Stanley Consultants INC.

A Stanley Group Company
Engineering, Environmental and Construction Services - Worldwide

Mr. Scott Wilson
General Manager
Central Iron County Water Conservancy District
88 East Fiddlers Canyon Road
Cedar City, UT 84721

Dear Mr. Wilson:

Subject: Central Iron county Water Conservancy District Population Growth and Water Demands

Central Iron County Water Conservancy District (CICWCD) was formed in 1997 to benefit the people and municipalities within the CICWCD boundaries. With the recent concerns of water availability that has been evidenced by groundwater mining and the rapid population growth, the major water purveyors in within the CICWCD boundaries are in the process of studying available water resources and planning for future population growth. This letter has been prepared to summarize the expected population growth and water demands and supply within the CICWCD boundaries. Since the District's responsible charge, in part, is to the municipalities within the District boundaries the draft copy of the Cedar City Water System Master Plan Update dated August 2008, and the final copy of the Enoch City Water Master Plan Report dated December 2007 were used in preparing this letter

Growth Projections

Estimates of future growth within the service area of CICWCD are based upon projections developed by CICWCD participating entities including Cedar City and Enoch, and the Governor's Office of Planning and Budget (GOPB). Both Cedar City and Enoch, the two largest constituents in CICWD, have completed Water System Master Plans or have them available in projects estimates a population increase of approximately 136,400 between 2008 and 2060. Enoch City estimates a population increase of approximately 32,350 between 2008 and build-out in 2039. Current (2008) GOPB projections estimate a 2.7% Average Annual Rate of Change (AARC) in the balance of Iron County through 2060 which represent a population increase of approximately 29,000. The actual growth rates experienced in Iron County indicate that GOPB estimates may be conservative. For the purposes of planning infrastructure needs, the combination of Cedar City, Enoch City, and GOBP, for the balance of Iron County, are used. Refer to Table 1 for projected population estimates for the Central Iron County planning area over the project planning period. The planning period is from present to 2060.

5353 South 960 East, Suite 220 • Salt Lake City, UT 84117 • phone 801.293.8880 • fax 801.293.8886
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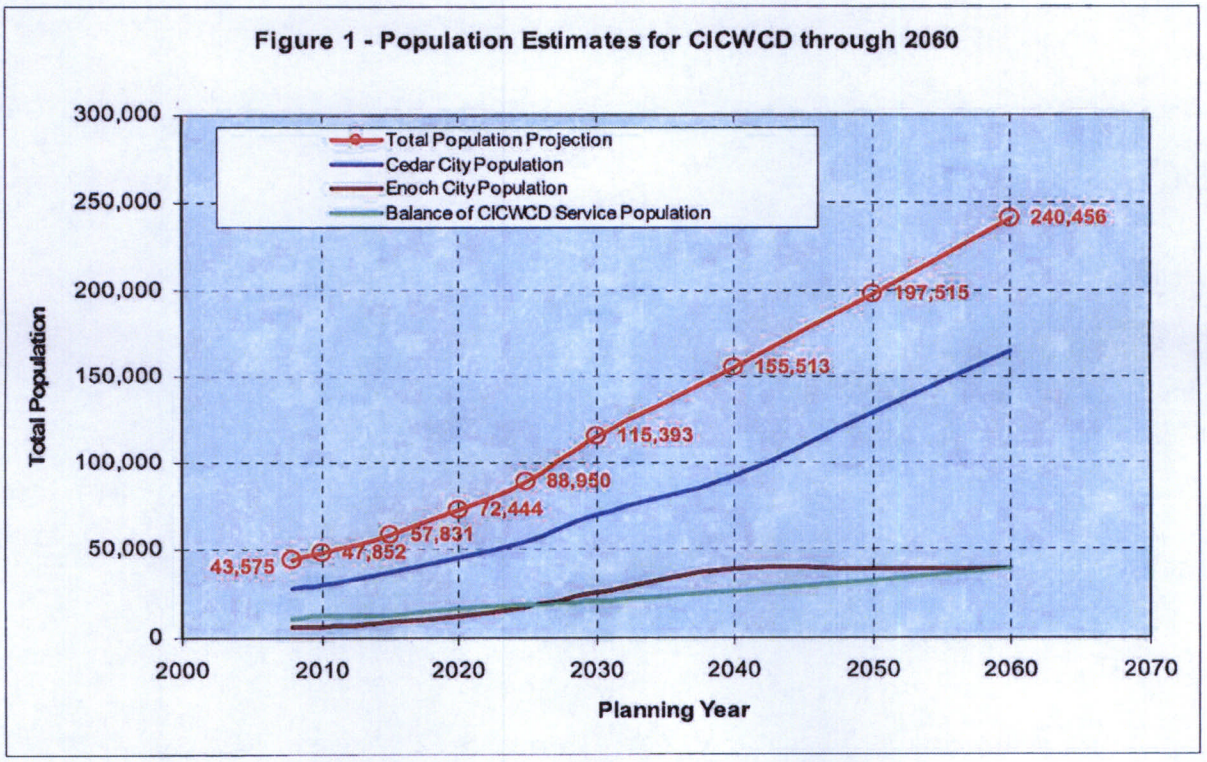
TABLE 1: CICWCD Growth Projections					
Year	Cedar City Population[1]	Enoch City Population[2]	Balance of County Popoulation[3]	Balance of CICWCD Service Area[4]	**Total Population**
2008	27,599	6,200	10,078	9,776	**43,575**
2010	29,961	6,500	11,743	11,391	**47,852**
2015	36,644	9,000	12,564	12,187	**57,831**
2020	44,566	12,500	15,854	15,378	**72,444**
2025	53,896	17,500	18,097	17,554	**88,950**
2030	69,663	26,000	20,340	19,730	**115,393**
2040	92,148	38,548	25,585	24,817	**155,513**
2050	128,078	38,548	31,844	30,889	**197,515**
2060	164,008	38,548	39,072	37,900	**240,456**

