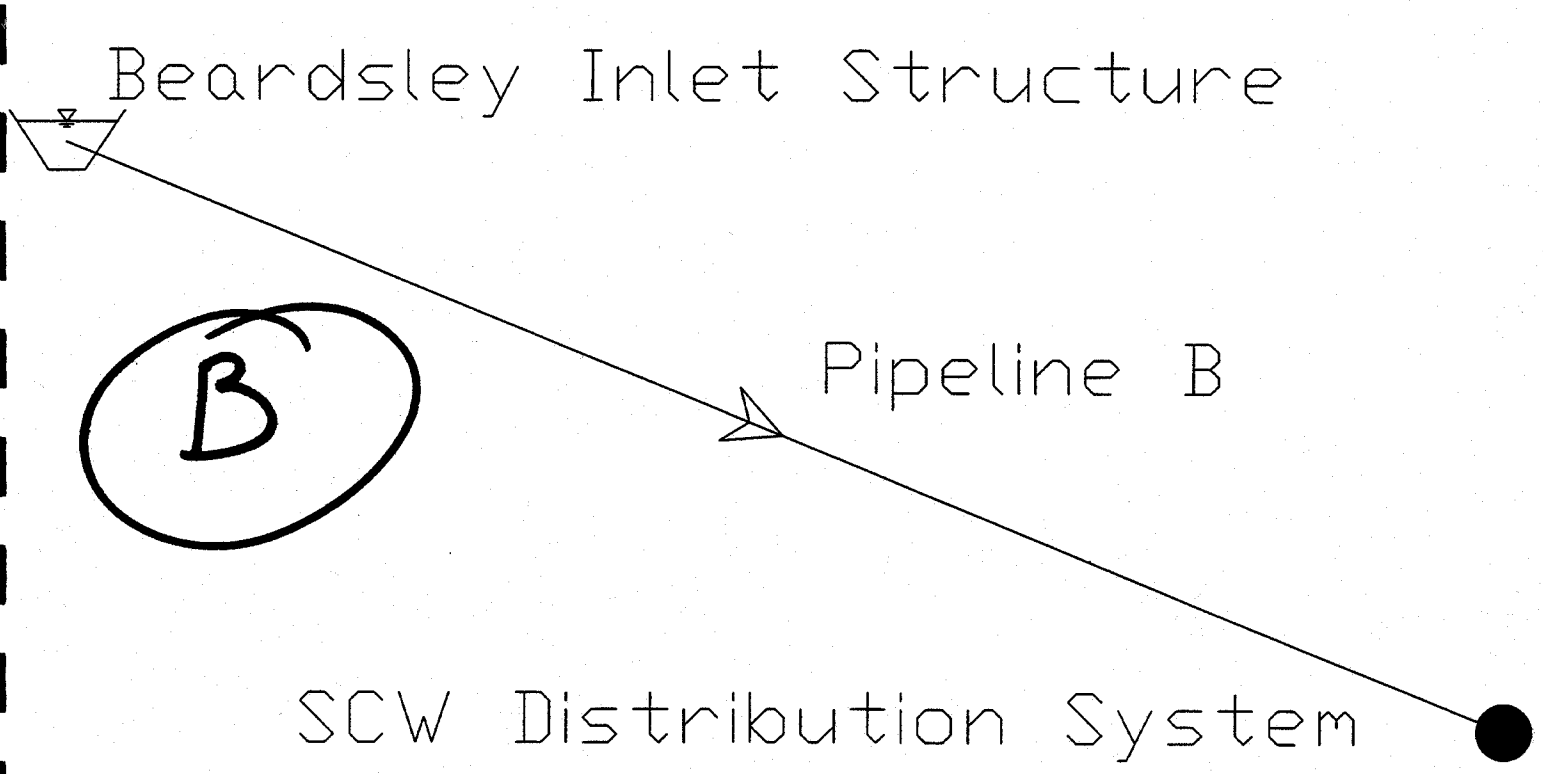
HDR Engineering
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Pipe Size (in)	Flow Rate (cfs)	Head @ End (Ft)	Pressure @ End (PSI)
24	9.1	1319.54	45.21
24	15	1280.83	28.47
30	15	1323.35	46.86
36	15	1336.09	52.36

CWS = 1345.0
End Elev = 1215.0

Static Pressure = 56 psi



Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,345.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline B

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,345.00	N/A	9.10000

24" - 9.1 cfs

Detailed Report for Pipe: Pipeline B

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	24 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	21,600.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	9.10000	2.90	1,345.00	1,319.54	25.46	0.00	25.46	1.18

24" - 9.1 cfs

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes

Pipeline B

Demand Summary

Type	Demand (cfs)	Pattern
Demand	9.10000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,319.54	45.21	9.10000	104.54

24" - 9.1 cfs

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,345.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes

Pipeline B

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,345.00	N/A	15.00000

24" - 15cfs

Detailed Report for Pipe: Pipeline B

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	24 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	21,600.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	4.77	1,345.00	1,280.83	64.17	0.00	64.17	2.97

24" - 1508

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Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipeline B

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,280.83	28.47	15.00000	65.83

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Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,345.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline B

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,345.00	N/A	15.00000

30" - 15cfs

Detailed Report for Pipe: Pipeline B

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	30 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	21,600.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	3.06	1,345.00	1,323.35	21.65	0.00	21.65	1.00

30" - 15cfs

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes

Pipeline B

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,323.35	46.86	15.00000	108.35

30" - 15cfs

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,345.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline B

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,345.00	N/A	15.00000

36"-15cfs

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Detailed Report for Pipe: Pipeline B

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	36 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	21,600.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	2.12	1,345.00	1,336.09	8.91	0.00	8.91	0.41

36" - 15cfs

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes

Pipeline B

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,336.09	52.36	15.00000	121.09

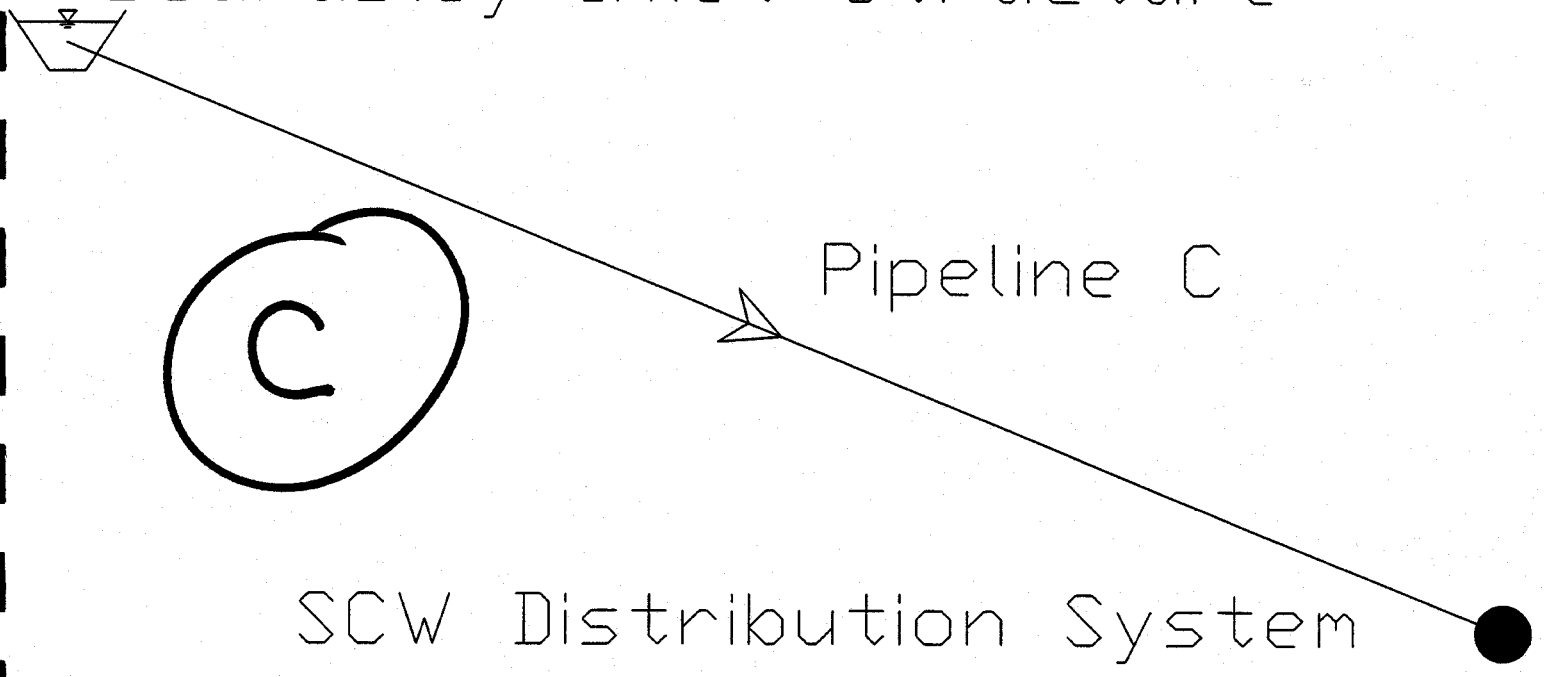
36 11-15-00

Pipe Size (in)	Flow Rate (cfs)	Head @ End (ft)	Pressure @ End (psi)
24	9.1	1316.54	43.91
24	15	1277.83	27.17
30	15	1320.35	45.56
36	15	1333.09	51.07

CWS = 1342.0
Elev @ End = 1215

Static Pressure = 55 psi

Beardsley Inlet Structure



Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes

Pipeline C

Demand Summary

Type	Demand (cfs)	Pattern
Demand	9.10000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,316.54	43.91	9.10000	101.54

24-9.1

Detailed Report for Pipe: Pipeline C

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	24 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	21,600.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	9.10000	2.90	1,342.00	1,316.54	25.46	0.00	25.46	1.18

24-9.1

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,342.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline C

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,342.00	N/A	9.10000

24-9.1

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipeline C

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,277.83	27.17	15.00000	62.83

24-15

Detailed Report for Pipe: Pipeline C

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	24 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	21,600.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	4.77	1,342.00	1,277.83	64.17	0.00	64.17	2.97

24-15

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,342.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline C

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,342.00	N/A	15.00000

24-15

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Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipeline C

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,320.35	45.56	15.00000	105.35

30-15

Detailed Report for Pipe: Pipeline C

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	30 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	21,600.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	3.06	1,342.00	1,320.35	21.65	0.00	21.65	1.00

20-15

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,342.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline C

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,342.00	N/A	15.00000

30-15

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipeline C

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,333.09	51.07	15.00000	118.09

36-15

Detailed Report for Pipe: Pipeline C

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	36 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	21,600.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	2.12	1,342.00	1,333.09	8.91	0.00	8.91	0.41

36-15

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Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,342.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline C

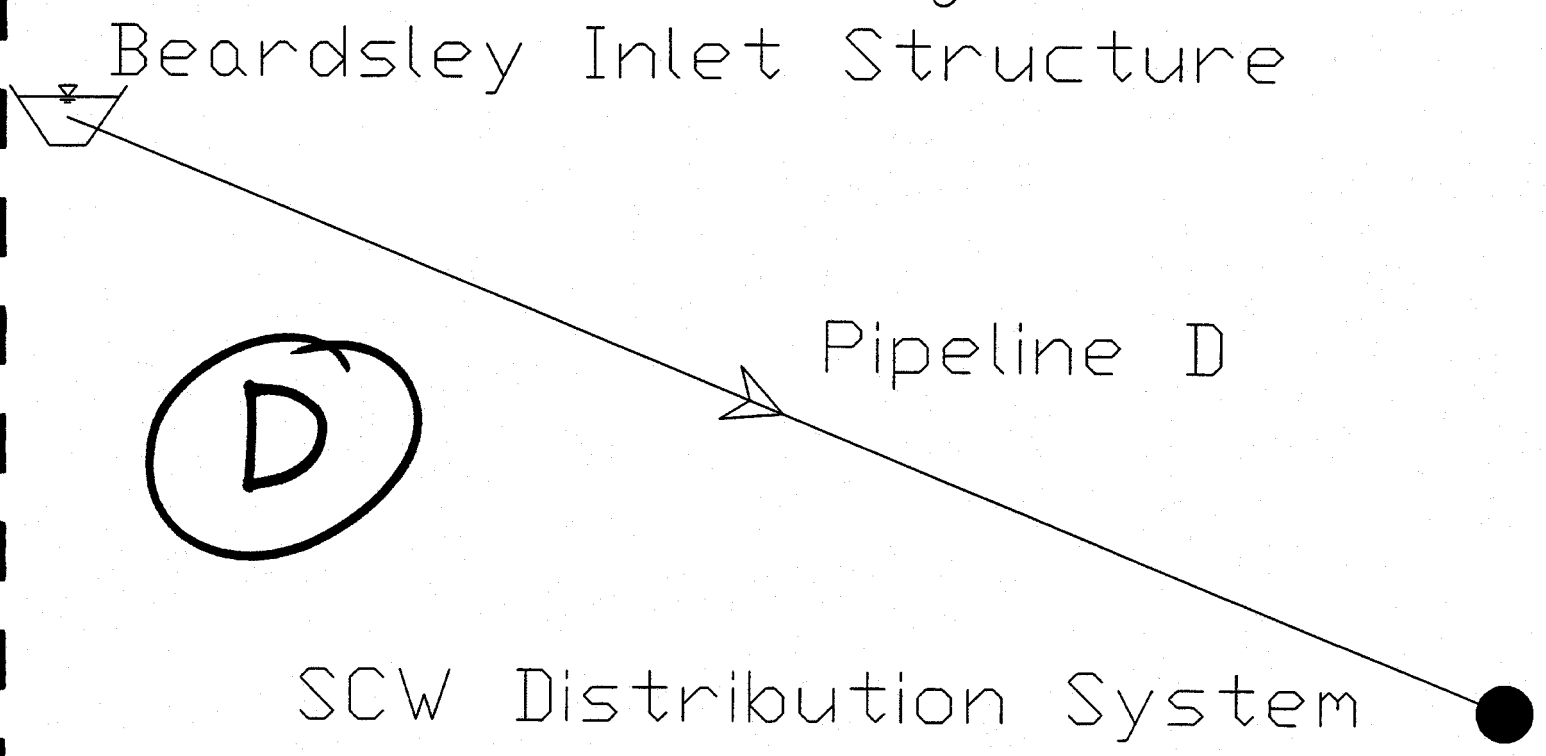
Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,342.00	N/A	15.00000

36-15

Pipe Size (in)	Flow Rate (CFS)	Head @ End (ft)	Pressure @ End (psi)
24	9.1	1304.44	38.68
24	15	1238.19	10.03
30	15	1310.96	41.50
36	15	1332.76	50.92

CWS Elev = 1338
Elev. @ End = 1215
Static Pressure = 53 psi



Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes

Pipeline D

Demand Summary

Type	Demand (cfs)	Pattern
Demand	9.10000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,304.44	38.68	9.10000	89.44

24-9.1

Detailed Report for Pipe: Pipeline D

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	24 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	36,960.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	9.10000	2.90	1,348.00	1,304.44	43.56	0.00	43.56	1.18

24-9.1

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,348.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline D

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,348.00	N/A	9.10000

24-9.1

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes

Pipeline D

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,238.19	10.03	15.00000	23.19

24-15

Detailed Report for Pipe: Pipeline D

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	24 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	36,960.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	4.77	1,348.00	1,238.19	109.81	0.00	109.81	2.97

24-15

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,348.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline D

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,348.00	N/A	15.00000

24-15

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipeline D

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,310.96	41.50	15.00000	95.96

30-15

Detailed Report for Pipe: Pipeline D

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	30 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	36,960.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	3.06	1,348.00	1,310.96	37.04	0.00	37.04	1.00

30-15

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,348.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline D

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,348.00	N/A	15.00000

30-15

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,215.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipeline D

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,332.76	50.92	15.00000	117.76

36-15

Detailed Report for Pipe: Pipeline D

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	36 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	36,960.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	2.12	1,348.00	1,332.76	15.24	0.00	15.24	0.41

36-15

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,348.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline D

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,348.00	N/A	15.00000

36-15

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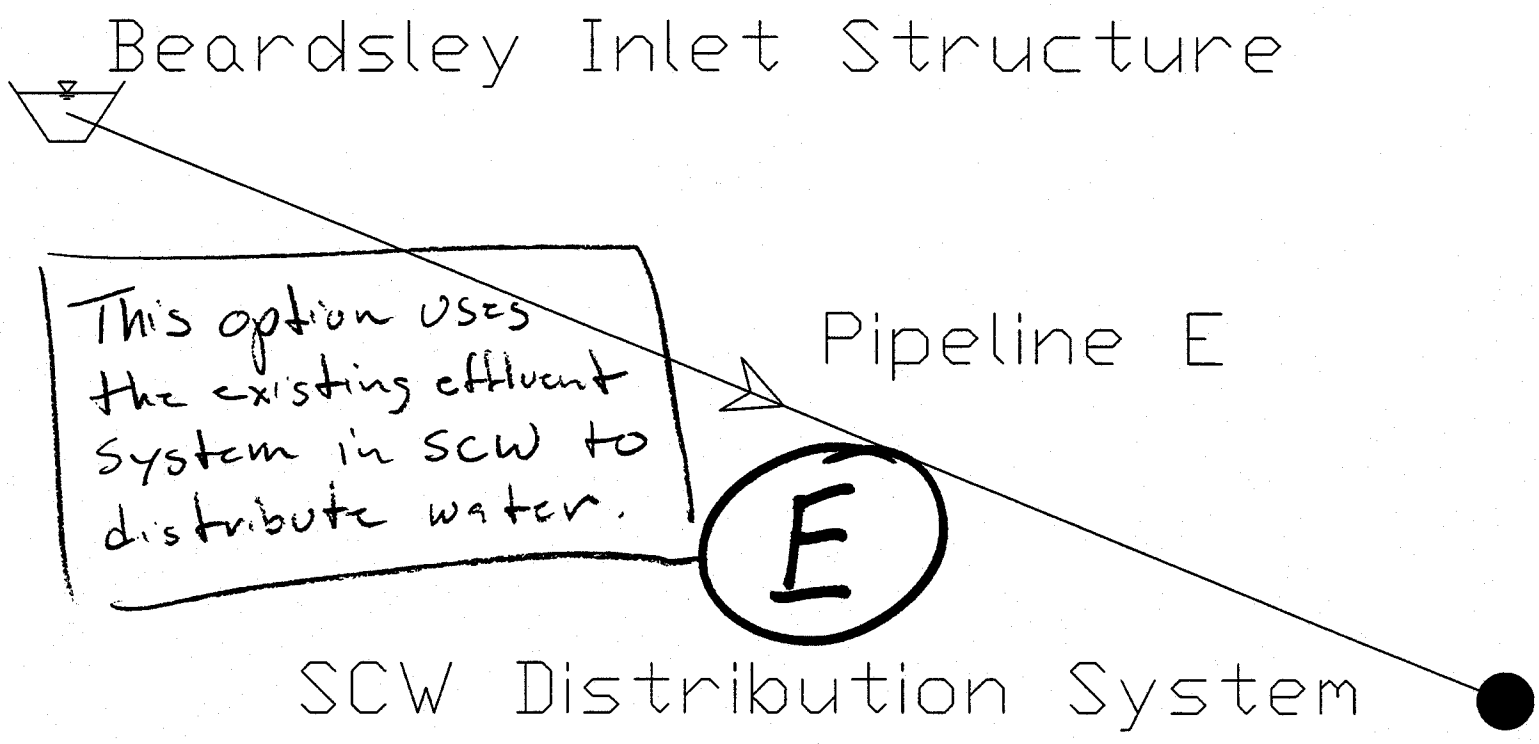
Pipe Size (in)	Flow Rate (cfs)	Head @ End (ft)	Pressure @ End (psi)
24	9.1	1334.00	21.19
24	15	1312.70	11.98
30	15	1336.09	22.09
36	15	1343.10	25.12

CWS Elev. =
Elev. @ End =
Static Pressure =



Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,285.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipeline E

Demand Summary

Type	Demand (cfs)	Pattern
Demand	9.10000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,334.00	21.19	9.10000	49.00

24-9.1

Detailed Report for Pipe: Pipeline E

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	24 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	11,880.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	9.10000	2.90	1,348.00	1,334.00	14.00	0.00	14.00	1.18

24-9.1

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,348.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline E

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,348.00	N/A	9.10000

24-9.1

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,285.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipeline E

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,312.70	11.98	15.00000	27.70

24-15

Detailed Report for Pipe: Pipeline E

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	24 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	11,880.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	4.77	1,348.00	1,312.70	35.30	0.00	35.30	2.97

24-15

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,348.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline E

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,348.00	N/A	15.00000

24-15

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,285.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipeline E

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,336.09	22.09	15.00000	51.09

30-15

Detailed Report for Pipe: Pipeline E

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	30 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	11,880.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	3.06	1,348.00	1,336.09	11.91	0.00	11.91	1.00

30-15

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,348.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes
Pipeline E

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,348.00	N/A	15.00000

30-15

Detailed Report for Junction: SCW Distribution System

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	43.08 ft	Elevation	1,285.00 ft
Y	2.57 ft	Zone	Zone-1

Connecting Pipes
Pipeline E

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.00000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,343.10	25.12	15.00000	58.10

36-15

Detailed Report for Pipe: Pipeline E

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
From Node	Beardsley Inlet Structure	Diameter	36 in
To Node	SCW Distribution System	Material	Ductile Iron
Check Valve	No	Roughness	130.0
Length	11,880.00 ft	Minor Loss	0.00

Initial Condition Summary	
Status	Open

Calculated Results Summary

Time	Status	Constituent (mg/l)	Flow (cfs)	Velocity (ft/s)	From Grade (ft)	To Grade (ft)	Friction Loss (ft)	Minor Loss (ft)	Total Headloss (ft)	Headloss Gradient (ft/1000ft)
0.00 hr	Open	N/A	15.00000	2.12	1,348.00	1,343.10	4.90	0.00	4.90	0.41

36-15

Detailed Report for Reservoir: Beardsley Inlet Structure

Scenario Summary	
Label	Base
Demand Alternative	Base-Average Daily
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-57.24 ft	Hydraulic Grade Line	1,348.00 ft
Y	43.67 ft	Zone	Zone-1

Connecting Pipes

Pipeline E

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,348.00	N/A	15.00000

36-15

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Sun City West with Effluent & 16" Stardust Line

Detailed Report for Reservoir: Alt B

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	11,261.18 ft	Hydraulic Grade Line	1,336.09 ft
Y	65.13 ft	Zone	Zone-1

Connecting Pipes
P-235

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,336.09	N/A	14.83108
1.00 hr	N/A	1,336.09	N/A	14.83106
2.00 hr	N/A	1,336.09	N/A	14.83108
3.00 hr	N/A	1,336.09	N/A	14.83106
4.00 hr	N/A	1,336.09	N/A	15.44694
5.00 hr	N/A	1,336.09	N/A	15.44694
6.00 hr	N/A	1,336.09	N/A	15.44695
7.00 hr	N/A	1,336.09	N/A	15.44695
8.00 hr	N/A	1,336.09	N/A	14.05697
9.00 hr	N/A	1,336.09	N/A	14.05694
10.00 hr	N/A	1,336.09	N/A	14.91430
11.00 hr	N/A	1,336.09	N/A	16.06776
12.00 hr	N/A	1,336.09	N/A	15.59963
13.00 hr	N/A	1,336.09	N/A	15.59963
14.00 hr	N/A	1,336.09	N/A	15.59963
15.00 hr	N/A	1,336.09	N/A	15.59963
16.00 hr	N/A	1,336.09	N/A	14.20963
17.00 hr	N/A	1,336.09	N/A	14.20962
18.00 hr	N/A	1,336.09	N/A	14.80032
19.00 hr	N/A	1,336.09	N/A	14.80031
20.00 hr	N/A	1,336.09	N/A	15.01114
21.00 hr	N/A	1,336.09	N/A	15.01112
22.00 hr	N/A	1,336.09	N/A	15.01114
23.00 hr	N/A	1,336.09	N/A	15.00933
24.00 hr	N/A	1,336.09	N/A	14.83106

Detailed Report for Junction: Briarwood

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-3,749.13 ft	Elevation	1,222.00 ft
Y	-217.82 ft	Zone	Zone-1

Connecting Pipes
P-14
P-201

Demand Summary

Type	Demand (cfs)	Pattern
Demand	26.20000	BW-20hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,176.13	-19.84	1.31000	-45.87
1.00 hr	N/A	1,176.13	-19.84	1.31000	-45.87
2.00 hr	N/A	1,176.13	-19.84	1.31000	-45.87
3.00 hr	N/A	1,176.13	-19.84	1.31000	-45.87
4.00 hr	N/A	1,162.57	-25.70	1.31000	-59.43
5.00 hr	N/A	1,162.57	-25.70	1.31000	-59.43
6.00 hr	N/A	1,162.57	-25.70	1.31000	-59.43
7.00 hr	N/A	1,162.57	-25.70	1.31000	-59.43
8.00 hr	N/A	1,193.48	-12.33	1.31000	-28.52
9.00 hr	N/A	1,193.48	-12.33	1.31000	-28.52
10.00 hr	N/A	1,173.36	-21.03	1.31000	-48.64
11.00 hr	N/A	1,147.28	-32.31	1.31000	-74.72
12.00 hr	N/A	1,158.09	-27.64	1.31000	-63.91
13.00 hr	N/A	1,158.09	-27.64	1.31000	-63.91
14.00 hr	N/A	1,158.09	-27.64	1.31000	-63.91
15.00 hr	N/A	1,158.09	-27.64	1.31000	-63.91
16.00 hr	N/A	1,189.43	-14.09	1.31000	-32.57
17.00 hr	N/A	1,189.43	-14.09	1.31000	-32.57
18.00 hr	N/A	1,176.79	-19.55	1.31000	-45.21
19.00 hr	N/A	1,176.79	-19.55	1.31000	-45.21

Detailed Report for Junction: Briarwood

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,173.32	-21.05	0.00000	-48.68
21.00 hr	N/A	1,173.32	-21.05	0.00000	-48.68
22.00 hr	N/A	1,173.32	-21.05	0.00000	-48.68
23.00 hr	N/A	1,173.35	-21.04	0.01310	-48.65
24.00 hr	N/A	1,176.13	-19.84	1.31000	-45.87

Detailed Report for Junction: Deer Valley 2

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-8,713.71 ft	Elevation	1,270.00 ft
Y	3,942.51 ft	Zone	Zone-1

Connecting Pipes
P-126
P-127

Demand Summary

Type	Demand (cfs)	Pattern
Demand	39.60000	DV-12hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,162.89	-46.32	3.28680	-107.11
1.00 hr	N/A	1,162.89	-46.32	3.28680	-107.11
2.00 hr	N/A	1,162.89	-46.32	3.28680	-107.11
3.00 hr	N/A	1,162.89	-46.32	3.28680	-107.11
4.00 hr	N/A	1,150.53	-51.66	3.28680	-119.47
5.00 hr	N/A	1,150.53	-51.66	3.28680	-119.47
6.00 hr	N/A	1,150.53	-51.66	3.28680	-119.47
7.00 hr	N/A	1,150.53	-51.66	3.28680	-119.47
8.00 hr	N/A	1,180.38	-38.75	3.28680	-89.62
9.00 hr	N/A	1,180.38	-38.75	3.28680	-89.62
10.00 hr	N/A	1,160.89	-47.18	3.28680	-109.11
11.00 hr	N/A	1,132.72	-59.36	3.28680	-137.28
12.00 hr	N/A	1,154.07	-50.13	0.00000	-115.93
13.00 hr	N/A	1,154.07	-50.13	0.00000	-115.93
14.00 hr	N/A	1,154.07	-50.13	0.00000	-115.93
15.00 hr	N/A	1,154.07	-50.13	0.00000	-115.93
16.00 hr	N/A	1,184.35	-37.04	0.00000	-85.65
17.00 hr	N/A	1,184.35	-37.04	0.00000	-85.65
18.00 hr	N/A	1,173.55	-41.71	0.00000	-96.45
19.00 hr	N/A	1,173.55	-41.71	0.00000	-96.45

Detailed Report for Junction: Deer Valley 2

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,166.44	-44.78	0.00000	-103.56
21.00 hr	N/A	1,166.44	-44.78	0.00000	-103.56
22.00 hr	N/A	1,166.44	-44.78	0.00000	-103.56
23.00 hr	N/A	1,166.49	-44.76	0.03287	-103.51
24.00 hr	N/A	1,162.89	-46.32	3.28680	-107.11

Detailed Report for Junction: Desert Trail

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-18,864.10 ft	Elevation	1,280.00 ft
Y	5,285.36 ft	Zone	Zone-1

Connecting Pipes
P-85
P-193

Demand Summary

Type	Demand (cfs)	Pattern
Demand	33.96000	DT-12hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,168.89	-48.05	0.00000	-111.11
1.00 hr	N/A	1,168.89	-48.05	0.00000	-111.11
2.00 hr	N/A	1,168.89	-48.05	0.00000	-111.11
3.00 hr	N/A	1,168.89	-48.05	0.00000	-111.11
4.00 hr	N/A	1,159.00	-52.32	0.00000	-121.00
5.00 hr	N/A	1,159.00	-52.32	0.00000	-121.00
6.00 hr	N/A	1,159.00	-52.32	0.00000	-121.00
7.00 hr	N/A	1,159.00	-52.32	0.00000	-121.00
8.00 hr	N/A	1,188.86	-39.41	0.00000	-91.14
9.00 hr	N/A	1,188.86	-39.41	0.00000	-91.14
10.00 hr	N/A	1,169.27	-47.88	0.00000	-110.73
11.00 hr	N/A	1,138.31	-61.27	0.00000	-141.69
12.00 hr	N/A	1,107.22	-74.72	2.81868	-172.78
13.00 hr	N/A	1,107.22	-74.72	2.81868	-172.78
14.00 hr	N/A	1,107.22	-74.72	2.81868	-172.78
15.00 hr	N/A	1,107.22	-74.72	2.81868	-172.78
16.00 hr	N/A	1,137.49	-61.62	2.81868	-142.51
17.00 hr	N/A	1,137.49	-61.62	2.81868	-142.51
18.00 hr	N/A	1,127.39	-66.00	2.81868	-152.61
19.00 hr	N/A	1,127.39	-66.00	2.81868	-152.61

Detailed Report for Junction: Desert Trail

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,118.03	-70.04	2.81868	-161.97
21.00 hr	N/A	1,118.03	-70.04	2.81868	-161.97
22.00 hr	N/A	1,118.03	-70.04	2.81868	-161.97
23.00 hr	N/A	1,118.83	-69.69	2.79049	-161.17
24.00 hr	N/A	1,168.89	-48.05	0.00000	-111.11

Detailed Report for Junction: Echo Mesa Lake

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-12,834.68 ft	Elevation	1,245.00 ft
Y	-422.63 ft	Zone	Zone-1

Connecting Pipes
P-191
P-192

Demand Summary

Type	Demand (cfs)	Pattern
Demand	21.42000	EM-14hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,170.75	-32.11	1.52082	-74.25
1.00 hr	N/A	1,170.75	-32.11	1.52082	-74.25
2.00 hr	N/A	1,170.75	-32.11	1.52082	-74.25
3.00 hr	N/A	1,170.75	-32.11	1.52082	-74.25
4.00 hr	N/A	1,158.61	-37.36	1.52082	-86.39
5.00 hr	N/A	1,158.61	-37.36	1.52082	-86.39
6.00 hr	N/A	1,158.61	-37.36	1.52082	-86.39
7.00 hr	N/A	1,158.61	-37.36	1.52082	-86.39
8.00 hr	N/A	1,188.46	-24.45	1.52082	-56.54
9.00 hr	N/A	1,188.47	-24.45	1.52082	-56.53
10.00 hr	N/A	1,169.19	-32.78	0.00000	-75.81
11.00 hr	N/A	1,140.47	-45.20	0.00000	-104.53
12.00 hr	N/A	1,149.16	-41.45	0.00000	-95.84
13.00 hr	N/A	1,149.16	-41.45	0.00000	-95.84
14.00 hr	N/A	1,149.16	-41.45	0.00000	-95.84
15.00 hr	N/A	1,149.16	-41.45	0.00000	-95.84
16.00 hr	N/A	1,179.43	-28.35	0.00000	-65.57
17.00 hr	N/A	1,179.43	-28.35	0.00000	-65.57
18.00 hr	N/A	1,169.33	-32.72	0.00000	-75.67
19.00 hr	N/A	1,169.33	-32.72	0.00000	-75.67

Detailed Report for Junction: Echo Mesa Lake

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,159.55	-36.95	1.52082	-85.45
21.00 hr	N/A	1,159.55	-36.95	1.52082	-85.45
22.00 hr	N/A	1,159.55	-36.95	1.52082	-85.45
23.00 hr	N/A	1,159.69	-36.89	1.52082	-85.31
24.00 hr	N/A	1,170.75	-32.11	1.52082	-74.25

Detailed Report for Junction: Effluent Inflow

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	6,752.79 ft	Elevation	1,191.93 ft
Y	48.97 ft	Zone	Zone-1

Connecting Pipes
P-103
P-102

Demand Summary

Type	Demand (cfs)	Pattern
Inflow	3.30000	Fixed

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,201.05	3.94	-3.30000	9.12
1.00 hr	N/A	1,201.05	3.94	-3.30000	9.12
2.00 hr	N/A	1,201.05	3.94	-3.30000	9.12
3.00 hr	N/A	1,201.05	3.94	-3.30000	9.12
4.00 hr	N/A	1,190.39	-0.67	-3.30000	-1.54
5.00 hr	N/A	1,190.39	-0.67	-3.30000	-1.54
6.00 hr	N/A	1,190.39	-0.67	-3.30000	-1.54
7.00 hr	N/A	1,190.39	-0.67	-3.30000	-1.54
8.00 hr	N/A	1,213.91	9.51	-3.30000	21.98
9.00 hr	N/A	1,213.91	9.51	-3.30000	21.98
10.00 hr	N/A	1,199.63	3.33	-3.30000	7.70
11.00 hr	N/A	1,179.27	-5.48	-3.30000	-12.66
12.00 hr	N/A	1,187.69	-1.83	-3.30000	-4.24
13.00 hr	N/A	1,187.69	-1.83	-3.30000	-4.24
14.00 hr	N/A	1,187.69	-1.83	-3.30000	-4.24
15.00 hr	N/A	1,187.69	-1.83	-3.30000	-4.24
16.00 hr	N/A	1,211.42	8.43	-3.30000	19.49
17.00 hr	N/A	1,211.42	8.43	-3.30000	19.49
18.00 hr	N/A	1,201.57	4.17	-3.30000	9.64
19.00 hr	N/A	1,201.57	4.17	-3.30000	9.64

Detailed Report for Junction: Effluent Inflow

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,197.97	2.61	-3.30000	6.04
21.00 hr	N/A	1,197.97	2.61	-3.30000	6.04
22.00 hr	N/A	1,197.97	2.61	-3.30000	6.04
23.00 hr	N/A	1,198.00	2.63	-3.30000	6.07
24.00 hr	N/A	1,201.05	3.94	-3.30000	9.12

Detailed Report for Junction: Grandview Lake

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-14,204.27 ft	Elevation	1,240.00 ft
Y	-4,256.33 ft	Zone	Zone-1

Connecting Pipes
P-219
P-189

Demand Summary

Type	Demand (cfs)	Pattern
Demand	27.58000	GV-14hrs

Grandview Lake

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,172.45	-29.21	0.00000	-67.55
1.00 hr	N/A	1,172.45	-29.21	0.00000	-67.55
2.00 hr	N/A	1,172.45	-29.21	0.00000	-67.55
3.00 hr	N/A	1,172.45	-29.21	0.00000	-67.55
4.00 hr	N/A	1,159.44	-34.84	0.00000	-80.56
5.00 hr	N/A	1,159.44	-34.84	0.00000	-80.56
6.00 hr	N/A	1,159.44	-34.84	0.00000	-80.56
7.00 hr	N/A	1,159.44	-34.84	0.00000	-80.56
8.00 hr	N/A	1,189.29	-21.93	0.00000	-50.71
9.00 hr	N/A	1,189.29	-21.93	0.00000	-50.71
10.00 hr	N/A	1,167.36	-31.41	1.95818	-72.64
11.00 hr	N/A	1,138.91	-43.72	1.95818	-101.09
12.00 hr	N/A	1,147.71	-39.91	1.95818	-92.29
13.00 hr	N/A	1,147.71	-39.91	1.95818	-92.29
14.00 hr	N/A	1,147.71	-39.91	1.95818	-92.29
15.00 hr	N/A	1,147.71	-39.91	1.95818	-92.29
16.00 hr	N/A	1,177.99	-26.82	1.95818	-62.01
17.00 hr	N/A	1,177.99	-26.82	1.95818	-62.01

Detailed Report for Junction: Grandview Lake

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
18.00 hr	N/A	1,167.93	-31.16	1.95818	-72.07
19.00 hr	N/A	1,167.93	-31.16	1.95818	-72.07
20.00 hr	N/A	1,158.74	-35.14	1.95818	-81.26
21.00 hr	N/A	1,158.74	-35.14	1.95818	-81.26
22.00 hr	N/A	1,158.74	-35.14	1.95818	-81.26
23.00 hr	N/A	1,158.92	-35.06	1.93860	-81.08
24.00 hr	N/A	1,172.45	-29.21	0.00000	-67.55

Detailed Report for Junction: Hillcreast Lake

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-7,273.22 ft	Elevation	1,249.17 ft
Y	-509.42 ft	Zone	Zone-1

Connecting Pipes
P-24
P-174

Demand Summary

Type	Demand (cfs)	Pattern
Demand	27.80000	HC-20hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,174.24	-32.40	1.39000	-74.93
1.00 hr	N/A	1,174.24	-32.40	1.39000	-74.93
2.00 hr	N/A	1,174.24	-32.40	1.39000	-74.93
3.00 hr	N/A	1,174.24	-32.40	1.39000	-74.93
4.00 hr	N/A	1,160.68	-38.27	1.39000	-88.49
5.00 hr	N/A	1,160.68	-38.27	1.39000	-88.49
6.00 hr	N/A	1,160.68	-38.27	1.39000	-88.49
7.00 hr	N/A	1,160.68	-38.27	1.39000	-88.49
8.00 hr	N/A	1,193.57	-24.04	0.00000	-55.60
9.00 hr	N/A	1,193.57	-24.04	0.00000	-55.60
10.00 hr	N/A	1,171.47	-33.60	1.39000	-77.70
11.00 hr	N/A	1,145.40	-44.88	1.39000	-103.77
12.00 hr	N/A	1,156.20	-40.20	1.39000	-92.97
13.00 hr	N/A	1,156.20	-40.20	1.39000	-92.97
14.00 hr	N/A	1,156.20	-40.20	1.39000	-92.97
15.00 hr	N/A	1,156.20	-40.20	1.39000	-92.97
16.00 hr	N/A	1,189.52	-25.80	0.00000	-59.65
17.00 hr	N/A	1,189.52	-25.80	0.00000	-59.65
18.00 hr	N/A	1,174.91	-32.11	1.39000	-74.26
19.00 hr	N/A	1,174.91	-32.11	1.39000	-74.26

Detailed Report for Junction: Hillcreast Lake

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,171.35	-33.65	1.39000	-77.82
21.00 hr	N/A	1,171.35	-33.65	1.39000	-77.82
22.00 hr	N/A	1,171.35	-33.65	1.39000	-77.82
23.00 hr	N/A	1,171.38	-33.64	1.39000	-77.79
24.00 hr	N/A	1,174.24	-32.40	1.39000	-74.93

Detailed Report for Junction: Pebblebrook Lake

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-2,176.08 ft	Elevation	1,190.00 ft
Y	-4,253.92 ft	Zone	Zone-1

Connecting Pipes
P-218
P-190

Demand Summary

Type	Demand (cfs)	Pattern
Demand	24.92000	PB-14hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,176.46	-5.86	0.00000	-13.54
1.00 hr	N/A	1,176.46	-5.86	0.00000	-13.54
2.00 hr	N/A	1,176.46	-5.86	0.00000	-13.54
3.00 hr	N/A	1,176.46	-5.86	0.00000	-13.54
4.00 hr	N/A	1,160.75	-12.65	1.76932	-29.25
5.00 hr	N/A	1,160.75	-12.65	1.76932	-29.25
6.00 hr	N/A	1,160.75	-12.65	1.76932	-29.25
7.00 hr	N/A	1,160.75	-12.65	1.76932	-29.25
8.00 hr	N/A	1,190.61	0.26	1.76932	0.61
9.00 hr	N/A	1,190.61	0.26	1.76932	0.61
10.00 hr	N/A	1,170.94	-8.24	1.76932	-19.06
11.00 hr	N/A	1,143.96	-19.91	1.76932	-46.04
12.00 hr	N/A	1,154.05	-15.54	1.76932	-35.95
13.00 hr	N/A	1,154.05	-15.54	1.76932	-35.95
14.00 hr	N/A	1,154.05	-15.54	1.76932	-35.95
15.00 hr	N/A	1,154.05	-15.54	1.76932	-35.95
16.00 hr	N/A	1,184.33	-2.45	1.76932	-5.67
17.00 hr	N/A	1,184.33	-2.45	1.76932	-5.67
18.00 hr	N/A	1,176.25	-5.94	0.00000	-13.75
19.00 hr	N/A	1,176.26	-5.94	0.00000	-13.74

Detailed Report for Junction: Pebblebrook Lake

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,170.62	-8.38	0.00000	-19.38
21.00 hr	N/A	1,170.62	-8.38	0.00000	-19.38
22.00 hr	N/A	1,170.62	-8.38	0.00000	-19.38
23.00 hr	N/A	1,170.68	-8.35	0.00000	-19.32
24.00 hr	N/A	1,176.46	-5.86	0.00000	-13.54

Detailed Report for Junction: Stardust

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-582.30 ft	Elevation	1,213.46 ft
Y	2,027.93 ft	Zone	Zone-1

Connecting Pipes
P-177
P-178

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.52000	SD-16hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,180.89	-14.09	0.97000	-32.57
1.00 hr	N/A	1,180.89	-14.08	0.97000	-32.57
2.00 hr	N/A	1,180.89	-14.09	0.97000	-32.57
3.00 hr	N/A	1,180.89	-14.08	0.97000	-32.57
4.00 hr	N/A	1,167.93	-19.69	0.97000	-45.53
5.00 hr	N/A	1,167.93	-19.69	0.97000	-45.53
6.00 hr	N/A	1,167.93	-19.69	0.97000	-45.53
7.00 hr	N/A	1,167.93	-19.69	0.97000	-45.53
8.00 hr	N/A	1,196.47	-7.35	0.97000	-16.99
9.00 hr	N/A	1,196.47	-7.35	0.97000	-16.99
10.00 hr	N/A	1,180.37	-14.31	0.00000	-33.09
11.00 hr	N/A	1,155.56	-25.04	0.00000	-57.90
12.00 hr	N/A	1,165.84	-20.59	0.00000	-47.62
13.00 hr	N/A	1,165.84	-20.59	0.00000	-47.62
14.00 hr	N/A	1,165.84	-20.59	0.00000	-47.62
15.00 hr	N/A	1,165.84	-20.59	0.00000	-47.62
16.00 hr	N/A	1,194.66	-8.13	0.00000	-18.80
17.00 hr	N/A	1,194.66	-8.13	0.00000	-18.80
18.00 hr	N/A	1,181.52	-13.81	0.97000	-31.94
19.00 hr	N/A	1,181.52	-13.81	0.97000	-31.94

Detailed Report for Junction: Stardust

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,177.15	-15.70	0.97000	-36.31
21.00 hr	N/A	1,177.15	-15.70	0.97000	-36.31
22.00 hr	N/A	1,177.15	-15.70	0.97000	-36.31
23.00 hr	N/A	1,177.19	-15.69	0.97000	-36.27
24.00 hr	N/A	1,180.89	-14.08	0.97000	-32.57

Sun City

Detailed Report for Reservoir: Alt B

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	8,765.71 ft	Hydraulic Grade Line	1,336.09 ft
Y	174.86 ft	Zone	Zone-1

Connecting Pipes
P-235

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,336.09	N/A	10.34425
1.00 hr	N/A	1,336.09	N/A	9.01375
2.00 hr	N/A	1,336.09	N/A	10.94591
3.00 hr	N/A	1,336.09	N/A	10.94592
4.00 hr	N/A	1,336.09	N/A	10.94591
5.00 hr	N/A	1,336.09	N/A	11.63136
6.00 hr	N/A	1,336.09	N/A	11.63136
7.00 hr	N/A	1,336.09	N/A	11.60426
8.00 hr	N/A	1,336.09	N/A	10.21426
9.00 hr	N/A	1,336.09	N/A	11.61424
10.00 hr	N/A	1,336.09	N/A	11.61425
11.00 hr	N/A	1,336.09	N/A	11.61425
12.00 hr	N/A	1,336.09	N/A	11.61425
13.00 hr	N/A	1,336.09	N/A	11.61425
14.00 hr	N/A	1,336.09	N/A	11.61425
15.00 hr	N/A	1,336.09	N/A	11.61425
16.00 hr	N/A	1,336.09	N/A	10.88426
17.00 hr	N/A	1,336.09	N/A	10.88425
18.00 hr	N/A	1,336.09	N/A	10.88425
19.00 hr	N/A	1,336.09	N/A	14.01020
20.00 hr	N/A	1,336.09	N/A	11.09919
21.00 hr	N/A	1,336.09	N/A	11.09918
22.00 hr	N/A	1,336.09	N/A	11.09918
23.00 hr	N/A	1,336.09	N/A	10.34424
24.00 hr	N/A	1,336.09	N/A	9.01376

Detailed Report for Junction: Willowbrook

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	10,718.14 ft	Elevation	1,195.00 ft
Y	-7,066.23 ft	Zone	Zone-1

Connecting Pipes
P-204
P-205

Demand Summary

Type	Demand (cfs)	Pattern
Demand	36.18000	WB-2.01

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,316.11	52.37	0.00000	121.11
1.00 hr	N/A	1,320.60	54.31	0.00000	125.60
2.00 hr	N/A	1,314.92	51.86	2.02608	119.92
3.00 hr	N/A	1,314.92	51.86	2.02608	119.92
4.00 hr	N/A	1,314.92	51.86	2.02608	119.92
5.00 hr	N/A	1,312.42	50.78	2.02608	117.42
6.00 hr	N/A	1,312.42	50.78	2.02608	117.42
7.00 hr	N/A	1,312.53	50.82	2.02608	117.53
8.00 hr	N/A	1,317.44	52.95	2.02608	122.44
9.00 hr	N/A	1,312.49	50.81	2.02608	117.49
10.00 hr	N/A	1,312.49	50.81	2.02608	117.49
11.00 hr	N/A	1,312.49	50.81	2.02608	117.49
12.00 hr	N/A	1,312.49	50.81	2.02608	117.49
13.00 hr	N/A	1,312.49	50.81	2.02608	117.49
14.00 hr	N/A	1,312.49	50.81	2.02608	117.49
15.00 hr	N/A	1,312.49	50.81	2.02608	117.49
16.00 hr	N/A	1,315.14	51.95	2.02608	120.14
17.00 hr	N/A	1,315.14	51.95	2.02608	120.14
18.00 hr	N/A	1,315.14	51.95	2.02608	120.14
19.00 hr	N/A	1,302.70	46.57	2.02608	107.70

Detailed Report for Junction: Willowbrook

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,313.32	51.17	0.00000	118.32
21.00 hr	N/A	1,313.32	51.17	0.00000	118.32
22.00 hr	N/A	1,313.32	51.17	0.00000	118.32
23.00 hr	N/A	1,316.11	52.37	0.00000	121.11
24.00 hr	N/A	1,320.60	54.31	0.00000	125.60

Detailed Report for Junction: Willowcreek

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	12,931.82 ft	Elevation	1,196.00 ft
Y	-3,661.23 ft	Zone	Zone-1

Connecting Pipes
P-197
P-198

Demand Summary

Type	Demand (cfs)	Pattern
Demand	36.18000	WC-2.01

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,322.94	54.89	0.00000	126.94
1.00 hr	N/A	1,325.89	56.17	0.00000	129.89
2.00 hr	N/A	1,312.22	50.26	2.02608	116.22
3.00 hr	N/A	1,312.22	50.26	2.02608	116.22
4.00 hr	N/A	1,312.22	50.26	2.02608	116.22
5.00 hr	N/A	1,310.48	49.51	2.02608	114.48
6.00 hr	N/A	1,310.48	49.51	2.02608	114.48
7.00 hr	N/A	1,310.55	49.54	2.02608	114.55
8.00 hr	N/A	1,313.98	51.02	2.02608	117.98
9.00 hr	N/A	1,310.53	49.53	2.02608	114.53
10.00 hr	N/A	1,310.53	49.53	2.02608	114.53
11.00 hr	N/A	1,310.53	49.53	2.02608	114.53
12.00 hr	N/A	1,310.53	49.53	2.02608	114.53
13.00 hr	N/A	1,310.53	49.53	2.02608	114.53
14.00 hr	N/A	1,310.53	49.53	2.02608	114.53
15.00 hr	N/A	1,310.53	49.53	2.02608	114.53
16.00 hr	N/A	1,312.37	50.32	2.02608	116.37
17.00 hr	N/A	1,312.37	50.32	2.02608	116.37
18.00 hr	N/A	1,312.37	50.32	2.02608	116.37
19.00 hr	N/A	1,303.77	46.60	2.02608	107.77

Detailed Report for Junction: Willowcreek

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,321.10	54.10	0.00000	125.10
21.00 hr	N/A	1,321.10	54.10	0.00000	125.10
22.00 hr	N/A	1,321.10	54.10	0.00000	125.10
23.00 hr	N/A	1,322.94	54.89	0.00000	126.94
24.00 hr	N/A	1,325.89	56.17	0.00000	129.89

Detailed Report for Junction: Lakes West

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	11,686.61 ft	Elevation	1,186.00 ft
Y	-18,025.82 ft	Zone	Zone-1

Connecting Pipes
P-139
P-208

Demand Summary

Type	Demand (cfs)	Pattern
Demand	46.80000	LW-1.95

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,228.54	18.40	1.96560	42.54
1.00 hr	N/A	1,253.86	29.35	1.96560	67.86
2.00 hr	N/A	1,277.19	39.43	1.96560	91.19
3.00 hr	N/A	1,277.19	39.43	1.96560	91.19
4.00 hr	N/A	1,277.19	39.43	1.96560	91.19
5.00 hr	N/A	1,268.50	35.68	1.96560	82.50
6.00 hr	N/A	1,268.50	35.68	1.96560	82.50
7.00 hr	N/A	1,265.95	34.57	1.96560	79.95
8.00 hr	N/A	1,286.83	43.60	1.96560	100.83
9.00 hr	N/A	1,265.79	34.50	1.96560	79.79
10.00 hr	N/A	1,265.79	34.50	1.96560	79.79
11.00 hr	N/A	1,265.79	34.50	1.96560	79.79
12.00 hr	N/A	1,265.79	34.50	1.96560	79.79
13.00 hr	N/A	1,265.79	34.50	1.96560	79.79
14.00 hr	N/A	1,265.79	34.50	1.96560	79.79
15.00 hr	N/A	1,265.79	34.50	1.96560	79.79
16.00 hr	N/A	1,277.22	39.45	1.96560	91.22
17.00 hr	N/A	1,277.22	39.45	1.96560	91.22
18.00 hr	N/A	1,277.22	39.45	1.96560	91.22
19.00 hr	N/A	1,225.61	17.13	1.96560	39.61

Detailed Report for Junction: Lakes West

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,215.93	12.94	1.96560	29.93
21.00 hr	N/A	1,215.93	12.94	1.96560	29.93
22.00 hr	N/A	1,215.93	12.94	1.96560	29.93
23.00 hr	N/A	1,228.54	18.40	1.96560	42.54
24.00 hr	N/A	1,253.86	29.35	1.96560	67.86

Detailed Report for Junction: Lakes East

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	16,302.99 ft	Elevation	1,186.00 ft
Y	-22,309.75 ft	Zone	Zone-1

Connecting Pipes
P-206
P-209

Demand Summary

Type	Demand (cfs)	Pattern
Demand	32.40000	LE-1.35

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,239.08	22.95	1.36080	53.08
1.00 hr	N/A	1,258.95	31.55	1.36080	72.95
2.00 hr	N/A	1,275.38	38.65	1.36080	89.38
3.00 hr	N/A	1,275.38	38.65	1.36080	89.38
4.00 hr	N/A	1,275.38	38.65	1.36080	89.38
5.00 hr	N/A	1,266.41	34.77	1.36080	80.41
6.00 hr	N/A	1,266.41	34.77	1.36080	80.41
7.00 hr	N/A	1,266.76	34.92	1.36080	80.76
8.00 hr	N/A	1,283.66	42.23	1.36080	97.66
9.00 hr	N/A	1,266.63	34.87	1.36080	80.63
10.00 hr	N/A	1,266.63	34.87	1.36080	80.63
11.00 hr	N/A	1,266.63	34.87	1.36080	80.63
12.00 hr	N/A	1,266.63	34.87	1.36080	80.63
13.00 hr	N/A	1,266.63	34.87	1.36080	80.63
14.00 hr	N/A	1,266.63	34.87	1.36080	80.63
15.00 hr	N/A	1,266.63	34.87	1.36080	80.63
16.00 hr	N/A	1,275.84	38.85	1.36080	89.84
17.00 hr	N/A	1,275.84	38.85	1.36080	89.84
18.00 hr	N/A	1,275.84	38.85	1.36080	89.84
19.00 hr	N/A	1,231.40	19.63	1.36080	45.40

Detailed Report for Junction: Lakes East

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,226.49	17.51	1.36080	40.49
21.00 hr	N/A	1,226.49	17.51	1.36080	40.49
22.00 hr	N/A	1,226.49	17.51	1.36080	40.49
23.00 hr	N/A	1,239.08	22.95	1.36080	53.08
24.00 hr	N/A	1,258.95	31.55	1.36080	72.95

Detailed Report for Junction: Maricopa Lake

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	6,020.15 ft	Elevation	1,200.00 ft
Y	-30,014.66 ft	Zone	Zone-1

Connecting Pipes
P-157
P-214

Demand Summary

Type	Demand (cfs)	Pattern
Demand	0.72000	ML-.03

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,193.51	-2.81	0.03024	-6.49
1.00 hr	N/A	1,231.58	13.65	0.03024	31.58
2.00 hr	N/A	1,269.54	30.07	0.03024	69.54
3.00 hr	N/A	1,269.54	30.07	0.03024	69.54
4.00 hr	N/A	1,269.54	30.07	0.03024	69.54
5.00 hr	N/A	1,260.85	26.31	0.03024	60.85
6.00 hr	N/A	1,260.85	26.31	0.03024	60.85
7.00 hr	N/A	1,252.45	22.68	0.03024	52.45
8.00 hr	N/A	1,281.82	35.38	0.03024	81.82
9.00 hr	N/A	1,252.89	22.87	0.03024	52.89
10.00 hr	N/A	1,252.89	22.87	0.03024	52.89
11.00 hr	N/A	1,252.89	22.87	0.03024	52.89
12.00 hr	N/A	1,252.89	22.87	0.03024	52.89
13.00 hr	N/A	1,252.89	22.87	0.03024	52.89
14.00 hr	N/A	1,252.89	22.87	0.03024	52.89
15.00 hr	N/A	1,252.89	22.87	0.03024	52.89
16.00 hr	N/A	1,268.18	29.48	0.03024	68.18
17.00 hr	N/A	1,268.18	29.48	0.03024	68.18
18.00 hr	N/A	1,268.18	29.48	0.03024	68.18
19.00 hr	N/A	1,201.04	0.45	0.03024	1.04

Detailed Report for Junction: Maricopa Lake

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,180.09	-8.61	0.03024	-19.91
21.00 hr	N/A	1,180.09	-8.61	0.03024	-19.91
22.00 hr	N/A	1,180.09	-8.61	0.03024	-19.91
23.00 hr	N/A	1,193.51	-2.81	0.03024	-6.49
24.00 hr	N/A	1,231.58	13.65	0.03024	31.58

Detailed Report for Junction: North

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	12,932.68 ft	Elevation	1,183.00 ft
Y	-29,650.60 ft	Zone	Zone-1

Connecting Pipes
P-212
P-215

Demand Summary

Type	Demand (cfs)	Pattern
Demand	33.92000	NO-2.12

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,190.04	3.05	2.12000	7.04
1.00 hr	N/A	1,230.00	20.32	2.12000	47.00
2.00 hr	N/A	1,269.93	37.59	0.00000	86.93
3.00 hr	N/A	1,269.93	37.59	0.00000	86.93
4.00 hr	N/A	1,269.93	37.59	0.00000	86.93
5.00 hr	N/A	1,261.24	33.83	0.00000	78.24
6.00 hr	N/A	1,261.24	33.83	0.00000	78.24
7.00 hr	N/A	1,251.94	29.81	2.12000	68.94
8.00 hr	N/A	1,280.65	42.23	2.12000	97.65
9.00 hr	N/A	1,250.35	29.12	2.12000	67.35
10.00 hr	N/A	1,250.35	29.12	2.12000	67.35
11.00 hr	N/A	1,250.35	29.12	2.12000	67.35
12.00 hr	N/A	1,250.35	29.12	2.12000	67.35
13.00 hr	N/A	1,250.35	29.12	2.12000	67.35
14.00 hr	N/A	1,250.35	29.12	2.12000	67.35
15.00 hr	N/A	1,250.35	29.12	2.12000	67.35
16.00 hr	N/A	1,268.44	36.95	0.00000	85.44
17.00 hr	N/A	1,268.44	36.95	0.00000	85.44
18.00 hr	N/A	1,268.44	36.95	0.00000	85.44
19.00 hr	N/A	1,199.17	6.99	2.12000	16.17

Detailed Report for Junction: North

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,176.69	-2.73	2.12000	-6.31
21.00 hr	N/A	1,176.69	-2.73	2.12000	-6.31
22.00 hr	N/A	1,176.69	-2.73	2.12000	-6.31
23.00 hr	N/A	1,190.04	3.05	2.12000	7.04
24.00 hr	N/A	1,230.00	20.32	2.12000	47.00

Detailed Report for Junction: Quail Run

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	16,538.27 ft	Elevation	1,182.00 ft
Y	-31,030.00 ft	Zone	Zone-1

Connecting Pipes
P-216
P-226

Demand Summary

Type	Demand (cfs)	Pattern
Demand	12.54000	QR-.1.14

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,186.78	2.07	1.14114	4.78
1.00 hr	N/A	1,227.73	19.78	1.14114	45.73
2.00 hr	N/A	1,267.36	36.91	1.14114	85.36
3.00 hr	N/A	1,267.36	36.91	1.14114	85.36
4.00 hr	N/A	1,267.36	36.91	1.14114	85.36
5.00 hr	N/A	1,258.68	33.16	1.14114	76.68
6.00 hr	N/A	1,258.68	33.16	1.14114	76.68
7.00 hr	N/A	1,252.24	30.37	0.00000	70.24
8.00 hr	N/A	1,280.95	42.79	0.00000	98.95
9.00 hr	N/A	1,250.21	29.50	0.00000	68.21
10.00 hr	N/A	1,250.21	29.50	0.00000	68.21
11.00 hr	N/A	1,250.21	29.50	0.00000	68.21
12.00 hr	N/A	1,250.21	29.50	0.00000	68.21
13.00 hr	N/A	1,250.21	29.50	0.00000	68.21
14.00 hr	N/A	1,250.21	29.50	0.00000	68.21
15.00 hr	N/A	1,250.21	29.50	0.00000	68.21
16.00 hr	N/A	1,268.01	37.19	0.00000	86.01
17.00 hr	N/A	1,268.01	37.19	0.00000	86.01
18.00 hr	N/A	1,268.01	37.19	0.00000	86.01
19.00 hr	N/A	1,199.04	7.37	0.00000	17.04

Detailed Report for Junction: Quail Run

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,173.43	-3.71	1.14114	-8.57
21.00 hr	N/A	1,173.43	-3.71	1.14114	-8.57
22.00 hr	N/A	1,173.43	-3.71	1.14114	-8.57
23.00 hr	N/A	1,186.78	2.07	1.14114	4.78
24.00 hr	N/A	1,227.73	19.78	1.14114	45.73

Detailed Report for Junction: Riverview (East)

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	12,983.18 ft	Elevation	1,188.00 ft
Y	-14,120.02 ft	Zone	Zone-1

Connecting Pipes
P-233
P-234

Demand Summary

Type	Demand (cfs)	Pattern
Demand	12.24000	RVE-.68

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,247.45	25.71	0.00000	59.45
1.00 hr	N/A	1,267.33	34.30	0.00000	79.33
2.00 hr	N/A	1,283.76	41.41	0.00000	95.76
3.00 hr	N/A	1,283.76	41.41	0.00000	95.76
4.00 hr	N/A	1,283.76	41.41	0.00000	95.76
5.00 hr	N/A	1,274.76	37.52	0.68544	86.76
6.00 hr	N/A	1,274.76	37.52	0.68544	86.76
7.00 hr	N/A	1,275.11	37.67	0.68544	87.11
8.00 hr	N/A	1,292.01	44.98	0.68544	104.01
9.00 hr	N/A	1,274.98	37.61	0.68544	86.98
10.00 hr	N/A	1,274.98	37.61	0.68544	86.98
11.00 hr	N/A	1,274.98	37.61	0.68544	86.98
12.00 hr	N/A	1,274.98	37.61	0.68544	86.98
13.00 hr	N/A	1,274.98	37.61	0.68544	86.98
14.00 hr	N/A	1,274.98	37.61	0.68544	86.98
15.00 hr	N/A	1,274.98	37.61	0.68544	86.98
16.00 hr	N/A	1,284.19	41.60	0.68544	96.19
17.00 hr	N/A	1,284.19	41.60	0.68544	96.19
18.00 hr	N/A	1,284.19	41.60	0.68544	96.19
19.00 hr	N/A	1,239.75	22.38	0.68544	51.75

Detailed Report for Junction: Riverview (East)

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,234.84	20.26	0.68544	46.84
21.00 hr	N/A	1,234.84	20.26	0.68544	46.84
22.00 hr	N/A	1,234.84	20.26	0.68544	46.84
23.00 hr	N/A	1,247.45	25.71	0.00000	59.45
24.00 hr	N/A	1,267.33	34.30	0.00000	79.33

Detailed Report for Junction: Riverview (West)

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	8,873.60 ft	Elevation	1,187.00 ft
Y	-15,280.96 ft	Zone	Zone-1

Connecting Pipes
P-130
P-187

Demand Summary

Type	Demand (cfs)	Pattern
Demand	12.12000	RVW-1.01

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,246.11	25.56	1.00596	59.11
1.00 hr	N/A	1,265.99	34.16	1.00596	78.99
2.00 hr	N/A	1,282.42	41.26	1.00596	95.42
3.00 hr	N/A	1,282.42	41.26	1.00596	95.42
4.00 hr	N/A	1,282.42	41.26	1.00596	95.42
5.00 hr	N/A	1,273.73	37.50	1.00596	86.73
6.00 hr	N/A	1,273.73	37.50	1.00596	86.73
7.00 hr	N/A	1,275.68	38.35	0.00000	88.68
8.00 hr	N/A	1,292.57	45.65	0.00000	105.57
9.00 hr	N/A	1,275.54	38.29	0.00000	88.54
10.00 hr	N/A	1,275.54	38.29	0.00000	88.54
11.00 hr	N/A	1,275.54	38.29	0.00000	88.54
12.00 hr	N/A	1,275.54	38.29	0.00000	88.54
13.00 hr	N/A	1,275.54	38.29	0.00000	88.54
14.00 hr	N/A	1,275.54	38.29	0.00000	88.54
15.00 hr	N/A	1,275.54	38.29	0.00000	88.54
16.00 hr	N/A	1,284.76	42.27	0.00000	97.76
17.00 hr	N/A	1,284.76	42.27	0.00000	97.76
18.00 hr	N/A	1,284.76	42.27	0.00000	97.76
19.00 hr	N/A	1,238.72	22.37	1.00596	51.72

Detailed Report for Junction: Riverview (West)

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,233.81	20.24	1.00596	46.81
21.00 hr	N/A	1,233.81	20.24	1.00596	46.81
22.00 hr	N/A	1,233.81	20.24	1.00596	46.81
23.00 hr	N/A	1,246.11	25.56	1.00596	59.11
24.00 hr	N/A	1,265.99	34.16	1.00596	78.99

Detailed Report for Junction: South (East)

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	13,854.66 ft	Elevation	1,183.00 ft
Y	-34,475.57 ft	Zone	Zone-1

Connecting Pipes
P-227
P-228

Demand Summary

Type	Demand (cfs)	Pattern
Demand	22.40000	SE-1.4

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,184.49	0.65	1.40000	1.49
1.00 hr	N/A	1,230.00	20.33	0.00000	47.00
2.00 hr	N/A	1,269.64	37.46	0.00000	86.64
3.00 hr	N/A	1,269.64	37.46	0.00000	86.64
4.00 hr	N/A	1,269.64	37.46	0.00000	86.64
5.00 hr	N/A	1,260.95	33.71	0.00000	77.95
6.00 hr	N/A	1,260.95	33.71	0.00000	77.95
7.00 hr	N/A	1,252.24	29.94	0.00000	69.24
8.00 hr	N/A	1,280.95	42.36	0.00000	97.95
9.00 hr	N/A	1,245.66	27.10	1.40000	62.66
10.00 hr	N/A	1,245.66	27.10	1.40000	62.66
11.00 hr	N/A	1,245.66	27.10	1.40000	62.66
12.00 hr	N/A	1,245.66	27.10	1.40000	62.66
13.00 hr	N/A	1,245.66	27.10	1.40000	62.66
14.00 hr	N/A	1,245.66	27.10	1.40000	62.66
15.00 hr	N/A	1,245.66	27.10	1.40000	62.66
16.00 hr	N/A	1,263.45	34.79	1.40000	80.45
17.00 hr	N/A	1,263.45	34.79	1.40000	80.45
18.00 hr	N/A	1,263.45	34.79	1.40000	80.45
19.00 hr	N/A	1,194.48	4.96	1.40000	11.48

Detailed Report for Junction: South (East)

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,171.14	-5.13	1.40000	-11.86
21.00 hr	N/A	1,171.14	-5.13	1.40000	-11.86
22.00 hr	N/A	1,171.14	-5.13	1.40000	-11.86
23.00 hr	N/A	1,184.49	0.65	1.40000	1.49
24.00 hr	N/A	1,230.00	20.33	0.00000	47.00

Detailed Report for Junction: South (West)

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	8,226.65 ft	Elevation	1,182.00 ft
Y	-33,155.49 ft	Zone	Zone-1

Connecting Pipes
P-210
P-211

Demand Summary

Type	Demand (cfs)	Pattern
Demand	22.24000	SW-1.39

Calculated Results Summary

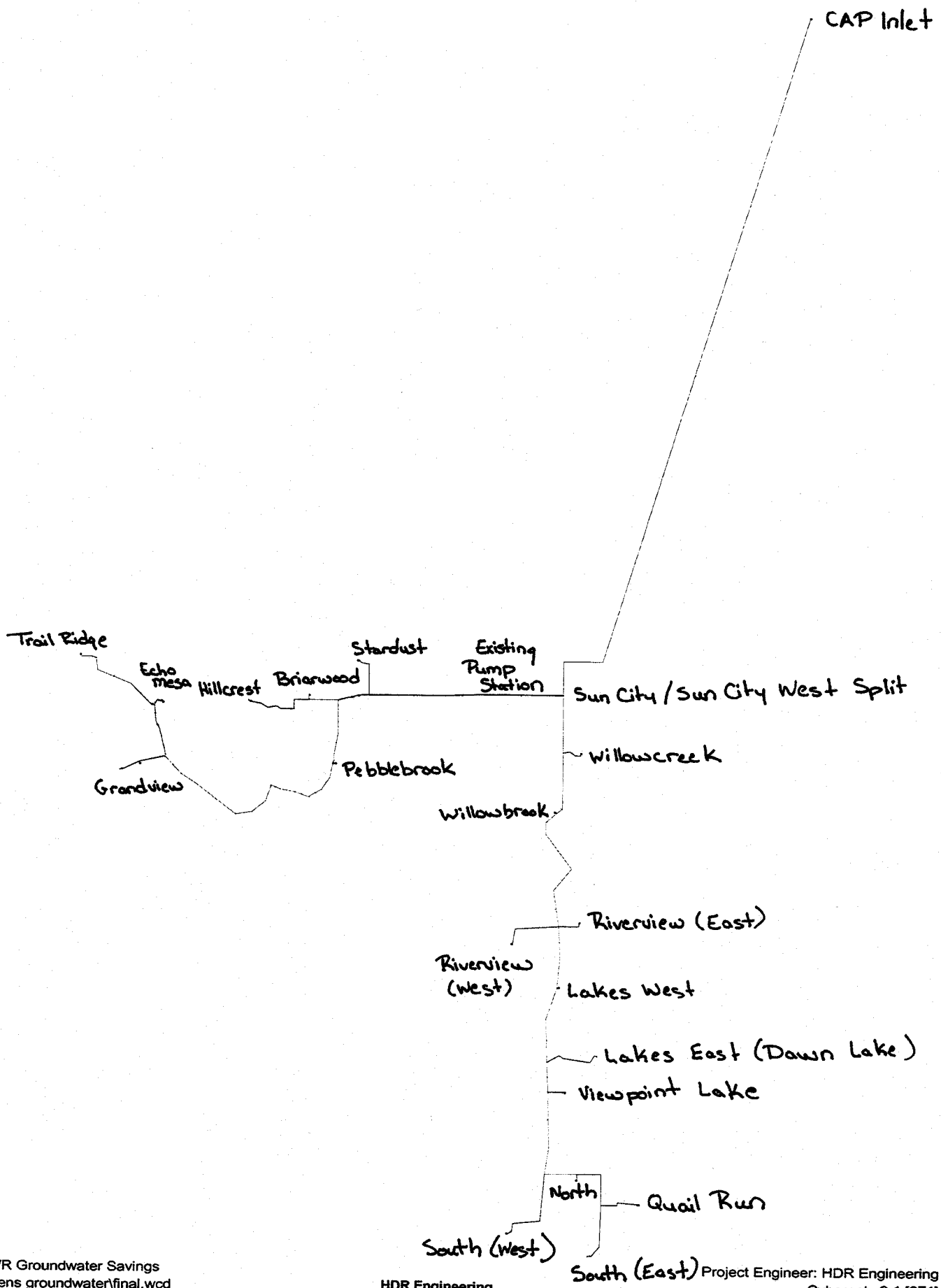
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,191.08	3.93	1.32050	9.08
1.00 hr	N/A	1,228.91	20.28	1.39000	46.91
2.00 hr	N/A	1,266.87	36.70	1.39000	84.87
3.00 hr	N/A	1,266.87	36.70	1.39000	84.87
4.00 hr	N/A	1,266.87	36.70	1.39000	84.87
5.00 hr	N/A	1,258.18	32.94	1.39000	76.18
6.00 hr	N/A	1,258.18	32.94	1.39000	76.18
7.00 hr	N/A	1,249.78	29.31	1.39000	67.78
8.00 hr	N/A	1,281.82	43.17	0.00000	99.82
9.00 hr	N/A	1,252.89	30.65	0.00000	70.89
10.00 hr	N/A	1,252.89	30.65	0.00000	70.89
11.00 hr	N/A	1,252.89	30.65	0.00000	70.89
12.00 hr	N/A	1,252.89	30.65	0.00000	70.89
13.00 hr	N/A	1,252.89	30.65	0.00000	70.89
14.00 hr	N/A	1,252.89	30.65	0.00000	70.89
15.00 hr	N/A	1,252.89	30.65	0.00000	70.89
16.00 hr	N/A	1,265.51	36.11	1.39000	83.51
17.00 hr	N/A	1,265.51	36.11	1.39000	83.51
18.00 hr	N/A	1,265.51	36.11	1.39000	83.51
19.00 hr	N/A	1,198.37	7.08	1.39000	16.37

Detailed Report for Junction: South (West)

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,177.43	-1.98	1.39000	-4.57
21.00 hr	N/A	1,177.43	-1.98	1.39000	-4.57
22.00 hr	N/A	1,177.43	-1.98	1.39000	-4.57
23.00 hr	N/A	1,191.08	3.93	1.32050	9.08
24.00 hr	N/A	1,228.91	20.28	1.39000	46.91

Scenario: Peak Demand July



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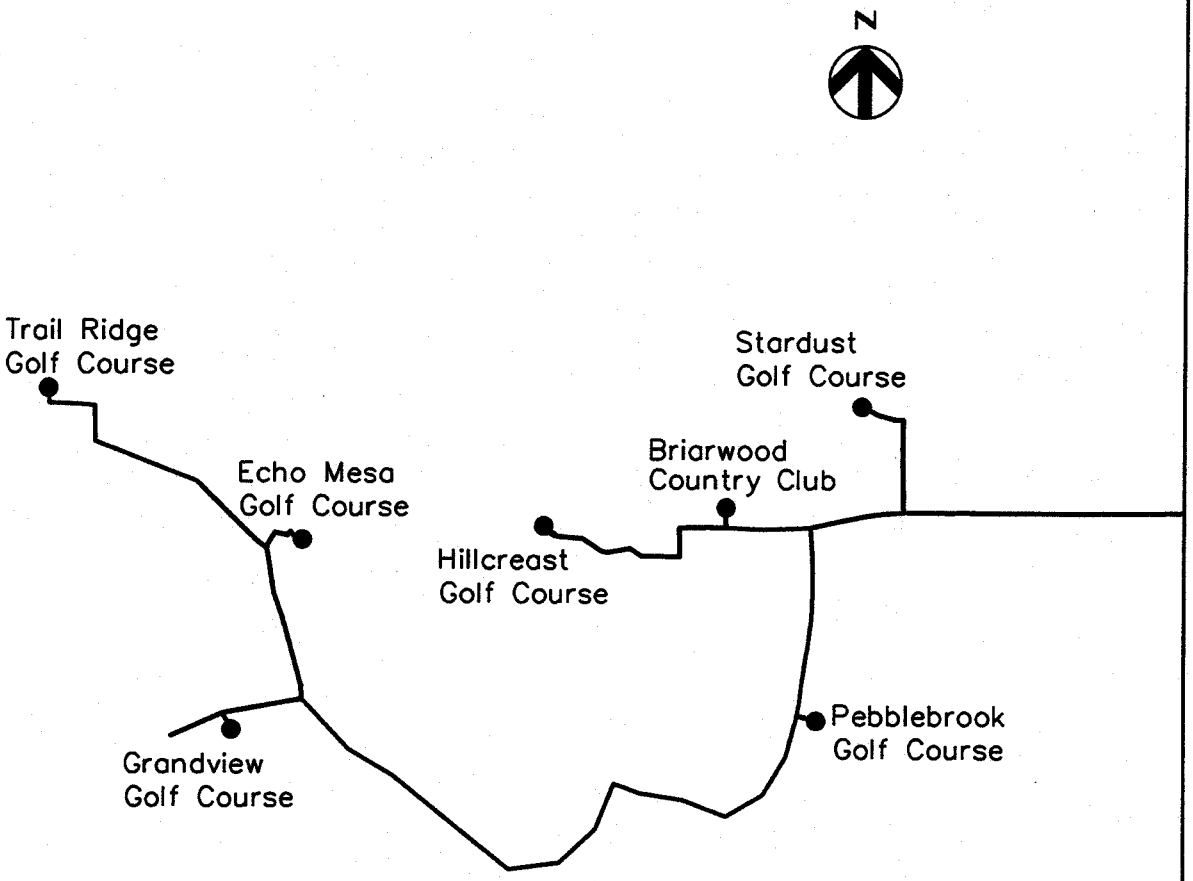
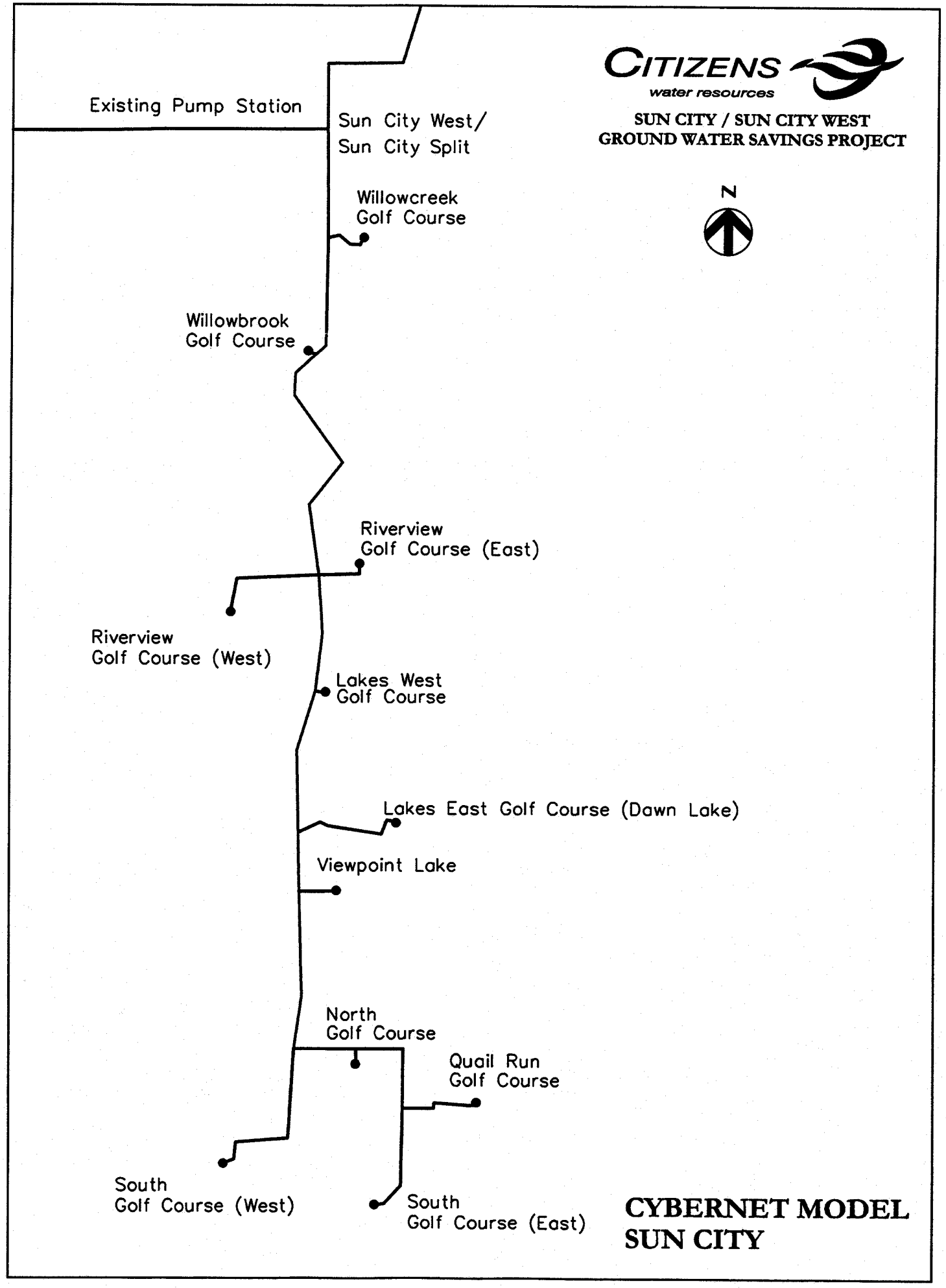
HDR Engineering
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

CITIZENS
water resources

SUN CITY / SUN CITY WEST
GROUND WATER SAVINGS PROJECT



CYBERNET MODEL
SUN CITY WEST


CITIZENS
water resources
SUN CITY / SUN CITY WEST
GROUND WATER SAVINGS PROJECT
N
Existing Pump Station
Sun City West/
Sun City Split
Willowcreek
Golf Course
Willowbrook
Golf Course
Riverview
Golf Course (East)
Riverview
Golf Course (West)
Lakes West
Golf Course
Lakes East Golf Course (Dawn Lake)
Viewpoint Lake
North
Golf Course
Quail Run
Golf Course
South
Golf Course (West)
South
Golf Course (East)
CYBERNET MODEL
SUN CITY

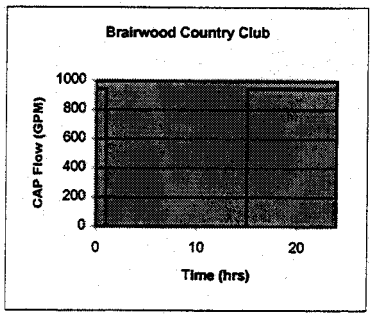
Job No. | No.

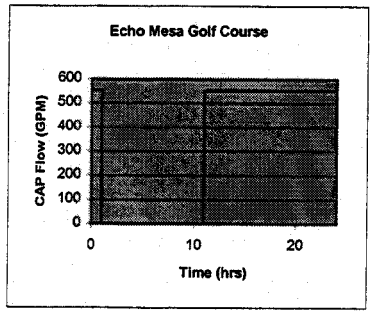
Computation

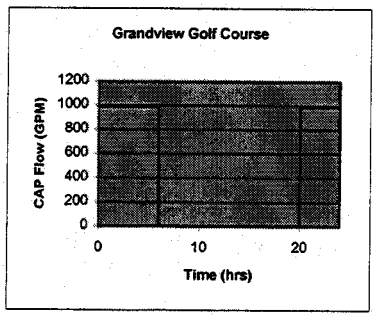
HDR

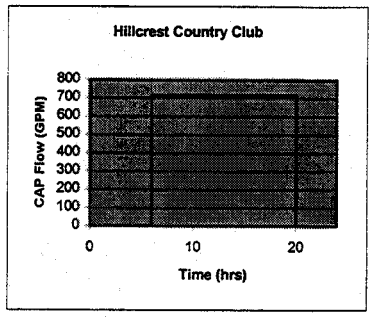
Project	Sun City / Sun City West Youngtown Groundwater Savings Project	Computed	JKE	Date	7/26/00
Subject	Sun City West	Checked		Date	
Task	CAP Delivery Schedule	Sheet	1	Of	1

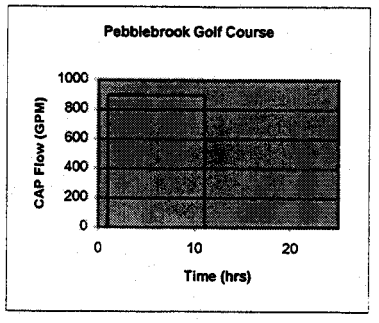
The graphs below represent the delivery schedule of the CAP water to each of the participating golf courses. The flow is based on the allocated water for Sun City West with the cypernet model to optimize flow to each course. The graphs indicate the time period and flow rate of each delivery.

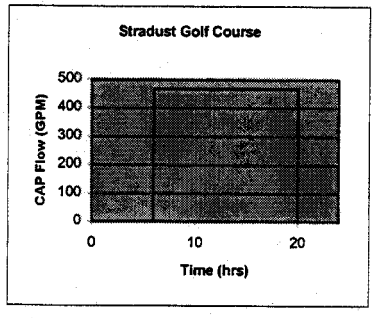


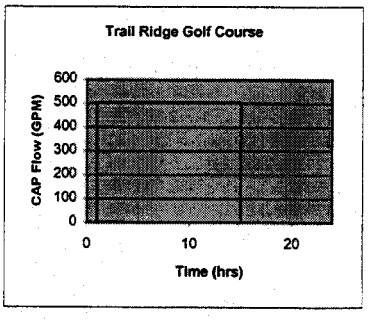












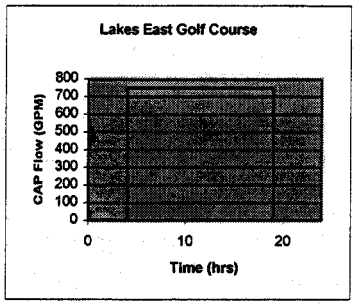
Job No. | No.

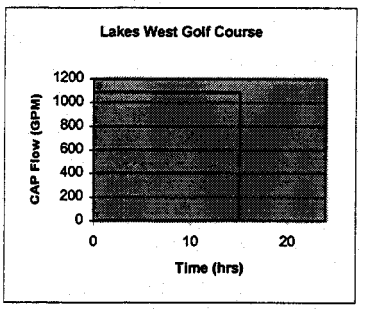
Computation

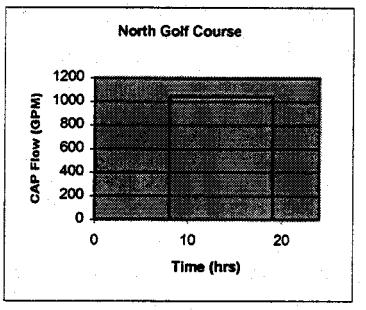
HDR

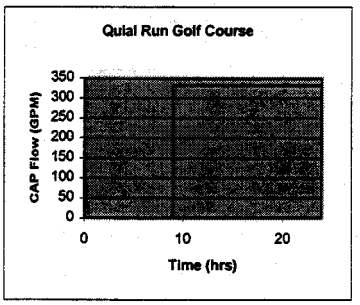
Project	Sun City / Sun City West Youngtown Groundwater Savings Project	Computed JKE	Date 7/26/00
Subject	Sun City /Youngtown	Checked	Date
Task	CAP Delivery Schedule	Sheet 1	Of 1

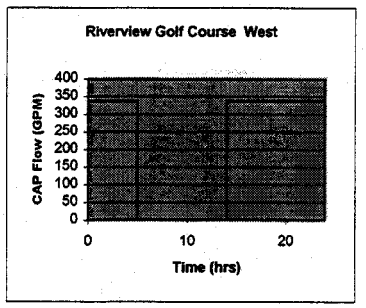
The graphs below represent the delivery schedule of the CAP water to each of the participating golf courses. The flow is based on the allocated water for Sun City and Youngtown with the cypernet model to optimize flow to each course. The graphs indicate the time period and flow rate of each delivery.

