May 2002 – Draft

City of Davis / UC Davis

JOINT WATER SUPPLY FEASIBILITY STUDY

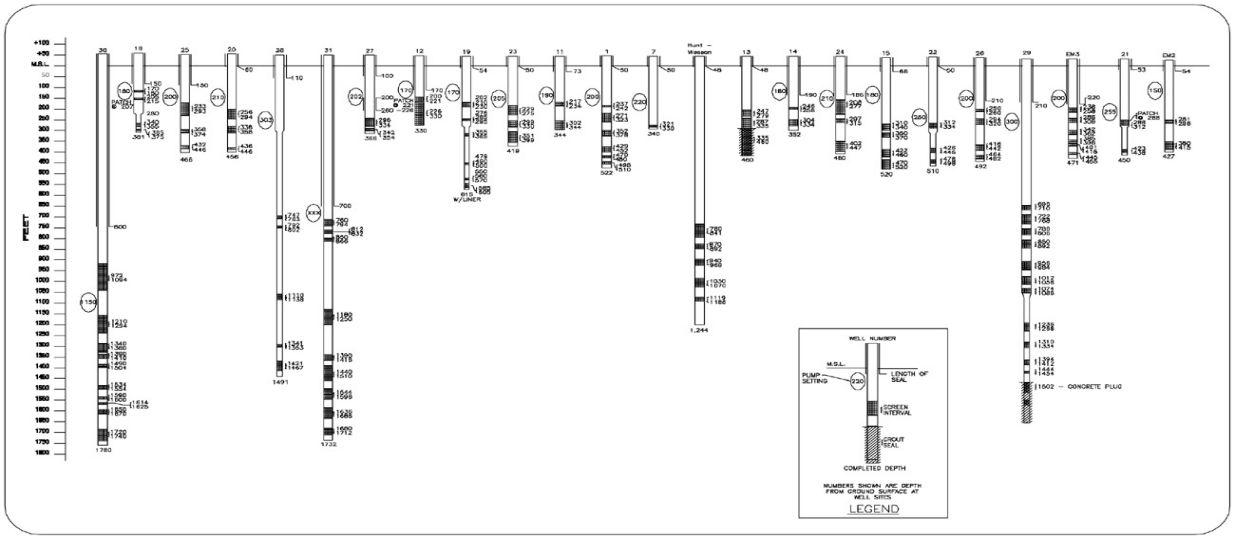
CHAPTER 1. EXECUTIVE SUMMARY

The City of Davis (Davis) and the University of California, Davis (UC Davis) currently rely solely on groundwater to meet their potable water needs. Concerns regarding groundwater quality and availability, wastewater disposal impacts, and impacts on consumers have caused Davis and UC Davis to jointly undertake a study to identify the feasibility of various future water supply alternatives. This study is funded by a grant from the State of California Department of Water Resources, and the results are presented in this report.

BACKGROUND

Two aquifers, each with unique characteristics, supply Davis and UC Davis with groundwater. Water-producing zones less that 700 feet deep are referred to as the intermediate depth aquifer. A slowly permeable clay layer confines underlying water producing zones, which are referred to as the deep aquifer. Figure 1-1 is a cross-section of Davis wells. As illustrated by this figure, four Davis wells draw water from the deep aquifer, and the remainder draw water from the intermediate depth aquifer. UC Davis obtains all of its domestic water supply from the deep aquifer.

Figure 1-1. City of Davis Well Depth, Screen Interval, and Pump Settings



Previous water supply planning activities by Davis have concluded that the city should drill new deep wells to obtain water with preferred water quality characteristics, and investigate supplemental surface water supplies. UC Davis has also identified the need for additional water supplies. In 1994 the Yolo County Flood Control and Water Conservation District (YCFCWCD) filed a water rights application to obtain surface water from the Sacramento River on behalf of the cities of Davis, Woodland, and Winters, and UC Davis. Recent water supply planning activities are summarized below:

1996 Davis completed Future Water Supply Needs Study that concluded that the city should further evaluate the adequacy of deep wells to support additional pumping and pursue the surface water rights application filed in 1994.

1997 UC Davis completed a Draft Water Management Plan that identified the need for additional water supplies and the desire for a high quality surface water supply.

1999 Davis and UC Davis jointly completed a Deep Aquifer Study. This study concluded the deep aquifer was highly confined, contains water that is roughly 8,000-17,000 years old, and may not be a sufficiently reliable source to satisfy future water supply needs of both Davis and UC Davis.

2000 Davis and UC Davis agreed to work together to implement water supply projects. Davis and UC Davis jointly received a grant from the State of California to fund the current Water Supply Feasibility Study to further evaluate the feasibility and cost of various surface and ground water supply options.

In recent years a number of Davis intermediate-depth wells have been removed from service due to water quality problems, including high concentrations of total dissolved solids, nitrates, iron, manganese, and selenium. These problems have caused Davis to drill additional wells into the deep aquifer, which in turn has heightened concerns regarding the long-term reliability of the deep aquifer. In summary, Davis faces a number of water supply challenges including:

- Water quality concerns
- Concerns regarding the long-term reliability of the deep aquifer
- Inability to replace old wells on small sites
- Difficulty of finding new well sites
- Inability to provide well-head treatment on small sites
- Regional subsidence concerns

By relying on water from the deep aquifer, UC Davis has avoided some of the water quality problems that Davis has experienced; however, UC Davis also faces a number of water supply challenges including:

- Providing for future growth in demands
- Concerns regarding the long-term reliability of the deep aquifer
- Water quality concerns regarding future drinking water standards

STATEMENT OF PROJECT OBJECTIVES

The overall objective of this investigation is to develop a plan to provide a reliable source of high quality potable water to Davis and UC Davis that meets all regulatory requirements and results in the lowest overall cost to the consumer.