1. Cedar City Water System Master Plan Update (Draft Copy subject to revision), August 2008, Table ES-1
   2060 population assumes the same percentage growth for the 2040-2050 time period
2. Enoch City Water Master Plan, December 2007, Figure 19.
3. GOPB 2008 Baseline City Population Projections excluding Parowan and Paragonah (not included in total population)
4. Assumed 97% of Balance of County population within CICWCD based on GOPB population projections



The population growth within the balance of Iron County CICWCD service area boundaries are expected to be approximately 97% of the population growth of Iron County excluding Parowan and Paragonah.

Projected Water Demands

Projected water demands for the study area are based primarily upon increases in population and heavy industrial users along the industrial corridor which includes Western Electrochemical Company (WECCO) and Palladon Mines.

WECCO is located northwest of Cedar city and is a producer of rocket fuel. The current source of water is ground water in the Beryl/Enterprise ground water basin. Palladon Mines is an iron mining company that is re-opening the iron mines west of Cedar City in planned growth phases. Due to over drafting and potential curtailment of the Beryl/Enterprise ground water aquifer, these entities have expressed interest in CICWCD supplying water. WECCO is estimating approximately 5,000 ac-ft of water and Palladon estimates 1,500 ac-ft of water needed, for a combined total of 6,500 ac-ft.

Total water demand for both Cedar City and the CICWCD service area is calculated as the product of per-capita usage and expected total population, adjusted for conversion of agricultural lands as well as water conservation initiatives over the planning period. The water demand for Enoch is calculated dividing the population by the average persons per household and using the State's Equivalent Residential Connection (ERC) requirements (Enoch City Water System Master Plan, 2007). The current total M&I water demand for the planning area is approximately12,130 ac-ft/yr. It should be noted that the agriculture demand is estimated at 27,500 ac-ft/yr (DWRe, 2005). The sustainable yield of the aquifer is estimated at 37,600 ac-ft/yr. The total demand for M&I and agriculture demands exceeds the sustainable yield of available sources by about 2,400ac-ft/yr. This has been evidenced by the decline of the groundwater elevation in the area.

Water Conservation Offsets

In order to make the best use of limited water resources in the arid Intermountain West, the State of Utah Governor's Office and Division of Water Resources have taken a leadership role in promoting water conservation in Utah. The Utah Board of Water Resources currently requires implementation of water conservation initiatives as a condition for funding of major projects. The current requirement is a 25% per capita reduction in culinary and irrigation consumption by year 2050 using 1995 consumption rates as the baseline quantity. Including the required reduction the total per-capita M&I demand goal for 2050 is 0.270 ac-ft per year. (DWRe, 2003). It should be noted that the CICWCD area is currently using about 0.273 ac-ft/capita-yr which is less than the State-wide average of 0.360 ac-ft/capita-yr. This represents a decrease of 9% in Iron County since the State wide goal was implemented. For the purposes of this study it is assumed that the additional 16% State conservation goal will be realized and that progress toward that goal will be more or less linear over the project planning period to 2050.

Total CICWCD Water Demand Estimates

Total water demand estimates for the CICWCD service area were developed to consider M&I only within the CICWCD service area. This considers service to growth-related customers; residences, businesses

and supporting infrastructure resulting from population growth. Total water demands over the planning period for M&I customers is indicated in Table 2. It is expected that total M&I demand will increase from about 12,129 ac-ft/yr (current) to approximately 73,052 ac-ft/yr by 2060. This includes demands identified in both the Cedar City and Enoch City Water System Master Plans discussed earlier, demands for the balance of the County within the CICWCD service area, and demands for future heavy industrial users.

Should the CICWCD elect to provide secondary or irrigation supply to the agricultural interests in the service area, total water demands upon the District will increase beyond levels shown in the previous paragraph. For the purposes of this study, agricultural demands will not be served by the CICWCD. The CICWCD will provide for only the additional demands resulting from M&I growth.

TABLE 2 - CICWCD Water Demand Projections

Year	Cedar City Demand[1]	Enoch City Demand[2]	Balance of CICWCD Service Area[3]	Additional Heavy Industrial Demand[5]	**Total CICWCD Demand**	
	(AF)	(AF)		(AF)		
2008	7,079	2,545	2,669	0	12,293	
2010	7,684	2,668	3,079	500	13,931	
2015	9,398	3,694	3,261	2,000	18,353	
2020	11,425	5,131	4,030	3,500	24,087	
2025	13,823	7,183	4,529	4,250	29,785	
2030	17,866	10,672	5,009	5,000	38,548	
2040	23,635	15,823	6,098	6,500	52,056	
2050	32,854	15,823	7,336	7,000	63,013	
2060	42,070	15,823	8,691	7,000	73,584	Note 4

1. Cedar City Water System Master Plan Update (Draft Copy), August 2008, Table ES-1
2. Enoch City Water Master Plan, December 2007, Figure 19.
3. GOPB 2008 Baseline City Population Projections
4. Obtained by multiplying 229 gal/capita/day (Cedar City Master Plan) by the population
5. WECCO and Palladon Mines

Projected Water Supply

The Cedar basin is essentially a hydrogeologic closed basin, which means there are no significant outflows or inflows of water. All existing water sources are derived from ground water sources though wells or springs. Groundwater sources in the Cedar Basin have been over appropriated and therefore are closed to any new water rights. There are three available existing supplies with CICWCD boundaries to meet future demands: existing developed water, conversion of agriculture water to M&I, and further development of existing water rights. Agriculture users are supplied by both groundwater and surface water. For the purpose of this report it is assumed that the agricultural demands will be met by existing supplies.