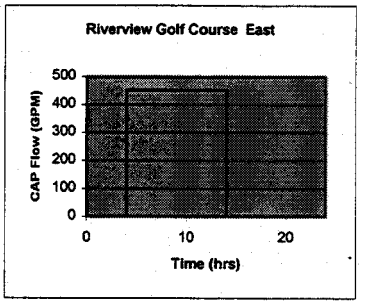


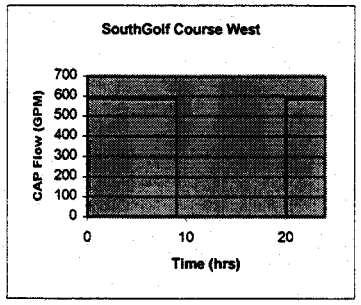


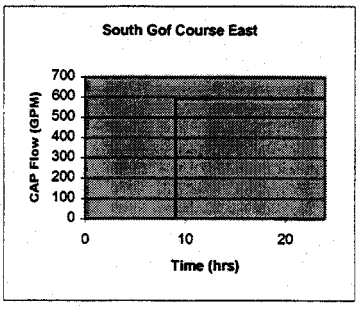


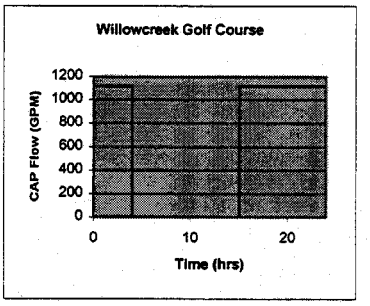


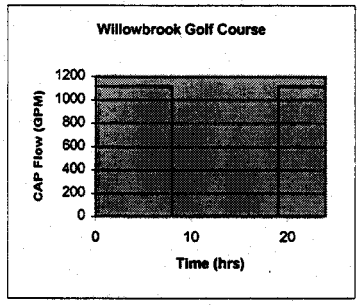












Detailed Report for Reservoir: CAP INLET

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	26,480.31 ft	Hydraulic Grade Line	1,517.10 ft
Y	41,988.39 ft	Zone	Zone-1

Connecting Pipes
P-235

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Reservoir Inflow (cfs)	Reservoir Outflow (cfs)
0.00 hr	N/A	1,517.10	N/A	15.10759
1.00 hr	N/A	1,517.10	N/A	14.89765
2.00 hr	N/A	1,517.10	N/A	14.89763
3.00 hr	N/A	1,517.10	N/A	14.89767
4.00 hr	N/A	1,517.10	N/A	15.08516
5.00 hr	N/A	1,517.10	N/A	14.24551
6.00 hr	N/A	1,517.10	N/A	14.66446
7.00 hr	N/A	1,517.10	N/A	14.66443
8.00 hr	N/A	1,517.10	N/A	14.50153
9.00 hr	N/A	1,517.10	N/A	15.25125
10.00 hr	N/A	1,517.10	N/A	15.25129
11.00 hr	N/A	1,517.10	N/A	14.48077
12.00 hr	N/A	1,517.10	N/A	14.48076
13.00 hr	N/A	1,517.10	N/A	14.48077
14.00 hr	N/A	1,517.10	N/A	13.47077
15.00 hr	N/A	1,517.10	N/A	14.51161
16.00 hr	N/A	1,517.10	N/A	14.51161
17.00 hr	N/A	1,517.10	N/A	15.35128
18.00 hr	N/A	1,517.10	N/A	15.35129
19.00 hr	N/A	1,517.10	N/A	15.51417
20.00 hr	N/A	1,517.10	N/A	14.73653
21.00 hr	N/A	1,517.10	N/A	14.73653
22.00 hr	N/A	1,517.10	N/A	14.73654
23.00 hr	N/A	1,517.10	N/A	14.73655
24.00 hr	N/A	1,517.10	N/A	15.10760

Detailed Report for Junction: SUn City West/Sun City Split

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	11,874.08 ft	Elevation	1,200.00 ft
Y	55.57 ft	Zone	Zone-1

Connecting Pipes
P-236
P-103
P-237

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,379.21	77.50	0.00000	179.21
1.00 hr	N/A	1,382.74	79.02	0.00000	182.74
2.00 hr	N/A	1,382.74	79.02	0.00000	182.74
3.00 hr	N/A	1,382.74	79.02	0.00000	182.74
4.00 hr	N/A	1,379.59	77.66	0.00000	179.59
5.00 hr	N/A	1,393.41	83.64	0.00000	193.41
6.00 hr	N/A	1,386.60	80.69	0.00000	186.60
7.00 hr	N/A	1,386.60	80.69	0.00000	186.60
8.00 hr	N/A	1,389.27	81.85	0.00000	189.27
9.00 hr	N/A	1,376.78	76.44	0.00000	176.78
10.00 hr	N/A	1,376.78	76.44	0.00000	176.78
11.00 hr	N/A	1,389.61	81.99	0.00000	189.61
12.00 hr	N/A	1,389.61	81.99	0.00000	189.61
13.00 hr	N/A	1,389.61	81.99	0.00000	189.61
14.00 hr	N/A	1,405.57	88.90	0.00000	205.57
15.00 hr	N/A	1,389.11	81.78	0.00000	189.11
16.00 hr	N/A	1,389.11	81.78	0.00000	189.11
17.00 hr	N/A	1,375.07	75.71	0.00000	175.07
18.00 hr	N/A	1,375.07	75.71	0.00000	175.07
19.00 hr	N/A	1,372.27	74.49	0.00000	172.27
20.00 hr	N/A	1,385.41	80.18	0.00000	185.41
21.00 hr	N/A	1,385.41	80.18	0.00000	185.41
22.00 hr	N/A	1,385.41	80.18	0.00000	185.41
23.00 hr	N/A	1,385.41	80.18	0.00000	185.41
24.00 hr	N/A	1,379.21	77.50	0.00000	179.21

Detailed Report for Junction: Briarwood

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-3,749.13 ft	Elevation	1,222.00 ft
Y	-217.82 ft	Zone	Zone-1

Connecting Pipes
P-14
P-201

Demand Summary

Type	Demand (cfs)	Pattern
Demand	21.00000	BW-10hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,365.89	62.22	2.10000	143.89
1.00 hr	N/A	1,371.37	64.59	0.00000	149.37
2.00 hr	N/A	1,371.37	64.59	0.00000	149.37
3.00 hr	N/A	1,371.37	64.59	0.00000	149.37
4.00 hr	N/A	1,368.23	63.23	0.00000	146.23
5.00 hr	N/A	1,382.05	69.21	0.00000	160.05
6.00 hr	N/A	1,373.63	65.57	0.00000	151.63
7.00 hr	N/A	1,373.63	65.57	0.00000	151.63
8.00 hr	N/A	1,376.30	66.73	0.00000	154.30
9.00 hr	N/A	1,363.81	61.32	0.00000	141.81
10.00 hr	N/A	1,363.81	61.32	0.00000	141.81
11.00 hr	N/A	1,379.62	68.16	0.00000	157.62
12.00 hr	N/A	1,379.62	68.16	0.00000	157.62
13.00 hr	N/A	1,379.62	68.16	0.00000	157.62
14.00 hr	N/A	1,395.58	75.06	0.00000	173.58
15.00 hr	N/A	1,373.03	65.31	2.10000	151.03
16.00 hr	N/A	1,373.03	65.31	2.10000	151.03
17.00 hr	N/A	1,359.00	59.24	2.10000	137.00
18.00 hr	N/A	1,359.00	59.24	2.10000	137.00
19.00 hr	N/A	1,356.19	58.03	2.10000	134.19

Detailed Report for Junction: Briarwood

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,372.09	64.91	2.10000	150.09
21.00 hr	N/A	1,372.09	64.91	2.10000	150.09
22.00 hr	N/A	1,372.09	64.91	2.10000	150.09
23.00 hr	N/A	1,372.09	64.91	2.10000	150.09
24.00 hr	N/A	1,365.89	62.22	2.10000	143.89

Detailed Report for Junction: Echo Mesa Lake

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-12,834.68 ft	Elevation	1,245.00 ft
Y	-422.63 ft	Zone	Zone-1

Connecting Pipes
P-191
P-192

Demand Summary

Type	Demand (cfs)	Pattern
Demand	17.22000	EM-14hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,343.29	42.51	1.22951	98.29
1.00 hr	N/A	1,342.56	42.19	0.00000	97.56
2.00 hr	N/A	1,342.56	42.19	0.00000	97.56
3.00 hr	N/A	1,342.56	42.19	0.00000	97.56
4.00 hr	N/A	1,339.41	40.83	0.00000	94.41
5.00 hr	N/A	1,353.23	46.80	0.00000	108.23
6.00 hr	N/A	1,366.91	52.72	0.00000	121.91
7.00 hr	N/A	1,366.91	52.72	0.00000	121.91
8.00 hr	N/A	1,369.58	53.87	0.00000	124.58
9.00 hr	N/A	1,357.08	48.47	0.00000	112.08
10.00 hr	N/A	1,357.08	48.47	0.00000	112.08
11.00 hr	N/A	1,365.83	52.25	1.22951	120.83
12.00 hr	N/A	1,365.83	52.25	1.22951	120.83
13.00 hr	N/A	1,365.83	52.25	1.22951	120.83
14.00 hr	N/A	1,381.79	59.15	1.22951	136.79
15.00 hr	N/A	1,371.32	54.63	1.22951	126.32
16.00 hr	N/A	1,371.32	54.63	1.22951	126.32
17.00 hr	N/A	1,357.28	48.55	1.22951	112.28
18.00 hr	N/A	1,357.28	48.55	1.22951	112.28
19.00 hr	N/A	1,354.48	47.34	1.22951	109.48

Detailed Report for Junction: Echo Mesa Lake

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,349.49	45.19	1.22951	104.49
21.00 hr	N/A	1,349.49	45.19	1.22951	104.49
22.00 hr	N/A	1,349.49	45.19	1.22951	104.49
23.00 hr	N/A	1,349.49	45.19	1.22951	104.49
24.00 hr	N/A	1,343.29	42.51	1.22951	98.29

Detailed Report for Junction: Grandview Lake

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-14,204.27 ft	Elevation	1,240.00 ft
Y	-4,256.33 ft	Zone	Zone-1

Connecting Pipes
P-219
P-189

Demand Summary

Type	Demand (cfs)	Pattern
Demand	22.10000	GV-10hrs

Grandview Lake

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,342.64	44.38	2.21000	102.64
1.00 hr	N/A	1,341.53	43.91	2.21000	101.53
2.00 hr	N/A	1,341.53	43.91	2.21000	101.53
3.00 hr	N/A	1,341.53	43.91	2.21000	101.53
4.00 hr	N/A	1,338.39	42.55	2.21000	98.39
5.00 hr	N/A	1,352.21	48.52	2.21000	112.21
6.00 hr	N/A	1,367.65	55.20	0.00000	127.65
7.00 hr	N/A	1,367.66	55.20	0.00000	127.66
8.00 hr	N/A	1,370.32	56.36	0.00000	130.32
9.00 hr	N/A	1,357.83	50.95	0.00000	117.83
10.00 hr	N/A	1,357.83	50.95	0.00000	117.83
11.00 hr	N/A	1,368.99	55.78	0.00000	128.99
12.00 hr	N/A	1,368.99	55.78	0.00000	128.99
13.00 hr	N/A	1,368.99	55.78	0.00000	128.99
14.00 hr	N/A	1,384.96	62.68	0.00000	144.96
15.00 hr	N/A	1,372.44	57.27	0.00000	132.44
16.00 hr	N/A	1,372.44	57.27	0.00000	132.44
17.00 hr	N/A	1,358.40	51.20	0.00000	118.40

Detailed Report for Junction: Grandview Lake

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
18.00 hr	N/A	1,358.40	51.20	0.00000	118.40
19.00 hr	N/A	1,355.60	49.99	0.00000	115.60
20.00 hr	N/A	1,348.84	47.06	2.21000	108.84
21.00 hr	N/A	1,348.84	47.06	2.21000	108.84
22.00 hr	N/A	1,348.84	47.06	2.21000	108.84
23.00 hr	N/A	1,348.84	47.06	2.21000	108.84
24.00 hr	N/A	1,342.64	44.38	2.21000	102.64

Detailed Report for Junction: Hillcreast Lake

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-7,273.22 ft	Elevation	1,249.17 ft
Y	-509.42 ft	Zone	Zone-1

Connecting Pipes
P-24
P-174

Demand Summary

Type	Demand (cfs)	Pattern
Demand	22.26000	HC-14hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,366.11	50.57	0.00000	116.94
1.00 hr	N/A	1,371.37	52.85	0.00000	122.20
2.00 hr	N/A	1,371.37	52.85	0.00000	122.20
3.00 hr	N/A	1,371.37	52.84	0.00000	122.20
4.00 hr	N/A	1,368.23	51.48	0.00000	119.06
5.00 hr	N/A	1,382.05	57.46	0.00000	132.88
6.00 hr	N/A	1,371.10	52.73	1.58936	121.93
7.00 hr	N/A	1,371.10	52.73	1.58936	121.93
8.00 hr	N/A	1,373.77	53.88	1.58936	124.60
9.00 hr	N/A	1,361.28	48.48	1.58936	112.11
10.00 hr	N/A	1,361.28	48.48	1.58936	112.11
11.00 hr	N/A	1,377.08	55.31	1.58936	127.91
12.00 hr	N/A	1,377.08	55.31	1.58936	127.91
13.00 hr	N/A	1,377.08	55.31	1.58936	127.91
14.00 hr	N/A	1,393.05	62.22	1.58936	143.88
15.00 hr	N/A	1,370.71	52.56	1.58936	121.54
16.00 hr	N/A	1,370.71	52.56	1.58936	121.54
17.00 hr	N/A	1,356.68	46.49	1.58936	107.51
18.00 hr	N/A	1,356.68	46.49	1.58936	107.51
19.00 hr	N/A	1,353.87	45.28	1.58936	104.70

Detailed Report for Junction: Hillcreast Lake

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,372.31	53.25	0.00000	123.14
21.00 hr	N/A	1,372.31	53.25	0.00000	123.14
22.00 hr	N/A	1,372.31	53.25	0.00000	123.14
23.00 hr	N/A	1,372.31	53.25	0.00000	123.14
24.00 hr	N/A	1,366.11	50.57	0.00000	116.94

Detailed Report for Junction: Pebblebrook Lake

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-2,176.08 ft	Elevation	1,190.00 ft
Y	-4,253.92 ft	Zone	Zone-1

Connecting Pipes
P-218
P-190

Demand Summary

Type	Demand (cfs)	Pattern
Demand	20.00000	PB-10hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,361.81	74.30	0.00000	171.81
1.00 hr	N/A	1,359.55	73.32	2.00000	169.55
2.00 hr	N/A	1,359.55	73.32	2.00000	169.55
3.00 hr	N/A	1,359.55	73.32	2.00000	169.55
4.00 hr	N/A	1,356.41	71.96	2.00000	166.41
5.00 hr	N/A	1,370.23	77.94	2.00000	180.23
6.00 hr	N/A	1,369.70	77.71	2.00000	179.70
7.00 hr	N/A	1,369.70	77.71	2.00000	179.70
8.00 hr	N/A	1,372.37	78.86	2.00000	182.37
9.00 hr	N/A	1,359.87	73.46	2.00000	169.87
10.00 hr	N/A	1,359.87	73.46	2.00000	169.87
11.00 hr	N/A	1,377.59	81.12	0.00000	187.59
12.00 hr	N/A	1,377.59	81.12	0.00000	187.59
13.00 hr	N/A	1,377.59	81.12	0.00000	187.59
14.00 hr	N/A	1,393.55	88.02	0.00000	203.55
15.00 hr	N/A	1,375.03	80.01	0.00000	185.03
16.00 hr	N/A	1,375.03	80.01	0.00000	185.03
17.00 hr	N/A	1,360.99	73.94	0.00000	170.99
18.00 hr	N/A	1,360.99	73.94	0.00000	170.99
19.00 hr	N/A	1,358.19	72.73	0.00000	168.19

Detailed Report for Junction: Pebblebrook Lake

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,368.01	76.98	0.00000	178.01
21.00 hr	N/A	1,368.01	76.98	0.00000	178.01
22.00 hr	N/A	1,368.01	76.98	0.00000	178.01
23.00 hr	N/A	1,368.01	76.98	0.00000	178.01
24.00 hr	N/A	1,361.81	74.30	0.00000	171.81

Detailed Report for Junction: Stardust

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-582.30 ft	Elevation	1,213.46 ft
Y	2,027.93 ft	Zone	Zone-1

Connecting Pipes
P-177
P-178

Demand Summary

Type	Demand (cfs)	Pattern
Demand	14.56000	SD-12hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,368.95	67.24	0.00000	155.49
1.00 hr	N/A	1,373.18	69.07	0.00000	159.72
2.00 hr	N/A	1,373.18	69.07	0.00000	159.72
3.00 hr	N/A	1,373.18	69.07	0.00000	159.72
4.00 hr	N/A	1,370.04	67.71	0.00000	156.58
5.00 hr	N/A	1,383.86	73.69	0.00000	170.40
6.00 hr	N/A	1,374.24	69.53	1.03958	160.78
7.00 hr	N/A	1,374.24	69.53	1.03958	160.78
8.00 hr	N/A	1,376.91	70.68	1.03958	163.45
9.00 hr	N/A	1,364.42	65.28	1.03958	150.96
10.00 hr	N/A	1,364.42	65.28	1.03958	150.96
11.00 hr	N/A	1,379.82	71.94	1.03958	166.36
12.00 hr	N/A	1,379.82	71.94	1.03958	166.36
13.00 hr	N/A	1,379.82	71.94	1.03958	166.36
14.00 hr	N/A	1,395.78	78.84	1.03958	182.32
15.00 hr	N/A	1,375.99	70.29	1.03958	162.53
16.00 hr	N/A	1,375.99	70.29	1.03958	162.53
17.00 hr	N/A	1,361.96	64.22	1.03958	148.50
18.00 hr	N/A	1,361.96	64.22	1.03958	148.50
19.00 hr	N/A	1,359.16	63.00	1.03958	145.70

Detailed Report for Junction: Stardust

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,375.15	69.92	0.00000	161.69
21.00 hr	N/A	1,375.15	69.92	0.00000	161.69
22.00 hr	N/A	1,375.15	69.92	0.00000	161.69
23.00 hr	N/A	1,375.15	69.92	0.00000	161.69
24.00 hr	N/A	1,368.95	67.24	0.00000	155.49

Detailed Report for Junction: Trail Ridge

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	-17,169.27 ft	Elevation	1,278.00 ft
Y	2,209.76 ft	Zone	Zone-1

Connecting Pipes
P-79
P-221

Demand Summary

Type	Demand (cfs)	Pattern
Demand	15.68000	TR-14hr

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,343.52	28.33	0.00000	65.52
1.00 hr	N/A	1,340.29	26.94	1.11955	62.29
2.00 hr	N/A	1,340.29	26.94	1.11955	62.29
3.00 hr	N/A	1,340.29	26.94	1.11955	62.29
4.00 hr	N/A	1,337.14	25.58	1.11955	59.14
5.00 hr	N/A	1,350.97	31.55	1.11955	72.97
6.00 hr	N/A	1,364.64	37.47	1.11955	86.64
7.00 hr	N/A	1,364.64	37.47	1.11955	86.64
8.00 hr	N/A	1,367.31	38.62	1.11955	89.31
9.00 hr	N/A	1,354.82	33.22	1.11955	76.82
10.00 hr	N/A	1,354.81	33.22	1.11955	76.81
11.00 hr	N/A	1,363.78	37.10	1.11955	85.78
12.00 hr	N/A	1,363.78	37.10	1.11955	85.78
13.00 hr	N/A	1,363.78	37.10	1.11955	85.78
14.00 hr	N/A	1,379.74	44.00	1.11955	101.74
15.00 hr	N/A	1,371.55	40.45	0.00000	93.55
16.00 hr	N/A	1,371.55	40.45	0.00000	93.55
17.00 hr	N/A	1,357.51	34.38	0.00000	79.51
18.00 hr	N/A	1,357.51	34.38	0.00000	79.51
19.00 hr	N/A	1,354.71	33.17	0.00000	76.71

Detailed Report for Junction: Trail Ridge

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,349.72	31.01	0.00000	71.72
21.00 hr	N/A	1,349.72	31.01	0.00000	71.72
22.00 hr	N/A	1,349.72	31.01	0.00000	71.72
23.00 hr	N/A	1,349.72	31.01	0.00000	71.72
24.00 hr	N/A	1,343.52	28.33	0.00000	65.52

Detailed Report for Junction: Lakes East (Dawn Lake)

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	13,900.71 ft	Elevation	1,186.00 ft
Y	-22,153.83 ft	Zone	Zone-1

Connecting Pipes
P-225
P-209

Demand Summary

Type	Demand (cfs)	Pattern
Demand	26.72000	LE-16hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,342.06	67.48	0.00000	156.06
1.00 hr	N/A	1,345.58	69.01	0.00000	159.58
2.00 hr	N/A	1,345.58	69.01	0.00000	159.58
3.00 hr	N/A	1,345.58	69.01	0.00000	159.58
4.00 hr	N/A	1,296.25	47.68	1.67000	110.25
5.00 hr	N/A	1,321.78	58.72	1.67000	135.78
6.00 hr	N/A	1,314.97	55.77	1.67000	128.97
7.00 hr	N/A	1,314.97	55.77	1.67000	128.97
8.00 hr	N/A	1,268.50	35.68	1.67000	82.50
9.00 hr	N/A	1,234.80	21.10	1.67000	48.80
10.00 hr	N/A	1,234.80	21.10	1.67000	48.80
11.00 hr	N/A	1,247.63	26.65	1.67000	61.63
12.00 hr	N/A	1,247.63	26.65	1.67000	61.63
13.00 hr	N/A	1,247.63	26.65	1.67000	61.63
14.00 hr	N/A	1,280.56	40.89	1.67000	94.56
15.00 hr	N/A	1,309.37	53.35	1.67000	123.37
16.00 hr	N/A	1,309.37	53.35	1.67000	123.37
17.00 hr	N/A	1,284.50	42.59	1.67000	98.50
18.00 hr	N/A	1,284.50	42.59	1.67000	98.50
19.00 hr	N/A	1,323.78	59.58	1.67000	137.78

Detailed Report for Junction: Lakes East (Dawn Lake)

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,347.78	69.96	0.00000	161.78
21.00 hr	N/A	1,347.78	69.96	0.00000	161.78
22.00 hr	N/A	1,347.78	69.96	0.00000	161.78
23.00 hr	N/A	1,347.78	69.96	0.00000	161.78
24.00 hr	N/A	1,342.06	67.48	0.00000	156.06

Detailed Report for Junction: Lakes West

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	11,686.61 ft	Elevation	1,186.00 ft
Y	-18,025.82 ft	Zone	Zone-1

Connecting Pipes
P-139
P-208

Demand Summary

Type	Demand (cfs)	Pattern
Demand	36.30000	LW-15hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,342.87	67.83	2.43210	156.87
1.00 hr	N/A	1,346.39	69.36	2.43210	160.39
2.00 hr	N/A	1,346.39	69.36	2.43210	160.39
3.00 hr	N/A	1,346.39	69.36	2.43210	160.39
4.00 hr	N/A	1,305.95	51.87	2.43210	119.95
5.00 hr	N/A	1,331.48	62.91	2.43210	145.48
6.00 hr	N/A	1,324.67	59.96	2.43210	138.67
7.00 hr	N/A	1,324.67	59.96	2.43210	138.67
8.00 hr	N/A	1,287.89	44.06	2.43210	101.89
9.00 hr	N/A	1,258.27	31.25	2.43210	72.27
10.00 hr	N/A	1,258.27	31.25	2.43210	72.27
11.00 hr	N/A	1,271.11	36.80	2.43210	85.11
12.00 hr	N/A	1,271.11	36.80	2.43210	85.11
13.00 hr	N/A	1,271.11	36.80	2.43210	85.11
14.00 hr	N/A	1,304.03	51.04	2.43210	118.03
15.00 hr	N/A	1,333.14	63.63	0.00000	147.14
16.00 hr	N/A	1,333.14	63.63	0.00000	147.14
17.00 hr	N/A	1,308.27	52.87	0.00000	122.27
18.00 hr	N/A	1,308.27	52.87	0.00000	122.27
19.00 hr	N/A	1,336.39	65.03	0.00000	150.39

Detailed Report for Junction: Lakes West

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,354.15	72.71	0.00000	168.15
21.00 hr	N/A	1,354.15	72.71	0.00000	168.15
22.00 hr	N/A	1,354.15	72.71	0.00000	168.15
23.00 hr	N/A	1,354.15	72.71	0.00000	168.15
24.00 hr	N/A	1,342.87	67.83	2.43210	156.87

Detailed Report for Junction: North

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	12,932.68 ft	Elevation	1,183.00 ft
Y	-29,650.60 ft	Zone	Zone-1

Connecting Pipes
P-212
P-215

Demand Summary

Type	Demand (cfs)	Pattern
Demand	25.60000	NO-11hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,340.48	68.10	0.00000	157.48
1.00 hr	N/A	1,344.01	69.62	0.00000	161.01
2.00 hr	N/A	1,344.01	69.63	0.00000	161.01
3.00 hr	N/A	1,344.01	69.62	0.00000	161.01
4.00 hr	N/A	1,299.60	50.42	0.00000	116.60
5.00 hr	N/A	1,325.13	61.46	0.00000	142.13
6.00 hr	N/A	1,318.32	58.52	0.00000	135.32
7.00 hr	N/A	1,318.32	58.52	0.00000	135.32
8.00 hr	N/A	1,261.19	33.81	2.32960	78.19
9.00 hr	N/A	1,220.14	16.06	2.32960	37.14
10.00 hr	N/A	1,220.14	16.06	2.32960	37.14
11.00 hr	N/A	1,232.98	21.61	2.32960	49.98
12.00 hr	N/A	1,232.98	21.61	2.32960	49.98
13.00 hr	N/A	1,232.98	21.61	2.32960	49.98
14.00 hr	N/A	1,265.90	35.85	2.32960	82.90
15.00 hr	N/A	1,294.71	48.31	2.32960	111.71
16.00 hr	N/A	1,294.71	48.31	2.32960	111.71
17.00 hr	N/A	1,269.84	37.55	2.32960	86.84
18.00 hr	N/A	1,269.84	37.55	2.32960	86.84
19.00 hr	N/A	1,323.99	60.97	0.00000	140.99

Detailed Report for Junction: North

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,337.66	66.88	0.00000	154.66
21.00 hr	N/A	1,337.66	66.88	0.00000	154.66
22.00 hr	N/A	1,337.66	66.88	0.00000	154.66
23.00 hr	N/A	1,337.66	66.88	0.00000	154.66
24.00 hr	N/A	1,340.48	68.10	0.00000	157.48

Detailed Report for Junction: Quail Run

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	16,538.27 ft	Elevation	1,182.00 ft
Y	-31,305.84 ft	Zone	Zone-1

Connecting Pipes
P-232
P-226

Demand Summary

Type	Demand (cfs)	Pattern
Demand	11.10000	QR-15hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,340.48	68.53	0.00000	158.48
1.00 hr	N/A	1,344.01	70.06	0.00000	162.01
2.00 hr	N/A	1,344.01	70.06	0.00000	162.01
3.00 hr	N/A	1,344.01	70.06	0.00000	162.01
4.00 hr	N/A	1,299.60	50.86	0.00000	117.60
5.00 hr	N/A	1,325.13	61.90	0.00000	143.13
6.00 hr	N/A	1,318.32	58.95	0.00000	136.32
7.00 hr	N/A	1,318.32	58.95	0.00000	136.32
8.00 hr	N/A	1,261.65	34.45	0.00000	79.65
9.00 hr	N/A	1,212.44	13.16	0.74037	30.44
10.00 hr	N/A	1,212.44	13.16	0.74037	30.44
11.00 hr	N/A	1,225.27	18.71	0.74037	43.27
12.00 hr	N/A	1,225.27	18.71	0.74037	43.27
13.00 hr	N/A	1,225.27	18.71	0.74037	43.27
14.00 hr	N/A	1,258.20	32.95	0.74037	76.20
15.00 hr	N/A	1,287.01	45.41	0.74037	105.01
16.00 hr	N/A	1,287.01	45.41	0.74037	105.01
17.00 hr	N/A	1,262.13	34.65	0.74037	80.13
18.00 hr	N/A	1,262.13	34.65	0.74037	80.13
19.00 hr	N/A	1,315.82	57.87	0.74037	133.82

Detailed Report for Junction: Quail Run

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,329.49	63.78	0.74037	147.49
21.00 hr	N/A	1,329.49	63.78	0.74037	147.49
22.00 hr	N/A	1,329.49	63.78	0.74037	147.49
23.00 hr	N/A	1,329.49	63.78	0.74037	147.49
24.00 hr	N/A	1,340.48	68.53	0.00000	158.48

Detailed Report for Junction: Riverview (East)

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	12,983.18 ft	Elevation	1,188.00 ft
Y	-14,120.02 ft	Zone	Zone-1

Connecting Pipes
P-233
P-234

Demand Summary

Type	Demand (cfs)	Pattern
Demand	10.10000	RVE-10hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,349.28	69.74	0.00000	161.28
1.00 hr	N/A	1,352.80	71.27	0.00000	164.80
2.00 hr	N/A	1,352.80	71.27	0.00000	164.80
3.00 hr	N/A	1,352.80	71.27	0.00000	164.80
4.00 hr	N/A	1,317.52	56.01	1.01000	129.52
5.00 hr	N/A	1,343.05	67.05	1.01000	155.05
6.00 hr	N/A	1,336.24	64.10	1.01000	148.24
7.00 hr	N/A	1,336.24	64.10	1.01000	148.24
8.00 hr	N/A	1,310.81	53.11	1.01000	122.81
9.00 hr	N/A	1,285.57	42.19	1.01000	97.57
10.00 hr	N/A	1,285.57	42.19	1.01000	97.57
11.00 hr	N/A	1,298.40	47.74	1.01000	110.40
12.00 hr	N/A	1,298.40	47.74	1.01000	110.40
13.00 hr	N/A	1,298.40	47.74	1.01000	110.40
14.00 hr	N/A	1,332.14	62.33	0.00000	144.14
15.00 hr	N/A	1,348.04	69.21	0.00000	160.04
16.00 hr	N/A	1,348.04	69.21	0.00000	160.04
17.00 hr	N/A	1,323.17	58.45	0.00000	135.17
18.00 hr	N/A	1,323.17	58.45	0.00000	135.17
19.00 hr	N/A	1,342.46	66.79	0.00000	154.46

Detailed Report for Junction: Riverview (East)

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,359.19	74.03	0.00000	171.19
21.00 hr	N/A	1,359.19	74.03	0.00000	171.19
22.00 hr	N/A	1,359.19	74.03	0.00000	171.19
23.00 hr	N/A	1,359.19	74.03	0.00000	171.19
24.00 hr	N/A	1,349.28	69.74	0.00000	161.28

Detailed Report for Junction: Riverview (West)

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	8,873.60 ft	Elevation	1,187.00 ft
Y	-15,280.96 ft	Zone	Zone-1

Connecting Pipes
P-130
P-187

Demand Summary

Type	Demand (cfs)	Pattern
Demand	10.08000	RVW-12hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,347.79	69.53	0.83966	160.79
1.00 hr	N/A	1,351.32	71.06	0.83966	164.32
2.00 hr	N/A	1,351.32	71.06	0.83966	164.32
3.00 hr	N/A	1,351.31	71.06	0.83966	164.31
4.00 hr	N/A	1,316.85	56.15	0.83966	129.85
5.00 hr	N/A	1,343.87	67.84	0.00000	156.87
6.00 hr	N/A	1,337.06	64.89	0.00000	150.06
7.00 hr	N/A	1,337.06	64.89	0.00000	150.06
8.00 hr	N/A	1,311.63	53.89	0.00000	124.63
9.00 hr	N/A	1,286.38	42.98	0.00000	99.38
10.00 hr	N/A	1,286.38	42.98	0.00000	99.38
11.00 hr	N/A	1,299.22	48.53	0.00000	112.22
12.00 hr	N/A	1,299.22	48.53	0.00000	112.22
13.00 hr	N/A	1,299.22	48.53	0.00000	112.22
14.00 hr	N/A	1,332.14	62.77	0.00000	145.14
15.00 hr	N/A	1,348.04	69.64	0.00000	161.04
16.00 hr	N/A	1,348.04	69.64	0.00000	161.04
17.00 hr	N/A	1,321.68	58.24	0.83966	134.68
18.00 hr	N/A	1,321.68	58.24	0.83966	134.68
19.00 hr	N/A	1,340.98	66.58	0.83966	153.98

Detailed Report for Junction: Riverview (West)

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,357.70	73.82	0.83966	170.70
21.00 hr	N/A	1,357.70	73.82	0.83966	170.70
22.00 hr	N/A	1,357.70	73.82	0.83966	170.70
23.00 hr	N/A	1,357.70	73.82	0.83966	170.70
24.00 hr	N/A	1,347.79	69.53	0.83966	160.79

Detailed Report for Junction: South (East)

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	13,854.66 ft	Elevation	1,183.00 ft
Y	-34,475.57 ft	Zone	Zone-1

Connecting Pipes
P-227
P-228

Demand Summary

Type	Demand (cfs)	Pattern
Demand	19.80000	SOE-15hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,340.48	68.10	0.00000	157.48
1.00 hr	N/A	1,344.01	69.62	0.00000	161.01
2.00 hr	N/A	1,344.01	69.63	0.00000	161.01
3.00 hr	N/A	1,344.01	69.62	0.00000	161.01
4.00 hr	N/A	1,299.60	50.42	0.00000	116.60
5.00 hr	N/A	1,325.13	61.46	0.00000	142.13
6.00 hr	N/A	1,318.32	58.52	0.00000	135.32
7.00 hr	N/A	1,318.32	58.52	0.00000	135.32
8.00 hr	N/A	1,261.65	34.01	0.00000	78.65
9.00 hr	N/A	1,209.51	11.46	1.32066	26.51
10.00 hr	N/A	1,209.51	11.46	1.32066	26.51
11.00 hr	N/A	1,222.34	17.01	1.32066	39.34
12.00 hr	N/A	1,222.34	17.01	1.32066	39.34
13.00 hr	N/A	1,222.34	17.01	1.32066	39.34
14.00 hr	N/A	1,255.27	31.25	1.32066	72.27
15.00 hr	N/A	1,284.08	43.71	1.32066	101.08
16.00 hr	N/A	1,284.08	43.71	1.32066	101.08
17.00 hr	N/A	1,259.21	32.95	1.32066	76.21
18.00 hr	N/A	1,259.21	32.95	1.32066	76.21
19.00 hr	N/A	1,312.89	56.17	1.32066	129.89

Detailed Report for Junction: South (East)

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,326.57	62.08	1.32066	143.57
21.00 hr	N/A	1,326.57	62.08	1.32066	143.57
22.00 hr	N/A	1,326.57	62.08	1.32066	143.57
23.00 hr	N/A	1,326.57	62.08	1.32066	143.57
24.00 hr	N/A	1,340.48	68.10	0.00000	157.48

Detailed Report for Junction: South (West)

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	9,015.04 ft	Elevation	1,182.00 ft
Y	-33,048.72 ft	Zone	Zone-1

Connecting Pipes
P-229
P-211

Demand Summary

Type	Demand (cfs)	Pattern
Demand	17.03000	SOW-13hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,335.58	66.41	1.31131	153.58
1.00 hr	N/A	1,339.10	67.94	1.31131	157.10
2.00 hr	N/A	1,339.10	67.94	1.31131	157.10
3.00 hr	N/A	1,339.10	67.94	1.31131	157.10
4.00 hr	N/A	1,294.70	48.73	1.31131	112.70
5.00 hr	N/A	1,320.23	59.78	1.31131	138.23
6.00 hr	N/A	1,313.42	56.83	1.31131	131.42
7.00 hr	N/A	1,313.42	56.83	1.31131	131.42
8.00 hr	N/A	1,258.11	32.91	1.31131	76.11
9.00 hr	N/A	1,225.01	18.60	0.00000	43.01
10.00 hr	N/A	1,225.01	18.60	0.00000	43.01
11.00 hr	N/A	1,237.84	24.15	0.00000	55.84
12.00 hr	N/A	1,237.84	24.15	0.00000	55.84
13.00 hr	N/A	1,237.84	24.15	0.00000	55.84
14.00 hr	N/A	1,270.77	38.39	0.00000	88.77
15.00 hr	N/A	1,299.58	50.85	0.00000	117.58
16.00 hr	N/A	1,299.58	50.85	0.00000	117.58
17.00 hr	N/A	1,274.71	40.09	0.00000	92.71
18.00 hr	N/A	1,274.71	40.09	0.00000	92.71
19.00 hr	N/A	1,325.07	61.87	0.00000	143.07

Detailed Report for Junction: South (West)

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,333.85	65.66	1.31131	151.85
21.00 hr	N/A	1,333.85	65.66	1.31131	151.85
22.00 hr	N/A	1,333.85	65.66	1.31131	151.85
23.00 hr	N/A	1,333.85	65.66	1.31131	151.85
24.00 hr	N/A	1,335.58	66.41	1.31131	153.58

Detailed Report for Junction: Willowbrook

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	11,483.17 ft	Elevation	1,195.00 ft
Y	-7,169.92 ft	Zone	Zone-1

Connecting Pipes
P-204
P-205

Demand Summary

Type	Demand (cfs)	Pattern
Demand	32.37000	WB-12hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,368.85	75.18	2.49249	173.85
1.00 hr	N/A	1,372.37	76.70	2.49249	177.37
2.00 hr	N/A	1,372.37	76.70	2.49249	177.37
3.00 hr	N/A	1,372.37	76.70	2.49249	177.37
4.00 hr	N/A	1,364.48	73.29	2.49249	169.48
5.00 hr	N/A	1,380.59	80.26	2.49249	185.59
6.00 hr	N/A	1,373.78	77.31	2.49249	178.78
7.00 hr	N/A	1,373.78	77.31	2.49249	178.78
8.00 hr	N/A	1,377.06	78.73	0.00000	182.06
9.00 hr	N/A	1,362.57	72.46	0.00000	167.57
10.00 hr	N/A	1,362.57	72.46	0.00000	167.57
11.00 hr	N/A	1,375.40	78.01	0.00000	180.40
12.00 hr	N/A	1,375.40	78.01	0.00000	180.40
13.00 hr	N/A	1,375.40	78.01	0.00000	180.40
14.00 hr	N/A	1,394.03	86.07	0.00000	199.03
15.00 hr	N/A	1,381.19	80.52	0.00000	186.19
16.00 hr	N/A	1,381.19	80.52	0.00000	186.19
17.00 hr	N/A	1,365.31	73.65	0.00000	170.31
18.00 hr	N/A	1,365.31	73.65	0.00000	170.31
19.00 hr	N/A	1,361.94	72.19	2.49249	166.94

Detailed Report for Junction: Willowbrook

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,375.90	78.23	2.49249	180.90
21.00 hr	N/A	1,375.90	78.23	2.49249	180.90
22.00 hr	N/A	1,375.90	78.23	2.49249	180.90
23.00 hr	N/A	1,375.90	78.23	2.49249	180.90
24.00 hr	N/A	1,368.85	75.18	2.49249	173.85

Detailed Report for Junction: Willowcreek

Scenario Summary	
Label	Peak Demand July
Demand Alternative	Demand-Peak Demand July
Physical Alternative	Base-Physical
Initial Settings Alternative	Base-Initial Settings
Operational Alternative	Base-Operational
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow

Calibration Summary			
Demand	<none>	Roughness	<none>

Geometric Summary			
X	12,931.82 ft	Elevation	1,196.00 ft
Y	-3,661.23 ft	Zone	Zone-1

Connecting Pipes
P-238
P-198

Demand Summary

Type	Demand (cfs)	Pattern
Demand	32.37000	WC-12hrs

Calculated Results Summary

Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
0.00 hr	N/A	1,371.10	75.72	2.49249	175.10
1.00 hr	N/A	1,374.62	77.24	2.49249	178.62
2.00 hr	N/A	1,374.62	77.24	2.49249	178.62
3.00 hr	N/A	1,374.62	77.24	2.49249	178.62
4.00 hr	N/A	1,374.91	77.37	0.00000	178.91
5.00 hr	N/A	1,389.45	83.65	0.00000	193.45
6.00 hr	N/A	1,382.64	80.71	0.00000	186.64
7.00 hr	N/A	1,382.64	80.71	0.00000	186.64
8.00 hr	N/A	1,385.44	81.92	0.00000	189.44
9.00 hr	N/A	1,372.32	76.25	0.00000	176.32
10.00 hr	N/A	1,372.32	76.24	0.00000	176.32
11.00 hr	N/A	1,385.15	81.79	0.00000	189.15
12.00 hr	N/A	1,385.15	81.79	0.00000	189.15
13.00 hr	N/A	1,385.15	81.79	0.00000	189.15
14.00 hr	N/A	1,401.95	89.06	0.00000	205.95
15.00 hr	N/A	1,381.84	80.36	2.49249	185.84
16.00 hr	N/A	1,381.84	80.36	2.49249	185.84
17.00 hr	N/A	1,367.11	73.99	2.49249	171.11
18.00 hr	N/A	1,367.11	73.99	2.49249	171.11
19.00 hr	N/A	1,364.16	72.72	2.49249	168.16

Detailed Report for Junction: Willowcreek

Calculated Results Summary					
Time	Constituent (mg/l)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Demand (Calculated) (cfs)	Pressure Head (ft)
20.00 hr	N/A	1,377.62	78.54	2.49249	181.62
21.00 hr	N/A	1,377.62	78.54	2.49249	181.62
22.00 hr	N/A	1,377.62	78.54	2.49249	181.62
23.00 hr	N/A	1,377.62	78.54	2.49249	181.62
24.00 hr	N/A	1,371.10	75.72	2.49249	175.10

Appendix G
Right-of-Way Report & Property Ownership Maps

Alternative A:

Unless otherwise indicated, the printout for Maricopa County tax record ownership has been obtained for future contact purposes, based upon parcel number(s) on the listed County Assessor's maps. These maps are also contained in the report. The maps and the parcels therein are listed in a north-to-south fashion from the CAP Canal to Lake Pleasant Road and Rose Garden Lane.

County Assessor Map Number	Sheet	Township	Section	Parcel Numbers
201-32		T5N, R1E		Shows no parcels (probable indicator government land).
201-30		T5N, R1E	15	201-30-001.
201-19		T5N, R1E	22, 27 & 28	201-19-003A, 005 and 007.
201-06	3	T4N, R1E	part of 33	201-06-075, 004A, 004B, 002B, 003L, 003S, 003U, 003W, 003N. Note: 003U and 003W were not found in Maricopa County Treasurer's database.
201-06	1	T4N, R1E	part of 4	201-06-009L, 009J, 009Q, 009R, 009S, 009E and 009D. Note: Parcel data incomplete for this section – need Maricopa County Recorder Map MCR 376-31.
201-17		T4N, R1E	4	201-17-002J.
201-08		T4N, R1E	8	201-08-008V, 008W, 008X, 010J, 010G, 043, 047E, one USA parcel, 049E, 050C, 050E , 040A, 051C, 051E, 041C and 041B: all on west side of roadway.
201-16		T4N, R1E	9	201-16-019B; data not obtained east side of roadway.
200-10	1	T4N, R1E	part of 17	200-10-006A, 013B, 013C, 034A, 036D, 016B and C – not in database, 025, 049A, 047A, 022A – not in database, and 017A.
200-10	8	T4N, R1E	part of 17	200-10-562 through 200-10-571;

				residential subdivision.
200-09	1	T4N, R1E	part of 17	Need MCR 456-06, 1998 subdivision.

Put assessor's maps for subdivisions in sequence from Williams Road to Rose Garden Lane, then west along Rose Garden Lane to the Citizen's Treatment Plant west of 111th Avenue.

The following data is the terminus ownership for all four alternatives:

200-1	3	T4N, R1E	SW4 of 19	200-13-002C, 002D, 002E, 002F and 002G. This map also shows the SRP powerline easement which enters the north end area of the treatment plant.

Alternative B:

Unless otherwise indicated, the printout for Maricopa County tax record ownership has been obtained for future contact purposes, based upon parcel number(s) on the listed County Assessor's maps. These maps are also contained in the report. The maps and the parcels therein are listed in a north-to-south fashion from the Beardsley Canal to Rose Garden Lane.

County Assessor Map Number	Sheet	Township	Section	Parcel Numbers
		T5N, R1E	31	No assessor's numbers on this map.
		T5N, R1W	35 & 36	No assessor's numbers on this map, but government land office parcels are.
201-21	1 of 2	T4N, R1E	6	201-21-011, 012, 017, 018A, 018B, 023, 024A, 029A, 030, 035, 036, 041C, 041D, 041B, 042, 047, 048, 054 and 055.
201-22	1	T4N, R1E	7	201-22-025A, 026, 029, 030, 033B, 033A, 034A, 034B, 037, 038, 021, 042, 045, 046 and 022.
200-11	1 of 3	T4N, R1E	18	200-11-044, 001 and 003A.
200-12	1 of 12	T4N, R1E	19	200-12-005, 006, 009, 010, 019, 011A, 011B, 014, 015B and 015C.

Alternative C:

Unless otherwise indicated, the printout for Maricopa County tax record ownership has been obtained for future contact purposes, based upon parcel number(s) on the listed County Assessor's maps. These maps are also contained in the report. The maps and the parcels therein are listed in a north-to-south fashion from the Beardsley Canal to Rose Garden Lane.

County Assessor Map Number	Sheet	Township	Section	Parcel Numbers
503-89	Sheet 7	T5N, R1W	35	Blank except for GLO comment
503-89	Sheet 1	T5N, R1W	35 & 36	Blank
503-53	1 of 2	T4N, R1W	1, 2, 3, 10, 11, 12, 13, 14 & 15	Section 2 – State Trust Land Section 11, - State Trust Land Section 14 – State Trust Land + 503-53-035E, 503-53-055F

Table: Assessor Parcel Number/Assessor Tax Statement Name(s) Alternatives A & B (at time of composition of this table, indications were that Alternatives C and D had been deleted and further research/documentation not necessary-will update for appendix as may be required at future date)

NORTH TO SOUTH

ALTERNATIVE A:		
202-30-001	United States of America	Valley Center, Suite 2200 Phoenix, AZ 85073
201-19-003A 201-19-005	Flood Control District of Maricopa County	3334 W. Durango Street Phoenix, AZ 85009
201-19-007 201-06-075	Pivotal Realty AZ ILLC	2415 E. Camelback Road, Suite 960 Phoenix, AZ 85016-4209
201-06-004A 201-06-004B	Lake Pleasant 241	2525 E. Arizona Biltmore Circle, Suite 118 Phoenix, AZ 85016-2129
201-06-002B 201-06-003L	10/18/99: Conveyed to Lawyers Title by Pleasant Road, LP	Attn: Harold M. Scarff: 5754 E. Orange Blossom Lane Phoenix, AZ 85018-6729
201-06-003J	Haught, Franklin V. and Ethel B.	27277 N. Lake Pleasant Road Peoria, AZ 85382-9724
201-06-003K	Reyes, Angel, & Amparo	18651 N. 73rd Avenue Glendale, AZ 85308-5829
201-06-003S	1/05/00: Conveyed to Binh G. Bui as sole & separate property by Diguida, Romeo and Theresa	15836 N. 51st Place Scottsdale, AZ 85254-1617
201-06-003T	Mannino, Carl	3007 E. Rockwood Drive Phoenix, AZ 85050-3423
201-06-003U	Rezotko, Linda M. & Cussen, Laura M. Trust	1609 E. Greenwood Drive Mt. Prospect, IL 60056-1521
201-06-003V 201-06-003W	These two parcels not available by internet inquiries in March and June of 2000.	
201-06-003N	Pleasant Road, LP	c/o Harold M. Scarff 5754 E. Orange Blossom Lane Phoenix, AZ 85018-6729
201-06-009J	Conveyed to JKW Partners, LLC. by Lutheran Church Extension Fund	Site #143, St. Louis, MO. 63122

ALTERNATIVE A:		
201-06-009L	Modonia Raffaele Trust	5537 W. Alameda Road Glendale, AZ 85310-3610
201-06-009Q 201-06-009R	Mount Baldy, LP	3303 S. 40th Street Phoenix, AZ 85040-1601
201-06-009S	Hung-Kong Yan	c/o Property Tax Relief 2920 N. Seventh Street, Suite 3 Phoenix, AZ 85014-5403
201-06-009D	Richard M. Feldheim, et al	6211 E. Arabian Way Paradise Valley , AZ 85253-1845
201-06-009E	36 Lake Pleasant Rd. Assoc., LP	5830 N. 12th Place, Apt. 5 Phoenix, AZ 85014-2359
201-17-002J	Brophy William Henry College, et al	4701 N. Central Avenue Phoenix, AZ 85012
201-08-008V 201-08-008W 201-08-008X	Kharme, Parmesh M. & Ladonna K.	7033 W. Sack Drive Glendale, AZ 85308-5763
201-08-010J 201-08-010G	Fahey, Tanya Melton Trust	3012 N. Manor Drive East Phoenix, AZ 85014
201-08-043E	Yankun, Richard A. and Joan	P.O. Box 5 Wollaston, MA 02170-0001
201-08-045B	This parcel not available by internet inquiries in March and June 2000	
201-08-047E	Karmo, Johnny and Diane, et al	4713 Wendrick West Bloomfield, MI 48323
201-08-049E	Starligh Enterprises, Inc.	R.R. 8 32 25 Lethbridge, AB TIJ 4P4 Canada
201-08-050C	Wong, Kim and Carol	1768 E. Desert Park Lane Phoenix, AZ 85020-4432
201-08-050E	Wong Kim/Carol TR Wong Kim/Carol TR	1768 E. Desert Park Lane Phoenix, AZ 85020-4432
201-08-040A	Amrose Frances Trust	9513 W. Glen Oaks Circle Sun City, AZ 85351-1406
201-08-051C 201-08-051E	Wong Kim/Carol TR Wong Kim/Carol Trust	1768 E. Desert Park Lane Phoenix, AZ 85020-4432

ALTERNATIVE A:		
201-08-041C	John C. Chan Family Trust, Chan John C N/Marilyn Trustees	16615 N. 35th Drive Phoenix, AZ 85053-2972
201-08-041B	Maricopa County Highway Department	3335 W. Durango Street Phoenix, AZ 85009-6214
201-08-052E	Wong Kim/Carol TR Wong Kim/ Carol Trust	1768 E. Desert Park Lane Phoenix, AZ 85020-4432
201-08-020B 201-08-019B 201-08-013B & 017B	SRPAI and PD	P.O. Box 1980 Phoenix, AZ 85001-1980
201-08-018B	This parcel not available by internet inquiries in March and June 2000	
200-10-006A	LLP Investors, LLC	8801 W. Union Hills, Suite E 200 Peoria, AZ 85382
200-10-013B	Lorvig, L.H. and Beverly Lee	3849 W. Mauna Loa Lane Phoenix, AZ 85053-4538
200-10-013C	P.R. Management Company	4216 N. Brown Avenue, Suite A Scottsdale, AZ 85251-3914
200-10-034A 200-10-016C	Peoria North Commercial, LP	4216 N. Brown Avenue, Suite A Scottsdale, AZ 85251-3914
200-10-036D	Sager, George	9516 S. Exchange Avenue Chicago, IL 60617-5027
200-10-016B	Exempt, City of Peoria (no assessor tax sheet)	
200-10-025	Reardon, Nina and McBride Zenia	P.O. Box 5103 Oakbrook, IL 60522-5103
200-10-049A	Lauterbach, Virginia and Edward G. Trust	1500 Evergreen Terrace Glenview, IL 60025
200-10-047A	Shemer Investment Company/ Shemer, W. Barry TR/E	5230 E. Shangri La Road Scottsdale, AZ 85254-4763
200-10-022A	This parcel not available by internet inquiries in March and June 2000	
200-10-017A	Taurus Properties, LLC	21743 21st Avenue West Brier, WA 98036-8186
200-10-562, 563, 564, 565, 566, 567, 568, 569, 570 & 571	CHI Construction Company	7001 N. Scottsdale Road, Suite 2050 Scottsdale, AZ 85253-3698

ALTERNATIVE A:		
200-11-005G 200-11-005H 200-12-001H 200-12-001J	SRPAI and PD	P.O. Box 1980 Phoenix, AZ 85001-1980
200-13-002C 200-13-002F	Sun City West Utilities Company	High Ridge Park Stamford, CT 06905
200-13-002D	Sun City West Utilities Company	c/o Financial/Tax Services Corp. 968 White Plains Road Trumbull, CT 06611-4550
200-13-002G	Del Webb Corporation	2231 E. Camelback Road, Suite 400 Phoenix, AZ 85016-3435

ALTERNATIVE B:

201-21-011	Stevens, Patricia G.	2939 N. 25th Place Phoenix, AZ 85016-7903
201-21-012	Renz. Curt H. and Virginia D. Trust	7127 N. 15th Place Phoenix, AZ 85020-5416
201-21-017	Pease, H. Roger and Carol A.	3345 W. Sandra Terrace Phoenix, AZ 85023
201-21-018	Stewart, Leland H. and Bobbye J.	2004 Brady Avenue Las Vegas, NV 89101-1248
201-21-023	Conveyed by Vorderer, Ronald L.	P.O. Box 1364 Sun City, AZ 83572
	W1/2 of Glo 33 to Rebekah Donoghue as sole and separate property; E1/2 of Glo 33 to Quintanna and Romie except W. 170' of E1/2 which was conveyed to Kalkbrenner & Manges	
201-21-024A	Rinard, Louis W.	P.O. Box 1515 Sun City, AZ 85372-1515
201-21-029A	Rinard, Louis W. and Rinard, Louis W. Conto	P.O. Box 1515 Sun City, AZ 85372-1515
201-21-030	Hineman, Lillian	P.O. Box 742 Marshalltown, IA 50148-0742
201-21-035	Gordon, Vera L. Trust	c/o Vera L. Gordon 2401 W. Southern Avenue, Lot 1 Tempe, AZ 85282-4307
201-21-036	Peters, Robert W. and Tammy L.	P.O. Box 11853 Sun City, AZ 85318-1853
201-21-041C 201-21-041D	Flanagan, Randal S.	4472 W. Oraibi Drive Sun City, AZ 857373
201-21-041B	Fitzgerald, Lynd L. and Kathryn A.	4155 Berkeley View Drive Duluth, GA 30096-3068
201-21-042	Lopez, Anna Christina	5226 W. Edgemont Avenue Phoenix, AZ 85035-1916
201-21-047 201-21-048	Chaifetz, Sam/Leigh/Lori/ McCormack, Jerry	6412 E. Claire Drive Scottsdale, AZ 85254-2623

ALTERNATIVE B:

201-21-054 201-21-055	Dalton, Larry J. and Korrean C.	1308 E. Commodore Place Tempe, AZ 85283
201-22-025A	Navazo, Cosme and Yolanda	4211 W. Greenway Road Phoenix, AZ 85053-3751
201-22-026 201-22-029	06/01/00: Conveyed to TGD Development by Mayhugh, Naoma H. Trust	1345 W. Woodland Avenue Phoenix, AZ 85007-2532
201-22-030	Pettolantiz, Joshua L.	19010 N. 20th Drive Phoenix, AZ 85027
201-22-033A	Fronsman, Adella M.	P.O. Box 321 Wittmann, AZ 85361-0321
201-22-033B	Adler, Dorothy M.	12435 Cherry Hill Sun City, AZ 85351
201-22-034A	Bayman, Jane Ann	742 W. Monte Vista Road Phoenix, AZ 85007-1529
	Not in Maricopa County Recorder's records on July 6, 2000	
201-22-034B	Rose, Larry	P.O. Box 995 Imperial, CA 92251-0995
201-22-037	Bayham, Alan Philip, Jr.	2125 E. Solano Drive Phoenix, AZ 85016-2725
201-22-038	Moseley, Wade and Joanne	9122 E. Diamond Drive Sun Lakes, AZ 85248-0824
201-22-021 201-22-042	Mullan, Gerald J. Trust	21731 Greater Mack Avenue St. Clair Shores, MI 48080-2418
	May have been conveyed to Rose, Larry D. on 4/26/00	
201-22-045 201-22-046	Rose, Larry D.	P.O. Box 995 Imperial, CA 92251-0995
201-22-022 201-11-004	Rose Larry Dale, et al	P.O. Box 2979 Yuma, AZ 85366
201-11-001	Arizona State Land Department	1616 W. Adams Street Phoenix, AZ 85007-2606
201-11-003A	Finley Hibbert Investment, et al	6528 E. Bar Z Lane Paradise Valley, AZ 85253-1873

ALTERNATIVE B:		
200-12-005	Camelback Trust Company Trust	c/o Colonial Trust Company 5336 N. 19th Avenue Phoenix, AZ 85015-2944
200-12-006 200-12-009	Colonial Trust Company	5336 N. 19th Avenue Phoenix, AZ 85015-2944
200-12-010	Neal S. Sundeen & Jane W. Sundeen	7454 E. Cactus Wren Road Scottsdale, AZ 85250-4603
200-12-019	Camelback Trust Company Trust	c/o Colonial Trust Company 5336 N. 19th Avenue Phoenix, AZ 85015-2944
200-12-011A	Hayes, George R. Trust	2636 Armstrong Avenue Holmes, PA 19043-1027
200-12-011B 200-12-014 200-12-015C	C.A. Norris Enterprises, Ltd., et al	6528 E. Bar Z Lane Scottsdale, AZ 85253-1873
200-12-015B	Maricopa County	111 S. Third Avenue, Frnt Phoenix, AZ 85003-2225

Appendix H
Geotechnical Report

PRELIMINARY GEOTECHNICAL EXPLORATION
GROUNDWATER SAVINGS PROJECT
NORTHWEST MARICOPA COUNTY, ARIZONA
FOR
HDR ENGINEERING, INC.

TEC 00T023RPT.01
JUNE 14, 2000

TERRANE ENGINEERING CORPORATION

TERRANE ENGINEERING CORPORATION
1920 East Third Street, #8
Tempe, Arizona 85281
480.894.1207 TEL • 480.894.2667 FAX

June 14, 2000

Mr. Dave Buras
HDR Engineering, Inc.
2141 E. Highland Ave., Ste. 250
Phoenix, AZ 85016-4736

Re: Preliminary Geotechnical Exploration
Groundwater Savings Project
Northwest Maricopa County, Arizona
TEC 00T023RPT.01

Dear Mr. Buras:

Terrane Engineering Corporation *(TEC)* is pleased to provide the attached report for the referenced project. This service was performed in general accordance with *TEC* Proposal 00015PR.FC, dated February 23, 2000.

The report summarizes project and site data, describes the services we performed, and presents preliminary geotechnical information for the three alternative pipeline routes. The report appendix presents supporting information such as figures and test pit logs. Soil samples from the test pits will be stored for 60 days from this date.

We have enjoyed providing this service for you. If you have any questions concerning this report, or if I may be of additional service, please contact me.

Sincerely,

TERRANE ENGINEERING CORPORATION

Frank Costello

Registered Professional Engineer (Civil) CERTIFICATE NO. 19397 FRANK COSTELLO Date Signed 6/14/00 ARIZONA, U.S.A.

Frank Costello, P.E.

Copies to: Addressee (4)

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PRELIMINARY GEOTECHNICAL EXPLORATION
GROUNDWATER SAVINGS PROJECT
NORTHWEST MARICOPA COUNTY, ARIZONA

FOR
HDR ENGINEERING, INC.

***TEC* 00T023RPT.01**
JUNE 14, 2000

1. INTRODUCTION

This report presents the results of a preliminary geotechnical exploration regarding pipeline route alternatives for the Groundwater Savings Project in northwest Maricopa County, Arizona. This service was performed in general accordance with *TEC* Proposal 00015PR.FC, dated February 23, 2000, to provide preliminary information regarding soil conditions along three alternative pipeline routes. Evaluation of potential effects of the Agua Fria River, such as scour or elevated groundwater levels, was not part of the scope of services for this preliminary geotechnical exploration

2. PROJECT DESCRIPTION

The pipeline is likely to be constructed of 24-inch, ductile iron pipe and be laid within 10 feet of existing grades. It will connect the Sun City Waste Water Treatment Plant (WWTP) to either the Beardsley Canal or the CAP Canal. Three routes (A, B, and C) are being considered; their alignments are shown on the Alternative Route Map in the Appendix. From the Sun City WWTP, Route A generally follows Rose Garden Lane and Lake Pleasant Highway to the CAP Canal; Route B generally follows 115th Avenue and the northward projection of 115th Avenue to the Beardsley Canal; and Route C generally follows Beardsley Road, El Mirage Road, and the northward projection El Mirage Road to the Beardsley Canal. Routes A, B, and C are about 8, 4, and 5 miles long, respectively.

3. SCOPE OF SERVICES

Two categories of services, field and engineering, were required for this geotechnical study, which are described in the following subsections. These services were performed by *TEC* in general accordance with *TEC* Proposal 00015PR.FC and current standards of practice for engineering.

3.1 Field

The field exploration program consisted of obtaining public utility clearances, obtaining permits for exploration in road right-of-ways, site reconnaissance by a field engineer, excavating and sampling 17 test pits with a rubber-tired backhoe, and performing field resistivity tests near the test pit locations. The test pits were excavated outside of the roadway and advanced to a depth of 10 feet or practical refusal, whichever occurred first, and backfilled with excavated soils upon completion. The field engineer logged the test pits, obtained grab samples of soils encountered for review by other project team members, and performed the field resistivity tests. There were seven test pits along Route A, four test pits along Route B, and six test pits along Route C. The approximate location of each test pit is shown on the Alternative Route Map.

3.2 Engineering

Engineering services included compiling field and research data, drafting written and graphical summaries of geotechnical data, and preparing a report of the preliminary exploration's results regarding soil conditions along the three alternative routes.

4. SITE CHARACTERIZATION

Information regarding topography, geology, and surface and near-surface soil conditions is presented in this section. The preliminary information presented herein is based on cursory reconnaissance along each route, U.S. Geological (USGS) surveys, shallow test pits along the alternative routes, and U.S. Soil Conservation Service (SCS) soil surveys.

4.1 Topography

Cursory reconnaissance indicated that most of the land along each route is undeveloped and in native condition. In developed areas, land usages included agricultural, commercial, industrial, and residential. Residential usage was denser in the southern and eastern parts of the alternative routes.

The USGS Calderwood Butte and Baldy Mountain Quadrangles indicate that drainage in the area bounded by the alternative routes is generally southward, following the Agua Fria River. Elevations at the ends of the routes are – 1,200 feet at the Sun City WWTP, 1,500 feet at the north end of Route A, 1,350 feet at the north end or Route B, and 1,340 at the north end of Route C. Surface grades along the routes were generally less than one percent; however, surface grades in the north part of Route B were about 3 percent. Each route crosses several washes. Also, Route A crosses the Marinette Heading Canal, and Routes B and C cross the Agua Fria River.

4.2 Regional and Site Geology

Southern and western Arizona are in the Basin and Range Province. This physiographic province is characterized by northwest-southeast trending, elongate, block-fault mountain ranges (horsts) separated by deep basins (grabens). During the latter part of the Cenozoic Era, the Earth's crust was pulling apart in this province; the resulting tension faulting caused the basins to sink. In the remainder of the Tertiary Period and during the Quaternary Period, the ranges have been eroding and filling the valleys with alluvium (clays, silts, sands, and gravels). Some of the basins have thick sequences of evaporite deposits. Also, layers of lava or volcanic ash related to volcanism in Arizona exist in some of the basins. The routes are in one of the valleys of the Basin and Range Province with isolated mountain ranges around the valley. Valley materials between the mountains above bedrock consist of late Tertiary and Quaternary soil deposits, and the primary landforms in the area bounded by the routes are valley fill, alluvial fans, and alluvium.

4.3 Test Pit and Laboratory Summary

Details observed in the test pits are presented on the logs in the Appendix, and a summary of observations for each route is presented in this section.

Along Route A, sandy lean clays (CL) were the predominant soils to the full depth of exploration. Clayey sands with gravel (SC) were encountered in Test Pits A1, A3, and A4 below depths of 5, 6, and 1 feet, respectively. Practical backhoe refusal was encountered in Test Pits A4 through A7 at depths of 3, 7, 2, and 3 feet, respectively. Heavy calcareous cementation was encountered in each of the test pits, generally, about 2 feet below the surface, but the depth to heavy cementation varied from less than 1 foot to 5 feet. Field resistivities at a depth of 10 feet ranged from 9,000 to 57,000 ohms/cm.

Along Route B, clayey sands with varying gravel and cobble percentages were the predominant surface and near-surface soils. Sandy lean clay was encountered at the surface in Test Pit B1. In and along the Agua Fria River (Test Pits B1 through B3), well-graded sands and gravels with cobbles (SW and GW) were encountered below depths of 3 to 5 feet. In Test Pit B4, heavy calcareous cementation was encountered at a depth of 3 feet and practical refusal was encountered at a depth of 5 feet. Field resistivities at a depth of 10 feet ranged from 30,000 to 42,000 ohms/cm.

Along Route C, interbedded sandy lean clays and clayey sands with varying gravel and cobble percentages were the predominant soils to the full depth of exploration. Silty sands with gravel (SM) were encountered in Test Pits C5 and C6 below a depth of 3 feet. Practical backhoe refusal was encountered in Test Pits C2, C3, C4, and C6 at a depth of 5 feet. Heavy calcareous cementation was encountered in each of the Test Pits C2 through C6 at depth 2 to 3 feet. Field resistivities at a depth of 10 feet ranged from 9,000 to 36,000 ohms/cm.

4.4 SCS Summary

Two SCS soil surveys were reviewed for this report -- *Soil Survey of Maricopa County, Arizona, Central Part* and *Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona.* These surveys provide information about the extent and characteristics of soils to a depth of about 5 feet. The SCS classifies soils, from general to specific, in associations, series, and individual soils. The following subsections provide selected information from the SCS publications for soil associations and soil series mapped along the alternative routes. The individual soils mapped along the routes are listed in the soil series subsection and shown on the Alternative Route Map in the Appendix.

- **4.4.1 Soil Associations:** Soils along the routes are of two general categories -- soils formed in recent alluvium and soils formed in old alluvium. Associations of soils formed in recent alluvium include Gilman-Estrella-Avondale, Antho-Valencia, and Carrizo-Brios. Associations of soils formed in old alluvium include Mohall-Laveen, Laveen-Coolidge, and Ebon-Pinamt-Tremant. Brief descriptions of each association and the soil series present in that association mapped in the area bounded by the routes are presented below:

  - Gilman-Estrella-Avondale Association: Nearly level loams and clay loams on valley plains and low stream terraces that include Gilman, Estrella, Avondale, Glenbar, Antho, Avonda, Agualt, Gadsden, and Cashion soils.

  - Antho-Valencia Association: Nearly level sandy loams on recent alluvial fans and valley plains that include Antho, Valencia, Gilman, Coolidge, Agualt, Maripo, Vint, Estrella, Carrizo, and Tremant soils.

  - Carrizo-Brios Association: Nearly level to gently sloping gravelly sandy loams in stream channels and on low stream terraces that include Carrizo, Brios, Vint, Torripsamment, Torrifluvent, Cashion, Gadsen, Maripo, and Antho soils.

  - Mohall-Laveen Association: Nearly level loams and clay loams on old alluvial fans and valley plains that include Mohall, Laveen, Tremant, Estrella, Vecont, Coolidge, and Valencia soils.

  - Laveen-Coolidge Association: Nearly level sandy loams, loams, and clay loams on old alluvial fans and valley plains that include Laveen, Coolidge, Mohall, Perryville, Tremant, Antho, Maripo, Rillito, and Gilman soils.

  - Ebon-Pinamt-Tremant Association: Nearly level to gently sloping gravelly loams, very cobbly loams, and gravelly clay loams on old alluvial fans at the base of

mountains that include Ebon, Pinamt, Tremant, Carrizo, Gunsight, Rillito, Cherioni, and Antho soils.

- **4.4.2 Soil Series:** Fifteen soil series and 21 individual soils were mapped by the SCS along the routes. Basic descriptions and typical engineering and index properties for each soil series are presented separately below; selected portions of this information for each are presented in summary tables in the Appendix. The symbols for the individual soils mapped in each series are listed in parentheses and shown on the Alternative Route Map. Soil series formed in recent alluvium include Antho, Brios, Carrizo, Estrella, Gilman, Torrifluvents, and Torripsamments and Torrifluvents, Frequently Flooded. Soil series formed in old alluvium include Beardsley, Estrella, Gunsight, Laveen, Mohall, Perryville, Pinal, Suncity, and Tremant.

  - **Antho Series (AGB):** "The Antho series consists of deep, well-drained soils. These soils formed in recent alluvium deposited on alluvial fans and stream terraces. The alluvium was derived from a wide variety of rock, but was dominantly from granite... In a representative profile, the soil is light yellowish-brown and light-brown sandy loam to a depth 47 inches and reddish-brown light sandy clay loam to a depth of 60 inches. The soil is slightly to strongly calcareous and moderately alkaline throughout. In places, it is gravelly throughout. Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate."

    Typically, Antho soils are non-plastic, silty sand with gravel (SM) from the surface to a depth of 60 inches. Permeability ranges from 2.0 to 6.0 inches per hour; pH ranges from 7.9 to 8.4, and salinity ranges from 1 to 2 millimhos per centimeter. Risk of corrosion is high for uncoated steel and low for concrete. These soils have medium shear strength, low to medium compacted permeability, and are susceptible to piping.

  - **Beardsley Series (BE):** "The Beardsley series consists of moderately deep, well-drained soils over an indurated hardpan. These soils formed on old alluvial fans and stream terraces derived from a wide mixture of rock, including andesite, granite, granite-gneiss, quartzite, and schist... In a representative profile, the surface layer is brown loam about 3 inches thick. The subsoil is reddish-brown clay loam and clay that extends to a depth of about 36 inches. The soil is moderately alkaline and strongly effervescent in the lower part of the subsoil. Permeability and runoff is slow, and there is no erosion hazard."

Typically, Beardsley soils are medium plasticity, fat clay (CL) from the surface to a depth of 36 inches and indurated silica-lime cemented hard pan below 36 inches. Permeability ranges from 0.2 to 0.6 inches per hour for the surface layer and 0.06 to 0.2 inches per hour; pH ranges from 7.9 to 8.4, and salinity ranges from 1 to 4 millimhos per centimeter. Risk of corrosion is high for uncoated steel and moderate for concrete. Limitations with regard to shallow excavations are severe and suitability as a source for road fill is poor. These soils have low shear strength, low compacted permeability, and are not susceptible to piping.

- **Brios Series (Br):** "The Brios series consists of deep, somewhat excessively drained soils. These soils formed in recent alluvium deposited on flood plains, low terraces, and alluvial fans. The alluvium was derived from rhyolite, andesite, quartzite, and limestone... In a representative profile, the surface layer is brown sandy loam about 14 inches thick. The underlying material to a depth of 60 inches is brown coarse sand that is stratified below a depth of 22 inches. The soil is moderately alkaline throughout. The surface layer is strongly effervescent, and the underlying material is slightly effervescent. Permeability is rapid. Runoff is slow, and the erosion hazard is slight."

  Typically, Brios soils are non-plastic, silty sand (SM) from the surface to a depth of 14 inches and non-plastic, poorly graded sand with gravel (SP) to a depth of 60 inches. Permeability ranges from 2.0 to 6.0 inches per hour for the surface layer and 6.0 to 20.0 inches per hour for the underlying layer; pH ranges from 7.9 to 8.4, and salinity ranges from 1 to 2 millimhos per centimeter. Risk of corrosion is moderate for uncoated steel and low to moderate for concrete. These soils have medium shear strength, low to medium compacted permeability, and are susceptible to piping.

- **Carrizo Series (Cb):** "The Carrizo series consists of deep, excessively drained soils. These soils formed in recent alluvium deposited on flood plains along the major streams and along stream channels in alluvial fans. The alluvium was derived from a wide mixture of rock, including granite, granite-gneiss, andesite, and basalt... In a representative profile, the surface layer is yellowish-brown gravelly sandy loam about 5 inches thick. The underlying material is pale-brown very gravelly loamy coarse sand and very gravelly coarse sand to a depth of 60 inches. The profile is moderately alkaline throughout and is weakly to moderately calcareous. Permeability is rapid. Runoff is slow, and erosion hazard is slight."

Typically, Carrizo soils are non-plastic, silty sands with gravel (SM) from the surface to a depth of 5 inches and non-plastic, well-graded sands and gravels with silt (SW-SM and GW-GM) to a depth of 60 inches. Permeability ranges from 2.0 to 6.0 inches per hour for surface layer to 20.0 inches per hour for underlying soil; pH ranges from 7.9 to 8.4, and salinity ranges from 1 to 2 millimhos per centimeter. Risk of corrosion is low for uncoated steel and concrete. These soils have high shear strength and high compacted permeability.

- **Carefree Series (13):** "The Carefree series consists of deep, well-drained, soils on fan terraces. These soils formed in alluvium derived dominantly from acid and basic igneous rock... In a representative profile, the surface layer is pink cobbly clay loam about 1 inch thick. The subsoil is about 17 inches thick. It is reddish-brown, clay. The underlying material is light reddish brown very plastic clay to a depth of 50 inches. The subsoils and underlying material pebbles and cobbles, large soft masses of lime and are moderately alkaline."

  Typically, Carefree soils are medium plasticity, cobbly clay loam (CL-ML) from the surface to a depth of 1 inch and high plasticity, fat clay (CH) to a depth of 60 inches. Permeability ranges from 0.06 to 0.2 inches per hour for the surface layer and underlying soil; pH ranges from 7.9 to 8.4, and salinity ranges from <2 to <4 millimhos per centimeter. Risk of corrosion is high for uncoated steel and low for concrete.

- **Estrella Series (Es):** "The Estrella series consists of deep, well-drained soils on broad alluvial fans and low terraces. These soils formed in medium-textured recent alluvium underlain by older alluvium from a wide mixture of rocks, including acid and basic igneous and some material from shale and limestone... In a representative profile, the soil is brown and light-brown loam to a depth of about 24 inches. Below this, to a depth of 48 inches, is an older, buried soil that is brown and reddish-yellow clay loam. The underlying material is mottled light-brown gravelly clay loam to a depth of 60 inches. The lower part of the older soils and the underlying material contain a large concentration of lime and a few pebbles. The soil is generally moderately alkaline throughout, but in some areas the lower part is strongly alkaline to very strongly alkaline. Permeability is moderately slow. Runoff is slow, and the erosion hazard is slight."

  Typically, Estrella soils are non-plastic, sandy silt (ML) from the surface to a depth of 24 inches and sandy lean clay (CL) to a depth of 60 inches. Permeability ranges from 0.6 to 2.0 inches per hour for the surface soil and from 0.2 to 0.6

inches per hour for the underlying soil; pH ranges from 7.9 to 8.5, and salinity ranges from 1 to 4 millimhos per centimeter. Risk of corrosion is high for uncoated steel and low for concrete. These soils have low shear strength, medium compacted permeability, and are susceptible to piping.

- **Gilman Series (Ge, GM, GgA):** "The Gilman series consists of deep, well-drained soils on valley plains and low stream terraces. These soils formed in recent alluvium derived from a wide mixture of rocks, including andesite, basalt, schist, rhyolite, and granite-gneiss... In a representative profile, the surface layer is yellowish-brown loam about 5 inches thick. The underlying material is light yellowish-brown loam and very fine sandy loam to a depth of 64 inches. The soil is moderately alkaline throughout and is weakly effervescent to strongly effervescent. Permeability is moderate. Runoff is slow, and the erosion hazard is slight to moderate."

  Typically, Gilman soils are non-plastic, sandy silt (ML) from the surface to a depth of 60 inches. Permeability ranges from 0.6 to 2.0 inches per hour; pH ranges from 7.9 to 9.6, and salinity ranges from 1 to 40 millimhos per centimeter. Risk of corrosion is high for uncoated steel and low to high for concrete. These soils have low shear strength, medium compacted permeability, and are susceptible to piping

- **Gunsight Series (GWD):** "The Gunsight series consists of deep, well-drained soils. These soils formed in mixed alluvium on old alluvial fans... In a representative profile, the surface layer is very pale brown and yellowish-brown gravelly loam about 1 inch thick. Below this is about 2 inches of light-brown loam, 4 inches of light-brown gravelly fine sandy loam, 39 inches of light-brown very gravelly loam, and 14 inches of yellowish-red and reddish-brown very gravelly sandy clay loam. The underlying material contains many soft lime masses and semi-rounded lime concretions and, in places, is weakly cemented. The soil is moderately alkaline. Permeability is moderate. Runoff is slow to medium and the erosion hazard is slight to moderate."

  Typically, Gunsight soil is medium plasticity, clayey gravel with sand (GC) from the surface to a depth of 60 inches. Permeability ranges from 0.6 to 2.0 inches per hour; pH ranges from 7.9 to 8.4, and salinity ranges from 1 to 4 millimhos per centimeter. Risk of corrosion is high for uncoated steel and low for concrete. These soils have medium shear strength and low compacted permeability.

- **Mohall Series (MTB, MV):** "The Mohall series consists of deep, well-drained soils that have visible amounts of lime at a moderate depth. These soils formed on old alluvial fans and valley plains. The alluvium was derived from granite, rhyolite, schist, and some material from neutral and basic igneous rocks and limestone... In a representative profile, the surface layer is brown clay loam about 12 inches thick. The subsoil is yellowish-red and reddish-brown clay loam to a depth of 35 inches and light-brown loam to a depth of 42 inches. The underlying material is light-brown very fine sandy loam to a depth of 60 inches. Permeability is moderately slow. Runoff is medium, and the erosion hazard is slight."

  Typically, Mohall soils are high plasticity, sandy lean clay (CL) from the surface to a depth of 35 inches and non-plastic, sandy silt (ML) to a depth of 60 inches. Permeability ranges from 0.2 to 0.6 inches per hour in the surface layer and 0.6 to 2.0 in the underlying soil; pH ranges from 7.9 to 8.4, and salinity ranges from 1 to 2 millimhos per centimeter. Risk of corrosion is high for uncoated steel and low for concrete. These soils have low shear strength, medium compacted permeability, and are susceptible to piping.

- **Perryville Series (PRB):** "The Perryville series consists of deep, well-drained soils that have large amounts of lime at or near the surface. These soils formed on old alluvial fans and stream terraces. The alluvium was derived from basalt, limestone, andesite, rhyolite, and rhyolite tuff and some granite and quartzite... In a representative profile, the surface layer is very pale brown gravelly loam about 8 inches thick. The underlying material is very pale brown gravelly loam and sandy loam to a depth of 65 inches and very pale brown very gravelly loamy sand to a depth of 72 inches. The soil is extremely calcareous and is moderately alkaline. The pebbles are lime nodules. Permeability is moderate. Runoff is slow to medium, and the erosion hazard is slight to moderate depending upon slope."

  Typically, Perryville soils are low plasticity, silty clayey sand (SC-SM) from the surface to a depth of 38 inches and non-plastic to low plasticity, silty sand (SM) to a depth of 60 inches. Permeability ranges from 0.6 to 2.0 for the surface layer and 2.0 to 6.0 inches per hour for the underlying soil; pH ranges from 7.9 to 8.4, and salinity ranges from 1 to 2 millimhos per centimeter. Risk of corrosion is high for uncoated steel and low for concrete. These soils have medium shear strength and medium compacted permeability.

- **Pinal Series (PT, PWB):** "The Pinal series consists of shallow, well-drained soils that are less than 20 inches deep over a silica-lime cemented hardpan. These

soils formed in old, gravelly or cobbly valley-fill material derived from mixed rocks on old alluvial fans and stream terraces. The rocks are chiefly granite, andesite, basalt, limestone, and tuff... In a representative profile, the surface layer is light yellowish-brown loam about 8 inches thick. The underlying material is light yellowish-brown cobbly loam to a depth of 12 inches. It is underlain by a white, indurated, silica-lime cemented hardpan. The soil is strongly alkaline and calcareous throughout. Permeability is moderate in the upper part, but the pan is nearly impermeable. Runoff is medium, and the erosion hazard is slight to moderate."

Typically, Pinal soils are non-plastic to low plasticity, sandy silt (ML) and silty sand (SM) from the surface to a depth of 12 inches. Permeability ranges from 0.6 to 2.0 inches per hour; pH ranges from 7.9 to 8.4, and salinity ranges from 2 to 4 millimhos per centimeter. Risk of corrosion is high for uncoated steel and low for concrete. Generally, hardpan is less than 20 inches deep.

- **Suncity Series (110):** "The Suncity Series consists of very shallow and well drained soils. These soils formed in alluvium. The alluvium was derived dominantly from acid and basic igneous rock on fan terraces. Depth to the duripan ranges from 5 to 20 inches. In a representative profile, the soil is light-brown gravely loam to a depth of about 1 inch. It is underlain by a reddish-brown gravely clay loam, that extends to a depth of 9 inches; and a pinkish white and light brown indurated silica and lime cemented duripan that is extremely hard, extremely firm, and violently effervescent to a depth of 60 inches. Permeability is moderate above the pan, and the pan is slowly permeable. Runoff is slow, and the erosion hazard is slight."

  Typically, Suncity soils are low plasticity, gravelly silt (GM-GC) at the surface and gravelly lean clay (CL) from 1 to 9 inches, and indurated duripan from 9 to 60 inches. Permeability ranges from 0.6 to 2.0 inches per hour; pH ranges from 7.9 to 8.4, and salinity is less than 2 millimhos per centimeter. Risk of corrosion is high for uncoated steel and low for concrete.

- **Tremant Series (TfA, TPB, TSC):** "The Tremant series consists of deep, well-drained soils. These soils formed in gravelly alluvium deposited as old alluvial fans and stream terraces. The alluvium was derived from mixed sources, but mainly from igneous rocks... In a representative profile, the surface layer is light-brown very gravelly loam about 1 inch thick. The subsoil is 35 inches thick. The upper 7 inches is reddish-brown clay loam, and the lower 28 inches is reddish-brown,

yellowish-red, reddish-yellow, and pink gravelly loam to a depth of 60 inches. The lower part of the subsoils and the underlying material contain large amounts of lime. The soil is moderately alkaline. Permeability is moderately slow. Runoff is medium, and the erosion hazard is slight to moderate depending upon slope."

Typically, Tremant soils are medium plasticity, clayey sand with gravel (SC) and clayey gravel with sand (GC) from the surface to a depth of 23 inches and non-plastic to low plasticity, silty sand (SM) and clayey sand (SC) to a depth of 60 inches. Permeability ranges from 0.2 to 0.6 inches per hour for the upper layer and 0.6 to 2.0 inches per hour for the underlying soil; pH ranges from 7.9 to 8.4, and salinity ranges from 1 to 4 millimhos per centimeter. Risk of corrosion is high for uncoated steel and low for concrete. These soils have medium shear strength and medium compacted permeability.

- **Torrifluvents (TB):** "Torrifluvents consist of young, unconsolidated gravelly, cobbly, and stony alluvium on young alluvial fans at the base of several mountain ranges. The surface is very undulating and dissected by many stream channels. Torrifluvents is highly stratified and varies widely in texture. It is 35 to 80 percent gravel, cobbles, and stones. The stony soils are near the mountains, and the gravelly soils are ¼ to 1 mile from the mountains... In a representative profile, the surface layer is brown clay loam about 10 inches thick. The underlying material is light-brown clay loam to a depth of 30 inches. Below this to a depth of 65 inches is old buried soil of brown sandy clay loam and clay loam. The lower part of the soil contains visible amounts of lime. The soil is moderately alkaline and strongly to violently effervescent. Permeability is moderately slow. Runoff is slow, and the erosion hazard is slight." Estimates of soil and engineering properties are not provided for Torrifluvents because of their high variability.

- **Torripsamments and Torrifluvents, Frequently Flooded (TD):** "Torripsamments and Torrifluvents, frequently flooded consists of soils formed in a variety of stratified sediment recently deposited by intermittent streams. It is mainly in long, narrow strips in the present channel of major streams, frequently flooded during intense summer storms. In most areas the surface is smooth, but a few are undulating as a result of blowing. It contains almost no organic matter and is mainly sandy and is 5 to 80 percent gravel and cobbles." Estimates of soil and engineering properties are not provided for Torripsamments and Torrifluvents, Frequently Flooded because of their high variability.

5. DISCUSSION

The summary and conclusions presented herein are based on limited research and exploration and our understanding of the project as presented in the Project Description. This information is intended to be used for preliminary evaluation only of proposed pipeline alignment alternatives. Additional services may be required during the iterative process of selecting the preferred pipeline alignment and will be required for design of the project. Services that may be required during the selection and design processes include: additional research, site reconnaissance, subsurface exploration, field and laboratory soil tests, and engineering analysis.

6. SUMMARY

Most of the land along each route is undeveloped and in native condition. In developed areas, land usages included agricultural, commercial, industrial, and residential. Residential usage was denser in the southern and eastern parts of the area bounded by the routes. Drainage in the area is generally southward, following the Agua Fria River, and elevations range from 1,200 to 1,500. Surface grades along the routes ranged from less than 1 percent to about 3 percent. Each route crosses several washes. Also, Route A crosses the Marinette Heading Canal, and Routes B and C cross the Agua Fria River.

The routes are in one of the valleys of the Basin and Range Province with isolated mountain ranges around the valley. Valley materials between the mountains above bedrock consist of late Tertiary and Quaternary soil deposits, and the primary landforms in the area bounded by the routes are valley fill, alluvial fans, and alluvium.

Other than in and along the Agua Fria River, clayey sands and sandy lean clays were the predominant soils encountered. Heavy calcareous cementation was encountered in these soils from depths of less than 1 foot to 5 feet, and practical backhoe refusal was encountered in 9 of the 14 test pits in these soils at depths of 2 to 7 feet. In and along the Agua Fria River, uncemented to lightly cemented, well-graded sands and gravels with cobbles were encountered below depths of 3 to 5 feet. The largest particle size observed in and along the Agua Fria River was on the order of 12 inches. Field resistivities along the alternative routes near pipeline invert depth ranged from 9,000 to 57,000 ohms/cm, which indicate low corrosion potential.

Low moisture contents and heavy cementation are suspected to have contributed to the high field resistitivity measurements. Laboratory measurements of minimum resistivity are likely to be significantly lower than the field measurements and more representative of conditions the pipeline

will be subjected to. Accordingly, SCS estimates of corrosive potential are considered more suitable for the alternative evaluation process.

From SCS publications, soils along the routes are of two general categories -- soils formed in recent alluvium and soils formed in old alluvium. The SCS has mapped 21 soil types along the routes that belong to 15 soil series and six soils associations, which are described in Sections 4.4.1 and 4.4.2, respectively. Section 4.4.2 also provides basic descriptions and typical engineering and index properties for each soil series, and selected portions of this information are presented in summary tables in the Appendix. Because of its limitations, information from the SCS publications should only be used for general evaluation of shallow improvement alternatives.

Mapped soils in the study area vary from fat clays (CH) to well-graded gravels with silt (GW-GM). With respect to natural and compacted permeability, reported characteristics agree with geotechnical theory; granular and non-plastic soils have moderate to high permeabilities, and fine-grained and plastic soils have moderate to low permeabilities. Agreement with geotechnical theory was also reported with respect to compacted shear strength and susceptibility to piping; granular and well-graded soils have higher shear strengths than fine-grained and poorly graded soils, and fine-grained soils are commonly susceptible to piping. Natural erosion risk was slight for most soils, but increased to moderate for some soils because of slope. The risk of corrosion for uncoated steel ranged from low to high and was high in 12 of the 15 soil series mapped along the routes. The risk of corrosion for concrete ranged from low to moderate and was low for 10 of the 15 soil series mapped along the routes. Corrosion estimates were not provided for two soil series because of their variability. Calcareous soils, cobbly soils, and hardpan were also reported in some soil series.

7. CONCLUSIONS

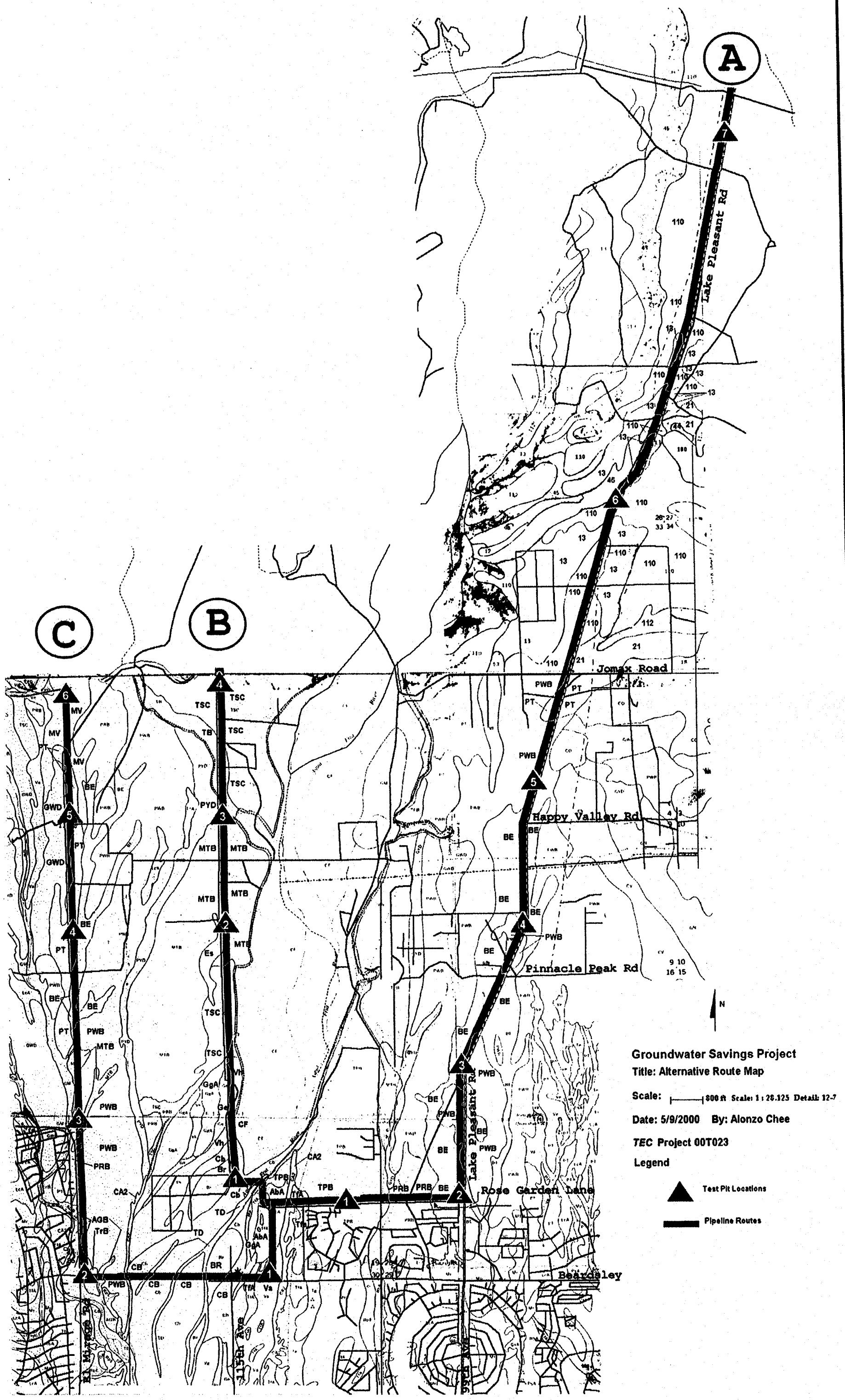
Based on our project understanding, excavation conditions and corrosivity are the primary geotechnical factors of concern for evaluation of the three alternatives. Preliminary exploration data indicates that soil conditions along the alternative routes can be placed in two general groups – (1) those not related to the Agua Fria River, most of Routes A and C and the northern portion of Route B, and (2) those near and in the Agua Fria River, most of Route B.

In the first group, soils with calcareous cementation and high corrosion risk to uncoated steel will commonly be encountered. Calcareous cementation is expected to cause difficult excavation conditions that will require heavy or specialized equipment for excavation. To a

large extent, soils in this group will have an OSHA classification of "Type A", for which OSHA provides a maximum allowable slope of ¾:1 (53°) for excavations less than 20 feet deep.

In the second group, cohesionless soils, soils with cobbles and boulders, and soils with low to moderate corrosion risk to uncoated steel will commonly be encountered. Excavation conditions are not anticipated to be as difficult in uncemented and lightly cemented, cohesionless soils and soils with cobbles and boulders; however, sloughing and less stable slopes are anticipated. To a large extend, soils in this group will have an OSHA classification of "Type C", for which OSHA provides a maximum allowable slope of 1½:1 (34°) for excavations less than 20 feet deep.

APPENDIX


A
B
C
Lake Pleasant Rd
Jomax Road
Happy Valley Rd
Pinnacle Peak Rd
Rose Garden Lane
Beardsley
N
Groundwater Savings Project
Title: Alternative Route Map
Scale: 800 ft Scale: 1 : 26,125 Detail: 12-7
Date: 5/9/2000 By: Alonzo Chee
TEC Project 00T023
Legend
Test Pit Locations
Pipeline Routes

TEST PIT LOG NOTES

These notes and test pit logs are intended for use with this geotechnical report for the purposes described therein. The logs indicate our interpretation of subsurface conditions at that location on the date noted. Subsurface conditions may vary, and groundwater levels may change because of seasonal or other factors. Accordingly, the test pit logs should not be made a part of the construction plans or be used to define construction conditions.

Test pit locations are based on visually referencing and pacing from existing site features and relating their locations to the improvements shown on the Alternative Route Map provided.

"Bucket Size" refers to the size and type of excavation tool used by the backhoe.

"Sample Type" refers to the sampling method and equipment used during exploration where:

- G indicates a grab sample from backhoe-excavated material.

"Description and Classification" refer to the materials encountered in the test pits. Generally, the descriptions and classifications are based on visual examination in the field. The terms and symbols used in the test pit logs are in general accordance with the Unified Soil Classification System and the American Society for Testing and Materials.

Log of Test Pit A1

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Sandy Lean Clay (CL); light brown, slightly moist, firm
5					hard, heavy cementation
	G				Clayey Sand with Gravel (SC); grey-brown, slightly moist, dense
10					Stopped @ 10 feet
15					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 48,000 ohms/cm
20					
25					
30					
35					
40					

Log of Test Pit A2

Project: Groundwater Savings Project
Location: Maricopa, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
5	G				Sandy Lean Clay (CL); light brown, slightly moist, firm hard, heavy cementation
10					Stopped @ 10 feet
15					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 15,000 ohms/cm
20					
25					
30					
35					
40					

Log of Test Pit A3

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Sandy Lean Clay (CL); light brown, slightly moist, firm
5					hard, heavy cementation
	G				Clayey Sand with Gravel and Cobbles (SC); light brown, slightly moist, very dense
10					Stopped @ 10 feet
15					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 19,000 ohms/cm
20					
25					
30					
35					
40					

Log of Test Pit A4

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Sandy Lean Clay (CL); brown, slightly moist, stiff, light cementation
	G				Clayey Sand (SC); white, slightly moist, very dense, heavy cementation
5					Refusal @ 3 feet
10					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 57,000 ohms/cm
15					
20					
25					
30					
35					
40					

Log of Test Pit A5

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
5	G				Sandy Lean Clay (CL); brown, slightly moist, stiff very stiff, moderate cementation hard, heavy cementation Refusal @ 7 feet
10					
15					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 9,000 ohms/cm
20					
25					
30					
35					
40					

Log of Test Pit A6

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Sandy Lean Clay (CL); tan, slightly moist, hard, heavy cementation
					Refusal @ 2 feet
5					Resistivity Notes:
					1) Four–pin method with 10-foot spacing
					2) Field resistivity was 38,000 ohms/cm
10					
15					
20					
25					
30					
35					
40					

Log of Test Pit A7

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Sandy Lean Clay (CL); light brown, slightly moist, firm
					hard, heavy cementation
5					Refusal @ 3 feet
					Resistivity Notes:
10					1) Four–pin method with 10-foot spacing 2) Field resistivity was 20,000 ohms/cm
15					
20					
25					
30					
35					
40					

Log of Test Pit B1

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Sandy Lean Clay (CL); light brown, slightly moist, stiff
5	G				Clayey Sand with Gravel and Cobbles (SC); light brown, slightly moist, dense
	G				Well-Graded Sand with Gravel and Cobbles (SW); grey-brown, slightly moist, very dense
10					Stopped @ 10 feet
15					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 36,000 ohms/cm
20					
25					
30					
35					
40					

Log of Test Pit B2

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Clayey Sand (SC); light brown, slightly moist, medium dense
					very dense, heavy cementation
5	G				Well-Graded Gravel with Sand and Cobbles (GW); grey-brown, slightly moist, very dense, light cementation
10					Stopped @ 10 feet
15					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 42,000 ohms/cm
20					
25					
30					
35					
40					

Log of Test Pit B3

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Drill Rig: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Clayey Sand (SC); light brown, slightly moist, medium dense, hard, heavy cementation
5	G				Well-Graded Gravel with Sand and Cobbles (GW); grey-brown, slightly moist, dense
10					Stopped @ 10 feet
15					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 30,000 ohms/cm
20					
25					
30					
35					
40					

Log of Test Pit B4

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Clayey Sand with Gravel and Cobbles (SC); light brown, slightly moist, dense
5					very dense, heavy cementation
					Refusal @ 5 feet
10					Resistivity Notes:
					1) Four–pin method with 10-foot spacing
					2) Field resistivity was 42,000 ohms/cm
15					
20					
25					
30					
35					
40					

Log of Test Pit C1

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Clayey Sand with Gravel and Cobbles (SC); brown, moist, dense
	G				Sandy Lean Clay (CL); brown, moist, stiff
5	G				Clayey Sand with Gravel and Cobbles (SC); brown, moist, dense,
10					Stopped @ 10 feet
15					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 11,000 ohms/cm
20					
25					
30					
35					
40					

Log of Test Pit C2

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Clayey Sand with Gravel and Cobbles (SC); light brown, slightly moist, stiff
	G				very densese, heavy cementation
5					Refusal @ 5 feet
10					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 9,000 ohms/cm
15					
20					
25					
30					
35					
40					

Log of Test Pit C3

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Sandy Lean Clay with Gravel (CL); light brown, slightly moist, stiff
5	G				Clayey Sand with Gravel and Cobbles (SC); light brown, slightly moist, very dense, heavy cementation
					Refusal @ 5 feet
10					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 30,000 ohms/cm
15					
20					
25					
30					
35					
40					

Log of Test Pit C4

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Sandy Lean Clay (CL); light brown, slightly moist, stiff
5	G				Clayey Sand with Gravel (SC); white, slightly moist, very dense, heavy cementation Refusal @ 5 feet
10					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 36,000 ohms/cm
15					
20					
25					
30					
35					
40					

Log of Test Pit C5

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Clayey Sand (SC); light brown, slightly moist, medium dense
5	G				Silty Sand with Gravel (SM); white, slightly moist, very dense, heavy cementation
10					Stopped @ 10 feet
15					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 21,000 ohms/cm
20					
25					
30					
35					
40					

Log of Test Pit C6

Project: Groundwater Savings Project
Location: Maricopa County, Arizona
***TEC* Job No:** 00T023
Date: April 18, 2000

Excavator: John Deere 410
Bucket Size: 24-inch
Elevation (ft): Not determined
Logged by: S. Grant

Excavated by: Terrane Engineering
Groundwater: Not encountered
Other: Field resistivity test performed near test pit

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
0	G				Clayey Sand (SC); light brown, slightly moist, medium dense
5	G				Silty Sand with Gravel (SM); white, slightly moist, very dense, heavy cementation Refusal @ 5 feet
10					Resistivity Notes: 1) Four–pin method with 10-foot spacing 2) Field resistivity was 30,000 ohms/cm
15					
20					
25					
30					
35					
40					

Table A.1 Summary SCS Information for Route A

SCS Soil Series (Type)	USCS Soil Class	Permeability		Corrosivity		Compacted Shear Strength	Erodibility	
		Natural	Compacted	Steel	Concrete		Natural	Compacted
Antho (AbA)	SM	m rapid	medium	high	low	medium	sl to mod	piping
Beardsley (BE)	CH	m slow - mod	medium	high	moderate	low	slight	piping
Carrizo (Cb)	SM, SW-SM	rapid	high	low	low	high	slight	not provided
Carefree (13)	CL, ML	slow	low	high	high	not provided	not provided	not provided
Perryville (PRB)	SC-SM, SM	mod	medium	high	low	Medium	sl to mod	not provided
Pinal (PT, PWB)	ML, SM	mod	not provided	high	low	not provided	sl to mod	not provided
Suncity (110)	GM-GC, SM-SC, CL	mod	medium	high	low	not provided	not provided	not provided
Tremant(TfA, TPB)	SC/GC, SM/SC	m slow	medium	high	low	medium	sl to mod	not provided
Torripsamments (TD)...	No valid estimate can be made. Too variable to be rated.							

Table A.2 Summary SCS Information for Route B

SCS Soil Series (Type)	USCS Soil Class	Permeability		Corrosivity		Compacted Shear Strength	Erodibility	
		Natural	Compacted	Steel	Concrete		Natural	Compacted
Brios (Br)	SM, SP	rapid	medium	moderate	low to moderate	medium	slight	piping
Carrizo(Cb)	SM, SW-SM	rapid	high	low	low	high	slight	not provided
Gilman (Ge, GgA)	ML	mod	medium	high	low to high	low	sl to mod	piping
Mohall (MTB)	CL, ML	M slow	medium	high	low	low	slight	piping
Tremant (TSC)	SC/GC, SM/SC	M slow	medium	high	low	medium	sl to mod	not provided
Torrifluvents (TB)	No valid estimate can be made. Too variable to be rated.							
Torripsamments (TD)...								

Table A.3 Summary SCS Information for Route C

SCS Soil Series (Type)	USCS Soil Class	Permeability		Corrosivity		Compacted Shear Strength	Erodibility	
		Natural	Compacted	Steel	Concrete		Natural	Compacted
Antho (AGB)	SM	m rapid	medium	high	low	medium	sl to mod	piping
Brios (Br)	SM, SP	rapid	medium	moderate	low to moderate	medium	slight	piping
Carrizo (Cb)	SM, SW-SM	rapid	high	low	low	high	slight	not provided
Gilman (GM)	ML	mod	medium	high	low to high	low	sl to mod	piping
Gunsight (GWD)	GC	mod	low	high	low	medium	sl to mod	not provided
Mohall (MTB, MV)	CL, ML	m slow	medium	high	low	low	slight	piping
Perryville (PRB)	SC-SM, SM	mod	medium	high	low	medium	sl to mod	not provided
Pinal (PT, PWB)	ML, SM	mod	not provided	high	low	not provided	sl to mod	not provided
Torripsamments (TD)...	No valid estimate can be made. Too variable to be rated.							

Appendix I
Miscellaneous Cost Information

OPERATION AND MAINTENANCE COST DEVELOPMENT AND PRESENT WORTH LIFE CYCLE COSTS

The operation and maintenance (O&M) costs for each of the alternate facilities was determined using common cost elements applied to water transmission main, water distribution mains and pump stations. The common cost elements for all alternates are as follows:

Pump Stations

- $0.07 per Kilowatt hour for electrical costs
- 1 percent of original structure cost per year for labor and material costs
- 2.5 percent of equipment cost per year for equipment maintenance / replacement and labor costs

Water Transmission Mains and Water Distribution Mains

- $0.50 per linear foot per year for all water mains regardless of pipe size.

Based on these cost elements, the O&M costs are directly related to the water main pipe length and the associated horsepower utilized. The annual costs were then calculated by summing each annual cost element. Each annual cost was then determined as a present worth value and the sum the present worth values is the Total O&M Present Worth costs.

A differential interest rate of 5.73% was used based on the cost of borrowing money at 8.73% minus an inflation rate of 3%. The cost of borrowing money at 8.73% for Citizens Water Resources is based on Arizona Corporation Commission Decision 60172. The inflation rate of 3.0% is based on an assumed average inflation rate over past number of years.