The following specific objectives are designed to achieve the overall objective stated above:

Drinking Water Quality. The water supply must meet current and anticipated primary and secondary drinking water standards established by the U.S Environmental Protection Agency (EPA) and the California Department of Health Services (DHS). Primary drinking water standards are established to protect public health. Secondary standards are established to protect the aesthetic quality of the water.

Reliability. The water supply source and the water treatment and delivery system must consistently meet the projected water demands for Davis and UC Davis. Water supply, and treatment and transmission facilities should be capable of meeting 110 percent of projected peak hour demands to provide for maintenance and unforeseen facility outage.

Wastewater Quality Objectives. Constituents in the water supply should not cause wastewater discharges by Davis or UC Davis to violate current or anticipated National Pollutant Discharge Elimination System (NPDES) permit requirements. In addition, constituents in the water supply should not inhibit the reuse of wastewater effluent produced by the Davis or UC Davis wastewater treatment plants for irrigation, wetlands, or similar reuse options.

Environmental Impacts. Construction, operation, and maintenance of the proposed water supply treatment and delivery facilities should not adversely impact the environment.

Implementation. Davis and UC Davis must be confident that the selected alternative can be implemented in a timely manner to ensure that water service requirements of all customers can be satisfied.

Impacts on Consumers. Consumer cost impacts should be minimized by selection of an appropriate supply source.

EXISTING WATER SYSTEMS

Davis

The Davis water system service area includes the area within the city limits and adjacent areas such as Willowbank and El Macero. As of 2002 the service area has a population of approximately 66,000. Water is supplied from 21 active groundwater wells. The majority of these wells draw water from intermediate depth aquifer, however the three newest wells draw water from the deep aquifer). Water is distributed to customers through about 175 miles of 4 through 14-inch diameter pipelines. The distribution system contains a 200,000 gallon elevated storage tank near Elmwood Drive and Eighth Street, and a four million gallon (MG) ground-based storage reservoir currently under construction along John Jones Road, adjacent to Sutter Davis Hospital.

In recent years, a number of intermediate depth Davis wells have been removed from service due to water quality problems. Table 1-1 identifies reasons why specific wells were removed from service.

Table 1-1. Summary of Davis Wells Recently Removed from Service

Well Number	Years in Service	Status	Year Taken Out of Service	Reason
10	28	Destroyed	1988	High TDS & low production
16	33	Destroyed	1998	Nitrate exceeds standard
17	34	Destroyed	1994	High TDS & low production
18	31	Out of Service	2001	Nitrate exceeds standard

UC Davis

The UC Davis water service area consists of about 5,200 acres and provides water to approximately 24,000 students and 10,000 faculty and staff. The UC Davis water system has separate domestic and utility water facilities. Water for building and laboratory use and for heating, cooling, and other "industrial" uses on the campus is supplied by the domestic water system. The utility water system supplies nonagricultural irrigation (*i.e.* campus landscape/turf irrigation). UC Davis operates six wells exclusively for domestic water supply. All wells are completed in the deep aquifer between 800 and 1,500 feet below ground surface. Water is distributed to users through about 27 miles of 2 through 16-inch diameter pipelines. The distribution system includes a 200,000 gallon elevated storage tank and a 1.5 MG underground reservoir. A 300,000 gallon ground-based storage reservoir is currently under construction.

West Sacramento

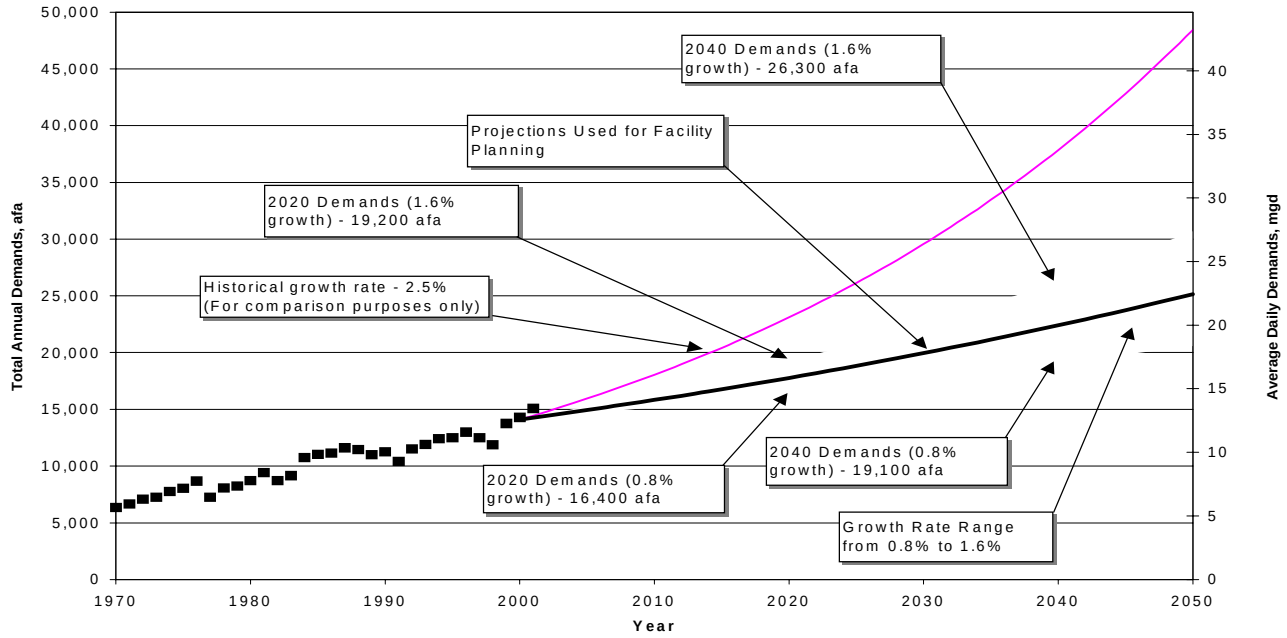
A potential future water supply source is water from the Sacramento River, treated by the City of West Sacramento (West Sacramento) water treatment plant. The West Sacramento water treatment plant was constructed in 1988. The plant currently has a nominal capacity of 24 million gallons per day (mgd). Improvements are currently under construction to increase the nominal capacity of the treatment plant to 42 mgd. Construction of these improvements is be completed by April 2004. At a later date West Sacramento intends to expand the nominal capacity of the treatment plant to 60 mgd, which is expected to be sufficient to satisfy West Sacramento's demands at build-out of the City.