Existing Developed Water

Since CICWCD is in it's infancy as a water district almost all of the existing developed water in the Cedar Basin area is comprised of municipal water supplies derived from groundwater sources mostly in Cedar City and Enoch with contributions from other smaller water companies. The total developed existing water supply consists of 11,360 ac-ft of potable water and 800 ac-ft of secondary water.

Conversion of Agricultural Lands

It is anticipated that as growth occurs, significant agricultural land and associated water right holdings within the CICWCD service area will be converted to municipal or industrial use.

It is estimated that approximately 5,936 acres of agricultural land will be converted to municipal and industrial use over the planning period. The UPLAN model (2008) developed by DWR indicates that, based upon expected development patterns in the planning area, conversion of about 40% of available agricultural land (i.e.; 5,936 acres ±) will be required.

The current irrigated agricultural acreage in the planning area is approximately 13,735 acres. Each acre of agricultural land is estimated as accounting for 4.08 ac-ft per year in demand at an approximate overall irrigation system efficiency of 53%. If converted to M&I use, it is expected that the final consumptive use factor will be 1.00, resulting in 4.08 ac-ft per year available source capacity for each acre of agricultural land converted to M&I use.

As noted above the Division of Water Rights (DWRi) has determined that the Cedar Basin has been over-appropriated. In 2005 the USGS completed a groundwater study for the Cedar basin and determined the available yield of the aquifer to be 37,600 AF/yr (USGS, 2005). This represents approximately 66% of the total appropriated groundwater rights for the basin. It is assumed that the DWRi will implement a groundwater management plan for the Cedar basin which will curtail water rights to the available yield of the aquifer.

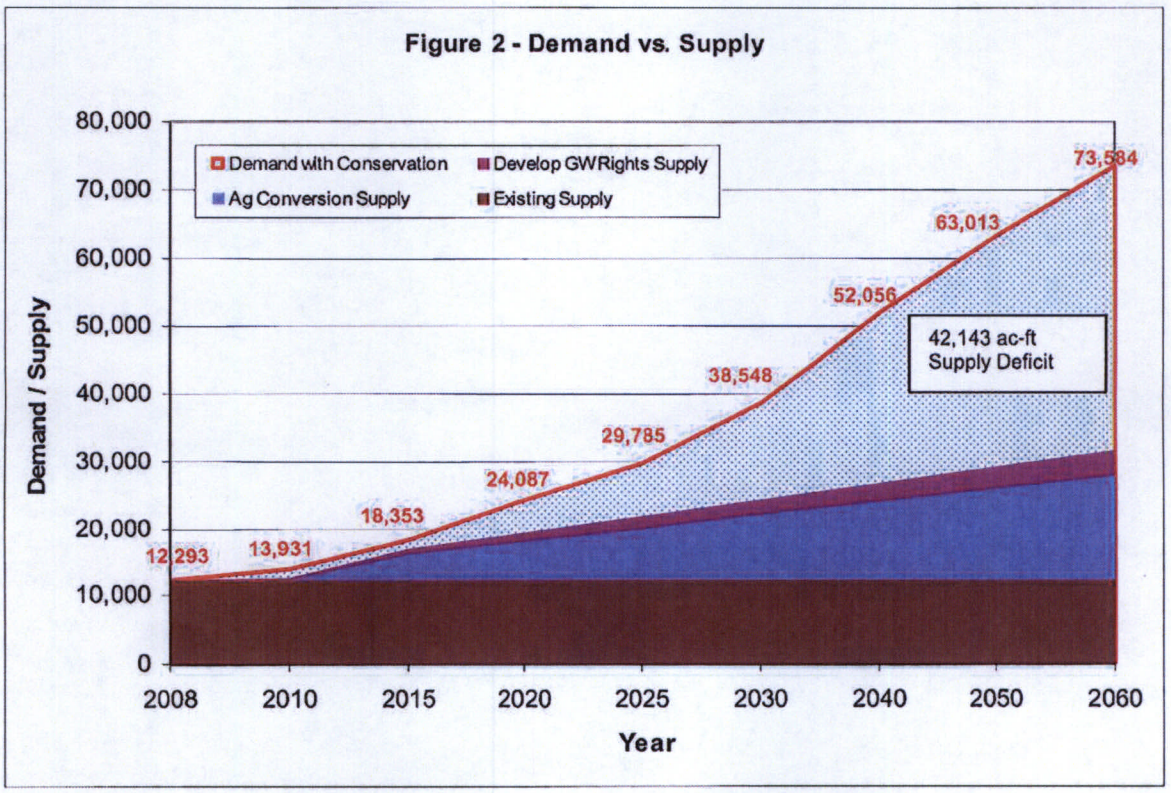
Because the timing of agricultural conversion will be related to factors not readily identifiable, it is assumed for the purposes of this report that conversion will occur linearly over the planning period.