Development of Pipeline Costs per Linear Foot

Costs for pipeline construction for pipe diameters 12", 16", 20", 24", 30", 36", and 48" were developed for the Groundwater Savings Project by accounting for the following parameters:

- Removal of Existing Pavement Costs
- Excavation and Haul Costs
- Pipe Installation Labor and Equipment Costs
- Pipe Bedding Costs
- Trench Backfill Costs
- Pipe Material Costs.

These cost parameters have been developed in the following spreadsheet for the following conditions:

- Normal Digging with pavement removal
- Normal Digging without pavement removal
- Hard Digging with pavement removal
- Hard Digging without pavement removal.

For "normal digging" the trench excavation cost of $1.75 per cubic yard was used. For "hard digging" the trench excavation cost was tripled so as to be $5.25 per cubic yard. The trench width used to calculate amount excavation material is based on MAG specifications for the minimum width required for Type A pavement replacement, which yields a reasonable approach for calculating the trench excavation quantities. Whereas, the pipe bedding trench width is based on MAG specifications for minimum width at springline each side of the pipe based on Table: 601-1.

Alternative Route A pipeline cost per linear foot was developed based on the geotechnical report statements that caliche and cemented soils would be encountered along the northern portion and middle portions of this alignment. From this it was assumed that 70 percent of Alternative Route A alignment would utilize pipeline costs for hard digging without pavement removal. In addition, 6,500 feet of the total alignment length of 46,398 feet (or 14 percent) was computed to have costs associated with normal digging with pavement removal for that portion of the alignment along Rose Garden Lane. The remaining 16 percent of the alignment for Alternative Route A was computed for pipeline costs associated with normal digging without pavement removal.

Alternative Route B pipeline cost per linear foot was developed based on the geotechnical report that hard digging would be encountered along some portions of the alignment. From this it was assumed that 20 percent of Alternative Route B alignment would utilize pipeline costs for hard digging without pavement removal. In addition, 1,000 feet of the total alignment length of 21,897 feet (or 4.6 percent) was computed to have costs associated with normal digging with pavement removal for those portions of the alignment that either cross through paved intersections or that are in actual pavement

alignments. The remaining 75.4 percent of the alignment for Alternative Route B was computed for pipeline costs associated with normal digging without pavement removal.

Alternative Route C pipeline cost per linear foot was developed for based on the geotechnical report that hard digging would be encountered along a significant portion of the alignment. From this it was assumed that 50 percent of Alternative Route C alignment would utilize pipeline costs for hard digging without pavement removal. In addition, 1,000 feet of the total alignment length of 28,259 feet (or 3.5 percent) was computed to have costs associated with normal digging with pavement removal for those portions of the alignment that either cross through paved intersections or that are in actual pavement alignments. The remaining 46.5 percent of the alignment for Alternative Route C was computed for pipeline costs associated with normal digging without pavement removal.

Alternative Route D pipeline cost per linear foot was developed for based on the geotechnical report that hard digging would be encountered along some portions of the alignment. From this it was assumed that 20 percent of Alternative Route D alignment would utilize pipeline costs for hard digging without pavement removal. In addition, 1,000 feet of the total alignment length of 39,139 feet (or 2.6 percent) was computed to have costs associated with normal digging with pavement removal for those portions of the alignment that either cross through paved intersections or that are in actual pavement alignments. The remaining 77.4 percent of the alignment for Alternative Route D was computed for pipeline costs associated with normal digging without pavement removal.

The Agua Fria Joint Facility Pipeline alternatives pipeline costs per linear foot were developed for based on the assumption that it would be for normal digging without pavement removal for the entire alignment length.

The pipeline costs per linear foot for the Sun City proposed new irrigation water distribution pipelines were assumed to be for normal digging with pavement removal for all associated pipe sizes.

CITIZENS WATER RESOURCES
GROUNDWATER SVINGS PROJECT
SUN CITY / SUN CITY WEST / YOUNGTOWN

PIPELINE COSTS PER LINEAR FOOT
SIZE 12" - PVC C-900 CLASS 150 WATER MAIN COSTS
SIZE 16" - PVC C-905 CLASS 165 WATER MAIN COSTS
SIZE 20" - PRESS. CLASS 250 DIP WATER MAIN COSTS
SIZE 24" - PRESS. CLASS 200 DIP WATER MAIN COSTS
SIZE 30" - PRESS. CLASS 150 DIP WATER MAIN COSTS
SIZE 36" & 48" - PRESS. CLASS 150 CCP WATER MAIN COSTS

SUMMARY OF WATER MAIN PIPELINE COSTS
WITH PAVEMENT REMOVAL FOR NORMAL DIGGING

NOMINAL PIPE SIZE	AVERAGE PIPE COST ($/L.F.)	
30	118.00	for normal digging
36	151.12	for normal digging
48	197.29	for normal digging
12	40.35	for normal digging
16	55.48	for normal digging
20	76.86	for normal digging
24	90.02	for normal digging

SUMMARY OF WATER MAIN PIPELINE COSTS
WITHOUT PAVEMENT REMOVAL FOR NORMAL DIGGING

NOMINAL PIPE SIZE	AVERAGE PIPE COST ($/L.F.)	
30	114.76	for normal digging
36	147.66	for normal digging
48	193.63	for normal digging
12	37.53	for normal digging
16	52.59	for normal digging
20	73.89	for normal digging
24	86.88	for normal digging

CITIZENS WATER RESOURCES
GROUNDWATER SVINGS PROJECT
SUN CITY / SUN CITY WEST / YOUNGTOWN

PIPELINE COSTS PER LINEAR FOOT
SIZE 12" - PVC C-900 CLASS 150 WATER MAIN COSTS
SIZE 16" - PVC C-905 CLASS 165 WATER MAIN COSTS
SIZE 20" - PRESS. CLASS 250 DIP WATER MAIN COSTS
SIZE 24" - PRESS. CLASS 200 DIP WATER MAIN COSTS
SIZE 30" - PRESS. CLASS 150 DIP WATER MAIN COSTS
SIZE 36" & 48" - PRESS. CLASS 150 CCP WATER MAIN COSTS

SUMMARY OF WATER MAIN PIPELINE COSTS
WITH PAVEMENT REMOVAL FOR HARD DIGGING

NOMINAL PIPE SIZE	AVERAGE PIPE COST ($/L.F.)	
30	124.53	for Hard digging
36	159.48	for Hard digging
48	205.18	for Hard digging
12	43.47	for Hard digging
16	59.14	for Hard digging
20	81.10	for Hard digging
24	95.49	for Hard digging

SUMMARY OF WATER MAIN PIPELINE COSTS
WITHOUT PAVEMENT REMOVAL FOR HARD DIGGING

NOMINAL PIPE SIZE	AVERAGE PIPE COST ($/L.F.)	
30	121.28	for Hard digging
36	156.03	for Hard digging
48	201.52	for Hard digging
12	40.64	for Hard digging
16	56.25	for Hard digging
20	78.13	for Hard digging
24	92.35	for Hard digging

CITIZENS WATER RESOURCES
GROUNDWATER SVINGS PROJECT
SUN CITY / SUN CITY WEST / YOUNGTOWN

PIPELINE COSTS PER LINEAR FOOT

1. COMPUTE PAVEMENT REMOVAL COSTS / L.F. FOR EACH PIPE SIZE.

INPUT: DEMOLITION COST ($/C.Y.) =	1.12	1.12	Set these costs to zero in column F if "no existing pavement".
HAULING COST ($/C.Y.)	1.96	1.96	otherwise costs are set to those values in the column E.
SAW CUT 6" DEEP ($/L.F.)	1.67	1.67	

Assumes existing pavement is 6" thick.

NOMINAL PIPE SIZE	PAY LIMITS(IN.) TYPE A	PAY LIMITS(IN.) TYPE T	DEMOLITION AREA S.Y./L.F. TYPE A	DEMOLITION AREA S.Y./L.F. TYPE T	PAVEMENT REFUSE C.Y./L.F. TYPE A	PAVEMENT REFUSE C.Y./L.F. TYPE T
30	60	84	0.5556	0.7778	0.0926	0.1297
36	72	96	0.6667	0.8889	0.1111	0.1482
12	36	50	0.3333	0.4630	0.0556	0.0772
16	40	64	0.3704	0.5926	0.0617	0.0988
48	84	108	0.7778	1.0000	0.1297	0.1667
20	44	68	0.4074	0.6296	0.0679	0.1050
24	54	78	0.5000	0.7222	0.0834	0.1204

NOMINAL PIPE SIZE	SAW CUT COST $/L.F.	DEMOLITION COST $/L.F. TYPE A	DEMOLITION COST $/L.F. TYPE T	HAULING COST $/L.F. TYPE A	HAULING COST $/L.F. TYPE T	TOTAL PAVEMENT REMOVAL COSTS $/L.F. TYPE A	TOTAL PAVEMENT REMOVAL COSTS $/L.F. TYPE T
30	1.67	0.62	0.87	0.18	0.25	2.47	2.80
36	1.67	0.75	1.00	0.22	0.29	2.63	2.96
12	1.67	0.37	0.52	0.11	0.15	2.15	2.34
16	1.67	0.41	0.66	0.12	0.19	2.21	2.53
48	1.67	0.87	1.12	0.25	0.33	2.80	3.12
20	1.67	0.46	0.71	0.13	0.21	2.26	2.58
24	1.67	0.56	0.81	0.16	0.24	2.39	2.71

2. COMPUTE TOTAL EXCAVATION & HAUL COSTS / L.F. FOR EACH DEPTH OF COVER FOR EACH PIPE SIZE.

INPUT: ENTER THE PIPE OUTSIDE DIAMETERS FOR EACH SIZE.

EXCAVATION COST ($/C.Y.) = 1.75 For "Hard Digging" triple the normal excavation cost of $1.75/C.Y.

HAULING COST ($/C.Y.) = 3.92

NOMINAL PIPE SIZE	AVG DEPTH OI COVER (FT.)	PIPE O.D. (IN.)	BED DEPTH (F.T.)	EXCAVATION DEPTH (FT.)	PAY LIMITS(FT.) TYPE A	TYPE T
30	5.00	32.00	4.17	7.67	5.0000	7.0000
30	5.00	32.00	4.17	7.67	5.0000	7.0000
36	5.00	38.30	4.69	8.19	6.0000	8.0000
36	5.00	38.30	4.69	8.19	6.0000	8.0000
12	5.00	13.20	2.60	6.10	3.0000	4.1667
12	5.00	13.20	2.60	6.10	3.0000	4.1667
16	5.00	17.40	2.95	6.45	3.3333	5.3333
48	5.00	19.50	3.13	6.63	7.0000	9.0000
20	5.00	21.60	3.30	6.80	3.6667	5.6667
24	5.00	25.80	3.65	7.15	4.5000	6.5000

NOMINAL PIPE SIZE	AVG DEPTH OI COVER (FT.)	LINEAR FEET TYPE A	TYPE T	EXCAVATION (C.Y./L.F.) TYPE A	TYPE T	HAUL EXCESS (C.Y./L.F.) TYPE A	TYPE T
30	5.00	4000	1	1.4198	1.5679	1.1420	1.5679
30	5.00	4000	1	1.4198	1.5679	1.1420	1.5679
36	5.00	4000	1	1.8204	1.9685	1.4870	1.9685
36	5.00	4000	1	1.8204	1.9685	1.4870	1.9685
12	5.00	4000	1	0.6778	0.6377	0.5111	0.6377
12	5.00	4000	1	0.6778	0.6377	0.5111	0.6377
16	5.00	4000	1	0.7963	0.9444	0.6111	0.9444
48	5.00	4000	1	1.7176	1.8657	1.3287	1.8657
20	5.00	4000	1	0.9235	1.0716	0.7198	1.0716
24	5.00	4000	1	1.1917	1.3398	0.9417	1.3398

NOMINAL PIPE SIZE	EXCAVATION COST ($/L.F.) TYPE A	TYPE T	HAUL COST ($/L.F.) TYPE A	TYPE T
30	2.4846	2.7438	4.4765	6.1462
30	2.4846	2.7438	4.4765	6.1462
36	3.1856	3.4449	5.8292	7.7166
36	3.1856	3.4449	5.8292	7.7166
12	1.1861	1.1159	2.0036	2.4996
12	1.1861	1.1159	2.0036	2.4996
16	1.3935	1.6528	2.3956	3.7022
48	3.0058	3.2650	5.2085	7.3137
20	1.6160	1.8753	2.8214	4.2007
24	2.0854	2.3447	3.6913	5.2521

2. (CONTINUED)

NOMINAL PIPE SIZE	EXCAVATION TOTAL COSTS ($) TYPE A	TYPE T	HAULING TOTAL COSTS ($) TYPE A	TYPE T	LINEAR FEET TOTAL TYPE A	TYPE T
30	19876.54	5.49	35812.35	12.29	8000.00	2.00
36	25485.19	6.89	46633.48	15.43	8000.00	2.00
12	9488.89	2.23	16028.44	5.00	8000.00	2.00
16	5574.07	1.65	9582.22	3.70	4000.00	1.00
48	12023.15	3.27	20834.07	7.31	4000.00	1.00
20	6464.20	1.88	11285.73	4.20	4000.00	1.00
24	8341.67	2.34	14765.33	5.25	4000.00	1.00

NOMINAL PIPE SIZE	AVERAGE EXCAVATION COSTS ($/L.F.) TYPE A	TYPE T	AVERAGE HAULING COSTS ($/L.F.) TYPE A	TYPE T
30	2.48	2.74	4.48	6.15
36	3.19	3.44	5.83	7.72
12	1.19	1.12	2.00	2.50
16	1.39	1.65	2.40	3.70
48	3.01	3.27	5.21	7.31
20	1.62	1.88	2.82	4.20
24	2.09	2.34	3.69	5.25

3. COMPUTE TOTAL BACKFILL COSTS / L.F. FOR VARIOUS DEPTHS OF COVER FOR EACH PIPE SIZE.

INPUT: BACKFILL MATERIAL COSTS ($/C.Y.) == ..ABC ($/C.Y.) = 7.51

PLACEMENT AND COMPACTION COSTS ..... ($/C.Y.) = 4.63

TOTAL BACKFILL MATERIAL, PLACEMENT, & COMPACTION COSTS:

ABC ..... = 12.14

NATIVE ... = 4.63

NOMINAL PIPE SIZE	AVG DEPTH OI COVER (FT.)	LINEAR FEET TYPE A	LINEAR FEET TYPE T	VOLUME OF BACKFILL (C.Y./L.F.) TYPE A ABC	VOLUME OF BACKFILL (C.Y./L.F.) TYPE A NATIVE	VOLUME OF BACKFILL (C.Y./L.F.) TYPE T ABC	BACKFILL COSTS ($/L.F.) TYPE A	BACKFILL COSTS ($/L.F.) TYPE T
30	5	4000	1	0.3704	0.2778	0.7963	5.78	9.67
30	5	4000	1	0.3704	0.2778	0.7963	5.78	9.67
36	5	4000	1	0.4444	0.3333	0.9259	6.94	11.24
36	5	4000	1	0.4444	0.3333	0.9259	6.94	11.24
12	5	4000	1	0.2222	0.1667	0.3488	3.47	4.23
12	5	4000	1	0.2222	0.1667	0.3488	3.47	4.23
16	5	4000	1	0.2469	0.1852	0.5802	3.85	7.04
48	5	4000	1	0.5185	0.3889	1.0556	8.10	12.81
20	5	4000	1	0.2716	0.2037	0.6235	4.24	7.57
24	5	4000	1	0.3333	0.2500	0.7315	5.20	8.88

NOMINAL PIPE SIZE	LINEAR FEET TOTAL TYPE A	LINEAR FEET TOTAL TYPE T	AVERAGE BACKFILL COST ($/L.F.) TYPE A	AVERAGE BACKFILL COST ($/L.F.) TYPE T
30	8000.00	2.00	3.39	10.17
36	8000.00	2.00	6.94	11.24
12	8000.00	2.00	3.47	4.23
16	4000.00	1.00	3.85	7.04
48	4000.00	1.00	8.10	12.81
20	4000.00	1.00	4.24	7.57
24	4000.00	1.00	5.20	8.88

4. COMPUTE BEDDING COSTS / L.F.

NOTE: THIS PROGRAM WILL COMPUTE THE MIN TRENCH WORK SPACE REQUIRED UNDER M.A.G. FOR YOU.

INPUT: COST OF BEDDING MATERIAL INCLUDING PLACEMENT AND COMPACTION ($/L.F.) = (ABC) 4.63 ASSUMES NATIVE MATERIAL FOR BEDDING

NOMINAL PIPE SIZE	PIPE O.D. (IN.)	MIN TRENCH WORK SPACE (IN.)	VOLUME OF BEDDING (C.Y./L.F.)	BEDDING COST ($/L.F.)
30	32.00	9.00	0.4359	2.02
36	38.30	9.00	0.5185	2.40
12	13.20	7.50	0.1910	0.88
16	17.40	7.50	0.2338	1.08
48	52.13	12.00	0.8234	3.81
20	21.60	7.50	0.2784	1.29
24	25.80	9.00	0.3588	1.66

5. COMPUTE INSTALLATION LABOR COST FOR EACH SIZE OF STRAIGHT LENGTH PIPE.
NOTE: INCLUDE ALL LABOR COSTS WHICH HAVE NOT ALREADY BEEN ACCOUNTED FOR.

INPUT: LABOR AND EQUIPMENT COSTS FOR INSTALLATION OF STRAIGHT PIPE LENGTHS.
THESE COSTS CAN BE TAKEN FROM R.L.MEANS (1987 P. 42).

NOMINAL PIPE SIZE	INSTALLATION LABOR & EQUIPMENT COSTS ($/L.F.)
30	22.75
36	24.75
12	9.05
16	13.34
48	27.50
20	19.65
24	21.05

6. COMPUTE TOTAL FITTINGS COST PER SIZE. – **NOT USED**
INPUT: FITTINGS DESCRIPTION, FITTINGS MATERIAL COSTS, FITTINGS INSTALLATION COST, AND THE NUMBER OF EACH PARTICULAR FITTINGS FOR EACH PIPE SIZE.

FITTINGS DESCRIPTION	SIZE	NUMBER OF FITTINGS	MATERIAL COST	TOTAL MATERIAL COST	INSTALLATION COST	TOTAL INSTALLATION COST	TOTAL COST
		1					
		2					
		3					
		4					
		5					
				SUBTOTAL			$0
				DIVIDE BY # OF LINEAR FEET			8002
			TOTAL COST / I T / L.F. FOR			0 " FITTINGS	$0.00
	36						
	36						
	36						
	36						
				SUBTOTAL			$0
				DIVIDE BY # OF LINEAR FEET			8002
			TOTAL COST / I T / L.F. FOR			" FITTINGS	$0

7. COMPUTE TOTAL PIPELINE COSTS PER LINEAR FOOT.
INPUT: PIPE FITTINGS COSTS AND PIPE MATERIAL COSTS / L.F.

NOMINAL PIPE SIZE	LINEAR FEET TYPE A	LINEAR FEET TYPE T	TOTAL PAVEMENT REMOVAL COSTS $/L.F. TYPE A	TOTAL PAVEMENT REMOVAL COSTS $/L.F. TYPE T	AVERAGE EXCAVATION COSTS ($/L.F.) TYPE A	AVERAGE EXCAVATION COSTS ($/L.F.) TYPE T	AVERAGE HAULING COSTS ($/L.F.) TYPE A	AVERAGE HAULING COSTS ($/L.F.) TYPE T
30	8000	2	2.47	2.80	2.48	2.74	4.48	6.15
36	8000	2	2.63	2.96	3.19	3.44	5.83	7.72
12	8000	2	2.15	2.34	1.19	1.12	2.00	2.50
16	4000	1	2.21	2.53	1.39	1.65	2.40	3.70
48	4000	1	2.80	3.12	3.01	3.27	5.21	7.31
20	4000	1	2.26	2.58	1.62	1.88	2.82	4.20
24	4000	1	2.39	2.71	2.09	2.34	3.69	5.25

NOMINAL PIPE SIZE	AVERAGE BACKFILL COST ($/L.F.) TYPE A	AVERAGE BACKFILL COST ($/L.F.) TYPE T	BEDDING COST ($/L.F.)	INSTALLATION LABOR & EQUIP COSTS ($/L.F.)	MANHOLE COSTS ($/L.F.)	PIPE MATERIAL COST ($/L.F.)	TOTAL PIPE COST / L.F. TYPE A	TOTAL PIPE COST / L.F. TYPE T
30	$3.39	$10.17	2.02	22.75	0.00	52.31	89.90	98.93
36	$6.94	$11.24	2.40	24.75	0.00	69.40	115.14	121.91
12	$3.47	$4.23	0.88	9.05	0.00	12.00	30.75	32.12
16	$3.85	$7.04	1.08	13.34	0.00	18.00	42.27	47.35
48	$8.10	$12.81	3.81	27.50	0.00	99.90	150.32	157.72
20	$4.24	$7.57	1.29	19.65	0.00	26.68	58.56	63.84
24	$5.20	$8.88	1.66	21.05	0.00	32.50	68.59	74.40

NOMINAL PIPE SIZE	TOTAL LINEAR FEET	AVERAGE PIPE COST ($/L.F.)	PLUS 25% OH&P AVERAGE PIPE COST ($/L.F.)	TOTAL PLUS 5% CONTRACTORS INSURANCE AVG PIPE COST ($/L.F.)
30	8002	89.91	112.38	118.00
36	8002	115.14	143.93	151.12
12	8002	30.75	38.43	40.35
16	4001	42.27	52.84	55.48
48	4001	150.32	187.90	197.29
20	4001	58.56	73.20	76.86
24	4001	68.59	85.73	90.02

PACIFIC STATES
CAST IRON PIPE COMPANY
DIVISION OF McWANE, INC.
P.O. BOX 1219, PROVO, UTAH 84603
TELEPHONE (AREA CODE 801) 373-6910

PSCIPCO

RON BIANCANI
Sales Representative
P.O. Box 11690
Glendale, Arizona 85318
Office (602) 566-6347
Fax (602) 566-6342
Mobile (602) 702-9567

JULY 13, 2000

Quotation No.

HDR ENGINEERING

ATTN: DAVE SCHETTLER
602-508-6677 FAX

Subject ESTIMATING PRICING

We are pleased to quote you on materials set forth below conforming to specifications in our catalog and subject to the terms and conditions as mentioned on the back of this sheet and hereby made a part hereof on this proposal, except as hereinafter modified.

6" TYTON JOINT PC 350	6.06
8" TYTON JOINT PC 350	8.14
10" TYTON JOINT PC 350	10.51
12" TYTON JOINT PC 350	13.49
14" TYTON JOINT PC 250	16.21
14" TYTON JOINT PC 300	16.95
14" TYTON JOINT PC 350	17.34
16" TYTON JOINT PC 250	19.72
16" TYTON JOINT PC 300	20.49
16" TYTON JOINT PC 350	21.55
18" TYTON JOINT PC 250	22.84
18" TYTON JOINT PC 300	24.35
18" TYTON JOINT PC 350	25.49
20" TYTON JOINT PC 250	26.68
20" TYTON JOINT PC 300	28.49
20" TYTON JOINT PC 350	29.94
24" TYTON JOINT PC 200	32.50
24" TYTON JOINT PC 250	35.63
24" TYTON JOINT PC 300	37.76
24" TYTON JOINT PC 350	40.36
30" FASTITE JOINT PC 150	52.31
36" FASTITE JOINT PC 150	72.57

Telephone Conversation Record

HDR

Project	CWR – Groundwater Savings Project	Project No.	00091-039-044
Time		Date	7/18/00
Call to	Dana Kepner Vince	602-255-0234 Phone No.	
Call from	Dave Schettler HDR	Phone No.	

Discussion, Agreement and/or Action

Called to get pricing on PVC Water Main Costs.

Prices were quoted for material costs per linear foot as follows:

	Class 150	Class 200
12" PVC C-900	$12.00	$15.25

	DR 25 Class 165	DR 18 Class 235
16" PVC C-905	$18.00	$24.25

These prices would be good for only 60 days. Prices are can fluctuate highly due to the influence of the price of oil directly effects the price of manufacturing PVC pipe.

Telephone Conversation Record

HDR

Project	CWR – Groundwater Savings Project	Project No.	00091-039-044
Time	2:00 p.m.	Date	6-20-00
Call to	John Lindsey	520-774-4621	
	Niles Radio	Phone No.	
	Flagstaff, AZ	fax 520-774-3080	
Call from	Dave Schettler	602-508-6677	
	HDR	Phone No.	

Discussion, Agreement and/or Action

Called John Lindsey to discuss the possibility and costs associated with having Niles Radio perform a radio line-of-sight path study to assess the likelihood of having radio problems with the 20 or so sites at each of the golf courses within Sun City/ Sun City West/ Youngtown. I also inquired as to whether they could assess the effectiveness of using Shaw Butte as the radio repeater site for the proposed telemetry for the Groundwater Savings Plan system and compare using Shaw Butte or having the omni-directional antennae at the master control center which will be located at the Sun City West WWTP. John said they could perform this study for approximately $1,400 and that this price would be pretty firm for completing this work.

John said that they could perform this study for Citizens probably by the second week of July if we got them all of the coordinates (latitudes and longitudes) for all of the proposed sites. He suggested actually going out to all of the remote sites at the golf courses, etc. and recording with a GPS the latitude and longitude for each site. He also mentioned that if any of the sites are with ¾ mile of any freeway overpass within line-of-site between radios that these sites be noted on an overall site map since there is the potential for interference.

John said that even though the telemetry system could be accomplished using broad band radio spectrum type radios his recommendation is to not employ these types of radios because of the potential interference that could occur and the difficulties trying to resolve them for this number of sites for the Groundwater Savings Project. The possibility exists that even after resolving interference problems and spending a good sum of money to do it, the same type or some similar interference could occur again from another company's radio system and it would be necessary to perform a similar fix for all the remote sites again for a good sum of money. He recommended going with a dedicated radio frequency license.

The existing radio repeater site at Shaw butte was discussed. John said though there is the potential for some microwave interference at the Shaw Butte radio repeater site, these types of problems are relatively easy and inexpensive to fix when they occur. Also, since it is a dedicated radio frequency the problem is not an extensive one.

John recommended using the MDS 2000 type radios. He mentioned that the company MDS has changed their name back to their previous name of Adapted Broadband California Microwave. I thought he mentioned the MDS 2000 radios use 900 MHz. (UHF).

John explained to me that in order to get more information on whether there may be other FCC frequencies available for this location the FCC requires that an application from Citizens Water Resources be sent in along with the required application fee. John emphasized that it is CWR's best interest to go ahead and apply for this license as quickly as possible since these licenses are on a first come first served basis.

Telephone Conversation Record

HDR

Project	CWR – Groundwater Savings Project	Project No.	00091-039-044
Time		Date	5/18/00
Call to	RDC Electrical Corp / Keith Dehan	Phone No.	480-927-8280
Call from	Dave Schettler / HDR	Phone No.	

Discussion, Agreement and/or Action SCADA System Requirements

Called Keith to discuss the possible installation costs associated for a SCADA system for the 22 or so remote sites for controlling the CAP water to supply water to the golf course in Sun City / Sun City West. I asked Keith for installation costs for the SCADA system. Keith was well informed on the existing SCADA system that CWR has for Anthem WWTP and the WTP located west of Anthem that RDC had installed the components for. RDC had been furnished RTUs and radios from TAVA Technologies for these and for a number of other well sites and sewage lift stations in Sun City, Sun City West and Surprize.

Keith mentioned that CWR utilizes almost exclusively Allen Bradley PLC controllers along with Modicon RTUs and Modicon modbus protocol for all of their existing SCADA remote sites.

The following are RDC's budget prices (from Keith) for SCADA construction installation work for any or all of the remote sites for the Groundwater Savings Project:

- Build RTU cabinet and as-built w/ Nema 4x enclosure	$2,500
- Construct antennae w/ cable and surge protector	$1,500
- 600 feet of conduit and cable w/ 50' radius to automatic control valve and meter	$3,000
- Electrical Feed to Site (assumes that there is already some sort of pumping station at the golf course that this can come from or some other site within reason to get electrical from)	$1,500
- Software development and programming	$2,500
- Modicon RTU w/ similar I/O	$4,500
- MDS 2000 Radio at each site	$2,000
Subtotal	$17,500

The Master SCADA site was estimated to cost approximately $35,000 to $40,000. This would include another authorized version of Intellution software and a new master computer along with a MDS 2000 Radio and master antennae. He mentioned that there might be additional costs if they were to need other office equipment, building, etc... that would not be included in this above cost.

Telephone Conversation Record

HDR

Project	CWR – Groundwater Savings Project	Project No.	00091-039-044
Time		Date	6/7/00
Call to	Keller Equipment Co. Inc.	Call from	Dave Schettler
	Howard Sun		HDR
	602-437-3015 Phone No.		602-508-6677 Phone No.

Discussion, Agreement and/or Action SCADA System Requirements

Called Keller Equipment, Howard Sun, to discuss the possible installation costs associated for a SCADA system for the 22 or so remote sites for controlling the CAP water to supply water to the golf course in Sun City / Sun City West. I asked for installation costs for the SCADA system.

Howard mentioned that CWR utilizes almost exclusively Allen Bradley PLC controllers along with modbus protocol for all of their existing SCADA remote sites which TAVA Technologies had been doing the initial programming for these for CWR.

The following are Keller's budget prices (from Howard Sun) for SCADA construction installation work for any or all of the remote sites for the Groundwater Savings Project:

- For Nema 4 Enclosure w/ AC unit including the following: Allen Bradley PLC w/ touch screen, RTU, Modbus communication, MDS 2000 radio & antennae $25,845
- Programming is additional $9,500

The following assmptions apply to the above prices for each RTU remote site:

- Build RTU cabinet and as-built w/ Nema 4 enclosure with air conditioner
- Construct antennae w/ cable and surge protector
- 600 feet of conduit and cable w/ 50' radius to automatic control valve and meter
- Electrical Feed to Site (assumes that there is already some sort of pumping station at the golf course that this can come from or some other site within reason to get electrical from)
- Software development and programming
- Modicon RTU w/ similar I/O With integral MDS Radio in RTU package at each site
- MDS 2000 Radio at each site

Howard said that Keller would not be interested in supplying budgetary cost numbers for a Master SCADA site since this not something they usually get involved with. I explained to him that it would include another authorized version of Intellution software and a new master computer along with a MDS 2000 Radio and master antennae and that it might also include additional building space to be constructed at the Sun City West WWTP. He did not think it would be something he could even estimate since they don't get involved with anything except remote RTU sites at this time.

Howard said these prices are no doubt high but for the limited information that we have for each site and its requirements these are within reason. The cost for the programming is additional cost and is high since Keller would have to hire some other company to do the programming.

Telephone Conversation Record

HDR

Project	CWR – Groundwater Savings Project	Project No.	00091-039-044
Time		Date	5/18/00
Call to	US WEST	800-549-5629	
	Large business & government services	Phone No.	
Call from	Dave Schettler		
	HDR	Phone No.	

Discussion, Agreement and/or Action: SCADA TELEPHONE LEASED LINES

Called to inquire about costs for leased telephone lines for a municipal type application for the SCADA system. The representative with US West asked if the type of application would be similar to what would be required for communication to a municipal water tank sending water elevation info. I told him it would be very similar since this type of application should have the same type of communication protocol except that we are not doing just one site but rather 20 to 30 sites. Based on that same type of similar application he did some calculating and responded that the basic monthly rates for a dedicated lease line would be $77 to $125 per month per site and that there would be an approximate $225 installation fee per site.

I asked if the following was still current information that we could use in our report for SCADA using telephone dedicated lease lines:
Lease rates depend upon a number of factors including mileage, number of central telephone offices involved, distance to the nearest pre-existing phone service, bandwidth, whether half duplex (2 wire) or full duplex (4-wire) and type of line utilized (voice grade versus analog or digital).

He said, "Yes. All of this is still valid for lease rates and that many of these same factors also influence the installation cost which can make it much higher than $225."

Telephone Conversation Record

HDR

Project	CWR – Groundwater Savings Project	Project No.	00091-039-044
Time		Date	7/12/00
Call to	Hennesy Equipment Sales Co.	Call from	Dave Schettler
	Mike Hammond		HDR
	602-277-7268 Phone No.		602-508-6677 Phone No.

Discussion, Agreement and/or Action: Booster Pump Station – Pump Material Costs

Called to obtain pump equipment costs from Hennesy Equipment for Fairbanks-Morse horizontal split case pumps for the booster pump station scenario. The booster pump station would have a firm pumping capacity of 15 CFS (or 6400 GPM). This means there would be three (3) each 3,200 GPM pumps. The booster pumps would raise pressure from approximately 50 PSI to 70 to 75 PSI. This results in a total dynamic head of about 25 PSI (or 58 feet). No VFD's would be required.

Mike said the basic pump cost would be for Fairbanks Morse model 10", 5821, 1185 rpm, 75 Hp horizontal split case pumps. The cost for the basic pump is about $17,733, add $2,200 for pump base and couplings, add $10,400 for the electric motor. The whole pump cost would be about $30,333. The installation cost for the contractor would be approximately an additional 20 percent. The installed cost would then be about 1.20 x $30,333 which equals $36,400.

Job No. 00091-039-044 | No.

HDR Computation

HDR

Project CWR-Groundwater Savings Project | Computed Dave S. | Date 7/14/00

Subject Meter Vaults to Sun City & Sun City West Distribution Systems | Checked | Date

Sheet | Of

Task: Calculate Meter Vault Costs

Sun City West System

-On 20" Water Main → Use 16" propeller meter w/ Totalizer & 4-20 mAmp

Item Description	Installed Cost Amount/Unit	Totals
1ea - Vault 6'x8'x7'high	$ 6,000 /ea	$6,000
1ea - 16" propeller meter	$ 12,000/ea	$12,000
2ea - 16" gate valves RW	$ 6,580/ea	$13,160
2ea - 20"x16" Reducers	$ 500 /ea	$1,000
800ft - Hard Wire w/ Conduit to SCADA Control	$ 6 /L.F.	$4,800
1 L.S. - Miscellaneous Piping	$ $1000/L.S.	$1,000
	Subtotal	$40,960

Sun City System

-On 24" Water Main → Use 18" propeller meter w/totalizer & 4-20 mAmp

Item Description	Amount/Unit	Totals
1ea - Vault 6x-8'x7'high	$6,000/ea	$6,000
1ea - 18" propeller Meter	$15,000/ea	$15,000
2ea - 18" RW Gate Valve	$8,500/ea	$17,000
2ea - 24"x18" Reducers	$700/ea	$1,400
800ft - Hard Wire w/ Conduit to SCADA Control	$6/L.F.	$4,800
1 L.S. - Misc. Piping	$1,000/L.F.	$1,000
	Subtotal	$45,200

Job No. 00091-039-044 | No.

HDR Computation

HDR

Project CWR- Groundwater Savings Project	Computed Dave S.	Date 7/14/00
Subject Meter Vault w/ Electronic Flow Control Valve to Percolation Ponds	Checked	Date
	Sheet	Of

Task: Calculate Costs for Vault w/ Meter & Control Valve

Item Description	Installed Cost/Unit	Totals
1ea - Meter Vault 6'x12'x7 high	$7,000/ea	$7,000
1ea - 8" Electronic Control Valve (list material price = $3,674) for Bermad	$6,000/ea	$6,000
1ea - 8" Propeller Meter	$3,800/ea	$3,800
1ea - 8" Basket Strainer ($900 List)	$1,125/ea	$1,125
1ea - 20"x8" Tee	$400/ea	$400
1ea - 8" RW Gate Valve	$800/ea	$800
1 L.S. - Misc. Piping	$1,500/ea	$1,500
1ea - Manhole to 42" RCP to Percolation Pond Pipeline	$4,000/ea	$4,000
600 ft - Hardwire to SCADA Control	$6/L.F.	$3,600
	Subtotal	$28,225
	Say	$28,300

Job No. 00091-039-044 | No.

HDR Computation

HDR

Project CWR-GSP		Computed Dave L.	Date 6/5/00
Subject Pressure Reducing Valve Vault on 24"Ø Trans Main		Checked	Date
Task		Sheet 1	Of 3

PRESSURE REDUCING VALVE VAULT STATION
Cost Material List

Quantity	Item	Mat. Cost	Labor	Equip	Subtotal w/other $/EA	Total plus OH&P $
2ea	24"X16" Reducer	400	100	50	$ 644	$1,288
2ea	16"X6" Tee	200	50	50	$ 406	$ 812
1ea	16" VICTAULIC COUPLING	150	50	50	$ 290	$ 290
2ea	16" RW GATE Valve	5,200	325	100	$6580	$13,160
1ea	16" Meter Strainer	2,100	300	50	$2,842	$ 2,842
2ea	6" RW Gate Valve	400	100	50	$644	$1,288
2ea	6"-90°EL	100	50	50	$232	$464
1ea	6" vic coupling	50	50	50	$174	$174
1ea	6" Meter Strainer	$800	150	50	1160	$1,160
1ea	16" PRValve Cla-Val Model 690-01	10,000	1000	200	$13,104	$13,104
1ea	6" PR Valve Cla-Val Model 90-01	2,000	500	100	$3,016	$3,016
1 LS	Pressure Meters & Tubing SST	2,000	1,000	—	3,480	3,480
1 EA	Precast Valve Vault 12'x6' w/ 2ea 3'x3' Access Hatches & Ladder & Vents	3,825	1000	500	6,230	6,230
					Subtotal	$47,308
					say	$48,000

To File

From Mike Heaton

Date June 2000

HDR

Memorandum

Subject **Cost for APS power**

I had place a call to APS in an attempt to determine the cost for obtaining power in the various locations that the Alternate Routes will require power. I finally spoke to Suzy @ 623-975-5740 for customer construction.

Suzy subsequently called me back and gave the following information:

She said that one of their engineers and supervisor went to the site at 115th and Beardsley canal to assess the situation. She said that they did have power in the vicinity, maybe about a mile away. They would have to bring in a pole line to get power to the area. I told her we expected that would be the case. Numbers that she got from them were in the range of $25,000 to $45,000 to the sites. She stated several times that these were very preliminary. I thanked her for their time.

My assessment is they gave a very rough estimate and because of that I would opt to take the higher number of $45,0000 for the Route B alignment. Also, because the Route C alignment is a mile away from B, I would double the amount for the import of power to that location.

To File

From Mike Heaton

Date Wednesday, July 19, 2000

HDR

Memorandum

Subject **Golf Course Creeks wrt Citizens GSP**

A question has arisen with respect to the creeks at the various golf courses where the CAP water is being delivered via the Groundwater Savings Project. Since the creeks will carry the flow, and the possibility of having to run the wells and the distribution system simultaneously exists, do the creeks have the capacity to carry the flows; which in some cases may be double the flowrate of the existing situation?

On July 13th a quick survey of the creeks was carried out and the following presents the information and conclusions based on the information from the survey. The estimation of flow was based on a typical slope of 0.1% and an n value of 0.018.

Lakes West Creek

- Creek is 5' wide and 5" deep.
- Creek is concrete lined.
- Well flow 2 cfs
- CAP flow 2.42 cfs
- **May have to deepen or widen to contain both flows simultaneously**

Riverview Creek

- Creek is 8' wide and 4.5" deep.
- Creek is not lined.
- Well flow 4.9 cfs and 4.0 cfs
- CAP flow 1.0 cfs and 0.8 cfs
- **Existing channel can probably contain flows of both**

Willowbrook Creek

- Creek is 5.5' wide and 4.5" deep.
- Creek is concrete lined.
- Well flow 2.3 cfs
- CAP flow 2.5 cfs
- **Existing channel can probably contain flows of both**

Willowcreek Creek

- Creek is 5.5' wide and 3" deep.
- Creek is not lined.

- Well flow 2.7 cfs
- CAP flow 2.5 cfs
- **May have to deepen or widen to contain both flows simultaneously**

Pebblebrook Creek

- Creek is 7' wide and 12" deep.
- Creek is concrete lined, with boulders
- Well flow 2.9 cfs
- CAP flow 2.0 cfs
- **Existing channel can probably contain flows of both**

Other information gathered at the same time the delivery points at some of the lakes.

Dawn Lake Access - Possible to use a boat ramp North of 13829 Whispering Lake & across From Fluoride. Another possibility near a meter box at 10210East Bolivar, although no markings were apparent showing ROW.

Willowcreek Access - Approximately a 10' easement between 20006 and 20010 Calypso Dr. although no markings were apparent showing ROW. There is also a possible easement at Willowcreek Circle @ Cherry Tree Lane. The width is 4' to 8' wide.

Appendix J
Environment & Cultural Information

LITERATURE REVIEW FOR THE SUN CITY/SUN CITY WEST GROUNDWATER SAVINGS PROJECT

Prepared by Barbara Macnider and Suzanne DeRosa
Archaeological Consulting Services, Ltd.
ACS Project No. 00-33
June 30, 2000

Under contract to HDR Engineering, Inc., ACS is providing services for the proposed Sun City/Sun City West Groundwater Savings Project. This project will utilize Central Arizona Project (CAP) water to irrigate the golf courses located within Sun City and Sun City West (the Sun Cities). The project is along the Agua Fria River and includes unincorporated county area, Sun City, Sun City West, City of Youngtown and the City of Peoria. Three alternative pipeline corridors have been proposed: A) from the Hayden-Rhodes Aqueduct (CAP) south along Lake Pleasant Road to Rose Garden Lane, B) from the Beardsley Canal south along the 115th Avenue alignment to Rose Garden Lane, and C) from the Beardsley Canal south along the El Mirage Road alignment to the Beardsley Road alignment. HDR Engineering has requested that Archaeological Consulting Services, Ltd. (ACS) summarize previous cultural resource investigations in the proposed project areas and recommend which corridor likely would cause the least destruction of cultural resources.

Project and site files at the State Historic Preservation office (SHPO), Bureau of Land Management (BLM) Phoenix Field Office, Arizona State Museum (ASM), and Arizona State University (ASU) were consulted. Also reviewed were historic General Land Office (GLO) maps at the BLM –Arizona State Office. The following report summarizes the review area, the region's cultural history, and the results of the file search.

Review Area

The review area (Table 1) covered portions of four USGS 7.5' topographic quadrangles: Baldy Mountain, Biscuit Flat, Hedgpeth Hills, and Calderwood Butte. It includes private, state, federal, and city or county owned land.

Table 1. Location of Alternatives and Review Areas.

Alternative	Legal Description (Gila and Salt River Baseline and Meridian)
A) CAP-Lake Pleasant Rd-Rose Garden Ln	T4N/R1E/S4, 5, 8, 9, 16–21 T5N/R1E/S15, 16, 21, 22; 27, 28, 32–34
B) Beardsley Canal-115th Ave-Rose Garden Ln	T4N/R1E/S6, 7, 18, 19; T4N/R1W/S1, 12, 13, 24 T5N/R1E/S31; T5N/R1W/S36
C) Beardsley Canal-El Mirage Rd-Beardsley Rd	T4N/R1E/S19; T4N/R1W/S1, 2, 11–14, 23, 24 T5N/R1W/S35, 36

Cultural History

The following is a brief culture history to provide a setting for the documented resources. The earliest evidence of human occupation in the Southwest is referred to as the Paleo-Indian period (10,000-7,500 B.C.). This period is characterized by a specialized flaked stone tradition associated with a mobile pattern of hunting large game and gathering wild plants (Huckell 1984). Although documented elsewhere in Arizona (e.g., Cordell 1997; Haury 1950; Huckell 1982, 1984), no Paleo-Indian sites have been reported near the review area.

Agua Fria Prehistory

The Paleo-Indian period is followed by the Archaic period, which is subdivided into three stages: Early Archaic (7500-5000 B.C.) (Haynes 1967; Martin 1963), Middle Archaic (5000-2000/1000 B.C.) (Agenbroad 1970), and Late Archaic (2000/1000 B.C.-A.D. 300/500) (Huckell 1984). This period is marked by a shift from generalized adaptations of big game hunting toward regional diversity and exploitation of smaller game and wild plant foods (Cordell 1997). The Early and Middle Archaic stages were hunter-gatherer traditions whereas the Late Archaic stage witnessed increased sedentism based on horticultural subsistence patterns and the introduction of maize (Huckell 1987). Archaic sites have been identified near South Mountain (Neily 1991), New River (Bruder 1983; Dittert 1976; Doyel and Elson 1985; Gumerman et al. 1976; Kenny 1986, 1987), in the Desert Foothills (Dove 1984; Henderson and Rodgers 1979), Paradise Valley (Berg et al 1999; Hackbarth 1999), and throughout the McDowell Mountains (Huckell 1987; Opfenring 1965).

The Formative period commenced with the development of ceramic technology and a transition from hunting and gathering subsistence to the use of agriculture. In Arizona, the major Formative cultures have been identified as the Anasazi, Mogollon, Patayan, and Hohokam. The Hohokam lived in the area along the Agua Fria.

The Hohokam occupied large, sedentary villages along the Salt and Gila Rivers between A.D. 150 and 1450. Large-scale irrigation agriculture, an elaborate political system, and wide-ranging trade networks were hallmarks of the Hohokam (Haury 1976). Their irrigation agricultural diet was supplemented with dry farming and upland area wild resources. The Hohokam culture is characterized by an expedient lithic assemblage, red-on-buff ceramics, cremation burials, and worked shell, stone, and bone. Some of these characteristics may represent continued use of the area by Late Archaic populations. Others are major changes associated with technological diffusion, environmental adaptations, and population growth. The most significant among these were the introduction of cotton, ceramics, and irrigation agriculture (Whittlesey et al. 1992).

Historic Native American Use of the Agua Fria River

Due to its location between the plentiful resources found along the Salt and Gila Rivers and those in the uplands of the Bradshaw Mountains, the more arid project area was not utilized for habitation by historic Native Americans. The waters of the Agua Fria were not as reliable as those found elsewhere, and therefore, farming and permanent settlement were eschewed. The only known historic settlement in the area was an Akimel O'odham (Pima) *rancheria* located on the north bank of the Gila near its confluence with the Salt. This small family settlement was documented in the 1700s by Fernandez del Castillo (Fontana 1983), and its exact location is unknown.

The sedentary Pima traditionally farmed along the banks of the Gila River. The Maricopa, who had migrated from their homes on the Colorado River in the mid-1800s, stayed with the Pima and farmed near the Gila. The Yavapai were nomadic hunter-gathers who also practiced some agriculture.

The Pima and Maricopa resource area encompassed the Hassayampa, Salt, and Gila Rivers and the land in between, including the lower and middle reaches of Agua Fria River. The Kewevkapaya, or Southeastern Yavapai, utilized the middle and upper reaches of the Agua Fria. Their traditional homeland extended from the Bradshaw Mountains to Tonto Basin to the Superstition and Pinal Mountains. There was minimal territorial overlap between the groups, who traditionally were enemies. All three groups utilized the Agua Fria region for the numerous wild resources found there, including saguaro fruit, mesquite beans, and various tubers. Hunters found some deer, but concentrated mainly on small birds and rabbits.

Historic Euroamerican Land Use Along the Agua Fria River

In the mid to late 1800s, the Agua Fria River Valley continued to be an area that people passed through on their way to settle elsewhere. Gold was discovered near present-day Wickenburg in 1863, and soon a wagon road branching from the southern overland route led north from the Salt-Gila River confluence,

across the Agua Fria to the Hassayampa River, then north to Wickenburg. With settlement increasing east of the Agua Fria, additional wagon roads crossed the Agua Fria in various locations. Stagecoach routes and wagon roads linked the mines in the Bradshaw Mountains with the agricultural areas along the Salt River. The first developments along the Agua Fria were stage and wagon stops. In 1895, the Santa Fe, Prescott and Phoenix Railway was built, thus linking Prescott and Phoenix (Sayre 1990). The railroad replaced the wagon roads as the main mode of transportation, and many of the stage and wagon stations were abandoned.

In 1910, Robert P. Davie completed excavation of the Marinette Canal, which transported water to his community of Marinette, east of the Agua Fria, from wells and a pumping plant in the river bottom. As early as1888, investors organized the Agua Fria Water and Land Company, to locate possible dam sites and canal alignments along the river. When William Beardsley invested in the project in the 1890s, a more modest proposal suggested two dams in the Frog Tanks vicinity, a diversion dam below, and some 250 miles of canals and laterals to irrigate approximately 160,000 acres on the west side of the Agua Fria. After financial setbacks and other adversities, the project was finally completed in 1935.

Agriculture continued to be the economic base for all communities along the Agua Fria River, until the expanding Salt River Valley population began to make it more profitable to use the land for housing. Since the 1950s, the population has continued to grow, and many areas have been sold to developers for residential and commercial centers as well as retirement communities, such as the Sun City developments.

Previous Research

Twenty-eight cultural resource projects have taken place in the review area (Table 2). Nearly all were Section 106-related inventories for state and/or federal agencies. Most were undertaken for linear right-of-way projects for roads and utilities. Other undertakings included residential and commercial development, gravel operations, a landfill, and water recharge. One large excavation project, the New River Authorized Dam, occurred on the northeastern edge of the review area. The Museum of Northern Arizona conducted the testing phase (Ciolek-Torrello 1981, 1982); Soil Systems, Inc., completed the data recovery investigations (Doyel and Elson 1985). There were extensive prehistoric agricultural fields using topography and rock alignments to move the water across the landscape. Several farmsteads and an important source of ground stone tools for throughout the Phoenix Basin also were found.

The area has many cultural resources. Seventy-five archaeological sites were documented within 0.5 mi of the three alternatives (Table 3); the number doubles within 1.0 mi of the alternatives. Most sites (n=57) are prehistoric. The area is rich in natural resources, including lithic raw material, plant resources, and arable land. Nearly half of the prehistoric sites are related to lithic procurement activities, including two sites that have ground stone tool manufacturing. The eight prehistoric habitation sites range from fieldhouses to large villages. Agricultural pursuits are represented by rockpile fields, rock alignments, and check dams. The numerous artifact scatters document the use of different resource areas along the river. Probably prehistoric trails were noted on the terraces east of the Agua Fria River. Petroglyphs were found at three sites.

The historic sites included five canals or canal systems, four artifact scatters, three road segments, and one homestead. The Marinette Canal, which skirts the east bank of the Agua Fria, was built in 1910 to irrigate the fields around Marinette. The other irrigation features were on the west side of the river and apparently represent unsuccessful attempts as no documents about them could be found. Of course, the Beardsley Canal, the in-use irrigation facility from which the project may draw water, was built in the 1930s after over 40 years of trying to capture water from the Agua Fria to reclaim tens of thousands of acres in the West Valley.

Two sites have both a prehistoric (lithic scatter) and historic (trash dump) components. The remaining sites were of unknown age. They include two possible graves, a "waffle" garden, and a cobble structure. Numerous historic road alignments and several house sites were plotted on GLO maps for the project area; however, the numerous surveys have yet to relocate any of these.

Table 2. Previous Projects in the Review Area.				
USGS 7.5' Quadrangle Reference/ASM Quad	**Project Location (T/R/Section/QQ)**	**Agency Project Number/Name**	**# of Sites Found (# in Review Area)**	**Reference**
Biscuit Flat/T:4 SW	T5N/R1E/S22, 27	New River Authorized Dam	44(5)	Ciolek-Torrello 1981, 1982; Doyel and Elson 1985
Calderwood Butte/T:7 NE	T4N/R1E/S4–9 T4N/R1W/S1, 11–14	ASM 97-271–Estrella Interim Parkway Survey	22(4)	Adams 1997c
Calderwood Butte/T:7 NE	T4N/R1E/S6	ASM 99-67/98-330–Agua Fria Recharge Survey	2(2)	Rhodes et al. 1992; Stubing 1998b, 1999
Calderwood Butte/T:7 NE	T4N/R1E/S5–8, 17–20	ASM 97-362–107th Avenue Class III Cultural Resource Survey	11(1)	Shepard et al. 1997
Calderwood Butte/T:7 NE	T7N/R1E/S 7, 18, 19	ASM 98-277–Westwing to Rio Vista 69kV Survey	4(4)	Adams and Macnider 1998
Calderwood Butte/T7 NE	T4N/R1E/S7, 18, 19 T4N/R1W/S12	ASM 97-409–Westwing to Rio Vista 69kV Survey	2(2)	Adams 1997a
Calderwood Butte/T:7 NE	T4N/R1W/S13, 14, 23, 24	ASM 99-33–El Mirage Road Survey	0(0)	Lackey and Lewenstein 1999
Calderwood Butte/T:7 NE	T7N/R1E/S17	ASM 98-217–Ironwood Survey	0(0)	Stubing 1998a
Calderwood Butte/T:7 NE	T4N/R1E/S17, 16, 20, 21	ASM 94-36-99th Ave & Deer Valley Road Survey	50(29)	Crary et al. 1994
Calderwood Butte/T:7 NE	T4N/R1E/S17, 20	ASM 95-157–99th Ave. III	1(1)	Mitchell 1995
Calderwood Butte/T:7 NE	T4N/R1E/S 17, 20, 21	ASM 97-178–Lake Pleasant Pkwy Survey	4(4)	Hackbarth 1997
Calderwood Butte/T:7 NE	T4N/R1E/S18, 19	ASM 87-179–McMurry Bros. Gravel	1(1)	Madsen 1987
Calderwood Butte/T:7 NE	T4N/R1E/S19, 20, 21	ASM 1997-195–Deer Valley Road: Westbrook to Rio Vista 69kV Survey	2(0)	Adams 1997b
Calderwood Butte/T:7 NE	T4N/R1E/S19	ASM 91-103–Finley Inventory Survey	1(0)	Rodgers 1991
Calderwood Butte/T:7 NE	T4N/R1E/S20	ASM 98-328–TRI Deer Valley Survey	0(0)	Wenker 1998
Calderwood Butte/T:7 NE	T4N/R1E/S20	ASM 97-214–Desert Winds Survey	1(0)	Stubing 1997
Calderwood Butte/T:7 NE	T4N/R1E/S20	ASM 95-229–Lake Pleasant Pkwy Survey	0(0)	Hoffman 1995
Calderwood Butte/T:7 NE	T4N/R1E/S 20, 21	ASM 86-51–State land survey	0(0)	Rozen 1986
Calderwood Butte/T:7 NE	T5N/R1E/S28	ASM 83-66–Maricopa County Landfill	2(0)	ASM letter report
Calderwood Butte/T:7 NE	T4N/R1W/S1, 11–14 T5N/R1W/36	ASM 83-122, 84-128, 94-459–Mead to Phoenix 500 kV Transmission Study	13(1)	Keller 1983, 1984; Purcell 1995; Purcell and Chadderdon 1996
Calderwood Butte/T:7 NE	T4N/R1WS1, 2, 11, 12	ASM 99-191–El Mirage Road Improvement Project Survey	0(0)	Garcia and Lewenstein 1999
Calderwood Butte/T:7 NE	T4N/R1W/S13	ASM 92-58–Salt River Sand and Rock	0(0)	Allen 1992

Table 3. Previously Recorded Archaeological Sites Within 0.5 mi of the Alternatives.						
USGS Map Reference	**Site No.**	**Location (T/R/Section)**	**Site Type**	**Site Size**	**Eligibility Recommended**	**Reference**
Biscuit Flat	T:4:10(ASU), T:4:16(ASM), NA16353	T5N/R1E/S22	Prehistoric habitation	670,000 m^2	Eligible	Ciolek-Torrello 1981, 1982; Doyel and Elson 1985
Biscuit Flat	T:4:12(ASM), T:4:39(ASU), NA16358	T5N/R1E/S22	Prehistoric farmstead	80,000 m^2	Eligible	Ciolek-Torrello 1981, 1982; Doyel and Elson 1985
Biscuit Flat	T:4:17(ASM), T:4:41(ASU), NA16360	T5N/R1E/S22	Prehistoric artifact scatter	Not available	Unknown	Ciolek-Torrello 1981, 1982
Biscuit Flat	T:4:19(ASM), NA16352	T5N/R1E/S22	Prehistoric artifact scatter	Not available	Unknown	Ciolek-Torrello 1981, 1982
Biscuit Flat	T:4:20(ASM), T:4:42(ASU), NA16361	T5N/R1E/S22	Prehistoric artifact scatter	Not available	Unknown	Ciolek-Torrello 1981, 1982
Calderwood Butte	T:7:6(ASM), poss. T:7:28(ASU)	T4N/R1E/S7	Prehistoric artifact scatter	155 x 73 m	Potentially eligible	Adams 1997b
Calderwood Butte	T:7:7(BLM)	T5N/R1E/S27	Prehistoric artifact scatter and ground stone manufacturing	100 x 110 m	Eligible	McQuestion and Gibson 1987
Calderwood Butte	T:7:8(BLM)	T5N/R1E/S27	Prehistoric artifact scatter with ground stone manufacturing	120 x 50 m	Eligible	McQuestion and Gibson 1987
Calderwood Butte	T:7:8(ASM)	T4N/R1E/S19	Prehistoric room block and rockpile	100 x 25 m	Unknown	Madsen 1987
Calderwood Butte	T:7:9(ASM)	T4N/R1E/S19	Possible prehistoric structure with lithic artifacts	20 x 20 m	Unknown	ASM site form, BLM cultural resource files
Calderwood Butte	T:7:10(ASM)	T4N/R1W/S19	Possible small prehistoric village	175 x 75 m	Unknown	ASM site form, BLM cultural resource files
Calderwood Butte	T:7:16(ASM)	T4N/R1E/S9	Prehistoric sherd scatter	5 x 16 m	Unknown	ASM site form
Calderwood Butte	T:7:28(ASM)	T4N/R1E/S5-8, 17, 18, 20, 21; T5N/R1E/S32	Historic Marinette Canal	27,720 x 8 ft	Eligible	Adams 1997b; Adams and Macnider 1997
Calderwood Butte	T:7:30(ASU)	4N/1E/S19	Prehistoric artifact scatter	11.6 acres	Unknown	Dittert 1974
Calderwood Butte	T:7:34(ASU)	T5N/R1E/S28	Prehistoric habitation	500 x 500 m	Unknown	McQuestion and Gibson 1987

Table 3. Previously Recorded Archaeological Sites Within 0.5 mi of the Alternatives.

USGS Map Reference	Site No.	Location (T/R/Section)	Site Type	Site Size	Eligibility Recommended	Reference
Calderwood Butte	T:7:35(ASU)	T5N/R1E/S28	Prehistoric petroglyphs, rock rings, artifacts	200 x 100 m	Eligible	McQuestion and Gibson 1987
Calderwood Butte	T:7:54(ASM)	T4N/R1E/S8	Historic homestead	110 x 170 ft	Unknown	ASM site form
Calderwood Butte	T:7:55(ASM)	T4N/R1E/S19	Historic or modern canal	190 x 6 m	Unknown	Rodgers 1991
Calderwood Butte	T:7:56(ASM)	T4N/R1E/S16	Prehistoric artifact scatter	114 x 85 m	Eligible	Crary et al. 1994
Calderwood Butte	T:7:61(ASM)	T4N/R1E/S16	Artifact scatter	124 x 82 m	Eligible	Crary et al. 1994
Calderwood Butte	T:7:62(ASM)	T4N/R1E/S16, 17	Prehistoric lithic scatter	120 x 120 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:63(ASM)	T4N/R1E/S17, 20	Prehistoric lithic scatter	209 x 41 m	Eligible	Crary et al. 1994
Calderwood Butte	T:7:67(ASM)	T5N/R1E/S31	Prehistoric agricultural site	1.29 acres	Unknown	Rhodes et al. 1992
Calderwood Butte	T:7:82(ASM)	T4N/R1E/S17	Prehistoric lithic scatter and historic trash dump	24 x 33 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:83(ASM)	T4N/R1E/S17, 20	Historic road segment and artifact scatter	1800 x 11 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:84(ASM)	T4N/R1E/S20	Prehistoric lithic scatter	284 x 78 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:85(ASM)	T4N/R1E/S20	Prehistoric artifact scatter	100 x 19 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:86(ASM)	T4N/R1E/S20	Prehistoric lithic scatter	109 x 35 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:87(ASM)	T4N/R1E/S17	Prehistoric lithic scatter	107 x 25 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:88(ASM)	T4N/R1E/S17	Prehistoric lithic scatter	163 x 33 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:89(ASM)	T4N/R1E/S17	Prehistoric lithic scatter	9 x 11 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:91(ASM)	T4N/R1E/S17	Prehistoric lithic scatter	329 x 58 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:92(ASM)	T4N/R1E/S17	Prehistoric lithic scatter	167 x 41 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:93(ASM)	T4N/R1E/S17	Prehistoric trail segment with no associated artifacts	190 x 3 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:94(ASM)	T4N/R1E/S17	Historic artifact scatter	54 x 31 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:95(ASM)	T4N/R1E/S17	Prehistoric trails with no associated artifacts	260 x 120 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:96(ASM)	T4N/R1E/S17	Prehistoric artifact scatter	137 x 30 m	Not eligible	Crary et al. 1994

Table 3. Previously Recorded Archaeological Sites Within 0.5 mi of the Alternatives.						
USGS Map Reference	**Site No.**	**Location (T/R/Section)**	**Site Type**	**Site Size**	**Eligibility Recommended**	**Reference**
Calderwood Butte	T:7:98(ASM)	T4N/R1E/S20	Prehistoric artifact scatter	144 x 24 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:99(ASM)	T4N/R1E/S20	Prehistoric artifact scatter	55 x 41 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:100(ASM)	T4N/R1E/S20	Historic artifact scatter	29 x 21 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:101(ASM)	T4N/R1E/S20	Prehistoric artifact scatter	131 x 52 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:102(ASM)	T4N/R1E/S20	Prehistoric artifact scatter	29 x 38 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:103(ASM)	T4N/R1E/S20	Prehistoric artifact scatter	18 x 24 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:104(ASM)	T4N/R1E/S20	Prehistoric artifact scatter	75 x 23 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:105(ASM)	T4N/R1E/S20	Prehistoric artifact scatter	37 x 18 m	Eligible	Crary et al. 1994
Calderwood Butte	T:7:106(ASM)	T4N/R1E/S20	Prehistoric artifact scatter	134 x 17 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:107(ASM)	T4N/R1E/S20	Prehistoric artifact scatter	43 x 17 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:108(ASM)	T4N/R1E/S21	Prehistoric artifact scatter	39 x 20 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:109(ASM)	T4N/R1E/S16, 17, 21	Historic road segment and artifact scatter	2,250 x 5 m	Eligible	Crary et al. 1994
Calderwood Butte	T:7:111(ASM)	T4N/R1E/S20	Lithic scatter and rock ring	6 x 6 m	Eligible	Crary et al. 1994
Calderwood Butte	T:7:112(ASM	T4N/R1E/S20	Lithic scatter and trail	98 x 30 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:121(ASM)	T4N/R1E/S16, 17	Prehistoric trail with no associated artifacts	180 x 0.2 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:123(ASM)	T4N/R1E/S17	Prehistoric trail with one flake	170 x 0.2 m	Not eligible	Crary et al. 1994
Calderwood Butte	T:7:128(ASM)	T4N/R1W/S11, 12	Prehistoric rockpiles and artifacts	45 x 11 m	Not eligible	Purcell 1995
Calderwood Butte	T:7:140(ASM)	T4N/R1E/S17	Historic trash dump	12 x 12 m	Not eligible	Hackbarth 1997
Calderwood Butte	T:7:141(ASM)	T4N/R1E/S20	Rock waffle garden	7 x 1.2 m	Not eligible	Hackbarth 1997
Calderwood Butte	T:7:143(ASM)	T4N/R1W/S11	Rock clusters and artifact scatter	78 x 34 m	Unknown	Adams and Macnider 1997
Calderwood Butte	T:7:144(ASM)	T4N/R1W/S11	Prehistoric chipped stone reduction	109 x 50 m	Unknown	Adams and Macnider 1997

Table 3. Previously Recorded Archaeological Sites Within 0.5 mi of the Alternatives.						
USGS Map Reference	**Site No.**	**Location (T/R/Section)**	**Site Type**	**Site Size**	**Eligibility Recommended**	**Reference**
Calderwood Butte	T:7:145(ASM)	T4N/R1W/S12	Prehistoric artifact scatter	86 x 70 m	Not eligible	Adams 1997a
Calderwood Butte	T:7:146(ASM)	T4N/R1W/S11	Prehistoric lithic scatter	15 x 8 m	Not eligible	Adams 1997c
Calderwood Butte	T:7:147(ASM)	T4N/R1W/S12,13	Prehistoric lithic scatter	2,423+ x 160 m	Eligible	Adams 1997c
Calderwood Butte	T:7:148(ASM)	T4N/R1W/S12	Prehistoric artifact scatter and possible roasting pit	75 x 60 m	Potentially eligible	Adams 1997c
Calderwood Butte	T:7:149(ASM)	T4N/R1W/S12	Prehistoric artifact scatter	91 x 69 m	Unknown	Adams 1997c
Calderwood Butte	T:7:150(ASM)	T4N/R1W/S12	Prehistoric lithic scatter and rock features	85 x 76 m	Unknown	Adams 1997c
Calderwood Butte	T:7:151(ASM)	T4N/R1W/S12	Cobble structure and alignment of unknown age	62 x 15 m	Unknown	Adams 1997c
Calderwood Butte	T:7:152(ASM)	T4N/R1W/S12	Rockpile (possible grave)	2.2 x 1 m	Not eligible	Adams 1997c
Calderwood Butte	T:7:153(ASM)	T4N/R1W/S12	Rockpile (possible grave)	2.3 x 0.7 m	Not eligible	Adams 1997c
Calderwood Butte	T:7:154(ASM)	T4N/R1W/S7, 11-13	Historic canal system	13,728+ m	Unknown; needs more research	Adams and Macnider 1998
Calderwood Butte	T:7:155(ASM)	T4N/R1W/S12	Possible prehistoric camp site	68 x 44 m	Potentially eligible	Adams 1997c
Calderwood Butte	T:7:156(ASM)	T4N/R1W/S12; T4N/R1E/S7	Prehistoric habitation	260 x 225 m	Eligible	Adams 1997c
Calderwood Butte	T:7:157(ASM)	T4N/R1W/S12	Possible historic road	1,515 x 10 ft	Not eligible	Adams 1997c
Calderwood Butte	T:7:158(ASM)	T4N/R1E/S6	Prehistoric village	240 x 197 m	Eligible	Stubing 1999
Calderwood Butte	T:7:161(ASM)	T4N/R1E/S4, 8, 9	Historic canal segments	1312 + m	Not eligible	Adams 1997c
Calderwood Butte	T:7:162(ASM)	T4N/R1W/S10-13	Historic canal	2105 + m	Not eligible	Adams 1997c
Calderwood Butte	T:7:183(ASM), T:7:15(ASU)	T4N/R1E/S6	Prehistoric rockpiles, possible structures, petroglyph	305 x 180 m	Eligible	Stubing 1998b, 1999

Of the 75 sites, 16 were recommended as eligible for the National and/or State Register, 38 as not eligible, and 3 as potentially eligible. The eligibility of 18 sites is unknown.

Cultural Resource Sensitivity

Five sites have been found in or near Alternative A (Table 4); however, this is the longest segment. The sites include both prehistoric and historic resources. One site, the Marinette Canal, is eligible for the National and State Register. Two sites were recommended not eligible and two sites have not been evaluated.

Table 4. Archaeological Sites in the Alternatives.

Site Number	Site Type	In Right-of-way?	Register Eligibility Recommendation
Alternative A			
AZ T:7:9(ASM)	Possible prehistoric structure with lithic artifacts	In or near	Not evaluated
AZ T:7:28(ASM)	Historic Marinette Canal	In	Eligible, Criterion A
AZ T:7:30(ASU)	Prehistoric artifact scatter	In or near	Not evaluated
AZ T:7:82(ASM)	Prehistoric lithic scatter and historic trash dump	In or near	Not eligible
AZ T:7:83(ASM)	Historic road	In	Not eligible
Alternative B			
AZ T:7:154(ASM)	Historic canal system	In	Needs more research
AZ T:7:156(ASM)	Prehistoric habitation	In	Potentially eligible
Alternative C			
AZ T:7:143(ASM)	Rock clusters and artifacts	Near	Needs testing
AZ T:7:144(ASM)	Prehistoric chipped stone reduction	Near	Needs testing

Two sites have been documented along Alternative B. One is a prehistoric habitation locus that is potentially eligible for the National/State Register. The other is a historic canal system of unknown age and function. No recommendation was made regarding its eligibility.

Three prehistoric sites have been recorded in or near the Alternative C right-of-way. One is recommended as not eligible; testing needs to occur at the other two to determine if they are eligible.

Recommendations

Portions of all three alternatives have been covered by the previous surveys. However, Alternative C has the best coverage (65–70 percent), and Alternative B has the least coverage (6–25 percent). About 43 percent of Alternative A has been surveyed; however, since this is the longest line it has the longest segment of right-of-way unsurveyed.

Alternative A

- All of Lake Pleasant Road right-of-way south of Pinnacle Peak Road has been surveyed
- Two short segments north of Pinnacle Peak Road have been surveyed
- Only about one-quarter of the Rose Garden Lane alignment has been surveyed
- *All of the right-of-way along Lake Pleasant Road north of Pinnacle Peak Road and the Rose Garden Lane alignment should be surveyed*

Alternative B

- Depending upon which side of the section lines this alternative is located, about 1 mi or 0.25 mi of the 115th Avenue alignment has been surveyed

- *All of the proposed right-of-way for this alternative, including the Rose Garden Lane segment, should be surveyed since sites were found within the previously covered portions.*

Alternative C

- Nearly all of the El Mirage Road alignment has been surveyed
- *All of the Beardsley Road alignment and the right-of-way between Beardsley Road and the wastewater treatment plant need survey. Also about 1.0 mi of right-of-way along the El Mirage Road alignment needs coverage.*

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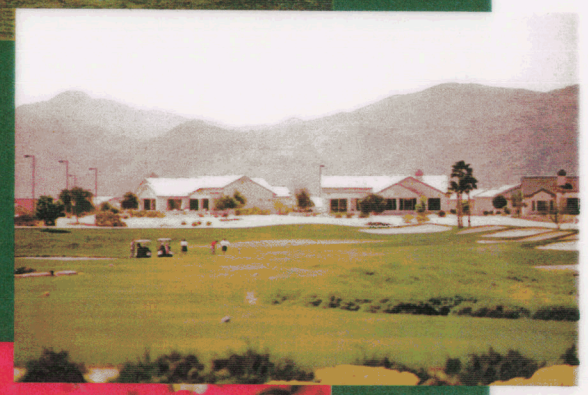

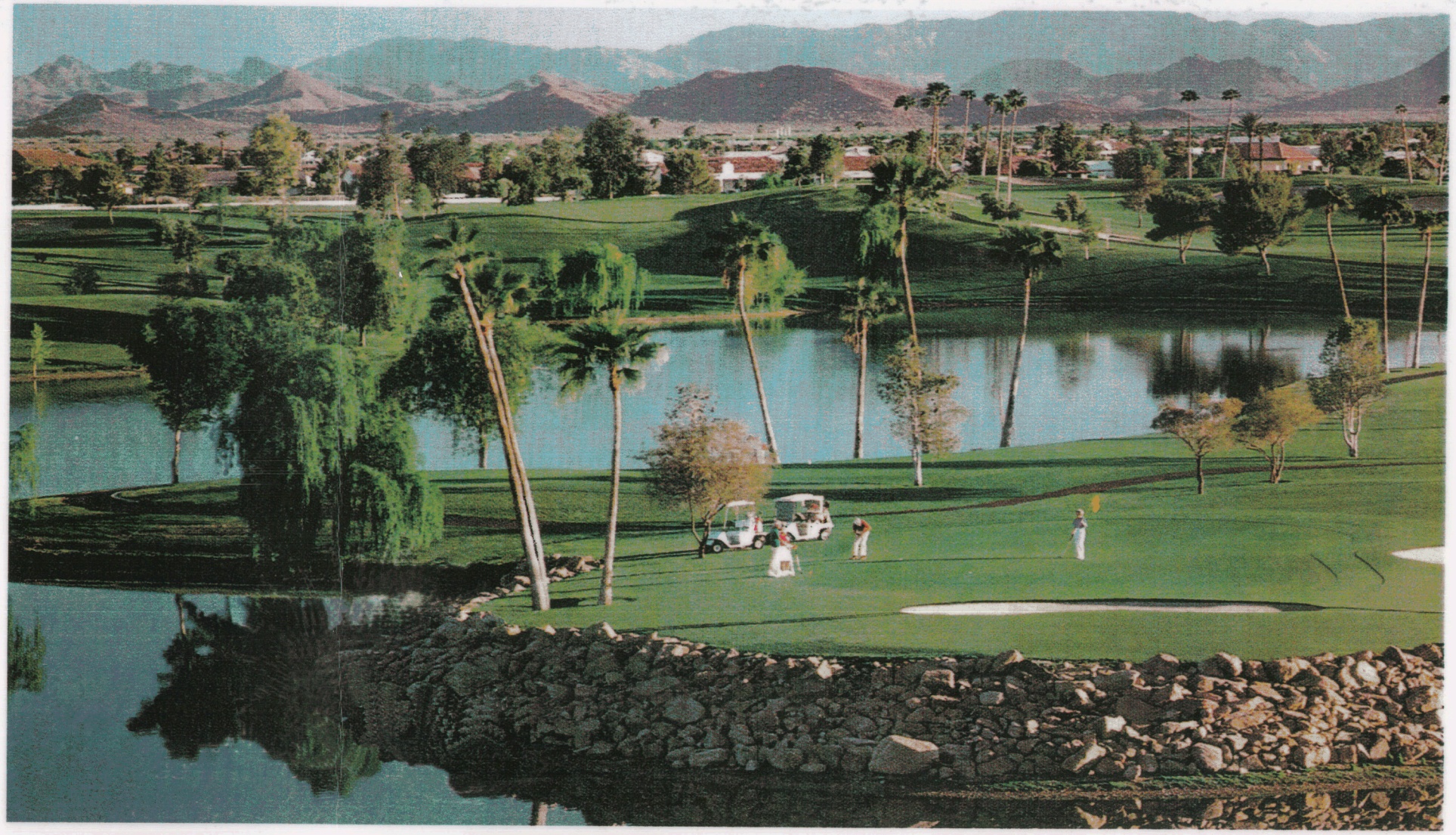

CITIZENS water resources

Sun City/Sun City West/Youngtown Groundwater Savings Project

Preliminary Engineering Report

July 2000

Registered Professional Engineer (Civil)
CERTIFICATE NO.
15268
DAVID W.
BURAS
Date Signed 7/20/00
ARIZONA, U.S.A.

HDR

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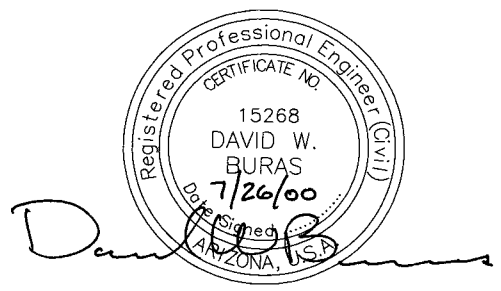

HDR

2141 E. Highland Avenue
Suite 250
Phoenix, AZ 85016
(602) 508-6600

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PART A – REPORT OVERVIEW

1 Project Purpose

The Sun Cities/Youngtown Groundwater Savings Project (GSP) is a conceptual water use plan developed by a community based task force called the CAP Task Force. The mission of the Task Force was to develop consensus on the best plan for the use of Central Arizona Project or CAP water in the Sun Cities and Youngtown. The Task Force recommended that the CAP water be used to replace groundwater pumping at local golf courses using either of two legal mechanisms: a groundwater savings project or a water exchange.

In order to bring the CAP water to local golf courses for the purpose of replacing groundwater pumping, the Task Force recommended that a non-potable pipeline be constructed from the CAP Canal to Citizens' water campus located north of Sun City and east of Sun City West. From the water campus, the CAP water would then be distributed through the existing effluent distribution system to golf courses in Sun City West and to a newly constructed distribution system to golf courses in Sun City.

On January 25, 2000, the Arizona Corporation Commission (ACC) approved the CAP Task Force's conceptual water use plan and recorded its order in Decision No. 62293. In its order, the ACC required Citizens to conduct a preliminary design and updated cost estimate for the GSP. In accordance with Decision No. 62293, the purpose of this Preliminary Engineering Report is to document a preliminary design and updated cost estimate for the GSP. Specifically the ACC required the preliminary design and updated cost estimate to consider two primary concerns raised during the proceedings before the ACC.

1. The feasibility of a joint transmission facility with the Agua Fria Division including the timeframe for as such joint transmission facility be investigated.

2. The need for all major elements of its proposed plan be justified.

The purpose of this Preliminary Engineering Report is to document the results of the preliminary design and updated cost estimate and to specifically address the two concerns raised in Decisions No. 62293.

2 Background Information

Since the early 1900s, groundwater levels have declined by approximately 300 feet in northwest Maricopa County. The Arizona Department of Water Resources (ADWR) and others have concluded that, over the next twenty-five years, water levels will decline another 300 feet if groundwater pumping is not curtailed in the area. In recent years, groundwater overdraft has been estimated at over 50,000 acre-feet per year for the northwest valley including the utilities operated by Citizens Water Resources that serve Sun City, Sun City West and Youngtown.

The purpose of the Sun Cities/Youngtown Groundwater Savings Project is to reduce a portion of this overdraft by meeting 6,561 acre-feet of demand in Sun City, Sun City West and Youngtown with CAP water instead of mined groundwater.

In 1985, Citizens secured a subcontract for CAP water for use in the Sun Cities. In 1993, the CAP was determined substantially complete and the CAP began assessing holding charges for the construction of the canal. In addition to making numerous requests to recover holding charges since 1985, Citizens also studied methods for using its CAP allocation. Most notably, Citizens prepared a study in 1994 that analyzed 20 options for using CAP water. This study concluded that storing water at the Agua Fria Recharge Project was the best option.

In 1995, within the context of a larger rate proceeding before the ACC, Citizens proposed storing its CAP allocation at the Agua Fria Recharge Project. In ACC Decision No. 60172, the Commission rejected this proposal. As a part of this proceeding, Citizens was strongly criticized for failing to consider the views of the community.

In response to this criticism, Citizens facilitated a task force to study the issue of whether or not the CAP allocation should be retained, and if retained, how the allocation should be used and paid for. Subsequent to its formation in early 1998, the CAP Task Force considered seven options including recharge projects, water treatment plants and groundwater savings projects. In the end, the Task Force concluded that the allocation should be retained. The Task Force also concluded that the best option for using the CAP water is to partner with local golf courses on a groundwater savings project. This conceptual water use plan is discussed generally in section 3, and it is the focus of this entire report.

In October of 1998, Citizens forwarded the Task Force's recommendation to the ACC in the form of an application. This application requested four approvals from the ACC:

1. Approval of the concept to use the golf courses as a groundwater savings project;

2. Approval to implement an interim groundwater savings project with a local irrigation district;

3. Approval to collect a groundwater savings fee to pay for past and ongoing holding charges; and

4. Approval to pay for delivery of CAP water to the interim project.

During the proceedings before the ACC, Sun City Taxpayers Association (SCTA) witnesses raised concerns about the need for some of the major components of the project. In addition, SCTA argued the possibility of developing a regional transmission main from the CAP Canal to the Sun Cities that could be used by Citizens' Agua Fria Division in addition to being used by Sun City Water Company and Sun City West Utilities Company. Under this proposal, SCTA envisioned approximately 65% of the costs to construct the transmission main being apportioned to customers in Agua Fria relieving customers in Sun City, Sun City West and Youngtown from certain costs.

On January 25, 2000, the ACC (Decision No. 62293) approved all of the requests made in the application. As part of its approval of the concept to use the golf courses as a groundwater savings project and in consideration of the issues raised by SCTA, the ACC ordered Citizens to conduct a preliminary design and updated cost estimate that would specifically address the following three items:

1. The feasibility of a joint transmission facility with the Agua Fria Division including a timeframe for any such joint facility.

2. The need for all major elements of the proposed plan (e.g. storage and booster stations).

3. Binding commitments from the golf courses, public and private, and the term and conditions related thereto.

In February of 2000, Citizens retained HDR Engineering, Inc. to conduct the preliminary design and updated cost estimate study. To assist the engineers in preparing their report and to solicit views from the community, Citizens formed a Technical Advisory Committee to review the progress of the study. This report directly addresses the first two points raised in Decision No. 62293: a joint transmission main with Agua Fria and the need for all major elements of the plan.

This report does not address the binding commitments from local golf courses as such commitments are financial and policy related and not engineering related. Instead, agreements with each Recreation Center and any participating private golf courses have been prepared and are awaiting approval by their respective Boards. Citizens will transmit these agreements to the ACC, under separate cover, upon execution by the participating parties.

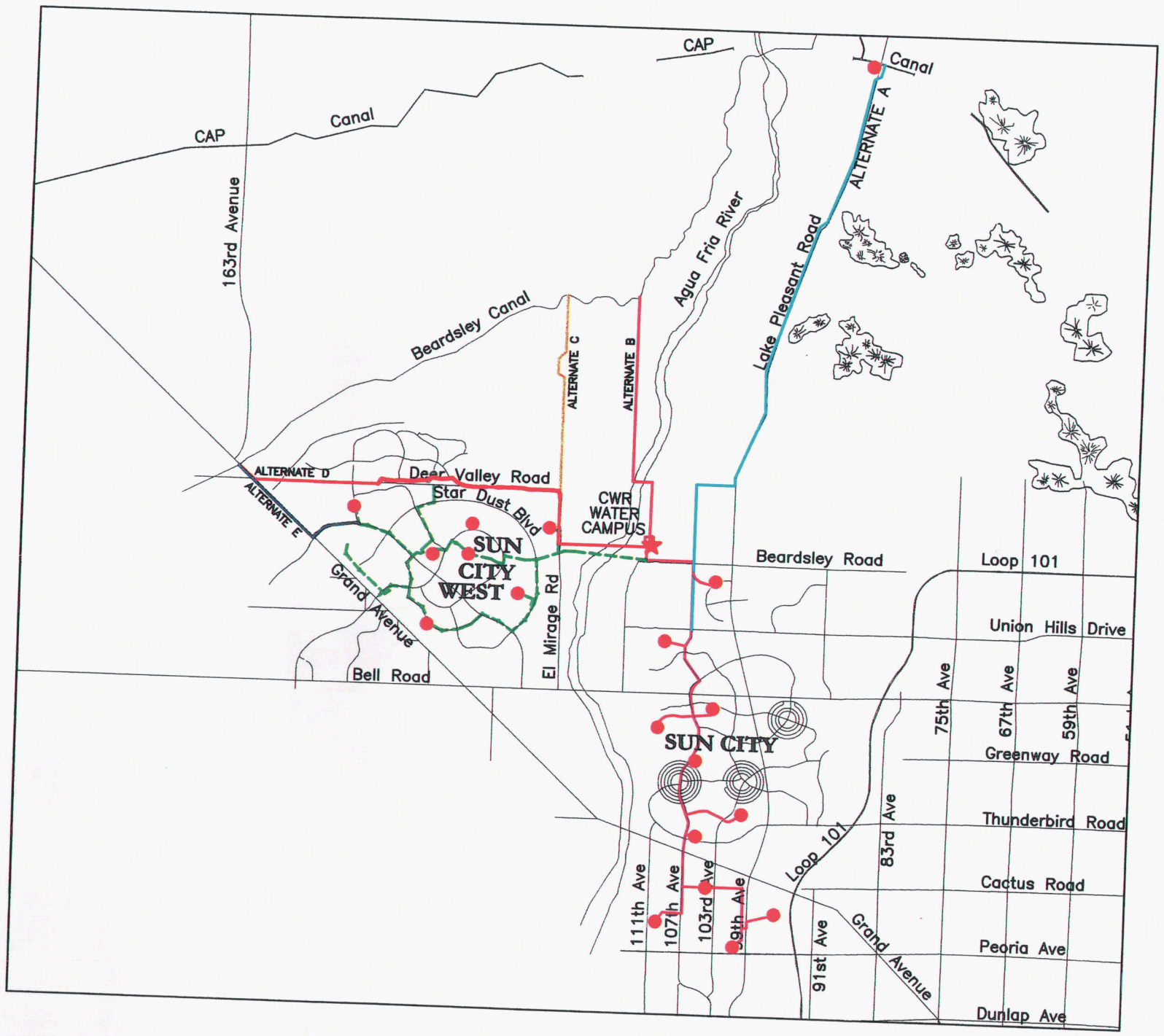
3 Groundwater Savings Project with Local Golf Courses as Recommended by the CAP Task Force

The Sun Cities/Youngtown Groundwater Savings Project (GSP) is a water exchange project where Sun City Water Company and Sun City West Utilities Company will exchange their CAP water for groundwater being used by local golf courses. As a part of the project, a water transmission main will be constructed to bring raw CAP water from the Hayden-Rhodes Aqueduct to the water campus where the Sun City West Utilities Company waste water treatment plant and effluent recharge basins are located. The Task Force's recommendation plus the alternative transmission main routes are depicted in **Figure A.1**.

From the water campus, the raw CAP water will be delivered through a smaller distribution system to participating golf courses in Sun City. Deliveries to participating golf courses in Sun City West will be made through the existing effluent distribution system owned and operated by the Recreation Centers of Sun City West. The proposed and existing irrigation distribution systems are shown on **Figure A.1**.

The transmission pipeline described above will branch to a smaller irrigation distribution system, the raw CAP water will be delivered directly to each participating golf course at a specified delivery point. The golf courses will then curtail their groundwater pumping and instead take the raw CAP water. As a part of the exchange, the golf courses will legally be using groundwater and the two utilities will legally be using CAP water.

Figure A.1



GENERAL VICINITY MAP

4 Project Participants

Due to the complexity of the project, Citizens retained a multi-disciplined consulting team to conduct the preliminary design and updated cost estimate and to prepare this report. Citizens retained HDR Engineering, Inc. as the lead consultant due to HDR's expertise in developing a similar system for the City of Scottsdale. In addition to retaining a multi-disciplined consulting team, Citizens established a community input group, and finally, Citizens included other organizations critical to the construction and implementation of the project.

Consulting Team

HDR Engineering, Inc.

HDR Engineering, Inc. was selected as the lead consultant based on their extensive expertise working on the Irrigation Water Distribution System (IWDS) in the city of Scottsdale. The IWDS is a project identical in many respects to the GSP. When complete, the IWDS will deliver untreated CAP water through a series of pump stations and pipelines to golf courses in the north Scottsdale area. The project will parallel an existing system, the Reclaimed Water Distribution System (RWDS) which has been providing this same function for the past eight years. Working closely with the City and golf courses, HDR's familiarity and understanding of delivering untreated CAP water to golf courses is unmatched.

Turf Science, Inc.

Dr. Harold Howard, Ph.D., proprietor of Turf Science, Inc. conducted the golf course assessment for the project. Dr. Howard was selected as a member of the consulting team because he served as Director of Golf Courses for the Recreation Centers of Sun City West, Inc. from 1986 to 1993. In that capacity, he was responsible for operation and maintenance of what was then six Recreation Center golf courses.

As a part of this project Dr. Howard was responsible for collecting background data on existing irrigation practices including water usage records, electrical usage records, facility layouts, and operating preferences of the individual maintenance personnel. In addition, Dr. Howard's responsibilities included:

- investigating irrigation requirements for each golf course:
- determining how the CAP supply can best meet those irrigation requirements:
- determining what impacts the use of CAP water may have on golf course operation; and
- determining what mitigation measures will need to be implemented to account for the difference in water quality between the existing groundwater supply and the CAP water.

DCI, Inc.

Mr. Leonard Duecker, P.E., president of DCI, Inc., provided technical expertise and quality control reviews to ensure that this report considers and addresses any "fatal flaws" in the preliminary design of delivering CAP water to the golf course.

Prior to becoming a consultant, Mr. Duecker was General Manager for the City of Scottsdale's Water Resources Department. In his capacity with Scottsdale, he developed and implemented the Reclaimed Water Distribution System (RWDS). The RWDS is a 14-mile reclaimed water distribution system designed to transport up to 20 million gallons of effluent to golf courses for irrigation. Initially, the RWDS distributed CAP water to the golf courses until sufficient effluent flows were available to deliver effluent to the golf courses. The RWDS was the predecessor of the Irrigation Water Distribution System (IWDS) that serves CAP water to golf courses in Scottsdale.

Universal Field Services

Universal Field Services collected county assessor maps for the general area and identified individual property owners along each potential route of the raw water pipeline. They produced exhibits showing all individual property owners, easements, and public rights-of-way along each route. They also determined the new permanent and temporary easements required for each alignment alternative.

Universal Field Services has also prepared estimated valuations of the right-of-way and easement costs for public and private ownership, along with estimated time frames and possible difficulties associated with acquiring the easements for each alignment alternative.

Terrane Engineering Corporation

Terrane Engineering Corporation is a geotechnical exploration and consulting firm. To support the evaluation of the alternative routes for the raw CAP water line, Terrane conducted field test pit examinations of the soil conditions and prepared a report summarizing the character of the soil conditions encountered, along with recommendations as to the constructibility and trenching requirements needed for pipeline construction.

Archeological Consulting Services

Specialty subconsultant, Archeological Consulting Services, conducted a literature search of documented cultural resource sites in the general area of the alternative routes for the raw CAP water line to avoid disturbing any known cultural resources. In addition, they collected documentation that will be used to secure federal 404 permits for future construction of the project.

BJ Communications

Suzanne Pfister, Vice-President of Environmental and Community Relations, was retained to organize the Technical Advisory Committee meetings and to provide community relations support to the engineering team. Ms. Pfister was retained because of her experience working with the CAP Task Force during the task force process and at the proceedings before the ACC.

CAP Technical Advisory Committee

At the conclusion of the CAP Task Force, Citizens committed to establish a smaller community group to participate in future phases of the project. To this end, the CAP Technical Advisory Committee (CAP TAC) was established to participate in the development of the preliminary design and updated cost estimate specifically for the purpose of providing operational and technical guidance to the consulting team.

To form the CAP TAC, Citizens asked the Recreation Centers of Sun City and the Recreation Centers of Sun City West to select two individuals from their organizations to represent the Recreation Center golf courses. In addition, Citizens asked each non-Recreation Center golf course to select one representative each to represent the non-Recreation Center courses. Finally, Citizens asked the Property

Owners and Residents Association (PORA), the Sun City Homeowners Association and the Sun City Taxpayers Association (SCTA) to select one individual each to represent their respective organizations. The TAC was then formed with twelve members. The organizations invited to participate in the TAC selected the following individuals to represent the interests of their organization on the CAP TAC:

CAP Technical Advisory Committee Members	
Member	**Representing**
John Powell	Recreation Centers of Sun City
Jerry Swintek	Recreation Centers of Sun City
Bob Jones	Recreation Centers of Sun City West
Dess Chappelear	Recreation Centers of Sun City West
Ernie Miller	Palmbrook Country Club
Jim Sander	Briarwood Country Club
Jeff Schuld	Hillcrest Golf Club
Jay Blackburn	Sun City Country Club
Gene Zylstra	Sun City Homeowners Association
Robert McCurdy	Sun City West Property Owners & Residents Association
Raymond Dare	Sun City Taxpayers Association
Donald Needham	Town of Youngtown

Other Critical Project Participants

In order to effect the GSP and to address the concerns raised in Decision No. 62293, Citizens enlisted the support of several organizations critical to successful construction and implementation of the project. Most critical to successful implementation is the involvement of the Recreation Centers of Sun City and Sun City West. Another critical participant is the Central Arizona Water Conservation District (CAWCD). Finally, in order to determine the need for a water transmission main and to determine the potential for the joint transmission main with Agua Fria, Citizens consulted with the Maricopa Water District (MWD).

Recreation Centers of Sun City

The Recreation Centers fulfills several important functions in this project. The Recreation Centers operate the majority of the golf courses in Sun City. Additionally, the Recreation Centers will partner with Citizens through a contractual agreement to effect the GSP.

There are ten golf courses located in Sun City. The Recreation Centers of Sun City operates seven of these golf courses. Without these golf courses, there is not sufficient golf course demand to use 100% of the CAP allocation intended for use in Sun City. As a part of the ACC proceedings, the ACC ordered Citizens to consider the participation of non-Recreation Center courses in the GSP. Upon commencing negotiations with the Recreation Centers of Sun City, the Recreation Centers expressed a desire to have exclusive rights to exchange the CAP water with Sun City Water Company.

Since the project cannot be effected without the Recreation Center courses, Citizens was compelled to respect the wishes of the Recreation Centers. Based on the premise that the Recreation Centers would be entitled to exclusive use of the CAP water, the assessment presented in this report assumes the delivery of CAP water only to Recreation Center courses. To that end, the consulting team and golf course management personnel for the Recreation Centers worked together to develop a preliminary operational procedure for the Recreation Center courses only.

Recreation Centers of Sun City West

The Recreation Centers of Sun City West fulfills several important functions in this project. Like the Recreation Centers of Sun City, the Recreation Centers of Sun City West operates the majority of the golf courses in Sun City West. Again like Sun City, the Recreation Centers of Sun City West will partner with Citizens through a contractual agreement to effect the GSP. In addition to the above-mentioned functions, the Recreation Centers of Sun City West owns and operates a non-potable distribution system that connects to all of the original golf courses in Sun City West.

There are nine golf courses in Sun City West. The Recreation Centers operates seven of those courses. Two of the seven courses operated by the Recreation Centers are reliant on effluent recharged at Citizens water campus and recovered from wells located on the golf courses. These courses cannot participate in the GSP because they do not have groundwater rights.

In addition to operating the majority of the courses, the Recreation Centers operates a non-potable distribution system originally intended for delivering treated effluent to Recreation Center courses. Past attempts to make these deliveries produced irrigation water quality unfavorable to golf course operations and resulted in the abandonment of this concept. Since that time, only small amounts of groundwater have been transported through the non-potable distribution system.

As a part of the ACC proceedings, the ACC ordered Citizens to consider the participation of non-Recreation Center courses in the GSP. Unlike Sun City, the Recreation Centers of Sun City West did not request an exclusive use of CAP water on Recreation Center courses. And in fact, as determined by the analysis conducted by the consulting team and presented in this report, without the participation of the two private courses in Sun City West, the GSP will not be operationally feasible.

Hillcrest Golf Club and Briarwood Country Club

Hillcrest Golf Club and Briarwood Country Club play important roles in the Sun City West portion of the GSP. Golf course demands in Sun City West are not large enough to allow for 100% use of the CAP allocation intended for use in Sun City West based on the timing of demands and the limitations of the non-potable distribution system. Like the Recreation Centers, Hillcrest and Briarwood will need to partner with Citizens through a contractual agreement to effect the GSP.

Central Arizona Water Conservation District (CAWCD)

The CAWCD or CAP is the entity that operates the CAP aqueduct. Each year, Citizens will coordinate annual delivery schedules with CAP. During the year, Citizens will communicate daily with CAP regarding deliveries to the GSP. During construction, Citizens will work with CAP to construct a connection between the CAP and the water transmission main. To the extent CAP can provide existing facilities, Citizens will enter into agreements with CAP to maximize the use of such facilities.

There are a number of operational issues associated with the CAP. Since the operation of the CAP affects all the potential alternatives to bringing CAP water to the Sun Cities, these operational issues will be discussed in section 2 of Part D under common elements.