WATER DEMAND PROJECTIONS

Davis

Historical Davis water production and use patterns were used to estimate future water demands. For the past 30 years water demands have increased at a rate of about 2.5 percent annually. For the purpose of this investigation, a future annual water demand growth rate of 0.8-1.6 percent has been assumed. The middle of the range (*i.e.* 1.2 percent) was used for facility planning. These projections assume that measures will be implemented to achieve a 20 percent reduction in water demands from historic levels, in conformance with the adopted City Urban Water Management Plan. City of Davis historic and projected future water demands are shown in Figure 1-2.

Figure 1-2. City of Davis Historic and Projected Future Water Demands

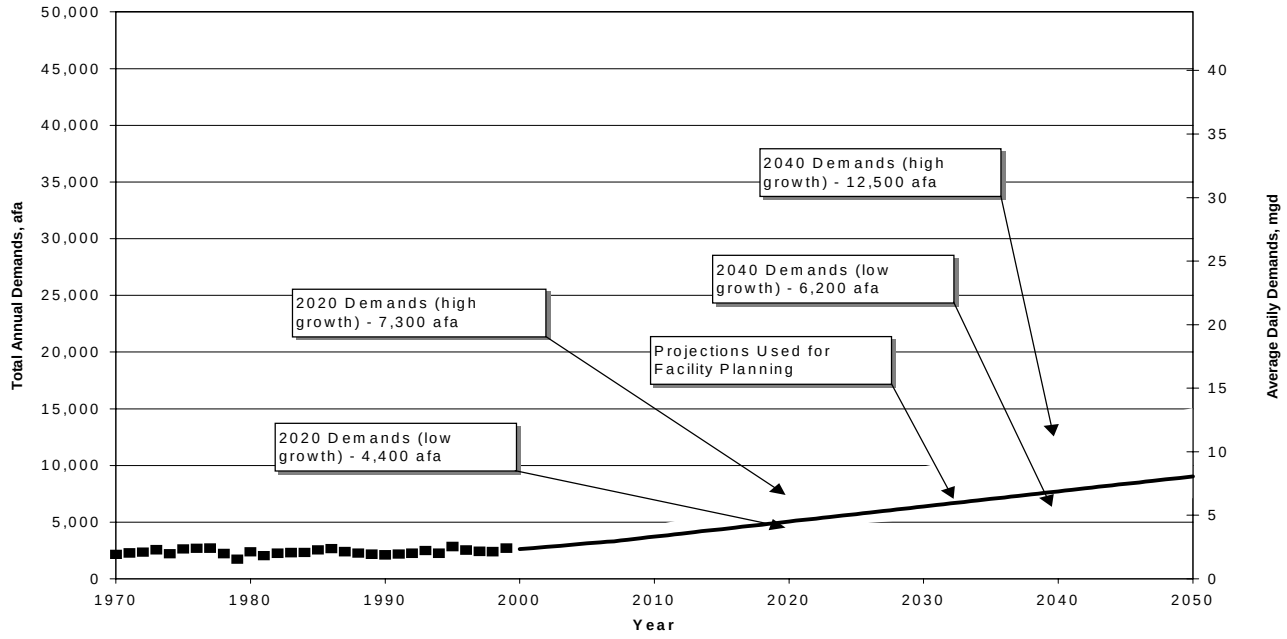


As indicated in Figure 1-2, Davis' total annual water demands are projected to increase from about 15,000 acre-feet in 2001 to between 19,100 and 26,300 acre-feet by 2040.

UC Davis

Future UC Davis water demands were estimated based on a review of historical water production and current development plans. These historic and projected future water demands are shown in Figure 1-3.

Figure 1-3. UC Davis Historic and Projected Future Water Demands



As indicated in Figure 1-3, UC Davis total annual water demands are projected to increase from about 3,000 acre-feet in 2001 to between 6,200 and 12,500 acre-feet by 2040.