Development of Existing Groundwater Rights

Development of existing groundwater rights includes rights that are currently held by primarily Cedar City and Enoch City limited by the assumed sustainable yield discussed in the previous paragraph.

TABLE 3 - CICWCD Total Supply				
Year	Existing Supply (AF)	Agriculture Conversions[1] (AF)	Development of Existing Rights[2] (AF)	**Total Supply (AF)**
2008	12,160	0	0	**12,160**
2010	12,160	1,959	451	**14,570**
2015	12,160	3,918	903	**16,980**
2020	12,160	5,877	1,354	**19,390**
2025	12,160	7,836	1,805	**21,801**
2030	12,160	9,794	2,256	**24,211**
2040	12,160	11,753	2,708	**26,621**
2050	12,160	13,712	3,159	**29,031**
2060	12,160	15,671	3,610	**31,441**

1. Division of Water Resources Memorandum, June 20, 2008 "CICWCD Uplan Study 2008 Results"
2. Additional water rights that could be developed up to sustainable aquifer yield



Conclusion

Central Iron county Water Conservancy District was formed to benefit the people and municipalities within the district boundaries. Planning efforts of primarily Cedar City, Enoch City, and CICWCD estimate that the population will significantly increase by the year 2060.

Based upon the assumed sustainable yield of existing water sources in the study area (37,600 AF/yr) and the available supply for municipal and industrial use (31,441 AF/yr), approximately 42,000 acre-feet of new source will be required to meet the needs of users in the CICWCD service area through 2060. Additional sources, in addition to the shortfalls estimated, will be required to meet the needs of CICWCD customers beyond 2060.

Sincerely,

Stanley Consultants, Inc.

Ted Mickelsen
Senior Engineer

TM

Appendix E

Board Presentation

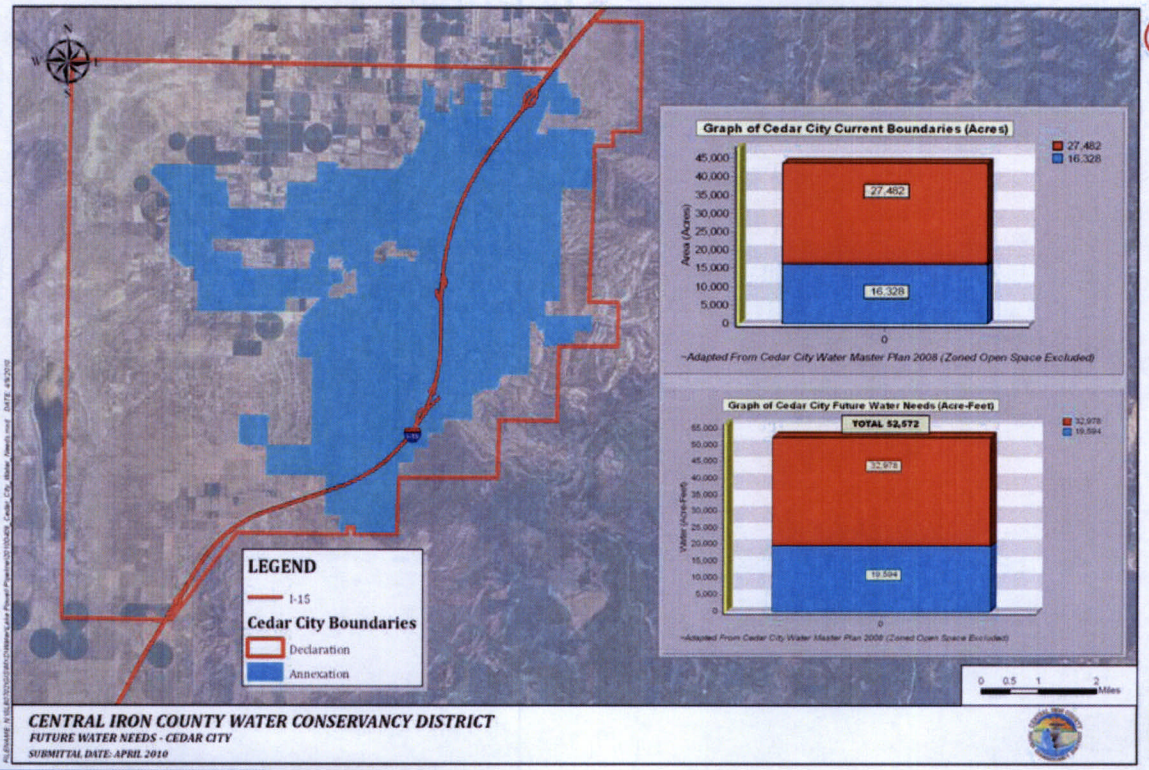
Future Water Needs

April 15th 2010

Cedar City Ordinance

- Utilizing the formula set forth in Cedar City ordinance Chapter 37 Waterworks Section 32-7 A 1
- If water is deeded at the time of annexation, the property owner will be required to deed 1.2 acre feet of water rights per acre of land annexed into the boundaries of Cedar City.
- From Cedar City ordinance Section 37-32-3 A 2c, "The City has determined the reserve amount necessary to keep ahead of reasonably foreseeable growth to be twenty percent (20%) of the total water rights owned by the City. With the annual Water Report, the City Engineer shall provide information relating to the status of the reserve amount. If at any time the reserve amount of water rights is reached, the City Council shall impose a moratorium on the approval of all annexations, residential platted subdivisions, and building permits not in a residential platted subdivision until the developer or owner is able to provide, or the City is able to acquire, sufficient water to meet the needs as established by this ordinance."
- Moratorium-fail safe mechanism