Maricopa Water District (MWD)

The Maricopa Water District (MWD) is an irrigation district to the west and south of the Sun Cities. MWD operates the Beardsley Canal. The Beardsley Canal interconnects with the CAP Canal at roughly the CAP Canal and the Agua Fria River. Due to the geographic layout of the Beardsley Canal, this report analyzes the possible advantages of utilizing this canal as a means of delivering CAP water closer to the project area before transferring the water to a closed pipe system.

As a part of this assessment, the consulting team worked with MWD to determine the costs and procedures associated with using the Beardsley Canal in the GSP.

There are a number of operational issues associated with the Beardsley Canal. Since the operation of the Beardsley Canal affects several potential alternatives to bringing CAP water to the Sun Cities, these operational issues will be discussed in section 2 of Part D under common elements.

5 Organization of Report

In addition to this overview, this report has four additional chapters. Part B presents the findings of the golf course assessment. This assessment determines how much golf course demand is required to use 100% of the CAP allocation and determines the preliminary operation of the project. Part C addresses the feasibility of a joint transmission facility with the Agua Fria Division as specifically ordered in Decision No. 62293.

Part D presents the evaluation of all major components of the project. Specifically, the assessment determines whether a water transmission pipeline is needed and if so what is the best route for such a transmission pipeline. In addition, the assessment determines if pumping, storage and treatment are required to operate the project. Part D also describes the distributions systems required to move the CAP water from Citizens' transmission pipeline to the golf courses. Finally, Part D describes the needed control system to manage the GSP. This section of Part D analyzes the various control system alternatives available for the GSP.

Part E presents the results of the analysis conducted in Parts C and D and recommends a preliminary design for the GSP. Part E also establishes plan components, costs and a schedule for completion as specified in Decision No. 62293.

PART B - GOLF COURSE ASSESSMENTS AND OPERATING PARAMETERS

1 Facility-specific Parameters

In order to develop a water delivery system that will satisfy the objectives of this project, it was necessary to become thoroughly familiar with the properties to which such deliveries will be made. This was necessary in order to best plan delivery points, system hydraulics, delivery flow patterns, etc. Also, it was essential to gain an understanding from the facility operators of the individual operational needs of each golf course. Thereby, the system would be designed to satisfy not only the water deliveries, but do so in a manner consistent with those operational needs.

Operator Surveys

During the course of this study, the golf course maintenance superintendents were met with collectively in Sun City and Sun City West. Few concerns regarding impact of the project were expressed. Those that were expressed were related to daily delivery timing, salinity, intrusion during construction, and ongoing costs.

Each superintendent was interviewed privately to obtain facility-specific information and discuss issues of concern. Also, the water-handling schematics of each facility were reviewed and pumping stations inspected. The staff at each golf course indicated provided the following information.

Legend	
G	Greens
T	Tees
F	Fairways
R	Rough

Lakes East Golf Course
Shirley Gaines, Superintendent (623) 876-3037

DWR Allocation (acre-feet)	516.21
DWR Well Registration #	59-609015
APS Well Account #	379750287
APS Well Meter #	375593
Well HP	200
Well Flow Rate (gpm)	900
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	N/A
Reservoir Area (acres)	Dawn Lake = 37.11
Distribution Station Motor HPs	10, 40, 60
Irrigation Control System	Toro 8000
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:00 p.m. / 7:00 p.m.
Sprinkler Head Model	Toro 655 & 674
Average Sprinkler Spacing	80 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F (26 acres)

North Golf Course
Brian Weir, Superintendent (623) 876-3038

DWR Allocation (acre-feet)	675.98
DWR Well Registration #	55-507850
APS Well Account #	276071287
APS Well Meter #	A37738
Well HP	150
Well Flow Rate (gpm)	1400
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	56 inches
Reservoir Area (acres)	2.52
Distribution Station Motor HPs	10, 25, 50,100, 100
Irrigation Control System	RB Nimbus
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:00 p.m. / 7:00 p.m.
Sprinkler Head Model	RB 47,51 & Eagle
Average Sprinkler Spacing	60 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, banks, practice (31 acres)

Lakes West Golf Course
Shirley Gaines, Superintendent (623) 876-3037

DWR Allocation (acre-feet)	876.30
DWR Well Registration #	59-609021
APS Well Account #	
APS Well Meter #	A92646
Well HP	200
Well Flow Rate (gpm)	900
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	N/A
Reservoir Area (acres)	Viewpoint Lake = 31.94
Distribution Station Motor HPs	40, 100, 100
Irrigation Control System	Toro 8000
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:00 p.m. / 7:00 p.m.
Sprinkler Head Model	Toro 655 & 674
Average Sprinkler Spacing	80 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F (27 acres)

Quail Run Golf Course
Don Souser, Superintendent (623) 876-3039

DWR Allocation (acre-feet)	252.38
DWR Well Registration #	55-609019
APS Well Account #	388601288
APS Well Meter #	348226
Well HP	125
Well Flow Rate (gpm)	1200
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	50”
Reservoir Area (acres)	1.37
Distribution Station Motor HPs	20, 50, 50
Irrigation Control System	Toro 8000
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:00 p.m. / 7:00 p.m.
Sprinkler Head Model	Toro 730, 750, 760, & 785
Average Sprinkler Spacing	60 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F (14 acres)

Riverview Golf Course
Chuck Manning, Superintendent (623) 876-3043

DWR Allocation (acre-feet)	700.92	
DWR Well Registration #	East	55-506072
	West	55-509014
APS Well Account #	East	086820285
	West	856820283
APS Well Meter #	East	A93101
	West	A67045
Well HP	East	250
	West	200
Well Flow Rate (gpm)	East	2200
	West	1800
Vertical Turbine or Submersible	East	V.T.
	West	V.T.
Reservoir Drawdown Height	East	(Couldn't Determine)
	West	66 inches
Reservoir Area (acres)	East	0.87
	West	1.06
Distribution Station Motor HPs	East	60,75,100
	West	25, 75
Irrigation Control System	Toro 8000	
Flow Management Capability (Y/N)	Yes	
Irrigation Start Times (Summer/Winter)	8:00 p.m. / 6:00 p.m.	
Sprinkler Head Model	Toro 750 & 780	
Average Sprinkler Spacing	70 feet	
Areas over-seeded (G, T, F, R, & acres)	G, T, F, banks, (50 acres)	

South Golf Course
Michael Miller, Superintendent (623) 876-3045

DWR Allocation (acre-feet)	905.66	
DWR Well Registration #	East	55-609013
	West	55-609012
APS Well Account #	East	424361286
	West	749990287
APS Well Meter #	East	A93101
	West	A67045
Well HP	East	200
	West	100
Well Flow Rate (gpm)	East	1800
	West	1000
Vertical Turbine or Submersible	East	V.T.
	West	V.T.
Reservoir Drawdown Height	East	50 inches
	West	52 inches
Reservoir Area (acres)	East	2.36
	West	1.79
Distribution Station Motor HPs	East	25, 50, 50, 100
	West	25, 50, 50, 100
Irrigation Control System	RB Nimbus	
Flow Management Capability (Y/N)	Yes	
Irrigation Start Times (Summer/Winter)	7:30 p.m. / 11:00 p.m.	
Sprinkler Head Model	RB 47 & 51	
Average Sprinkler Spacing	60 feet	
Areas over-seeded (G, T, F, R, & acres)	G, T, F, banks, (52 acres)	

Palmbrook Country Club
Ernie Miller, Superintendent (623) 933-1591

DWR Allocation (acre-feet)	682.96	
DWR Well Registration #	North	55-603236
	South	55-603269
APS Well Account #	North	279180280
	South	914180287
APS Well Meter #	North	920433
	South	800002
Well HP	North	200
	South	200
Well Flow Rate (gpm)	North	650
	South	1000
Vertical Turbine or Submersible	North	V.T.
	South	V.T.
Reservoir Drawdown Height	80 inches	
Reservoir Area (acres)	2.03	
Distribution Station Motor HPs	10, 75, 75, 75 VFD	
Irrigation Control System	RB Maxi 5	
Flow Management Capability (Y/N)	Yes	
Irrigation Start Times (Summer/Winter)	7:30 p.m. / 7:00 p.m.	
Sprinkler Head Model	RB 51 & Eagle PC	
Average Sprinkler Spacing	65 feet	
Areas over-seeded (G, T, F, R, & acres)	G, T, F (65 acres)	

Sun City Country Club
Jim Trikoff, Superintendent (623) 933-2276

DWR Allocation (acre-feet)	590.94	
DWR Well Registration #	East	55-800409
	West	55-800408
APS Well Account #	East	081422285
	West	933421287
APS Well Meter #	East	D26964
	West	855368
Well HP	East	75
	West	125
Well Flow Rate (gpm)	East	600
	West	Varies
Vertical Turbine or Submersible	East	V.T.
	West	V.T.
Reservoir Drawdown Height	East	No Vault
	West	No Reservoir
Reservoir Area (acres)	2.62	
	No Reservoir	
Distribution Station Motor HPs	40, 100	
	Direct connection to well	
Irrigation Control System	RB Maxi 5	
Flow Management Capability (Y/N)	Yes	
Irrigation Start Times (Summer/Winter)	7:00 p.m. / 9:00 p.m.	
Sprinkler Head Model	RB 47 & 51	
Average Sprinkler Spacing	70 feet	
Areas over-seeded (G, T, F, R, & acres)	G, T, F, some R (90 acres)	

Union Hills Country Club
Scott McCall, Superintendent (623) 977-0926

DWR Allocation (acre-feet)	679.72	
DWR Well Registration #	North	55-604718
	South	55-604717
APS Well Account #	North	1602713400
	South	1620013040
APS Well Meter #	North	851579
	South	A66643
Well HP	North	200
	South	200
Well Flow Rate (gpm)	North	850
	South	850
Vertical Turbine or Submersible	North	V.T.
	South	V.T.
Reservoir Drawdown Height	North	Couldn't Determine
	South	Couldn't Determine
Reservoir Area (acres)	North	1.14
	South	1.94
Distribution Station Motor HPs	North	10, 30, 100
	South	10, 30, 100
Irrigation Control System	Rainbird Numbus	
Flow Management Capability (Y/N)	Yes	
Irrigation Start Times (Summer/Winter)	7:45 p.m. / 6:00 p.m.	
Sprinkler Head Model	RB Eagle	
Average Sprinkler Spacing	65 feet	
Areas over-seeded (G, T, F, R, & acres)	G, T, F, some R (90 acres)	

Willowbrook Golf Course
Thomas Sibray, Superintendent (623) 876-3047

DWR Allocation (acre-feet)	1168.70 (w/ Willowcreek)
DWR Well Registration #	55-609017
APS Well Account #	238310280
APS Well Meter #	431244
Well HP	200
Well Flow Rate (gpm)	1000
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	N/A (No vault)
Reservoir Area (acres)	1.36
Distribution Station Motor HPs	40, 60, 200
Irrigation Control System	Toro 8000
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:00 p.m. / 7:00 p.m.
Sprinkler Head Model	Toro 750, 760, & 780
Average Sprinkler Spacing	69 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, banks, practice (14 acres)

Willowcreek Golf Course
Thomas Sibray, Superintendent (623) 876-3047

DWR Allocation (acre-feet)	1168.70 (w/ Willowbrook)
DWR Well Registration #	55-609016
APS Well Account #	508310281
APS Well Meter #	15375276
Well HP	200
Well Flow Rate (gpm)	1200
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	N/A (No vault)
Reservoir Area (acres)	1.70
Distribution Station Motor HPs	40, 60, 150
Irrigation Control System	Toro 8000
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:00 p.m. / 7:00 p.m.
Sprinkler Head Model	Toro 750, 760, & 780
Average Sprinkler Spacing	69 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, banks, practice (44 acres)

Deer Valley Golf Course
Dan Maurer, Superintendent (623) 546-8959

DWR Allocation (acre-feet)	546.62
DWR Well Registration #	55-536231
APS Well Account #	429732285
APS Well Meter #	A33736
Well HP	200
Well Flow Rate (gpm)	1300
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	60 inches
Reservoir Area (acres)	3.08
Distribution Station Motor HPs	10, 40, 100 100, VFD
Irrigation Control System	RB Maxi 5
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:30 p.m. / 6:00 p.m.
Sprinkler Head Model	RB 47 & 51
Average Sprinkler Spacing	60 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, banks (52 acres)

Echo Mesa Golf Course
Pete Sagasta, Superintendent (623) 584-2919

DWR Allocation (acre-feet)	456.62
DWR Well Registration #	55-612961
APS Well Account #	682681288
APS Well Meter #	920403
Well HP	250
Well Flow Rate (gpm)	1000
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	50 inches
Reservoir Area (acres)	2.64
Distribution Station Motor HPs	25, 50, 100
Irrigation Control System	RB Maxi 5
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:30 p.m. / 6:00 p.m.
Sprinkler Head Model	RB 700 & 750
Average Sprinkler Spacing	60 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, banks (33 acres)

Pebblebrook Golf Course
Brad Ackerman, Superintendent (623) 584-3100

DWR Allocation (acre-feet)	690.68
DWR Well Registration #	55-610212
APS Well Account #	622630284
APS Well Meter #	373787
Well HP	200
Well Flow Rate (gpm)	1300
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	90 inches
Reservoir Area (acres)	1.32
Distribution Station Motor HPs	10, 20, 100, 100
Irrigation Control System	RB Maxi 5
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:30 p.m. / 6:00 p.m.
Sprinkler Head Model	RB 47 & 51
Average Sprinkler Spacing	60 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, banks (57 acres)

Desert Trails Golf Course
Dan Maurer, Superintendent (623) 546-8959

DWR Allocation (acre-feet) (not yet assigned)	405.54
DWR Well Registration #	55-612960
APS Well Account #	591542280
APS Well Meter #	A65743
Well HP	200
Well Flow Rate (gpm)	1200
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	100 inches
Reservoir Area (acres)	2.80
Distribution Station Motor HPs	25, 50, 100
Irrigation Control System	RB Maxi 5
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:30 p.m. / 6:00 p.m.
Sprinkler Head Model	RB 47 & 51
Average Spacing	60 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, banks (35 acres)

Grandview Golf Course
Patrick Burgess, Superintendent (623) 584-2286

DWR Allocation (acre-feet)	784.16
DWR Well Registration #	55-604494
APS Well Account #	506722289
APS Well Meter #	885665
Well HP	250
Well Flow Rate (gpm)	1200
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	90 inches
Reservoir Area (acres)	1.41
Distribution Station Motor HPs	25, 50, 100, 100
Irrigation Control System	RB Maxi 5
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:30 p.m. / 6:00 p.m.
Sprinkler Head Model	RB 700 & 750
Average Sprinkler Spacing	60 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, banks (67 acres)

Stardust Golf Course
Pete Sagasta, Superintendent (623) 584-2919

DWR Allocation (acre-feet)	480.46
DWR Well Registration #	55-610211
APS Well Account #	760820285
APS Well Meter #	373398
Well HP	250
Well Flow Rate (gpm)	1200
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	70 inches
Reservoir Area (acres)	1.56
Distribution Station Motor HPs	10, 20, 75, 75
Irrigation Control System	Toro Osmac
Flow Management Capability (Y/N)	No
Irrigation Start Times (Summer/Winter)	7:30 p.m. / 6:00 p.m.
Sprinkler Head Model	RB 700 & 750
Average Sprinkler Spacing	60 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, banks (33 acres)

Trail Ridge Golf Course
Brad Ackerman, Superintendent (623) 584-3100

DWR Allocation (acre-feet)	546.64
DWR Well Registration #	55-612962
APS Well Account #	208802284
APS Well Meter #	A66070
Well HP	200
Well Flow Rate (gpm)	1200
Vertical Turbine or Submersible	Submersible
Reservoir Draw-down Height	100 inches
Reservoir Area (acres)	2.91
Distribution Station Motor HPs	25, 50, 100
Irrigation Control System	Maxi 5
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	7:30 p.m. / 6:00 p.m.
Sprinkler Head Model	RB 700 & 750
Average Sprinkler Spacing	60 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, banks (50 acres)

Briarwood Country Club
Jim Sander, Superintendent (623) 546-8484

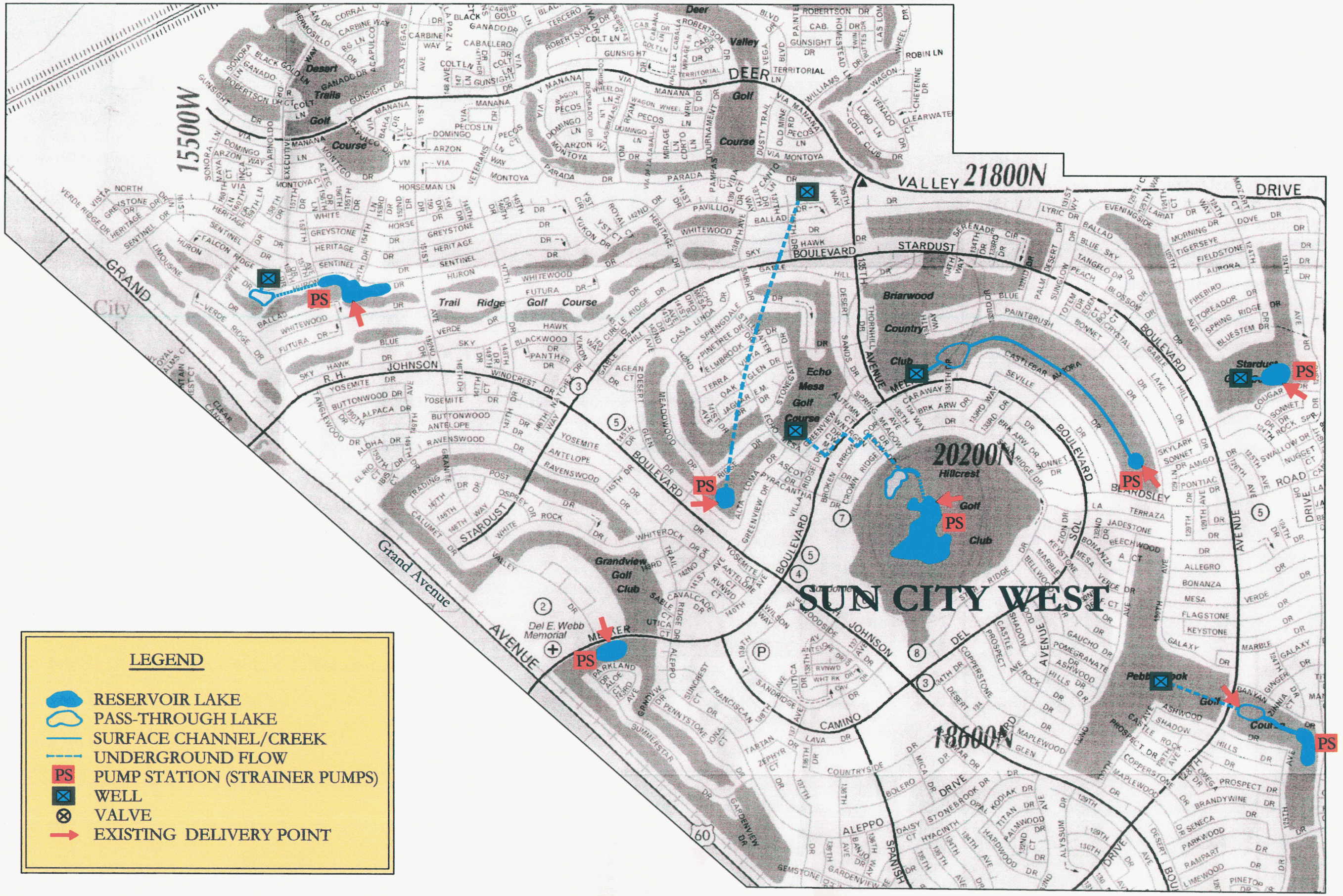
DWR Allocation (acre-feet)	714.82
DWR Well Registration #	
APS Well Account #	
APS Well Meter #	
Well HP	
Well Flow Rate (gpm)	
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	60 inches
Reservoir Area (acres)	1.51
Distribution Station Motor HPs	
Irrigation Control System	RB Maxi 5
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	8:00 p.m. / 7:00 p.m.
Sprinkler Head Model	RB 47 & 51
Average Sprinkler Spacing	65 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F, R (106 acres)

Hillcrest Golf Course
Jeff Schuld, Superintendent (623) 584-3320

DWR Allocation (acre-feet)	843.94
DWR Well Registration #	55-610216
APS Well Account #	267702280
APS Well Meter #	915907
Well HP	300
Well Flow Rate (gpm)	240
Vertical Turbine or Submersible	V.T.
Reservoir Draw-down Height	50 inches
Reservoir Area (acres)	18.71
Distribution Station Motor HPs	40, 75, 125
Irrigation Control System	RB Maxi 5
Flow Management Capability (Y/N)	Yes
Irrigation Start Times (Summer/Winter)	8:00 p.m. / varies
Sprinkler Head Model	RB 47 & 51
Average Sprinkler Spacing	76 feet
Areas over-seeded (G,T,F,R & acres)	G, T, F (68 acres)

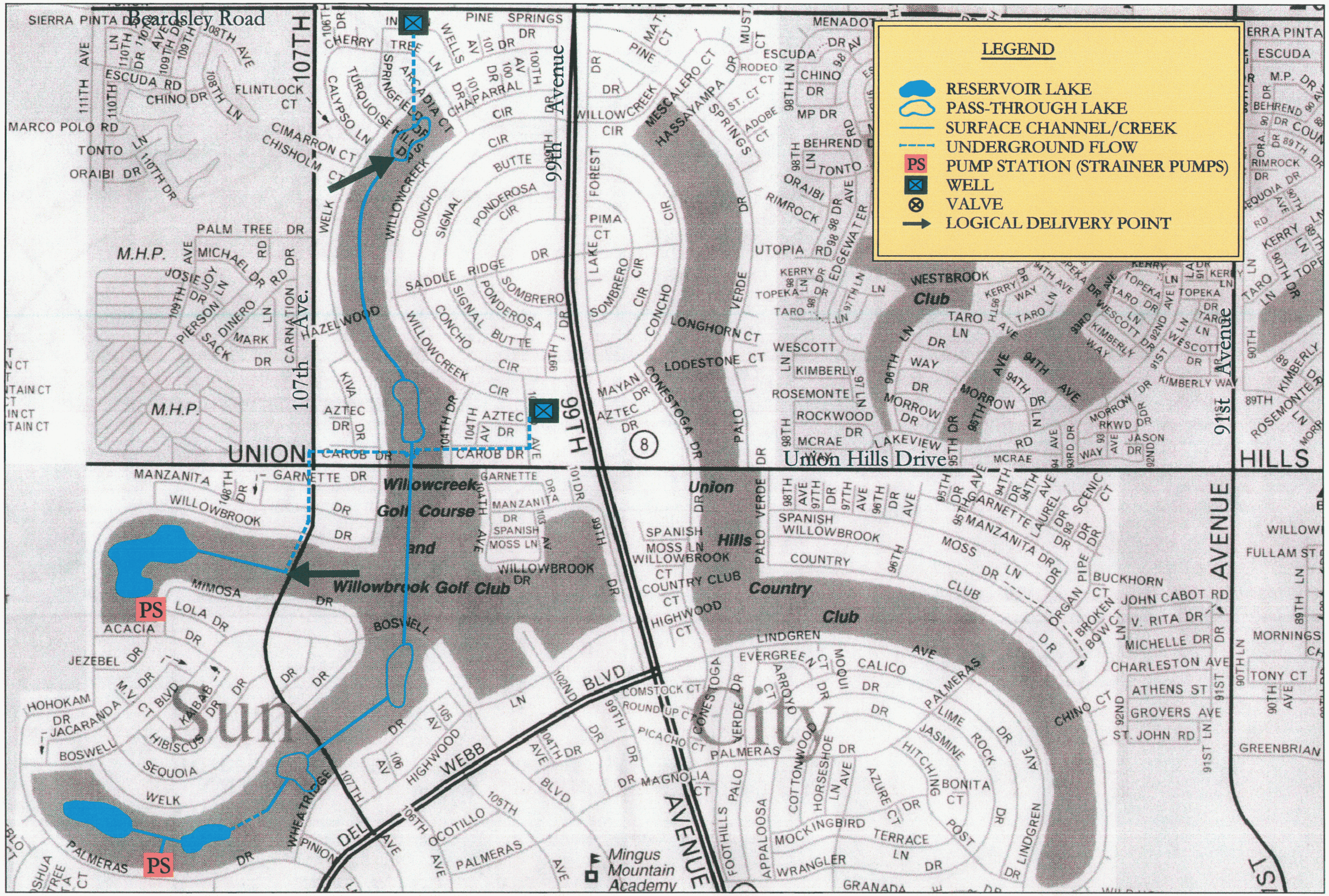
Water-handling Schematics

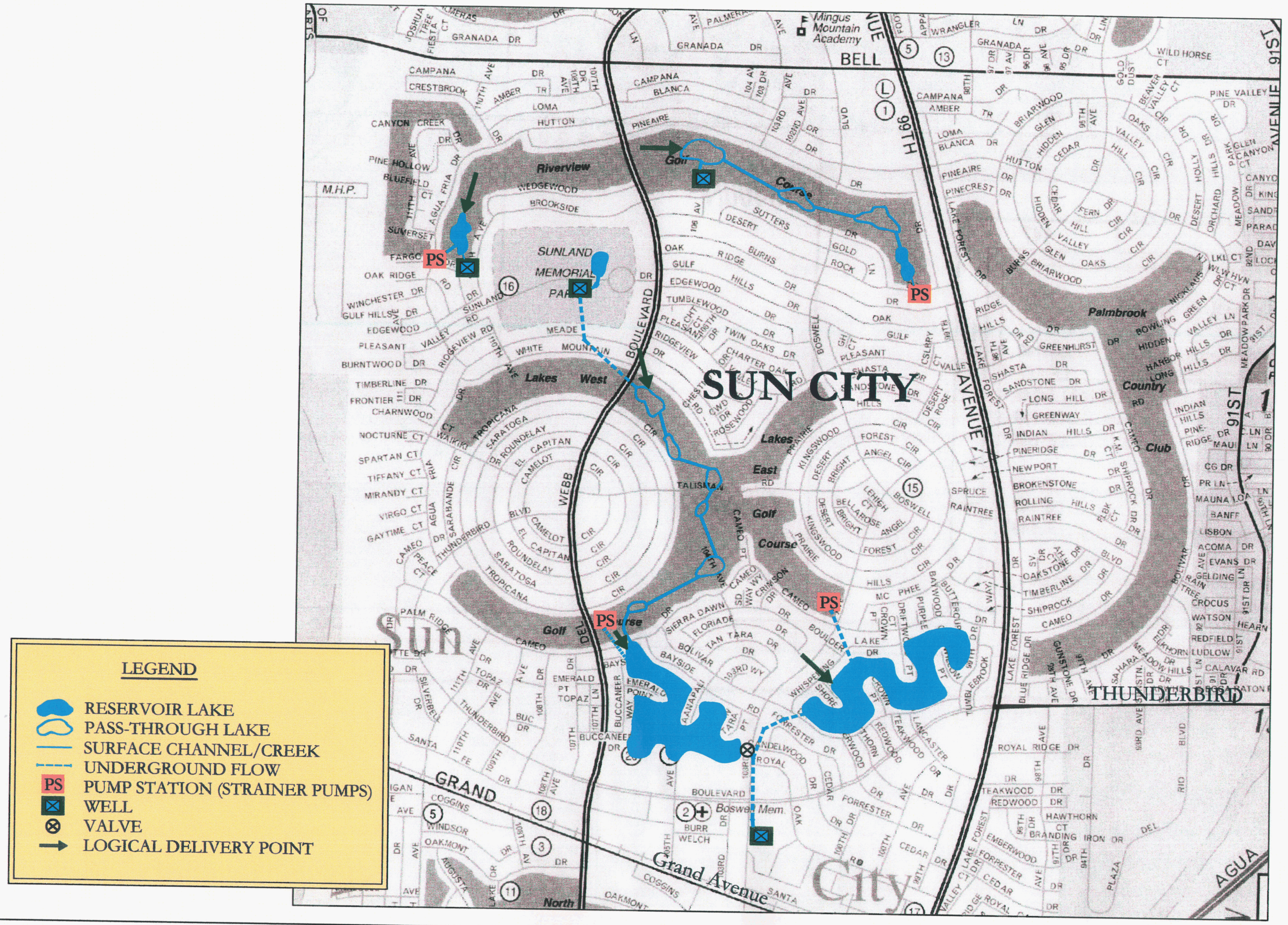
During the Superintendent interviews and site inspections, the current relationship between well-water delivery equipment, creeks, reservoirs, pumping systems, valving, etc. was determined for each facility. This information was essential in planning system delivery points and delivery daily programming. These relevant relationships are illustrated as follows.

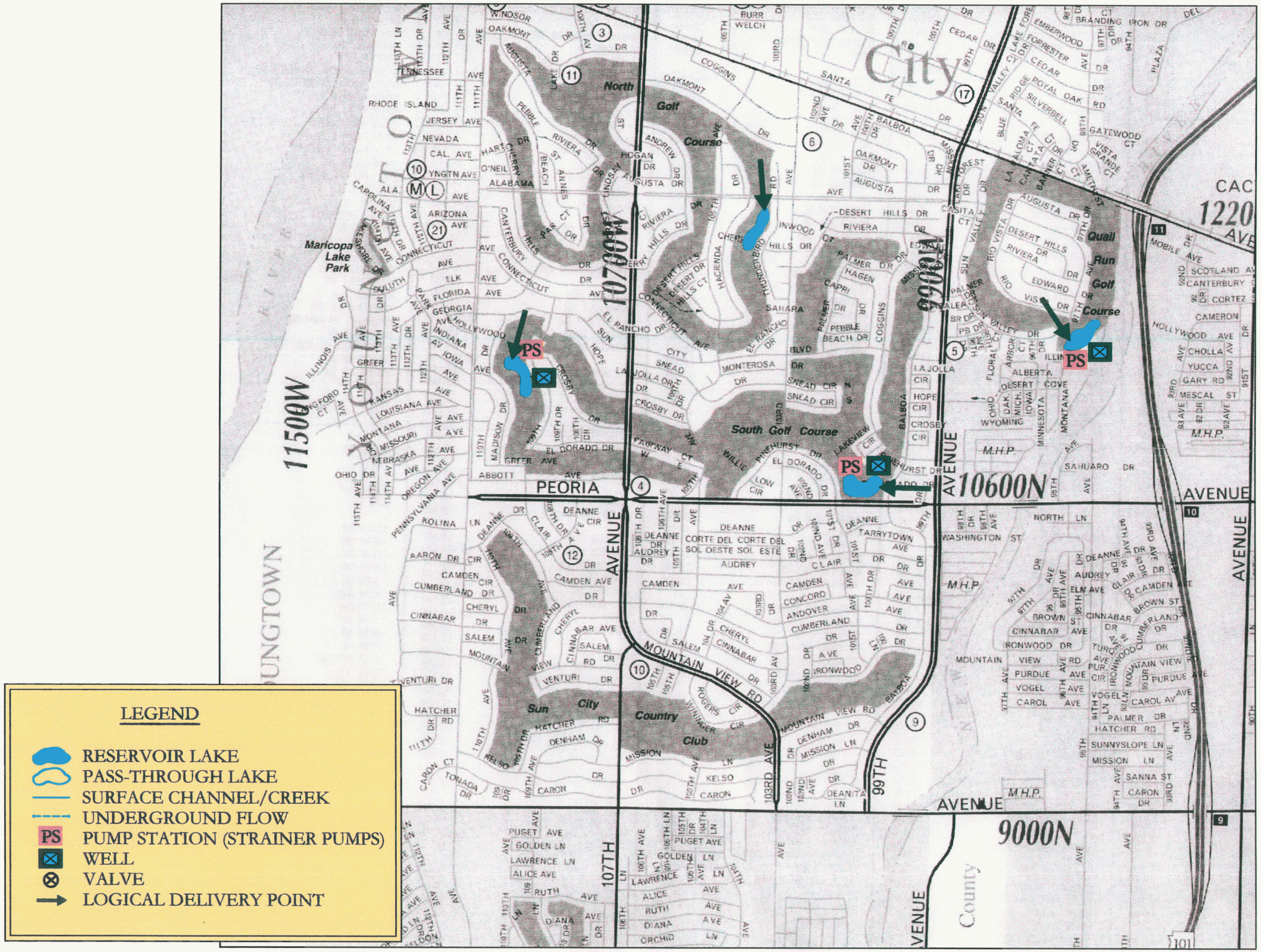


LEGEND

- RESERVOIR LAKE
- PASS-THROUGH LAKE
- SURFACE CHANNEL/CREEK
- UNDERGROUND FLOW
- PS — PUMP STATION (STRAINER PUMPS)
- WELL
- VALVE
- EXISTING DELIVERY POINT


Beardsley Road
Union Hills Drive
107th Ave.
99th Avenue
91st Avenue
LEGEND
RESERVOIR LAKE
PASS-THROUGH LAKE
SURFACE CHANNEL/CREEK
UNDERGROUND FLOW
PS PUMP STATION (STRAINER PUMPS)
WELL
VALVE
LOGICAL DELIVERY POINT
PS
PS
Willowcreek Golf Course
Willowbrook Golf Club
Union Hills Country Club
Mingus Mountain Academy
Sun City
WILLOWCREEK
WILLOWBROOK
WESTBROOK Club
PINE SPRINGS
SIERRA PINTA
ESCUDA
CHINO DR
FLINTLOCK CT
MARCO POLO RD
TONTO
ORAIBI DR
CIMARRON CT
CHISHOLM CT
PALM TREE DR
M.H.P.
MICHAEL DR
JOSIE JOY
PIERSON
DINERO
MARK
SACK DR
CARNATION
HAZELWOOD
CHERRY
TREE LN
WELLS
SPRINGFIELD DR
ARCADIA CT
CALYPSO LN
TURQUOISE
CHAPARRAL
CIR
BUTTE
CONCHO
SIGNAL
PONDEROSA
SADDLE RIDGE DR
SOMBRERO
SIGNAL BUTTE
KIVA
AZTEC
CAROB DR
MANZANITA
GARNETTE DR
WILLOWBROOK
MIMOSA
LOLA DR
ACACIA
JEZEBEL DR
HOHOKAM
JACARANDA
BOSWELL
HIBISCUS
SEQUOIA
WELK
BOSWELL
PALMERAS
WHEATRIDGE
PINION
OCOTILLO
105TH
HIGHWOOD
WEBB
BLVD
102ND
104TH AVE
106TH AVE
107TH
99TH
98TH
97TH
96TH
95TH
94TH
93RD
92ND
91ST
90TH
89TH
MENADO
RODEO CT
CHINO
MP DR
BEHREND
TONTO
ORAIBI
RIMROCK
EDGEWATER
UTOPIA RD
KERRY
TOPEKA
TARO
WESCOTT
KIMBERLY
ROSEMONTE
ROCKWOOD
MCRAE
LAKEVIEW
MORROW
KIMBERLY WAY
JASON
MIRA VISTA
MESCALERO CT
HASSAYAMPA DR
SPRINGS
ADOBE CT
FOREST
PIMA
LAKE CT
SOMBRERO
VERDE
LONGHORN CT
LODESTONE CT
MAYAN
CONESTOGA DR
PALO
SPANISH
MOSS LN
COUNTRY
CLUB
HIGHWOOD CT
LINDGREN
EVERGREEN
CALICO
PALMERAS
LIME ROCK
JASMINE
HITCHING
BONITA CT
AZURE CT
POST
LINDGREN
CHINO CT
COMSTOCK CT
ROUND UP CT
PICACHO CT
MAGNOLIA CT
COTTONWOOD
HORSESHOE
APPALOOSA
FOOTHILLS
MOCKINGBIRD
TERRACE
WRANGLER
GRANADA
ORGAN PIPE
BUCKHORN
BROKEN BOW CT
JOHN CABOT RD
V. RITA DR
MICHELLE DR
CHARLESTON AVE
ATHENS ST
GROVERS AVE
ST. JOHN RD
TONY CT
MORNINGS
GREENBRIAN
FULLAM ST
WILLOW
SCENIC CT
LAUREL
MANZANITA DR
GARNETTE
MOSS
COUNTRY
CLUB
SPANISH
WILLOWBROOK
MOSS LN
WILLOWBROOK DR
HILLS
AVENUE


SUN CITY
SUN CITY WEST
SUN CITY GRAND
THUNDERBIRD
Mingus Mountain Academy
BELL
91ST AVENUE
99TH
Riverview
Golf Course
Palmbrook Country Club
Lakes West
Lakes East
Golf Course
North Golf Course
SUNLAND MEMORIAL PARK
BOULEVARD
Grand Avenue
Boswell Mem.
M.H.P.
PS
LEGEND
RESERVOIR LAKE
PASS-THROUGH LAKE
SURFACE CHANNEL/CREEK
UNDERGROUND FLOW
PUMP STATION (STRAINER PUMPS)
WELL
VALVE
LOGICAL DELIVERY POINT


LEGEND
RESERVOIR LAKE
PASS-THROUGH LAKE
SURFACE CHANNEL/CREEK
UNDERGROUND FLOW
PS PUMP STATION (STRAINER PUMPS)
WELL
VALVE
LOGICAL DELIVERY POINT
PEORIA AVENUE
10600N
9000N
11500W
10700W
9900W
99TH AVENUE
103RD AVENUE
107TH AVENUE
MOUNTAIN VIEW RD
North Golf Course
South Golf Course
Country Club
Sun City
Quail Run Golf Course
Maricopa Lake Park
City
County
M.H.P.

2 Historical Water Use

Historical irrigation water usage records from each golf course in the Glendale and Peoria area were gathered, analyzed and utilized, in order to predict the future water usage for irrigation of the Sun City and Sun City West golf courses. From this data, the future peak flows and annual consumptions can be predicted.

Historical Annual Totals

Each year, every golf course within the Phoenix AMA that consumes non-effluent irrigation water is required to file an annual report with the Arizona Department of Water Resources. These reports contain annual water consumption totals and were the information source for the following information (**Appendix D.1**). Except where noted, the data represents 6-year averages (1993 – 1998).

Facility Annual Totals

Facility	Acre-feet/year*
Sun City Rec Center:	
Lakes East/Dawn Lake	594
Lakes West/Viewpoint Lake	863
North GC	623
Quail Run GC	231
Riverview GC	447
South GC	819
Willowcreek/Willowbrook	1329
Sun City Private Clubs:	
Palmbrook CC	613
Sun City CC	533
Union Hills CC	729
Youngtown:	
Maricopa Lake****	15
Sun City West Rec Center:	
Deer Valley GC**	546
Desert Trails GC***	469
Echo Mesa GC**	592
Grandview GC	761
Pebblebrook GC	689
Stardust GC	429
Trail Ridge GC	539
Sun City West Private Clubs:	
Briarwood CC	725
Hillcrest GC	769
TOTAL	**12,315**

* - 6-year data (93-98)
** - 4-year data (95-98)
*** - 3-year data (96-98)
**** - 2-year data (96&99)
Data source – Arizona Dept of Water Resources

Estimated Monthly Usage

The demand for irrigation water follows a diurnal cycle throughout the year. Specifically, demand is low in the winter and high in the summer. Knowledge of this monthly use pattern is necessary in planning the design and operational concept for the system. Prior experience over a period of several years with the SCW golf courses has provided information upon which to base a monthly model of irrigation water consumption. By applying that model to each of the facility historical annual totals listed above, the facility consumptions can be estimated for each month of the year. Those estimations are as follows:

Estimated Monthly Use Pattern
(Data in Acre-feet)

	Ann. Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sun City Rec Center:													
Lakes East/Viewpoint Lake	594	9	13	15	43	90	88	105	66	56	69	29	11
Lakes West/Dawn Lake	863	13	19	22	62	131	128	153	96	82	99	42	16
North GC	623	9	14	16	45	94	93	110	69	59	72	30	12
Quail Run GC	231	4	5	6	17	35	34	41	26	22	26	11	4
Riverview GC	447	7	10	11	32	68	67	79	50	42	51	22	8
South GC	819	12	18	21	59	124	122	145	91	78	94	40	15
Willowcreek/Willowbrook	1329	20	29	33	96	201	198	235	148	126	153	65	25
Sun City Private Clubs:													
Palmbrook CC	613	9	13	16	44	93	92	108	68	58	71	30	11
Sun City CC	533	8	12	13	39	81	79	94	59	51	61	26	10
Union Hills CC	729	11	16	18	53	110	108	129	81	69	84	36	14
Youngtown: Maricopa Lake	15	0	0	0	1	2	2	3	2	2	2	1	0
Sun City West Rec. Center:													
Deer Valley GC	546	8	12	14	39	83	81	96	61	52	63	27	10
Desert Trails GC	469	7	10	12	34	71	70	83	52	44	54	23	9
Echo Mesa GC	592	9	13	15	43	90	88	104	66	56	68	29	11
Grandview GC	761	12	16	19	55	115	113	135	85	72	88	37	14
Pebblebrook GC	689	11	15	17	50	104	102	122	77	65	79	34	13
Stardust GC	429	6	9	11	31	65	64	76	48	41	49	21	8
Trail Ridge GC	539	8	12	14	39	82	80	95	60	51	62	26	10
Sun City West Private Clubs:													
Briarwood CC	725	11	16	18	52	110	108	128	81	69	83	35	14
Hillcrest GC	769	12	17	19	55	116	114	136	86	73	89	38	14
TOTAL	**12315**	**186**	**269**	**310**	**889**	**1865**	**1831**	**2177**	**1372**	**1168**	**1417**	**602**	**229**

Peak Demand

As illustrated above, the system demand is not constant throughout the year. In order to evaluate the supply system design versus demand, it is necessary to estimate the peak demand. The peak demands listed below occur during the month of July. It is recognized that demand is not constant throughout the month due to weather fluctuations, operational issues and operator preferences. The data presented represents an average demand for the peak usage month of the year. The following estimates of peak demand are calculated from the average daily demand during the month of July times a correction factor of 1.05.

Facility Peak Demand

Facility	Peak daily usage*
Sun City Rec Center:	**(Ac-Ft/Day)**
Lakes East/Dawn Lake	3.56
Lakes West/Viewpoint Lake	5.17
North GC	3.73
Quail Run GC	1.38
Riverview GC	2.68
South GC	4.91
Willowcreek/Willowbrook	7.96
Sun City Private Clubs:	
Palmbrook CC	3.67
Sun City CC	3.19
Union Hills CC	4.37
Youngtown: Maricopa Lake	0.09
Sun City West Rec Center:	
Deer Valley GC	3.27
Desert Trails GC	2.81
Echo Mesa GC	3.55
Grandview GC	4.56
Pebblebrook GC	4.13
Stardust GC	2.57
Trail Ridge GC	3.23
Sun City West Private Clubs:	
Briarwood CC	4.34
Hillcrest GC	4.61
TOTAL	**73.78**

* - average July daily usage X 1.05

3 Theoretical Water Use

The purpose of this sub section is to demonstrate the relative efficiency of irrigation water usage on the golf courses of Sun City and Sun City West as compared to the best theoretical prediction of usage available. Performing this calculation and comparison with historical wager usage provides some measure of assurance that the CAP water delivered to these courses will be used efficiently.

As demonstrated in the following text and tables showing the actual historical irrigation usage, all golf courses in Sun City and Sun City West either closely approximates or is less than the theoretical water consumption calculated.

Many researchers have studied methods of predicting the theoretical water use by turfgrass. This information is of particular interest during facility design for predicting water demand. It is also of interest to regulatory agencies in formulation of allocations. To date, prediction of water requirements for culture of turfgrass has not been an exact science. Rather, predictions are based on calculations derived from weather parameters, crop coefficient multipliers, and a variety of assumptions. These variables tend to reduce confidence in the accuracy of the predictions such that further research will be necessary for predictions to be highly reliable. The methodology for predicting turfgrass water needs and application of current methodology to the SC and SCW golf courses are as follows.

Methodology for Predicting Irrigation Needs

Turfgrass Water Consumption

The amount of water that evaporates from the soil surface and leaf tissue (evapotranspiration) may be referred to as the water consumption by that stand of turfgrass. It does not take into consideration the other loss factors detailed below. The prediction of turfgrass water consumption is based on historical records of weather data from a local monitoring site. Several of these monitoring sites are operated by the University of Arizona as part of the AZMET system and are located throughout the state. From this weather data, the consumption is calculated by using the "modified Penman equation". The turfgrass weather monitoring site nearest to Sun City is the Greenway station located at the Cave Creek Golf Course at 23rd Avenue and Greenway and was used as the source for the data listed below (**Appendix D.2**).

The data below was derived from the Greenway weather data and was calculated using the Penman equation. The coefficients used were appropriate for a high-quality bermudagrass fairway turf that has been overseeded with perennial ryegrass for the winter season. Also listed is data for non-overseeded turf. This data assumes that non-overseeded turf consumes water quantities similar to overseeded turf except that the non-overseeded consumption during the dormant months (December – March) is one-half that of the overseeded turf (estimation from U of A).

Turfgrass Water Consumption (inches, Greenway AZMET Station)

Month	Overseeded	Non-overseeded
Jan	1.8	0.9
Feb	2.4	1.2
Mar	4.1	2.1
Apr	5.9	5.9
May	7.3	7.3
Jun	7.5	7.5
Jul	7.8	7.8
Aug	7.4	7.4
Sep	5.6	5.6
Oct	4.4	4.4
Nov	2.6	2.6
Dec	1.7	0.9
Total	**58.5** (4.88 AF/Acre)	**53.6** (4.47 AF/Acre)

Averages of years 1988 to 1999

Leaching Fraction

In order to remove salts from the rootzone and prevent their accumulation to detrimental levels, excess water must be applied which passes out the bottom of the rootzone profile. This leachate carries salts out the bottom of the rootzone profile along with it. This water which is applied in excess of the turfgrass water consumption is referred to as the leaching fraction.

Unfortunately, irrigation water applied to a turfgrass area from sprinkler heads is not applied uniformly. In order to ensure that salts are successfully leached from the weaker areas of the sprinkler pattern, excessive leaching water must be applied to the turf area

throughout the sprinkler pattern. The result is that the volumes of water necessary for satisfactory leaching exceed those from theoretical calculations. It is generally accepted in scientific literature that a leaching fraction of 15% of the turfgrass water consumption is the *minimum* necessary for successful salt leaching from most turfgrass areas. This value of 15% shall be used as the leaching fraction in the calculations later in this section.

Scheduling Coefficient

As mentioned above, irrigation water applied through sprinklers to a turfgrass area is not applied uniformly. Some areas receive water in excess of the average application rate and some other areas receive less than the average application rate. In order to satisfy the irrigation needs of most of the weak areas of the sprinkler pattern, surplus water must be applied to the turf area in general. Hence, in order to compensate for less-than-perfect sprinkler uniformity, irrigation water in excess of calculated amounts must be applied. The magnitude of the excess water requirement is dependent upon the uniformity of the sprinkler pattern, the greater the uniformity, the lesser the requirement for excess water application. Because of this situation, when inferior golf course irrigation systems are replaced with quality modern systems, not only does turf quality improve but water consumption usually goes down also.

The uniformity of an irrigation system may be quantified and expressed in terms of a scheduling coefficient. This scheduling coefficient is a multiplier factor, which when multiplied times the desired water application rate, results in the calculation of application rate necessary to avoid inadequate irrigation of the weak areas in the sprinkler pattern. A state-of-the-art irrigation system considered to be of excellent uniformity would typically have a scheduling coefficient of 1.2. This value will be used for subsequent calculations.

Overseed Germination

When a turfgrass area is overseeded (usually in October), the fresh seedbed must be kept very wet for approximately two weeks. This moisture enables the ryegrass seeds to germinate and the seedlings to survive. In order to maintain this wet condition, irrigation water must be applied far in excess of the turfgrass water consumption. It is generally accepted that the process of overseed germination and its subsequent culture require approximately 6 inches of water in excess of the turfgrass water consumption. However, the annual leaching fraction (15%) is greater than this overseed germination requirement. Hence, the overseed germination water constitutes a portion of the annual leaching requirement. For this reason, no additional water for the sole purpose of overseed germination shall be included in the following calculations.

Lake Water Surface

The golf course properties each have one or more lakes that serve reservoir and/or aesthetic functions. The water supplied to these lakes is comingled with the irrigation system water and, hence, must be considered in predictions of irrigation water requirements. The AZMET system reports a weather-data-derived value termed "reference ET" for each of its monitoring sites. This value is an accurate estimate of the water loss by evaporation from a medium-to-large golf course lake (U of A). As in an earlier section, the Greenway monitoring site was selected as most representative of the SC and SCW locations (**Appendix D.3**). Data from this location indicates that water evaporation from a lake surface in this area will account for 76.43 inches (6.34 feet per acre) per year. This value will be used in the calculations later in this section.

Irrigated Desert Landscape

Three golf courses in SCW have substantial acreage as desert landscape rather than turfgrass. This desert landscape is planted with low-water-use plant species that are served with drip irrigation. There is presently no good methodology for predicting the irrigation water requirements of such a landscape. These requirements are highly variable and are dependent upon several factors such as plant type, plant density and cultural treatment. The Arizona Department of Water Resources allocates 1.5 feet of water per year for irrigation of desert landscape. However, it is generally accepted that this value overestimates the actual water requirement. For purposes of calculating irrigation requirements later in this section, a value of 1.0 foot of water per year will be used.

Rainfall

Water derived from rainfall contributes to the soil moisture, hence, reduces the requirement for irrigation water. A portion of the incident rainfall soaks into the soil and is of beneficial use. The remainder of the incident rainfall runs off from the turf surface to drainage systems and is not of beneficial use. Prediction of the portion of the incident rainfall that is beneficial is both site specific and event specific, thus not possible to enumerate without a great deal of research. It shall be assumed in the calculations below that 50% of the incident rainfall soaks into the soil and is of beneficial use.

Historical records (1988 to 1999) from the Greenway AZMET station indicate that the annual precipitation at that site is 9.28 inches per year (**Appendix D.4**). Assuming that 50% of that rainfall soaks into the soil, then the beneficial rainfall will be assumed in the following calculations to be 4.64 inches (0.39 feet) per year.

Summary of Water Use Prediction Factors

The above factors and their influence upon the irrigation water requirements calculated in the section below are as follows;

Factor	Influence (per year)
1. Overseeded turf	4.88 acre-feet / acre
2. Non-overseeded turf	4.47 acre-feet / acre
3. Leaching fraction	0.15 times items 1 and 2
4. Scheduling coefficient	0.20 times items 1 and 2
5. Lake surface	6.34 acre-feet per acre
6. Irrigated desert	1.0 acre-feet per acre
7. Rainfall	Minus 0.39 acre-feet times total facility acreage

Theoretical Facility Irrigation Requirements

Theoretical Facility Annual Usage

Facility	Historical Usage* (acre-feet)	Total turf (acres)*	Lake Surface Area (acres)*	Irrigated desert (acres)*	Over-seeded turf (acres)**	Non-OS turf (acres)**	Theoretical usage*** (acre-feet)
Sun City Rec Center:							
Lakes East/Dawn Lake	594	57.90	37.50		26	31.90	564
Lakes West/Viewpoint Lake	863	140.70	37.50		27	113.70	1032
North GC	623	139.60	5.90		31	108.60	840
Quail Run GC	231	50.80	1.40		14	36.80	303
Riverview GC	447	143.20	7.60		50	93.20	881
South GC	819	199.50	4.30		52	147.50	1180
Willowcreek/Willowbrook	1329	238.50	8.50		70	168.50	1436
Sun City Private Clubs:							
Palmbrook CC	613	141.50	5.80		65	76.50	869
Sun City CC	533	123.30	2.70		90	33.30	762
Union Hills CC	729	141.00	5.60		90	51.00	879
Youngtown: Maricopa Lake	15						
Sun City West Rec Center:							
Deer Valley GC	546	101.37	7.64	50.22	52	49.37	677
Desert Trails GC	469	79.00**	5.00**	19.00**	35	44.00	507
Echo Mesa GC	592	100.80	7.60		33	67.80	633
Grandview GC	761	163.70	7.80		67	96.70	1008
Pebblebrook GC	689	142.50	6.40		57	85.50	874
Stardust GC	429	96.30	2.30		33	63.30	576
Trail Ridge GC	539	81.60	14.87	81.44	50	31.60	626
Sun City West Private Clubs:							
Briarwood CC	725	152.10	4.10		106	46.10	942
Hillcrest GC	769	154.00	23.70		68	86.00	1048
TOTAL	**12315**						**15636**

Data source:
* – Arizona Dept of Water Resources (Appendix D.1 and D.5)
** – facility operators
*** – calculated (Appendix D.6)

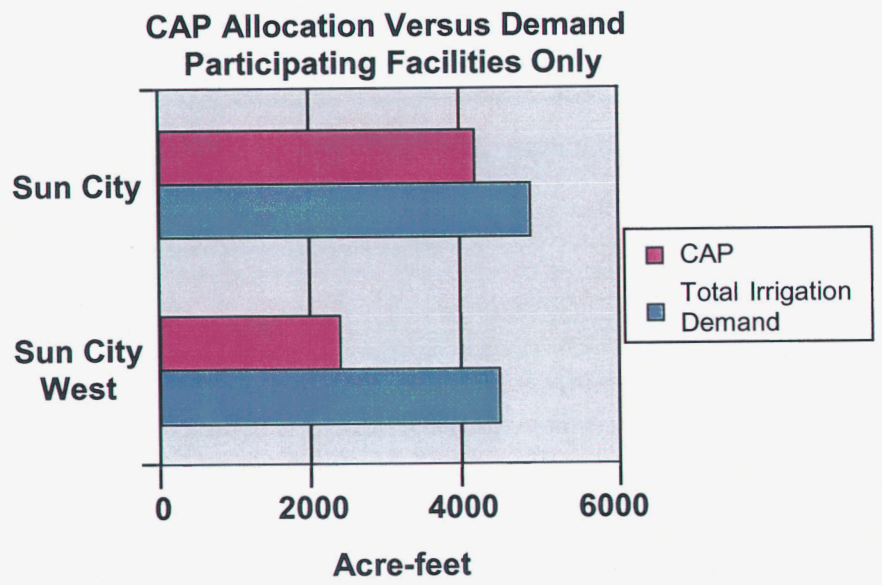
4 Water Delivery Capabilities of the System

The objective of the proposed project is to deliver the full annual allocations of CAP water to Sun City West and Sun City West for use in irrigation of golf courses. However, the CAP allocation will not be sufficient to fulfill all the irrigation needs of those golf courses. Thus, when the system is in full operation, operators of the facilities will use a combination of CAP and well water to fulfill those irrigation needs.

CAP Allocations to Sun City West and Sun City West

As mentioned above, the CAP allocations (4,189 acre-feet per year to Sun City and 2,372 acre-feet per year to Sun City West) will be insufficient to serve the irrigation needs of the participating golf courses in either community. The portions of the needs that will be fulfilled by CAP water from the proposed system are as follows.

Participating Facilities



Not all golf courses in Sun City West will be included in the GSP delivery program for reasons indicated in Part A of this report. Likewise, in Sun City West, two golf courses will not be included because of legal issues that require the utilization of effluent. The participating facilities are listed below.

Sun City Golf Courses

Participating	Not Participating
Lakes East GC	Palmbrook Country Club
Lakes West GC	Sun City Country Club
North GC	Union Hills Country Club
Riverview GC	
South GC	
Quail Run GC	
Willowcreek GC	
Willowbrook GC	

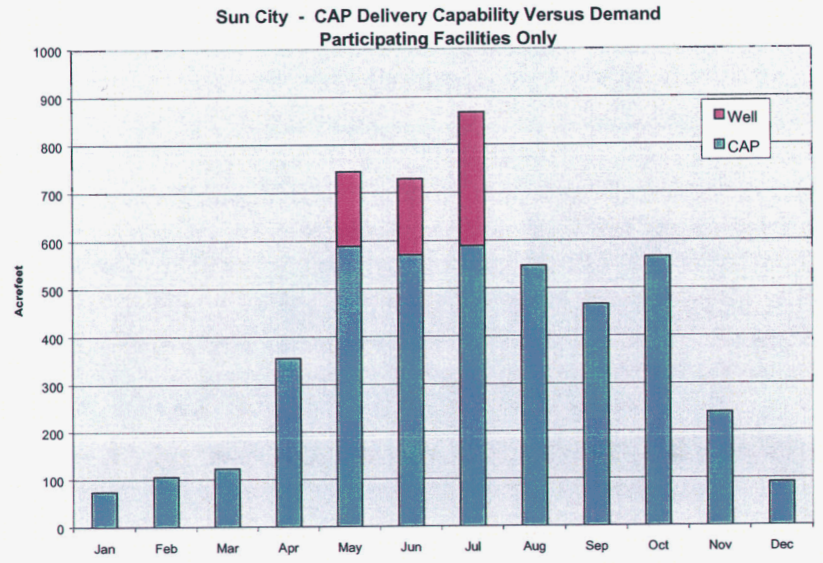
Sun City West Golf Courses

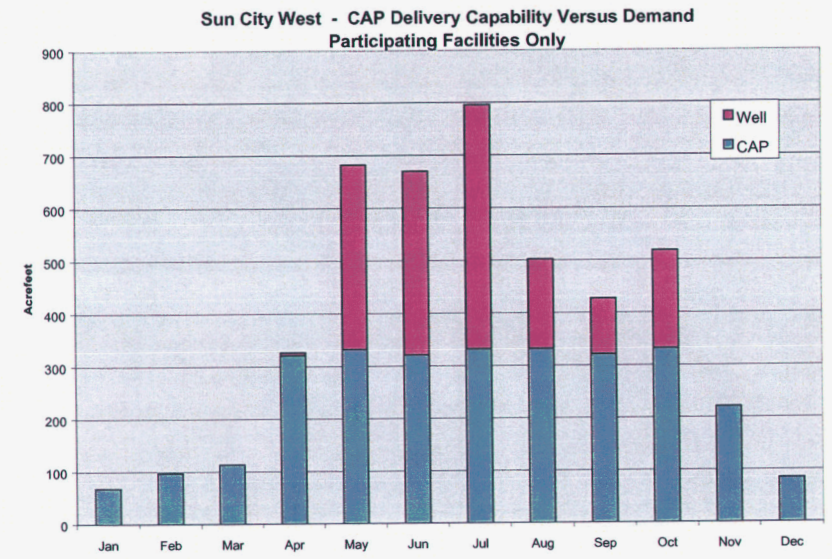
Participating	Not Participating
Echo Mesa GC	Deer Valley GC
Grandview GC	Desert Trails GC
Pebblebrook GC	
Stardust GC	
Trail Ridge GC	
Briarwood Country Club	
Hillcrest Golf Club	

Relationship Between Delivery Capability and Demand

The demand for irrigation water follows a diurnal cycle throughout the year, which approximately follows the annual temperature cycle. Demand is low in the winter and high in the summer. As an operating procedure, all demand will be met by utilizing CAP water at each of the facilities unless demand exceeds the CAP system delivery capability or after the point in each year when the CAP allocation of the particular community has been fully consumed. Only then will well water be utilized to augment the CAP deficiencies. Hence, in the cooler months, the water source will be the proposed CAP system. In warmer months, the water utilized by the facility operator for irrigation will be a blend of CAP and well water.

The following graphs illustrate the irrigation water demand for Sun City and Sun City West through an annual cycle. They also illustrate the requirements for blending. The data was derived from historical water use data (section 2b).

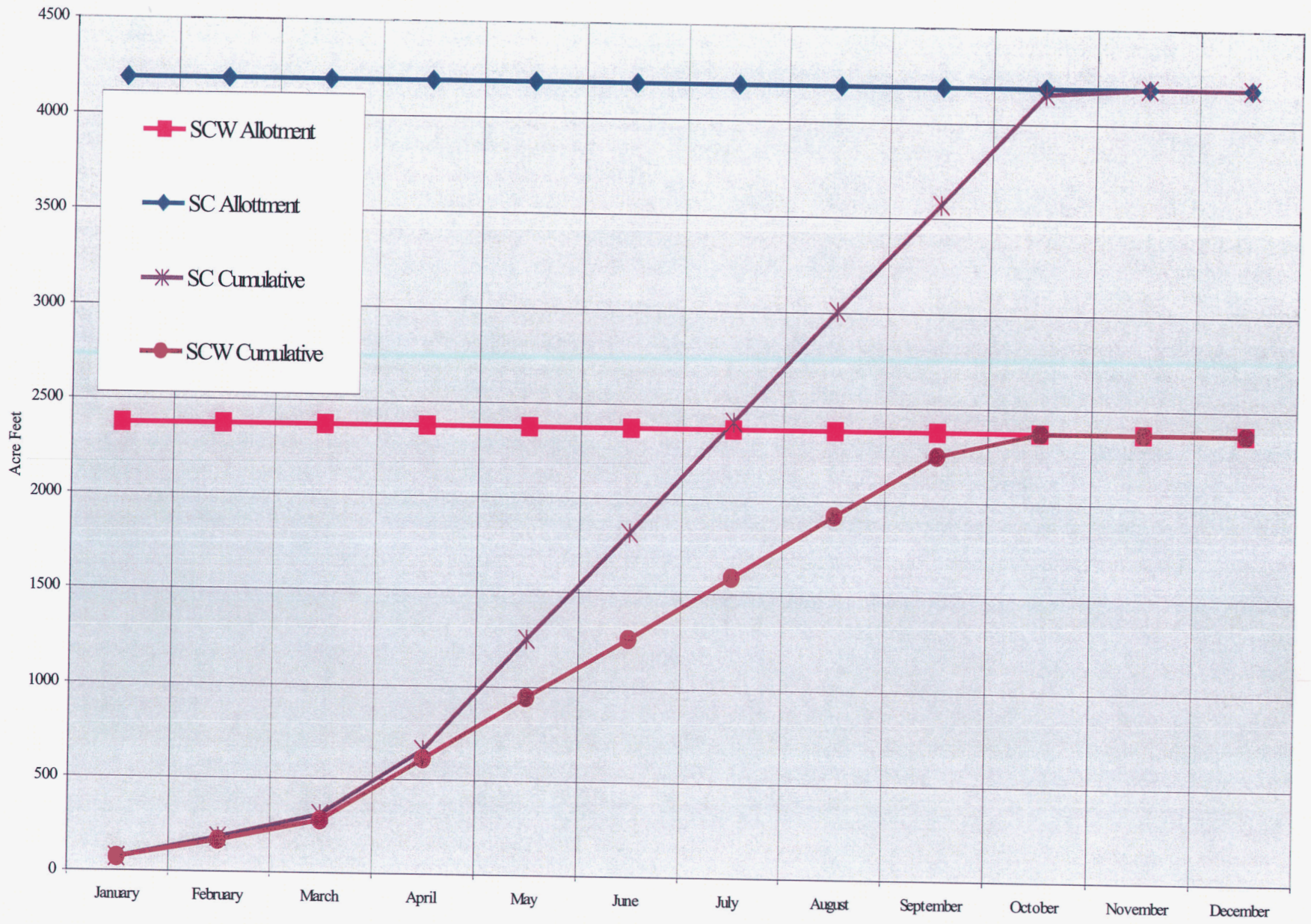




Delivery Profile

As mentioned above, CAP water will be utilized in preference to well water unless the demand exceeds the supply capacity. This is necessary to ensure that the entire CAP allocation will be consumed by the end of the calendar year. Given this operational policy, it is anticipated that the CAP allocation will not be fully consumed until quite late in the year. The following graphics illustrate the anticipated CAP delivery versus time profile and assume consistent operations. Operational complications and/or years with above average rainfall would have the effect of extending the date of full allocation delivery beyond the dates illustrated here.

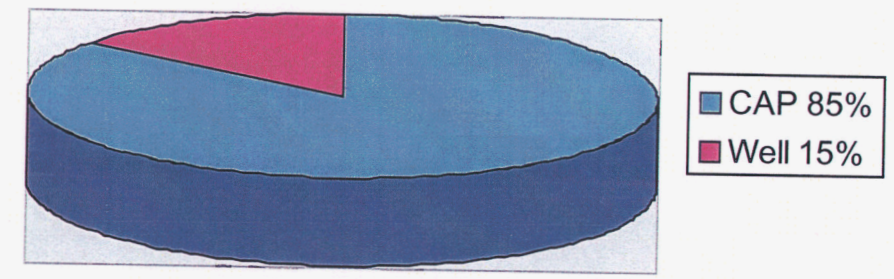
Sun City & Sun City West Supply & Demand



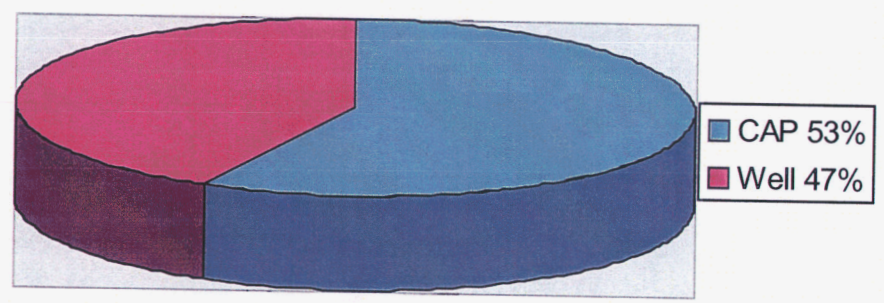
CAP / Well Water Blending

The anticipated annualized blending ratios based on historical golf course irrigation usage for SC and SCW are as follows.

Sun City
Annualized Blending Ratio
(participating facilities)



Sun City West
Annualized Blending Ratio
(participating facilities)



Summary

In conclusion, the proposed system will be capable of fulfilling the objectives of the project. Provided that well water is utilized only when the CAP system is incapable of fulfilling the demand, then the entire CAP allocations will be utilized.

5 Water Quality

Water quality is an essential element of successful agriculture. When considering water quality of groundwater or surface water, salinity and the concentration of sodium and calcium ions have the greatest impact.

To evaluate the impacts of using CAP water in conjunction with well water, instead of the current well water sources, water quality issues were evaluated for each of the two water sources. Those results are presented here.

Current Well Water

To evaluate the quality issues of the existing well water sources, June 1999 analytical data for each Recreation Centers of Sun City West golf course was obtained from Todd Patty, Recreation Centers of Sun City West golf course manager (**Appendix D.7**). It will be assumed that this data is typical and representative of all of the golf courses. Please note that water salinity is measured as electrical conductivity (EC) and expressed in the units, dS m^{-1}.

Water Analysis from Recreation Centers of Sun City West June 1999

Golf course	pH	EC	Ca (ppm)	Na (ppm)
Pebblebrook	9.5	0.356	17	69
Stardust	8.2	0.425	24	53
Grandview	9.2	0.490	8	95
Echo Mesa	8.2	0.616	30	112
Trail Ridge	9.9	0.506	15	119
Deer Valley	9.8	0.566	13	131
Desert Trail	10.2	0.450	6	93
Average	**9.3**	**0.487**	**16**	**96**

CAP Water

Data on the water-quality parameters listed above were also acquired for CAP water. The CAP organization routinely samples water from several locations within the system and laboratory analyses are performed on those samples and the results recorded. In general, waters are sampled weekly, although not all parameters are analyzed each week. The 1999 weekly data were obtained from CAP for the 99th avenue sampling location. Average values for the 1999 data are presented below:

Water Analysis from CAP (99th Ave) Average of 1999 weekly data

Golf course	pH	EC	Ca (ppm)	Na (ppm)
Average	8.5	0.891	71	80

Projected Blending Ratios and Corresponding Water Quality Parameters

The water used for golf course irrigation will come from well water, CAP water, or a blend of the both. The actual quality of the irrigation water will likely fluctuate within the limits of the original well and CAP sources as the water blend ratio fluctuates. Because the salt and specific ion influx are additive, instantaneous water quality parameters within the above limits are not of critical importance. Instead, the values of primary importance are the annual averages of the quality parameters.

The annual well/CAP ratios for both Sun City and Sun City West were given in an earlier section. These ratios assume that each of the Sun Cities will utilize their entire CAP allotments. Based on these ratios and the water quality information listed above, the average water quality values in a given year for each parameter (with the exception of pH) can be calculated. They are presented below:

Projected Average Water Quality

	Well*	CAP*	Ratio	EC**	Calcium***	Sodium***
SC	717	4189	1:5.84	0.830	63	82
SCW	2132	2372	1:1.11	0.701	45	88

* - acre-feet/year
** - electrical conductivity (dS $^{m-1}$)
*** - ppm

Because pH is a logarithmic rather than linear representation of hydrogen ion concentration, the values for the parent waters cannot be averaged, as was done above for the salinity and ion concentration parameters, and the anticipated pHs of proposed blends cannot be projected. It can be concluded, however, that the resulting pHs of the proposed blends will be lower, and therefore more favorable, than the pH of the existing well water.

Salt Leaching

As indicated above, switching from the current well water to a well/CAP water blend will cause the salinity of the irrigation waters to increase. All irrigation water contains salts which, if unmanaged, can accumulate in the rootzone to detrimental levels. These salts can be managed successfully by leaching them out of the bottom of the rootzone via application of water in excess of that required for evapotranspiration from the turf surface. The additional water necessary for adequate leaching is referred to as the leaching requirement and is expressed as a percentage of the total requirement for turf evaporation and leaching. If the salt content of the irrigation water is increased, additional leaching will be required. Leaching requirements for any irrigation water can be calculated as follows:

$$LR = EC_w / 5(EC_e) - EC_w, \quad \text{where}$$

ECw - salinity of the irrigation water
ECe - salinity of a soil extract that is tolerated by the turf plants (3 for ryegrass)

When the above equation is applied to the projected water salinities, the following minimum leaching requirements are calculated.

Calculated Minimum Leaching Requirement (%)

Water	LR (%)
Well	3.4
CAP	6.3
SC blend	5.9
SCW blend	4.9

The meteorological staff at the University of Arizona has determined that the annual water consumption (evapotranspiration) from turf in the northwest valley is approximately 60 inches per year. Applying the above leaching requirement percentages to the 60-inch-per-year value results in the following calculations of minimum leaching requirements, expressed as inches-per-year.

Calculated Minimum Leaching Requirement (inches per year)

Water	LR (in/yr)
Well	2.0
CAP	3.8
SC blend	3.5
SCW blend	2.9

The difference between the leaching requirements for the current well water and the projected blends is an estimation of the additional irrigation water that will be required to compensate for the higher salinity of the projected blends. These values will reflect an increased annual water consumption by the turf facilities.

Increased Water Consumption for Leaching (inches per year)

Users	Inches per year
SC	1.5
SCW	0.9

Increased Water Consumption for Leaching (acre-feet per year)

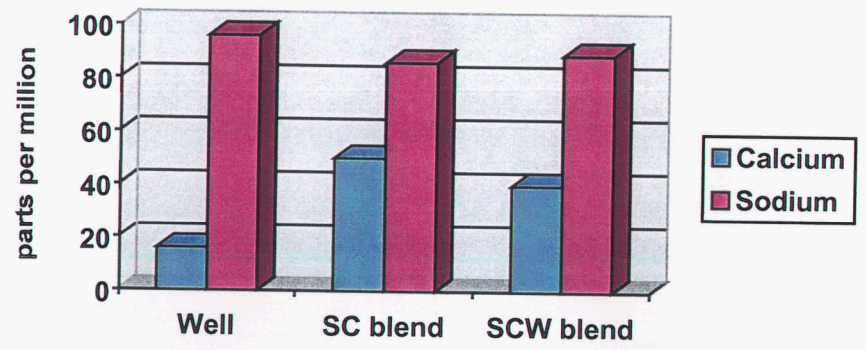
Users	Inches per year
SC	123
SCW	68

Projected Changes in Specific Ions

Water salinity is a non-specific term referring to the total ion concentration in water. This parameter is important because it reflects the total amount of salts in a given volume of water and, therefore, the requirements for leaching water. However, specific ions vary in their negative (and positive) impacts on agriculture. For example, fertilizer elements added to a soil or to irrigation water are ions that contribute to salinity. Of particular interest in agriculture is calcium, which has a positive impact on soil structure and is often added in the form of gypsum, and sodium, which has a detrimental effect on soil structure.

As discussed earlier, the existing well water differs significantly from CAP water with regard to concentrations of calcium and sodium.

Specific Ion Concentrations



When the projected well/CAP water blends are utilized for irrigation, the concentrations of these ions will change accordingly.

As indicated in the graph above, the inclusion of CAP water in the irrigation blends will result in a slight decrease in the sodium application to the turf, a desirable outcome. In addition, there will be an increase in the calcium applied, also a desirable outcome. Therefore, with reference the specific concentrations of calcium and sodium, the two ions of greatest impact on agriculture, the conversion from well water to either of the two blends will result in a more favorable situation.

City of Scottsdale Experience

There is a significant precedent regarding the use of CAP water for irrigation of golf courses in the Phoenix metropolitan area. For approximately eight years, the City of Scottsdale supplied 100 percent CAP water to 20 golf courses in north Scottsdale (north of Bell Road) via the RWDS. In anticipation of utilizing a blend of partial CAP water in the Sun Cities, the experiences of these Scottsdale facilities may offer insight into potential impacts. An informal telephone survey of seven individuals who managed these facilities during the time of the 100% CAP utilization was conducted. The comments offered by these individuals are as follows:

Survey of RWDS Users

Question: What problems or complications did you encounter when using CAP water prior to the addition of effluent?

1. Shawn Emerson (Desert Mountain Properties)
   a. The salt content was higher in the winter than in the summer months.
   b. It was like having two different waters at different times of the year.
   c. We compensated for the salt by leaching occasionally.
   d. It did not pose any real problems.
   e. It may have caused a little more salt staining on hardscape.

2. Ed Shimkus (Troon North, Legend Trail)
   a. Any problems that people talked about at the time were blown out of proportion.
   b. We didn't have any problems with it.
   c. The water quality was pretty good.
   d. It wasn't a big deal.

3. Carl Rygg (The Estansia Club)
   a. No problems at all.
   b. Quality wasn't bad, actually, it was quite good.
   c. We tested it continuously and the ions were in a good balance.

4. Scott McCall (The Boulders)
   a. Salts usually run at 400 – 600 (ppm) but can creep up as high as 900 (ppm).
   b. No real problems.
   c. You have to leach away the excess salts.
   d. We treated with acid.

5. Ernie Pock (Terravita, Grayhawk)
   a. We had no problem at all, nobody had any problems before effluent was incorporated.
   b. They may be better off than before because CAP has so little sodium in it.
   c. TDSs are higher but you make up for it with more flushing on bentgrass greens.
   d. Rye and bermudagrass wouldn't require any changes.
   e. It is very manageable.
   f. You would want to treat for the high bicarbonates.

6. Paul Ellwood (Terravita, TPC)
    a. No problems whatsoever, any reports of problems were sensationalized.
    b. Dissolved salts were a little higher than well water.
    c. Compared to what I'm using now (effluent), it was fabulous.

7. Kevin Smith (Troon Country Club)
    a. We didn't have any problems.
    b. The salts were a little high but leaching wasn't an issue.

Conclusions - Water Quality

The inclusion of CAP water with the existing well water will result in an increase in the total salinity of the irrigation water as compared to the existing well-water sources. However, this increase will be manageable. Management of this additional salt influx will require the additional application of approximately 1.5 inches of irrigation water to the turf areas on an annual basis, less than 3% of the annual consumption.

Changing to the CAP blends will also alter the balances of specific ions applied to the turf. It is anticipated that the application of sodium (a detrimental salt ion) will decrease slightly, whereas the application of calcium (a favorable salt ion) will increase substantially. Thus, with regard to the specific ions of primary interest in agriculture, the ion balance situation will improve.

To evaluate the potential impacts of CAP water usage for irrigation, facility managers with experience using CAP water for irrigation were surveyed. Of the seven individuals polled, there were no significant negative comments. Comments were either neutral or positive.

In summary, it is concluded that the use of CAP water to supplement golf course irrigation in the Sun Cities will not cause any substantial difficulties related to water quality. Minor difficulties that may arise can be overcome with additional leaching via the application of slightly increased irrigation water quantities.

6 Treatment Systems

The purpose of this section is to discuss the possible need to provide treatment of the CAP water prior to it being delivered to golf courses for turf irrigation. The use of untreated CAP water for golf course irrigation has been common practice in the Phoenix metropolitan area since the CAP Canal began delivering water. The best example of this has been the City of Scottsdale's Reclaimed Water Distribution System (RWDS). For approximately eight years, the RWDS has delivered untreated CAP water to 20 golf courses in the north Scottsdale area.

The RWDS system consists of a series of five major pump stations and pipelines (16- to 30-inch diameter) that take water from the CAP Canal and deliver it north along Pima Road approximately 13 miles. Various golf courses tie-in to the transmission main along its route for delivery of water to their irrigation reservoirs. The RWDS provides no treatment to the CAP water prior to being delivered to the golf courses. There is, however, an 8-million gallon (MG) storage pond at the RWDS main pump station. This pond was initially installed at the request of and payment by the golf courses for storage capacity in emergency situations (e.g. if pump stations are out of service). As it has been operating, the storage capacity function has not been necessary since the golf courses already have on-site storage and the RWDS pump stations have not been out of service for extended periods. The storage pond has, indirectly, provided some level of treatment to the CAP water, particularly during low demand months. In those months, water is retained in the storage pond long enough to allow some settlement of particulates. During high demand months when the RWDS is delivering 20 MGD, the 8 MG pond is essentially a flow-through pond and little settlement occurs. In that case, the golf courses are receiving approximately the same quality water that is taken directly from the CAP Canal.

Initially, strainers were installed at the RWDS pump station nearest the CAP Canal. The strainers were installed to remove algae and other particles not removed by the bar screen at the CAP turn-out. The City experienced severe operational difficulties with the strainers due to excessive clogging. The strainers were taken out of service shortly after commissioning and the RWDS has been delivering the untreated CAP water for essentially the eight years it has been in operation.

With the completion of the City's Water Campus, which is an advanced wastewater treatment plant, the RWDS is now beginning to deliver treated effluent to the golf courses. Depending on the time of year and subsequent demand, the treated effluent will supplement or take the place of the CAP water.

As part of this project, seven of the golf courses using CAP water delivered in the RWDS were contacted to discuss their experience. All of seven courses reported neutral to favorable experience in using the untreated CAP water.

Some of the golf courses which utilize CAP water for at least a portion of their irrigation needs as of 1998 are; (Source ADWR)

- Red Mountain Ranch
- Raven
- TPC
- Viewpoint RV and Golf Resort
- Gold Canyon Golf Resort
- 500 Club
- Apache Sun
- Rancho Manana
- Johnson Ranch Golf Club
- Happy Trails
- Sunland Village
- Traditions
- Fiesta Lakes

It is also worth noting that most golf courses in the SRP service area are using untreated SRP water for the irrigation of their courses. The source of water for SRP is the Salt and Verde Rivers, and the quality is similar to that conveyed in the CAP Canal. In fact, in many cases, SRP water has a higher occurrence of algae than the CAP Canal.

Based on the well-established historical successes of using untreated CAP water for golf course irrigation in the Phoenix metropolitan area, no treatment of the CAP water is recommended for this project.

PART C – FEASIBILITY OF A JOINT TRANSMISSION FACILITY WITH THE AGUA FRIA DIVISION

1 Introduction

This section of this report investigates and reports on the feasibility of combining the Groundwater Savings Project with a project for Citizens' Agua Fria Division. The Agua Fria Division is a service area of Citizens Water Resources that generally comprises the area surrounding the town of Surprise and some adjoining County land, as shown in **Figure C.1**.

Currently, the Agua Fria Division has a CAP water allocation for an annual allotment of 11,093 acre-feet. A portion of the allocation (2100 ac-ft) is presently being used to recharge the aquifer by way of the Maricopa Water District's groundwater savings facility. The current plan is to increase the use of Agua Fria's CAP water allotment annually by 1100 ac-ft increments. In the future, as the demand increases in the Agua Fria Division and a CAP water treatment plant is required, the volume recharged into the Maricopa Water District's groundwater savings facility will be reduced to account for the CAP water being delivered to the future CAP water treatment plant. The water is currently being conveyed to the recharge facility through the Beardsley Canal. Thus the present method of utilizing the Agua Fria Division's CAP water allocation does not require a separate pipeline conveyance facility.

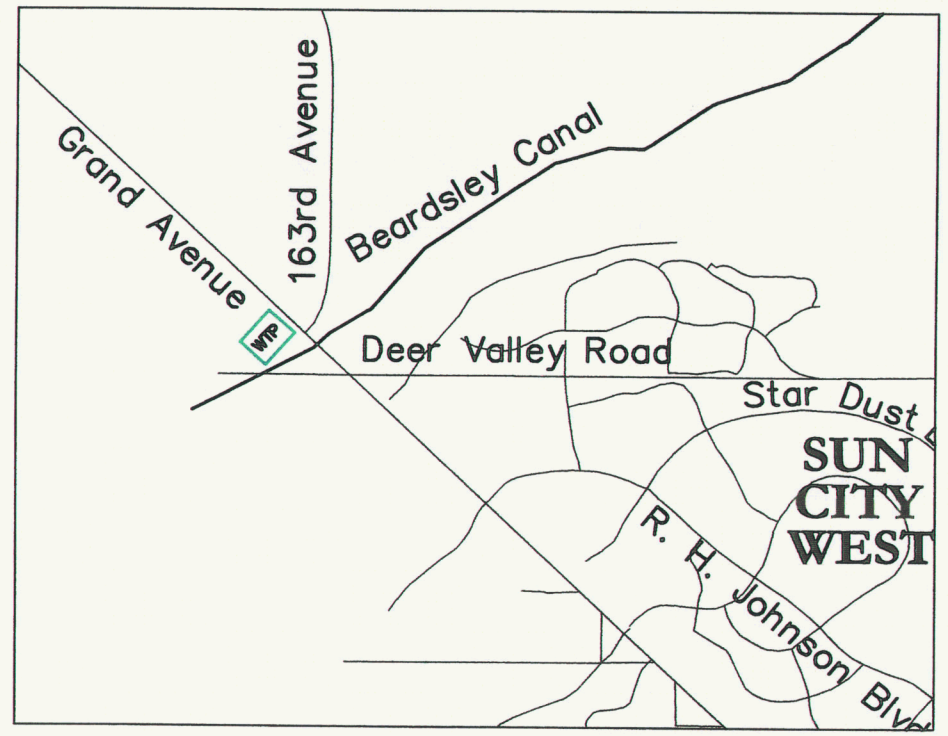
2 Agua Fria Division Master Plan

A Master Plan[1] has been prepared for the Agua Fria Division that provides both a short-term and a long-term strategy for water supply and distribution in Citizens' Central Agua Fria service area. The master plan investigates a planning horizon of the year 2020. Included in the master plan is an implementation plan and schedule that describes the phased implementation of facilities during the 20-year planning period, that are necessary to serve the demands of the area.

Figure C.1

The recommended alternative in the master plan for meeting future demands calls for the first phase of a water treatment plant to be in service by the year 2005. The plant is to be located somewhere south of Greenway Road near the Beardsley Canal. The initial plan is to supply the WTP by "wheeling" CAP water through the Beardsley Canal. The capacity of the plant will be expanded over time to meet the forecasted demands of the service area. Prior to the construction of the WTP described above, customers are being served by the use of groundwater wells.

Figure C.2



[1] Brown and Caldwell, *Citizens Water Resources, Central Agua Fria Master Plan Draft*, June 2000.

If, over time, the capacity of the plant cannot be fed by the Beardsley Canal, or if the Beardsley Canal annual dry-up period becomes an operational problem, or if the wheeling costs make the use of the Beardsley Canal economically prohibitive, a pipeline conveyance project from either the CAP Canal or Lake Pleasant to the WTP may become necessary. However, if required, this pipeline conveyance project will not be constructed until after year 2005, well after the completion of the first phase of the WTP. In fact, since the actual necessity of this pipeline conveyance project to the Agua Fria Division is unknown, the construction of this pipeline conveyance project was not projected within the Agua Fria Division's 20 year planning horizon through the year 2020.

The current CAP allotment contract secured by the Agua Fria Division amounts to 11,093 acre-feet. There are no plans to acquire additional CAP water, so the total future anticipated flow to the Agua Fria Division service area would remain at 11,093 acre-feet.

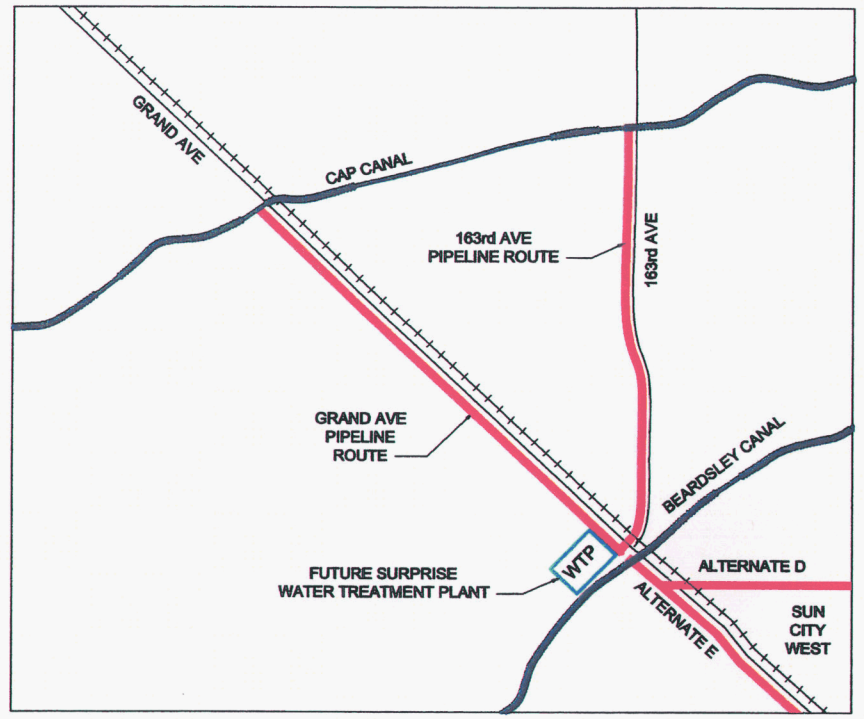
3 City of Surprise Pipeline Project

During the course of researching a possible joint project with the Agua Fria Division, it was discovered that the city of Surprise has long-range plans to construct a CAP raw water transmission line from the CAP Canal to the future site of a water treatment plant. The plant may be located at the southwest corner of Grand Avenue and 163rd Avenue (Sarival Avenue). This project is projected to be in service in 2007.

The pipeline route proposed by the city of Surprise has not yet been established, but it is likely to follow either the existing alignment of Grand Avenue or 163rd Avenue. The Grand Avenue route is approximately 6.0 miles long while the 163rd Avenue route would be approximately 5.0 miles long. See **Figure C.3**.

The current CAP allotment contract secured by the city of Surprise amounts to 7,373 acre-feet. The city plans to acquire an additional allotment of 2,608 acre-feet of CAP water bringing the total anticipated flow in the city of Surprise pipeline to 9,981 acre-feet.

Figure C.3



4 Joint Facility Description

As a part of this Groundwater Savings Project study, the Agua Fria Master Plan has been reviewed together with the city of Surprise concept for the possibility of combining a joint facility pipeline project. The concept of a joint facility project would be to minimize infrastructure cost for all parties. The possible combinations for a joint facility pipeline includes:

- Groundwater Savings Project / Agua Fria Division
- Groundwater Savings Project / Agua Fria Division / City of Surprise
- Groundwater Savings Project / City of Surprise

For a joint facility to be feasible, it will have to be sized to accommodate the combined flow rates of the respective partners. For purposes of estimating the pipe size, the following assumptions have been made:

- Flow in the pipeline will be by gravity.
- Velocity will be approximately 5 feet per second.
- Flow rate will be based on the annual allotment times a peaking factor of 1.5

Using these assumptions, the size of a joint pipeline facility, based on the contributing partners, would be:

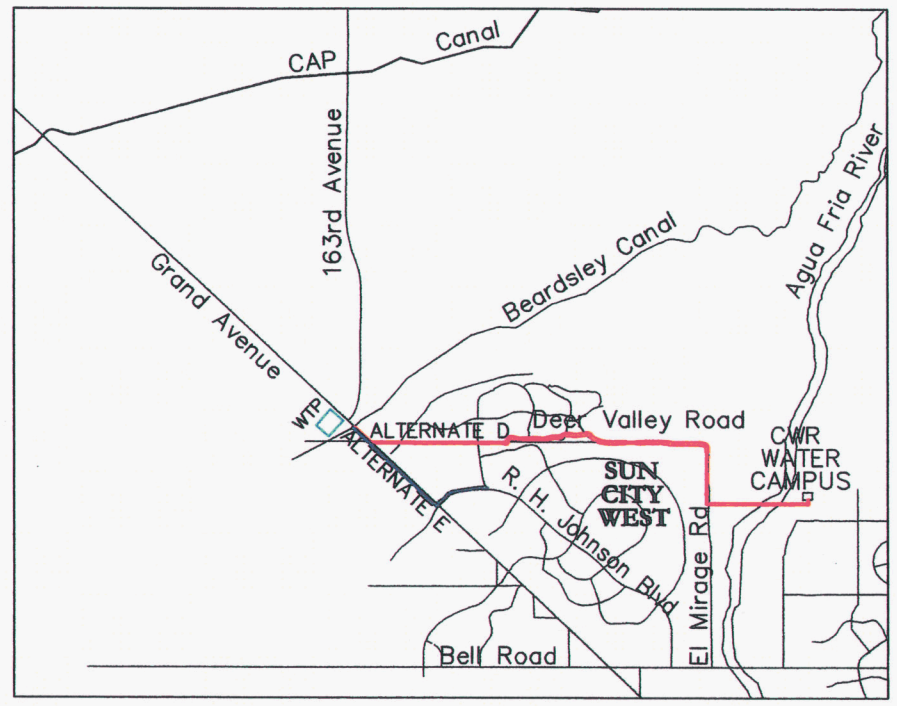
Joint Facility Pipe Size

Contributing Partners	Pipe Diameter (in.)
Groundwater Savings Project Agua Fria Division	36
Groundwater Savings Project Agua Fria Division City of Surprise	48
Groundwater Savings Project City of Surprise	36

A complete hydraulic investigation would have to be performed to determine if the operating pressure zone requirements and other delivery conditions of each of the parties to the joint facility would be met.

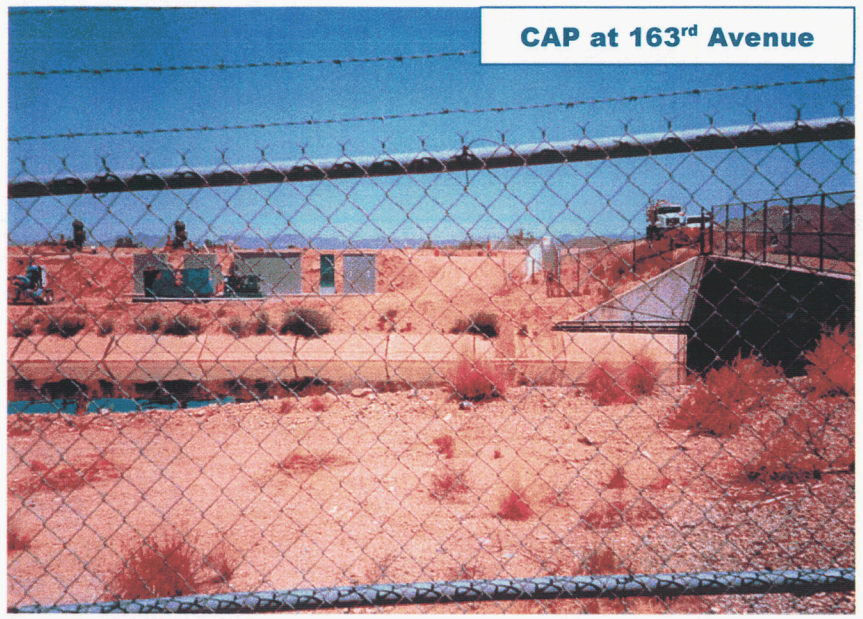
The joint pipeline facility would take delivery of CAP water from a new turnout on the CAP Canal, which would be constructed under this project. Ultimately, the joint facility pipeline would connect to the GSP through one of several routes. These possible routes are very similar to the Alternative D and Alternative E alignments, respectively, that are described in Section D.2

Figure C.4



5 Joint Facility Location

The joint pipeline system could start at a new turnout structure on the CAP, to be constructed either at Grand Avenue or at 163rd Avenue. No existing turnout is available at either of these locations. Because CAP does not have an annual canal dry-up, the tie-in process would have to be accomplished in the wet condition. This is done by placing cofferdams around the work area and can typically be quite expensive.



CAP at 163rd Avenue

CAP Review of Design Plans

The engineering department at CAP will coordinate the review of construction design plans required for installation of the new turnout structure. CAP requires approximately two weeks for the review of each plan set, with the cost of these reviews applied to the project.

The new turnout to be constructed on the CAP Canal would be on the south side of the canal. It would include a screen flush with the lining and a manual gate at the opening to a 36 to 48-inch diameter concrete cylinder iron pipe (RCCP). An open meter box, intended for measurements in feet of water, will need to be constructed about 28 feet from the canal. The entire turnout is to be constructed on CAP right-of-way and enclosed by a chain link fence, but access can be provided to CWR for monitoring equipment maintenance. Plans for a typical turnout are included in **Appendix E**.

A short piece of pipe, or spool piece, containing a water meter for measuring flow in the pipe, will be installed in the meter box. An acoustic meter, will be the revenue meter for CAP and will connect to a Measure Control Unit (MCU) that transmits the information to CAP to a check structure downstream from the turnout. The MCU can be hardwired or radio transmitted to the RTU at the check structure. I/O ports are available for these connections. Power will be required to operate the flowmeter and MCU, and although there is currently none at the site of the turnout, power is close by.

Everything inside the fence becomes property of CAP, who will operate and maintain the facilities. CAP will clean the grate at the inlet and provide maintenance to the telemetry and measurement systems. CAP can provide access to the meter box area for CWR and will provide a courtesy signal from its RTU to CWR, although CWR will be required to provide its own telemetry.

CAP Easement Requirements and Right-of-Way

Because the turnout will be new, some permanent easement may be required. Before construction begins, a Land Use application and $500 application fee must be filed. The applicant is responsible for additional costs, including those for inspection and oversight, and plan review costs incurred by CAP until construction ends. The application, along with insurance documents, will be reviewed before granting a "Construction Period Land Use License." CAP personnel have issued the Groundwater Savings Project a project number and are aware of the status of the project. Copies of the application, relevant information sheets, and a right-of-way map are included in the **Appendix E**.

CAP Operations

The CAP Canal has continuous, year round flow and does not schedule regular dry-up times for maintenance. Construction in the canal will have to be done "in the wet." There are times when the water surface falls below the control water surface. Customers affected by this situation will be notified and difficulties worked out in advance of low water surfaces.

CAP customers are allowed two flow rate adjustments per 24 hours, which must be called in by 9:00 a.m. the previous day.

For annual order estimates, the CAP has a peak averting measure called the "eleven percent rule", applied when the peak flows predicted by annual water orders exceed the ability of CAP to deliver those flows. The rule permits CAP to limit a subcontractors monthly order (not its allocation) to 11% of their annual allocation, thereby easing canal operations during high-use periods. In such a case, CAP notifies M & I customers, which include this project, of the invocation of the rule. Customers may then revise their forecast for water accordingly. Flow changes are implemented only after customer notification. While this rule has yet to be invoked, it remains a tool for CAP Canal management. Peak GSP flows are predicted during the months of May through October. These months could be affected by the 11% rule if it is invoked.