POTENTIAL WATER SUPPLY SOURCES

Three primary water supply sources are potentially available to Davis and UC Davis: the intermediate depth aquifer, the deep aquifer, and surface water from the Sacramento River. The quality and availability of water from each source are discussed below.

Intermediate Depth Aquifer

The intermediate depth aquifer is considered to extend from about 200 feet to 700 feet below the ground surface. Most of the Davis intermediate depth wells are completed between 200 and 600 feet below the ground surface.

Water Quality. Water from the intermediate depth wells is generally very hard and high in total dissolved solids (TDS). Nitrate levels are close to the drinking water limit in several wells, and several Davis wells have been abandoned due to high nitrate concentrations. Boron levels are high enough to adversely affect sensitive plants. Arsenic levels are below the new national standard. Chromium-6 levels may exceed future drinking water limits. Selenium concentrations are below drinking water limits, but are sufficiently high to cause discharge limit concerns at the City's wastewater treatment plant. The intermediate depth aquifer has experienced contamination in the Davis area from petroleum-based contaminants, solvents and other dry cleaning chemicals, chlorinated hydrocarbons, and less hazardous contaminants such as nitrate.

Availability. Although water levels in the intermediate aquifer are impacted by drought conditions, the aquifer has historically fully recovered following drought periods. Availability of water from the intermediate aquifer is not a concern at the present level of withdrawal.

Deep Aquifer

The deep aquifer is considered to be located between about 700 and 2,700 feet below the ground surface. Deeper aquifers (greater than 2,700 feet below ground surface) are composed of marine sediments and are saline. The Davis deep wells are completed between 1,490 and 1,800 feet below the ground surface. UC Davis deep wells are completed between 800 and 1,470 feet below the ground.

Water Quality. Water from the deep aquifer has moderate levels of hardness and total dissolved solids. Arsenic levels vary between wells, with the highest concentrations slightly below the new national drinking water standard. Boron concentrations in deep wells are similar to the concentrations in intermediate wells, and are high enough to adversely affect sensitive plants. Available information indicates that nitrate, chromium-6, and selenium are not problematic constituents.

Availability. Recent studies of the long-term quality and yield of the deep aquifer indicate that the reliability of this aquifer could be at risk if both Davis and UC Davis rely on it as their only source of supply.

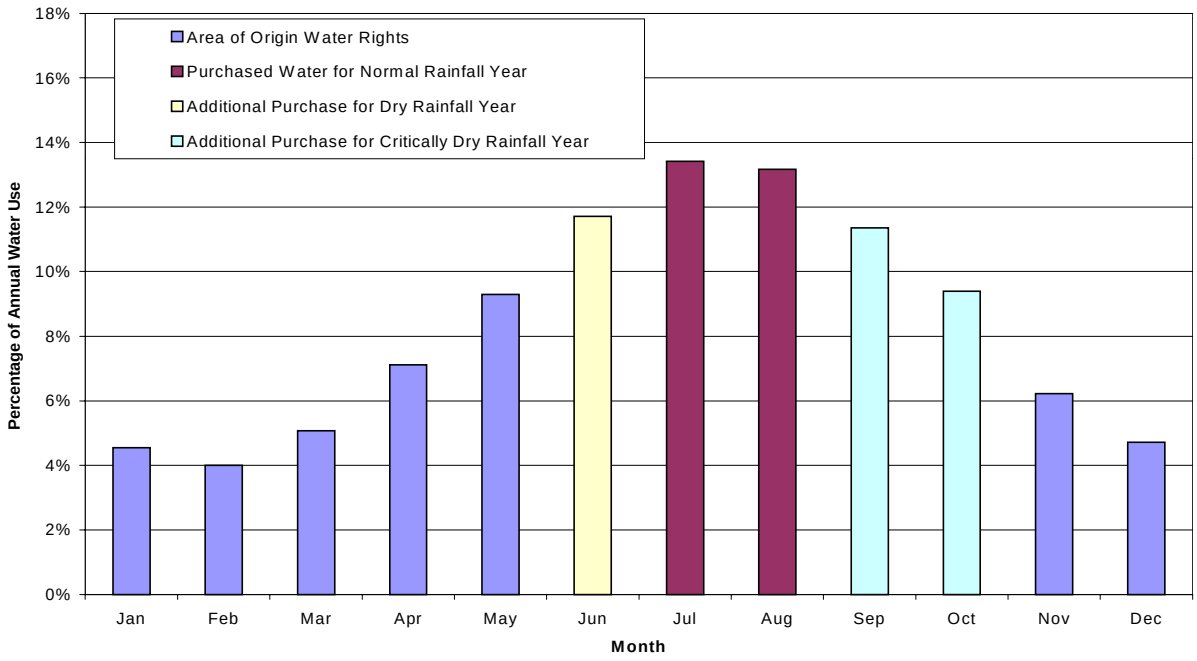
Sacramento River

Water Quality. Sacramento River water is low in hardness and TDS. Concentration of regulated inorganic and organic chemicals in Sacramento River water at the West Sacramento treatment plant intake are generally below detection limits, and the untreated water has consistently met all drinking water standards with the exception of turbidity and coliform bacteria. Sedimentation, filtration, and disinfection during the treatment process remove turbidity and bacteria and insure compliance with all drinking water standards. Trace concentrations of unregulated organic wastewater contaminants are known to be present in many untreated surface waters. Regulation of these constituents is an emerging issue. Treatment process such as activated carbon filtration may be necessary in the future to comply with new regulations.