Cedar City Current & Future Water Needs



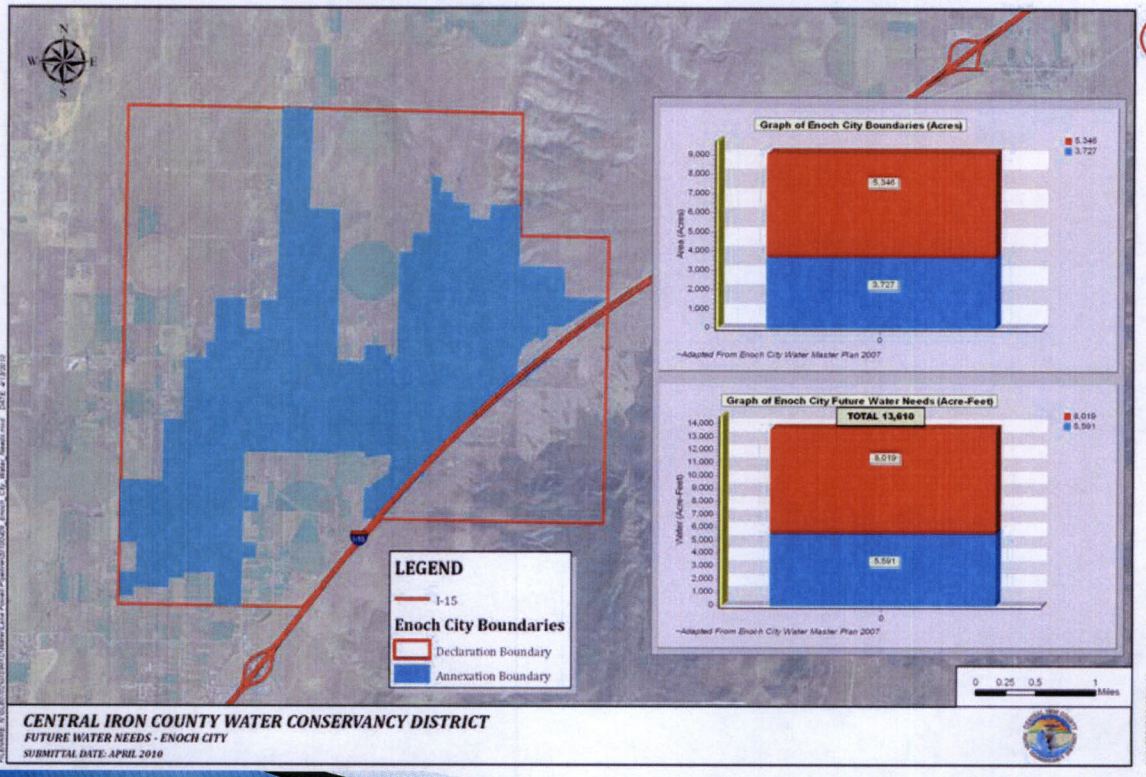
CENTRAL IRON COUNTY WATER CONSERVANCY DISTRICT
FUTURE WATER NEEDS - CEDAR CITY
SUBMITTAL DATE: APRIL 2010

NOLTE

Enoch City water acquisition policy

- 1 AF per lot
- One-acre foot of water shall be deeded to Enoch City for each single dwelling lot created in the subdivision. Water rights requirements for all multi-residential, commercial and industrial/manufacturing properties will be determined in accordance with City ordinances. The subdivider must pay any and all costs incurred for deeding and transferring the water. When deeding water to Enoch City, the water right must be in the Cedar City Valley Drainage on the north side of Highway 56 with a water right prefix of 73. An affidavit of water transfer will be required with the water deed. (Amended 2-6-08)

Enoch City Current & Future Water Needs



CENTRAL IRON COUNTY WATER CONSERVANCY DISTRICT
FUTURE WATER NEEDS - ENOCH CITY
SUBMITTAL DATE: APRIL 2010

NOLTE

CICWCD Water Acquisition Policy

No Conservation Effort

Water Right (acre-feet/year/lot) = 1.0

Tier One Conservation Level (21% reduction)

To qualify for a 21% reduced amount of water rights required in exchange for service, developers must specify the following condition in the formal Codes, Conditions and Restrictions required and enforced for every lot owner in the development, namely that the front yard be landscaped with native plants named on the Acceptable Native Plant List. By complying with this requirement the water rights exchange amount will be:

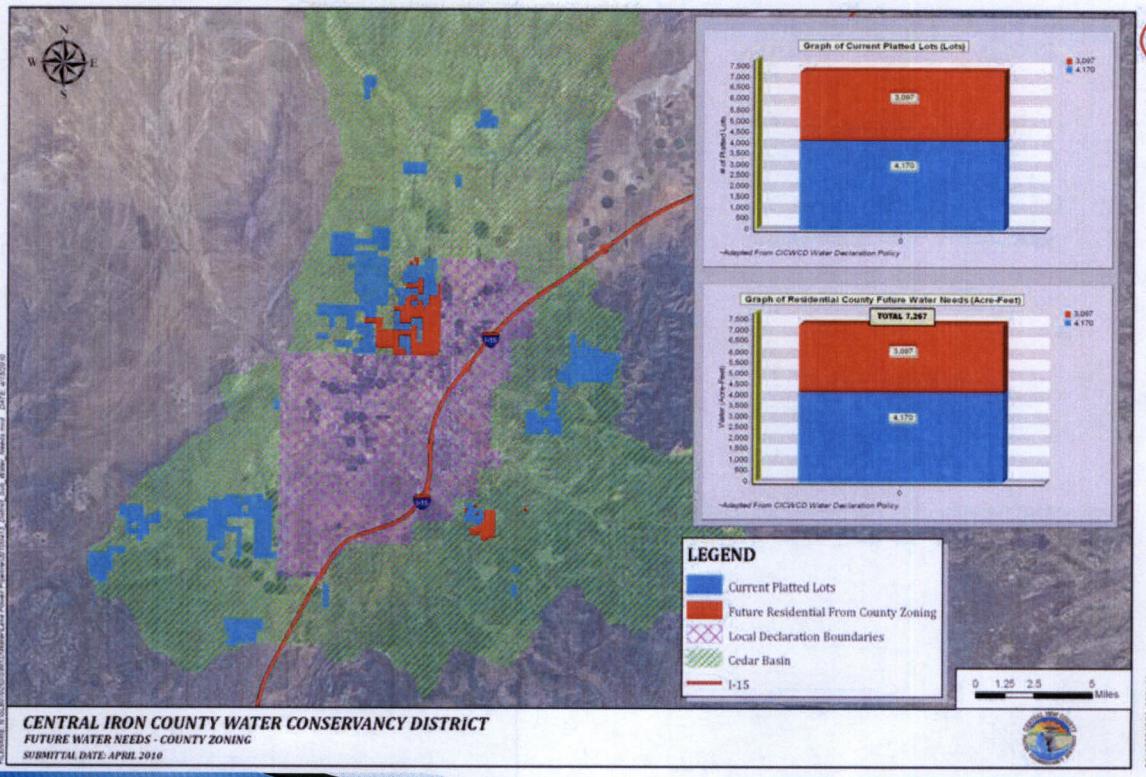
Water Right (acre-feet/year/lot) = 0.80

Tier Two Conservation Effort (45% reduction)

To qualify for a 45% reduction in the amount of water rights required in exchange for service, developers must specify the following condition in the formal Codes, Conditions and Restrictions required and enforced for every lot owner in the development, namely that the front and back yards be landscaped with native plants named on the Acceptable Native Plant List. By complying with this requirement the water rights exchange amount will be:

Water Right (acre-feet/year/lot) = 0.60

CICWCD Current & Future Water Needs

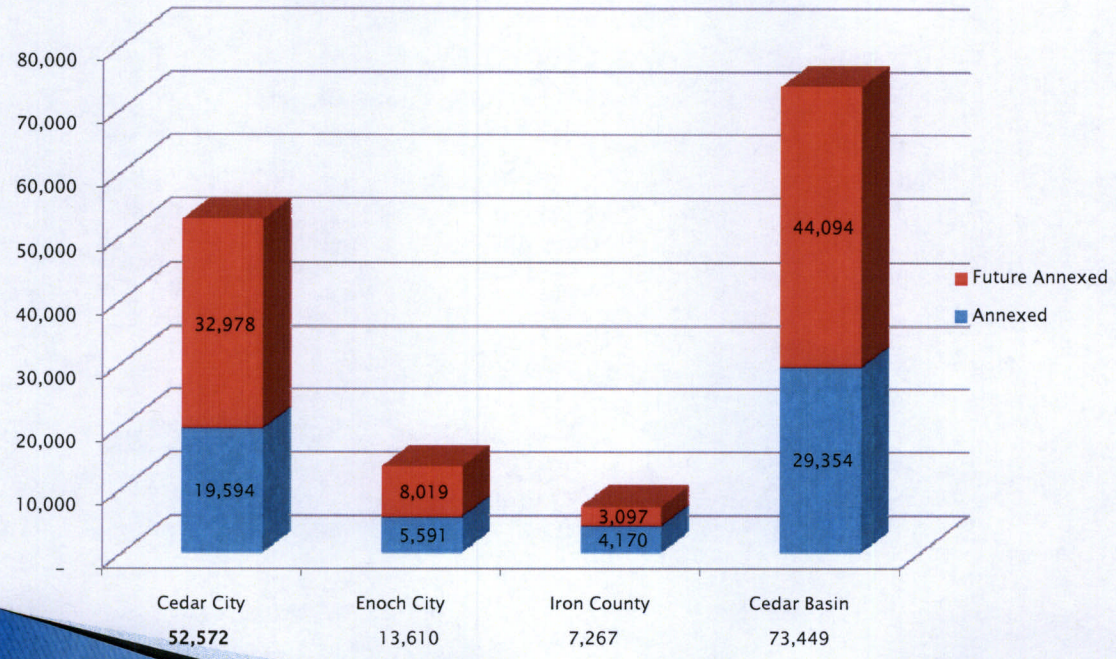


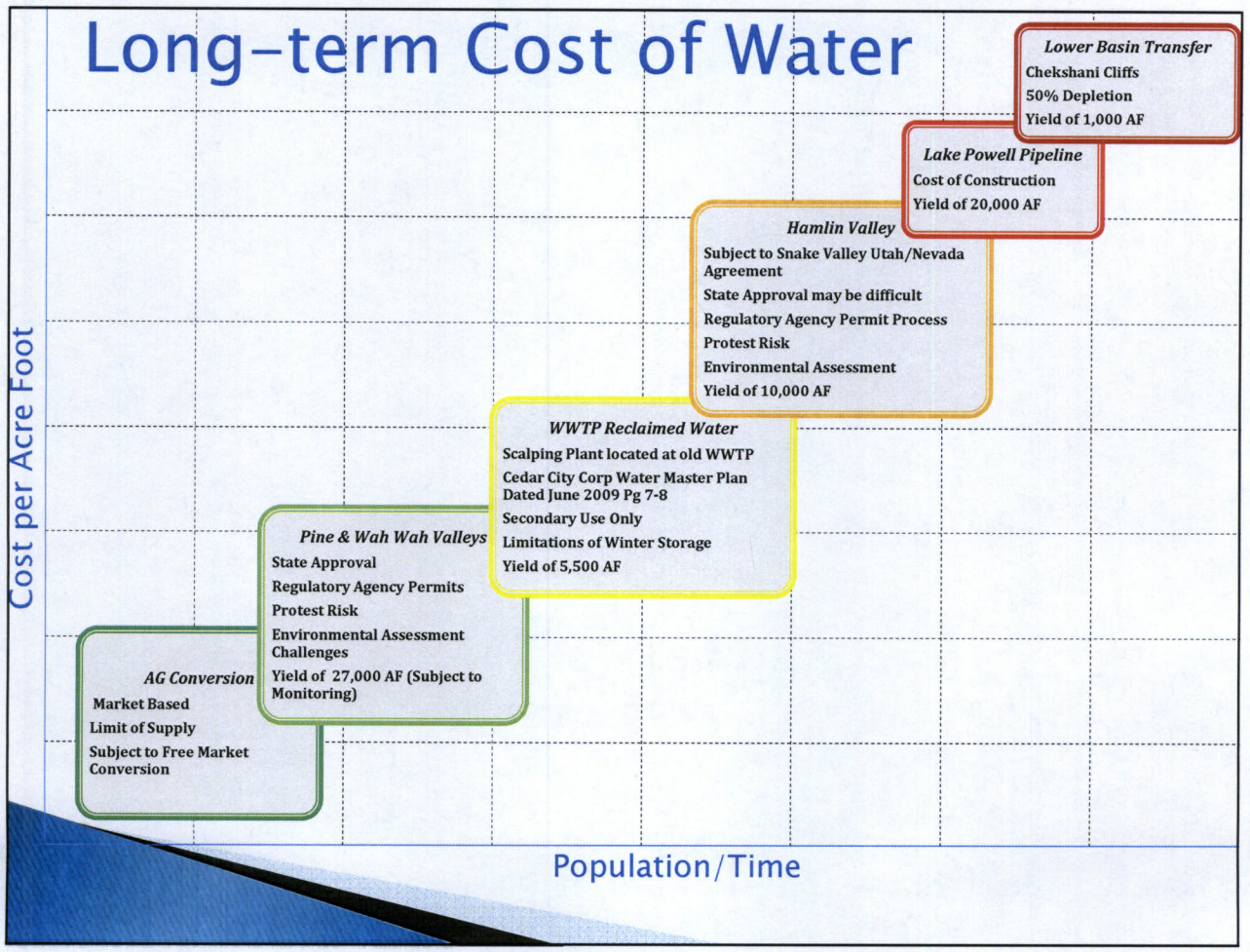
C-1

CENTRAL IRON COUNTY WATER CONSERVANCY DISTRICT
FUTURE WATER NEEDS - COUNTY ZONING
SUBMITTAL DATE: APRIL 2010

NOLTE

Regional, Municipal, & Industrial Water Demand (Acre-Feet)




Long-term Cost of Water
Cost per Acre Foot
Population/Time
AG Conversion
Market Based
Limit of Supply
Subject to Free Market Conversion
Pine & Wah Wah Valleys
State Approval
Regulatory Agency Permits
Protest Risk
Environmental Assessment Challenges
Yield of 27,000 AF (Subject to Monitoring)
WWTP Reclaimed Water
Scalping Plant located at old WWTP
Cedar City Corp Water Master Plan Dated June 2009 Pg 7-8
Secondary Use Only
Limitations of Winter Storage
Yield of 5,500 AF
Hamlin Valley
Subject to Snake Valley Utah/Nevada Agreement
State Approval may be difficult
Regulatory Agency Permit Process
Protest Risk
Environmental Assessment
Yield of 10,000 AF
Lake Powell Pipeline
Cost of Construction
Yield of 20,000 AF
Lower Basin Transfer
Chekshani Cliffs
50% Depletion
Yield of 1,000 AF

Central Iron County
Water Conservancy District
88 East Fiddlers Canyon Road, Suite A
Cedar City, Utah 84721-0037
(435)865-9901
(435)865-9902 fax

Purpose

The purpose of this report is to provide the Utah State Engineer, Protestants, and the Interested Public with information regarding the District's plans to develop the water filings in both Pine (14-118) and Wah-Wah(69-101) Valleys 30 days prior to the public hearing which has been scheduled for 9:00 AM on Wednesday, July 14th at the Auditorium of Beaver High School located at 195 East Center Street.