Other measures which could be invoked by the CAP during high demand periods include cutting daily water orders on peak demand days to meet as much demand as possible for all customers. In these cases however, Native American Community and M & I water allocations have the highest priority. Since CWR has water considered as M&I use they would have the highest priority and as with the 11% rule, flow changes would be implemented only after notification

Joint Facility Route

After reviewing the possible options for the joint pipeline system, the 163rd Avenue route appears the most direct alignment. Either side of 163rd Avenue could accommodate the pipeline within the existing roadway right-of-way. It is anticipated that the pipeline would be placed outside of the existing area of pavement. The only apparent underground utilities that may be in conflict with the alignment are telephone lines. Fiber optic lines run parallel to the railroad at Grand Avenue. Overhead power is available.

Typical view of 163rd

There are numerous stormwater cross culverts on 163rd Avenue from Grand to Jomax. North of Jomax Road the drainage crosses in roadway dip sections. Drainage along Grand Avenue is conveyed by cross culverts. Either route may require a crossing of the Burlington Northern, Santa Fe railroad that parallels the north side of Grand Avenue. Typically crossing a railroad with a utility adds time to the design phase of a project because the railroad will review the design and require a construction license and an operating license.

163rd Avenue at Grand Avenue and BNSF

GSP Alternative D Alignment

The Alternative D pipeline route for connecting the joint facility to the Groundwater Savings Project begins at the split from the joint facility near the future city of Surprise WTP. The alignment parallels Grand Avenue southeasterly for approximately 0.4 miles, then turns east for 4.8 miles, on a Deer Valley Road extended centerline alignment through Sun City West, until reaching El Mirage Road. There the pipeline turns south for one mile to Beardsley Road, then east one mile to Citizens Water Resource's SCW wastewater treatment plant.

Along its alignment, the route passes through a residential area of Sun City West, Deer Valley Golf Course, the existing McMicken Dam Outlet Wash and the Agua Fria River. From Grand Avenue the pipeline follows an existing concrete-lined channel east until reaching the golf course. From the golf course, the alignment moves back onto the Deer Valley Road alignment and continues east to El Mirage Road.

The hydraulic grade line (HGL) elevation available in the joint facility pipeline is used as the basis for the hydraulics design of the Alternative D pipeline. The HGL elevation, which can be translated into pressure at the delivery point in the Sun City Area, is calculated by subtracting the losses incurred in the pipeline from the CWS elevation at the CAP Canal. The major portion of the losses in the pipeline will be from friction. There are minor losses when valves or bends in the pipe are encountered, but these are typically insignificant. Vacuum relief valves and air release valves will be required on the pipeline at high points and other locations, and valves will be included to allow the pipeline to be isolated for one-mile segments.

The pressure required in the Alternative D pipeline at the delivery point near the CWR water campus is 70 psi. This pressure is required in order to operate the Sun City West CAP water distribution system and the Sun City CAP water distribution system by gravity.

The preliminary hydraulics analysis for the Alternative D pipeline has determined that a 24-inch diameter transmission pipeline best serves the hydraulic requirements of this project. The resulting pressures not adequate to supply the normal operating range of pressures for this system, requiring the use of a booster pump station. The use of pressure reducing valves along route of the joint facility will not be required to control excess pressure.

GSP Alternative E Alignment

The Alternative E pipeline routes begin at the split off the joint facility pipeline. The alignment parallels Grand Avenue southeasterly for approximately one-and-a-half miles, turning east on R.H. Johnson Boulevard to Granite Valley Drive, where it can be joined to the existing Recreation Centers of SCW irrigation network.

The hydraulic grade line (HGL) elevation available in the joint facility pipeline is used as the basis for the hydraulics design of the Alternative E pipeline. The HGL elevation, which can be translated into pressure at the delivery point in the Sun City West area, is calculated by subtracting the losses incurred in the pipeline from the CWS elevation at the CAP Canal. The major portion of the losses in the pipeline will be from friction. There are minor losses when valves or bends in the pipe are encountered, but these are typically insignificant. Vacuum relief valves and air release valves will be required on the pipeline at high points and other locations, and valves will be included to allow the pipeline to be isolated for one-mile segments.

The preliminary hydraulics analysis for the Alternative E pipeline assumed the use of a 24-inch DIP. The delivery pipeline from Alignment E was assumed to connect to the existing SCW effluent delivery system. Because the closest point of connection is on the downstream end of the system, the pipes are relatively small diameter. These small diameter pipes require high pressure to drive the flows back to the Aqua Fria crossing and into Sun City. Calculations indicate that the existing SCW effluent system is inadequate to carry the required flows back to and across the river, without increasing the pressure in the pipeline via a new pumping system. The pressure required would exceed the physical limits of the existing pipe and could potentially produce excessive leakage and pipe breaks. The delivery pressure produced by gravity flow in the Alternative E pipeline is not adequate to provide flows at the various discharge locations. It will, therefore, not be possible to deliver water from the joint facility pipeline via the Alternative E pipeline.

The SCW effluent irrigation system is owned by the Recreation Centers of Sun City West. The Recreation Centers has indicated to CWR that the pipeline crossing of the Agua Fria River cannot be used to convey CAP from west to east (the direction of flow required for the Alternative E alignment) because of their obligation to provide effluent to Sun City West Recreation Center golf courses in an east to west direction.

The use of GSP Alternative E will not be considered as a delivery method for CAP water to the GSP due to the hydraulic and legal reasons stated in the two preceding paragraphs.

6 Joint Facility Cost

The transportation and delivery of CAP water through a joint facility pipeline project adds a pro-rated portion of the joint facility cost to those costs already determined for either Alternative D or Alternative E.

For purposes of comparing alternatives, the cost of a joint pipeline facility serving the Groundwater Savings Project and the Agua Fria Division may be reasonably estimated to be:

Joint Pipeline Facility
Agua Fria Division &
Groundwater Savings Project

Item Description	Unit	Quantity	Unit Price	Amount
Pipeline				
Mobilization @ 5%	Ea.	5%	$217,386	$217,386
RCCP 36", (Class 150)	L.F.	26,400	$147.66	$3,898,224
36" Butterfly Valve w/ Bypass	Ea.	10	$15,000	$150,000
Pavement Replacement	S.Y.	50	$30	$1,500
Railroad Crossing	L.F.	300	$65	$19,500
Traffic Control	L.F.	26,000	$7	$182,000
Combination AirVac Valve (3")	Ea.	3	$5,000	$15,000
R/W Costs (New CAP Turnout)	S.F.	10,000	$1	$10,000
CAP Turnout				
Headwall	Ea.	1	$20,000	$20,000
Slide Gate	Ea.	1	$2,500	$2,500
Construction License	Ea.	1	$500	$500
Accusonic Flowmeter	Ea.	1	$32,000	$32,000
MCU	Ea.	1	$15,000	$15,000
Connection to CAP SCADA	Ea.	1	$1,500	$1,500
			Subtotal	**$4,565,110**
Engineering Design	8%	1	$365,209	$365,209
Construction Administration	12%	1	$547,813	$547,813
Admin./Legal/Financial	10%	1	$456,511	$456,511
Contingency	25%	1	$1,141,278	$1,141,278
			Total Capital Cost	**$7,075,921**

O&M Life Cycle Costs*	Annual Cost	Present Worth
36" Pipeline O&M (50 yr) (26,400 L.F. at $0.50/ft/yr)	$13,200	$216,159
Total Life Cycle Cost		**$7,292,080**
Pro-rated Cost per Participant (Based on Annual Allotment)		
Groundwater Savings Project (6,561 ac-ft)		$2,710,057
Agua Fria Division (11,093 ac-ft)		$4,582,024
Total Joint Facility Life Cycle Cost		**$7,292,080**

*8.73% Discount Rate Applied, Inflation Factor 3%

If the city of Surprise is added as a partner to the joint pipeline facility, the pipeline would be increased in size. The cost for this option is listed below. The pro-rated cost for each participant, based on annual allotment is also shown:

Joint Pipeline Facility
Agua Fria Division & Groundwater Savings Project With City of Surprise

Item Description	Unit	Quantity	Unit Price	Amount
Pipeline				
Mobilization @ 5%	Ea.	5%	$280,906	$280,906
RCCP 48", (Class 150)	L.F.	26,400	$193.63	$5,112,624
48" Butterfly Valve w/ Bypass	Ea.	10	$20,000	$200,000
Pavement Replacement	S.Y.	50	$30	$1,500
Railroad Crossing	L.F.	300	$65	$19,500
Traffic Control	L.F.	26,000	$7	$182,000
R/W Costs (New CAP Turnout)	S.F.	10,000	$1	$10,000
Combination AirVac Valve (4")	Ea.	3	$7,000	$21,000
CAP Turnout				
Headwall	Ea.	1	$20,000	$20,000
Slide Gate	Ea.	1	$2,500	$2,500
Construction License	Ea.	1	$500	$500
Accusonic Flowmeter	Ea.	1	$32,000	$32,000
MCU	Ea.	1	$15,000	$15,000
Connection to CAP SCADA	Ea.	1	$1,500	$1,500
			Subtotal	**$5,899,030**
Engineering Design	8%	1	$471,922	$471,922
Construction Administration	12%	1	$707,884	$707,884
Admin./Legal/Financial	10%	1	$589,903	$589,903
Contingency	25%	1	$1,474,758	$1,474,758
			Total Capital Cost	**$9,143,497**

O&M Life Cycle Costs*	Annual Cost	Present Worth
48" Pipeline O&M (50 yr) (26,400 L.F. at $0.50/ft/yr)	$13,200	$216,159
Total Life Cycle Cost		**$9,359,656**
Pro-rated Cost per Participant (Based on Annual Allotment)		
Groundwater Savings Project (6,561 ac-ft)		$2,222,135
Agua Fria Division (11,093 ac-ft)		$3,757,071
City of Surprise (9,981 ac-ft)		$3,380,450
Total Life Cycle Cost		**$9,359,656**

*8.73% Discount Rate Applied, Inflation Factor 3%

The option of combining the Groundwater Savings Project with the city of Surprise as the partner to a joint facility, without the Agua Fria Division, is reported below:

Joint Pipeline Facility
Groundwater Savings Project &
City of Surprise

Item Description	Unit	Quantity	Unit Price	Amount
Pipeline				
Mobilization @ 5%	Ea.	5%	$217,386	$217,386
RCCP 36", (Class 150)	L.F.	26,400	$147.66	$3,898,224
36" Butterfly Valve w/ Bypass	Ea.	10	$15,000	$150,000
Pavement Replacement	S.Y.	50	$30	$1,500
Railroad Crossing	L.F.	300	$65	$19,500
Traffic Control	L.F.	26,000	$7	$182,000
Combination AirVac Valve (3")	Ea.	3	$5,000	$15,000
R/W Costs (New CAP Turnout)	S.F.	10,000	$1	$10,000
CAP Turnout				
Headwall	Ea.	1	$20,000	$20,000
Slide Gate	Ea.	1	$2,500	$2,500
Construction License	Ea.	1	$500	$500
Accusonic Flowmeter	Ea.	1	$32,000	$32,000
Geomation MCU	Ea.	1	$15,000	$15,000
Connection to CAP SCADA	Ea.	1	$1,500	$1,500
			Subtotal	**$4,565,110**
Engineering Design	8%	1	$365,209	$365,209
Construction Administration	12%	1	$547,813	$547,813
Admin./Legal/Financial	10%	1	$456,511	$456,511
Contingency	25%	1	$1,141,278	$1,141,278
			Total Capital Cost	**$7,075,921**

O&M Life Cycle Costs*	Annual Cost	Present Worth
36" Pipeline O&M (50 yr) (26,400 L.F. at $0.50/ft/yr)	$13,200	$216,159
Total Life Cycle Cost		**$7,292,080**
Pro-rated Cost per Participant (Based on Annual Allotment)		
Groundwater Savings Project (6,561 ac-ft)		$2,892,234
City of Surprise (9,981 ac-ft)		$4,399,846
Total Life Cycle Cost		**$7,292,080**

*8.73% Discount Rate Applied, Inflation Factor 3%.

These cost estimates are approximate. No engineering calculations have been performed to verify that the hydraulic assumptions noted will acceptable to the Agua Fria Division or to the city of Surprise, because no concept currently exists for an Agua Fria Division pipeline and the city of Surprise pipeline concept is at the very early stages of development.

The cost may range from $2.0 million to $2.6 million in addition to the cost for either Alternative D or Alternative E. However, as will be demonstrated in Section D.2, the use of the Alternative E alignment cannot be pursued because of ownership conflicts together with hydraulic inadequacies.

The cost to the Groundwater Savings Project of using a joint facility with the city of Surprise, or with the City of Surprise and the Agua Fria Division, would therefore need to include the cost of an Alternative D pipeline:

Cost of Alternative D Pipeline

Item Description	Unit	Quantity	Unit Price	Amount
Pipeline				
Mobilization @ 5%	Ea.	1	$218,358	$218,358
Ductile Iron Pipe (24", Class 200)	L.F.	39,139	$88.45	$3,461,845
24" Resilient Wedge Gate Valves	Ea.	7	$13,500	$94,500
Pavement Replacement	S.Y.	13,000	$20	$260,000
Combination Air/Vac Valve (2")	Ea.	5	$4,000	$20,000
R/W Costs	S.F.	200,000	$1	$200,000
Permitting & Compliance	L.S.	1	$23,150	$23,150
Booster Pump Station				
Pump Station Capital Costs	L.S.	1	$307,660	$307,660
			Subtotal	**$4,585,513**
Engineering Design	8%	1	$366,841	$366,841
Construction Administration	12%	1	$550,262	$550,262
Citizens (Admin./Legal/Financial)	10%	1	$458,551	$458,551
Pipeline Contingency	10%	1	$426,247	$426,247
Pump Station Contingency	25%	1	$80,761	$80,761
			Total Capital Cost	**$6,468,175**
O&M Life Cycle Costs*			**Annual Cost**	**Present Worth**
Pump Station O&M (50-yr) (See Estimate, Page D-47)			$68,273	$1,114,527
36" Pipeline O&M (50 yr) (39,139 L.F. at $0.50/ft/yr)			$19,570	$320,464
			Total Life Cycle Cost, Alternate D	**$7,903,166**

*8.73% Discount Rate, Inflation Factor 3%

The total cost to the Groundwater Savings Project of a joint facility with the Agua Fria Division may therefore be the pro-rated share of the joint facility pipeline plus the Alternative D pipeline modified to connect to the joint facility. This amount is:

Agua Fria Division & Groundwater Savings Project

Joint Facility Cost Estimate	
GSP Share of Joint Facility	$2,710,057
Alternative D Cost	$7,903,166
Total Cost to GSP	**$10,613,223**

The total cost to the Groundwater Savings Project of a joint facility with the Agua Fria Division and the city of Surprise may therefore be the pro-rated share of the joint facility pipeline plus the Alternative D pipeline modified to connect to the joint facility. This amount is:

Agua Fria Division & Groundwater Savings Project With City of Surprise

Joint Facility Cost Estimate	
GSP Share of Joint Facility	$2,222,135
Alternative D Cost	$7,903,166
Total Cost to GSP	**$10,125,301**

Likewise, the total cost to the Groundwater Savings Project of a joint facility with the city of Surprise may be pro-rated share of the joint facility pipeline plus the Alternative D pipeline modified to connect to the joint facility. This amount is:

Groundwater Savings Project & City of Surprise

Joint Facility Cost Estimate	
GSP Share of Joint Facility	$2,892,234
Alternative D Cost	$7,903,166
Total Cost to GSP	**$10,795,400**

7 Joint Facility Timeline

The new Agua Fria Division water treatment plant is programmed to be in service in 2005. Some time after that, as demand and economic conditions dictate, a transmission pipeline project may be necessary. However, a transmission pipeline to serve the needs of the Agua Fria Division is not currently projected within the 20 year planning horizon through the year 2020. The City of Surprise pipeline is not programmed to be in service until the year 2007.

The project schedules indicated above conflict with the Groundwater Savings Project goal of being in service in the year 2003, making a joint project with either the Agua Fria Division or a joint project with the city of Surprise and the Agua Fria Division neither timely nor cost effective as compared to the alternatives presented in Part D of this report. See Part E for a full comparison of all alternative costs.

8 Conclusion

A joint facility between the Groundwater Savings Project and either the Agua Fria Division or the city of Surprise should not be pursued because the timing of the needs for the Groundwater Savings Project and the Agua Fria Division and city of Surprise do not coincide. Furthermore, a joint facility project is not the least cost alternative for this GSP as is demonstrated in Part E.

PART D – ANALYSIS OF MAJOR ELEMENTS OF THE GROUNDWATER SAVINGS PROJECT

1 Introduction

The Arizona Corporation Commission order, Part B; defines the main purpose of this section of the report, it is to complete a preliminary design and update of the estimated cost including determining "the need for all major elements of its proposed plan (e.g. storage and booster stations)." This section develops the option recommended in the CAP Task Force Study into a concept-level engineering plan by investigating and evaluating the various parameters that will affect the feasibility, constructability, and cost of building the recommended option. Specifically, the elements investigated include:

CAP Trunk Pipeline

The trunk pipeline will carry CAP water into the Sun Cities. This pipeline will convey water from the source at the CAP Hayden-Rhodes Aqueduct to the distribution systems in Sun City and Sun City West. This section discusses the investigations that took place and the various alternatives for routing of the pipeline that have been examined to ensure the most economical and expeditious design. Various criteria are discussed including a cost estimate for each alternative. **Figure D.1** shows the alternate alignments investigated by this study. Concept level plan and profile sheets for each alternate are provided at the end of the section discussing each route.

Pumping Systems

Several of the alternative routes investigated do not have sufficient elevation to produce the pressures required to deliver water to all of the golf course delivery locations by gravity. In this case a booster pump station would be required to provide adequate delivery pressure for these alternatives.

Storage Reservoirs

Storage reservoirs are required if hydraulic calculations revealed an economic advantage in lowering the size of the transmission pipeline (described above) so as to convey less than the average daily flow demand. Storage would then be used to store water during low demand times and use it later when the demand is high. Reservoirs would also be required if system-wide golf course lake volume is insufficient to attenuate the system-wide flows that are suddenly not needed due to factors such as unusually long rain storms or pipe breaks or service down time. Distribution systems such as those proposed for the golf courses in Sun City and Sun City West use large quantities of water and would most likely require reservoir storage rather than tank storage.

Treatment Systems

Water quality differences exist between the groundwater currently being pumped to irrigate the golf courses and CAP water. The possibility of applying some form of treatment to the CAP water prior to its use has been investigated.

Distribution System

A distribution system is required to take the water from the GSP main line to the various delivery points at each golf course. The systems will consist of an arrangement of pipe networks and valves to convey the water to the golf courses in Sun City and Sun City West, sized to fully utilize the water allotment. An existing effluent water distribution system is in place in Sun City West that will be reassigned by its owners as the CAP distribution system within the Sun City West Community. A new distribution system will be constructed to serve the Sun City Area.

Control Systems (SCADA)

With 15 golf courses taking water in two distribution systems at various times throughout a 24-hour period, a very accurate control system must be in place to ensure the total use of the annual CAP allotment going to Sun City and Sun City West. To control the deliveries, a Supervisory Control and Data Acquisition (SCADA) system will be employed. Several possible methods for implementing a SCADA system are discussed.

2 CAP Trunk Pipeline

The Groundwater Savings Project (GSP) CAP main pipeline will be used to convey the CAP water from either the Hayden-Rhodes Aqueduct or the Beardsley Canal to the distribution systems for Sun City and Sun City West. Various alternatives for routing and construction of the pipeline are possible. To ensure the most economical design, several different routes were investigated.

Criteria for Evaluation

The following is a discussion of the criteria used for selecting the best possible route.

Cost

This report presents the conceptual level cost estimates for various parts of the project. Each alternative route was brought to a concept level design (i.e. component size was calculated to meet hydraulic needs and physically laid out on a large scale area map), and the components of the system priced using common methods of cost estimating, including the application of bid tabulations from similar projects in the area and by obtaining price quotes from manufacturer representatives.

Hydraulic Investigations

Preliminary hydraulic calculations determine the size of the various components of the transmission and distribution systems, including pipe size, pumping requirements, storage requirements, and the number, size, and location of various appurtenant equipment such as pressure reducing stations, air release and vacuum relief valves, and other flow control considerations.

Community Disruption

The preparation of concept level plans also allowed for an examination of the community disruption that may occur during construction. Where the alternate routes are in desert areas, little or no disruption is expected. However as the pipeline enters the developed areas of the communities, disruption during construction could be a consideration. Community disruption could include the blocking of residential or business driveways, detours on roads and streets, noise, dust, etc. Public acceptance is preferred and lesser community disruption helps achieve that goal.

CITIZENS
water resources

SUN CITY/SUN CITY WEST/YOUNGTOWN GROUND WATER SAVINGS PROJECT

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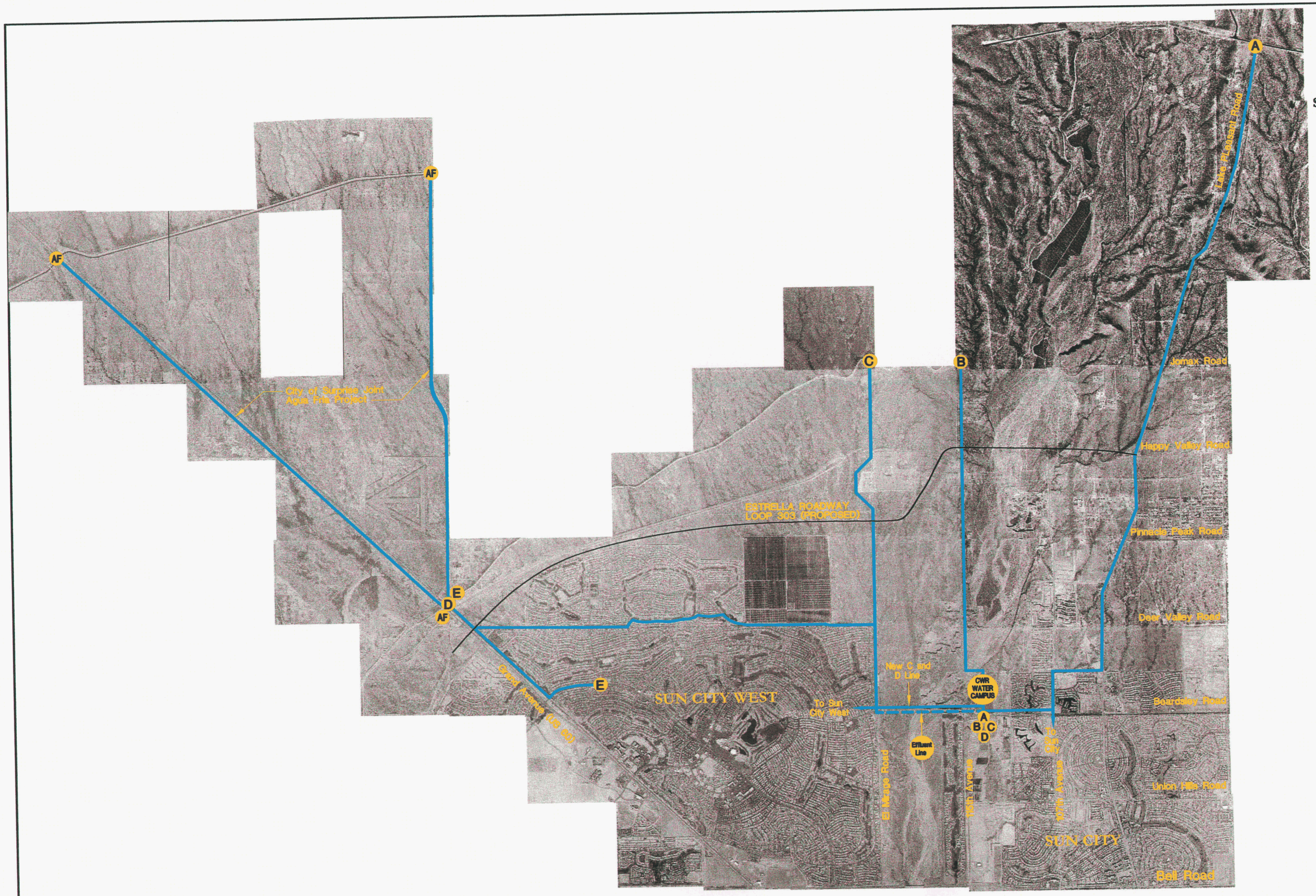


PIPELINE ROUTE SURVEY
ALTERNATIVE ROUTE ANALYSIS

Figure D.1

Easements/Right-of-Way Acquisition

The ownership of existing easements and rights-of-way and the need to acquire new easements and rights-of-way (if available), have a direct impact on both the cost and the construction time of the project. Land ownership along several of the alternative routes includes the Arizona State Land Department. There is a lengthy acquisition process associated with acquiring right-of-way from the ASLD.

Environmental/ Regulatory Considerations

Literature and field reviews to identify threatened and endangered species, cultural and/or archeological sites, and other environmental considerations have been documented to ensure that the various routes examined avoid, or at least minimize, the potential for conflicts during construction.

Any permits that may be required for this project (federal, state, county or other) have been identified, along with costs, associated processing times, and other requirements (such as public notification) to ensure the project will be in regulatory compliance.

While the cost of permits may be minimal, the cost of non-compliance could be enormous considering the time that the project could be delayed if the proper clearances and permits are not in place at the time of construction.

Geotechnical Considerations

Various geotechnical factors affect selection of the pipe material and of appropriate construction techniques. Sampling of in-field soil borings and test-pits, and laboratory analysis of the samples allowed the project geotechnical engineer to provide recommendations for construction techniques and pipe material. Specifically soil conditions affecting pipe-laying operations (such as rock), and corrosion protection measures were investigated.

Operation of Canals and Water Delivery

The CAP, through the Hayden-Rhodes Aqueduct, conveys water from the Colorado River to the GSP. The alternative routes investigated include the possibility of utilizing the Beardsley Canal at various locations along its length to convey the GSP CAP allocation closer to the end users of the water (Sun City and Sun City West golf courses) than does the CAP canal. This shortens the length of the pipe conveyance required. The Beardsley Canal is owned and operated by the Maricopa Water District. The MWD must receive the water allocation from the CAP and then "wheel" the water to the CWR turnout location downstream for distribution to the golf courses. The operation of either or both of the canal systems has a large impact on the operation of the GSP.

Utility Coordination

Several local utility companies have facilities in the area of the trunk line alternative routes. Each existing utility may have an impact on the project. Possible utility conflicts with the proposed alternatives are reported and resolution to the conflicts, either avoidance or re-location, are noted.

Ownership Considerations

The consideration of ownership of some of the components of the various alternatives is a criterion for route selection. This is particularly true of those components that interface with the delivery canals. Complete ownership is preferred, but negotiated operating agreements with the owners of the canals may also be acceptable depending on the cost and conditions of operation.

Common Elements

Many common features are found when evaluating the various alternatives for route locations. Items that are common to all the various alternative routes examined are reported in this section to reduce repetition in the detailed discussion of each alternative route that follows.

Central Arizona Project (CAP) and Maricopa Water District (MWD) Canal Operations Elements

CAP Water Deliveries

The CAP Canal has continuous, year round flows in the Hayden-Rhodes Aqueduct and does not schedule dry-up times for maintenance. The *normal water surface elevation* (NWS) in the CAP is the elevation of the water that the canal carries most of the time. The *control water surface elevation* (CWS) is slightly lower. While the CAP guarantees the CWS for most times, in an emergency the water surface may drop below the CWS. Customers affected are notified as soon as possible regarding such occurrences.

CAP water users with individual turnouts are allowed two (2) flow rate adjustments per 24 hours, which must be prearranged with the CAP by 9:00 a.m. the previous day. This allows CAP operators to manage the water balance in the CAP canal on a day to day basis.

For annual order estimates, the CAP has a peak averting measure called the "eleven percent rule," applied when the peak flows predicted by annual water orders exceed the ability of CAP to deliver those flows. The rule permits CAP to limit a subcontractors monthly order (not its allocation) to 11% of their annual allocation, thereby easing canal operations during high-use periods. In such a case, CAP notifies M&I customers, which include this project, of the invocation of the rule. Customers may then revise their forecast for water accordingly. Flow changes are implemented only after customer notification. While this rule has yet to be invoked, it remains a tool for CAP Canal management. Peak GSP flows are predicted during the months of May through October. These months could be affected by the 11% rule if it is invoked.

Other measures which could be invoked by the CAP during high demand periods include cutting daily water orders on peak demand days to meet as much demand as possible for all customers. In these cases however, Native American Community and M&I water allocations have the highest priority. Since CWR has water considered as M&I use they would have the highest priority and as with the 11% rule, flow changes would be implemented only after notification.

MWD Water Wheeling Policy

MWD does not presently "wheel water" for none-district members but has recently published a "Policy For Wheeling Non-District Water" enabling it to respond to possible requests such as this GSP to convey "non-district" waters to locations along the Beardsley Canal. This policy would apply to all water carried for the GSP, Routes B, C, D, and E. Because MWD does not currently wheel any non-district water, the policy has not been tested. The policy is located in the **Common Elements** section as side bar text.

The alternatives associated with the Beardsley Canal and MWD will carry additional costs as a result of the water wheeling policy. Anticipated costs could include those costs for system improvements in the Beardsley Canal necessary for wheeling non-district water, wheeling fees on a per-acre-foot basis, and shared costs for overall system improvements within the MWD system. Because MWD is still developing the accounting of the policy, no fees have been established.

The costs for system improvements to accommodate water delivery for the alternatives are particular to the alternative and are discussed in the corresponding section.

It should be noted that the **Draft Report "Beardsley Canal Capacity Study,"** dated September 10, 1999, states that "No capital improvements will be required to deliver an additional 50,000 acre-feet per year...at Cactus Road." The district board discussed the per-acre-foot costs and district management suggested that the fee for the per-acre-foot wheeling of the water might be approximately $20 to $30. For the purposes of this study, a $25 amount will be used. Costs for future system-wide improvements to the Beardsley Canal to be constructed by MWD will be based on all the current customers and the amount of delivery each receives. These costs will be minimal for the GSP due to the relatively small amount of water conveyed and are not covered in this study.

There are other impacts associated with using the system owned and operated by MWD. Some of the more significant are listed below:

- MWD historically dries up the canal when water orders drop below 35 cfs and does not reactivate the canal until water is required again. This dry up typically begins around the end of October and lasts until the end of February or beginning of March. Because the peak order for the GSP is less than 35 cfs and does not come during the dry up, the GSP alone will not provide sufficient flow to keep the Beardsley Canal flowing during the during the dry up period. MWD has indicated that the annual dry up period may be eliminated in the future in order to facilitate water wheeling.

  Since the Beardsley Canal will not convey water during four months of the year, the GSP will have to use all of its allotment in eight months instead of twelve. This scenario would require an increased trunk pipe size and an increase in the size of pumps at the booster pump station required for all of the Beardsley Canal alternates, above that which was estimated in this study. This enlarged system would then be inactive for four months of the year. **This effectively eliminates these alternates as long as the MWD continues to undergo an annual dry-up in the Beardsley Canal.**

- MWD requires advance water orders and allows only minimal changes. CAP also has similar requirements for ordering water. MWD will receive all orders for CAP water being wheeled and the make the order to CAP. CWR would contact MWD instead of CAP. Estimated annual orders are required for water balancing and planning by the MWD and the CAP.

- Water losses in the Beardsley Canal, currently estimated at 0.5% per mile, are the result of evaporation and infiltration in areas of earthlined channel. At 0.5% per mile, as much as 123 acre-feet of the total GSP allotment would be lost in transmission through the MWD facilities and would not be available to replace groundwater.

- There is no discussion in the policy regarding the term length for a wheeling agreement. Because of the possibility of wheeling price increases each time the board meets and discusses contract renewal, a longer term for the wheeling of GSP water would be better. This is particularly important in this case because the GSP must pay for improvements to the canal in order to take delivery of wheeled water. The canal improvement costs would be better realized if they are amortized over a greater length of time. It is reasonable to assume that for the purposes of this study the water wheeling rates will increase at, at least, the rate of inflation.

MWD Review of Design Plans

The MWD engineer will coordinate the review of construction design plans for the connection to the Beardsley Canal. MWD requires approximately 30 days for the review of each plan set, with the cost of these reviews applied to the project.

MWD Easement Requirements and Right-of-Way

Right-of-way agreements and temporary construction easements are necessary prior to construction and would be negotiated with the MWD administrative manager.

Final plans and insurance documents must be reviewed by MWD before granting a "Construction Period Land Use License." MWD has been informed of the concept of the GSP.

MWD Tie-In Process

Tie-in to the Beardsley Canal must take place during the November to March dry-up period to facilitate construction of the tie-in and water distribution operations of the canal. Following its final review of the tie-in, MWD will license the project to begin operation. MWD representatives will be on site during construction for oversight and coordination.

MWD Turnout Construction

The existing Beardsley Canal is a shotcrete-lined channel. A new turnout will include a screen or grate placed flush with the channel lining in addition to a manual gate at the beginning of the pipe. The turnout pipe and gate diameter will be sized to match the trunk pipeline, which will pass through the meter box or manhole constructed behind the canal. This will be the revenue meter for MWD, connecting to an MCU that records measurements from the flowmeter and transmits the information to MWD and CWR.

No established CWS exists because the new turnout would be located where no other turnouts exist. Construction of a check structure similar to the one near Grand Avenue in the Beardsley Canal will be necessary to provide a CWS. The check structure design will incorporate two radial gates with electric actuators, which will require automated control to allow for flow changes to keep the CWS as constant as possible. Overflow weirs allowing the passage of the maximum canal flow might also be a design requirement. This structure will be constructed in the vicinity of the CWR turnout and be connected to the same MCU for supervisory command and control.

Large gates with electric actuators typically require three-phase power. There is currently no power at the possible sites of this new turnout and, because this type of electrical power is not close by, it will have to be brought to the site by Arizona Public Service (APS).

The entire turnout and check structure will be constructed on MWD right-of-way. The canal at the location under consideration has no fencing. Protection from vandalism must be a consideration in the design of the meter box area. Access would be provided to CWR.

All newly constructed improvements within MWD right-of-way will become property of MWD. MWD is responsible for operation and maintenance, including cleaning the grate at the inlet and maintaining the telemetry and measurement systems provided for the control of their system. MWD would provide necessary access to the meter box area for CWR. CWR would be required to provide the telemetry to send the flow monitoring signal to the site it chooses.

MWD Operations

As previously discussed MWD dries up the Beardsley Canal when flow drops below 35 cfs. Maintenance and/or construction is typically carried out during this annual dry-up. At other times, the water surface

MARICOPA WATER DISTRICT
POLICY FOR WHEELING NON-DISTRICT WATER

BACKGROUND AND INTRODUCTION

Maricopa Water District (MWD) recognizes that west Salt River Valley entities will require additional renewable water supplies in order to meet their water demands now and in the future. MWD has determined that the Beardsley Canal has capacity available to convey (wheel) non-District water to entities in the west Salt River Valley. MWD wishes to assist west Salt River Valley users by providing the use of the Beardsley Canal to encourage efficient regional water management practices. MWD has developed the following policy statement and wheeling principles to govern wheeling agreements.

POLICY STATEMENT

MWD finds that it is in the best interest of the District and other west Salt River Valley water users to develop arrangements to use the Beardsley Canal to convey non-District water to west Salt River Valley entities who will benefit from such conveyance. It is the policy of MWD to:

1) Develop partnership agreements with west Salt River Valley entities to use the Beardsley Canal to improve regional water resource management through wheeling non-District water through the Beardsley Canal.
2) Provide benefits to District members from wheeling partnerships by increasing the use of available canal capacity and sharing operational costs with wheeling partners.
3) Provide an economical alternative for conveyance of CAP water to west Salt River Valley entities.

WHEELING PRINCIPLES

1. MWD may provide capacity in the Beardsley Canal for the conveyance and delivery of non-District water to the extent that capacity is available in the Beardsley Canal so that District water is not displaced nor District deliveries impaired by wheeling.

2. MWD will make reasonable efforts to deliver wheeled water but will not guarantee wheeling deliveries. Spills or loss of wheeled water will not be replaced by MWD.

3. MWD will own, operate, and maintain all conveyance and delivery facilities within the Beardsley Canal right-of-way.

4. MWD will recover all costs incurred by the District associated with system improvements necessary for wheeling. System improvements include but are not limited to turnouts, gates, meters, and controls. Recovery of costs for such improvements will be in addition to wheeling fees charged by the District. If later wheeling partners accrue benefits from these system improvements, the wheeling entity may recover some portion of the system improvement costs pursuant to provisions and conditions in a wheeling agreement.

5. MWD will be responsible for design (or approval of design pursuant to provisions and conditions in a wheeling agreement), construction (or inspection and approval of construction pursuant to provisions and conditions in a wheeling agreement), and operation and maintenance of any system improvements necessary for wheeling.

6. Wheeling fees will be charged per acre-foot of wheeled water exclusive of delivery location. An annual administrative fee will be assessed for each wheeling delivery point. The wheeling fee and annual administrative fee will be adjusted annually based on an appropriate inflation factor.

7. Wheeling fees may vary to reflect specific conditions of delivery and use including but not limited to the following (subject to wheeling agreement provisions):

   a) Commitment to wheel water on a non-interruptible (firm) basis, other than emergency outages;
   b) Commitment to provide higher than normal peaking factors;
   c) Long-term contracts; and
   d) Wheeling for use on non-District lands.

8. Additional costs may be incurred by the District or overall system improvements. Wheeling partners will share in the cost of system improvements based on their pro-rata use of MWD system deliveries or on a case-by-case basis, as appropriate.

9. Canal losses will be shared proportionately between District and non-District water. At present, losses are estimated at 0.5 percent per mile of conveyance per month. As improvements are made to the Beardsley Canal, the loss factor may be adjusted as appropriate.

10. The quality of non-District water wheeled through the Beardsley Canal should be consistent with the general water quality of District water and Central Arizona Project water, subject to approval by MWD.

11. MWD will not enter into agreements that would trigger District compliance with Reclamation Reform Act provisions.

12. MWD and its wheeling partners shall establish contract renewal terms and conditions for reopening, such as significant canal improvements or destruction, significant changes in law or environmental regulations, or changes in technology.

MWD WHEELING POLICY 09/14/9[illegible]

may be lowered below the control water surface for repair or maintenance activities. Customers affected by this situation are notified and difficulties resolved as far in advance as possible.

MWD customers are allowed one flow change per 24 hours, communicated to the MWD office by 12:00 p.m. the previous day.

Because MWD is merely "wheeling" CAP water, a layer of bureaucracy is added to the water orders. This is mitigated somewhat because the GSP turnout would be located in the very upstream reaches of the Beardsley Canal and because the flows demanded by GSP would be a small part of the canal's total flow. Thus flow changes by the GSP minimally impact the much larger Beardsley Canal and more than one adjustment per day might be tolerated.

The CAP's "eleven percent rule" (described above) would still apply to GSP even though the water is delivered through the Beardsley Canal.

Right-of Way Elements

Right-of-Way route and requirements for the various alignments has been evaluated. An overview of the ROW is discussed in the following paragraphs.

It is estimated that land values in the proposed project area will range from $0.25 per to $1.00 per square foot. This range is established by such factors as parcel size, zoning, land usage, and ownership of a particular parcel.

Since calculations indicate that a 24" diameter trunk pipeline will be required, a utility easement of 20 feet was selected to help establish costs estimates for the pipelines.

The costs of the utility easement can range from one half of the purchase value to the full purchase value of the land. Each alternative route crosses several individual parcels that will require easements. Each parcel requires a separate appraisal.

Further information on parcels and Right-of Way ownership is found in Appendix G.

Environmental Elements

This overview of environmental considerations summarizes the preliminary requirements that must be addressed during the final design phase. Specifically the project should evaluate cultural, biological, hazardous materials, socioeconomic impacts as well as impacts to the waters of the U.S. The considerations will be the same for each alternative proposed.

During project planning and conceptual design, consideration was given to the requirements of the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), the Migratory Bird Treaty, the Native Plant Law, the Clean Water Act (CWA), the Clean Air Act (CAA), Resource Conservation Recovery Act (RCRA), and the National Historic Preservation Act. This section details the environmental components that apply to the proposed project and its alternatives. Depending on the scope and impact of the project, the following regulatory acts may be addressed in varying degrees in order to comply with environmental issues.

Biological Evaluation

In coordination with the U.S. Fish and Wildlife Service and the Arizona Game and Fish Department, biological resources within the project area, including vegetation communities, aquatic resources, and habitat, have been documented for all alternatives. Based on habitat requirements and natural features in the project area, the project's effect on federally listed plants and animal species and their habitats will be determined. A Biological Evaluation (BE) summarizing the findings of the field work described above will be prepared.

Native Plants

The Arizona Department of Agriculture (ADA) must be contacted prior to the start of construction regarding intended destruction and/or salvage of native plants occurring within the project area. The Department must be contacted at least 20 days before plants are destroyed over an area less than one acre, 30 days before for an area less than 40 acres, and 60 days before for over an area of 40 acres or more. The notification allows authorized companies to salvage and relocate native plants.

Air Quality

Deterioration of air quality may be expected during construction due to the operation of construction equipment, but this will be a localized condition and will discontinue when the project is completed. Fugitive dust generated during construction must be controlled in accordance with Maricopa County Rule 310, Open Fugitive Dust Sources, which requires the preparation and submission of an earth-moving permit and a fugitive dust control plan for the construction site.

Jurisdictional Waters of the U.S.

A preliminary jurisdictional delineation will be performed for the selected alternative to determine if jurisdictional waters of the U.S.,

which include ephemeral drainage channels found throughout the proposed project areas, will be impacted by the project. A Pre-construction Notification (PCN) will be prepared at the same time. If the delineation shows that waters of the United States (i.e., natural drainage channels such as the Agua Fria River) are impacted by the proposed project, a CWA Section 404 Permit will be required from the U.S. Army Corps of Engineers. It should be noted that, on a state level, a Section 401 State Water Quality Certification Permit from the Arizona Department of Environmental Quality (ADEQ) is necessary prior to the 404 Permit. Section 401 requires the review of any federal permits, actions, and approvals that may result in a discharge to waters of the state to ensure compliance with state water quality standards. It should be further noted that the 404 Permit to the U.S. Army Corps of Engineers and Section 401 Certification for the ADEQ could be submitted concurrently.

A Section 402 permit, National Pollution Discharge Elimination System (NPDES), issued from the U.S. Environmental Protection Agency (EPA) is necessary if the project involves grading or disturbing five or more acres of land. NPDES is designed to improve water quality by establishing a permit system to reduce erosion potential, minimize sedimentation, and eliminate non-stormwater discharges from construction sites.

Hazardous Materials

A preliminary site investigation assessment will be performed during the design phase of this project on the selected trunk pipeline. This will involve a data search of the federal, state, and local environmental lists and databases for the alignment selected and the typical search radius of one mile to half-a-mile to determine if regulatory sites are within the project area. A document will be prepared summarizing any regulatory sites including, the site description and location, type of regulated substance or waste at the site, extent of contamination, the status of the site, the responsible party and the potential impacts to the project. Should the preliminary investigation indicate the need for further investigation, a Phase I/II environmental site assessment would be required to evaluate the potential problems for the project.

Cultural Resources

This project will require involvement with the Bureau of Reclamation (BOR) for Alignment A and the Army Corps of Engineers for Alignments B and C, and therefore will be considered an undertaking subject to review under Section 106 of the National Historic Preservation Act (NHPA).

A literature search of previous archaeological projects and recorded sites within and adjacent to the project area has been completed (see Appendix J). All three alignments have been partially surveyed. Alternative C has the best coverage and will require the least additional survey, whereas Alternative A contains the least amount of surveyed land. Alternative C has two previously identified sites situated immediately adjacent to the project area but none directly within the proposed alignment. Alternatives A and B both contain sites directly within the path of the proposed pipeline easement that will require some type of mitigation.

The remaining un-surveyed portions of the alignments will need to be assessed. In addition, portions with previously identified sites within or immediately adjacent to the project area will need to be reassessed so that the site boundaries can be accurately reestablished. Given the proximity of the project area to the Aqua Fria River, a major water corridor used extensively both prehistorically and historically, there is a high probability of encountering archaeological sites throughout the project area. It is therefore likely that the remaining areas to be surveyed will yield additional sites.

Regulatory Considerations

The following is a summary of regulatory considerations and applicable permits that are likely to be required for each alternative. Contact names are included; further information may be obtained from these contacts when a final design and alternative is selected.

Maricopa Water District
Contact: Mr. Jim Sweeney - (623) 546-8266

Central Arizona Water Conservation District
Contact: Ms. Jodie Gould - (623) 869-2333

The MWD and the Central Arizona Water Conservation District (CAWCD) were contacted to obtain information regarding regulatory issues that may require resolution if water is transferred from either the CAP Canal or Beardsley Canal. MWD and CAWCD have jurisdiction over the Beardsley Canal and CAP Canal, respectively. Regulatory agreements that address water transfers from the CAP Canal are currently in place. At the present time, Citizens Water Resources will not need to address environmental issues for the transfer of water from the Beardsley Canal (MWD per. comm. to HDR, 2000). Water transfers from the CAP Canal will require that the environmental clearances are in place and/or updated (see following).

Environmental Assessment

U.S. Bureau of Reclamation
Contact: (602) 216-3863

Environmental considerations would expand if the project falls under federal jurisdiction such as the U.S. Army Corps of Engineers or U.S. Bureau of Reclamation becoming involved in the proposed project. The Bureau of Reclamation currently has federal authority over the CAP Canal and, because the Bureau of Reclamation will be associated with the project, all CAP contracts require NEPA compliance.

An Environmental Assessment (EA) was prepared by the Bureau of Reclamation for activities involving the CAP Canal. The Bureau of Reclamation can, however, request that an update be prepared in the event that Alternative A is selected and significant impacts are associated with the project. If Alternative A is selected, the Bureau of Reclamation will be contacted during the design phase for consultation. Because Alternatives B,C, and D do not involve the CAP canal, the same process will not be necessary.

Section 404 Permit
U.S. Army Corps of Engineers
Contact: Ms. Sally MacGuire - (602) 640-5385

The applicant must notify the U.S. Army Corps of Engineers if the proposed project will impact more than one-tenth of an acre of U.S. jurisdictional waters. In addition, if the proposed activity impacts less than one-tenth acre but occurs in jurisdictional waters found within a 100-year floodplain, a PCN must be submitted to the U.S. Army Corps of Engineers. The type of Section 404 Permit (Nationwide or Individual) required for this project will depend on the amount of disturbance resulting from construction activities within waters of the U.S. A 404 permit will not be needed at all if (1) construction activities take place in jurisdictional waters that are only temporarily impacted and later brought back to their natural grade with no impact to water flow and (2) that work does not take place within a 100-year floodplain. An Individual 404 Permit will be required if the impacted area exceeds one-half acre.

Section 401 Permit
Arizona Department of Environmental Quality
Contact: Ms. Theresa Pella - (602) 207-4480

Section 401 Water Quality Certification (401 Certification) is mandatory for any activity requiring a Nationwide Section 404 Permit and prior to discharging any dredged or fill material into waters of the U.S. In Arizona, the ADEQ grants 401 Certification to all projects that comply with the terms and conditions of a Section 404 Nationwide permit.

Section 402 Permit
U.S. Environmental Protection Agency
Contact: EPA Region IX (San Francisco) - (415) 744-1906

An NPDES Permit is mandatory if five or more acres will be graded or disturbed. A Notice of Intent (NOI) form must be completed by the owner/operator and submitted to EPA at least 48 hours prior to construction. Copies of the form must also be sent to the ADEQ. A Storm Water Pollution Prevention Plan (SWPP) must be prepared prior to the NOI submittal and kept on site. It is not submitted to the EPA or ADEQ unless requested. A Notice of Termination must be sent to EPA and ADEQ by the permittee when the project is complete.

Earth Moving Permit
Maricopa County Environmental Services, Air Quality
Contact: (602) 506-6700

An Earth Moving Permit will be required from the Maricopa County Control Officer if more than one-tenth of an acre of ground disturbance takes place. Pursuant to Maricopa County Rule 310, a dust control plan must be submitted with the permit application, typically applied for by the construction contractor during the pre-construction phase.

Notice of Intent to Clear Land
Arizona Department of Agriculture
Contact: Mr. Jim McGinnis (602) 542-3292

The Arizona Native Plant Law categorizes protected plants as Highly Safeguarded and Salvage Restricted. Destruction of Highly Safeguarded plants is subject to review by the ADA. It is unlawful to collect, transport, transplant, or kill protected native plants without a permit or without following specific regulatory procedures. Such regulation also applies to protected plants on private lands. The law does not prevent the destruction of protected plants on private lands as long as (1) the plants are not transported from the land or offered for sale and (2) the landowner notifies the ADA of the intended destruction. The ADA must be contacted at least 60 days before construction and a plant survey must be performed before construction. Destruction of protected native plants may not begin until a confirmation has been received from the ADA.

State Historic Preservation Office
Contact: (602) 542-4174

Cultural resources work must be completed in accordance with guidelines provided under the National Historic Preservation Act and through coordination with the State Historic Preservation Office (SHPO) regulations. The SHPO should be contacted for concurrence after a final cultural resources literature search and survey takes place. The SHPO concurrence is issued when the state agency agrees with the survey findings that no eligible sites or cultural resources are affected. The SHPO office could also determine if a testing phase would be necessary.

Environmental Costs and Timeline

Costs for permits are nominal, with costs associated with permits totaling $36.00. At a minimum, a cultural resource survey, biological survey, and hazardous materials report will be required for any of the pipeline alternatives. Applications and documentation associated with environmental clearances will be based on two survey documents and the fees associated with preparation of a 404 Nationwide or Individual application. Following are estimated costs for survey and documents that may be necessary during the environmental clearance process for this project.

Biological Estimate

A biological survey will be conducted and a report prepared indicating the vegetation type and wildlife in the area. Coordination with the Arizona Game and Fish for a listing of special status species and a review of Threatened and Endangered species occurring within Maricopa County will be evaluated for impacts to habitat and sensitive species. The cost of preparing this report is estimated at between **$2,700** and **$4,000**. A Biological Assessment is estimated to take 45 days from notification to proceed. Should native vegetation be impacted, the Arizona Department of Agriculture must be notified by the lead agency 60 days prior to construction.

This estimate does not include costs for species specific surveys necessary if threatened and endangered species are involved, consultation with the U.S. Fish and Wildlife Service, the inventory of native plants, the salvage of native plants, or for mitigation plans where necessary.

Cultural Estimate

A Class III cultural resources survey and Section 106 consultation with SHPO will be required for any of the alignments selected because of the high probability of encountering historical sites. Depending on the size of the area to be surveyed, along with the high probability of encountering sites, the estimated cost for the cultural survey will be between **$8,700** and **$11,500**. Upon notification to proceed the cultural resources survey report will be expected within 120 days and completion of the SHPO consultations will be expected within 180 days. If eligibility testing or data recovery excavations are required, months could be added to the project.

Hazardous Materials Report

The hazardous materials report for the preliminary site investigation assessment (PISA) consists of searching regulatory lists and databases. A general field observation of the project area identifying general land use, confirming the database information, and noting any storage areas or drums of materials or unusual soil staining would be noted. The PISA estimate would be between **$2,000** and **$2,750**. Should a Phase I Environmental Site Assessment be recommended it is anticipated that this would cost between **$2,500** and **$4,500** or higher should sampling and laboratory analysis be necessary.

404 Permit or PCN

An estimated cost of **$5,500.00** to **$6,200.00** is expected if either a 404 Nationwide Permit application or Pre-Construction Notice (PCN) is necessary. This includes the cost for the 401 Certificate, obtained from the ADEQ, assuming that there is no pre-application meeting with the U.S. Army Corps of Engineers, no mitigation measures are necessary, and no special aquatic resources are present. An authorization letter from the U.S. Army Corps of Engineers will be expected within three to six months from the time a delineation is conducted, with the understanding that the 60% design plans are completed and the area of impact can be determined.

If an individual 404 Permit is necessary, costs range from **$13,000.00** to **$16,000.00**, with a nine-month to one-year schedule extension before authorization is issued. As the scope of the project now stands an Individual 404 Permit is not anticipated.

National Environmental Protection Act (NEPA) Document

The NEPA document carries the greatest cost range due to the number of variables involved (Federal Agency, scoping process, public involvement, EA or Categorical Exclusion, length of process, number of stakeholders, issues, and impacts). Costs for a Categorical Exclusion are estimated at **$1,750.00** to **$2,500.00.** Depending on the number of issues and potential impacts to the environment, an EA can cost **$20,000** or more and take 9 to 15 months to complete.

Geotechnical Considerations

This section presents the results of a preliminary geotechnical exploration of pipeline route alternatives for the GSP.

The field exploration program consisted of obtaining public utility clearances, obtaining permits for exploration in road right-of-ways, site reconnaissance by a field engineer, excavating and sampling 17 test pits with a rubber-tired backhoe, and performing field resistivity tests near the test pit locations. The test pits were excavated outside of the roadway and advanced to a depth of 10 feet or practical refusal, whichever occurred first, then backfilled with excavated soils upon completion. The field engineer logged the test pits, obtained grab samples of soils encountered for review by other project team members, and performed the field resistivity tests. There were seven test pits along Alternative A, four test pits along Alternative B, and six test pits along Alternative C. The approximate location of each test pit is shown on a map in Appendix H. Alternatives D and E occur in previously suburban development areas, therefore no geotechnical investigation was conducted along these routes since typical developed right-of-way construction conditions and techniques can be anticipated.

Site Characterization

Information regarding topography, geology, and surface and near-surface soil conditions is presented in this section. The preliminary information presented here is based on cursory reconnaissance along each route, U.S. Geological (USGS) surveys, shallow test pits along the alternative routes, and U.S. Soil Conservation Service (SCS) soil surveys.

Topography

Cursory reconnaissance indicated that most of the land along each route is undeveloped and in native condition. In developed areas, land usage includes agricultural, commercial, industrial, and residential, with residential usage denser in the southern and eastern parts of the alternative routes.

The USGS Calderwood Butte and Baldy Mountain Quadrangles indicate that drainage in the area bounded by the alternative routes is generally southward, following the Agua Fria River. Elevations at the ends of the routes are – 1,200 feet at the Sun City WWTP, 1,500 feet at the north end of Alternative A, 1,350 feet at the north end of Alternative B, and 1,340 at the north end of Alternative C. Surface grades along the routes were generally less than 1%, although surface grades in the north part of Alternative B were closer to 3%. Each route crosses several washes and, in addition, Alternative A crosses the Marinette Heading Canal, and Alternatives B and C cross the Agua Fria River.

Test Pit and Laboratory Summary

A summary of observations for each alternative is presented in this section. More detailed logs of test pit findings are in Appendix H.

Along Alternative A, sandy lean clays (CL) were the predominant soils to the full depth of exploration. Clayey sands with gravel (SC) were encountered in Test Pits A1, A3, and A4 below depths of 5, 6, and 1 feet, respectively. Practical backhoe refusal was encountered in Test Pits A4 through A7 at depths of 3, 7, 2, and 3 feet, respectively. Heavy calcareous cementation was encountered in each of the test pits, generally about 2 feet below the surface, but the depth to heavy cementation varied from less than 1 foot to 5 feet. Field resistivities at a depth of 10 feet ranged from 9,000 to 57,000 ohms/cm.

Along Alternative B, clayey sands with varying gravel and cobble percentages were the predominant surface and near-surface soils. Sandy lean clay was encountered at the surface in Test Pit B1. In and along the Agua Fria River (Test Pits B1 through B3), well-graded sands and gravels with cobbles (SW and GW) were encountered below depths of 3 to 5 feet. In Test Pit B4, heavy calcareous cementation was encountered at a depth of 3 feet and practical refusal was encountered at a depth of 5 feet. Field resistivities at a depth of 10 feet ranged from 30,000 to 42,000 ohms/cm.

Along Alternative C, interbedded sandy lean clays and clayey sands with varying gravel and cobble percentages were the predominant soils to the full depth of exploration. Silty sands with gravel (SM) were encountered in Test Pits C5 and C6 below a depth of 3 feet. Practical backhoe refusal was encountered in Test Pits C2, C3, C4, and C6, all at a depth of 5 feet. Heavy calcareous cementation was encountered in each of the Test Pits C2 through C6 at depths of 2 to 3 feet. Field resistivities at a depth of 10 feet ranged from 9,000 to 36,000 ohms/cm.

Geotechnical Summary

Most of the land along each alternative is undeveloped and in native condition. In developed areas, land usage include agricultural, commercial, industrial, and residential, with residential usage denser in the southern and eastern parts of the area bounded by the routes. Drainage in the area is generally southward, following the Agua Fria River, with elevation range from 1,200 to 1,500. Surface grades along the routes ranged from less than 1% to about 3%. Each Alternative crosses several washes and, in addition, Alternative A crosses the Marinette Heading Canal, and Alternatives B and C cross the Agua Fria River.

The routes are in valley materials between the mountains above bedrock and consist of late Tertiary and Quaternary soil deposits, and the primary landforms in the area bounded by the routes are valley fill, alluvial fans, and alluvium.

Other than in and along the Agua Fria River, clayey sands and sandy lean clays were the predominant soils encountered. Heavy calcareous cementation was encountered in these soils from depths of less than 1 foot to 5 feet, and practical backhoe refusal was encountered in 9 of the 14 test pits in these soils at depths of 2 to 7 feet. In and along the Agua Fria River, uncemented to lightly cemented, well-graded sands and gravels with cobbles were encountered below depths of 3 to 5 feet. The largest particle size observed in and along the Agua Fria River was on the order of 12 inches. Field resistivities along the alternative routes near pipeline invert depth ranged from 9,000 to 57,000 ohms/cm, indicating low corrosion potential.

Low moisture contents and heavy cementation are suspected to have contributed to the high field resistivity measurements. Laboratory measurements of minimum resistivity are likely to be significantly lower than the field measurements and more representative of conditions to which the pipeline will be subjected. Accordingly, SCS

estimates of corrosive potential are considered more suitable for the alternative evaluation process.

Mapped soils in the study area vary from fat clays (CH) to well-graded gravels with silt (GW-GM). In reference to natural and compacted permeability, reported characteristics agree with geotechnical theory: granular and non-plastic soils have moderate to high permeabilities, and fine-grained and plastic soils have moderate to low permeabilities.

Agreement with geotechnical theory was also reported with respect to compacted shear strength and susceptibility to piping: granular and well-graded soils have higher shear strengths than fine-grained and poorly graded soils, and fine-grained soils are commonly susceptible to piping. Natural erosion risk was slight for most soils, but increased to moderate for some soils because of slope. The risk of corrosion for uncoated steel ranged from low to high and was high in 12 of the 15 soil series mapped along the routes. The risk of corrosion for concrete ranged from low to moderate and was low for 10 of the 15 soil series mapped along the routes. Corrosion estimates were not provided for two soil series because of their variability. Calcareous soils, cobbly soils, and hardpan were also reported in some soil series.

Geotechnical Conclusions

Based on our project understanding, excavation conditions and corrosivity are the primary geotechnical factors of concern for evaluation of the three alternatives. Preliminary exploration data indicate that soil conditions along the alternative routes can be placed in two general groups – (1) those not related to the Agua Fria River, which include most of Alternatives A and C and the northern portion of Alternative B, and (2) those near and in the Agua Fria River, which include most of Alternative B.

In the first group, soils with calcareous cementation and high corrosion risk soils will commonly be encountered. Calcareous cementation is expected to cause difficult excavation conditions that will require heavy or specialized equipment for excavation. To a large extent, soils in this group will have an OSHA classification of "Type A," for which OSHA provides a maximum allowable slope of ¾:1 (53°) for excavations less than 20 feet deep.

In the second group, cohesionless soils, soils with cobbles and boulders, and soils with low to moderate corrosion will commonly be encountered. Excavation conditions are not anticipated to be as difficult in uncemented and lightly cemented, cohesionless soils and soils with cobbles and boulders; however, sloughing and less stable slopes are anticipated. To a large extent, soils in this group will have an OSHA classification of "Type C," for which OSHA provides a maximum allowable slope of 1½:1 (34°) for excavations less than 20 feet deep.

Utility Coordination

Local utility companies were contacted regarding existing facilities within or adjacent to the pipeline corridors for the considered alternatives. Utility maps were obtained from each company to verify and document the location of existing facilities and determine if any conflicts or issues were present. All existing facilities will be shown on the final construction plans, based on the best available information from the utility companies and additional sources. Exact location and depth of utility facilities must be verified in the field prior to any construction.

Maricopa Water District

The Maricopa Water District has identified the project site as either outside their service area or does not provide irrigation service within the project site.

Salt River Project Water Division

SRP water division does not provide irrigation service within the project site.

Salt River Project Electric Division

SRP water division does not provide irrigation service within the project site or no conflicts were identified.

US West Communications

US West maps for telephone service facilities were evaluated. The following areas were identified as possible conflicts. These will preferably be protected or otherwise replaced.

Alternative A: This alternative crosses US West Communication facilities in four locations. Telephone lines run parallel to the proposed alignment for the major part of the stretch until reaching Sta. 193+00 just north Jomax Road. The telephone lines cross again at approximately Sta. 207+00 and head east on Happy Valley Road. Two other conflicts occur at the intersections of Lake Pleasant Road with Pinnacle Peak Road and Deer Valley Road.

Alternatives B and C: No conflicts are present.

Alternative D: Existing telephone lines cross the proposed alignment at three locations. US West facilities adjacent to Grand Avenue cross alternative D at approximately Sta. 26+50. In addition, Sta. 143+20 and 179+00 were identified as conflicts.

Alternative E: Existing telephone lines parallel to Grand Avenue cross this alternative at one location (approximately Sta. 26+50).

Southwest Gas

Southwest Gas provided maps of their facilities within the project site. The following items were found to be in conflict with the considered alternatives.

Alternatives A, B, C, and E: No conflicts are present.

Alternative D: A Southwest Gas facility crosses this proposed alignment at one location (approximately Sta. 180+00). This 4-inch line runs along Deer Valley Road and measures for protection of this line will be taken during the design process if alternative D is selected

El Paso Natural Gas

El Paso Natural Gas was contacted to obtain the location of existing gas lines within the project site. The following El Paso Natural Gas facilities appear to present conflicts with the considered alternatives. Note that the following items will preferably be protected or otherwise replaced.

Alternative A: The proposed alignment for alternative A crosses a 20-inch El Paso Natural Gas line (running from San Juan line to Phoenix area) at two locations (approximately Stations135+00 and 362+00). This is the only alternative that presents a conflict with El Paso Natural Gas facilities.

Alternatives B, C, D, and E: No conflicts are present.

Cox Communications

Maps of cable TV facilities provided by Cox Communications were evaluated. The following facilities were found to conflict with the proposed alternatives. These will preferably be protected or replaced.

Alternative A: The alignment for alternative A crosses an underground fiber optic line at approximately Sta. 420+00. Due to the nature of this line, it will be protected during the design of the pipeline if alternative A is selected.

Alternatives B, C, D, and E: No conflicts are present.

Arizona Public Service

APS existing facilities were evaluated from utility maps provided by their company. APS facilities in conflict with the proposed alternatives are as follows. Note that these facilities will preferably be protected or otherwise replaced.

Alternative A: APS facilities present a conflict with this alternative at one location (approximately Sta. 420+00). This is an electric line and standard measures will be taken to protect it.

Alternatives B and C: No conflicts are present.

Alternative D: The proposed alignment for this alternative presents conflict with APS facilities at two locations. One line runs along 115th Avenue at approximately Sta. 99+00 and the other is located at Deer Valley Road at approximately Sta. 180+00.

Alternate A – Lake Pleasant Road Route

The Lake Pleasant Road pipeline route begins at an existing CAP Canal turnout located approximately 8 miles north-northeast of Sun City. The pipeline route then follows Lake Pleasant Road southerly to Rose Garden Lane where it turns west for 0.5 miles to approximately 107th Avenue. The pipeline then turns south and extends to Beardsley Road alignment. From here the trunk line ends and the division of Sun City and Sun City West allocation is split. Sun City distribution system continuing south on 107th and the Sun City West pipeline turning west and connecting to the 20" effluent pipeline near the water campus. The alignment will be mostly contained within public right-of-way either Maricopa County or City of Peoria. The City of Peoria is currently planning to obtain new right-of-way along the Lake Pleasant Road from the ASLD. Route A alignment would likely be within Peoria's new right-of-way at the time of construction.

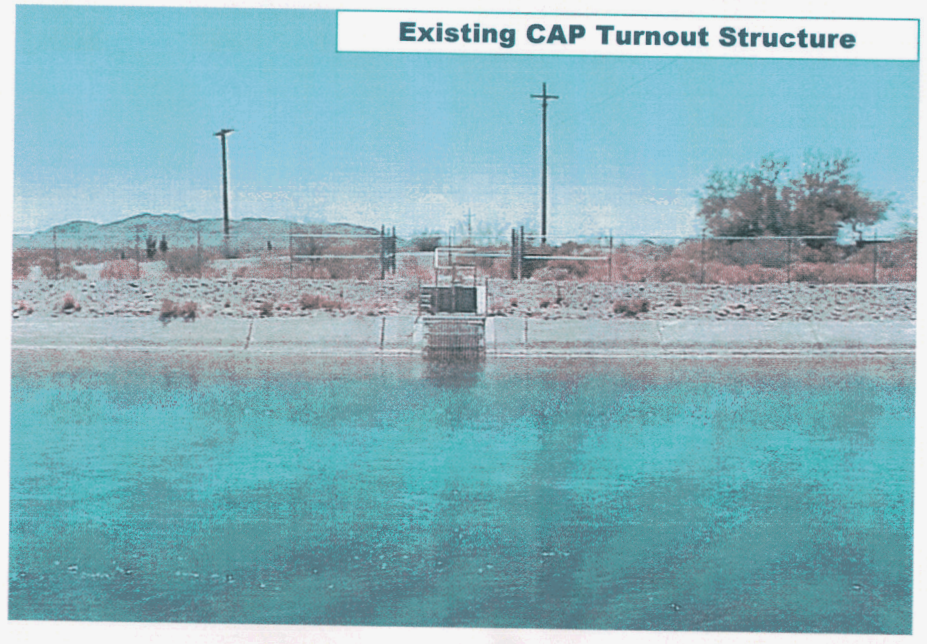
Looking South on Lake Pleasant Road

CAP Review Of Turnout Design Plans

The engineering department at CAP will coordinate the review of construction design plans required for the connection to Reach 9 of the Hayden-Rhodes Aqueduct. CAP requires approximately two weeks for the review of each plan set, with the cost of these reviews applied to the project.

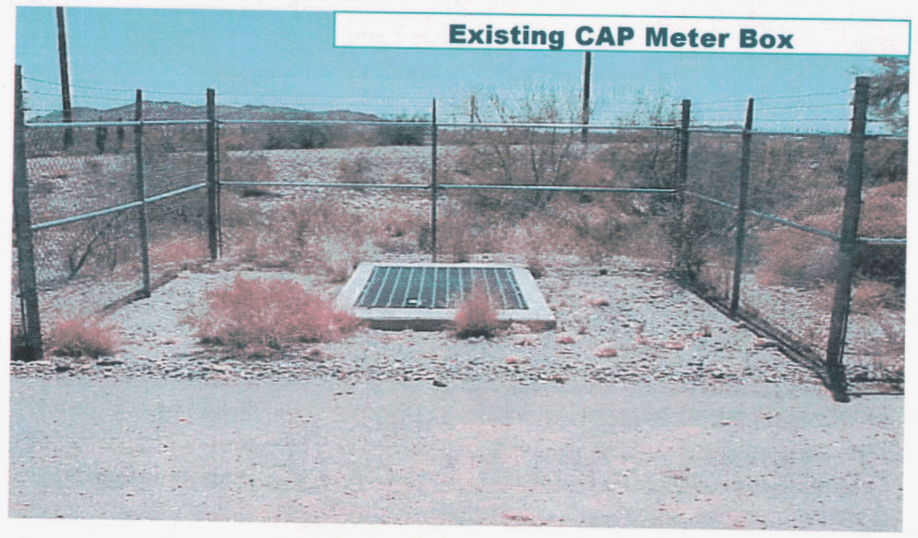
CAP Tie-In Process

The CAP does not have an annual canal dry-up, thus the tie-in process is typically quite expensive. An existing turnout located approximately 140 feet east of Lake Pleasant Road on the south side of the canal, may be utilized for this project and will mitigate that expense. The existing turnout was built during canal construction for the Sunrise Water Company that had an allocation for CAP water. CAP would like to make use of the turnout and, because it views the GSP as a good opportunity, will allow a connection to the turnout using the existing stub-out.


Existing CAP Turnout Structure

Existing CAP Turnout

The existing canal turnout is at Reach 9 Station 869+00 on the south side of the canal. It includes a screen flush with the lining and a manual gate at the opening of a 12-inch diameter asbestos-cement (AC) pipe. An open meter box, intended for measurements in feet of water, has been constructed about 28 feet from the canal. A section pipe is stubbed out approximately 20 feet beyond the meter box and plugged with a plywood bulkhead. The entire turnout is constructed on CAP right-of-way and enclosed by a chain link fence. Pictures of the turnout and meter box and the surrounding area are shown in this section. Plans for the turnout are included in the Appendix E "Miscellaneous CAP Plans and Related Items."

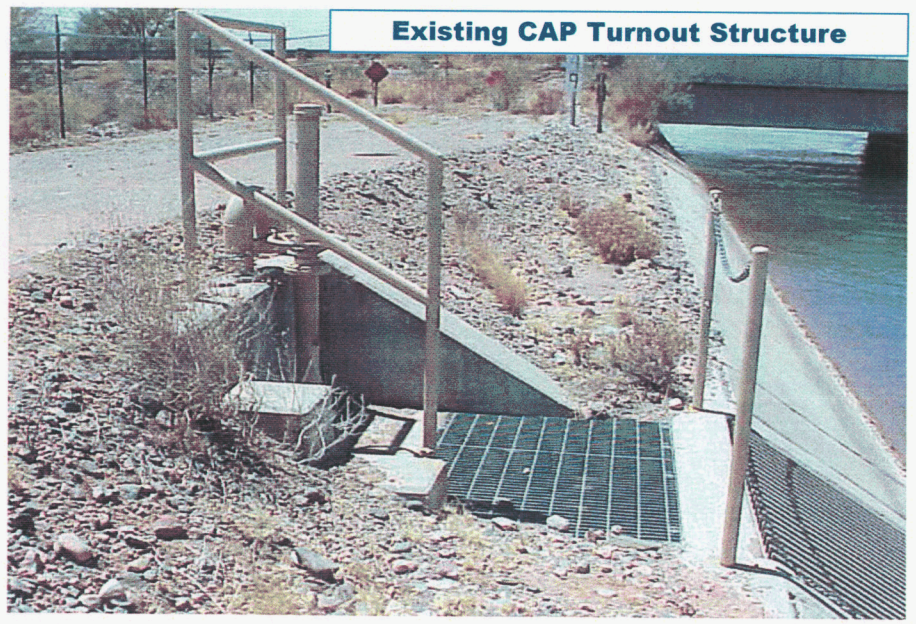

Existing CAP Meter Box

Grate on Existing CAP Meter Box

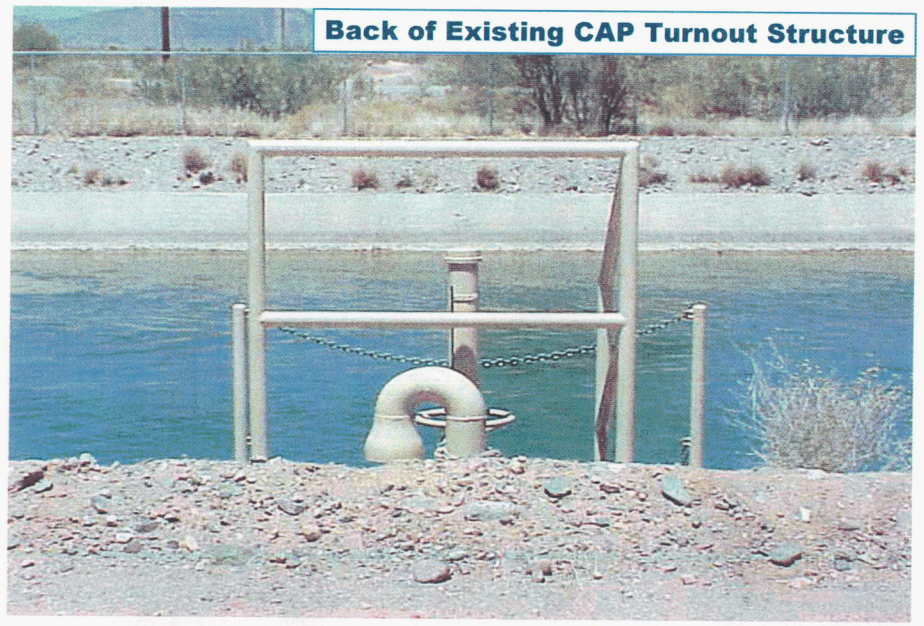
CAP Turnout Modifications

The turnout includes a 12-inch pipe, intended originally to deliver water to the Sunrise Water Company at an average delivery flowrate of 3 cfs, about one-third the average flowrate for the GSP (see the Granite Reef Turnout sheet provided by CAP in the Appendix). Reconstruction of the 12-inch pipe is possible if necessary, although preliminary hydraulic calculations indicate that the pipe will be able to convey the flow required by the GSP.

A water meter for measuring flow will be installed in the existing meter box. The meter, required by CAP to be an **Accusonic Technologies Inc.** acoustic meter, will be the revenue meter for CAP and will connect to a **Geomation** Measure Control Unit (MCU) that transmits information to a CAP check structure approximately one-quarter mile downstream from the turnout. The MCU can be hardwired or radio transmitted to the RTU at the check structure. Power will be required to operate the flowmeter and MCU, and although there is currently none at the site of the turnout, power is available adjacent to Lake Pleasant Road. The final modification at the turnout will connect the new raw water pipeline to the existing pipe at the turnout.


Existing CAP Turnout Structure

The CAP will own, operate, and maintain the facilities within its ROW. CAP will clean the grate at the inlet and provide maintenance to the telemetry and measurement systems. CAP can provide access to the meter box area for CWR and will provide a courtesy signal from its RTU to CWR, although CWR will be required to provide its own telemetry.


Back of Existing CAP Turnout Structure

CAP Easement Requirements and Right-of-Way

No new permanent easements from CAP are required if the existing turnout structure is utilized. Before construction begins, a Land Use application and $500 application fee must be filed. The applicant is responsible for additional costs, including those for inspection and oversight, and plan review costs incurred by CAP until construction ends. The application, along with insurance documents, will be reviewed before granting a "Construction Period Land Use License." CAP personnel have issued the GSP a tracking number and are aware of the project. Copies of the application, relevant information sheets, and a right-of-way map are included in the Appendix E.

CAP Operations

The CAP Canal operates continuously year round and does not schedule dry-up times for maintenance. At times, due to construction, the water surface falls below the control water surface. CAP deliveries affected by this situation are notified and difficulties worked out in advance of low water surfaces.

CAP customers with individual turnouts are allowed two flow rate adjustments per 24 hours, which must be received by 9:00 a.m. the previous day. The meter installed with this project is the revenue meter CAP uses to determine deliveries.

For annual order estimates, the CAP has a peak averting measure called the "eleven percent rule," applied when the peak flows predicted by annual water orders exceed the ability of CAP to deliver those flows. The rule permits CAP to limit a subcontractors monthly order (not its allocation) to 11% of their annual allocation, thereby easing canal operations during high-use periods. In such a case, CAP notifies M&I customers, which include this project, of the invocation of the rule. Customers may then revise their forecast for water accordingly. Flow changes are implemented only after customer notification. While this rule has yet to be invoked, it remains a tool for CAP Canal management. Peak GSP flows are predicted during the months of May through October. These months could be affected by the 11% rule if it is invoked.

Other measures which could be invoked by the CAP during high demand periods include cutting daily water orders on peak demand days to meet as much demand as possible for all customers. In these cases however, Native American Community and M&I water allocations have the highest priority. Since CWR has water considered as M&I use they would have the highest priority and as with the 11% rule, flow changes would be implemented only after notification.

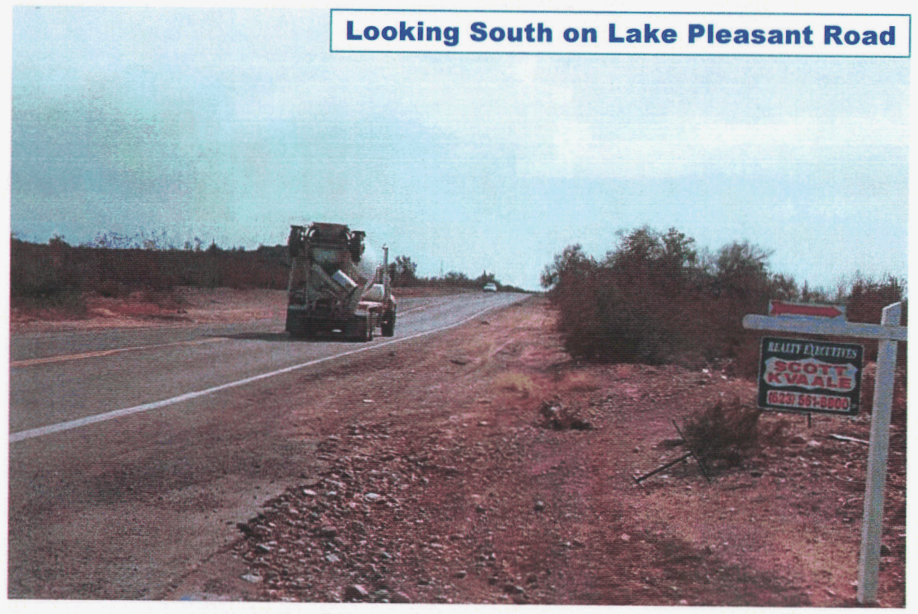
Alternative A Hydraulics

CAP provided information detailing the design water surface elevations for the inlet to the Alternative A pipeline. At the turnout, the *normal water surface elevation* (NWS) is 1,520.87, and the *control water surface elevation* (CWS) is 1,517.10. While CAP guarantees the CWS the majority of the time, in an emergency the water surface may drop below the CWS.

The CWS was used for the hydraulics design of the pipeline. The water surface elevation, which can be translated into pressure at the delivery point in the Sun City Area, is calculated by subtracting all losses for the pipeline from the CWS. The major portion of the losses in most pipelines results from friction or transmission. There are minor losses when valves or bends in the pipe are encountered, but these are typically insignificant. Vacuum relief valves and air release valves will be required on the pipeline at high points and other locations, and isolation valves will be included to allow the pipeline to be isolated for one-mile segments.

The preliminary hydraulics analysis indicates that a 24-inch diameter pipe will be required to deliver water a flow rates and pressure to adequately serve Sun City West and Sun City distribution systems. Because the static pressure for this system is approximately 130 psi, pressure-reducing valves will be required to reduce the pressure prior to reaching the delivery system so as not to exceed the hydraulic design of the piping materials and their joint systems.

The pressure requirements for operation of the water distribution systems in Sun City West and in Sun City can be met when the Alternative A pipeline is connected to them as shown in the hydraulic model. The pressure required for operation of the Sun City West water distribution system is 70 psi (at the CWR water campus location). Pressure required for the Sun City water distribution system is 70 psi. Since the delivery pressure of water in the Alternative A trunk pipeline meets or exceeds the required operating pressures of Sun City and Sun City West distribution systems, a pump station will not be required to deliver water from the CAP Canal via Alternative A.



Alternative A Utility Coordination

Alternative A crosses US West Communication facilities in four locations. Telephone lines run parallel to the proposed alignment for the major part of the reach until approximately Sta. 193+00 just north Jomax Road. The telephone lines cross again at approximately Sta. 207+00 and continue east on Happy Valley Road. Two other possible conflicts occur at the intersections of Lake Pleasant Road with Pinnacle Peak Road and Deer Valley Road.

Alternative A has no known crossings of Southwest Gas facilities.

The Alternative A alignment crosses a 20-inch El Paso Natural Gas line (running from San Juan line to Phoenix area) at two locations (approximately Stations135+00 and 362+00).

The alignment for alternative A crosses a Cox Communications underground fiber optic line at approximately Sta. 420+00.

The proposed Alternative A alignment presents a possible conflict with APS facilities at two locations. One line runs along 115th Avenue at approximately Sta. 99+00 and the other is located at Deer Valley Road at approximately Sta. 180+00.

Alternative A Easement and Right-of-Way

The City of Peoria is currently engaged in an effort with the State Land Department to obtain fee simple right-of-way, to a 150 foot width within the current Lake Pleasant Road alignment from Beardsley at the south to the junction of State Route 74 on the north. Peoria is developing plans to upgrade the road to a divided 4-lane roadway with a center median with city utilities within the ROW. The Alternative A pipeline will be allowed to be in the right-of-way after an amendment to the franchise agreement between Citizens and Peoria.

If Peoria were to be successful in obtaining the right-of-way from the State land Department, the right-of-way would be greatly simplified as Alternative A will then consist of mostly one owner. Currently costs for Alternative A range from $152,000 to $555,000 for right-of-way and easements. If Peoria becomes the owner of the ROW the costs drops to around $50,000 due to the parcels along Rose Garden Lane and the vacant land near the CWR Water Campus.

For the purposes of this report ands cost estimate it will be assumed the city of Peoria will be successful in its attempts to secure the ROW described above.

Alternative A Environmental Considerations

The Central Arizona Water Conservation District (CAWCD) was contacted to obtain information regarding regulatory issues that may require resolution if water is transferred from the CAP Canal. CAWCD has jurisdiction over the CAP Canal. Regulatory agreements that address water transfers from the CAP Canal are currently in place. Water transfers from the CAP Canal will require that the environmental clearances be in place and/or updated.

The Bureau of Reclamation previously prepared an Environmental Assessment (EA) for activities involving the CAP Canal. The Bureau of Reclamation can request that an update be prepared in the event that Alternative A is selected and significant impacts are associated with the project.

Alternative A does not require crossing an ephemeral drainage impacting more than 1/10 acre, but the location of the treatment plant is near the Agua Fria River and it is possible that construction activities involved in the connection of the pipeline to the treatment plant may occur within the 100-year floodplain. In that case, a PCN or a Nationwide 404 Permit #12: Utility Line Activities may be required. The Nationwide Permit application process is not as extensive as the Individual 404 Permit process. The appropriate Section 404 permit needed for Alternative A will be determined after a jurisdictional delineation is conducted and an estimate of the required construction easement is made.

The cultural resources report has determined that there have been five sites found in or near Alternative A. The sites include historic and prehistoric resources. One site, the Marinett Canal, is eligible for the National and State Register. Two sites were recommended not eligible and two sites have not been evaluated. Part of Alternative A has been surveyed, but a majority has not. It is recommended that all of Lake Pleasant Road, north of Pinnacle Peak Road, as well as Rose Garden Lane should be surveyed.

Alternative A Soils Considerations

Excavation conditions and corrosivity are the primary geotechnical factors of concern for evaluation of the alternatives. Preliminary exploration data indicate that soil conditions along most of Alternative A are in the group of soils which are not related to the Agua Fria River.

In this group, soils with calcareous cementation and high corrosion risk will commonly be encountered. Calcareous cementation is expected to cause difficult excavation conditions that will require heavy or specialized equipment for excavation.

The southernmost end of Alternative A is in the group of soils that are cohesionless soils, soils with cobbles and boulders, and soils with low to moderate corrosion risk will commonly be encountered. Excavation

conditions are not anticipated to be as difficult in uncemented and lightly cemented, cohesionless soils and soils with cobbles and boulders; however, sloughing and less stable slopes are anticipated.

Since encountering soils difficult for excavation are anticipated, the cost of pipe installation will be increased. Corrosion is a factor in some of the soils along the route and wrapping or coatings on the pipe will protect the pipe material.

Alternative A Estimate of Probable Costs and Time of Construction

An estimate of probable cost has been prepared for this alternative. The costs are shown below:

Alternative Route A – Lake Pleasant Road
Opinion of Probable Life Cycle Costs

Item Description	Unit	Quantity	Unit Price	Amount
Pipeline				
Mobilization @ 5%	Ea.	1	$238,594	$238,594
Ductile Iron Pipe (24" Class 200)	L.F.	42,936	$92.56	$3,974,156
24" Gate Valve	Ea.	9	$13,500	$121,500
PRV Vault Station	Ea.	2	$48,000	$96,000
Pavement Replacement	S.Y.	3,540	$20	$70,800
Combination AirVac Valve (2")	Ea.	5	$4,000	$20,000
Traffic Control	L.F.	41,038	$7	$287,266
Permitting & Compliance	L.S.	1	$23,150	$23,150
R/W Costs	S.F.	100,000	$1.00	$100,000
CAP Turnout				
Remove bulkhead/connect to CAP	Ea.	1	$6,500	$6,500
Meter Box, Power hookup (APS)	Ea.	1	$5,000	$5,000
Accusonic Flowmeter	Ea.	1	$32,000	$32,000
Geomation MCU	Ea.	1	$15,000	$15,000
Connect to CAP SCADA	Ea.	1	$20,000	$20,000
Construction License	Ea.	1	$500	$500
			Subtotal	**$5,010,466**
Engineering Design	8%	1	$400,837	$400,837
Construction Administration	12%	1	$601,256	$601,256
Citizens (Admin./Legal/Financial)	10%	1	$501,047	$501,047
Contingency	10%	1	$501,047	$501,047
			Total Capital Cost	**$7,014,653**

O&M Life Cycle Costs	Annual Cost	Present Worth
24" Pipeline O&M (50 yr) (42,936 L.F. at $0.50/L.F./yr)	$21,468	$351,554
PRV Station O&M (50 yr) (1.5% of Station/yr)	$1,440	$23,581
Total O&M Life Cycle Cost		**$375,135**
Total Life Cycle Cost, Alternative A		**$7,389,787**

The life cycle costs were determined using common cost elements applied to anticipated annualized costs. The annual costs were calculated by summing each annual cost element. These were then determined as a present worth value.

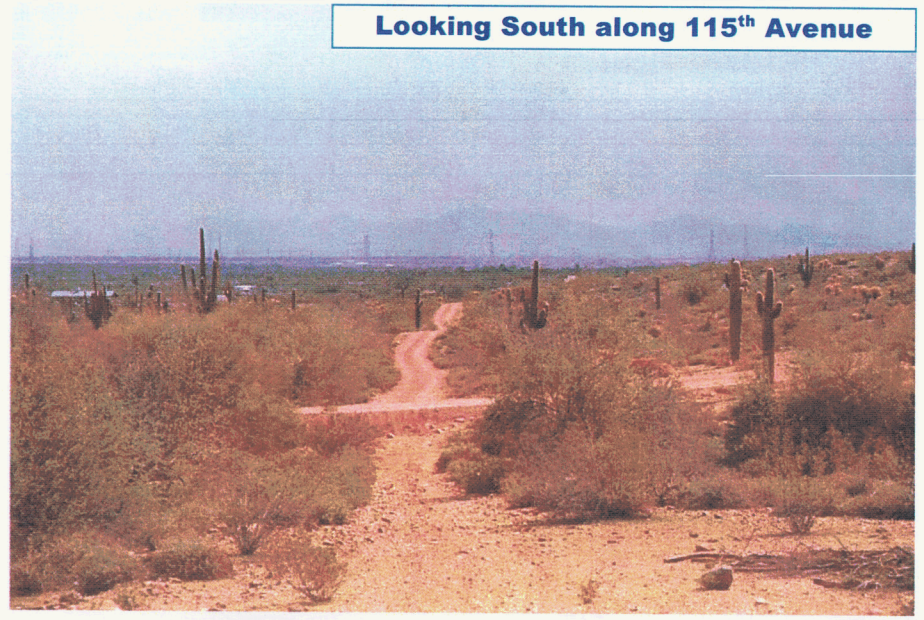
A differential interest rate of 5.73% was used for calculations. This rate was based on the weighted cost of capital at 8.73%, minus an inflation rate of 3%. The weighted cost of capital at 8.73% for Citizens Water Resources is based on Arizona Corporation Commission Decision 60172. The inflation rate of 3.0% is based on an assumed average inflation rate over past number of years.

It is anticipated that this route will take approximately 190 working days to construct (approximately 9 months).

Alternate B – 115th Avenue Route

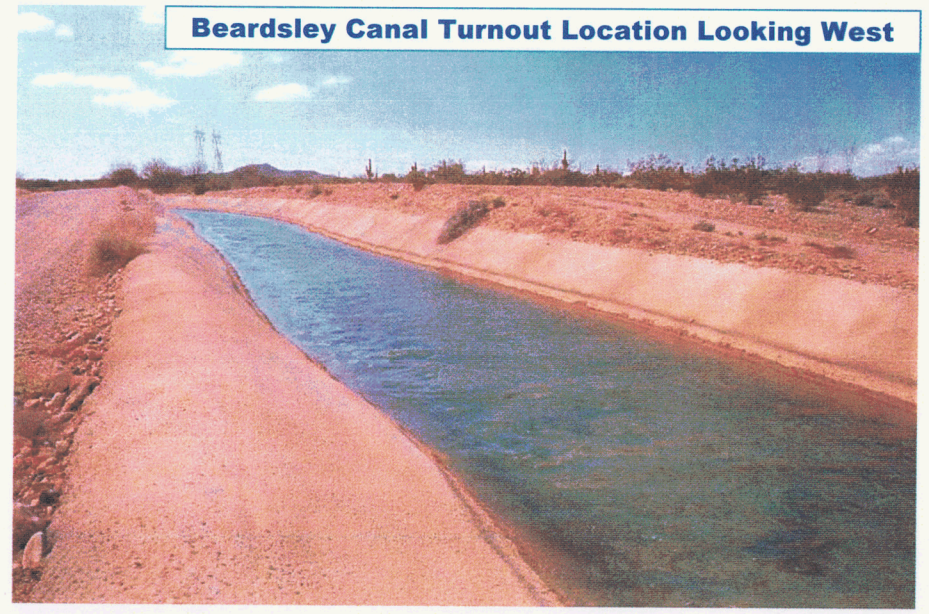
The Alternative B pipeline begins near the northeast corner of Section 1, T4N, R1W, at a proposed Beardsley Canal turnout. The pipeline route proceeds directly south along the section line (115th Avenue alignment) to the CWR Water Campus for a total length of approximately 3.75 miles. Maricopa County roadway right-of-way is intermittent along the alignment.

Looking South along 115th Avenue

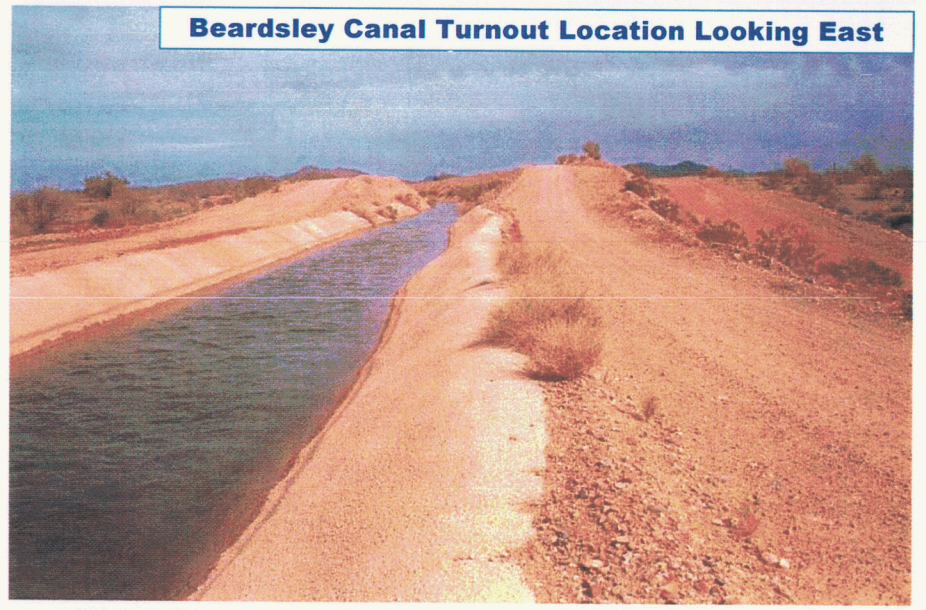


Over the length of the alignment, the pipeline will cross (in north to south sequence) existing Twin Buttes Wash, future Estrella Roadway, unimproved Hatfield Road (which serves as access to the SRP substation), the Agua Fria River, and at least one sand and gravel operation in the riverbed.

Beardsley Canal Turnout Location Looking West



Beardsley Canal Turnout Location Looking East



Alternative B Hydraulics

According to information provided by MWD regarding estimated design water surface elevation for the inlet to the Alternative B pipeline, the NWS at the turnout is 1,344.2, while the CWS, the most consistent elevation provided at the canal, is estimated at 1,345.0. Although MWD guarantees the CWS the majority of the time, in an emergency the water surface may drop below the CWS.

The CWS elevation is used as the basis for the hydraulics design of the pipeline. The water surface elevation, which can be translated into pressure at the delivery point in the Sun City Area, is calculated by subtracting the losses incurred in the pipeline from the CWS elevation at the Beardsley Canal. The major portion of the losses in the pipeline will be from friction. There are minor losses when valves or bends in the pipe are encountered, but these are typically insignificant. Vacuum relief valves and air release valves will be required on the pipeline at high points and other locations, and isolation valves will be included to allow the pipeline to be isolated for one-mile segments.

The preliminary hydraulics analysis indicates that a 24-inch diameter pipe will be required to deliver water a flow rates and pressure to adequately serve Sun City West and Sun City distribution systems. Because the static pressure for this system is approximately 56 psi, pressure-reducing valves will not be required to reduce the pressure prior to reaching the delivery system.

The pressure required for operation of the Sun City West water distribution system is 70 psi (at the CWR water campus location). Pressure required for the Sun City water distribution system is 70 psi. Because the delivery pressure of water in the Alternative B pipeline cannot meet these operating pressures by gravity, a pump will be required to deliver water from the Beardsley Canal. This pressure (70 psi at the water campus) will allow deliveries to be made to each of the participating golf courses connected to the distribution systems.

The Beardsley Canal currently does not convey water during four months of the year. Until this changes, the GSP will have to use all of its allotment in eight months instead of twelve. This scenario would require an increased trunk pipe size and an increase in the size of pumps at the booster pump station required for all of the Beardsley Canal alternates, above that which was estimated in this study. This enlarged system would then be inactive for four months of the year. **This effectively eliminates Alternate B as long as the MWD continues to undergo an annual dry-up in the Beardsley Canal.**

Alternative B Utility Coordination

US West maps showed no facilities in conflict with the Alternative B pipeline.

Southwest Gas maps indicated no conflicts with their facilities within the Alternative B corridor.

El Paso Natural Gas has no gas lines within the project site for Alternative B.