Availability. In October 1994, the YCFCWCD filed a water rights application under the area of origin statutes for appropriation of surface water from the Sacramento River on behalf of Davis, UC Davis, and other entities in Yolo County. Davis and UC Davis continue to pursue rights under this application to divert up to 20,000 acre-feet per year (Davis) and 10,000 acre-feet per year (UC Davis) of water from the Sacramento River.

Assuming that this water rights application is perfected, and the State Water Resource Control Board (SWRCB) issues a water rights permit, water could be diverted under this permit application during most months in a normal rainfall year as shown in Figure 1-4. During dry or critically dry years, there would be additional months when water would not be available under area-of-origin water rights.

Figure 1-4. Availability of Water Rights Water



Water could be purchased from an existing upstream water rights holder when water is not available under this area-of-origin permit application.

PROJECT ALTERNATIVES

Seven potential water supply alternatives are identified and analyzed in this study. Two of the alternatives would rely on groundwater only; three of the alternatives would integrate surface water into a conjunctive use program with groundwater; and two of the alternatives would rely on surface water only to supply all water demands of Davis and domestic water demands of UC Davis. These seven alternatives are summarized below.

Groundwater Only Alternatives

Alternative 1 – All demands would be supplied with groundwater, entirely derived from the deep aquifer by 2040. This alternative represents a continuation of the current long-range water supply policy and plan for both Davis and UC Davis.

Alternative 2 – All demands would be supplied with groundwater from both intermediate and deep aquifers, using wellhead treatment on intermediate depth wells as required to meet water quality objectives.

Conjunctive Surface Water/Groundwater Use Alternatives

Alternative 3 – Available treatment capacity at the West Sacramento water treatment plant at Bryte Bend would be used to supply treated surface water. Remaining demands would be satisfied with groundwater.

Alternative 4 – Available treatment capacity at the West Sacramento water treatment plant at Bryte Bend would be used to supply treated surface water to meet demands and to inject into the underlying groundwater aquifer. Remaining demands would be satisfied with groundwater that has been extracted from groundwater storage, or with native groundwater.

Alternative 5 – Treatment capacity of the West Sacramento water treatment plant at Bryte Bend would be increased to supply treated surface water to meet average-day and most of maximum-day demands. Groundwater would be pumped as needed to meet the remaining demands.

Surface Water Only Alternatives

Alternative 6 – Demands would be supplied using treated surface water from the West Sacramento water treatment plant at Bryte Bend.

Alternative 7 – Demands would be supplied using treated surface water from a new Sacramento River diversion and a new water treatment plant.

SCREENING OF ALTERNATIVES

Potential water supply sources and project alternatives were screened with regard to how well they would meet the specific project objectives (water quality considerations, reliability, wastewater disposal impacts, potential environmental impacts, difficulty of implementation, and

impact to consumers), as well as estimated total annualized costs. Total annualized costs represent the estimated total annual cost of constructing and operating community water supply facilities, plus the estimated total annual consumer cost of facilities such as water softeners within the City of Davis (based on survey data). Table 1-2 summarizes this screening process.

Screening Process Conclusions

Groundwater Only Alternatives. Alternative 1 (continuation of current long-term City of Davis policy of transition to, and current UC Davis policy of, reliance on groundwater from the deep aquifer) has the lowest projected total annualized cost of any of the alternatives. The major disadvantage of this alternative is that the deep aquifer may not be capable of supplying the long-term needs of both Davis and UC Davis. Other disadvantages are that individual wells may require well-head treatment facilities to remove specific constituents such as arsenic, iron, or manganese; that suitable new, larger well sites must be obtained to accommodate well-head treatment facilities; and that the boron concentrations would continue to be sufficiently high to adversely impact vegetation.

Alternative 2 (which includes the use of reverse osmosis well-head treatment on intermediate wells) has the second lowest projected total annualized cost. Under this alternative Davis would rely on water from the deep aquifer, and water from the intermediate depth aquifer treated by reverse osmosis to insure compliance with primary and secondary standards. UC Davis would continue to obtain all of its domestic water supply from the deep aquifer, so many of the disadvantages of Alternative 1 would also be applicable to UC Davis water supply under this alternative. The major disadvantage of this alternative is that reverse osmosis well-head treatment would produce a brine stream that would make disposal difficult and potentially costly.

Table 1-2. Project Alternatives Screening

Conjunctive Use Alternatives

Alternative 5 (supplying base water demands with surface water from West Sacramento's water treatment plant at Bryte Bend and supplying peak demands with deep aquifer groundwater), would have the lowest capital and lowest total annualized costs of the three conjunctive use alternatives (Alternatives 3, 4, and 5). In addition, during summer months Alternative 5 would provide a water supply with a lower concentration of dissolved minerals than Alternatives 3 and 4. Therefore Alternative 5 is the preferred conjunctive use alternative. Alternative 5 also has several advantages over Alternatives 1 or 2, including that it would provide a water supply with a lower concentration of dissolved minerals and a more reliable dual source water supply.

The disadvantage of Alternative 5 (in addition to being more costly than Alternatives 1 and 2) is that to achieve its implementation would require approval of the pending Davis and UC Davis area-of-origin water rights applications and required water transfers, as well as an interagency agreement with West Sacramento to wheel and treat surface water to Davis and UC Davis service areas.