No Cox Communication facilities were found to be in conflict with the Alternative B alignment.

Existing power facilities were evaluated from utility maps provided by Arizona Public Service. Alternative B appeared to have not conflicts.

Alternative B Easement and Right-of-Way

Alternative B is estimated to require approximately 21,120 square feet of surface area for Right-of-way or easement. This area currently consists of parcels owned by 46 individual owners that would require a separate appraisal.

The projected costs for easement or right-of-way acquisition for Alternative B range from $49,000 to $68,000.

Alternative B Environmental Considerations

The MWD was contacted to obtain information regarding regulatory issues that may require resolution if water is transferred from the Beardsley Canal. MWD has jurisdiction over the Beardsley Canal. At the present time, this project would not be required to address environmental issues for the transfer of water from the Beardsley Canal.

Alternative B requires crossing the Agua Fria River floodplain thus it is possible that construction activities involved in the construction of the pipeline will require a PCN or a Nationwide 404 Permit #12: Utility Line Activities. The Nationwide Permit application process is not as extensive as the Individual 404 Permit process. The appropriate Section 404 permit needed for Alternative B can be determined after a jurisdictional delineation is conducted and an estimate of the required construction easement is made.

The cultural resources report has determined that there are two sites found in or near Alternative B. One is a prehistoric habitation locus that is potentially eligible for National and State Register. The other is a historic canal system of unknown age and function. It is recommended that all of this route, including Rose Garden Lane should be surveyed since sites were found within previously surveyed portions.

Alternative B Soils Considerations

Excavation conditions and corrosivity are the primary geotechnical factors of concern for evaluation of the three alternatives. Preliminary exploration data indicate that soil conditions along most of Alternative B are in the group of soils that are related to the Agua Fria River.

In this group, cohesionless soils, soils with cobbles and boulders, and soils with low to moderate corrosion risk will commonly be encountered. Excavation conditions are not anticipated to be as difficult in uncemented and lightly cemented, cohesionless soils and soils with cobbles and boulders

Since encountering soils not difficult for excavation are anticipated, the cost of pipe installation will be for normal installation of pipelines. Moderate corrosion potential, however is still a factor in some of the soils along the route and wrapping or coatings on the pipe will protect the pipe material.

Alternative B Estimate of Probable Costs and Time of Construction

An estimate of probable cost has been prepared for this alternative. The costs are shown in below.

Alternative Route B – 115th Avenue
Opinion of Probable Life Cycle Costs

Item Description	Unit	Quantity	Unit Price	Amount
Pipeline				
Mobilization @ 5%	Ea.	1	$133,421	$133,421
Ductile Iron Pipe (24" Class 200)	L.F.	21,897	$88.49	$1,937,666
24" Gate Valve	Ea.	3	$13,500	$40,500
Pavement Replacement	S.Y.	722	$20	$14,440
Combination AirVac Valve (2")	Ea.	1	$4,000	$4,000
Permitting & Compliance	L.S.	1	$23,150	$23,150
R/W Costs	S.F.	116,000	$1.00	$116,000
MWD Improvements (Turnout Structure)				
Headwall	Ea.	1	$10,000	$10,000
Slide Gate	Ea.	1	$2,500	$2,500
Connect to MWD Turnout	Ea.	1	$5,000	$5,000
Meter Box, Power hookup (APS)	Ea.	1	$45,000	$45,000
Flowmeter	Ea.	1	$5,000	$5,000
MCU	Ea.	1	$25,000	$25,000
Telemetry to CWR	Ea.	1	$2,000	$2,000
Construction License	Ea.	1	$500	$500
MWD Improvements (Check Structure)				
Structure A (concrete & steel)	Ea.	1	$100,000	$100,000
Radial Gate (4'W x 6'H)	Ea.	2	$10,000	$20,000
Flowmeter	Ea.	1	$5,000	$5,000
Connection to MWD SCADA	Ea.	1	$5,000	$5,000
Booster Pump Station				
Pump Station Capital Cost	L.S.	1	$307,660	$307,660
			Subtotal	**$2,801,837**
Engineering Design	8%	1	$224,147	$224,147
Construction Administration	12%	1	$336,220	$336,220
Pipeline Contingency	10%	1	$247,879	$247,879
Pump Station Contingency	25%	1	$80,761	$80,761
Citizens (Admin,/Legal/Financial)	10%	1	$280,184	$280,184
			Total Capital Cost	**$3,971,028**

O&M Life Cycle Costs	Annual Cost	Present Worth
24" Pipeline O&M (50 yr) (21,897 L.F. at $0.50/ft/yr)	$10,949	$179,289
Pump Station O&M (50 yr) (See Estimate, Page D-50)	$7,692	$125,954
MWD Water Losses (50 yr) (148 ac-ft at $106/ac-ft)	$15,688	$256,902
MWD Wheeling Cost (50 yr) (6,561 ac-ft at $25/ac-ft)	$164,025	$2,686,025
Total O&M Life Cycle Cost		**$3,997,272**
Total Life Cycle Cost, Alternate B		**$7,968,300**

The life cycle costs were determined using common cost elements applied to anticipated annualized costs. The annual costs were calculated by summing each annual cost element. These were then determined as a present worth value.

A differential interest rate of 5.73% was used for calculations. This rate was based on the weighted cost of capital at 8.73%, minus an inflation rate of 3%. The weighted cost of capital at 8.73% for Citizens Water Resources is based on Arizona Corporation Commission Decision 60172. The inflation rate of 3.0% is based on an assumed average inflation rate over past number of years.

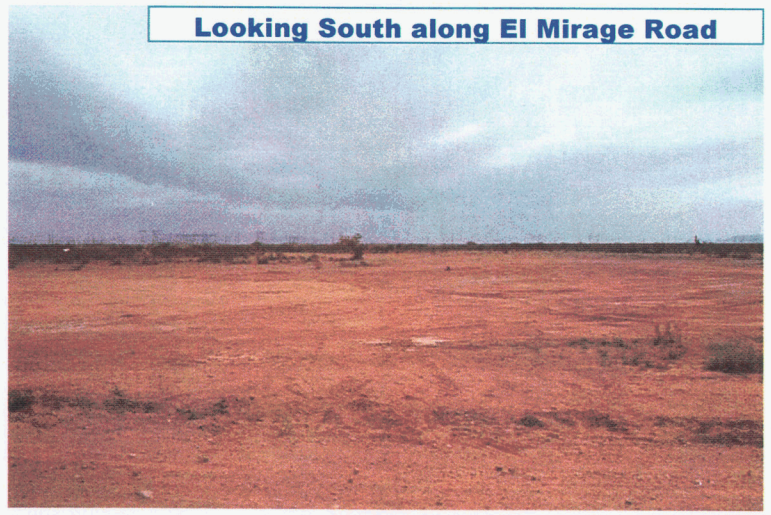
It is anticipated that this route will take approximately 130 working days to construct (approximately 6 months) using separate contractors for the pump station and the trunk pipeline.

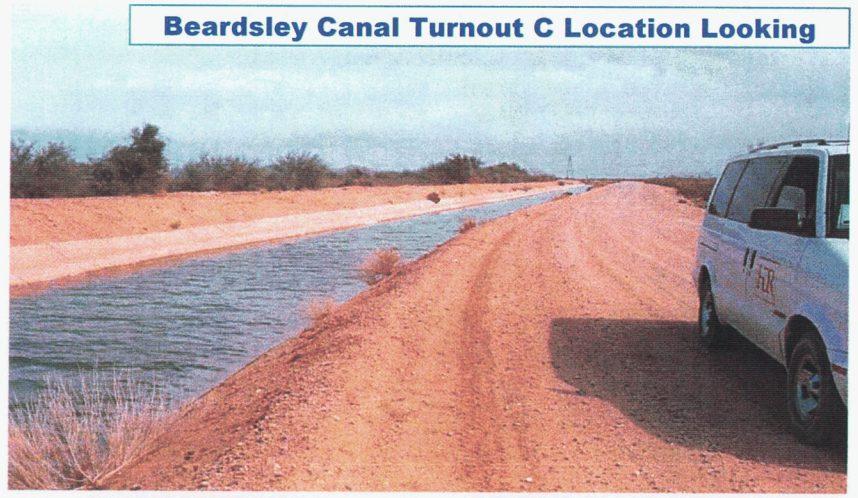
Alternate C – El Mirage Road Alignment

The Alternative C pipeline route begins near the northeast corner of Section 2, T4N, R1W at a proposed Beardsley Canal turnout. The route proceeds southerly along the section line (El Mirage Road alignment) for approximately 3.8 miles to the extended east-west centerline of Beardsley Road. From there the pipeline proceeds east along Beardsley Road to the CWR Water Campus.

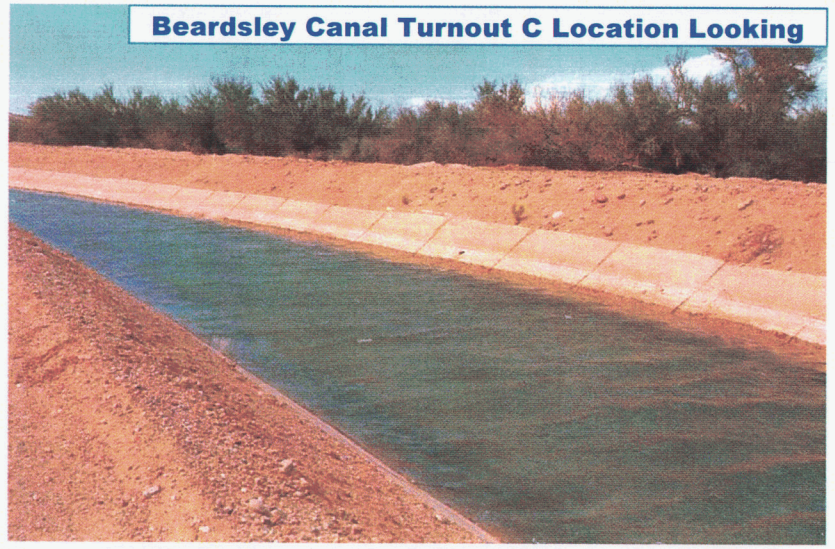
This route is fairly clear of major natural and man-made obstacles. The pipeline will cross the future Estrella Roadway and, depending on the precise alignment, the existing McMicken Dam Outlet Wash as well. Along unimproved Beardsley Road, the pipeline must cross the Agua Fria River and pass through extensive sand and gravel operations within the riverbed.

Alternative C Hydraulics


Looking South along El Mirage Road


Beardsley Canal Turnout C Location Looking

According to information provided by MWD regarding estimated design water surface elevation for the inlet to the Alternative C pipeline, the NWS at the turnout is 1,341.0, while the CWS, the most consistent elevation provided at the canal, is estimated 1,342.0. Although MWD guarantees the CWS the majority of the time, in an emergency the water surface may drop below the CWS.


Beardsley Canal Turnout C Location Looking

The CWS elevation is used as the basis for the hydraulics design of the pipeline. The water surface elevation, which can be translated into pressure at the delivery point in the Sun City Area, is calculated by subtracting the losses incurred in the pipeline from the CWS elevation at the Beardsley Canal. The major portion of the losses in the pipeline will be from friction. There are minor losses when valves or bends in the pipe are encountered, but these are typically insignificant. Vacuum relief valves and air release valves will be required on the pipeline at high points and other locations, and isolation valves will be included to allow the pipeline to be isolated for one-mile segments, but these additions will add little to the losses calculated for this preliminary hydraulics analysis.

The preliminary hydraulics analysis indicates that a 24-inch diameter pipe will be required to deliver water a flow rates and pressure to adequately serve Sun City West and Sun City distribution systems. Because the static pressure for this system is approximately 55 psi, pressure-reducing valves will not be required to reduce the pressure prior to reaching the delivery system.

The pressure required for operation of the Sun City West water distribution system is 70 psi (at the CWR water campus location). Pressure required for the Sun City water distribution system is 70 psi. Because the delivery pressure of water in the Alternative C pipeline cannot meet these operating pressures by gravity, a pump will be required to deliver water from the Beardsley Canal. This pressure (70 psi at the water campus) will allow deliveries to be made to each of the participating golf courses connected to the distribution systems.

The Beardsley Canal currently does not convey water during four months of the year. Until this changes, the GSP will have to use all of its allotment in eight months instead of twelve. This scenario would require an increased trunk pipe size and an increase in the size of pumps at the booster pump station required for all of the Beardsley Canal alternates, above that which was estimated in this study. This enlarged system would then be inactive for four months of the year. This effectively eliminates Alternate C as long as the MWD continues to undergo an annual dry-up in the Beardsley Canal.

Alternative C Utility Coordination

US West maps showed no facilities along the Alternative C pipeline.

Southwest Gas maps indicated no conflicts with their facilities within the Alternative C project site.

El Paso Natural Gas has no gas lines within the project site for Alternative C.

No Cox Communication facilities were found to be in conflict with the Alternative C pipeline.

Existing power facilities were evaluated from utility maps provided by Arizona Public Service. Alternate C appeared to have no conflicts.

Alternative C Easement and Right-of-Way

Alternative C requires the skirting of an APS/SRP power substation as well as the McMicken Dam Outfall Channel owned and operated by the Flood Control District of Maricopa County.

The projected costs for easement or Right-of-Way for Alternative C will range from $60,000 to $90,000.

Alternative C Environmental Considerations

The MWD was contacted to obtain information regarding regulatory issues that may require resolution if water is transferred from the Beardsley Canal. MWD has jurisdiction over the Beardsley Canal. At the present time, this project will not be required to address environmental issues for the transfer of water from the Beardsley Canal.

The cultural resources report has determined that there are three sites found in or near Alternative Route C. One site is recommended as not eligible and testing is required to determine a recommendation for the other two sites. Nearly the entire route for Alternative C has been surveyed. It is recommended that all of the route between Beardsley Road and the Sun City West WWTP should be surveyed since sites were found within previously surveyed portions.

Alternative C Soils Considerations

Based on excavation conditions and corrosivity are the primary geotechnical factors of concern for evaluation of the this alternative. Preliminary exploration data indicate that soil conditions along most of Alternative C are in the group of soils that are not related to the Agua Fria River.

In this group, soils with calcareous cementation and high corrosion risk will commonly be encountered. Calcareous cementation is expected to cause difficult excavation conditions that will require heavy or specialized equipment for excavation.

The southernmost end of Alternative C, and where it crosses the Agua Fria River, is in the group of soils that are cohesionless soils, soils with cobbles and boulders, and soils with low to moderate corrosion risk to uncoated steel will commonly be encountered. Excavation conditions are not anticipated to be as difficult in uncemented and lightly cemented, cohesionless soils and soils with cobbles and boulders.

Since encountering soils difficult for excavation are anticipated, the cost of pipe installation will be increased. Corrosion is a factor in some of the soils along the route and wrapping or coatings on the pipe will protect the pipe material.

Alternative C Estimate of Probable Costs and Time of Construction

An estimate of probable cost has been prepared for this alternative. The costs are shown below.

Alternative Route C – El Mirage Road
Opinion of Probable Life Cycle Costs

Item Description	Unit	Quantity	Unit Price	Amount
Pipeline				
Mobilization @ 5%	Ea.	1	$170,676	$170,676
Ductile Iron Pipe (24" Class 200)	L.F.	28,259	$90.76	$2,564,779
24" Gate Valve	Ea.	5	$13,500	$67,500
Pavement Replacement	S.Y.	722	$20	$14,440
Combination AirVac Valve (2")	Ea.	4	$4,000	$16,000
Permitting & Compliance	L.S.	1	$23,150	$23,150
R/W Costs	S.F.	150,000	$1.00	$150,000
MWD Improvements (Turnout Structure)				
Headwall	Ea.	1	$10,000	$10,000
Slide Gate	Ea.	1	$2,500	$2,500
Connect to MWD Turnout	Ea.	1	$5,000	$5,000
Meter Box, Power hookup (APS)	Ea.	1	$90,000	$90,000
Flowmeter	Ea.	1	$5,000	$5,000
MCU	Ea.	1	$25,000	$25,000
Telemetry to CWR	Ea.	1	$2,000	$2,000
Construction License	Ea.	1	$500	$500
MWD Improvements (Check Structure)				
Structure A (concrete & steel)	Ea.	1	$100,000	$100,000
Radial Gate (4'W x 6'H)	Ea.	2	$10,000	$20,000
Flowmeter	Ea.	1	$5,000	$5,000
Connection to MWD SCADA	Ea.	1	$5,000	$5,000
Booster Pump Station				
Pump Station Capital Cost	L.S.	1	$307,660	$307,660
			Subtotal	**$3,584,205**
Engineering Design	8%	1	$286,736	$286,736
Construction Administration	12%	1	$430,105	$430,105
Pipeline Contingency	10%	1	$326,116	$326,116
Pump Station Contingency	25%	1	$80,761	$80,761
Citizens (Admin./Legal/Financial)	10%	1	$358,421	$358,421
			Total Capital Cost	**$5,066,344**

O&M Life Cycle Costs	Annual Cost	Present Worth
24" Pipeline O&M (50 yr) (28,259 L.F. at $0.50/ft/yr)	$14,130	$231,381
Pump Station O&M (50 yr) (See Estimate, Page D-50)	$7,692	$125,954
MWD Water Losses (50 yr) (180 ac-ft at $106/ac-ft)	$19,080	$312,448
MWD Wheeling Cost (50 yr) (6,561 ac-ft at $25/ac-ft)	$164,025	$2,686,025
Total O&M Life Cycle Cost		**$4,104,910**
Total Life Cycle Cost, Alternate C		**$9,171,254**

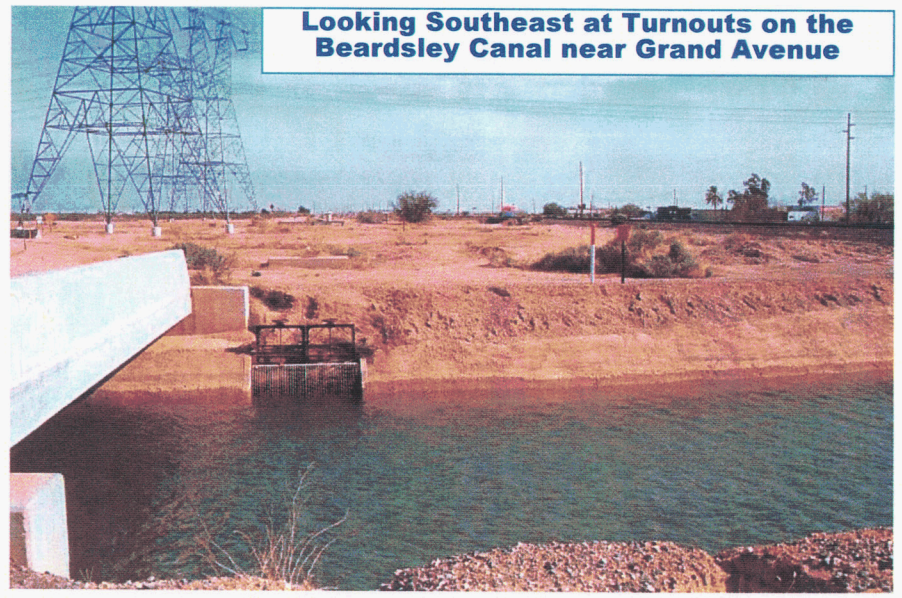
The life cycle costs were determined using common cost elements applied to anticipated annualized costs. The annual costs were calculated by summing each annual cost element. These were then determined as a present worth value.

A differential interest rate of 5.73% was used for calculations. This rate was based on the weighted cost of capital at 8.73%, minus an inflation rate of 3%. The weighted cost of capital at 8.73% for Citizens Water Resources is based on Arizona Corporation Commission Decision 60172. The inflation rate of 3.0% is based on an assumed average inflation rate over past number of years.

It is anticipated that this route will take approximately 145 working days to construct (approximately 7 months) using separate contractors for the pump station and the trunk pipeline.

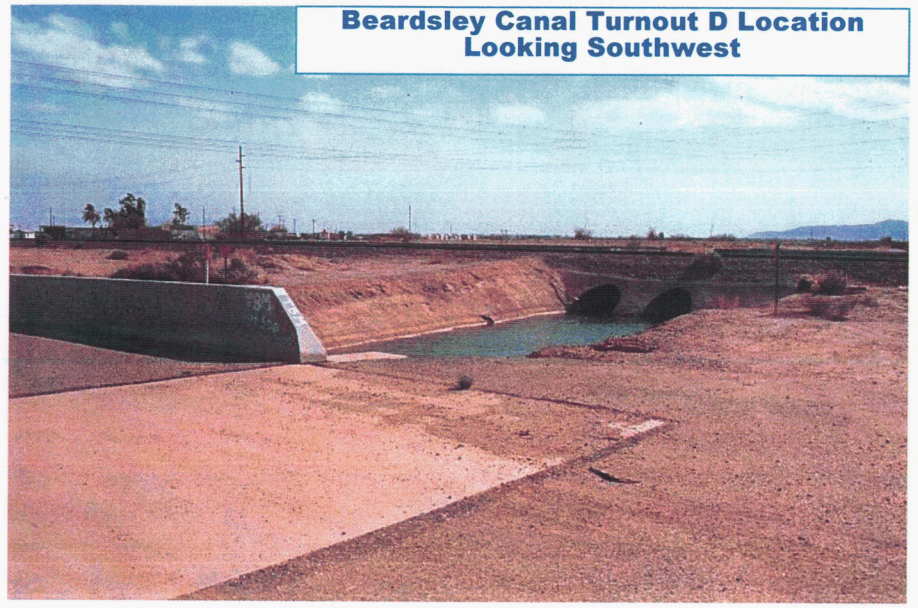
Alternate D – Deer Valley Road Alignment

The Alternative D pipeline route begins at a proposed Beardsley Canal turnout east of both Grand Avenue and the railroad. The alignment parallels Grand Avenue southeasterly for approximately 0.4 miles, then turns east for 4.8 miles on a Deer Valley Road extended centerline alignment through Sun City West until reaching El Mirage Road. There the pipeline turns south for one mile to Beardsley Road, then east one mile to the CWR Water Campus.



Looking Southeast at Turnouts on the Beardsley Canal near Grand Avenue

Along its alignment, the route passes through an area of developed Sun City West, Deer Valley Golf Course, the existing McMicken Dam Outlet Wash and the Agua Fria River. From Grand Avenue the pipeline follows an existing concrete-lined channel east until reaching Desert Hills golf course. Continuing through Deer Valley golf course, the alignment moves back onto the Deer Valley Road alignment and continues east to El Mirage Road.


Beardsley Canal Turnout D Location
Looking Southwest

Alternative D Hydraulics

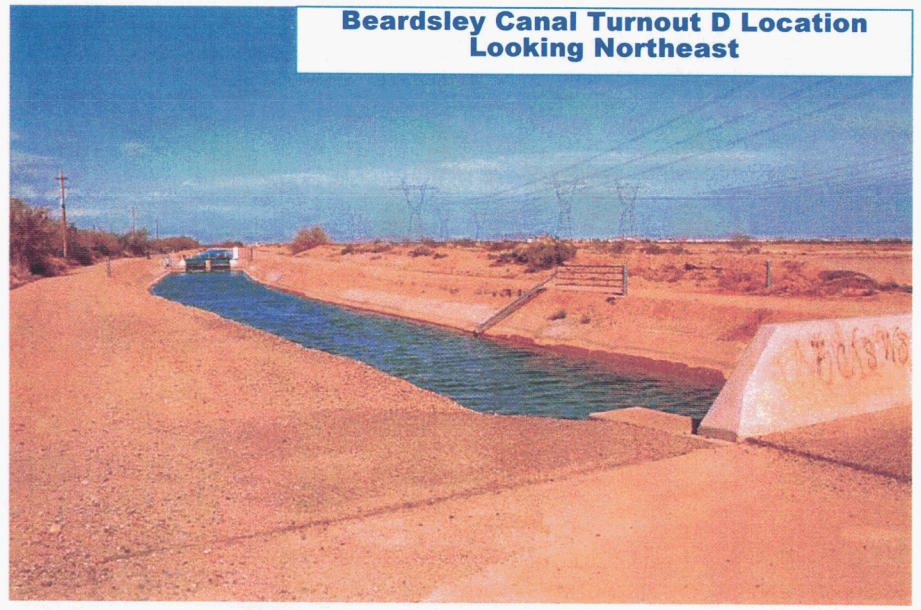
The estimated NWS at the Beardsley Canal is approximately 1,336.0. The estimated design water surface elevation for the inlet to the Alternative D pipeline will be approximately 1,338.0, which will be the CWS, the elevation that the Beardsley Canal will provide most consistently. Although MWD guarantees the CWS the majority of the time, in an emergency the water surface may drop below the CWS.

The CWS elevation is used as the basis for the hydraulics design of the pipeline. The water surface elevation, which can be translated into pressure at the delivery point in the Sun City Area, is calculated by subtracting the losses incurred in the pipeline from the CWS elevation at the Beardsley Canal. The major portion of the losses in the pipeline will be from friction. There are minor losses when valves or bends in the pipe are encountered, but these are typically insignificant. Vacuum relief valves and air release valves will be required on the pipeline at high points and other locations, and isolation valves will be included to allow the pipeline to be isolated for one-mile segments, but these additions will add little to the losses calculated for this preliminary hydraulics analysis.

The preliminary hydraulics analysis indicates that a 24-inch diameter pipe will be required to deliver water a flow rates and pressure to adequately serve Sun City West and Sun City distribution systems. Because the static pressure for this system is approximately 55 psi, pressure-reducing valves will not be required to reduce the pressure prior to reaching the delivery system.

The pressure required for operation of the Sun City West water distribution system is 70 psi (at the CWR water campus location). Pressure required for the Sun City water distribution system is 70 psi. Because the delivery pressure of water in the Alternative D pipeline cannot meet these operating pressures by gravity, a pump will be required to deliver water from the Beardsley Canal. This pressure (70 psi at the water campus) will allow deliveries to be made to each of the participating golf courses connected to the distribution systems.

The Beardsley Canal currently does not convey water during four months of the year. Until this changes, the GSP will have to use all of its allotment in eight months instead of twelve. This scenario would require an increased trunk pipe size and an increase in the size of pumps at the booster pump station required for all of the Beardsley Canal alternates, above that which was estimated in this study. This enlarged system would then be inactive for four months of the year. **This effectively eliminates Alternate D as long as the MWD continues to undergo an annual dry-up in the Beardsley Canal.**


Beardsley Canal Turnout D Location
Looking Northeast

Alternative D Utility Coordination

US West facilities adjacent to Grand Avenue cross Alternative D at approximately Sta. 26+50. In addition, Sta. 143+20 and 179+00 were identified as possible conflicts.

A Southwest Gas facility crosses this proposed alignment at one location (approximately Sta. 180+00). This 4-inch line runs along Deer Valley Road and measures for protection of this line will be taken during the design process if Alternative D is selected

El Paso Natural Gas was contacted to obtain the location of existing gas lines within the project site. No conflicts with El Paso Natural Gas lines are present on Route D

Alternate D has no conflicts with Cox Communications.

The proposed alignment for Alternative D presents possible conflicts with APS facilities at two locations. One line runs along 115th Avenue at approximately Sta. 99+00 and the other is located at Deer Valley Road at approximately Sta. 180+00.

Alternative D Easement and Right-of-Way

Alternative D requires the use of a drainage easement and two golf courses in the Sun City West expansion area. After leaving the golf courses the pipeline route follows along the Deer Valley road alignment to the El Mirage Road Alignment. The pipe then turns south and extends to the Beardsley Road alignment and the existing effluent line. The pipe then turns across the Aqua Fria River and connects to the Sun City Distribution System.

The project costs for easement or Right-of-Way for Alternative D will range from $80,000 to $120,000.

Alternative D Environmental Considerations

The MWD was contacted to obtain information regarding regulatory issues that may require resolution if water is transferred from the Beardsley Canal. MWD has jurisdiction over the Beardsley Canal. At the present time, Citizens Water Resources will not need to address environmental issues for the transfer of water from the Beardsley Canal.

Alternative D Soils Considerations

A field investigation (soil borings) for Alternative D was not performed for its alignment.

The easternmost end of Alternative D however is near the investigations done for Alternative C. The soils for this portion of the pipeline are considered to be the same as those results for the purposes of this report.

Alternative D Estimate of Probable Costs and Time of Construction

An estimate of probable cost has been prepared for this alternative. The costs are shown below.

Alternative Route D – Deer Valley Road
Opinion of Probable Life Cycle Costs

Item Description	Unit	Quantity	Unit Price	Amount
Pipeline				
Mobilization @ 5%	Ea.	1	$225,858	$225,858
Ductile Iron Pipe (24" Class 200)	L.F.	39,139	$88.45	$3,461,840
24" Gate Valve	Ea.	7	$13,500	$94,500
Pavement Replacement	S.Y.	13,000	$20	$260,000
Combination AirVac Valve (2")	Ea.	5	$4,000	$20,000
Permitting $ Compliance	L.S.	1	$23,150	$23,150
R/W Costs	S.F.	200,000	$1.00	$200,000
MWD Improvements (Turnout Structure)				
Headwall	Ea.	1	$10,000	$10,000
Slide Gate	Ea.	1	$2,500	$2,500
Connect to MWD Turnout	Ea.	1	$5,000	$5,000
Meter Box, Power hookup (APS)	Ea.	1	$90,000	$90,000
Flowmeter	Ea.	1	$5,000	$5,000
MCU	Ea.	1	$25,000	$25,000
Telemetry to CWR	Ea.	1	$2,000	$2,000
Construction License	Ea.	1	$500	$500
Remove Bulkhead	Ea.	1	$5,000	$5,000
Connection to MWD SCADA	Ea.	1	$5,000	$5,000
Booster Pump Station				
Pump Station Capital Cost	L.S.	1	$307,660	$307,660
			Subtotal	**$4,743,008**
Engineering Design	8%	1	$379,441	$379,441
Construction Administration	12%	1	$569,161	$569,161
Pipeline Contingency	10%	1	$441,997	$441,997
Pump Station Contingency	25%	1	$80,761	$80,761
Citizens (Admin./Legal/Financial)	10%	1	$474,301	$474,301
			Total Capital Cost	**$6,688,669**

O&M Life Cycle Costs	Annual Cost	Present Worth
24" Pipeline O&M (50 yr) (39,139 L.F. at $0.50/ft/yr)	$19,570	$320,464
Pump Station O&M (50 yr) (See Estimate, Page D-50)	$7,692	$125,954
MWD Water Losses (50 yr) (398 ac-ft at $106/ac-ft)	$42,188	$690,858
MWD Wheeling Cost (50 yr) (6,561 ac-ft at $25/ac-ft)	$164,025	$2,686,025
Total O&M Life Cycle Cost		**$4,572,403**
Total Life Cycle Cost, Alternate D		**$11,261,072**

The life cycle costs were determined using common cost elements applied to anticipated annualized costs. The annual costs were calculated by summing each annual cost element. These were then determined as a present worth value.

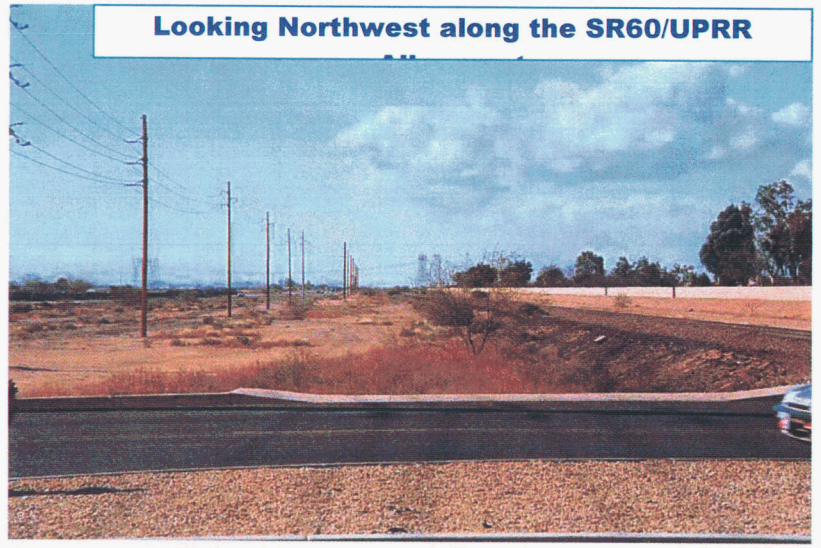
A differential interest rate of 5.73% was used for calculations. This rate was based on the weighted cost of capital at 8.73%, minus an inflation rate of 3%. The weighted cost of capital at 8.73% for Citizens Water Resources is based on Arizona Corporation Commission Decision 60172. The inflation rate of 3.0% is based on an assumed average inflation rate over past number of years.

It is anticipated that this route will take approximately 190 working days to construct (approximately 9 months) using separate contractors for the pump station and the trunk pipeline.

Alternate E – Through Sun City West

The Alternative E pipeline routes begin at a proposed Beardsley Canal turnout east of both Grand Avenue and the railroad. The alignment parallels Grand Avenue southeasterly for approximately one-and-a-half miles, turning east on R.H. Johnson Boulevard to Granite Valley Drive, where it would be connected to the existing irrigation network owned and operated by the Recreation Centers of Sun City West (Rec Centers).

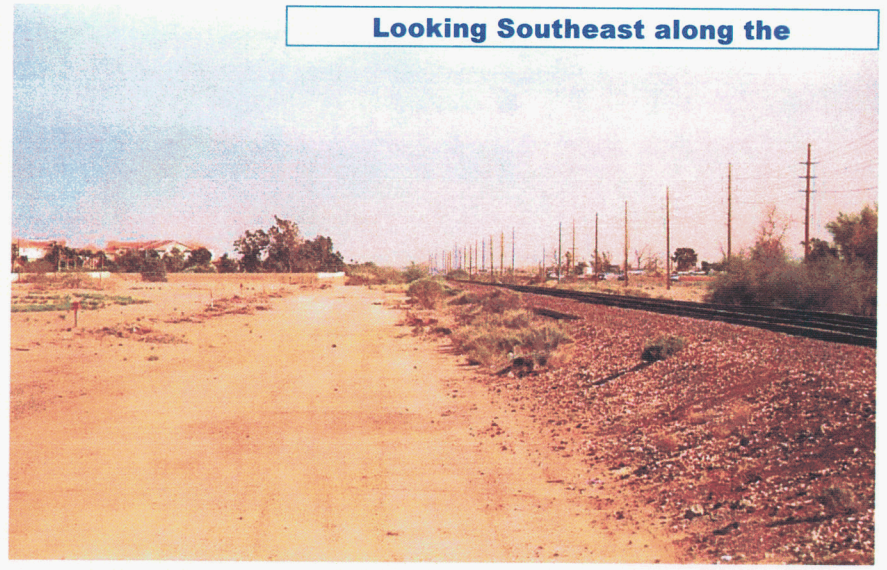
Looking Northwest along the SR60/UPRR



Alternative E Hydraulic Profile

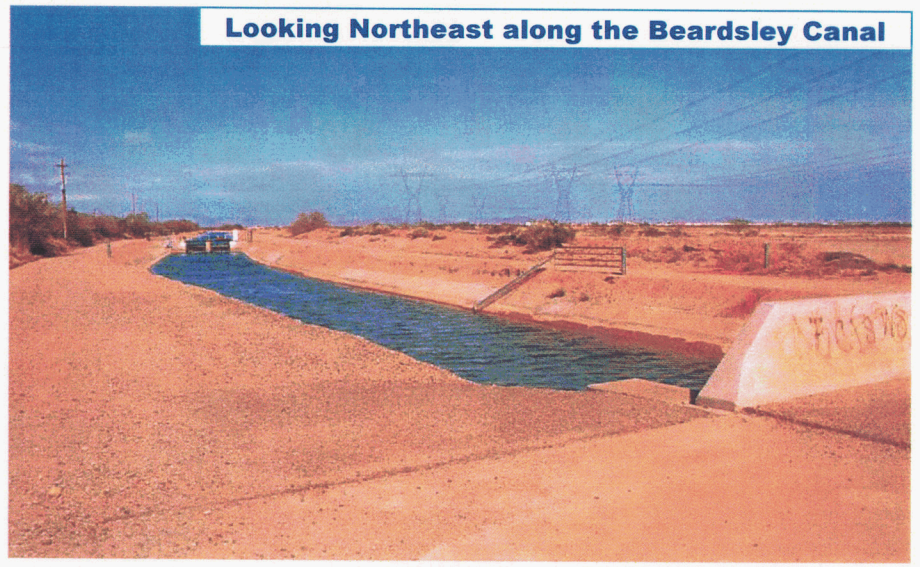
The estimated NWS at the Beardsley Canal is approximately 1,336.0. The estimated design water surface elevation for the inlet to the Alternative E pipeline will be approximately 1,338.0, which will be the CWS, the elevation that the Beardsley Canal will provide most consistently. Although MWD guarantees the CWS the majority of the time, in an emergency the water surface may drop below the CWS.

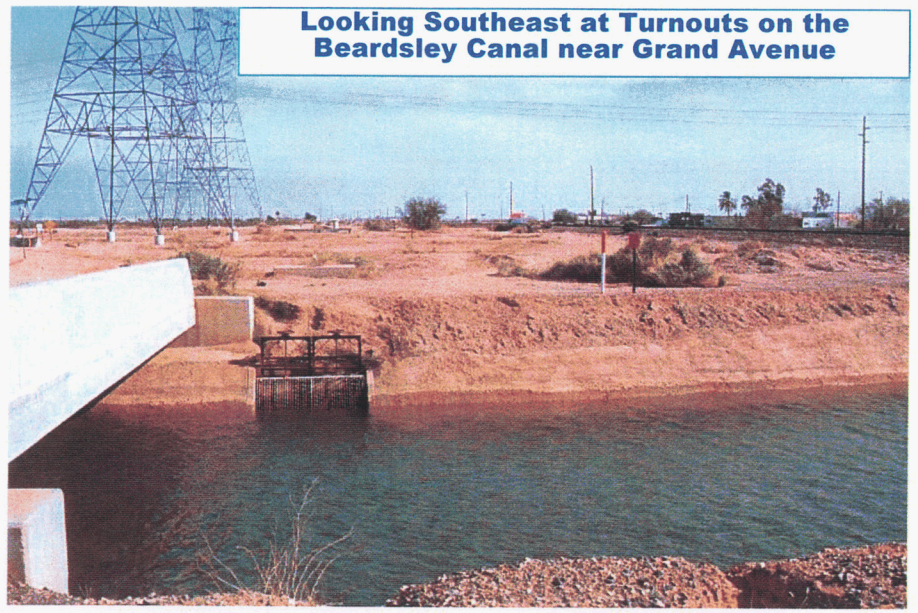
Looking Southeast along the



The CWS elevation is used as the basis for the hydraulics design of the pipeline. The water surface elevation, which can be translated into pressure at the delivery point in the Sun City Area, is calculated by subtracting the losses incurred in the pipeline from the CWS elevation at the Beardsley Canal. The major portion of the losses in the pipeline will be from friction. There are minor losses when valves or bends in the pipe are encountered, but these are typically insignificant. Vacuum relief valves and air release valves will be required on the pipeline at high points and other locations, and isolation valves will be included to allow the pipeline to be isolated for one-mile segments.

Looking Northeast along the Beardsley Canal

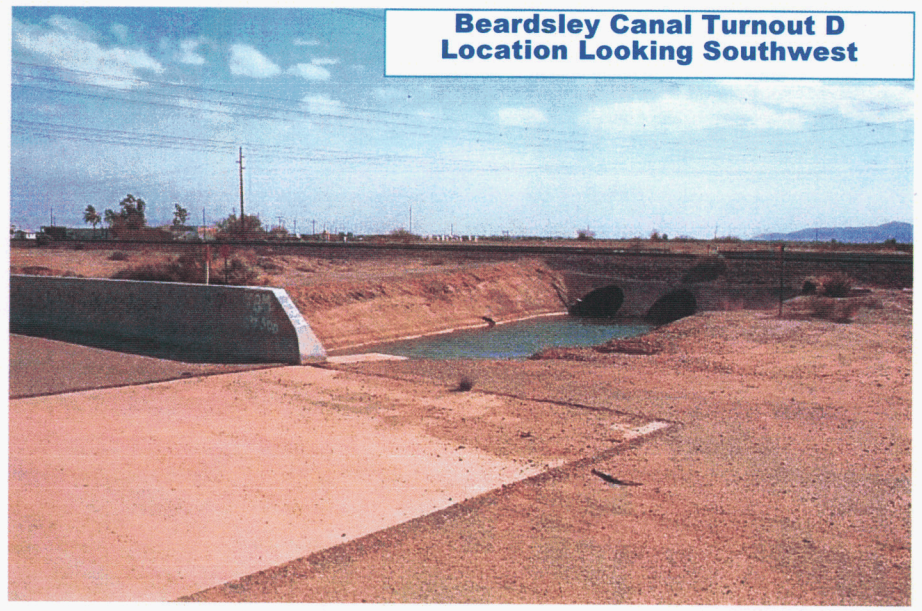




Looking Southeast at Turnouts on the Beardsley Canal near Grand Avenue

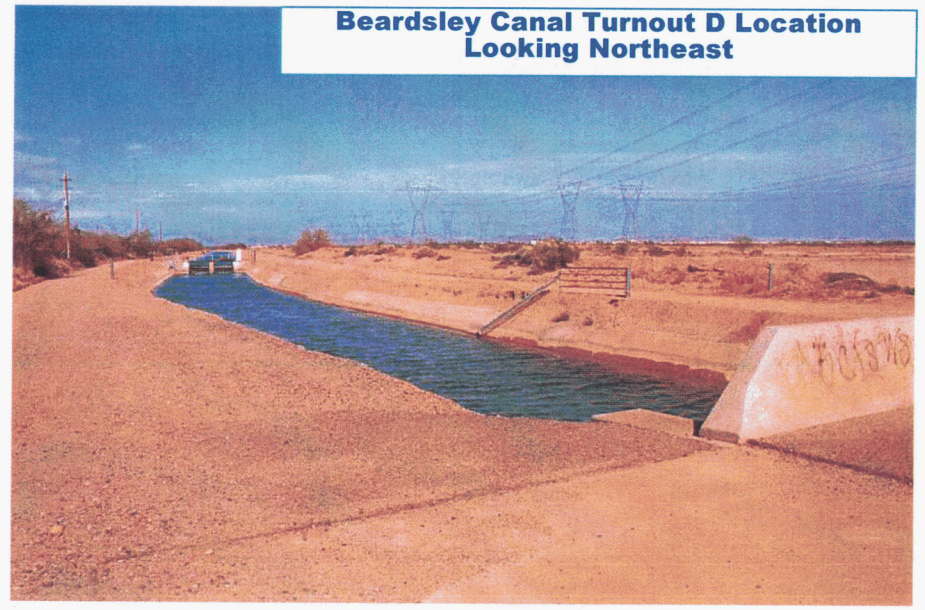
The preliminary hydraulics analysis indicates that a 24-inch diameter pipe will be required to deliver water a flow rates and pressure to adequately serve Sun City West and Sun City distribution systems. Because the static pressure for this system is approximately 55 psi, pressure-reducing valves will not be required to reduce the pressure prior to reaching the delivery system.

The delivery pipeline from Alignment E was assumed to connect to the existing SCW effluent delivery system. Because the closest point of connection is on the downstream end of the system, the pipes are relatively small diameter. These small diameter pipes require high pressure to drive the flows back to the Aqua Fria crossing and into Sun City. Calculations indicate that the existing SCW effluent system is inadequate to carry the required flows back to and across the river, without increasing the pressure in the pipeline via a new pumping system. The pressure required would exceed the physical limits of the existing pipe and could potentially produce excessive leakage and pipe breaks. The delivery pressure produced by gravity flow in the Alternative E pipeline is not adequate to provide flows at the various discharge locations. It will, therefore, not be possible to deliver water from the joint facility pipeline via the Alternative E pipeline.



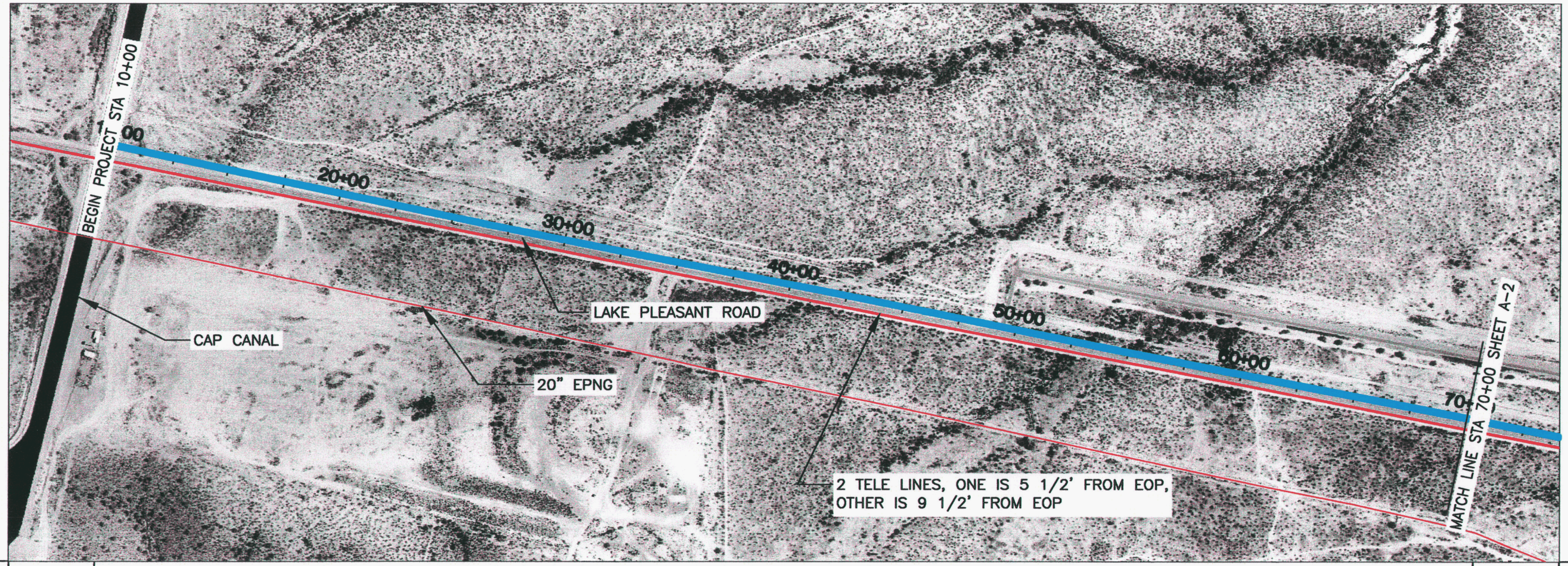
Beardsley Canal Turnout D Location Looking Southwest

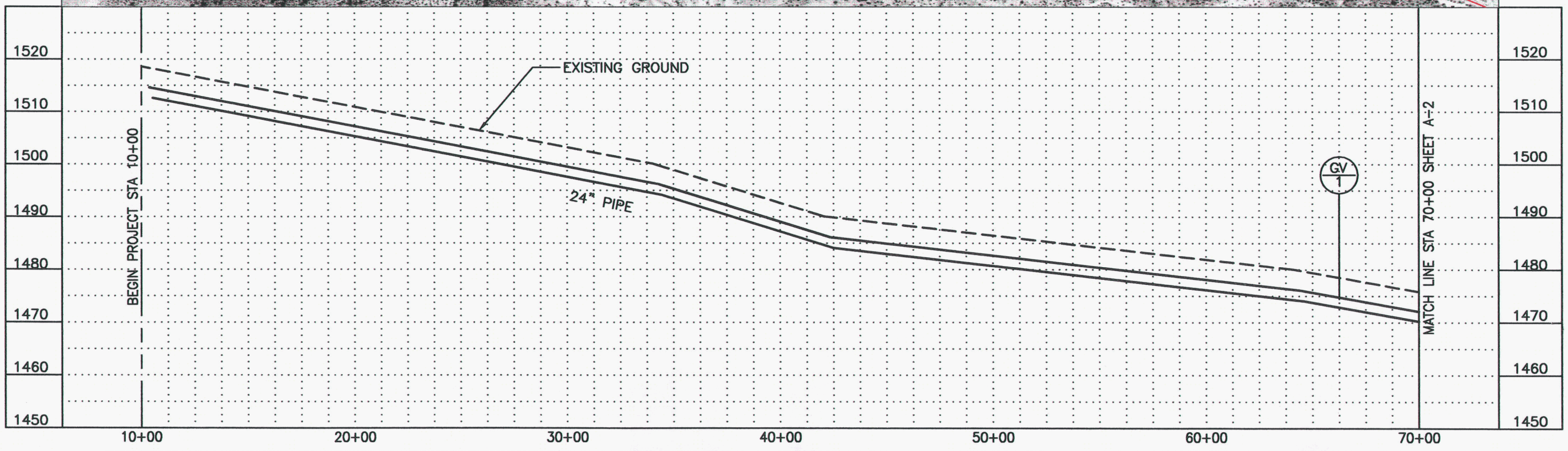
The SCW effluent irrigation system is owned by the Recreation Centers of Sun City West, Inc.. The Recreation Centers has indicated to CWR that the pipeline crossing of the Agua Fria River cannot be used to convey CAP from west to east (the direction of flow required for the Alternative E alignment) because of their obligation to provide effluent to Sun City West Recreation Center golf courses in an east to west direction.



Beardsley Canal Turnout D Location Looking Northeast

The use of GSP Alternative E will not be considered as a delivery method for CAP water to the GSP due to the hydraulic and legal reasons stated in the two preceding paragraphs.





HDR Engineering, Inc.

Issue No.	Description	Date	Drwn.	Chkd.	Resp. Engr.	Prof. Mgr.

Project Manager	
Architect	ME
Civil	Structural
Electrical	Structural
Process	Drawn By

CITIZENS water resources

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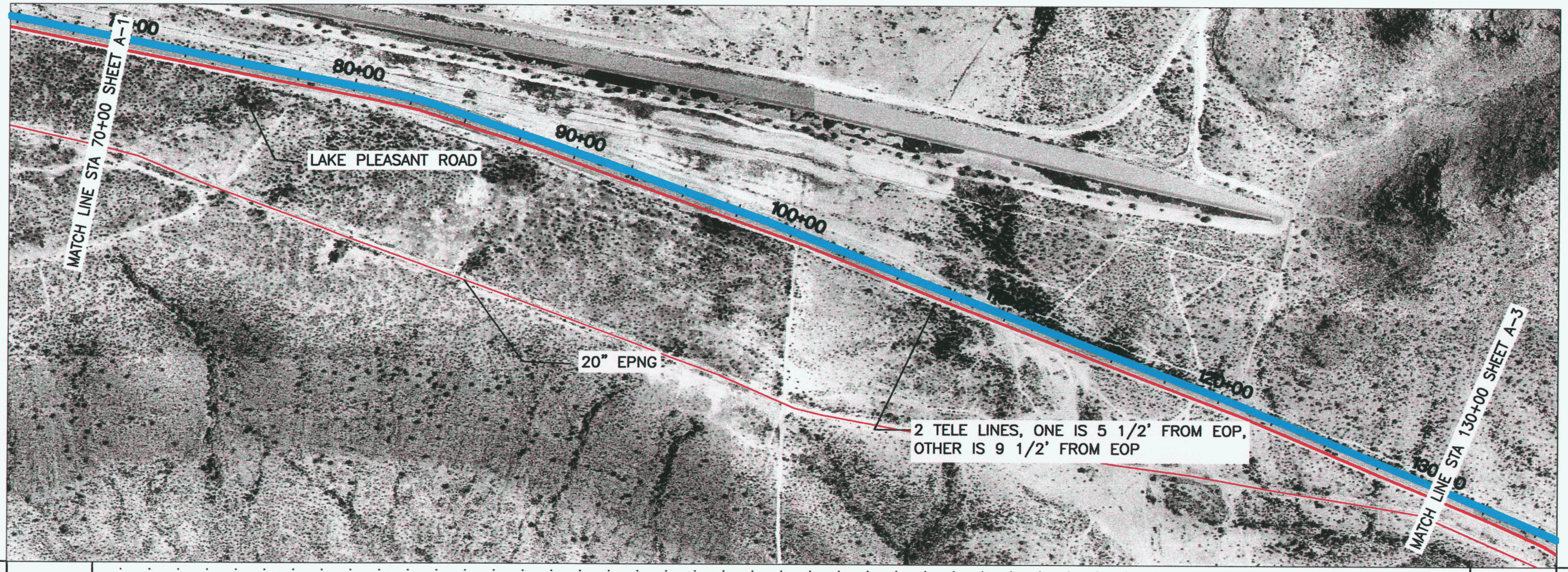
PRELIMINARY
NOT FOR CONSTRUCTION

Date	Project No.	Drawing No.	Issue
Scale 1"=500'		SHEET A-1	



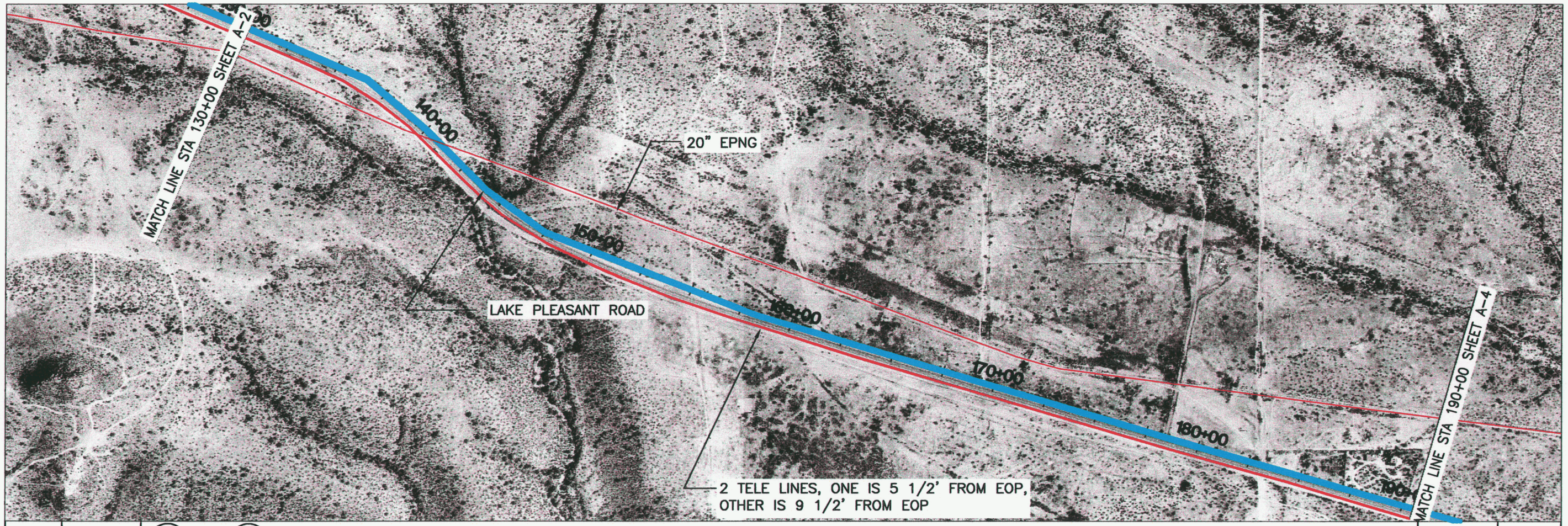
HDR Engineering, Inc.

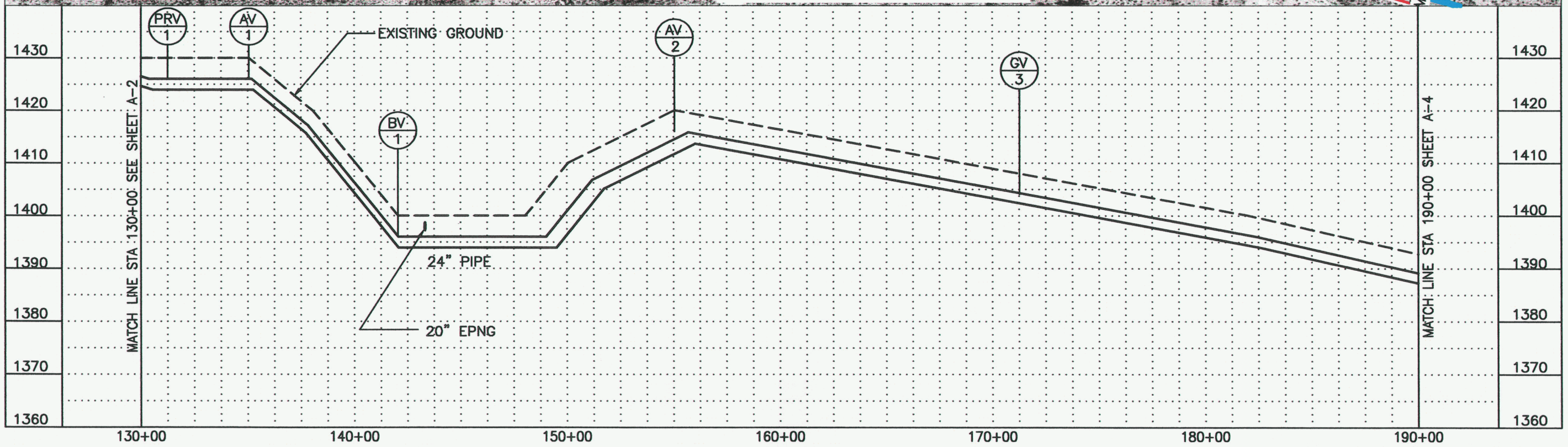
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

Scale: 1"=500'

SHEET A-2





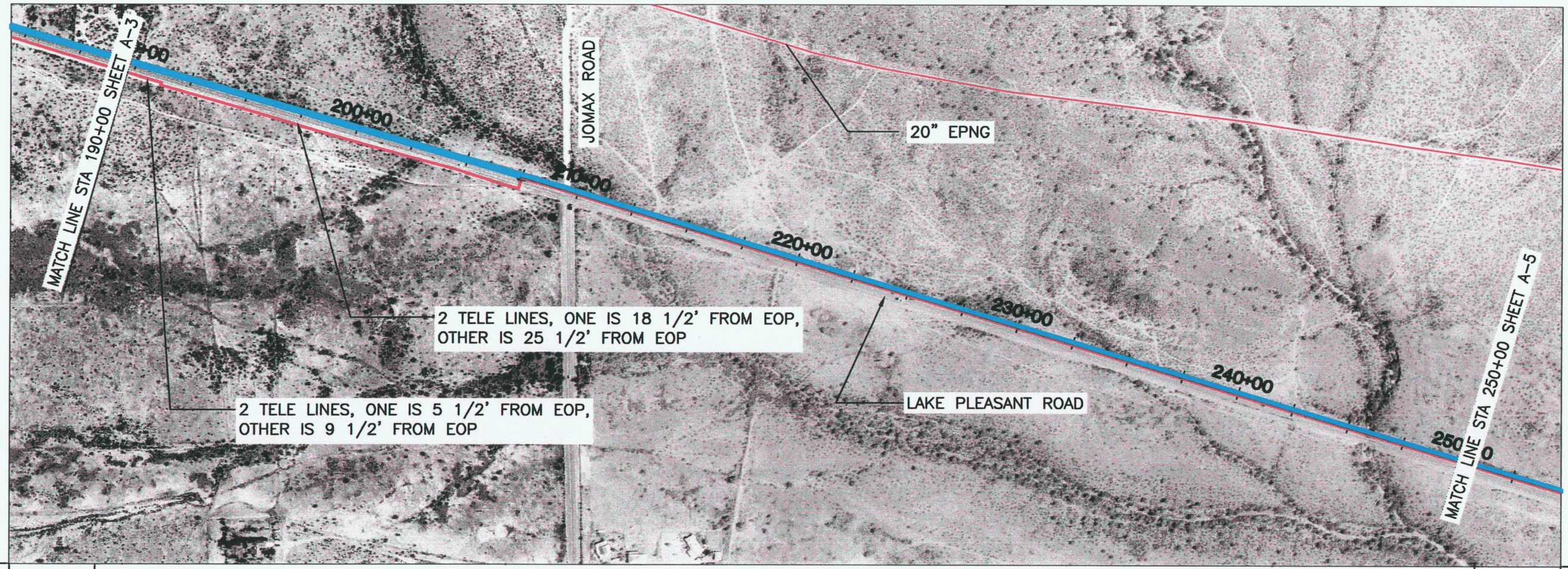
HDR Engineering, Inc.

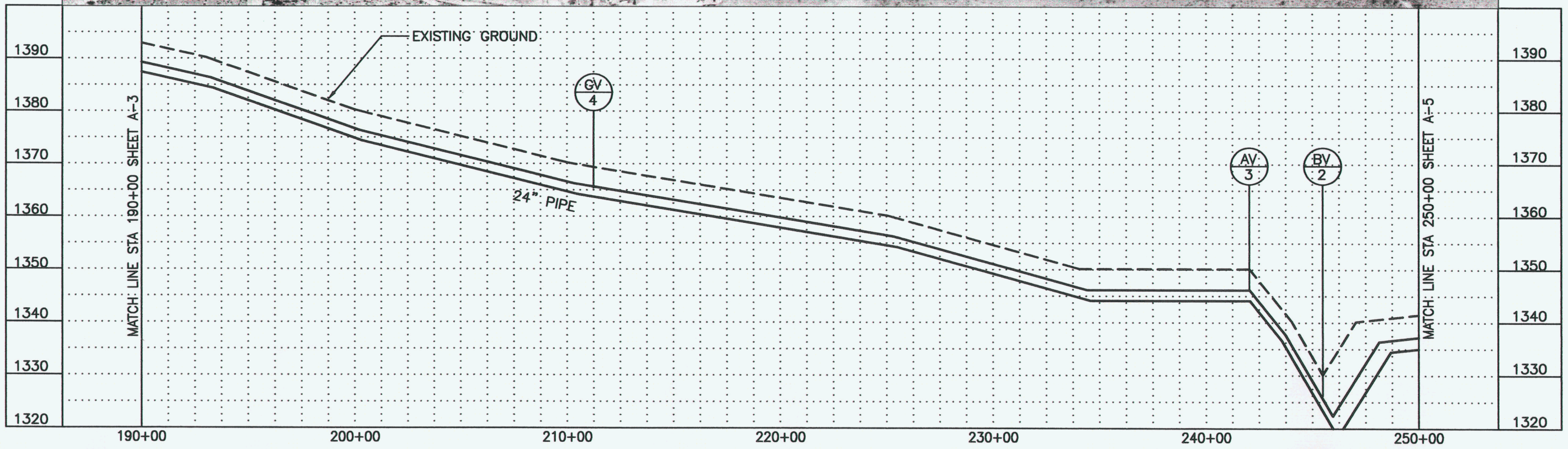
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

SHEET A-3





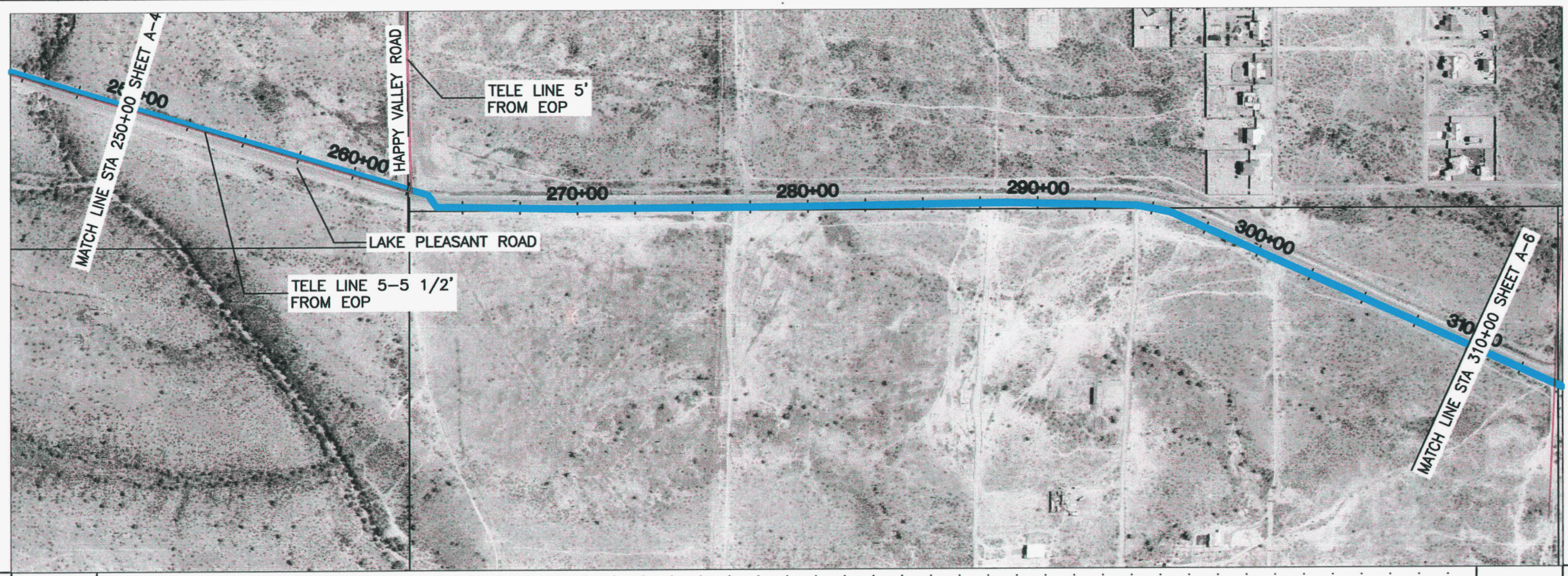
HDR Engineering, Inc.

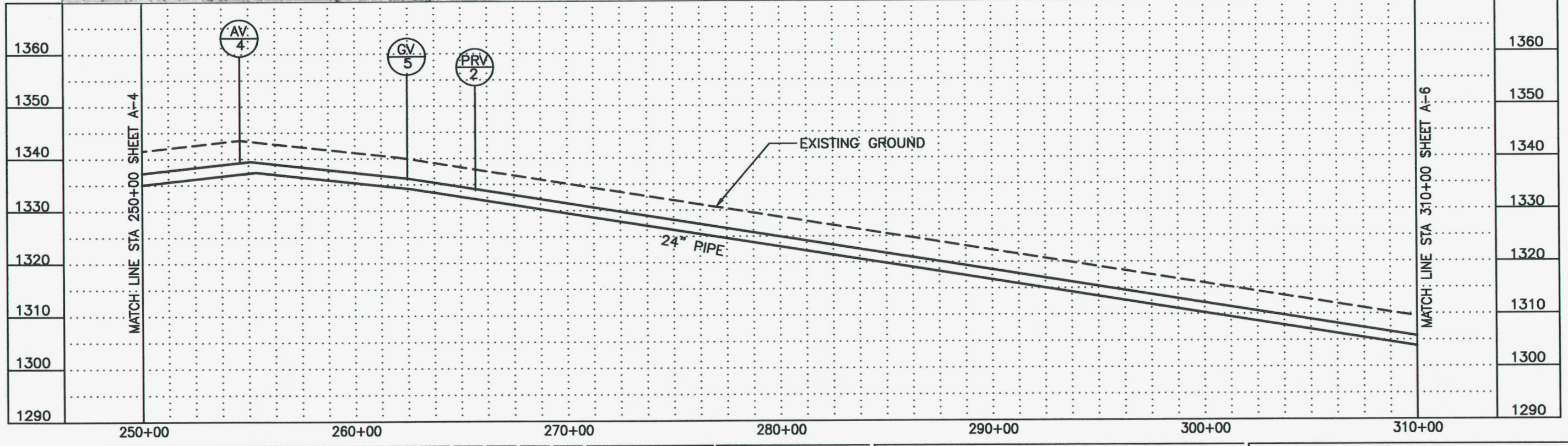
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

Scale: 1"=500'

SHEET A-4





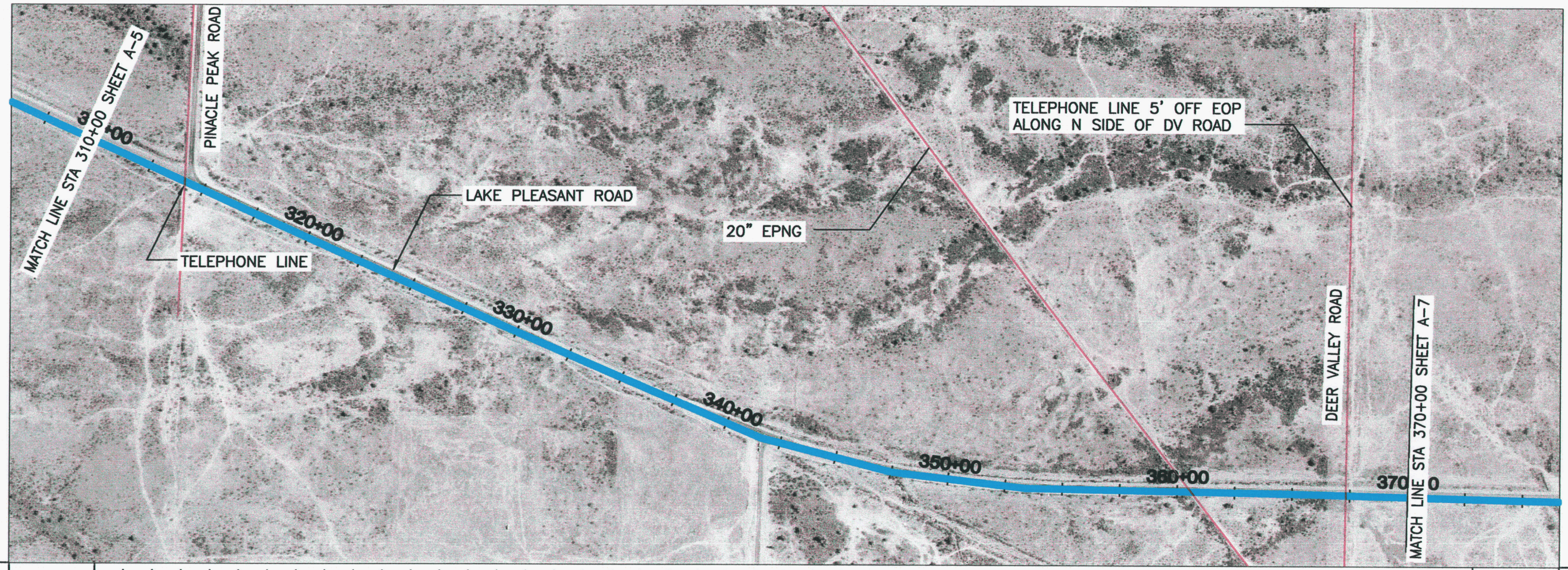
HDR Engineering, Inc.

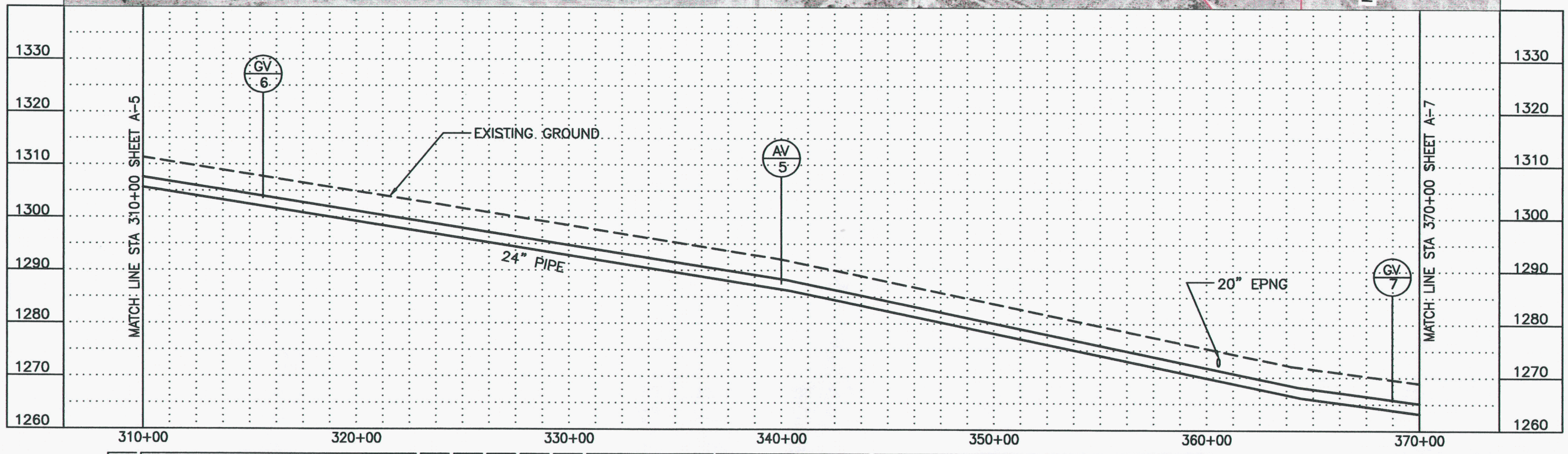
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

Scale: 1"=500'

SHEET A-5





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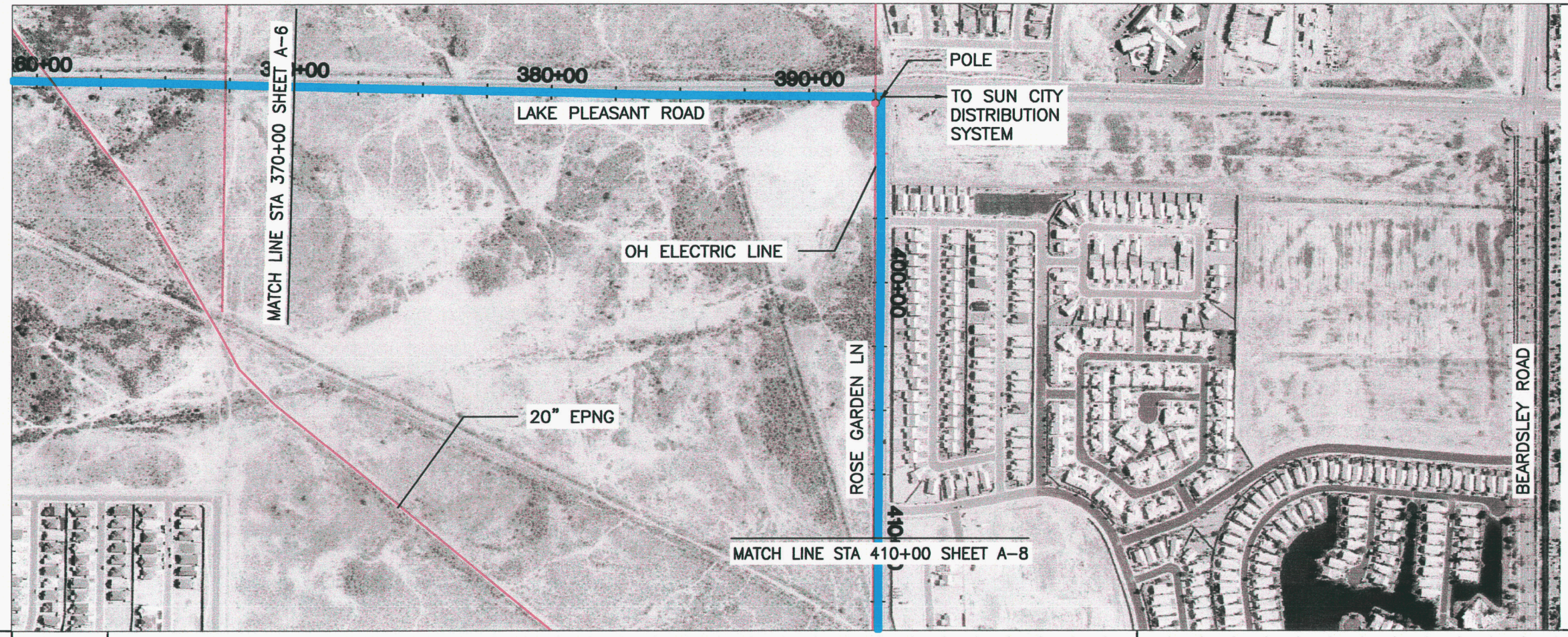
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

SHEET A-6



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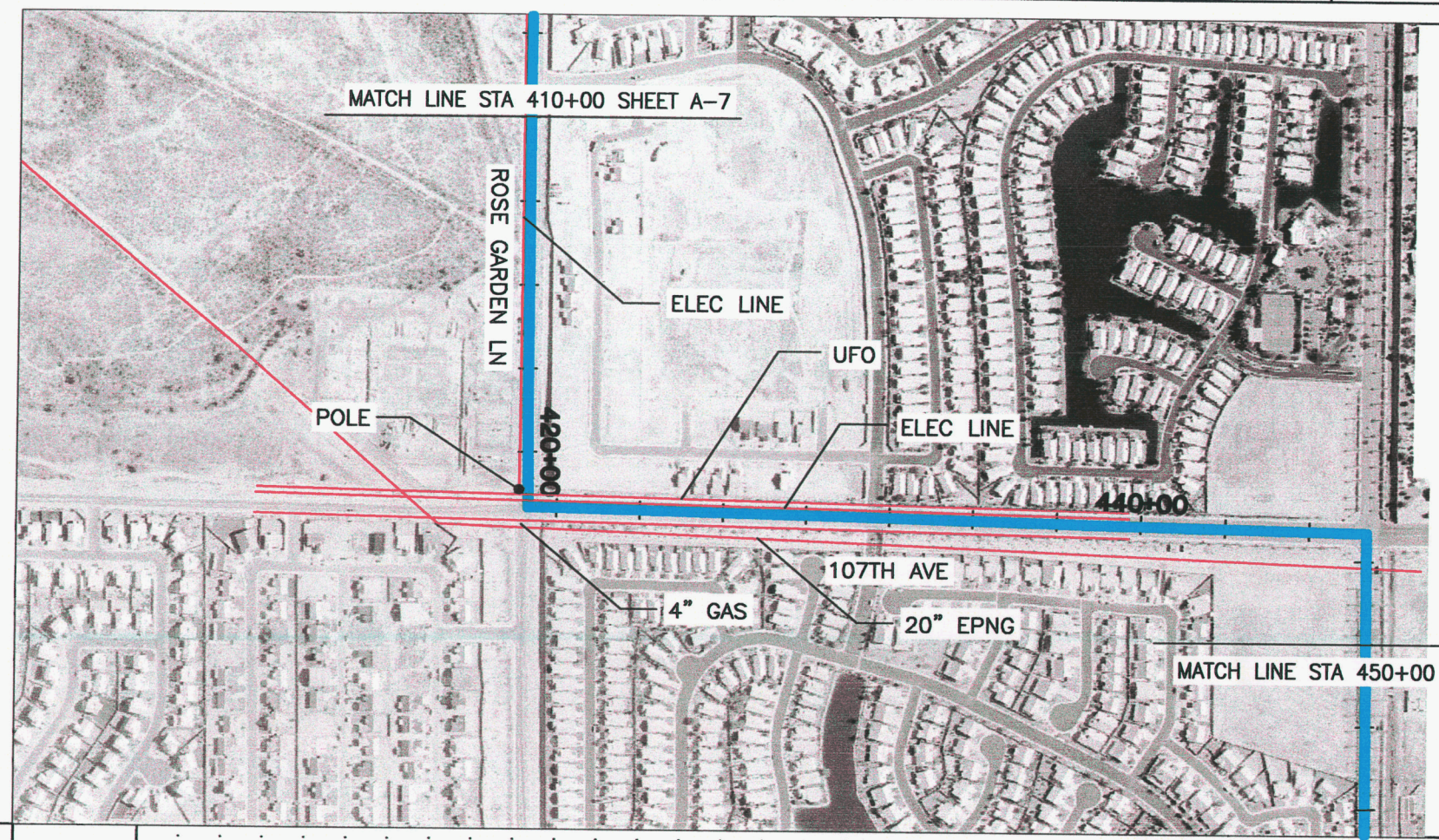
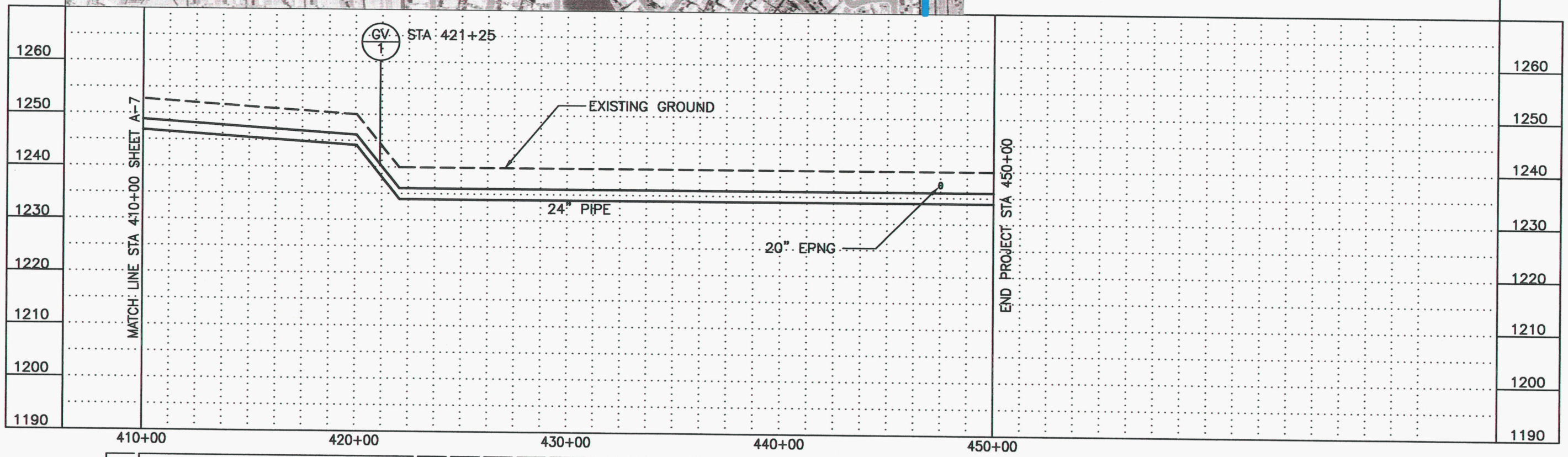
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

Scale: 1"=500'

SHEET A-7





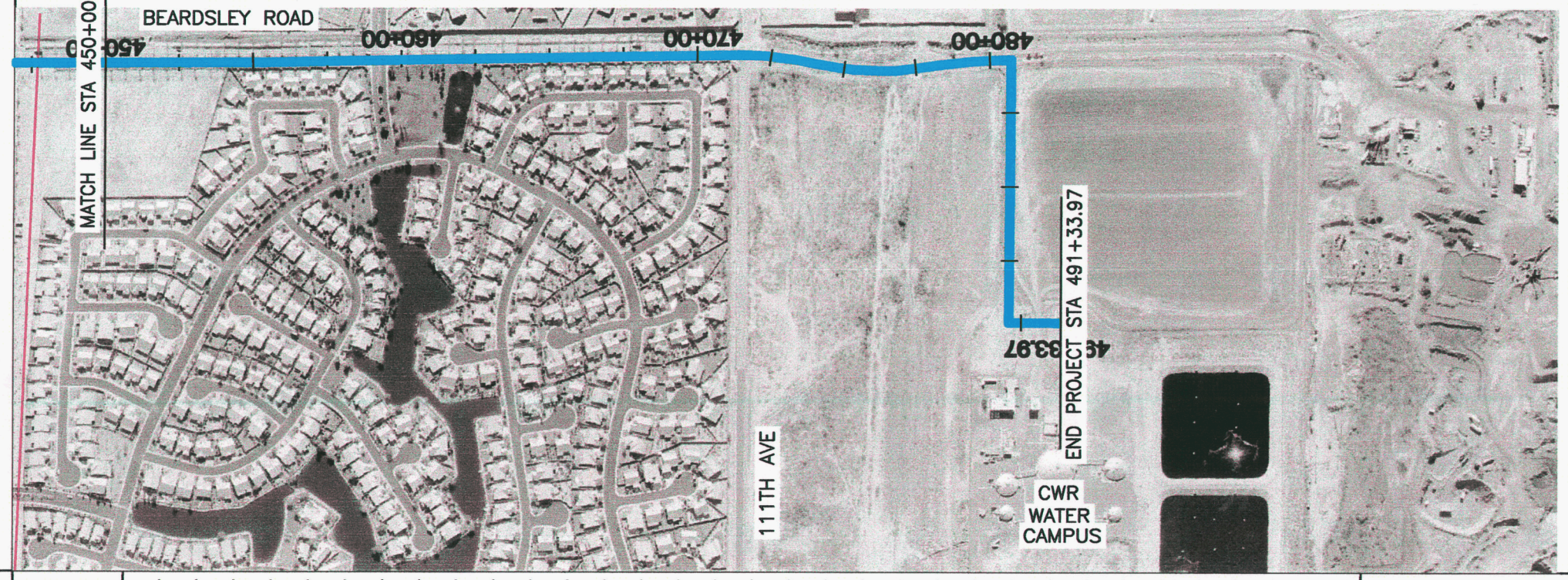
HDR Engineering, Inc.

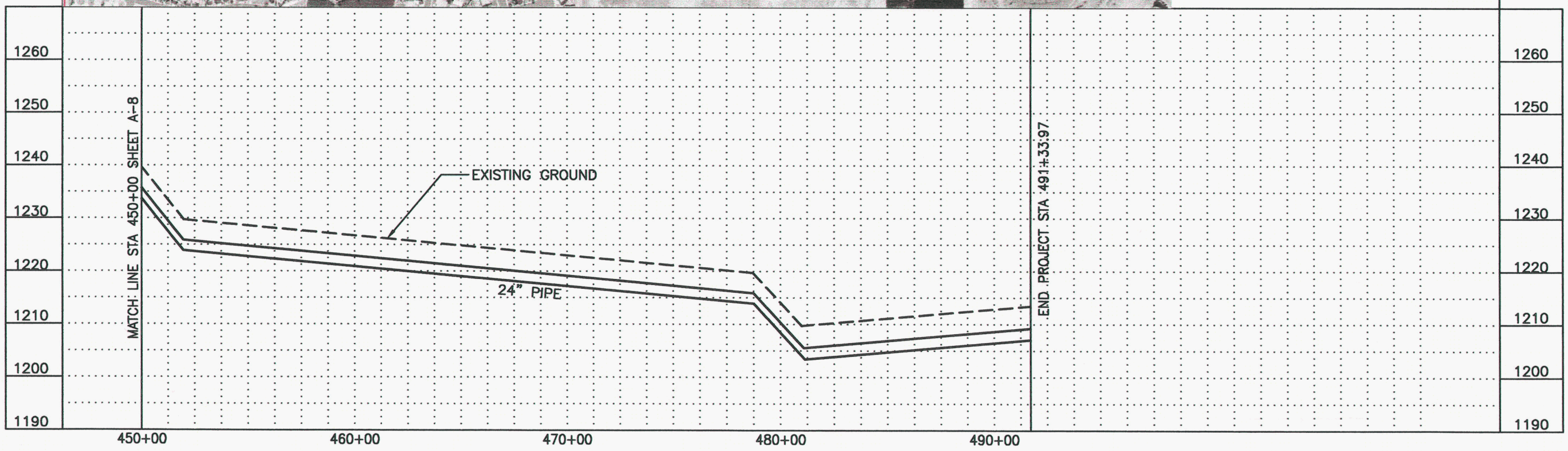
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

SHEET A-8





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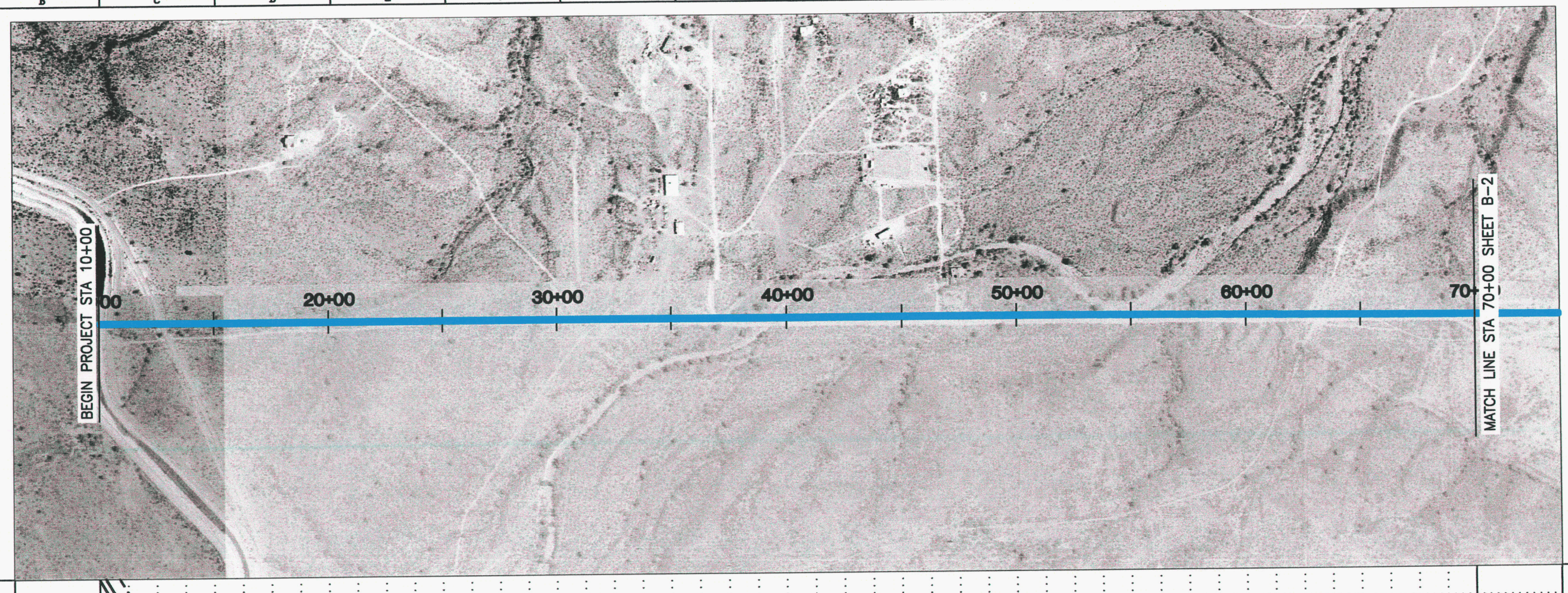
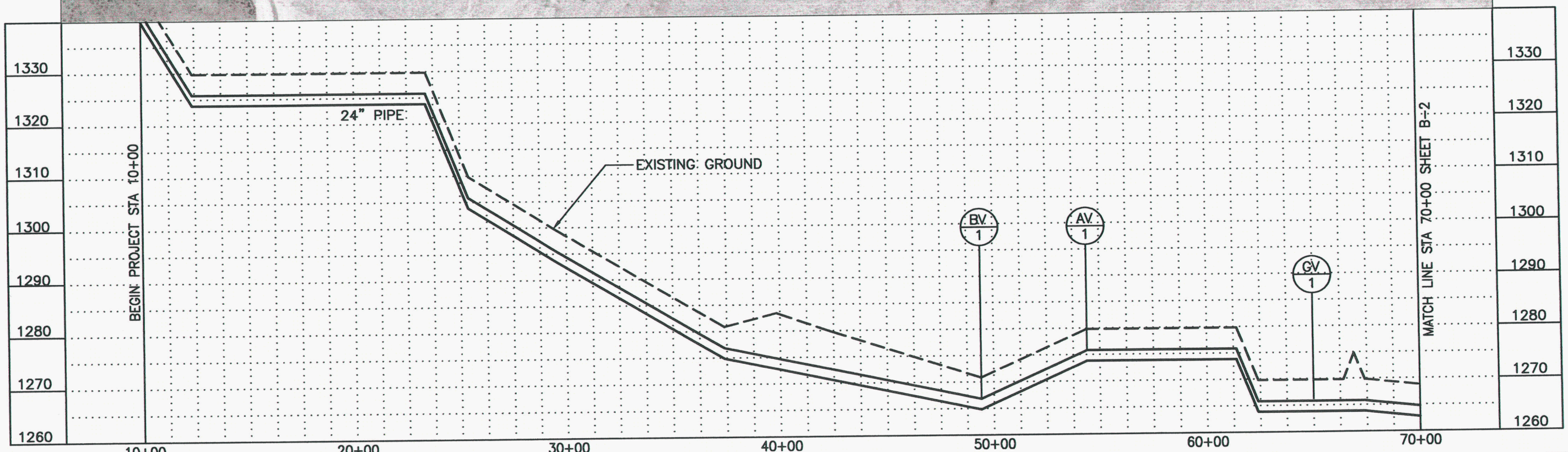
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

SHEET A-9





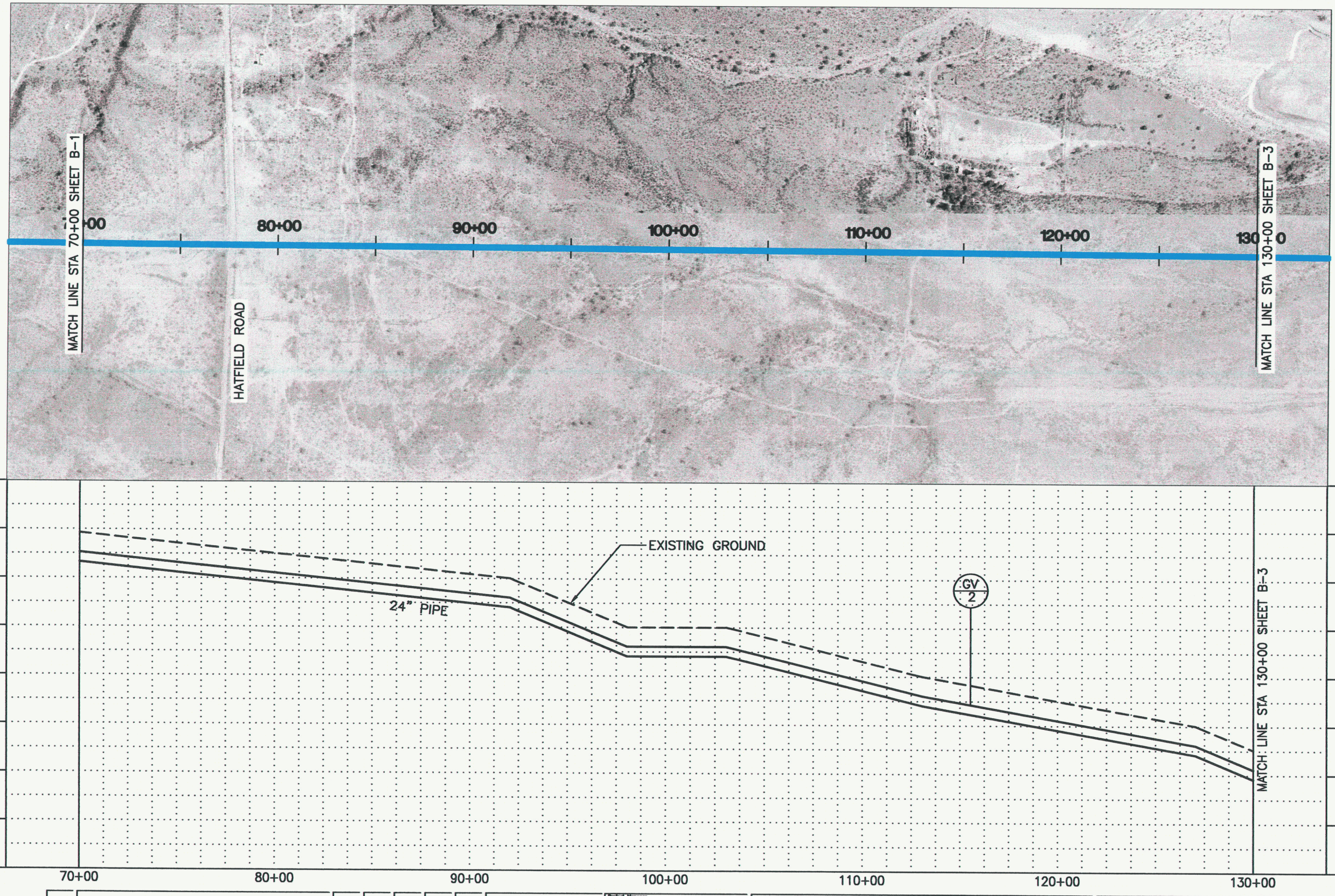
HDR Engineering, Inc.

CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

SHEET B-1



HDR Engineering, Inc.

CITIZENS water resources

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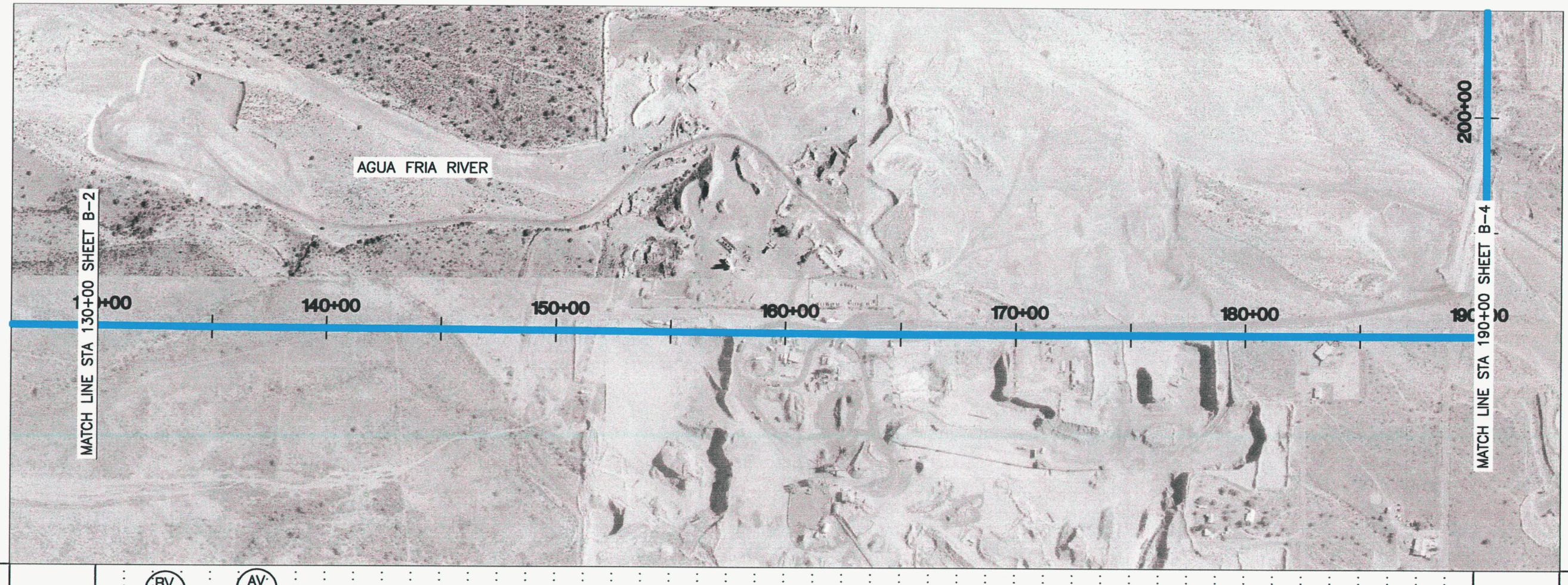
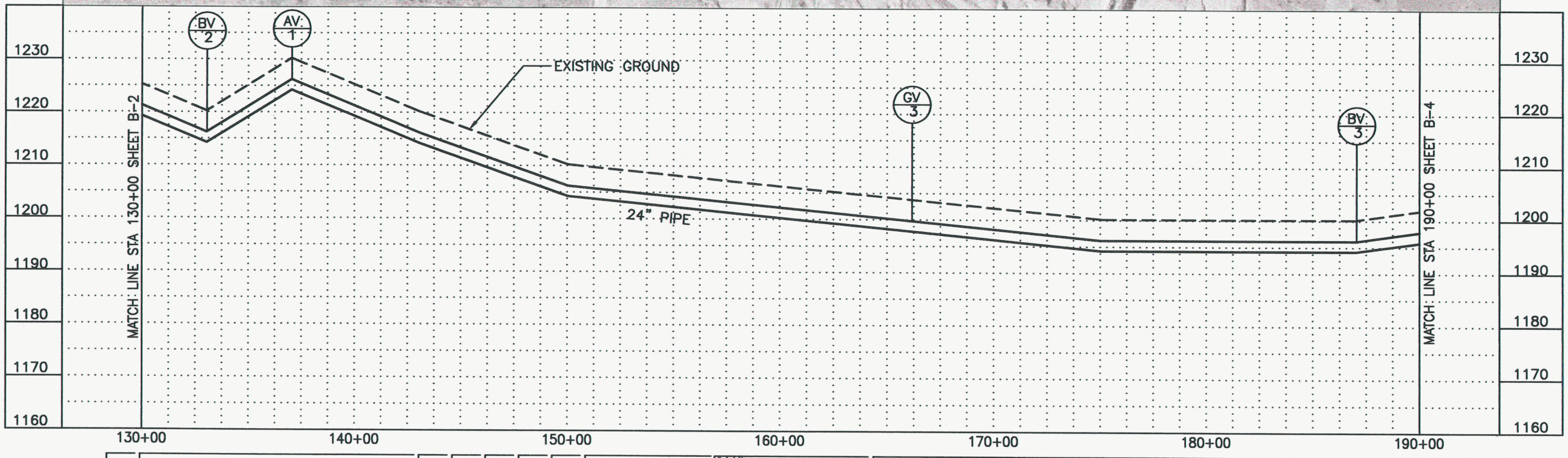
PRELIMINARY
NOT FOR CONSTRUCTION

Scale: 1"=500'

SHEET B-2





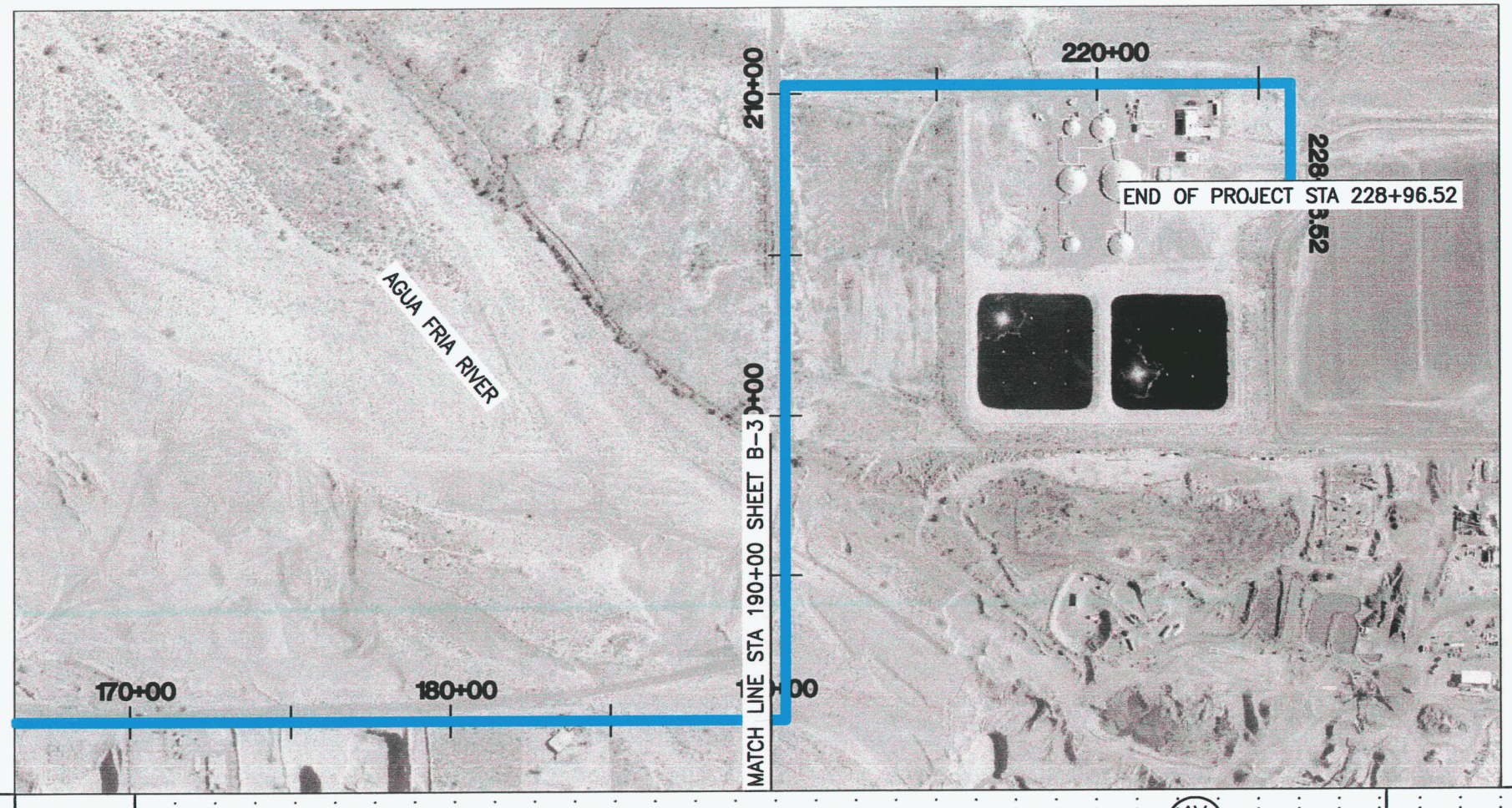
HDR Engineering, Inc.

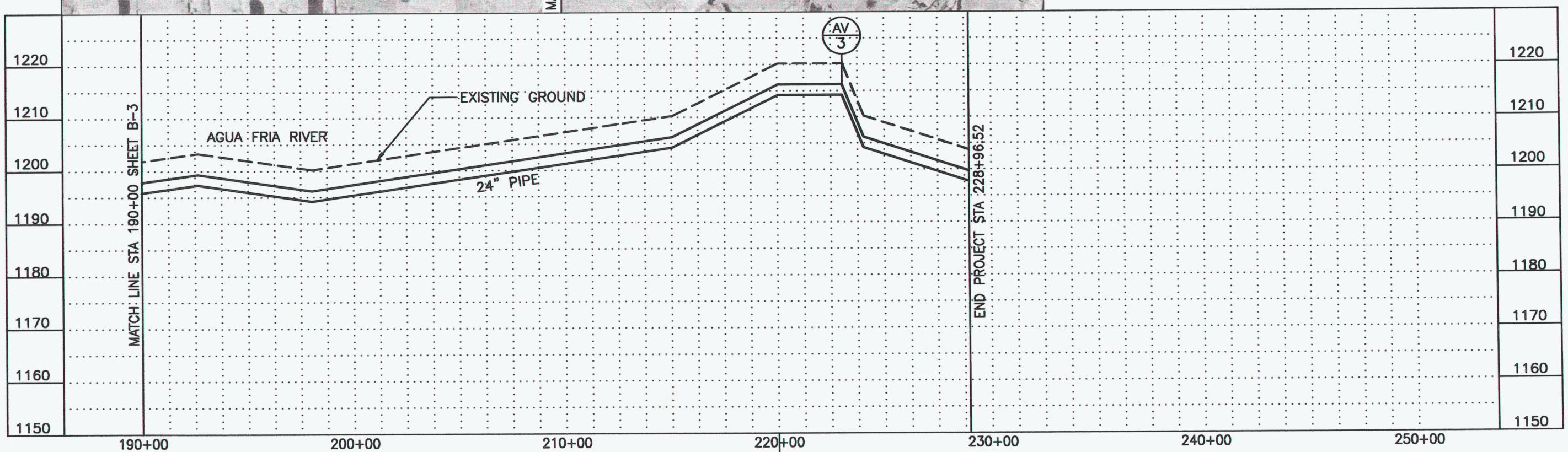
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

SHEET B-3





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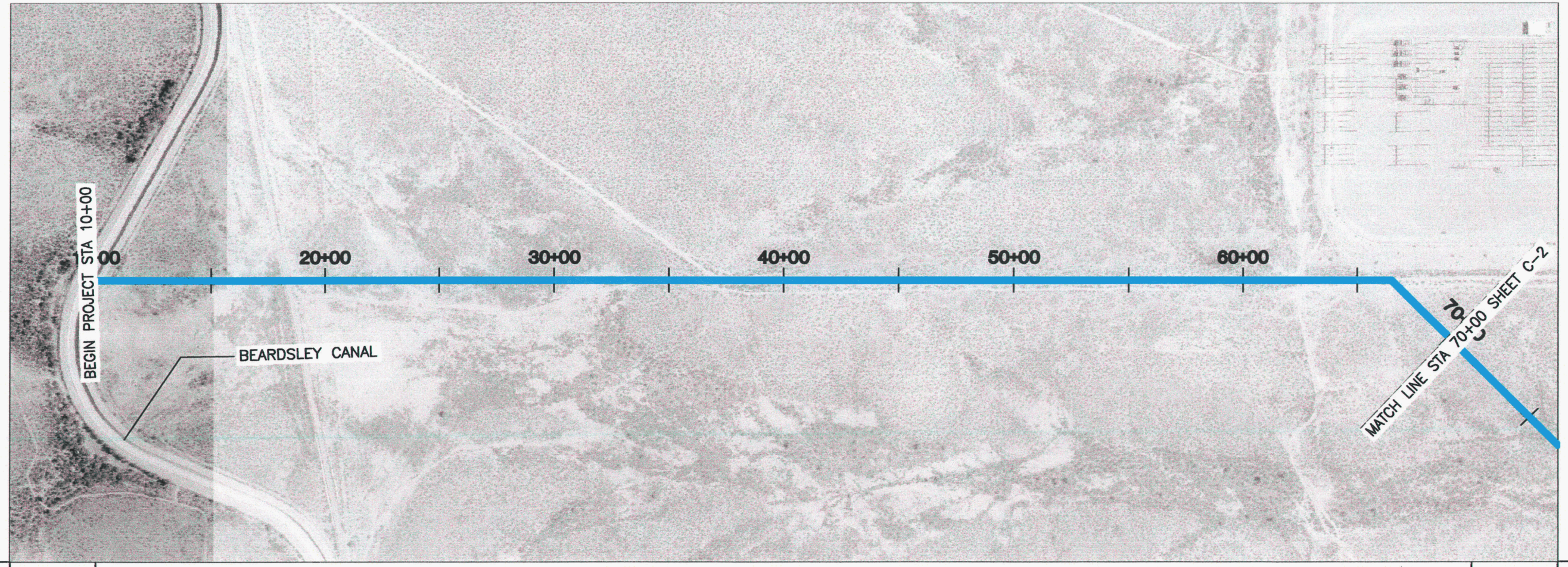
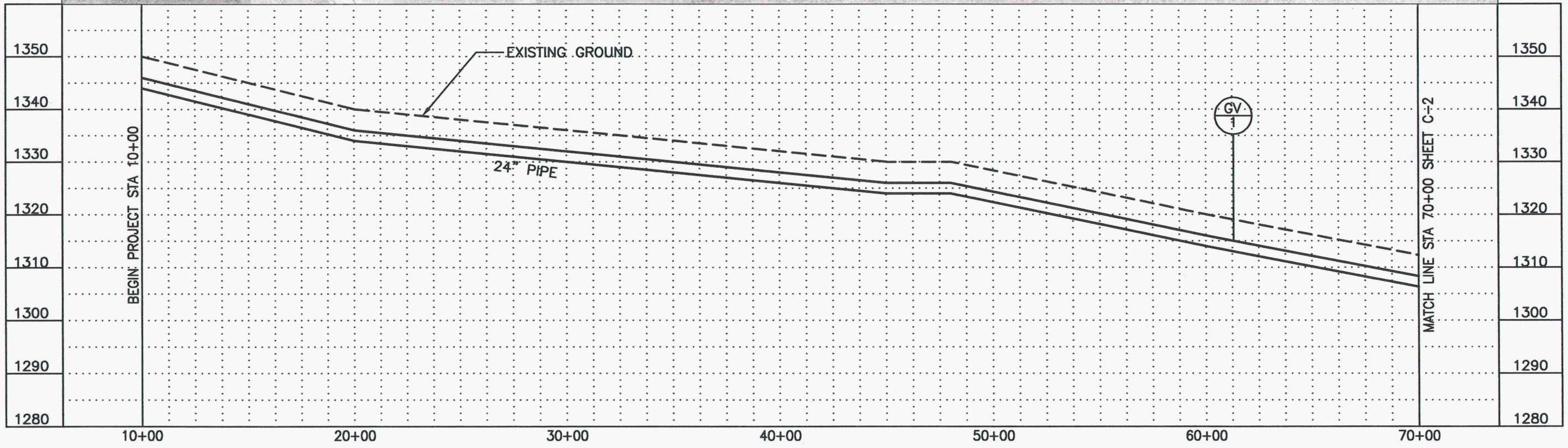
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

SHEET B-4





HDR Engineering, Inc.

CITIZENS water resources

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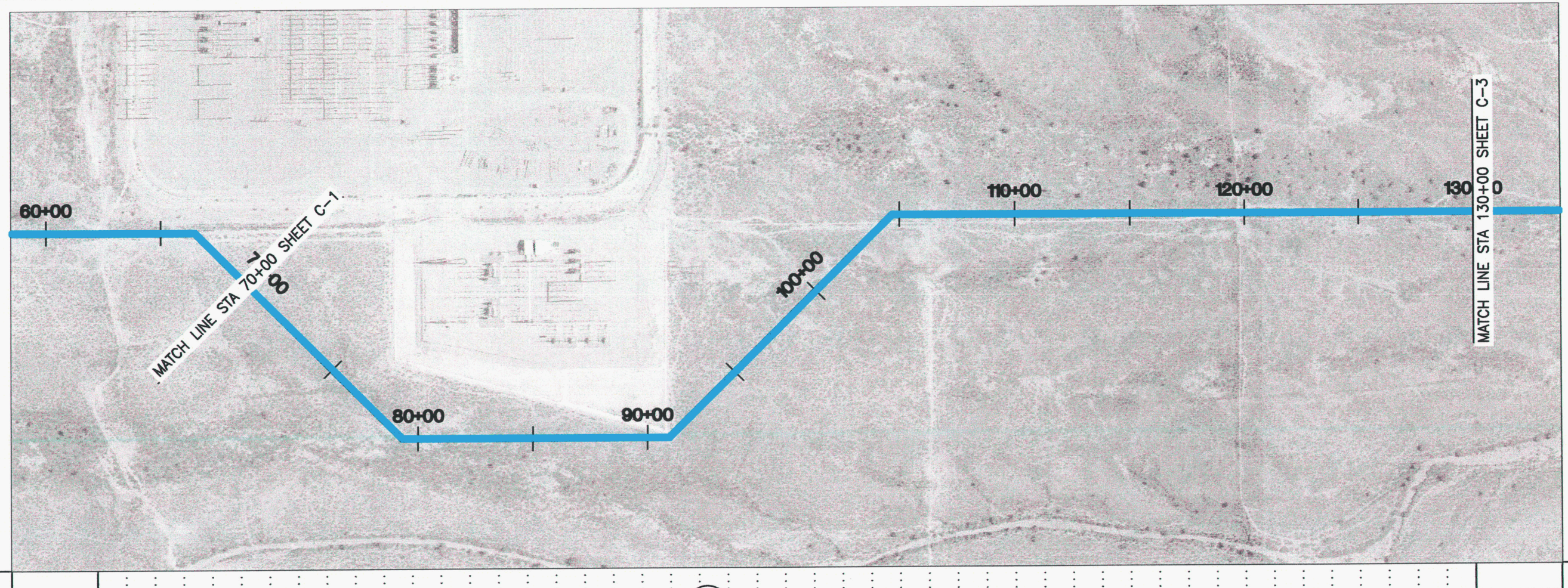
PRELIMINARY
NOT FOR CONSTRUCTION

Scale: 1"=500'

SHEET C-1



HDR Engineering, Inc.

CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

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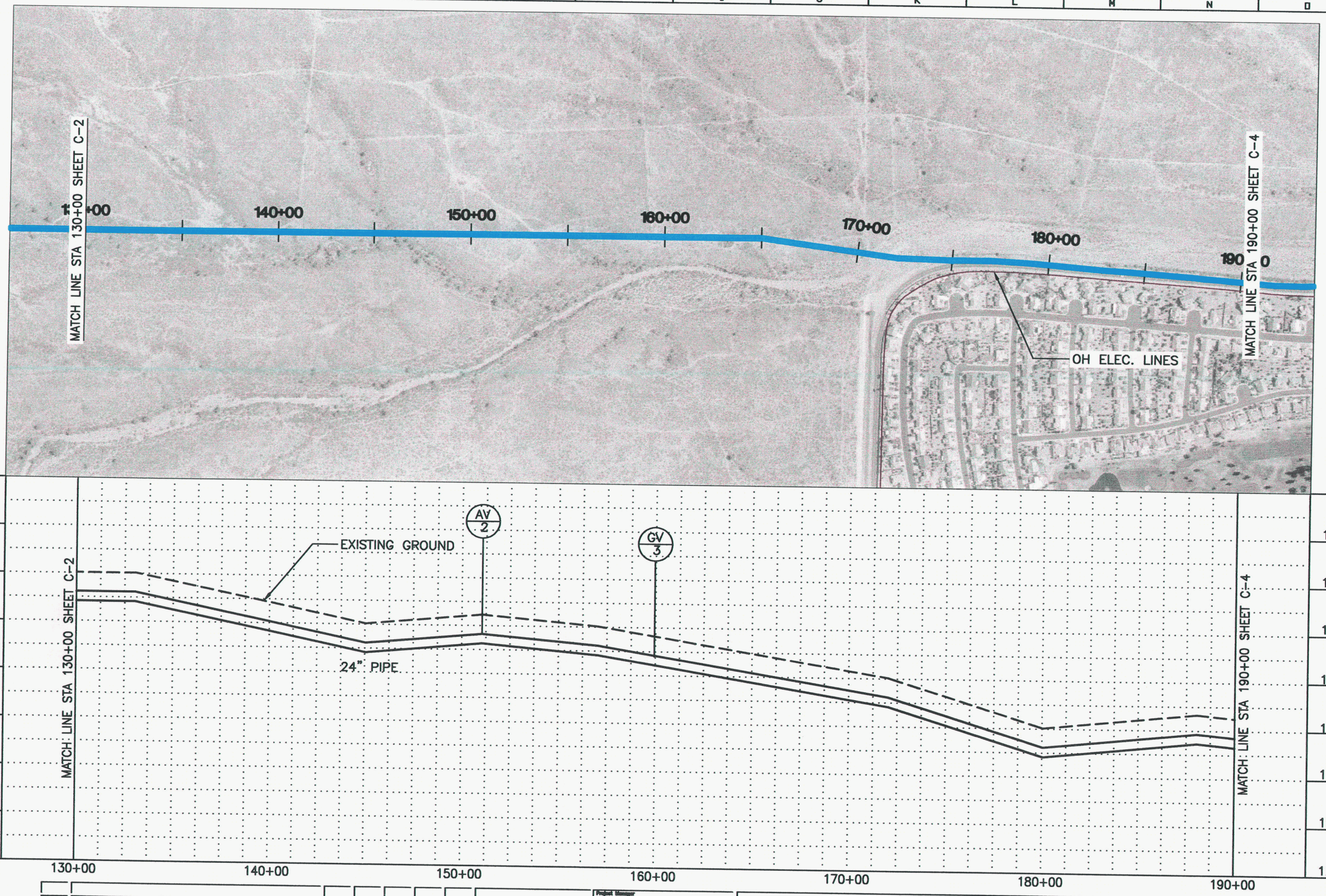


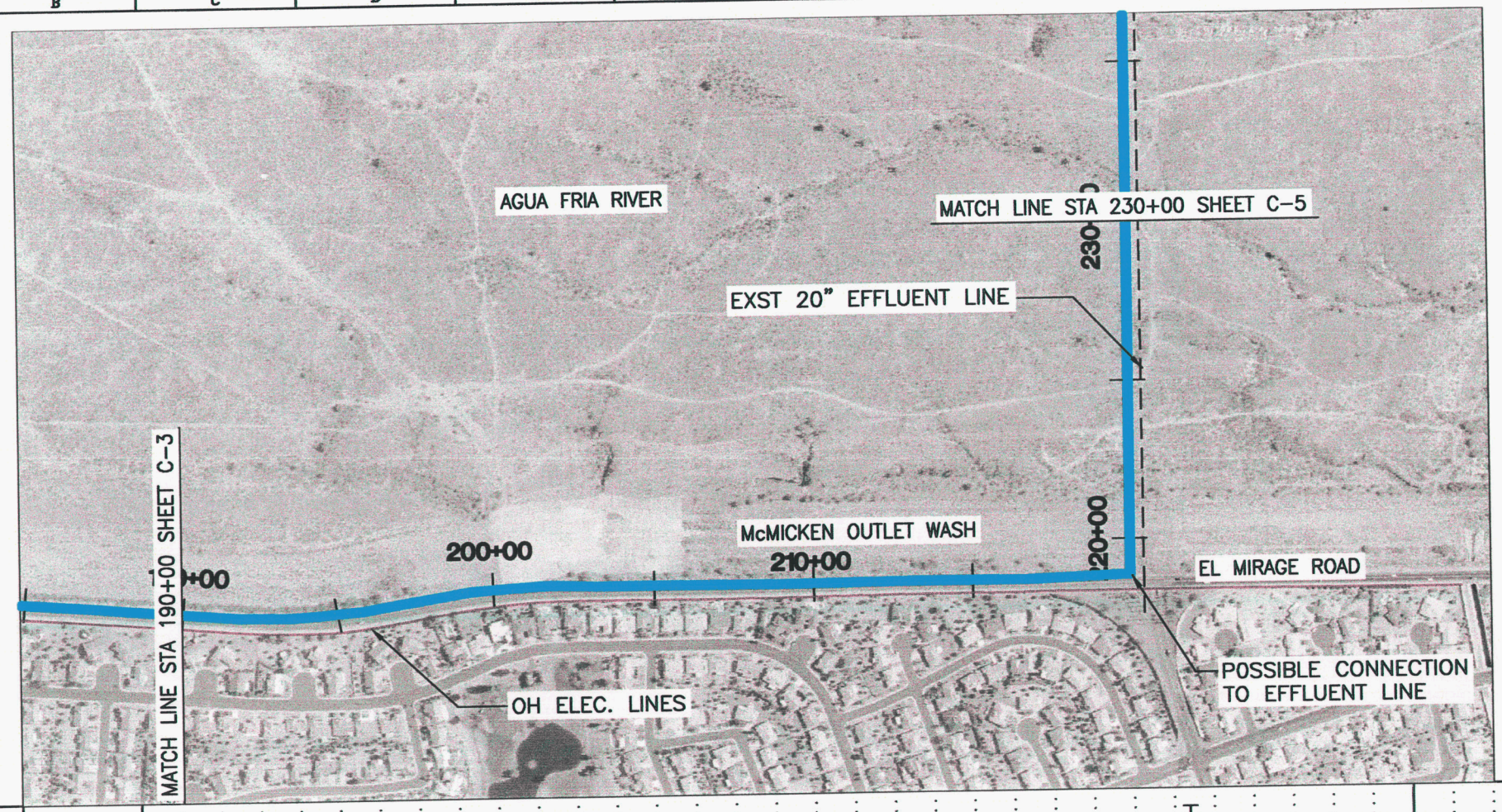
HDR Engineering, Inc.

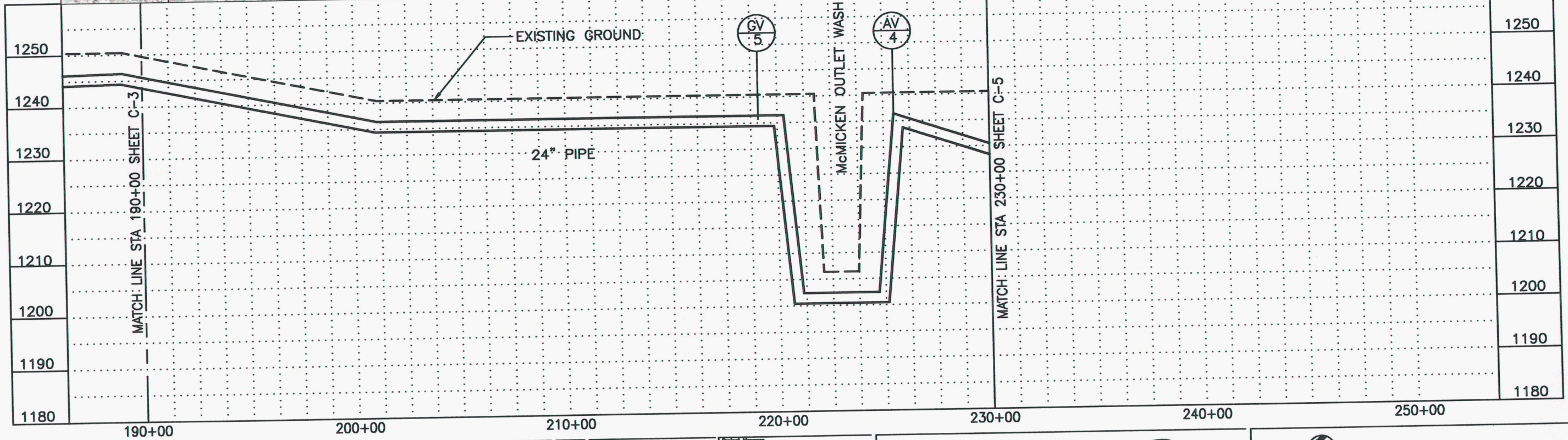
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

SHEET C-3





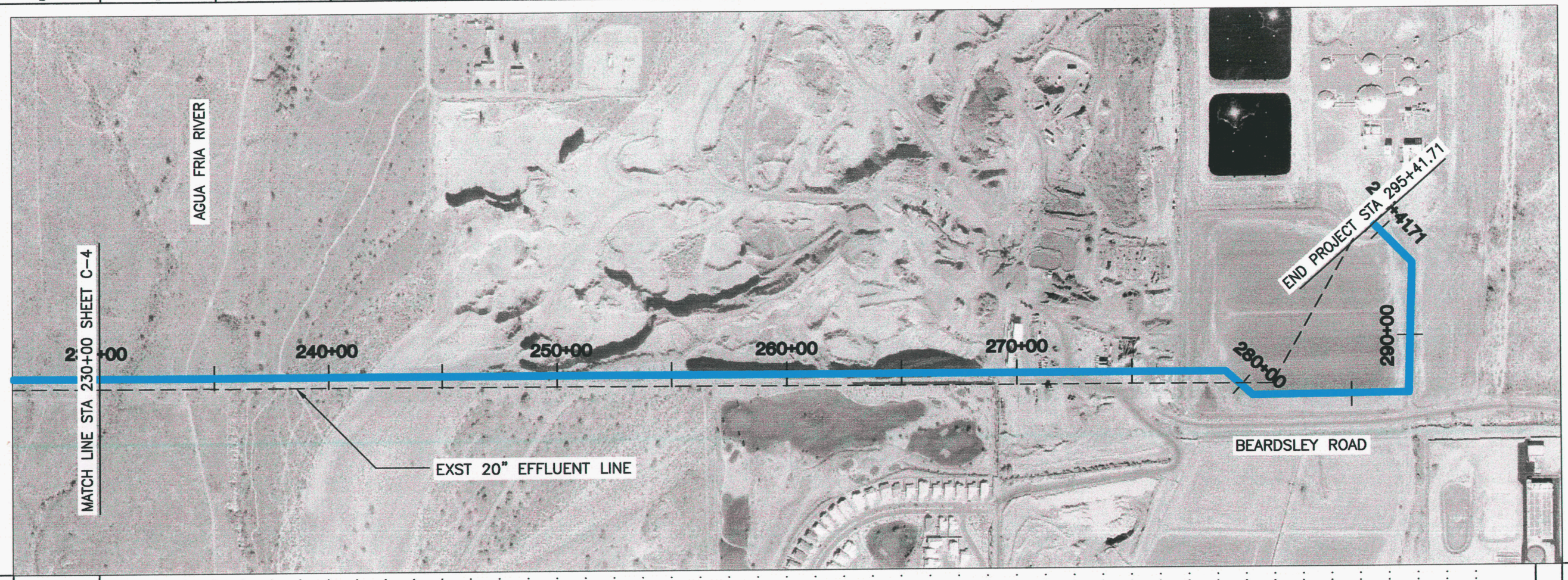
HDR Engineering, Inc.

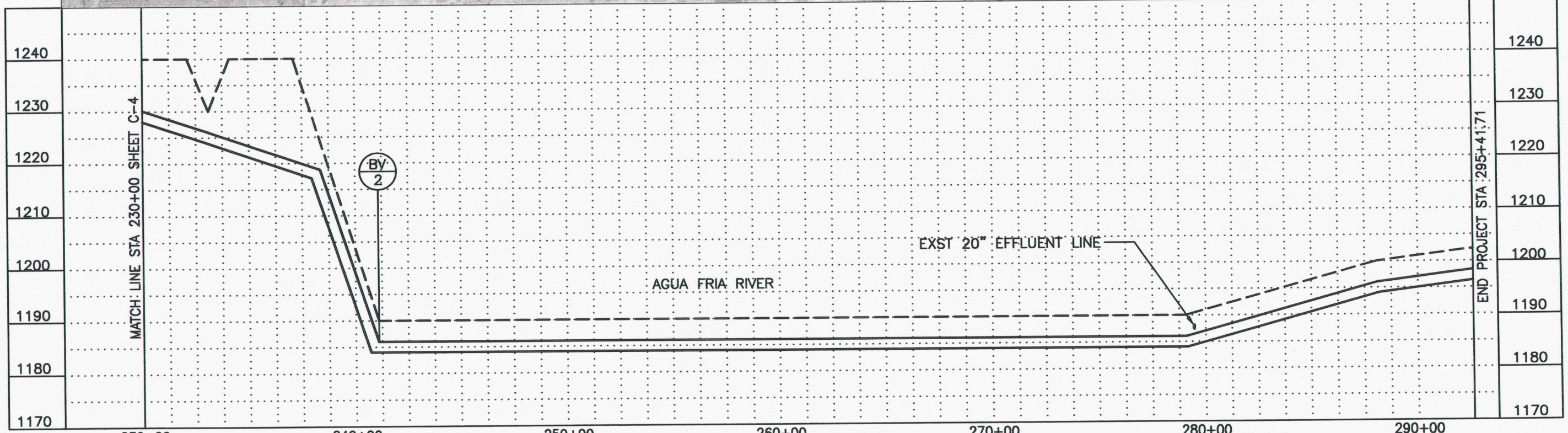
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

Scale: 1"=500'

SHEET C-4





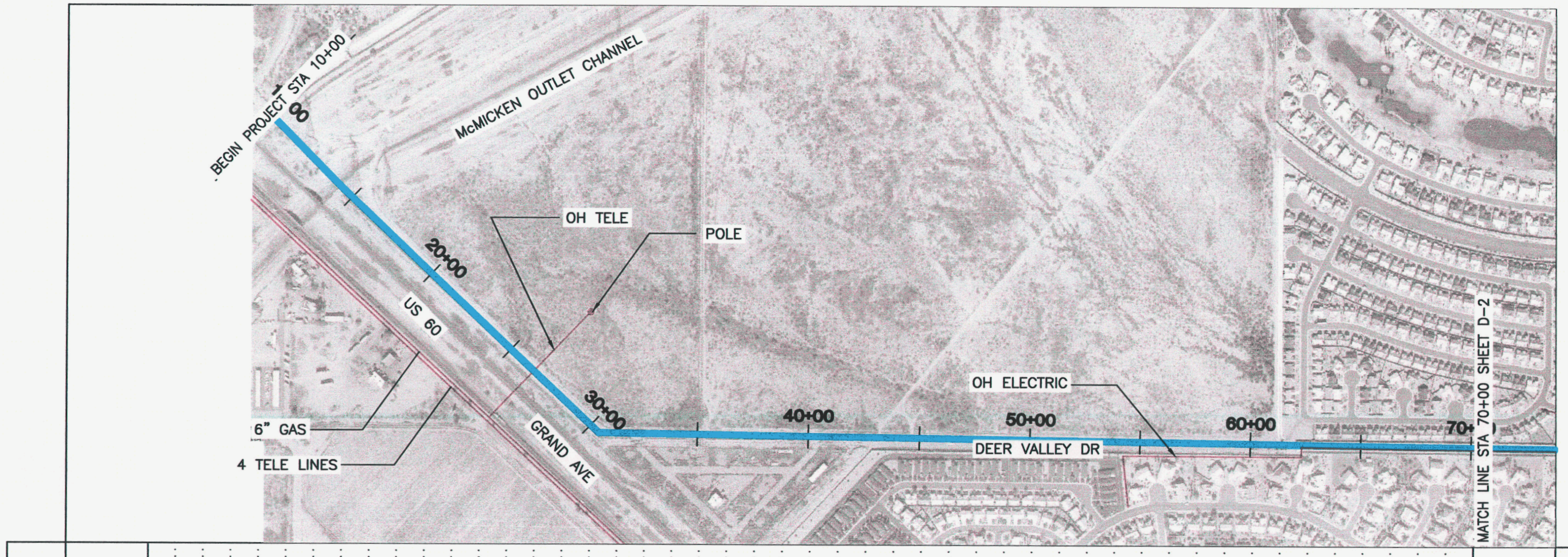
HDR Engineering, Inc.

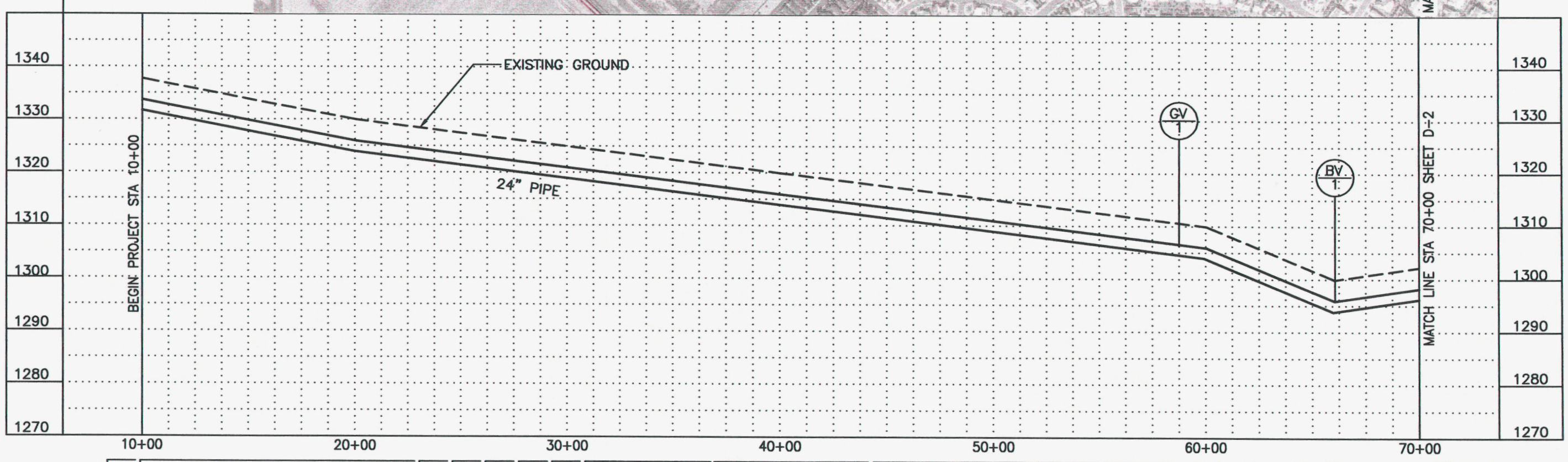
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

SHEET C-5





HDR Engineering, Inc.

CITIZENS water resources

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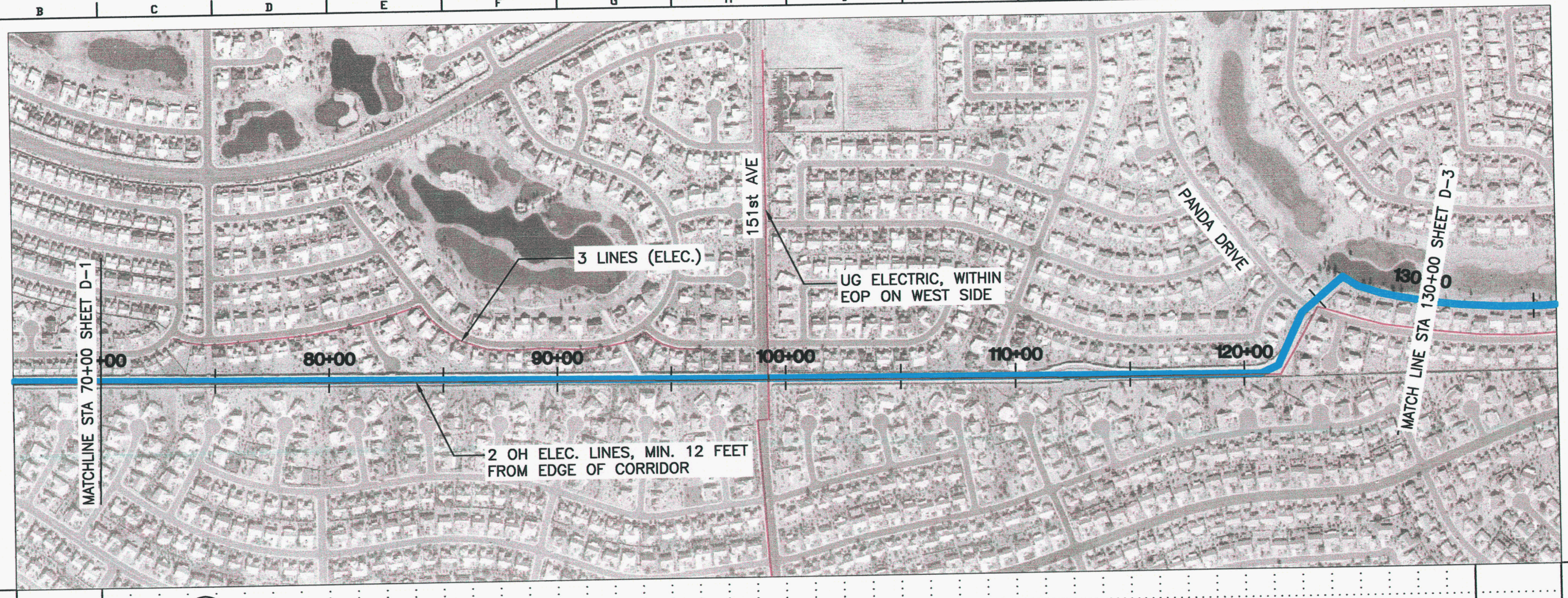
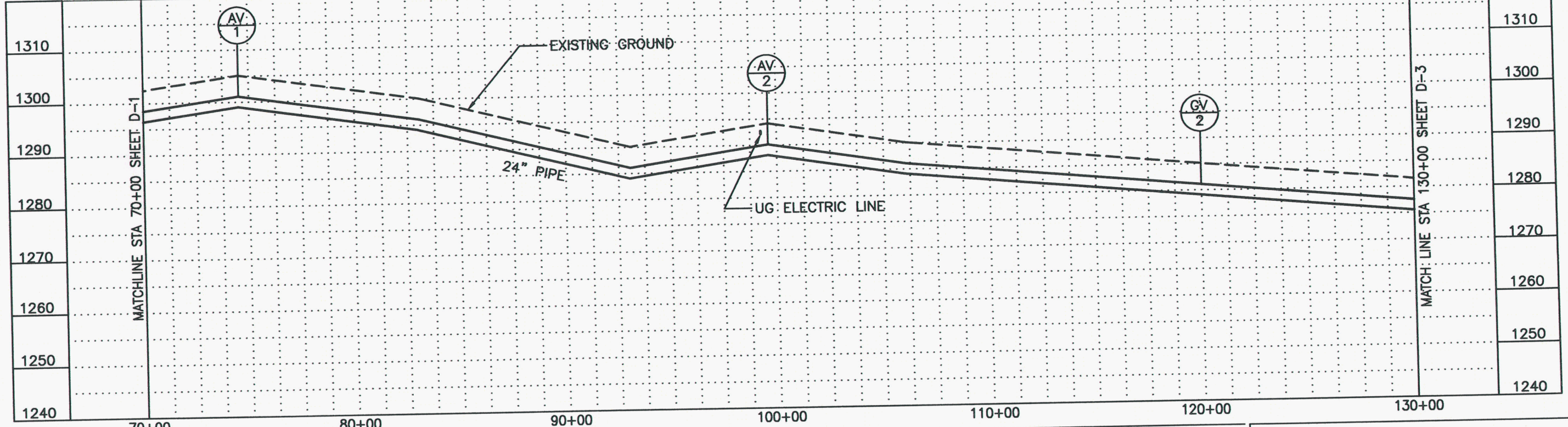
PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

SHEET D-1





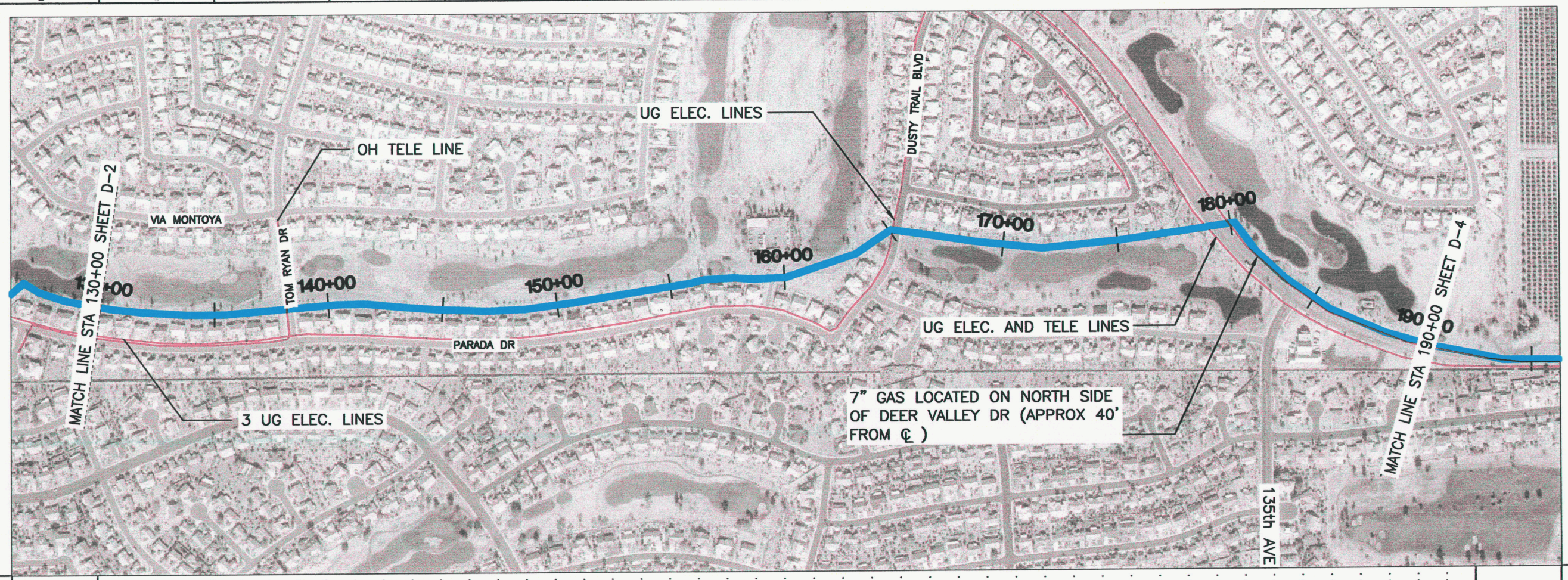
HDR Engineering, Inc.

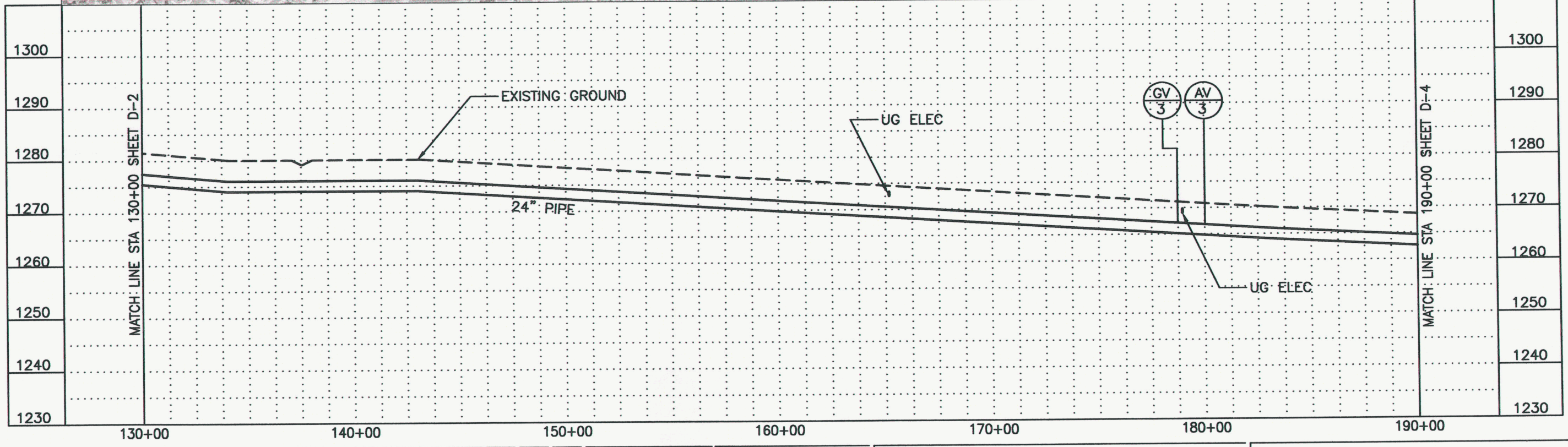
CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

Scale: 1"=500'

SHEET D-2





HDR
HDR Engineering, Inc.

Item No.	Description	Date	Item	Chkd.	Dsgn. Appd.	Prod. Appd.

Project Manager	
Architect	RCE
CEA	Electrical
Structural	Structural
Process	Drawn By

CITIZENS water resources

N

320 0 320

PRELIMINARY
NOT FOR CONSTRUCTION

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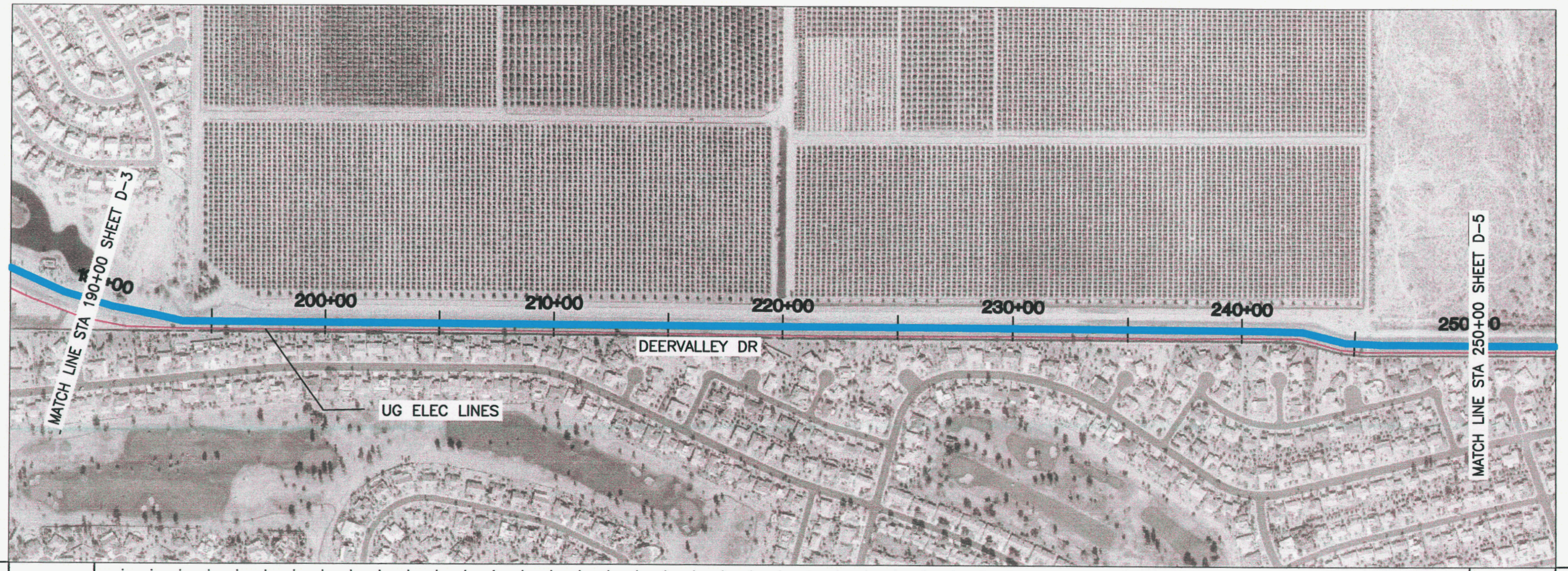

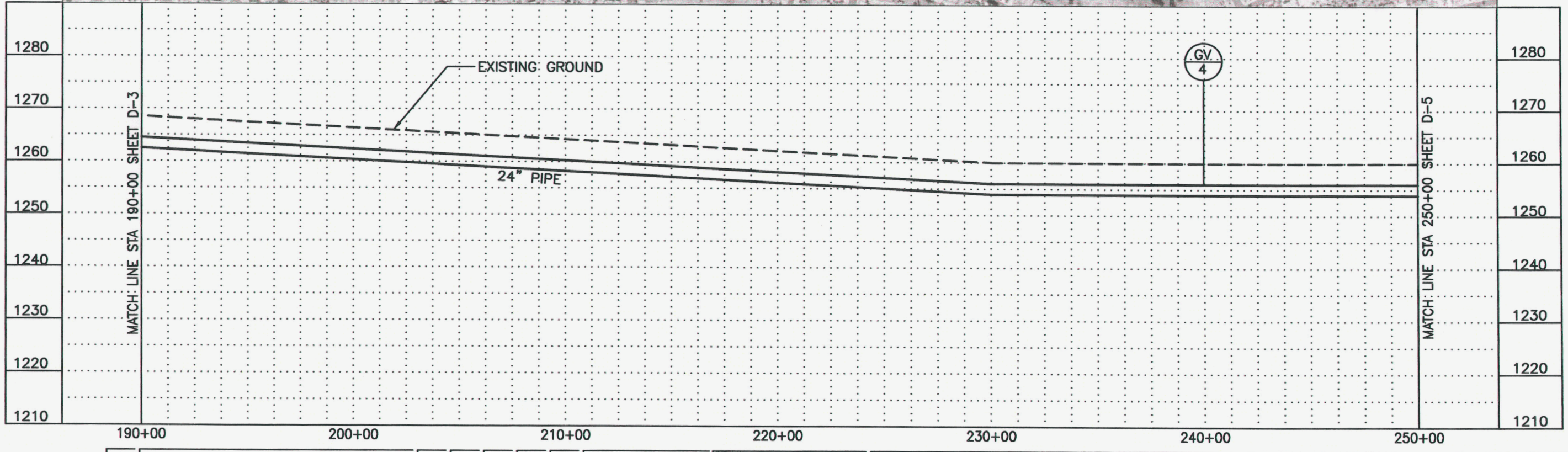

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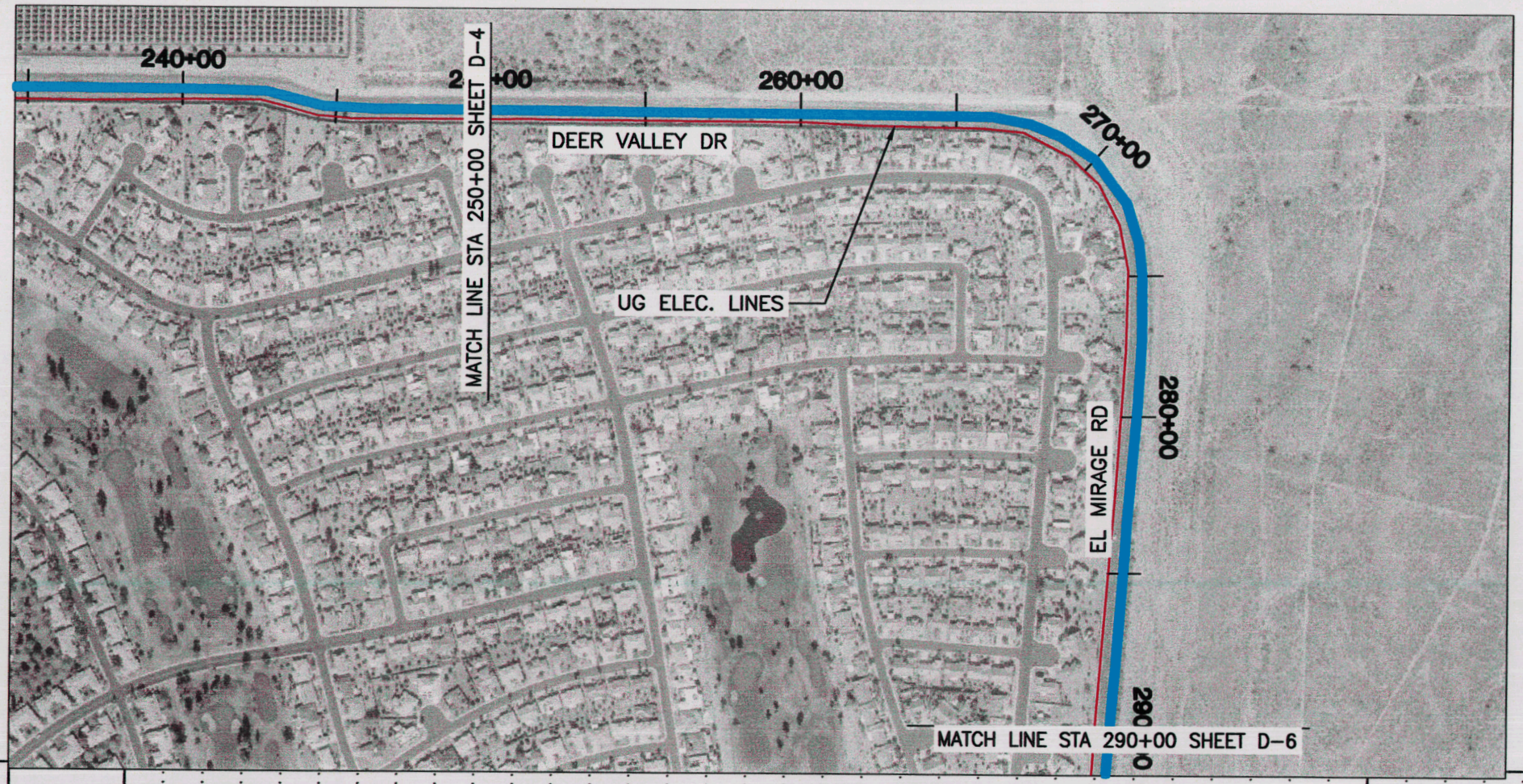

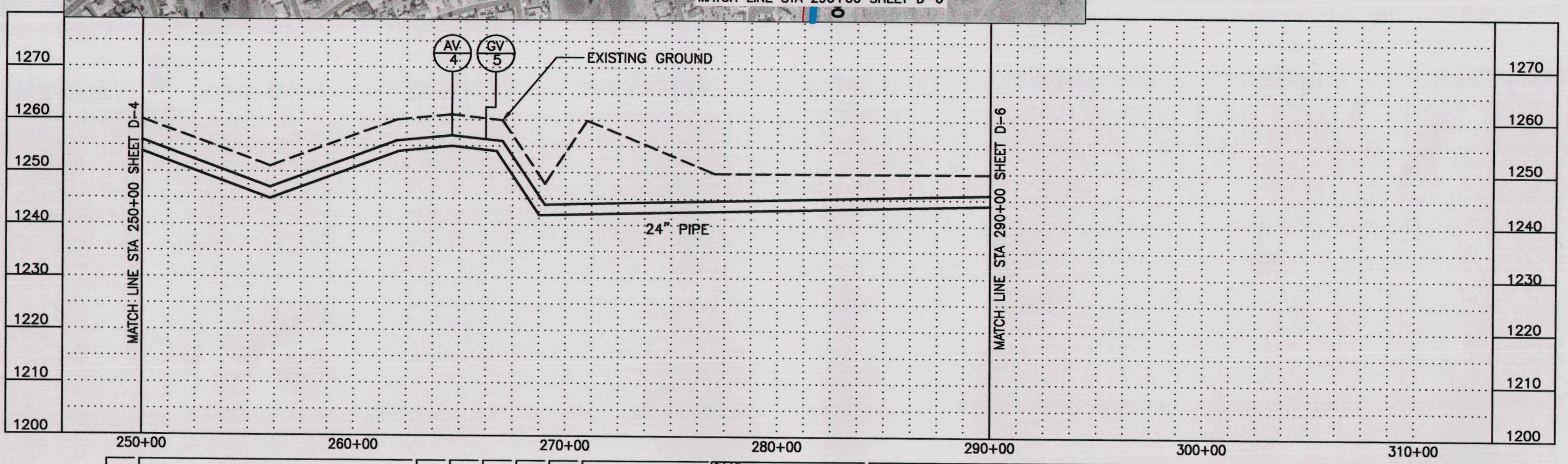

HDR Engineering, Inc.

CITIZENS water resources

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1"=500'

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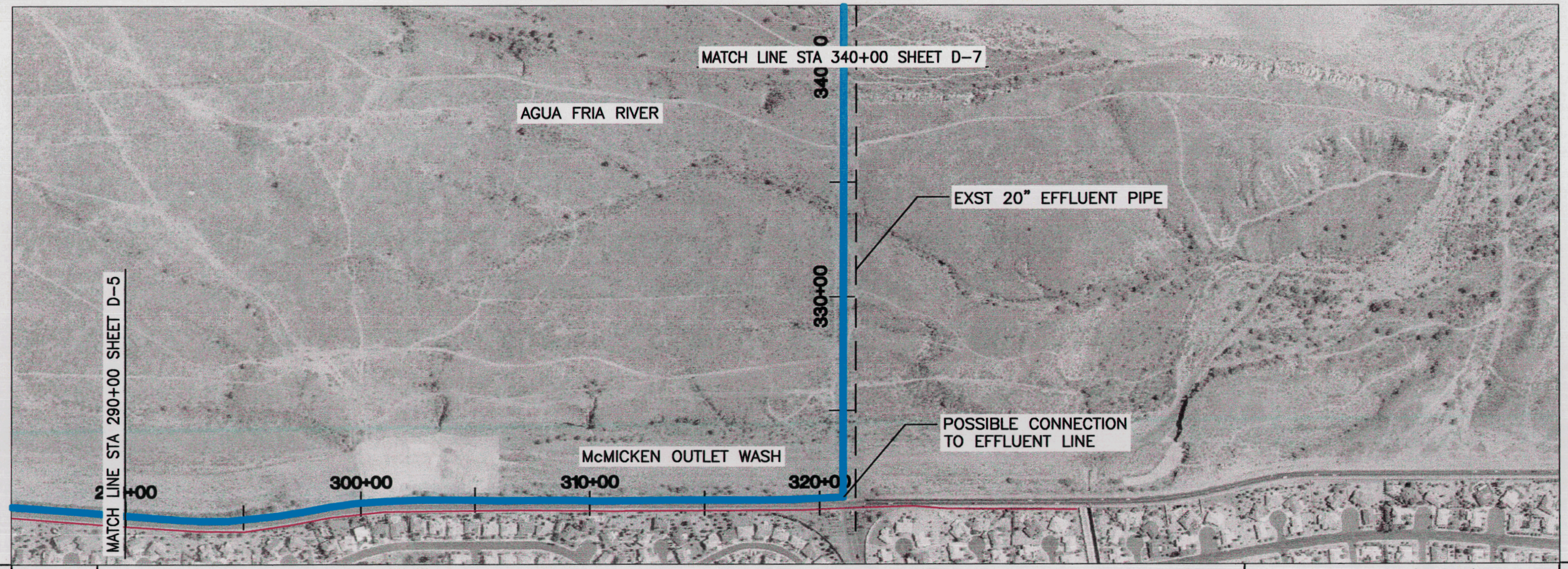

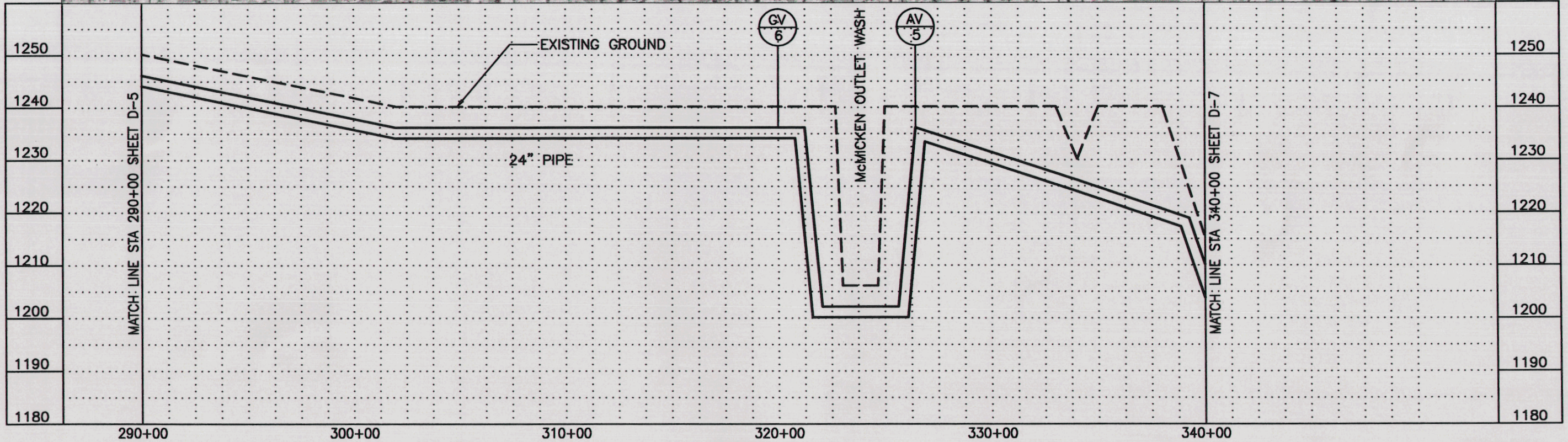

HDR Engineering, Inc.

CITIZENS water resources

PRELIMINARY
NOT FOR CONSTRUCTION

1"=500'

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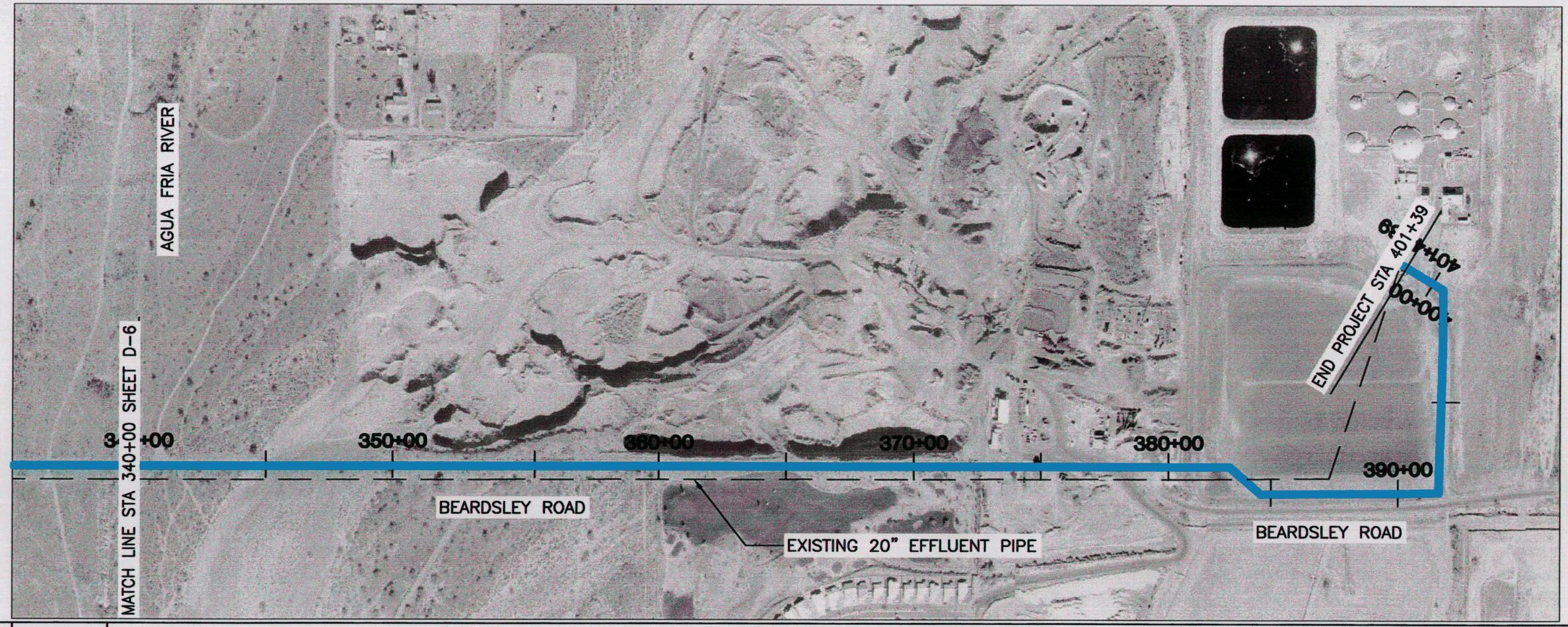

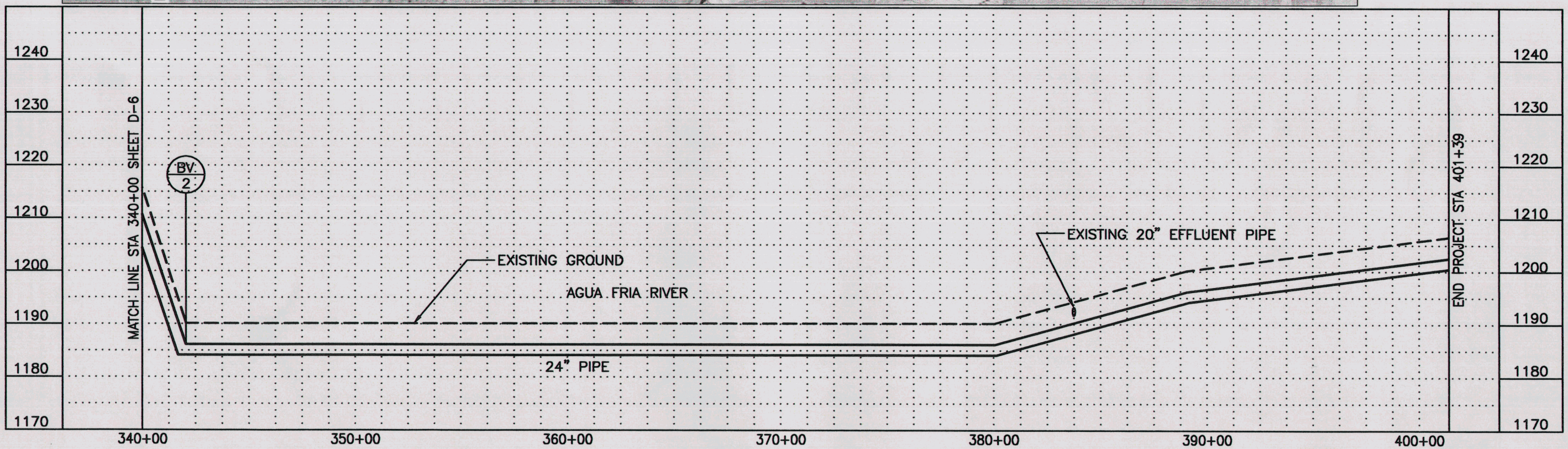

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Summary Evaluation of Alternate Routes

This section summarizes the advantages and of each CAP transmission pipeline Alternative Route.

The criteria put forth includes the cost, hydraulics, operations of CAP or MWD, community disruption during construction, easements/ROW, gravity/pump station, environmental issues, utility coordination, and ownership consideration.

Alternative Route A

Advantages

- Lowest overall cost of the routes studied.
- Uses existing turnout on the CAP Canal.
- Gravity flow provides sufficient pressure to deliver water to each golf course connected to the distribution systems in Sun City and Sun City West.
- Direct source connection to CAP Canal minimizes agency coordination.
- No annual canal dry-up period to disrupt water supply.
- Minimal Sun City and Sun City West community disruption.
- City of Peoria majority control of ROW simplifies requirements for utility coordination and access across existing utility line easements.
- No ephemeral stream or rivers crossed.
- CAP will own, operate and maintain the turnout facilities and equipment within CAP right-of-way.

Disadvantages

- CAP may require environmental study update prior to project construction.
- Cultural survey is recommended due to existence of several known sites along alignment.
- Some calcareous cementation will require heavy or specialized equipment for excavation of soils in the upper portions of the alignment.
- Several utilities to cross, including El Paso Natural Gas lines.
- High right-of-way costs if City of Peoria is not successful in obtaining the Lake Pleasant Road right-of-way.

Alternative Route B

Advantages

- Shorter length of pipeline than other Alternative Routes.
- Utility conflicts minimal or non-existent.
- Minimal cultural sites expected along Route B.
- No excessively heavy equipment required for excavation.
- MWD will own, operate and maintain the turnout facilities and equipment within MWD right-of-way.

Disadvantages

- More costly than Alternate A.
- Construction of new turnout required.
- Booster pump station required to achieve sufficient pressure for deliveries.
- Beardsley Canal requires 4-month annual dry-up period. This may eliminate Alternative B as an option if a dry-up period cannot be avoided.
- Turnout directly from MWD canal adds intermediate layer of coordination between GSP and CAP.
- Requires Wheeling Agreement with MWD.
- Canal water transmission losses.
- Requires construction of check structure in Beardsley Canal.
- Requires the importation of APS power to the site for a distance of approximately one mile.
- Requires a new crossing of Agua Fria River for Sun City distribution system.
- Requires the appraisal and acquisition of 46 parcels for right-of-way.

Alternative Route C

Advantages

- Utility conflicts minimal or non-existent.
- Minimal cultural sites expected along alignment.
- MWD will own, operate and maintain the turnout facilities and equipment within MWD right-of-way.

Disadvantages

- More costly than either Alternate A or B.
- Construction of new turnout required.
- Booster pump station required to achieve sufficient pressure for deliveries.
- Requires Wheeling Agreement with MWD.
- Beardsley Canal requires 4-month annual dry-up period. This may eliminate Alternative C as an option if a dry-up period cannot be avoided.
- Necessitates canal transmission losses.
- Turnout directly from MWD canal adds intermediate layer of coordination between GSP and CAP.
- Requires construction of check structure in Beardsley Canal.
- Requires the importation of APS power to the site for a distance of approximately two miles.
- New crossing of Agua Fria River.
- Some calcareous cementation will require heavy or specialized equipment for excavation of soils in the upper portions of the alignment.

Alternative Route D

Advantages

- Uses existing turnout on the Beardsley Canal.
- Minimal cultural sites expected along alignment.
- MWD will own, operate and maintain the turnout facilities and equipment within MWD right-of-way.
- Uses mostly public right-of-way.

Disadvantages

- Most costly of the Alternative Routes.
- Booster pump station required to achieve sufficient pressure for deliveries.
- Beardsley Canal requires 4-month annual dry-up period. This may eliminate Alternative D as an option if a dry-up period cannot be avoided.
- Requires Wheeling Agreement with MWD.
- Canal water transmission losses.
- Turnout directly from MWD canal adds intermediate layer of coordination between GSP and CAP.
- Requires construction of check structure in Beardsley Canal.
- Requires new delivery of APS power service to the site.
- New crossing of Agua Fria River.

Alternative Route E

This alternative has been found to be not feasible for two major reasons:

1. Hydraulic modeling has indicated that conveying water from the Beardsley Canal to the westernmost end of the existing effluent delivery system in Sun City West would not produce sufficient pressure for water deliveries without a booster pump station. A booster pump station however, would likely cause pipe failure in the existing effluent system if the system were subjected to required pressure levels. This alternative requires connecting the trunk line to relatively small diameter pipes that cannot convey the amount of water required at reasonable operating pressures. Nearly a complete reconstruction of the entire system would be required to make this option work.

2. Furthermore, the Recreation Centers of Sun City West, Inc. which owns and operates the existing delivery system declined to allow reverse flow through the existing crossing of the Agua Fria River. This is because it may be necessary to utilize the pipeline in the future to convey wastewater treatment plant effluent as the system was designed.

Pipeline Corridor – Summary of Issues

CONCEPT	ALTERNATIVE	MAJOR COST	COMMUNITY DISRUPTION	RIGHT-OF-WAY	RIVER CROSSING ISSUES	GRAVITY FLOW	OWNERSHIP
Take delivery of CAP allotments directly from CAP facility (Hayden-Rhodes Aqueduct).	A) Pipeline from an existing, unused turnout on the CAP Canal, directly south along the edge of Lake Pleasant Road, south to Rose Garden Lane, then into Sun City.	• ± 9.25 miles of new pipeline • Some difficult excavation	• Disrupt ± 1900 feet along Rose Garden Lane.	• Route would follow within R/W of Lake Pleasant Parkway (if Peoria obtains from ASLD) • Possible temporary construction easements will be required	• Makes use of existing SCW Recreation Center river crossing to distribute flow to golf courses.	• Flow in transmission or trunk pipeline will be by gravity • Makes maximum use of available head (eliminates need for pumping options)	• CAP will own, operate and maintain the turnout (no cost to CWR) • CWR will own, operate and maintain the pipeline
Take delivery of CAP allotment from the Beardsley Canal (MWD) north of SC and SCW. Take advantage of the existing canal conveyance system.* ***Alternatives B and C would have to be increased in size if 4 month annual dry-up is not eliminated.**	B) Pipeline from a new turnout on the Beardsley Canal, directly south along the 115th Avenue alignment.	• ± 3.75 miles of new pipeline • "Water wheeling" costs with MWD • New turnout construction • New canal control check structure	• Minimal Community Disruption along private property owners along 115th Avenue	• New right-of-way must be acquired	• Requires new crossing of the Agua Fria River	• Flow in pipeline is by gravity • Pumping will be required for distribution to golf courses in SC and SCW.	• MWD will own, operate and maintain the turnout (no cost to CWR) • CWR will own, operate and maintain the pipeline
	C) Pipeline from a new turnout on the Beardsley Canal, directly south along the El Mirage Road alignment.	• ± 3.8 miles of new pipeline • "Water wheeling" costs with MWD • New turnout construction • New canal control check structure	• Minimal Community Disruption along Deer Valley and El Mirage Roads.	• New right-of-way would need to be acquired	• Requires new crossing of the Agua Fria River	• Flow in pipeline is by gravity • Pumping will be required for distribution to golf courses in SC and SCW.	• MWD will own, operate and maintain the turnout (no cost to CWR) • CWR will own, operate and maintain the pipeline
Take delivery of CAP allotment from the Beardsley Canal (MWD) west of SCW. ** **** Alternative D would have to be increased in size if annual 4 month dry-up is not eliminated.** **Alternative E is unworkable due to hydraulic and ownership considerations**	D) Pipeline from an existing turnout on the Beardsley Canal, near Grand Avenue. New pipeline would route east, generally along Deer Valley Road alignment, through existing development in SCW.	• ± 7.2 miles of new pipeline • "Water wheeling" costs with MWD • No turnout construction	• Moderate disruption through SCW including areas the Deer Valley GC, Deer Valley Rd., and El Mirage Road under pavement, landscape, and drainageways.	• New right-of way would need to be acquired for portions of the pipeline, although significant portions could be built in existing drainage easement areas.	• Requires new crossing of the Agua Fria River	• Flow in pipeline is by gravity • Pumping will be required for distribution to golf courses in SC and SCW.	• MWD will own, operate and maintain the turnout (no cost to CWR) • CWR will own, operate and maintain the pipeline
	E) Pipeline from an existing turnout on the Beardsley Canal, near Grand Avenue. Connect as soon as possible to the existing SCW effluent delivery system.	• Unworkable – Would require reconstruction of the entire existing SCW distribution system.			• Requires new crossing of the Agua Fria River. (Rec. Centers declined use of the crossing in favor of their future planned use.)	• Would require extensive re-construction of existing SCW effluent system. • Pumping will be required for distribution to golf courses in SC and SCW.	• SCW Recreation Center owns the effluent delivery system.

3 Pumping Systems

Alternate CAP trunk pipelines other than Alternative A will require a booster pump station to achieve the level of service required to deliver CAP allocation water to the Sun City and Sun City West participating golf courses. A pressure of approximately 70 psi is the pressure required at the CWR water campus location in order to distribute irrigation water to the most distant golf courses.

A concept design for the proposed booster pump station is based on a horizontal split case pump design with the suction and discharge headers on the 24-inch water mains buried below grade. The booster pumps would boost pressure about 20 to 25 PSI from about 50 to 75 psi. The required firm pumping capacity of the booster pump station is 15 cfs (or 6800 gpm). Three 3400 gpm, 75 Hp pumps are proposed for the booster pump station with the third pump serving as standby. The booster pumps would be controlled to turn on when pressure falls below a preset pressure of 55 psi and turn off when pressure reaches 75 psi. It is anticipated that the summer demands and the seasonal new growth of winter turf in the fall will require two of the 3400 gpm pumps to run continuously 24 hours a day to meet demand for about significant portion of the year. Winter demands are anticipated to require only one 3400 gpm pump to run almost continuously for the remainder of the year. The layout for the proposed booster pump station is shown in **Figure D.2**.

The opinion of probable capital costs and Present Worth O&M / Salvage costs for a 50 year life for the proposed booster pump station are shown below.

Booster Pump Station
Opinion of Probable Life Cycle Costs

Item Description	Unit	Quantity	Unit Price	Amount
Concrete Base Slab & Excavation	C.Y.	30	$350	$10,500
Pumps 3400 GPM, 75 hp	EA.	3	$36,400	$109,200
Electrical and Control Equipment	L.S.	1	$38,000	$38,000
Electrical Feed	L.S.	1	$9,000	$9,000
10" Pump Control Valves	EA.	3	$4,390	$13,170
10" Cushioned Check Valves	EA.	3	$6,990	$20,970
16" Gate Valve	EA.	3	$6,580	$19,740
14" Gate Valve	EA.	3	$3,800	$11,400
2" Air Release Valves	EA.	3	$650	$1,950
Miscellaneous Piping	L.S.	1	$34,400	$34,400
Site Grading & 2" D.G.	S.Y.	990	$7	$6,930
8' High Block Wall	L.F.	372	$50	$18,600
20' Sliding Gate	L.S.	1	$1,800	$1,800
Property Costs	S.F	12000	$1	$12,000
			Total Capital Cost	**$307,660**
O&M Life Cycle Costs			Annual Cost	Present Worth
Power Costs @ $0.07/kwh			$45,745	$749,102
O&M Labor Costs @ 0.5 hrs/day for $30,000/yr salary			$1,875	$30,704
O&M Costs @ 1% of Structure & 2.5% of Equipment/ Year			$4,367	$71,513
Salvage Value of Structure			-	($1,906)
			Total O&M Life Cycle Cost	**$849,413**
			Total Life Cycle Cost	**$1,157,073**

Note: Power Costs were computed by assuming 2 pumps run continuously 3/4 of the year and 1 pump will run continuously the remaining 1/4 of the year.

The life cycle costs were determined using common cost elements applied to anticipated annualized costs. The annual costs were calculated by summing each annual cost element. These were then determined as a present worth value.

A differential interest rate of 5.73% was used for calculations. This rate was based on the weighted cost of capital at 8.73%, minus an inflation rate of 3%. The weighted cost of capital at 8.73% for Citizens Water Resources is based on Arizona Corporation Commission Decision 60172. The inflation rate of 3.0% is based on an assumed average inflation rate over past number of years.

4 Storage Systems

Storage is sometimes necessary in irrigation systems to allow the flexibility a system needs to make deliveries in an orderly manner.

Storage may be required in the irrigation system unconsideration to on of both of the following reasons:

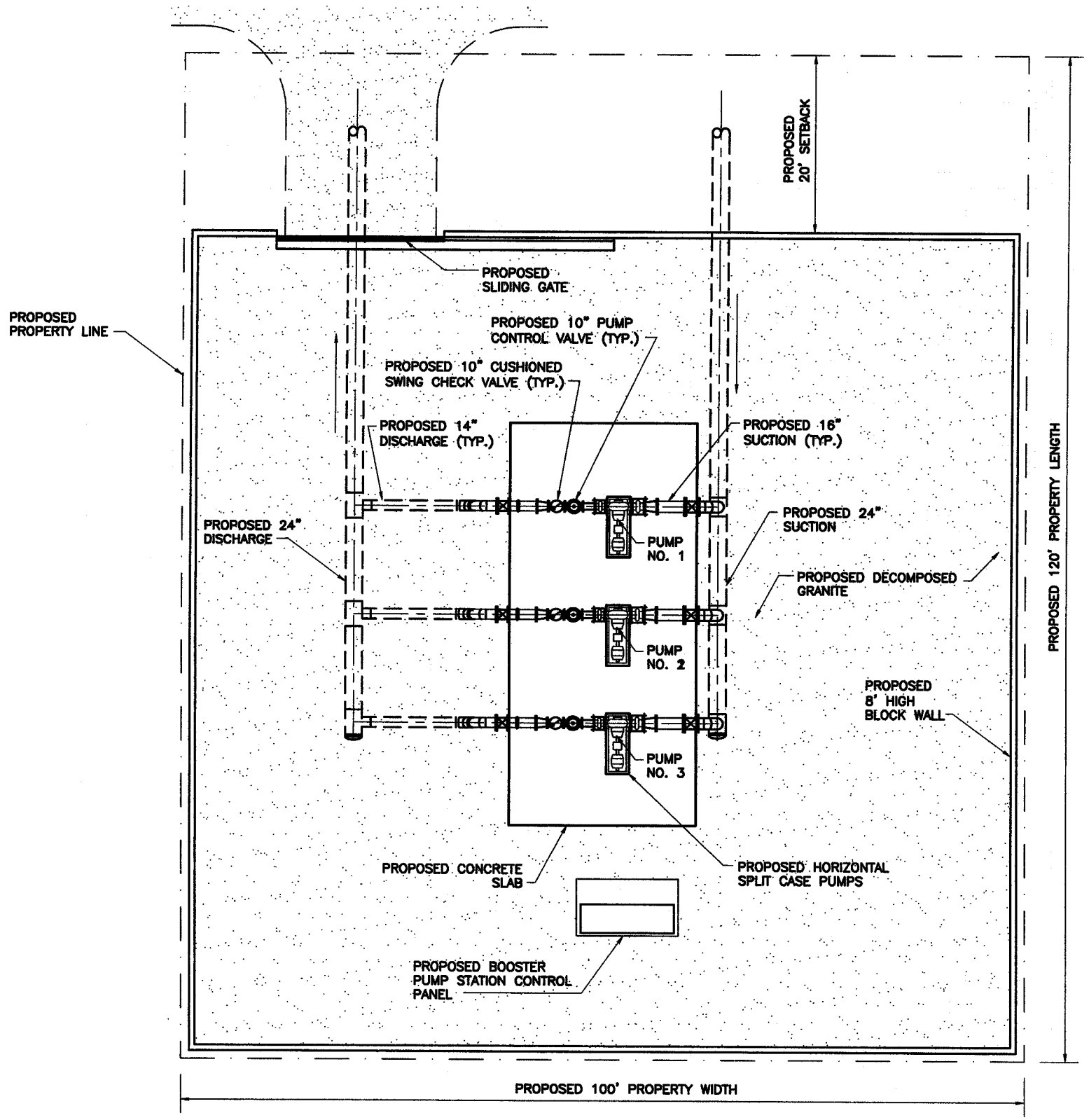
1. If the calculations indicate an economic advantage in delivering water from the Cap canal at a lower flow rate than the golf course demand and storing the water for use at high demand times thus lowering the trunk pipeline size.

2. If little or no storage existed in the individual golf course lakes thus making flow balancing into and out of the lakes difficult or impossible, alternate storage would be required. This is known as the "wide spot in the pipe principal."

Analysis of the distribution systems hydraulic models and of the participating golf courses for the Sun City and Sun City West indicate that all individual golf course lakes have adequate volume for flow balancing throughout the daily diurnal flow cycle.

CITIZENS water resources

SUN CITY / SUN CITY WEST/ YOUNGTOWN GROUND WATER SAVINGS PROJECT



CONCEPT PLAN

SCALE: NTS

PROPOSED BOOSTER PUMP STATION

HDR

Figure D.2

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Furthermore, due to the need to convey flow on an essentially round-the-clock schedule, to meet the operational needs of the participating golf courses and to assure complete consumption of the annual CAP allotment, the opportunity to convey bulk flow in a small trunk main for storage and use at peak periods is not available.

To ensure the annual allocation can be completely consumed, a large capacity lake was identified in both systems act as a buffer should system operational problems arise or a golf course has problems and can not take water from the distribution system. In such a case the lakes identified would absorb the average daily allocation not consumed and utilize the stored water during high demand periods. Hillcrest Lake, the largest capacity lake in Sun City West, provides for the volumetric flexibility needed to account for daily fluctuations in system demands for Sun City West. In Sun City, Dawn Lake and Viewpoint Lake are identified for this purpose.

5 Treatment Systems

Transmission of CAP Water

Treatment of CAP water for transmission and for use as irrigation water is a much-studied issue. It is not as complicated as it may seem. Treatment for transmission is discussed in the following paragraphs. Treatment for use on golf courses is discussed later in this Section.

CAP water is surface water conveyed from the Colorado River via the Central Arizona Project Canal. This water is pumped from the river at Lake Havasu into the Hayden-Rhodes Aqueduct. Before it reaches the proposed CWR turnout at the Lake Pleasant Road the water passes through a total of four pumping plants, hundreds of miles of canal, and several miles of pipeline. Water is also added to the CAP canal system from Lake Pleasant via the Waddel Canal. Lake pleasant is filled with CAP water during portions of the year and contributes stored CAP water and impounded surface water from the Aqua Fria River system to the canal during other times of the year.

Sediment, algae, and pH are the major items of concern with the transmission of raw water. Each of these items could cause problems with the trunk pipeline. However, based on the experience in the area, and the information of water quality from the CAP, none of these items will be of concern to the ability of the pipeline to function as proposed.

Sediment - Generally CAP water has traveled great distances prior to reaching the proposed pipeline. The flow in the canal is at a velocity that will cause most sediment to settle out in the canal long before it approaches the CWR turnout. The velocity of flow in the pipeline during a large part of the year will be near 5 cfs. This velocity is more that sufficient to clean any sediment in the line that collects during lower flow periods. There have been instances of high sediment loads in the CAP canal due to unusually high surface runoff to Lake Pleasant. Should sediment loads in the canal become excessive, this project can be temporarily taken out of service (the golf courses would utilize wells) until the water quality reruns to normal.

Algae - Each pumping station along the CAP canal screens out any floating or suspended objects to prevent pump damage. The inlet to the turnout of this project will also have a trash rack to screen large floating or suspended objects from the flow prior to entering the pipe. The CAP will monitor the flow into the pipe and clean the grate as often as necessary. The CAP also has preventative measures for algae and other canal vegetation that prevents large amounts of growth. Because of the short amount of time water spends in the pipeline algae growth will be negligible. Algae growth is further hindered because light is not available in the pipe and because the amount of oxygen available within the pipe is limited.

pH - The problem pH poses to a pipeline is corrosion. The proposed pipeline material for this project is cement coated DIP and PVC plastic pipe. CAP water being very near neutral, poses little threat for corrosion. PVC Plastic pipe has no susceptibility to the pH of water in the acidic or basic range of CAP water.

Golf Course Application of CAP Water

The following paragraphs discuss the possible need to provide treatment of the CAP water prior to it being delivered to golf courses for turf irrigation. The use of untreated CAP water for golf course irrigation has been common practice in the Phoenix metropolitan area since the CAP Canal began delivering water. The best example of this has been the City of Scottsdale's Reclaimed Water Distribution System (RWDS). For approximately eight years, the RWDS has delivered untreated CAP water to 20 golf courses in the north Scottsdale area.

The RWDS system consists of a series of five major pump stations and pipelines (16- to 30-inch diameter) that take water from the CAP Canal and deliver it north along Pima Road approximately 13 miles. Various golf courses tie-in to the transmission main along its route for delivery of water to their irrigation reservoirs. The RWDS provides no treatment to the CAP water prior to being delivered to the golf courses. There is, however, an 8-million gallon (MG) storage pond at the RWDS main pump station. This pond was initially installed at the request of and payment by the golf courses for storage capacity in emergency situations (e.g. if pump stations are out of service). As it has been operating, the storage capacity function has not been necessary since the golf courses already have on-site storage and the RWDS pump stations have not been out of service for extended periods. The storage pond has, indirectly, provided some level of treatment to the CAP water, particularly during low demand months. In those months, water is retained in the storage pond long enough to allow some settlement of particulate matter. During high demand months when the RWDS is delivering 20 MGD, the 8-MG pond is essentially a flow-through pond and little settlement occurs. In that case, the golf courses are receiving approximately the same quality water that is taken directly from the CAP Canal.

Initially, strainers were installed at the RWDS pump station nearest the CAP Canal. The strainers were installed to remove algae and other particles not removed by the bar screen at the CAP turnout. The City experienced severe operational difficulties with the strainers due to excessive clogging. The strainers were taken out of service shortly after commissioning and the RWDS has been delivering the untreated CAP water for essentially the eight years it has been in operation.

With the completion of the CWR's Water Campus, which is an advanced wastewater treatment plant, the RWDS is now beginning to deliver treated effluent to the golf courses. Depending on the time of year and subsequent demand, the treated effluent will supplement or take the place of the CAP water.

As part of this project, seven of the golf courses using CAP water delivered in the RWDS were contacted to discuss their experience. All of seven courses reported neutral to favorable experience in using the untreated CAP water.

Some of the golf courses which utilize CAP water for at least a portion of their irrigation needs as of 1998 are: (Source ADWR)

- Red Mountain Ranch,
- Raven,
- TPC,
- Viewpoint RV and Golf Resort,
- Gold Canyon Golf Resort,
- 500 Club,
- Apache Sun,

- Rancho Manana,
- Johnson Ranch Golf Club,
- Happy Trails,
- Sunland Village,
- Traditions, and
- Fiesta Lakes.

It is also worth noting that most golf courses in the SRP service area are using untreated SRP water for the irrigation of their courses. The source of water for SRP is the Salt and Verde Rivers, and the quality is similar to that conveyed in the CAP Canal. In fact, in many cases, SRP water has a higher occurrence of algae than the CAP Canal.

Based on the well-established historical successes of using untreated CAP water for golf course irrigation in the Phoenix metropolitan area, no treatment of the CAP water is recommended for this project.

6 Distribution Systems

Figure D.3 shows the existing effluent distribution system in Sun City West and the proposed irrigation water distribution system for Sun City. The Sun City West effluent system will be used to distribute CAP irrigation water.

The Cybernet modeling package by Hastead Methods Inc. was used to analyze the alternative trunk pipeline and distribution network. The program performs steady state analysis and extended time models, allowing for variation in delivery rates and times. The model is used to assist in sizing pipes, locating pumps, valves and other system devices, and determining the most efficient use of the CAP water. If necessary, it also analyzes pump and storage requirements and characteristics.

Sun City West Distribution System

The existing effluent distribution system in Sun City West conveys flow to the Recreation Center of Sun City West golf courses as well the country club courses. The system, originally constructed around 1981 is owned and operated by the Recreation Center of Sun City West, Inc. The pipe was sized to deliver 2 - 3.14 mgd (3.1 - 4.85 cfs) from the CWR Sun City West Water Campus. Pipe sizes ranging from 12" to 20" in diameter as well as locations, sizes and pipe material acquired from as-built plans and previous reports. The existing system is shown in dashed lines on **Figure D.4.** Golf Courses connected to the system in the Sun City West include:

- Briarwood Country Club,
- Echo Mesa Golf Course,
- Grandview Golf Course,
- Hillcrest Golf Club,
- Pebblebrook Golf Course,
- Stardust Golf Course, and
- Trail Ridge Golf Course.

Water is typically delivered to golf course lakes. Hillcrest Lake will provide volumetric flexibility to balance the daily system demands against system limits for all the courses in Sun City West. The table on the following page summarizes the Sun City West system characteristics.

Figure D.5 illustrates the ability of the system to deliver the entire CAP allotment for Sun City West according to the demands for each golf course and the optimization of the trunk line. From the monthly breakdowns of demand, the peak demand flow of July was used to simulate the maximum golf course demand for the computer simulations. The computer model allowed for the analysis of the distribution of allotted water. The model demonstrated that the existing system is adequate. With flows distributed throughout the year, the peak flow rate in the distribution system is very close to the design flow of the effluent system.

The peak flow to Sun City West is approximately 5.5 cfs. This represents the practical hydraulic limits of the existing piping system. Transmission of CAP water is via the Alternative A alignment for the model simulations. The table titled **Peak Day CAP Water Delivery Schedule** illustrates the simulated golf course demands for the Cybernet model.

Distribution System Alternatives – Significant Issues

System	System	Cost	Allotment Utilization	Impact On Pumping	Impact On Storage	Impact On Operations
Sun City West	• Distribute to Recreation Center Golf Courses and to Country Club Courses	• Cost regarding the existing effluent system would be for control system at delivery points.	• The entire SCW allotment is be used and distributed to both the Rec. Center Courses and the Country Club Courses.	• No major impact on system pumping requirements as the flow characteristics for the existing system remain the same, whether or not delivery is made to the Country Club Courses	• Hillcrest Lake in Sun City West provides the volumetric flexibility needed to account for daily fluctuations in system demands. .	• Entire system is coordinated to deliver to each course according to its demands as closely as possible. During peak demands, well will still be utilized to keep lakes full.
Sun City / Youngtown	• Distribute to Recreation Center Golf Courses only	• Savings in distribution pipeline costs realized by not extending the system to serve the County Club Courses	• The entire SC allotment is used by distributing to the Rec. Center Courses only. • Delivery is both north and south of Grand Avenue.	• No major impact on system pumping requirements as the system was designed using the flow characteristics of the transmission pipeline.	• Dawn Lake and Viewpoint Lake in Sun City provides the volumetric flexibility needed to account for daily fluctuations in system demands.	• Entire system is coordinated to deliver to each course according to its demands as closely as possible. During peak demands, well will still be utilized to keep lakes full.

Peak Day CAP Water Delivery Schedule

Facility Annual Totals

Sun City Rec Center Courses	July Peak Daily Usage ac-ft/day	% of Demand	Hours of Delivery	Peak Demand ft^3/day per Hour of Delivery	Peak Demand cfs per Hour of Delivery	Priority	Time Distribution 0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Calculated Total	Ac-ft/day
Lakes East	3.56	0.75	16	7252	2.01	Low – overflow	0.00	0.00	0.00	1.70	1.36	1.46	0.00	0.00	1.25	2.42	2.42	2.42	1.58	1.68	1.52	1.78	1.69	2.53	2.63	1.63	2.76	0.43	0.43	0.54	32.23	2.66
Lakes West	5.17	0.61	16	8604	2.39	Low	1.89	2.80	2.37	2.42	0.00	0.00	2.20	2.36	2.42	2.42	2.42	2.42	2.42	2.42	2.42	0.00	2.42	2.42	0.00	0.00	0.00	0.00	0.00	2.42	38.24	3.16
North GC	3.73	0.67	12	9087	2.52	Med	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	0.00	0.00	2.33	0.00	0.00	2.33	2.33	2.33	30.29	2.50
Quail Run GC	1.38	0.62	14	2664	0.74	Low	0.00	0.74	0.00	0.74	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	10.36	0.86
Riverview GC (West)	1.34	0.62	12	3024	0.84	Mid	0.00	0.84	0.84	0.84	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.00	0.00	0.84	0.84	0.00	0.00	0.84	0.84	0.84	0.84	0.84	10.08	0.83
Riverview GC (East)	1.34	0.62	10	3636	1.01	High	0.00	0.00	0.00	0.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.10	0.83
South GC (West)	2.45	0.62	14	4716	1.31	Med-Low	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.31	1.31	1.31	1.31	1.31	1.31	18.34	1.52
South GC (East)	2.46	0.62	14	4752	1.32	Med-Low	1.32	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.32	1.32	1.32	1.32	1.32	0.00	1.32	1.32	1.32	0.00	0.00	1.32	1.32	1.32	1.32	18.48	1.53
Willowcreek	3.98	0.62	12	8964	2.49	Med	2.49	0.00	2.49	2.49	2.49	2.49	2.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.49	2.49	2.49	2.49	2.49	2.49	0.00	0.00	0.00	0.00	29.88	2.47
Willowbrook	3.98	0.62	12	8964	2.49	Med	2.49	2.49	2.49	0.00	2.49	2.49	2.49	2.49	2.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.49	2.49	2.49	2.49	0.00	29.88	2.47
Total							**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.50**	**9.46**	**9.46**	**9.46**	**9.50**		

Sun City West Rec Center Courses	July Peak Daily Usage ac-ft/day	% of CAP Demand	Hours of Delivery	Peak Demand ft^3/day per Hour of Delivery	Peak Demand cfs per Hour of Delivery	Priority	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Calculated Total	Ac-ft/day
Echo Mesa GC	3.55	0.43	14	4744	1.32	Med	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	0.00	18.45	1.52
Grandview GC	4.56	0.40	10	7956	2.21	High	2.21	2.21	2.21	2.21	2.21	2.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.21	2.21	2.21	2.21	22.10	1.83
Pebblebrook GC	4.13	0.40	10	7200	2.00	High	0.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	1.65
Stardust GC	2.57	0.40	12	3744	1.04	Med	0.00	0.00	0.00	0.00	0.00	0.00	1.04	1.04	1.04	0.00	0.00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	0.00	0.00	0.00	0.00	12.48	1.03
Trail Ridge GC	3.23	0.40	14	4032	1.12	Low	1.12	1.12	1.12	1.12	0.00	0.00	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12	15.68	1.30
Sun City West Private Clubs																																
Briarwood CC	4.34	0.40	10	7560	2.10	High	2.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	21.00	1.74
Hillcrest GC	4.61	0.40	14	5763	1.60	Low-overflow	0.07	0.17	0.17	0.17	1.29	1.29	1.34	1.34	0.11	1.15	1.15	2.11	2.11	2.11	2.11	1.13	1.13	1.13	1.13	1.13	0.00	0.00	0.00	0.07	22.41	1.85
																															360.00	
TOTAL	**56.38**						**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.50**	**5.54**	**5.54**	**5.54**	**5.50**	**132.12**	

SYSTEM TOTAL							**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**	**15.00**		

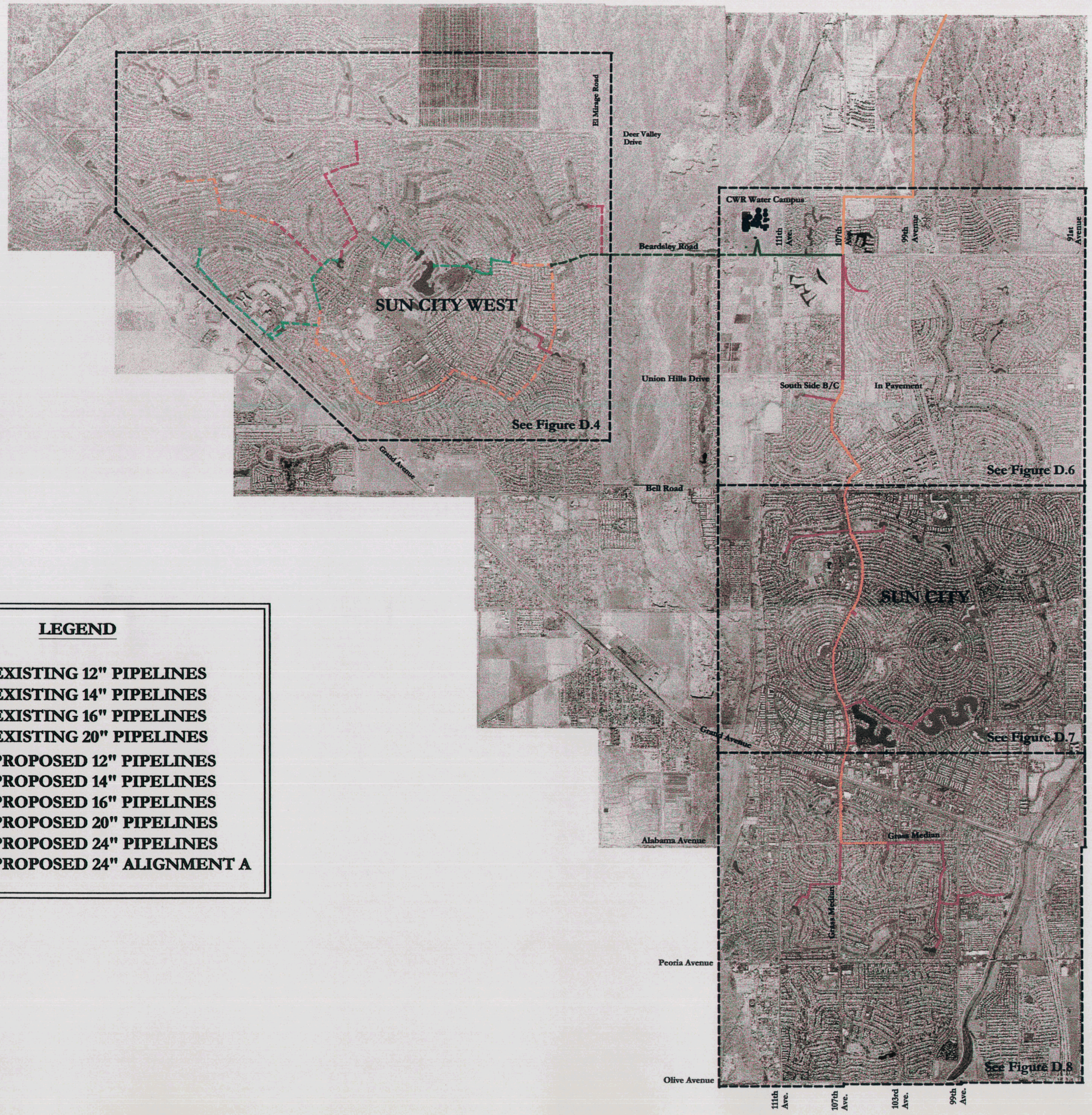
Sun City Sized for 11.5 cfs – CAP flow to be approximately 9.5 cfs
Sun City West CAP flow to be approximately 5.5 cfs

CITIZENS water resources

SUN CITY / SUN CITY WEST / YOUNGTOWN GROUND WATER SAVINGS PROJECT

N

1 mi 0 1 mi



LEGEND

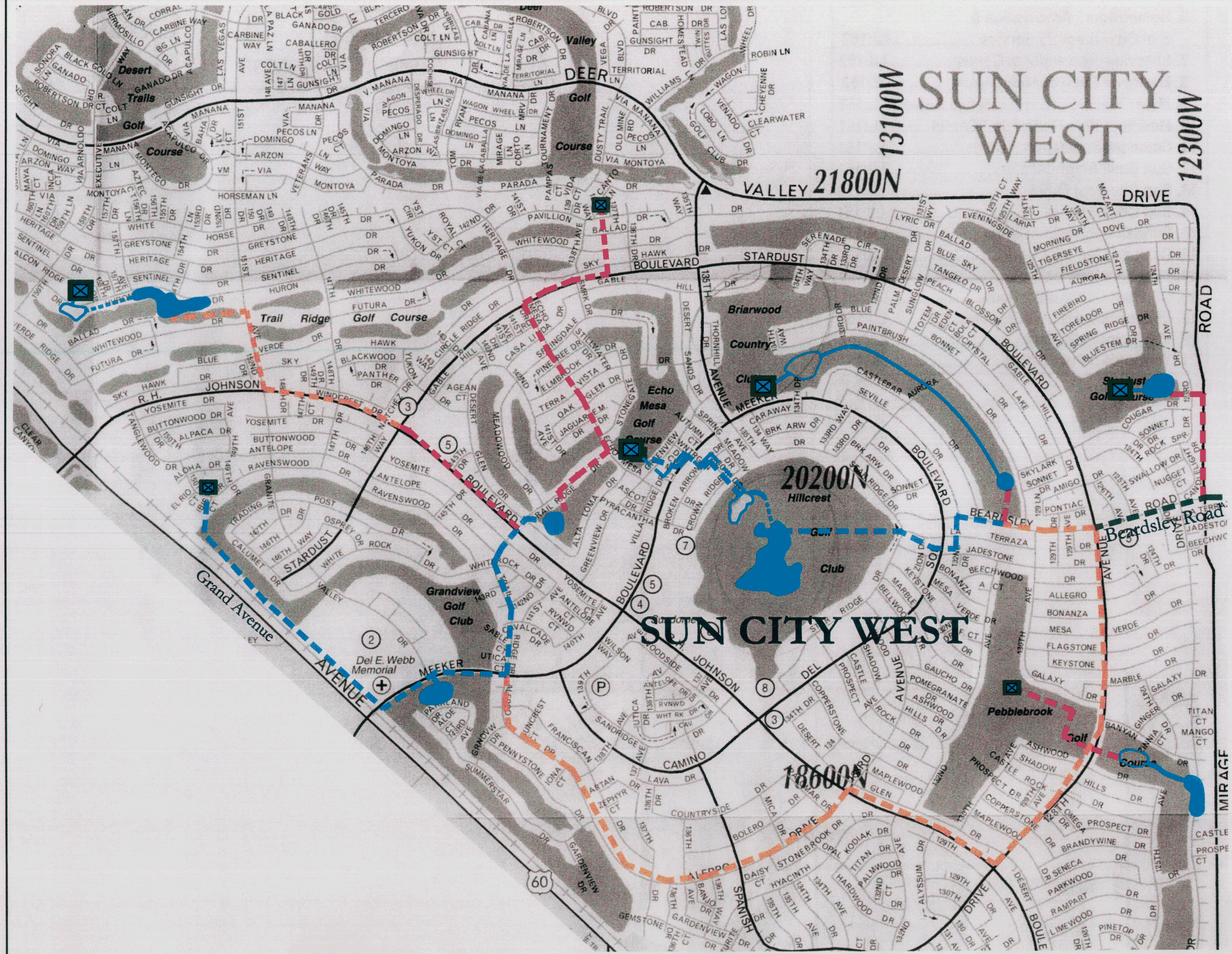
- EXISTING 12" PIPELINES
- EXISTING 14" PIPELINES
- EXISTING 16" PIPELINES
- EXISTING 20" PIPELINES
- PROPOSED 12" PIPELINES
- PROPOSED 14" PIPELINES
- PROPOSED 16" PIPELINES
- PROPOSED 20" PIPELINES
- PROPOSED 24" PIPELINES
- PROPOSED 24" ALIGNMENT A

IRRIGATION DISTRIBUTION SYSTEM

Figure D.3

CITIZENS water resources

SUN CITY / SUN CITY WEST/YOUNGTOWN GROUND WATER SAVINGS PROJECT

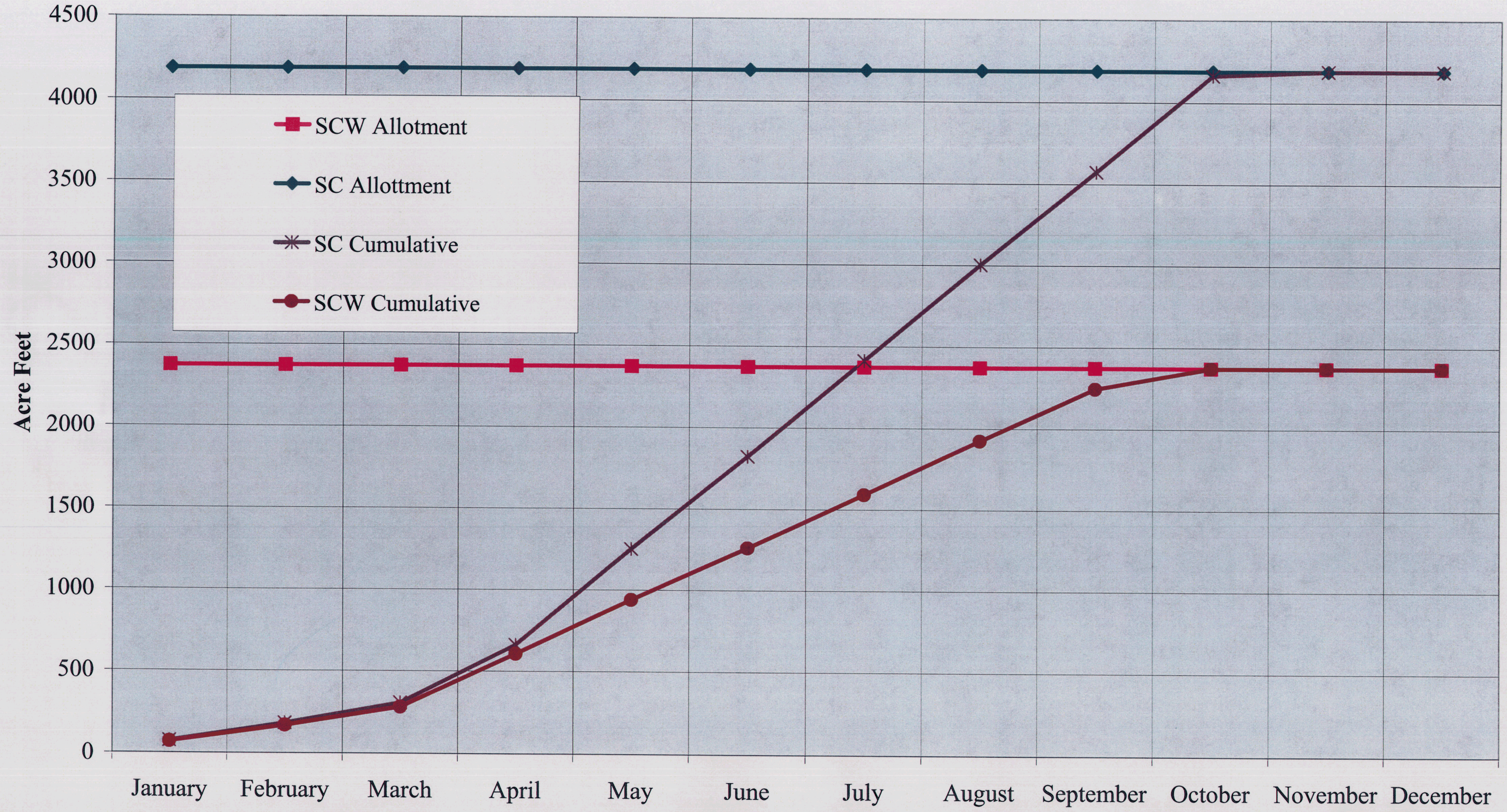


Sun City West

EXISTING DISTRIBUTION NETWORK

Figure D.4

Figure D.5 - Sun City & Sun City West Supply & Demand



The model simulates the existing systems at approximately 40% of July (peak) daily demand. Maximum and minimum pressure results from the model are summarized in the following table as well as flow through the trunk line and HGL at start of the Sun City West system. Cybernet output is also included in Appendix D for each model.

Summary of Cybrernet Model Results

	Minimum	Maximum
CAP Flow Through Alignment Pipe A (cfs)	13.5	15.5
HGL @ Bifurcation (ft)	1372.3	1405.6
Sun City West		
Stardust Delivery Pressure (psi)	49.1	50.6
Briarwood Delivery Pressure (psi)	44.2	46.8
Hillcrest Delivery Pressure (psi)	31.4	34.4
Pebblebrook Delivery Pressure (psi)	54.9	59.7
Echo Mesa Delivery Pressure (psi)	23.8	33.5
Grandview Delivery Pressure (psi)	25.5	36.1
Trail Ridge Delivery Pressure (psi)	8.5	19.3

Numbers based on approximately 40% July Peak Daily Demand for Sun City West. All new pipe designed as DIP.

Due to the methodical operation of water delivery required for proper system operation, a control system must be added to the discharge pipe at each golf course.

Sun City Distribution System

Possible routes for water delivery systems to golf courses within Sun City were developed as part of this project. Routes will be located within streets and through the golf course properties and other possible open easement areas. Critical points are the points of access between the public right-of-way and/or easements and the golf course lakes. Least disruptive routes were also investigated as a means to lessen the traffic control requirement. Development of the proposed concept route location included input from received from CWR, TAC members, and others. The proposed network is shown in **Figures D.6, D.7, and D.8.** The delivery points for the golf courses are located at storage reservoirs or lakes allowing for flow along water features to storage lakes.

The proposed Sun City Distribution System is designed to deliver irrigation flow only to the Recreation Centers of Sun City Inc. golf courses. **Figure D.5** demonstrates the ability of the system to deliver the entire Sun City CAP allocation during the calendar year. The distribution system in Sun City and the CAP trunk pipeline were design to deliver as much of the daily demand as possible while minimizing the pipeline sizes. This allowed for meeting the total demand for flows in the off-peak periods and a portion of the demand during peak periods. In Sun City the allotment can be used entirely by the Recreation Center golf courses. Golf Courses in the Sun City system include:

- Lakes East Golf Course(Dawn Lake),
- Lakes West Golf Course,
- North Golf Course,
- Quail Run Golf Course,
- Riverview Golf Course,
- South Golf Course,
- Willowbrook Golf Course, and
- Willowcreek Golf Course.

Water deliveries typically are made to the golf course lakes. Dawn Lake and Viewpoint Lake will provide volumetric flexibility to balance the daily system demands for all the courses in Sun City.

From the monthly breakdowns of demand, the peak demand flow of July was used to simulate the maximum golf course demand for the computer simulations. The model was adjusted until the desired flow rate was achieved.

The peak flow to Sun City is approximately 9.5 cfs. Transmission of CAP water is via the Alternative A pipeline for the model simulations. The table titled **Peak Day CAP Water Delivery Schedule** illustrates the simulated golf course demands used for the Cybernet model.

The model simulates the existing systems at approximately 65% of July daily demand. Maximum and minimum pressure results from the model are summarized in the following table as well as flow through the transmission line and HGL at start of the Sun City system. Cybernet output is also included in Appendix D for each model.

Summary of Cybrernet Model Results

	Minimum	Maximum
CAP Flow Through Alignment Pipe A (cfs)	13.5	15.5
HGL @ Bifurcation (ft)	1372.3	1405.6
Sun City/ Youngtown		
Lakes East(Dawn Lake) Delivery Pressure (psi)	21.1	70.0
Lakes West (View Point Lake) Delivery Pressure (psi)	31.3	72.7
North Delivery Pressure (psi)	16.1	69.6
Quail Run Delivery Pressure (psi)	13.2	70.0
Riverview (West) Delivery Pressure (psi)	43.0	73.8
Riverview (East) Delivery Pressure (psi)	42.2	74.0
South (West) Delivery Pressure (psi)	18.6	67.9
South (East) Delivery Pressure (psi)	11.5	69.6
Willowbrook Delivery Pressure (psi)	72.2	86.1
Willowcreek Delivery Pressure (psi)	72.8	89.1

Numbers based on approximately 60% July Peak Daily Demand for Sun . All new pipe designd as DIP.

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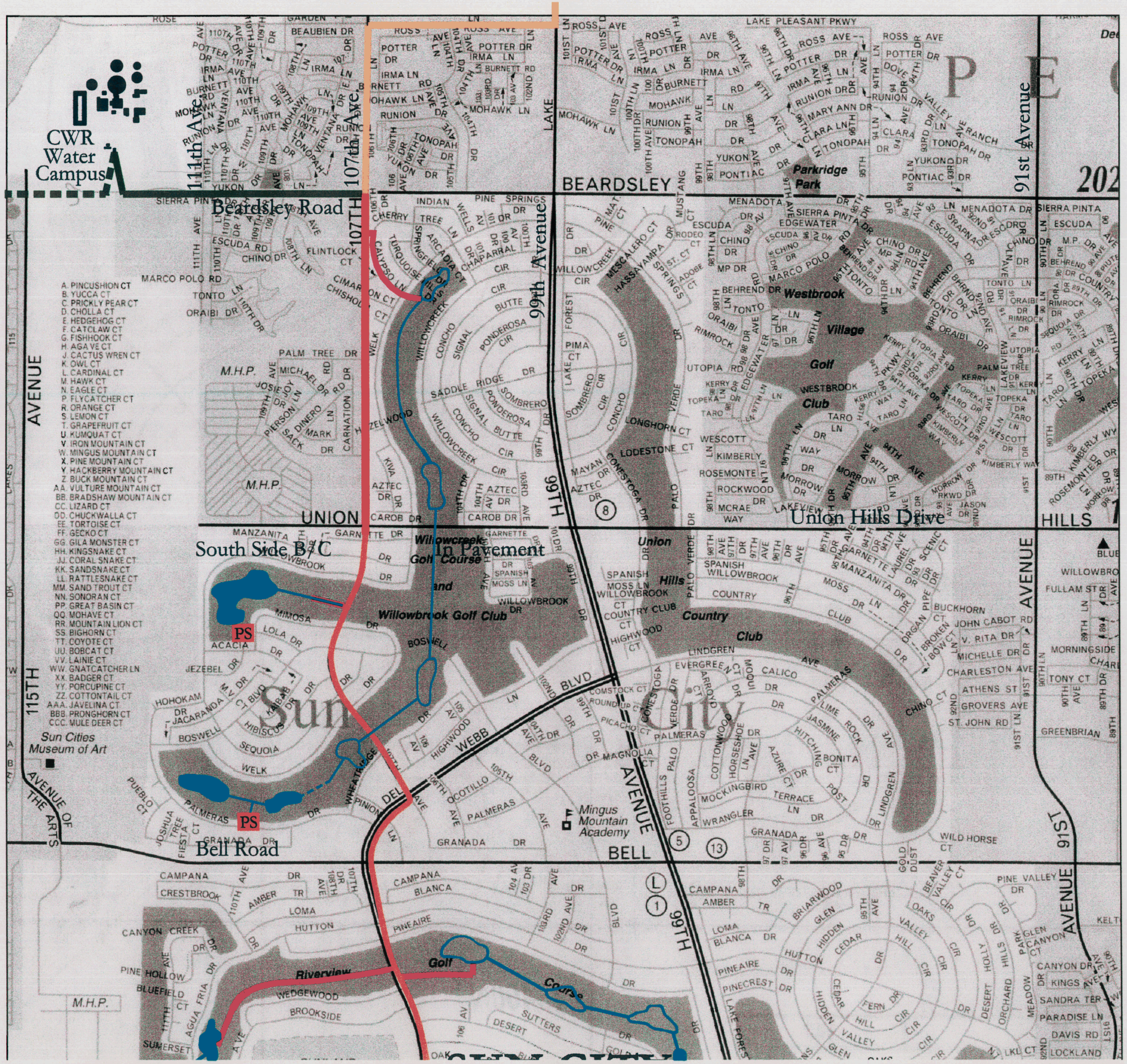


(SEE FIGURE D.7)

N

LEGEND

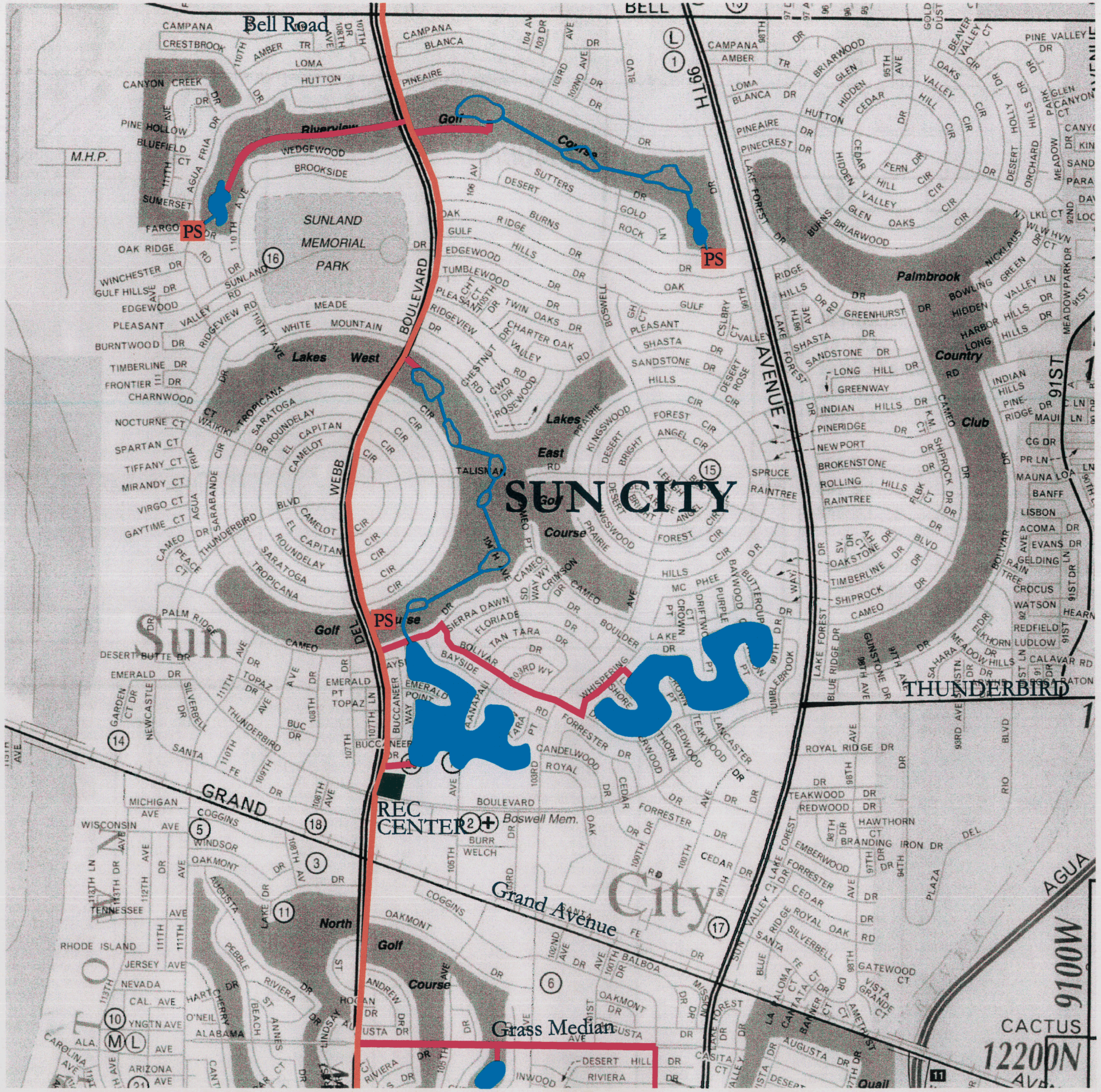
- PROPOSED 12" PIPELINES
- PROPOSED 16" PIPELINES
- PROPOSED 20" PIPELINES
- PROPOSED 24" PIPELINES
- PROPOSED 24" MAINLINE
- PS PUMP STATION
- RESERVOIR LAKE

Sun City

PROPOSED DISTRIBUTION NETWORK

Figure D.6

(SEE FIGURE D.6)



CITIZENS water resources

SUN CITY / SUN CITY WEST / YOUNGTOWN GROUND WATER SAVINGS PROJECT

N

LEGEND

- PROPOSED 12" PIPELINES
- PROPOSED 16" PIPELINES
- PS PUMP STATION
- RESERVOIR LAKE

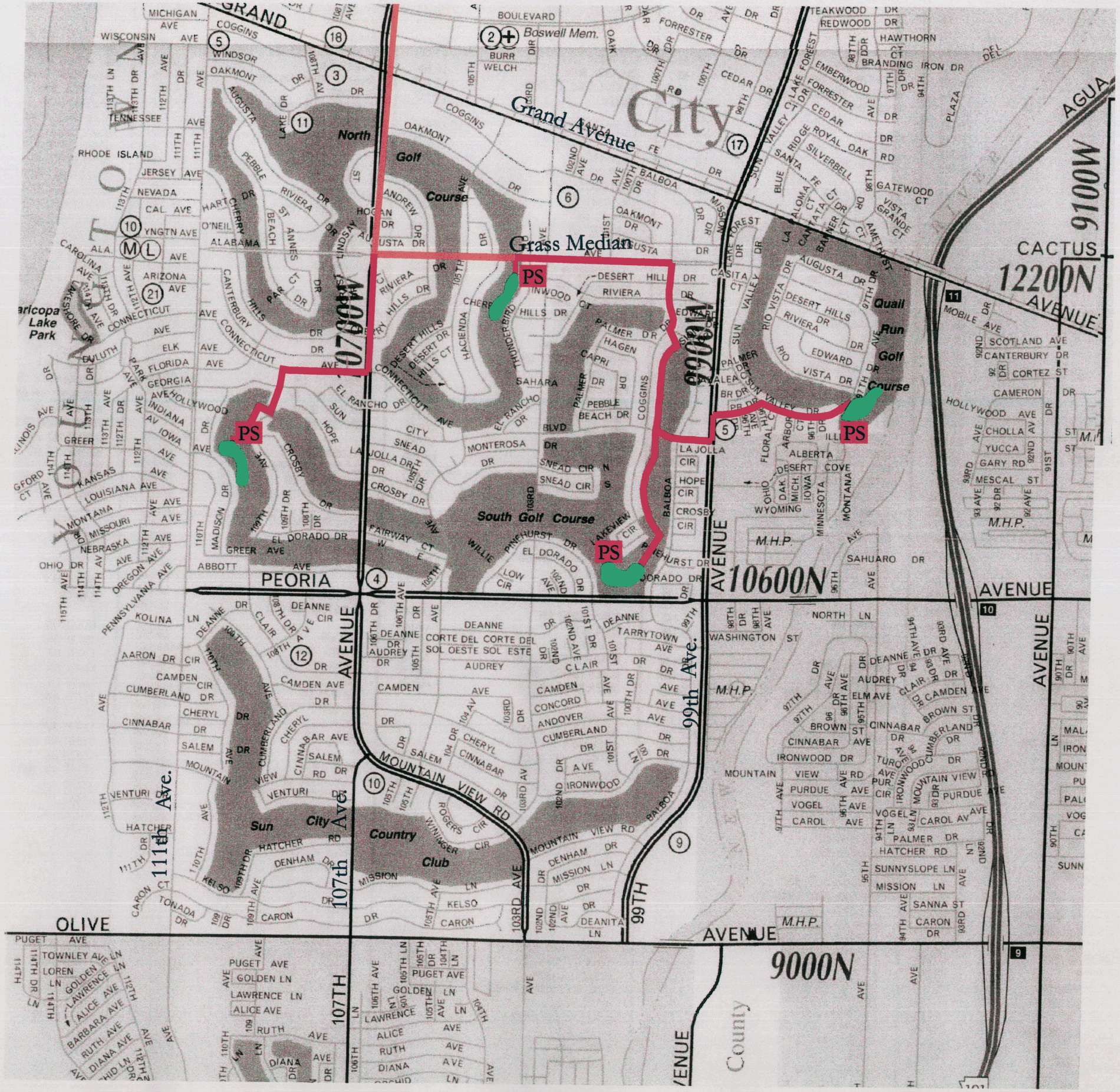
Sun City

PROPOSED DISTRIBUTION NETWORK

Figure D.7

(SEE FIGURE D.8)

(SEE FIGURE D.7)



CITIZENS water resources

SUN CITY / SUN CITY WEST / YOUNGTOWN GROUND WATER SAVINGS PROJECT

N

LEGEND

- PROPOSED 12" PIPELINES
- PROPOSED 16" PIPELINES
- PS PUMP STATION
- RESERVOIR LAKE

Sun City

PROPOSED DISTRIBUTION NETWORK

Figure D.8

For design, the peak demands at each golf course were increased approximately 20% to allow for operational flexibility. The normal peak inflow to the Sun City system of 9.5 cfs was increased to approximately 11.5 cfs to size the pipes only. The actual flow of approximately 9.5 cfs is used for the final operational model.

Cost for the Sun City distribution system is as shown below.

Sun City Distribution System
Opinion of Probable Life Cycle Costs

Description	Unit	Quantity	Unit Price	Amount
Mobilization @ 5%	Ea.	1	$230,314	$230,314
PVC Pipe (12",C-900, Class 150)	L.F.	27,418	$40.35	$1,106,316
PVC Pipe (16", C-905, Class 165)	L.F.	26,245	$55.48	$1,456,073
Ductile Iron Pipe (20", Class 250)	L.F.	4,962	$80.00	$396,960
Ductile Iron Pipe (24", Class 200)	L.F.	5,280	$90.00	$475,200
12" Gate Valve	Ea.	23	$1,800	$41,400
16" Gate Valve	Ea.	10	$6,600	$66,000
20" Gate Valve	Ea.	1	$10,950	$10,950
24" Gate Valve	Ea.	4	$13,500	$54,000
Pavement Replacement	S.Y.	29,555	$20	$591,098
Golf Course Turf Restoration	Ac.	4.53	$19,600	$88,788
Combination AirVac Valve (2")	Ea.	2	$4,000	$8,000
Combination AirVac Valve (2")	Ea.	3	$3,000	$9,000
Traffic Control	L.F.	20,000	$7	$140,000
36" Jack & Bore (Grand Ave. & RR)	L.F.	250	$650	$162,500
			Subtotal	**$4,863,599**
Engineering Design	8%	1	$389,088	$389,088
Construction Administration	12%	1	$583,632	$583,632
Citizens (Admin./Legal/Financial)	10%	1	$483,660	$483,660
Contingency	10%	1	$483,660	$483,660
			Total Capital Cost	**$6,803,639**
O&M Life Cycle Costs			**Annual Cost**	**Present Worth**
Pipeline O&M (50 yr) (63,905 L.F. at $0.50/ft/yr)			$31,953	$523,245
			Total O&M Life Cycle Cost	**$523,245**
			Total Life Cycle Cost, Distribution System	**$7,326,884**

The life cycle costs were determined using common cost elements applied to anticipated annualized costs. The annual costs were calculated by summing each annual cost element. These were then determined as a present worth value.

A differential interest rate of 5.73% was used for calculations. This rate was based on the weighted cost of capital at 8.73%, minus an inflation rate of 3%. The weighted cost of capital at 8.73% for Citizens Water Resources is based on Arizona Corporation Commission Decision 60172. The inflation rate of 3.0% is based on an assumed average inflation rate over past number of years.

It is anticipated that installation of the Sun City Distribution System would be broken into three separate construction contracts which would be completed in approximately 6 months.

Additional complications may occur due to the crossing of Grand Avenue and the Burlington Northern, Santa Fe railroad. Typically crossing a railroad with a utility adds time to the design phase of a project because the railroad will review the design and require a construction license and an operating license.

Distribution System Summary

The existing and proposed distribution systems for Sun City West and Sun City have been analyzed/modeled. The results of that analysis have shown that the distribution of the CAP allocation can be achieved. The final model combines the Sun City design model and the Sun City West Model allowing the distribution from transmission pipeline Route A to two distribution systems. The system must operate using an organized and methodical approach to deliveries each day. This will ensure that CWR can:

- Consume the entire CAP allocation of both communities.
- Maintain a peak flowrate of approximately 15 cfs in the transmission pipeline. This corresponds to the hydraulic limits of a system optimized for economy.
- Meet as much of each golf course's daily demand as possible within the hydraulic limits of the pipeline system.

The existing Sun City West system is adequate to deliver its allocation to the golf courses involved in this project. The existing asbestos cement pipes range in size from 12" to 20" in diameter. During peak periods, wells must be utilized to supply full golf course demand.

A new distribution system is proposed for Sun City. The proposed system utilizes PVC pipe in sizes ranging in size from 12" to 16" in diameter and ductile iron pipe for sizes 20 inch to 24 inch. Conceptual routes have been designed along roadways, golf courses and other easements to minimize community impact. Wells must be utilized during peak demand times to fully supply golf course demands. The Sun City distribution system requires a crossing of the Burlington Northern, Santa Fe railroad that parallels the north side of Grand Avenue. This will need to be accomplished by a jack and bore operation and will add time to the design phase of a project due to railroad involvement.

7 Peak Day CAP Water Delivery Schedule Control Systems

Introduction

Need for SCADA Telemetry for Proposed Groundwater Savings Project

The proposed GSP would involve telemetry communication to as many as 18 remote sites throughout the participating golf courses in Sun City and Sun City West (7 sites in Sun City West, 10 sites in Sun City) and the remote site at the CAP Canal. Each of these golf course remote sites would have an electronic control valve, water meter, and a level sensor to determine lake water levels. Irrigation water would be delivered to each of these golf courses on a daily cycle with varying delivery times and durations.

Each site will communicate via telemetry to a central supervision, control and data acquisition (SCADA) control system. Monitoring and control functionality would be provided from the SCADA control center for each remote site as follows:

Monitoring	Control
Valve position indication	Remote operation of irrigation valve
Pond water level indication (some continuous, some point levels)	Preprogrammed irrigation start and stop times for each participating golf course
Flow rate indication	
Flow totalization	

Existing Citizens Utilities SCADA Systems

Shaw Butte Mountain, located in the area of the North Mountain Preserve area near 19th Avenue and Thunderbird Road, serves as a repeater radio site for Citizens Water Resources, currently using an MDS model 2000 radio, which operates on fixed transmit and receive frequency pair licensed by the FCC. The Shaw Butte radio repeater station could possibly be used as a radio repeater site to relay radio signals from the SCADA control center to the various remote golf course sites, etc. A line-of-sight study must be performed during the detailed design phase of this project to investigate the ability of the Shaw Butte radio repeater sight to properly communicate with all of the proposed remote RTU/ radio sites.

Currently, Citizens Water Resources uses almost exclusively Allen Bradley controllers and a mix of either Modicon or Allen Bradley DH Plus communication protocols at their existing water and wastewater facilities for telemetry. CWR has in use both spread spectrum and fixed frequency radios in their telemetry systems.

The proposed CWR SCADA master control system will be located at Citizen Water Resource's Water Campus operations building due to its central location.

Typical Telemetry System Communication Components

A typical telemetry system includes the following possible subsystems and components.

Remote Terminal Units (RTUs)

RTUs are microprocessor-based remote measurement and control devices that can be integrated into a communication/control system through direct connection, telephone line, or radio link. They typically provide radio modem, private-line modem, leased-line modem, or dial-up modem (communication) connections. RTUs usually support both polled and report-by-exception information exchange and can use any of several communication protocols including Modicon or Allen Bradley DH Plus, both popular versions currently used by CWR.

Programmable Logic Controllers (PLCs)

PLCs are industrially hardened computers with the capability to interface with field devices and to communicate with remote devices. PLCs can be integrated into a communication/control system through direct connection, telephone line, or radio link and are frequently interfaced with third party control systems using a variety of communication options. Radio modems or leased-line modems can be utilized to support remote communications.

Radio

Many utilities have selected radio as a medium for communication with remote sites. Utilizing radio can provide several advantages.

Flexibility

New remote radio sites can easily be added within the range of an existing repeater or base station. The installation of new leased lines or communication cable is not required, and as long as Federal Communications Commission (FCC) rules are met, a SCADA radio can be installed independent of other utilities or communications companies.

Maintenance Control

Utilizing radio communications allows a utility to employ in-house maintenance and avoid reliance on the telephone company or third-party technicians. Retaining control of the communications system maintenance can result in more immediate system restoration in the event of a problem.

Reliability

A radio telemetry system is considered to be reliable when well engineered and maintained. While leased telephone company circuits are also normally reliable, retaining in-house control of the telemetry equipment maintenance provides the opportunity to improve system reliability with proper preventative maintenance procedures.

Cost

Utilizing radio-based telemetry systems can provide a cost saving over cable, where the cost to install and/or lease the cable is prohibitive. The opinion of probable cost for a MDS 2000 radio and antennae at each remote site is approximately $4,400.

Leased Telephone Lines

Leased telephone lines are frequently used for telemetering data, and normally provide reliable service. Monthly lease rates normally range from $77 to $125 per leased line and have a one-time normal installation fee of $225. Lease rates depend on a number of factors including mileage, number of central telephone offices involved, distance to the nearest pre-existing phone service, bandwidth, whether half duplex (2 wire) or full duplex (4-wire), and type of line utilized (voice grade versus analog or digital). Installation costs may vary, depending on availability and proximity of existing telephone service.

In addition to the installation and monthly leasing costs associated with leasing a telephone communications line, disadvantages of using telephone lines include the potential for damage from excavation, corrosion, water, or rodents. There is no direct control over the installation and maintenance of leased lines. The cost of leased telephone lines compared to radio equipment is shown on the following page. There are a total of 19 sites which would be linked to the SCADA system, seven which would be at golf courses in Sun City West, ten at golf courses in Sun City, one at the CAP Canal site, and one at the main control SCADA center. This cost analysis is based on the fact that the CAP Canal remote site would require a radio system to communicate with the SCADA control center and there would be 17 remote RTU sites along with a RTU at the SCADA control center, therefore, two sites (the CAP site and the SCADA control center) would require RTUs with radios. The cost analysis assumes that for the lease lines system there would be approximately half of the sites which would require installation of a new cable to the site for an approximate cost of $5,000. From this cost analysis, it is evident that radio equipment is less costly.

Cost Comparison of Leased Telephone Lines to Radio Equipment

The following table compares telemetry SCADA costs of telephone vs. radio:

SCADA System Cost Comparison Telephone Leased Lines vs. Radio/ Antennae Equipment				
Telephone Leased Lines System Costs				
Description	**Unit**	**Quantity**	**Unit Price**	**Amount**
Present Worth of Leasing Lines over 25 years (17 golf course sites and Master SCADA Site = 18 sites @ $77 per site per month)	L.S.	1	$168,863	$168,863
Installation Fee per Site	Ea.	18	$225	$4,050
9 sites assumed to have additional costs for initial cable construction	Ea.	9	$5,000	$45,000
RTU Controls at Golf Courses	Ea.	17	$19,450	$330,650
2 Sites with RTUs with radios (CAP Canal Meter site and Master SCADA Control Center site)	Ea.	2	$24,000	$48,000
Telephone Leased Lines System - Total Cost				**$596,563**
Radio / Antennae Equipment System Costs				
Radio/ RTU Equipment for 19 Sites (17 golf course sites, CAP Canal Meter site, and Master SCADA Control Center site)	Ea.	19	$24,000	$456,000
Radio / Antennae Equipment System- Total Cost				**$456,000**

For the cost comparison of leased telephone lines verses radio equipment a 25 year life cycle was used since both of these technologies would be at the end of their normal life at 25 years and would require an equipment evaluation study before being replaced with similar equipment.

The cost comparison of telephone leased lines versus radio equipment clearly shows that the radio equipment alternative is less costly. The costs for leased lines actually could be substantially more since the monthly leased lines cost used in this analysis is $77 but could be as much as $125 per month per site.

Utility Owned Communications Cable

Rather than leasing telephone communication circuits, CWR could use their own communications cable to directly link remote sites. In addition to saving monthly leased-line costs, this option allows CWR to retain control of system maintenance. Buried communications cable normally provides a reliable means of communication between sites, although buried cables do have the potential for damage from corrosion or excavation.

Linking sites via hard wire can provide cost savings if the sites are relatively close together, i.e. less than 1,000 to 1,500 feet apart. The cost for buried cable is approximately $6 per lineal foot. In this scenario, most of the sites are a mile or more apart from the next nearest site. In addition, the golf course sites within the Sun City West area already have the effluent distribution pipelines in place which makes it cost prohibitive to install these communication cables compared to the proposed irrigation distribution pipelines for the Sun City area where the communication cables may be placed in the same trench as the new pipelines.

The cost of one mile of buried cable at $6/L.F. is $31,680 whereas the cost for the radio/antennae unit is approximately $3,500. Clearly, for the distances involved between sites, it is cost prohibitive to use communications cable rather than radio.

Telemetry Alternatives

Figure D.9 displays the approximate locations of SCADA remote sites used to control valves to turn water off and on to golf courses and to record the water flow from the CAP Canal. The main control center the remote site would be located at Citizens Water Resources' administration building at the CWR Water Campus.

Proposed Groundwater Savings Project SCADA System

The proposed CAP Water SCADA system for distribution of irrigation water to the golf courses would use a dedicated radio frequency system. All of the remote sites for the golf courses would be outfitted for a radio/antennae system along with an RTU. The installed cost for a RTU radio/antenna system at each remote site is approximately $24,000. An overview schematic of the proposed telemetry system is shown in **Figure D.10**.

The radio line-of-sight investigation study may recommend a new radio repeater station be located somewhere on top of the mountains in the area of 59th Avenue north of the Loop 101 freeway or somewhere on the eastside of the White Tank Mountains, if there are line-of-sight problems with Shaw Butte or with sighting an omni-directional antennae at Citizens Water Resources Water Campus. Either of the possible new radio repeater sites would give CWR a repeater station with a very strong, non-interfered site which would serve to reach all the west valley and points north to the CAP Canal.

The site at the CAP Canal may require a relay repeater radio site between its site and the central SCADA control center since it appears there may line-of-sight problems over to the Shaw Butte radio repeater site. A radio signal test investigation would need to be performed at the CAP Canal site to verify that it will transmit properly with the Shaw Butte radio repeater site.

The connection of the water transmission main to the distribution systems to Sun City and Sun City West will be at a tee near the Citizens Water Resources Water Campus. Water meters will be provided at this location so as to totalize the amount of water being supplied to the Sun City West system and the Sun City system. The purpose of these meters is to determine the full utilization of the CAP allotments for Sun City and Sun City West. These meters will be connected to the SCADA system via hard wire to the SCADA control center at the Citizens Water Resources Water Campus.

Should CAP water allotments for either Sun City or Sun City West not be completely used by the end of the year due to unforeseen factors such as excessive rainfall the remaining allotment amounts will be diverted to the percolation ponds at Citizens Water Resources Water Campus so this water can serve to recharge the groundwater tables. A pipe connection to the percolation ponds can be attained easily by teeing off the CAP water transmission main. There will be an 8-inch electronic flow control valve, which will be controlled remotely by the SCADA system along with a water meter for totalizing flow to the percolation ponds from the water transmission main. This flow control valve and meter will be connected to the SCADA system via hard wire to the SCADA control center at the Citizens Water Resources Water Campus.

CITIZENS water resources

SUN CITY / SUN CITY WEST / YOUNGTOWN GROUND WATER SAVINGS PROJECT

N

CAP

Canal

CAP Canal RTU/Meter

West Wing Mntn

1934 Ft East Wing Mntn

1696 Ft Keefer Hill

Caulderwood Butte 1703 Ft

Beardsley Canal

Agua Fria River

Lake Pleasant Road

Ludden Mntn 1934 Ft

1585 Ft Pitcher Hill

Hedgepeth Hills

LEGEND

- RTU Control Sites
- Central SCADA Control Center

Deer Valley Road

Star Dust Blvd

Grand Avenue

R. H. Johnson Blvd

El Mirage Rd

SUN CITY WEST

CWR Water Campus

Beardsley Road

Loop 101

Union Hills Drive

75th Ave

67th Ave

59th Ave

51st Ave

43rd Ave

35th Ave

I-17

Bell Road

Grand Avenue

SUN CITY

Greenway Road

Thunderbird Road

Loop 101

83rd Ave

Cactus Road

111th Ave

107th Ave

103rd Ave

99th Ave

91st Ave

Grand Avenue

Peoria Ave

19th Ave

Dunlap Ave

Shaw Butte (Existing Radio Antennae Repeater Station)

PROPOSED SCADA SYSTEM SITE LOCATIONS

Figure D.9

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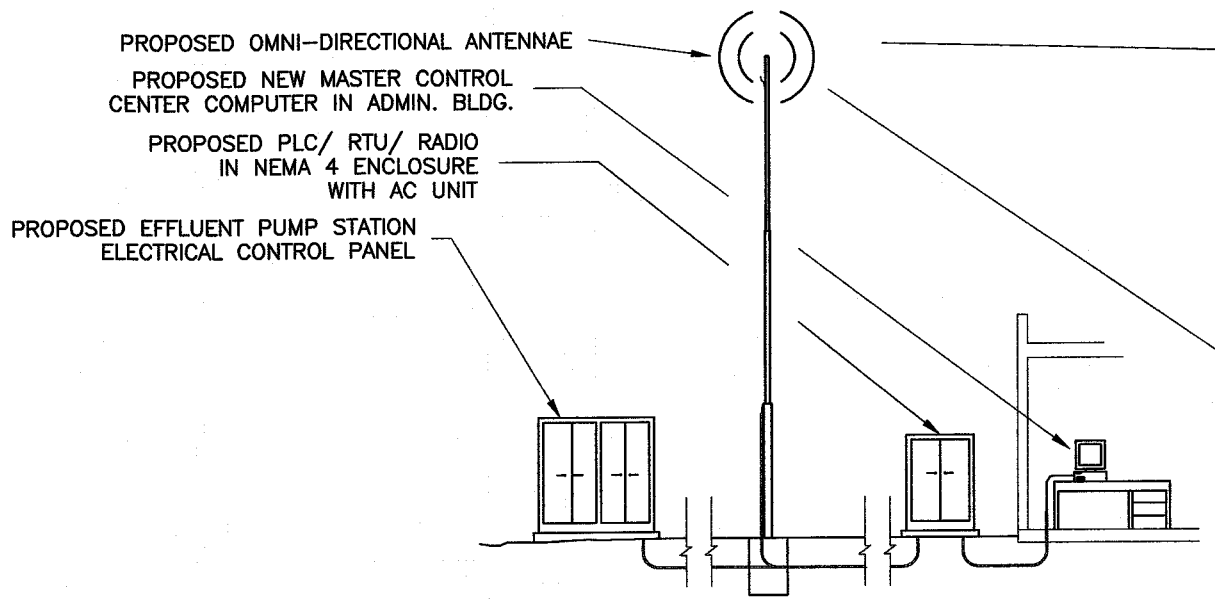
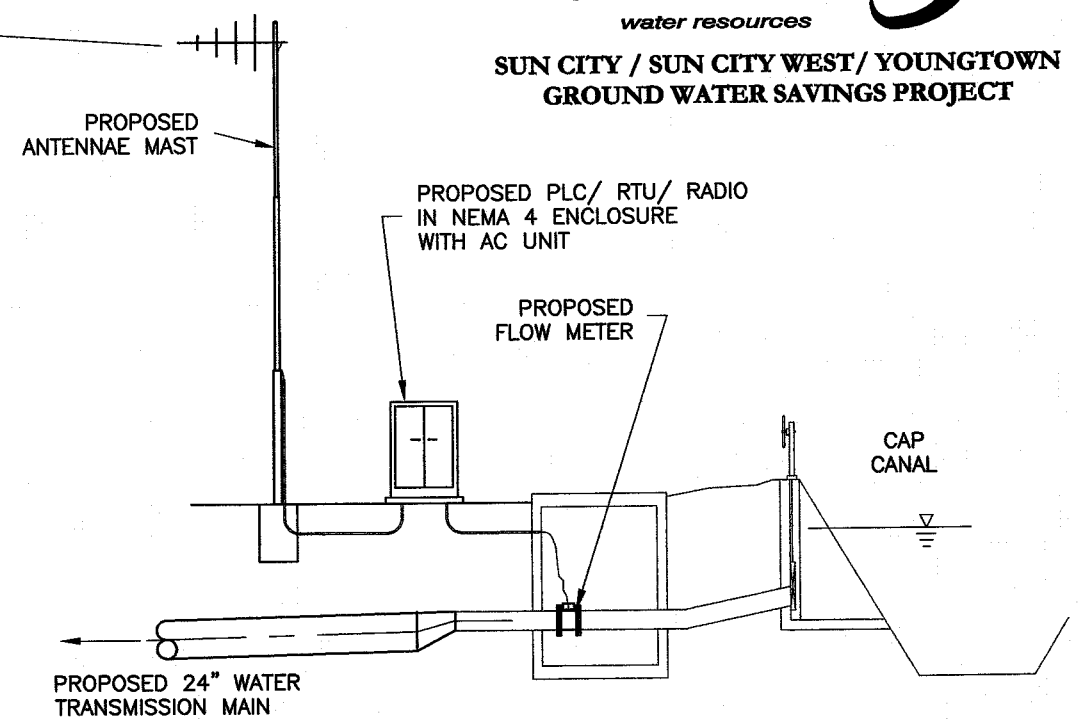
CITIZENS water resources

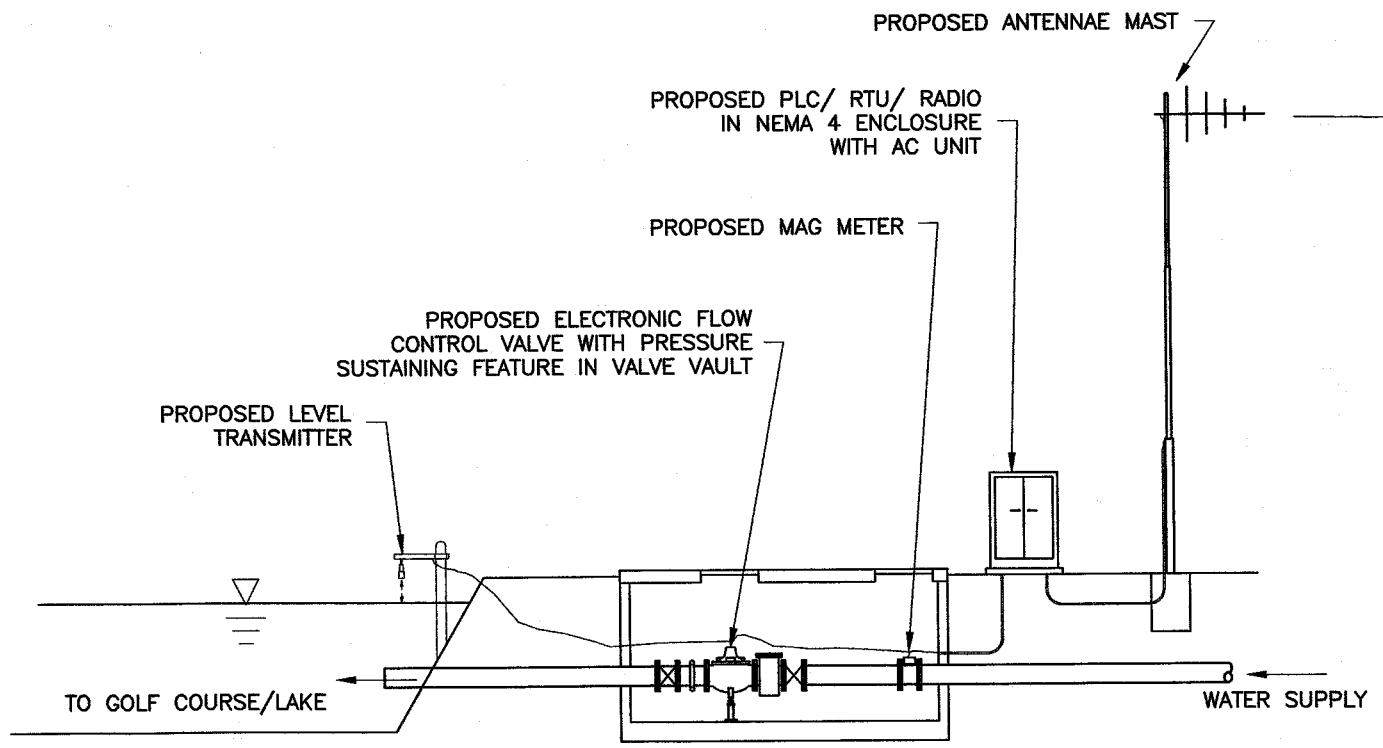
SUN CITY / SUN CITY WEST / YOUNGTOWN GROUND WATER SAVINGS PROJECT



SUN CITY WEST WATER CAMPUS



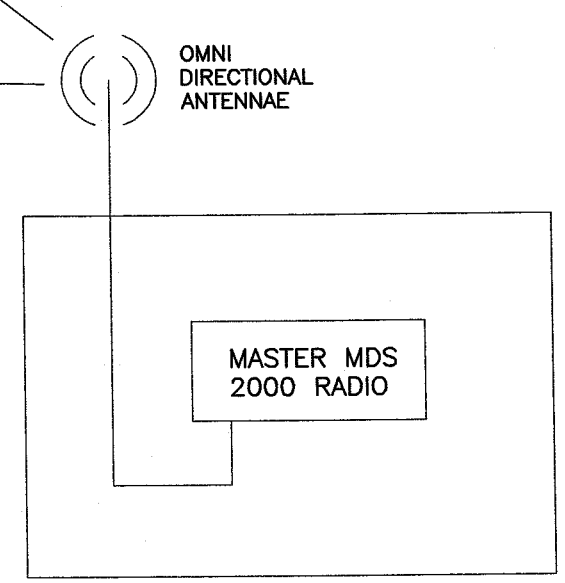
REMOTE RTU/ RADIO SITE AT CAP CANAL



REMOTE RTU/ RADIO SITES AT GOLF COURSES (TYPICAL)

SCHEMATIC

SCALE: NOT TO SCALE



SHAW BUTTE – EXISTING RADIO REPEATER SITE

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OVERVIEW OF RECOMMENDED TELEMETRY SYSTEM

Figure D.10

The opinion of probable construction costs for the proposed SCADA system to serve Sun City and Sun City West is as follows:

SCADA System for Sun City and Sun City West
Opinion of Probable Life Cycle Costs

Description	Unit	Quantity	Unit Price	Amount
Mobilization @ 5%	Ea.	1	$58,019	$58,019
Remote RTU/Radio Sites	Ea.	17	$24,000	$408,000
Vault w/ Control Valve Meter & Level Transmitter	Ea.	17	$32,120	$546,040
Remote RTU/Radio/Meter @ CAP	Ea.	1	$41,150	$41,150
SCADA Master Control Center @ CWR Water Campus	L.F.	1	$52,000	$52,000
SCW – 16" Propeller Meter Station Vault	L.S.	1	$37,960	$37,960
SC – 18" Propeller Meter Station Vault	L.S.	1	$45,200	$45,200
Percolation Ponds – 8" Elect. Control Valve Vault Meter Station	L.S.	1	$28,300	$28,300
Radio Line of Sight Path Study	L.S.	1	$1,400	$1,400
FCC License Application Fee	L.S.	1	$330	$330
			Total Capital Cost	**$1,218,399**

O&M Life Cycle Costs	Annual Cost	Present Worth
Power Cost (%Hp @ $0.07/kwh)	$2,287	$37,455
O&M Labor (2.0 hrs./day for $30,000/yr salary)	$7,500	$122,818
O&M (1% of Structure & 2.5% of Equipment/year)	$22,427	$367,258
Total O&M Life Cycle Cost		**$527,531**
Total Life Cycle Cost, SCADA System		**$1,745,930**

The seven proposed golf courses in the Sun City West area to be served by the GSP which will have SCADA control equipment are as follows:

- Briarwood Country Club,
- Echo Mesa Golf Course,
- Grandview Golf Course,
- Hillcrest Golf Course,
- Pebblebrook Golf Course,
- Stardust Golf Course, and
- Trail Ridge Golf Course.

That portion of the total costs for the proposed SCADA system to serve only the Sun City West area is as follows:

SCADA System for Sun City West
Opinion of Probable Life Cycle Costs

Description	Unit	Quantity	Unit Price	Amount
Mobilization @ 5%	Ea.	1	$24,076	$24,076
Remote RTU/Radio Sites	Ea.	7	$24,000	$168,000
Vault w/ Control Valve Meter & Level Transmitter	Ea.	7	$32,120	$224,840
SCW – 16" Propeller Meter Station Vault	L.S.	1	$37,960	$37,960
Portion of Common SCADA Elements for Complete System (7/17)x(41,150+52,000+28,300+ 1,400+330)	L.S.	1	$50,721	$50,721
			Total Capital Cost	**$505,597**

O&M Life Cycle Costs	Annual Cost	Present Worth
Power Cost (%Hp @ $0.07/kwh)	$942	$15,423
O&M Labor (2.0 hrs./day for $30,000/yr salary)	$3,088	$50,572
O&M (1% of Structure & 2.5% of Equipment/year)	$9,235	$151,225
Total O&M Life Cycle Cost		**$217,220**
Total Life Cycle Cost, Sun City West SCADA System		**$722,817**

The eight proposed golf courses in the Sun City area to be served by the GSP which will have SCADA control equipment are as follows:

- Lakes East Golf Course (Dawn Lake),
- Lakes West Golf Course,
- North Golf Course,
- Quail Run Golf Course,
- Riverview Golf Course (two outlets - both with SCADA controls),
- South Golf Course (two outlets - both with SCADA controls),
- Willowbrook Golf Course, and
- Willowcreek Golf Course.

Thus, there are 10 SCADA control equipment locations among the golf course in Sun City.

That portion of the total costs for the proposed SCADA system to serve only the Sun City area is as follows:

SCADA System for Sun City
Opinion of Probable Life Cycle Costs

Description	Unit	Quantity	Unit Price	Amount
Mobilization @ 5%	Ea.	1	$33,943	$33,943
Remote RTU/Radio Sites	Ea.	10	$24,000	$240,000
Vault w/ Control Valve Meter & Level Transmitter	Ea.	10	$32,120	$321,200
SC – 18" Propeller Meter Station Vault	L.S.	1	$45,200	$45,200
Portion of Common SCADA Elements for Complete System (10/17)x(41,150+52,000+28,300+ 1,400+330)	L.S.	1	$72,459	$72,459
			Total Capital Cost	**$712,802**

O&M Life Cycle Costs	Annual Cost	Present Worth
Power Cost (%Hp @ $0.07/kwh)	$1,345	$22,032
O&M Labor (2.0 hrs./day for $30,000/yr salary)	$4,412	$72,246
O&M (1% of Structure & 2.5% of Equipment/year)	$13,192	$216,033
Total O&M Life Cycle Cost		**$310,311**
Total Life Cycle Cost, Sun City SCADA System		**$1,023,113**

The life cycle costs were determined using common cost elements applied to anticipated annualized costs. The annual costs were calculated by summing each annual cost element. These were then determined as a present worth value.

A differential interest rate of 5.73% was used for calculations. This rate was based on the weighted cost of capital at 8.73%, minus an inflation rate of 3%. The weighted cost of capital at 8.73% for Citizens Water Resources is based on Arizona Corporation Commission Decision 60172. The inflation rate of 3.0% is based on an assumed average inflation rate over past number of years.

PART E - RECOMMENDED PLAN

1 Introduction

This part of the report summarizes the various components and elements that make up the recommended improvements to be constructed under this Groundwater Savings Plan. An overall plan view of the recommended major components is shown in **Figure E.1**. Specific engineering details for each component have been discussed in the previous sections of this report.

2 Alternatives Analyzed

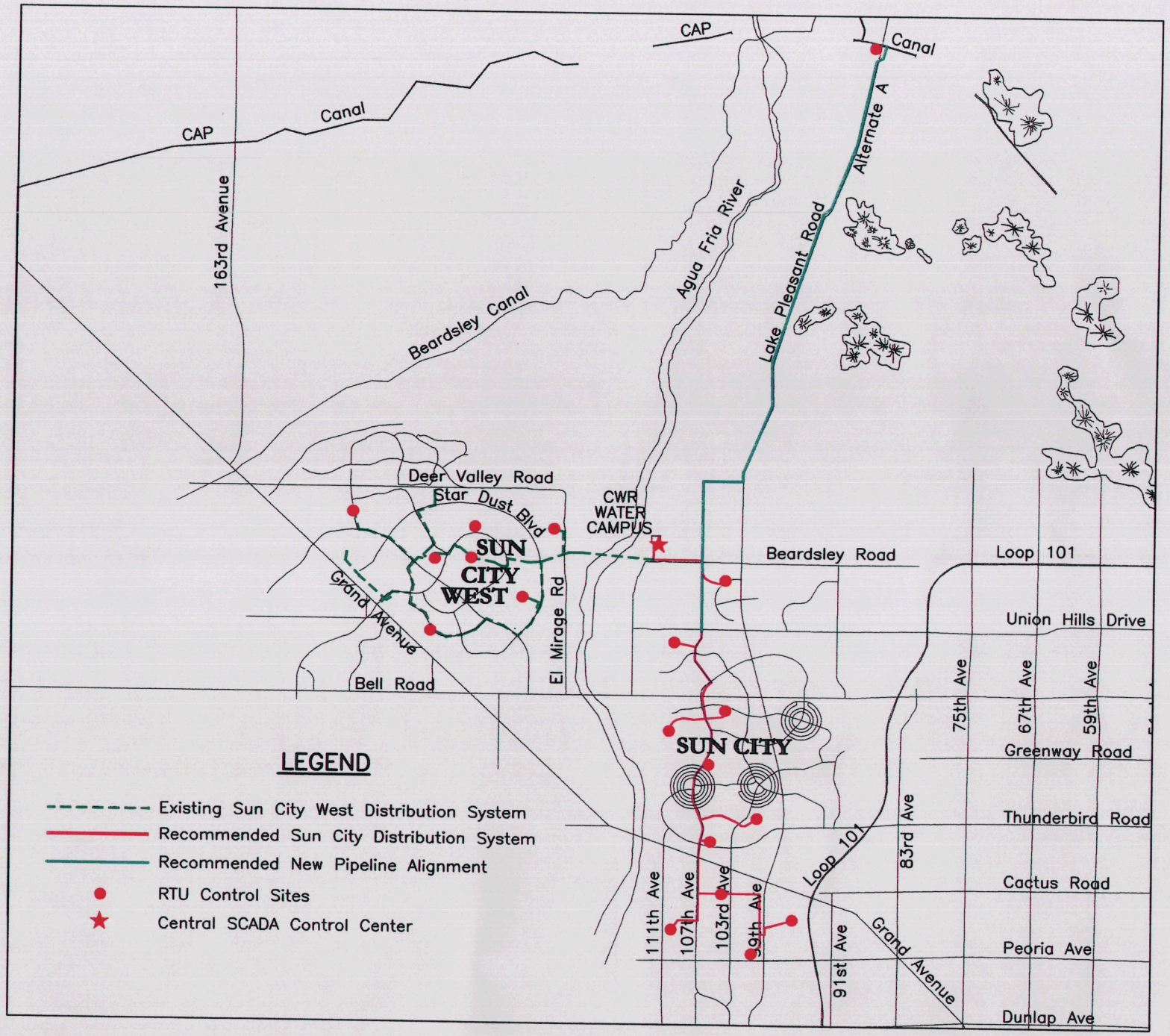
The alternatives analyzed have included:

- Alternative routes for the CAP water transmission pipeline,
- Taking delivery via the Beardsley Canal,
- Using the existing SCW distribution piping for CAP water transmission,
- Combining the Groundwater Savings Project into a joint facility with the Agua Fria Division and/or others,
- Various combinations of Recreation Centers and Country Club golf courses,
- Booster pumping station alternatives,
- Reservoir and/or tank storage alternatives,
- Golf course lake storage alternatives,
- CAP water treatment requirements,
- Alternative routing of the distribution piping,
- SCADA telemetry alternatives, and
- Pipe material alternatives.

The various alternatives have been evaluated on the basis of capital cost, ease of construction, Federal, state and local permitability, environmental consequences, right-of-way requirements, construction duration, operation and maintenance cost, annual costs, and how well the alternative achieves the goal of groundwater savings.

Most of the evaluation criteria have been quantified in terms of present value dollars. Some qualitative judgement is necessary however to evaluate the criteria of achieving the groundwater savings goal. While a cost figure has not been prepared specifically for these criteria, it is obvious that the trunk line alternatives that take delivery of the CAP water via the Beardsley Canal are not as desirable because the water lost through conveyance of that facility is lost to evaporation and leakage and does not serve to replace pumped groundwater.

Figure E.1



3 Recommended Plan Major Plan Components

The major components of the recommended plan consists of the following items:

- CAP Trunk Pipeline,
- Sun City West Distribution System,
- Sun City Distribution System, and
- Control (SCADA) System.

A full description of each of these plan components is included in Part D of this report. A brief description of each component is included below:

CAP Trunk Pipeline

The Alternative A alignment for the CAP water transmission pipeline is the recommended alternative. This corresponds to the Lake Pleasant Road alignment recommended by the CAP Task Force committee. The pipe size will be 24 inches in diameter. For estimating purposes the pipe material was assumed to be ductile iron, mortar lined and polyethylene wrapped. Concept plan and profile drawings of the Alternative A grade and alignment are included in Part D. A plan view of the Alternative A route is shown in **Figure E.1**.

Pumping Station

Calculations presented in Part D of the report indicate that pumping of the CAP water is not required in the recommended plan. The recommended alignment for the CAP trunk pipeline, Alternative A, operates by gravity and is able to deliver CAP water to the golf courses with sufficient pressure without having to boost the pressure by pumping.

Storage

Calculations presented in Part D of this report indicate that a dedicated reservoir or tank for storage of the CAP water is not required in the recommended plan. The recommended plan system is capable of delivering the annual allotment of Sun City and Sun City West by using the storage volume already available in the lakes on each golf course.

Treatment

Experience with numerous golf courses in Maricopa County irrigating with CAP water over several years leads to the conclusion that treatment of the CAP water is not required in the recommended plan. The quality of the CAP water is different from the groundwater being pumped at the golf courses. The difference that affects turf irrigation centers on salinity. This difference will require management practices, specifically some increased watering to achieve additional leaching, to properly utilize the CAP water on turf. An analysis of the chemical constituents in the CAP water shows no levels requiring treatment. The recommendation for no treatment of the CAP water for turf irrigation is supported by the present use of CAP water for other golf course facilities around the Valley.

Sun City West Distribution System

The Sun City West distribution component of the Groundwater Savings Project essentially consists of the existing effluent irrigation system owned by the Recreation Centers of Sun City West. The only modifications required for the use of the existing system to function as a component of the Groundwater Savings Project is the installation of flow control/metering vaults and a control (SCADA) system at each participating golf course. No significant improvements or upgrades to the existing piping system are anticipated. Cost for any minor work that may be required, such as the potential replacement of a stuck valve, would be covered as a contingency item of the recommended plan. The existing SCW distribution system is shown in **Figure E.1**.

Golf courses to be served by the SCW distribution system include:

- Briarwood Country Club,
- Echo Mesa Golf Course,
- Grandview Golf Course,
- Hillcrest Golf Club,
- Pebblebrook Golf Course,
- Stardust Golf Course, and
- Trail Ridge Golf Course.

Sun City Distribution System

An all-new distribution system is proposed to serve Sun City as no current facility exists. The route for the distribution system is presented in detail in Part D and is summarized in **Figure E.1**. Routes will be located within streets and through the golf course properties and other possible open easement areas. Critical points are the points of entry into golf course properties between the public right-of-way and/or easements and the golf course lakes. Least disruptive routes were also investigated as a means to lessen the traffic control requirement. Development of the proposed concept route location included input from received from CWR, TAC members, and others. The delivery points for the golf courses are located at storage reservoirs or lakes allowing for flow along water features to storage lakes.

The proposed Sun City Distribution System is designed to deliver only to the Recreation Center of Sun City Inc. golf courses, specifically:

- Lakes East Golf Course(Dawn Lake),
- Lakes West Golf Course,
- North Golf Course,
- Quail Run Golf Course,
- Riverview Golf Course,
- South Golf Course,
- Willowbrook Golf Course, and
- Willowcreek Golf Course.

The distribution system will use PVC pipe in sizes ranging in size from 12" to 16" in diameter and ductile iron pipe for sizes 20 inch to 24 inch. The Sun City distribution system requires a crossing of the Burlington Northern, Santa Fe railroad that parallels the north side of Grand Avenue.

Supervisor Control and Data Acquisition System

An all new SCADA system will be included as a part of the Groundwater Savings Project involving as many as 18 remote sites throughout the participating golf courses in Sun City and Sun City West. Each of these remote sites would have an electronic control valve, water meter, and a level sensor to determine lake water levels. Irrigation water would be delivered to each of these golf courses on a daily cycle with varying delivery times due to the amount of water ordered by each user. Each site will communicate via telemetry to a central SCADA control system. Monitoring and control functionality will be provided from the central SCADA control center for each remote site.

4 Cost

Costs have been estimated for each alternative of each component of the Groundwater Savings Project. These costs include initial capital cost for items such as design, construction and right-of-way, as well as annual costs over the life of the project. The life of the project has been assumed to be 50 years, to represent the practical life of the materials and equipment being considered. Annual costs include those for operation, maintenance and for conveyance charges for the use of the Beardsley Canal. These costs vary significantly from alternative to alternative.

The annual costs have been converted to present worth value to allow for equal comparison in terms of year 2000 dollars. An inflation rate of 3% has been assumed over the life of the annual costs, as documented in **Appendix I**. A present worth discount rate of 8.73 % was used also as documented in **Appendix I**.

Construction Costs

A summary of the construction costs for the major components of the recommended plan are shown in the table to the right, as well as costs for the other alternatives analyzed.

A construction cost estimate for Alternative E was not prepared because the route was found to be not feasible both hydraulically, because of the very limiting existing pipe sizes, and because of conflicts with the direction of flow required to meet effluent delivery obligations with the Recreation Centers of Sun City West.

Note that a contingency of 10% has been applied to the construction cost estimates to allow for items unknown at this level of design. The contingency has been increased to 25% for the joint facility portion of the each joint facility alternative. This is to allow for uncertainty of the requirements for a proposed joint facility system.

Summary of Construction Costs

Alternative	Joint Facility	CAP Trunk	Booster Pump Station	Storage	Treatment	Distribution	SCADA	Total
A – Lake Pleasant Road (Recommended Plan)	-	**$7,014,653**	-	-	-	**$6,803,639**	**$1,218,399**	**$15,036,691**
B - 115th Avenue	-	$3,494,155	$476,873	-	-	$6,803,639	$1,218,399	$11,993,066
C – El Mirage Road	-	$4,589,471	$476,873	-	-	$6,803,639	$1,218,399	$13,042,382
D – Deer Valley Road	-	$6,211,796	$476,873	-	-	$6,803,639	$1,218,399	$14,664,707
E – Through SCW	-	-	-	-	-	-	-	-
Joint Facility w/ Agua Fria Division	$2,629,723	$5,991,302	$476,873	-	-	$6,803,639	$1,218,399	$17,073,936
Joint Facility w/ Agua Fria Division & City of Surprise	$2,170,815	$5,991,302	$476,873	-	-	$6,803,639	$1,218,399	$16,615,028
Joint Facility w/ City of Surprise	$2,806,500	$5,991,302	$476,873	-	-	$6,803,639	$1,218,399	$17,250,713
Cost Estimate Presented to CAP Task Force	-	**$6,826,132**	**$540,945**	**$1,774,732**	-	**$5,851,191**	-	**$14,993,000**

Operation and Maintenance Costs

The estimated costs for the operation and maintenance of each of the various alternatives are summarized in the table to the right. Many of the costs are the same from alternative to alternative for the major components. The only differences are in the length of the CAP trunk lines and whether or not a booster pump station is required. The recommended alternative has the highest O & M costs for the CAP trunk pipeline, since it is the longest. However, it has the lowest overall O & M cost because no booster pump station is required.

Summary of Operation & Maintenance Costs

Alternative	Joint Facility	CAP Trunk	Booster Pump Station	Storage	Treatment	Distribution	SCADA	Present Worth
A – Lake Pleasant Road (Recommended Plan)	-	**$375,135**	-	-	-	**$523,245**	**$525,858**	**$1,424,238**
B - 115th Avenue	-	$179,289	$1,114,527	-	-	$523,245	$525,858	$2,342,919
C – El Mirage Road	-	$231,381	$1,114,527	-	-	$523,245	$525,858	$2,395,011
D – Deer Valley Road	-	$320,464	$1,114,527	-	-	$523,245	$525,858	$2,484,094
E – Through SCW	-	-	-	-	-	-	-	-
Joint Facility w/ Agua Fria Division	$80,334	$320,464	$1,114,527	-	-	$523,245	$525,858	$2,564,428
Joint Facility w/ Agua Fria Division & City of Surprise	$51,320	$320,464	$1,114,527	-	-	$523,245	$525,858	$2,535,414
Joint Facility w/ City of Surprise	$85,734	$320,464	$1,114,527	-	-	$523,245	$525,858	$2,569,828
Cost Estimate Presented to CAP Task Force *	-	**$308,797**	**$1,312,398**	**$1,441,062**	-	-	-	**$3,062,257**

* O&M Costs presented to Task Force were computed on an annual basis (total = $187,000) and have been converted to present worth for comparison purposes.

Costs Due to Use of the Beardsley Canal

The recommended plan, as well as the joint facility plans, would receive the CAP water directly from the CAP Canal. The remaining alternatives would take delivery of the CAP water through the Maricopa Water District's Beardsley Canal and therefore have annual costs associated with them for water conveyance losses and water wheeling. The conveyance losses, transmission and evaporation, are charged at one half of one percent of the annual allotment per mile of transmission. The figure shown in the cost estimate at the right is based on cost of the water at $106 per acre-foot as per the year 2000 cost of Citizen's M & I contract with CAP.

Water wheeling costs are estimated at $25 per acre-foot for 50 years, converted to present worth.

Summary of Costs Due to Use of Beardsley Canal

Alternative	Transmission & Evaporation Costs	Water Wheeling Costs	Present Worth
A – Lake Pleasant Road (Recommended Plan)	-	-	-
B – 115th Avenue	$256,902	$2,686,025	$2,942,927
C – El Mirage Road	$312,448	$2,686,025	$2,998,473
D – Deer Valley Road	$690,858	$2,686,025	$3,376,883
E – Through SCW	-	-	-
Joint Facility w/ Agua Fria Division	-	-	-
Joint Facility w/ Agua Fria Division & City of Surprise	-	-	-
Joint Facility w/ City of Surprise	-	-	-
Cost Estimate Presented to CAP Task Force	-	-	-

Life Cycle Cost Estimate

The total of the previous three estimates; construction cost, operation and maintenance costs, and costs for water losses are combined in the table to the right to represent the total life cycle cost for the recommended plan, Alternative A, as well as for the other alternatives investigated. This comparison justifies the selection of the recommended alternative as having the least cost over the life of the project.

Summary of 50 Year Life Cycle Costs

Alternative	Joint Facility	CAP Trunk	Booster Pump Station	Storage	Treatment	Distribution	SCADA	Total
A – Lake Pleasant Road (Recommended Plan)	-	**$7,389,787**	-	-	-	**$7,326,884**	**$1,744,257**	**$16,460,928**
B - 115th Avenue	-	$6,616,371	$1,591,400	-	-	$7,326,884	$1,744,257	$17,278,912
C – El Mirage Road	-	$7,287,338	$1,591,400	-	-	$7,326,884	$1,744,257	$17,949,879
D – Deer Valley Road	-	$9,909,143	$1,591,400	-	-	$7,326,884	$1,744,257	$20,571,684
E – Through SCW	-	-	-	-	-	-	-	-
Joint Facility w/ Agua Fria Division	$2,710,057	$6,311,766	$1,591,400	-	-	$7,326,884	$1,744,257	$19,684,364
Joint Facility w/ Agua Fria Division & City of Surprise	$2,222,135	$6,311,766	$1,591,400	-	-	$7,326,884	$1,744,257	$19,196,442
Joint Facility w/ City of Surprise	$2,892,234	$6,311,766	$1,591,400	-	-	$7,326,884	$1,744,257	$19,866,541
Cost Estimate Presented to CAP Task Force*	-	**$7,134,929**	**$1,853,343**	**$3,215,794**	-	**$5,851,191**	-	**$18,055,257**

5 Schedule

Attached as sheet E-6 is a proposed schedule for the design and construction of the Groundwater Savings Project. The schedule is based on an anticipated start date of January 1, 2001. Twelve months is shown as the duration for engineering design. This includes efforts for data collection (as-builts and utility maps), field survey, geotechnical investigation, preliminary and final design. Also the acquisition of permits, licenses and miscellaneous right-of-way for the pipeline will take place during this period. The franchise agreement between the city of Peoria and Citizens Water Resources will also be amended during this period.

The schedule assumes that at least two design firms are engaged to design the Groundwater Savings Project. One firm would design the CAP trunk pipeline and the SCADA system. The other firm would design the distribution system. The SCADA system design could be broken out into a third design package. This would require Citizens to coordinate two or three design contracts along the same timeline.

The construction schedules for each of the three construction packages, CAP trunk pipeline, distribution system, and SCADA system, would be staggered to allow for the contractor selection processes not to overlap. All construction packages would be scheduled to end at the same time, however, so the entire system could be tested and approved as a unit.

Again, this would require that Citizens manage 3 different contractors at the same time. Because the contractors will mostly be working in geographically distinct areas, this should not be a problem, and in fact should help to expedite the construction phase.

The schedule shows that CAP could start to be delivered to the golf courses as early as December 2002.

6 Groundwater Savings Plan Summary

The recommended plan for the Groundwater Savings Project is essentially the concept originally proposed by the CAP Task Force. The cost estimates prepared for this report compare favorably with those previously reported to CWR. The recommended plan will achieve the goal of groundwater savings by reducing the need for pumped groundwater at the golf courses.

A joint project with the Agua Fria Division is possible, but would increase costs to the Groundwater Savings Project. Also the timing of the need for a pipeline for the Agua Fria Division is unknown, but certainly not before 2007 (assuming that city of Surprise builds their contemplated pipeline), some three years after the groundwater Savings Project is scheduled to go into service.

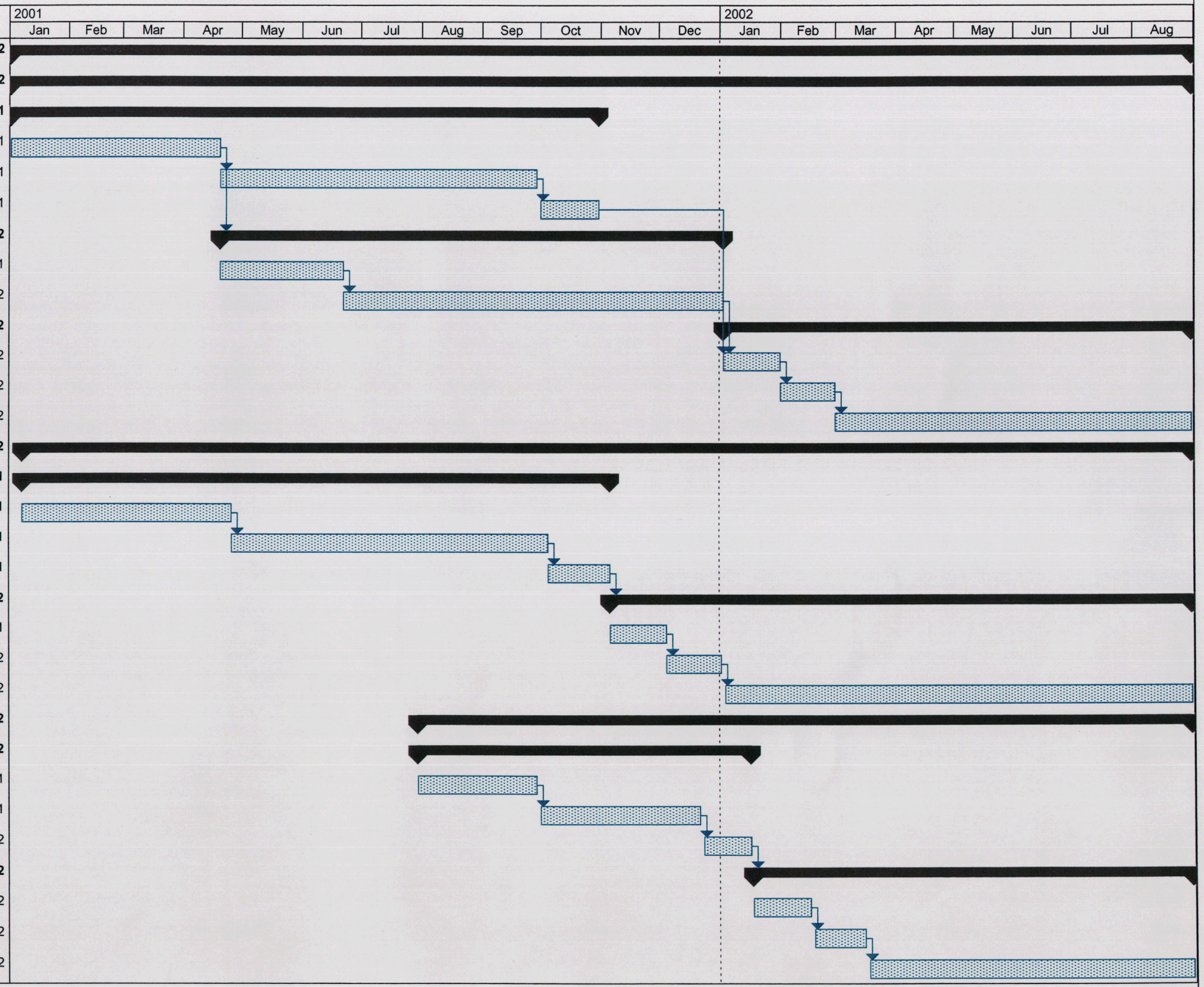
The need for the major components of the project have been thoroughly evaluated and documented. Pumping, storage and treatment are not required for the recommended plan. The need for pumping has been eliminated by taking advantage of the elevation difference between the CAP Canal and the golf course lakes. The need for any reservoir or tank storage has been eliminated by taking advantage of the storage available in the delivery lakes on the golf courses, and by use of a SCADA system that will control the timing and rate of delivery to the golf course lakes. There is no need to treat CAP water for use as golf course irrigation. The use of raw, untreated CAP water for golf course irrigation in the Phoenix metropolitan area is well documented.

The Sun City West distribution system will be essentially the existing system originally constructed to deliver treated effluent from the SCW wastewater treatment plant.

A new distribution system to serve the Recreation Center golf courses in Sun City has been sized to optimally deliver the required flows to use the annual CAP allotment, while maintaining enough flexibility to allow for seasonal and annual variations.

Groundwater Savings Project
Proposed Design & Construction Schedule

ID	Task Name	Duration	Start	Finish
1	**GROUNDWATER SAVINGS PROJECT**	**434 days**	**Tue 1/2/01**	**Fri 8/30/02**
2	**Lake Pleasant Road Pipeline**	**434 days**	**Tue 1/2/01**	**Fri 8/30/02**
3	**Pipeline Design**	**216 days**	**Tue 1/2/01**	**Tue 10/30/01**
4	Preliminary Design Documents (30%)	78 days	Tue 1/2/01	Thu 4/19/01
5	Final Design I (95%)	116 days	Fri 4/20/01	Fri 9/28/01
6	Final Design II (100%)	22 days	Mon 10/1/01	Tue 10/30/01
7	**Right-of-Way Acquisition**	**184 days**	**Fri 4/20/01**	**Wed 1/2/02**
8	Right-of-Way Plans	45 days	Fri 4/20/01	Thu 6/21/01
9	Right-of-Way Acquisition	139 days	Fri 6/22/01	Wed 1/2/02
10	**Pipeline Construction**	**172 days**	**Thu 1/3/02**	**Fri 8/30/02**
11	Advertise for Bids	21 days	Thu 1/3/02	Thu 1/31/02
12	Bid Opening	20 days	Fri 2/1/02	Thu 2/28/02
13	Construction Period	131 days	Fri 3/1/02	Fri 8/30/02
14	**Distribution System**	**430 days**	**Mon 1/8/01**	**Fri 8/30/02**
15	**Distribution System Design**	**216 days**	**Mon 1/8/01**	**Mon 11/5/01**
16	Preliminary Design Documents (30%)	78 days	Mon 1/8/01	Wed 4/25/01
17	Final Design I (95%)	116 days	Thu 4/26/01	Thu 10/4/01
18	Final Design II (100%)	22 days	Fri 10/5/01	Mon 11/5/01
19	**Distribution System Construction**	**214 days**	**Tue 11/6/01**	**Fri 8/30/02**
20	Advertise for Bids	21 days	Tue 11/6/01	Tue 12/4/01
21	Bid Opening	20 days	Wed 12/5/01	Tue 1/1/02
22	Construction Period	171 days	Fri 1/4/02	Fri 8/30/02
23	**SCADA System**	**285 days**	**Mon 7/30/01**	**Fri 8/30/02**
24	**SCADA System Design**	**123 days**	**Mon 7/30/01**	**Wed 1/16/02**
25	Preliminary Design Documents (30%)	45 days	Mon 7/30/01	Fri 9/28/01
26	Final Design I (95%)	60 days	Mon 10/1/01	Fri 12/21/01
27	Final Design II (100%)	18 days	Mon 12/24/01	Wed 1/16/02
28	**SCADA System Construction**	**161 days**	**Fri 1/18/02**	**Fri 8/30/02**
29	Advertise for Bids	21 days	Fri 1/18/02	Fri 2/15/02
30	Bid Opening	20 days	Mon 2/18/02	Fri 3/15/02
31	Construction Period	120 days	Mon 3/18/02	Fri 8/30/02



Groundwater Savings Project
Citizens Water Resources

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