Surface Water Only Alternatives

The two surface water only alternatives (Alternative 6 and 7) would have significantly higher capital and total annualized costs than the preferred conjunctive use alternative (Alternative 5) while providing a water supply with only a slightly lower concentration of dissolved minerals. In addition, under Alternatives 6 and 7 surface water would be the sole water supply source. The reliability of this single source could be impacted by drought conditions or by future environmental restrictions.

Recommendations From Screening Process

Alternative 1 and 5 are considered to be the best alternatives. but water quality, water availability, or institutional issues could impact the suitability of either of these alternatives. It is thus recommend that Davis and UC Davis maintain flexibility in their long-term water supply planning by adopting the following general course of action:

- In the immediate future, Davis should continue the transition to, and UC Davis should continue the practice of, relying on water from the deep aquifer (Alternative 1). The deep aquifer should be monitored for signs of groundwater overdraft, and water quality constituents should be closely monitored with respect to current and future drinking water quality criteria and wastewater discharge permit requirements.
- Davis and UC Davis should pursue Alternative 5 by negotiating interagency agreements, preparing environmental documentation, and pursing State Water Resource Control Board approval of their pending area-of-origin surface water rights applications.

FINANCIAL ANALYSIS

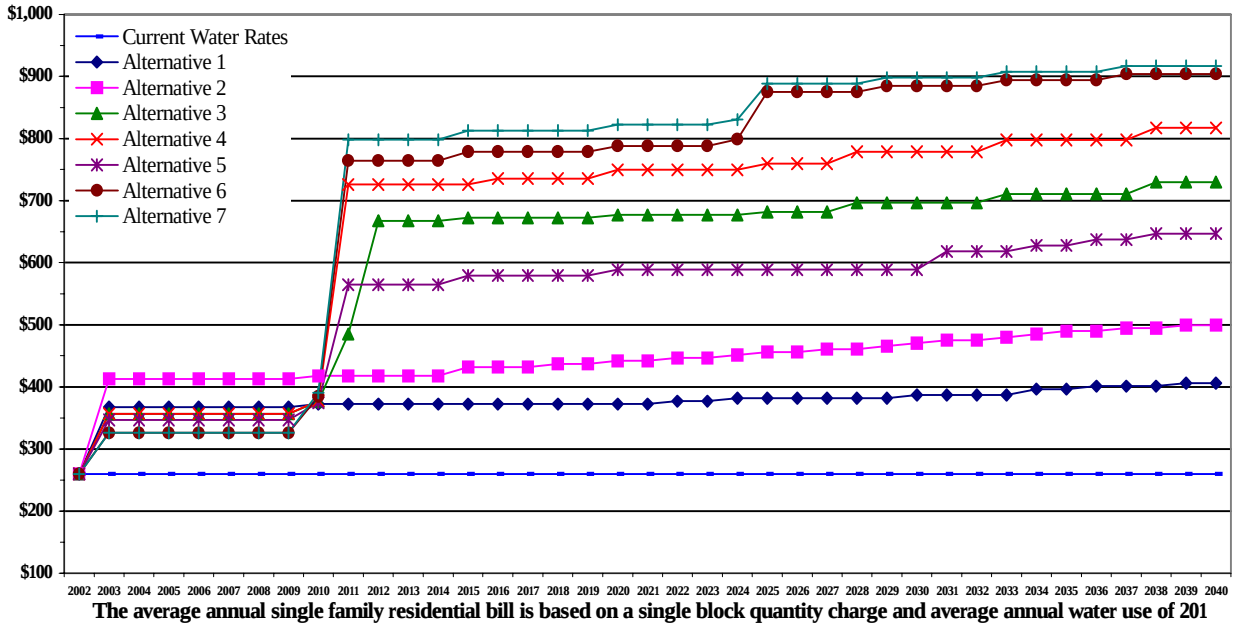
A financial analysis was completed to estimate the potential impact of each alternative on Davis water rates and capacity charges. The state budgetary process funds UC Davis expenditures, so the financial analysis did not include UC Davis.

This analysis was based on the following assumptions:

- Large capital costs of major new facilities, such as surface water treatment, transmission, or storage facilities, would be financed using bonds. Costs for new wells or wellhead treatment, which are significantly smaller, would be funded on a pay-as-you-go basis.
- The allocation of capital costs between current ratepayers and new development is based on the proportional benefit received by each from the project facilities whose capital costs are being allocated. Over the study period (2002-2040) approximately 30 percent of the design capacities benefit new development, and the remainder benefits all ratepayers.
- All costs and resulting rates are in 2002 dollars. While costs and rates will be subject to inflation, cost and rates presented herein do not assume a rate of inflation so this information can be evaluated from the perspective of a current ratepayer.

Figure 1-5 shows projected impacts of the project on single-family average annual water bills. Alternative 1 is the current policy direction, and rates would have to be raised to at least this level if the capital improvements program is to be supported solely by water rates and capacity fees. As indicated by Figure 1-5, in 2020 the estimated annual water bill would be roughly $370 under Alternative 1, and about $590 under Alternative 5. In 2001 the state-wide average water bill was $370.

Figure 1-5 Projected Single Family Average Annual Water Bill, 2002 - 2040



The average annual single family residential bill is based on a single block quantity charge and average annual water use of 201 ccf.

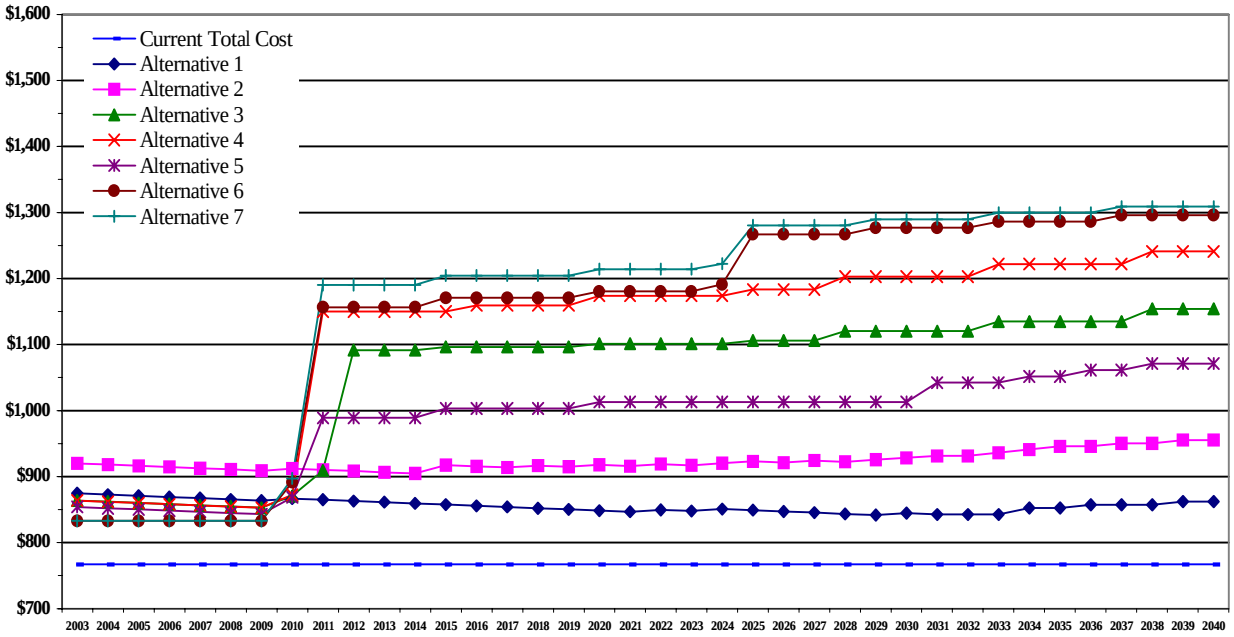
There are many costs incurred by local water users that are often not recognized. The costs associated with using water with high levels of total dissolved solids (TDS) include the purchase of bottled water, water softening or treatment systems, and the replacement or repair of plumbing, water heaters, or water-using appliances caused by scaling and/or deterioration. To mitigate these problems, most consumers purchase home water softening units and bottled water, use more cleaning agents, and replace water heaters, household plumbing, and water-using appliances more frequently than would be necessary if the water supply had lower hardness and TDS. Table 1-3 shows the estimated average annual consumer cost per Davis household of using water with various levels of TDS. These costs reflect the fact that all consumers do not use water softeners or bottled water (*e.g.* since about 41 percent of Davis residents use water softeners, the average annual cost per resident is 41 percent of the cost if all residents used water softeners.) A TDS level of 100 mg/L represents Sacramento river water, 400 mg/L represents water from the deep aquifer, and 700 mg/L represents water from the intermediate aquifer. (As Table 1.3 indicates, expenditures for bottled water are relatively unaffected by changes in TDS concentrations.)

Table 1-3. Estimated Average Annual Consumer Costs per Household, dollars

Item	TDS Level, mg/L		
	100	400	700 (Current Situation)
Bottled/Filtered Water	203	205	207
Water Softening System	66	106	133
Water Heater	35	43	50
Faucets/Plumbing	24	25	27
Clothes Washers	35	42	49
Dish Washers	29	35	41
Total per Household	392	456	507
Davis Total (million dollars)	5.10	5.93	6.59

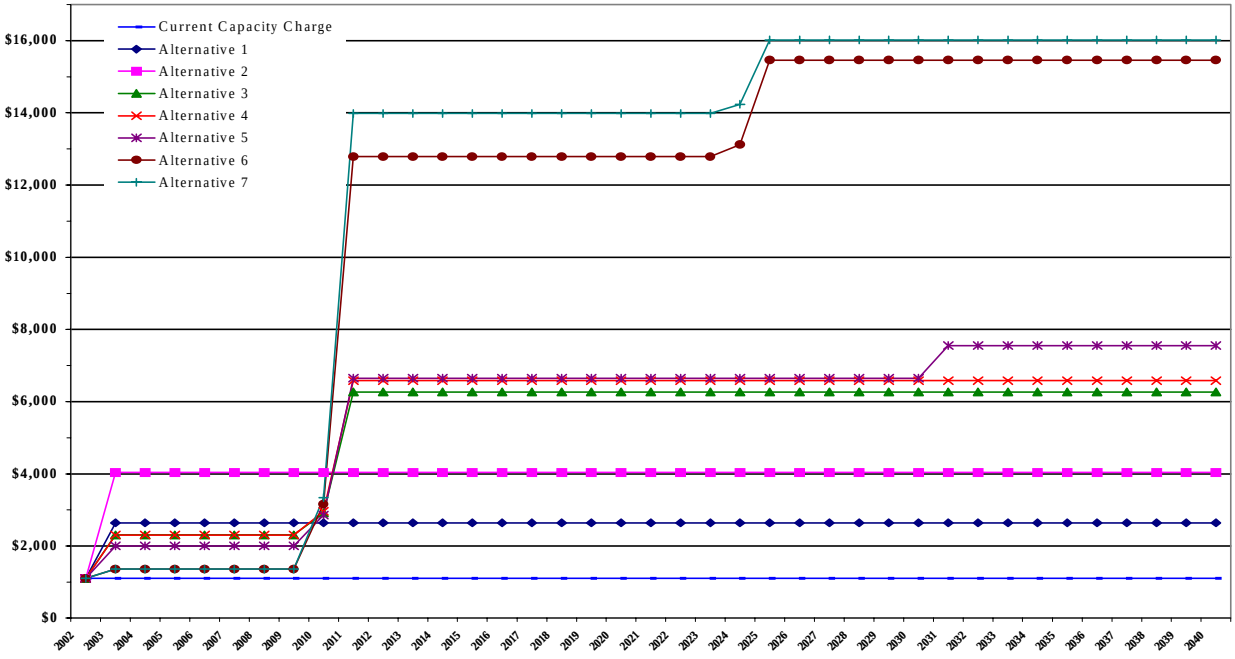
Figure 1-6 shows the projected single family average annual total costs of each water supply alternative. These costs are the sum of the estimated average annual water bill and the estimated annual consumer cost under each alternative. As indicated by Figure 1-6, in 2020 the estimated average total cost would be roughly $850 annually under Alternative 1, and about $1010 annually under Alternative 5.

Figure 1-6 Projected Single-Family Average Annual Total Cost – Water Purchase and Consumption, 2003 – 2040



As indicated previously, the allocation of capital costs between current ratepayers and new development is based on the benefits received from each from the capital projects whose costs are being allocated. Over the study period (2002-2040) approximately 30 percent of the project capacity benefits new development. Figure 1-7 shows projected capacity chargers per EDU under each alternative, based on the assumption that 30 percent of the cost of each project will be paid by new development. As indicated by Figure 1-7, in 2020 the projected capacity charge per EDU would be roughly $4,000 under Alternative 1, and about $6,680 annually under Alternative 5. This cost allocation may be adjusted to future City Council direction or policy.

Figure 1-7. Projected Capacity Charge Per EDU, 2002 – 2040



RECOMMENDED IMPLEMENTATION PLAN

A detailed plan to implement this recommended course action plan summarized in Table 1-4. This plan involves the following types of actions:

Deep Aquifer and Water Quality Monitoring

Consistent with its previously adopted policy direction, Davis is gradually transitioning from reliance on intermediate depth groundwater to relying primarily on water from the deep aquifer. UC Davis currently obtains all of its domestic water supply from the deep aquifer. There are concerns that the deep aquifer may not have sufficient yield to supply the long-term needs of both Davis and UC Davis. Furthermore, drinking water standards for constituents such as arsenic may impact the reliability of this source. In light of these concerns, the systematic groundwater investigation and associated monitoring programs summarized in Table 1-4 is recommended.

Legal, Environmental & Engineering Implementation Steps

The proposed water supply action plan presented in Table 1-4 would require continuing action over the next decade. This overall process would require expenditures of significant resources by both Davis and UC Davis. As indicated in Table 1-4, it is suggested that annual progress reports be prepared for the governing bodies of both agencies, and that authorizations to proceed with subsequent implementation steps be obtained annually or upon reaching major project milestones.

Other recommended future water supply planning legal, environmental, and engineering steps include:

- Developing draft interagency agreements
- Developing draft agreement for purchase of surface water
- Negotiating land and right-of-way purchases
- Conducting environmental impact studies
- Obtaining approval of surface water rights permits and water transfer
- Adopting funding plans
- Designing surface water treatment, transmission, and storage facilities/obtaining permits required for construction

Table 1-4 presents a recommended schedule for future water supply planning legal, environmental, and engineering steps. Initially it is recommended that Davis and UC Davis begin negotiations with the City of West Sacramento regarding wheeling water through the West Sacramento water treatment plant. Other initial recommended steps include beginning negotiations with a senior upstream water rights permit holder for the purchase of summer water, and negotiations regarding land and right-of-way purchases. These initial steps should be completed prior to initiating subsequent steps, including the preparation of an environmental impact report.

Capital Improvements

Both Davis and UC Davis have adopted long range capital improvement plans that involve the abandonment and replacement of problematic wells. It is assumed that in the immediate future Davis would continue the transition to, and UC Davis would continue the practice of relying on, water from the deep aquifer. In the short term this would afford both agencies some flexibility. In the event that surface water facilities are either not constructed or delayed, system demands can be fully supplied by groundwater, if the deep aquifer has sufficient yield to do so. A recommended capital improvements plan is presented in Table 1-4.

ANNUAL IMPLEMENTATION PLAN COSTS

Estimated annual costs of implementing the steps outlined in this plan are summarized in Table 1-5.

Table 1-4. Recommended City of Davis and UC Davis 10-Year Water Supply Action Plan

Table 1-5. Estimated Annual Costs of Implementation Plan