Introduction

Mission Statement: The Central Iron County Water Conservancy District (District) was formed in 1997 to benefit the people and municipalities within the District's boundaries. The District was organized under the Utah Water Conservancy District Act to achieve the following objectives:

- Conserve, develop and stabilize existing supplies of water for the beneficial uses of domestic, irrigation, power, manufacturing, aquatic life, wildlife, and stock watering for the direct benefit of the District's residents.
- Develop additional supplies of water for use within both the municipalities and unincorporated areas of the District boundaries.
- Plan for, finance, design and construct reservoirs, pipelines, water distribution systems, wells, drainage improvements and other improvements necessary to utilize water supplies within the District boundaries.
- Benefit the municipalities within the District boundaries by providing adequate supplies of water for domestic, industrial and municipal use.
- Manage and stabilize the flow of water to directly benefit irrigated lands.

Since its organization in 1997, the District has participated in many scientific investigations and engineering reports to accomplish the above objectives.

District Description: The District boundaries include the Cedar Valley aquifer, and portions of the Beryl/Enterprise, Parowan Valley, and lower Colorado River basins. The Cedar Valley water basin is a closed basin with limited surrounding opportunities for developing additional water resources. The Cedar Valley aquifer is experiencing surface fissures resulting in significant property damage.[1] The Utah Geologic Survey (UGS) indicates that groundwater mining of the aquifer is occurring and that underground water levels have declined at a rate of 3 to 4 feet per year since year 2000.[1] The sustainable water inflows to the Cedar Valley aquifer have been estimated to be 37,600 ac-ft/yr.[2]

Executive Summary

- The sustainable yield of the Cedar Valley aquifer is estimated to be 37,600 ac-ft/yr.
- The District's water applications of 27,000 ac-ft in the Pine and Wah-Wah Valleys are a key component in the Cedar Valley region's economic future.[4]
- Future water needs for the District have been projected to be around 43,000 ac-ft/yr through the year 2060.[2]
- The District's *Long-term Cost of Water Schedule* identifies the preferred ranking of additional water resources to achieve the District's future water resource needs.[4]
- Water conservation is based upon achieving 25% water conservation as indicated in the Utah Water Plan.[2]
- The project financial analysis determines that the cost per acre-foot of the Pine and Wah-Wah valleys is $5,542 per developed ac-ft (see assumptions in the financial analysis section).
- The District's Pine and Wah-Wah water rights include 4,000 livestock units (112 ac-ft) of stock-watering to enhance available water for existing grazing and wildlife uses.
- Cedar Valley agricultural water usage, within the City's growth corridors, is anticipated to be converted to municipal and industrial water uses.
- Cedar City and the immediate surrounding area will experience significant growth and economic development limitations without additional water resources.[3]

Projected Water Need

Stanley Consultants prepared a letter for the District based upon the *Cedar City Water System Plan Update* (June 2009) and Enoch City Corporation's *Water Master Plan* (December 2007) and projected water needs within the District's boundaries stating that approximately 42,000 ac-ft of additional water will be needed through the year 2060.[2]

Nolte Engineering performed a geographic information system (GIS) analysis of future water requirements within the District by calculating the acreage within the existing legal city boundaries of Cedar and Enoch Cities and within the unincorporated area of the County. Nolte concluded that approximately an additional 44,000 af/yr will be required to build out existing master plans (Cedar City 33,000 (rounded), Enoch 8,000 (rounded), District 3,000 (rounded)).[3]

The District's projected water needs by Stanley Consultants includes the 25% water conservation reduction target included with the Utah State Water Plan.[2] As part of that water conservation effort, the District recognizes that the regional wastewater effluent will have to be reclaimed and reused as secondary water for agricultural or municipal secondary purposes.[4]

Lack of additional water resources will result in extreme conservation measures and/or placement of moratoriums on future growth and will negatively impact future economic development.[3]

Montgomery, Watson, and Harza (MWH) identified that the District needs 11,470 ac-ft/yr by the year 2023. This report was prepared by using the more conservative Governor's Office of Planning and Budget (GOPB) population projections.[5]

Project Description

The West Desert Pipeline Project is designed to convey up to 27,000 ac-ft of water from underground wells in the Pine and Wah-Wah valleys north and west of Cedar City Utah. This overall project includes the drilling and development of a network of wells identified as Exhibit B in the appendix. Power will have to be extended to service this well network. Water transmission lines will initially collect and then ultimately convey the water to the Cedar Valley where the water will be distributed through the District's existing regional water system.

The well network includes drilling and development of 20 wells in the Wah-Wah Valley and 10 wells in the Pine Valley. These wells will be developed and pumped into a transmission line which will be boosted from the valley floor over the highpoint to the south of each of the valleys. In the Wah-Wah Valley a single pump station will take the water from each of the individual wells and add the head necessary to cross the highpoint of the valley. In the Pine Valley two pump stations will be necessary to convey the water collected from the individual wells over the highpoint of the valley.

The project will also include a hydro station to recover power from the head created over the highpoint. This will be located on the Pine valley water transmission line. Once all of the pipelines from the Pine and Wah-Wah valleys are collected near the railroad crossing at Lund, they will have one last pump station to convey the water over the final highpoint, and into the Cedar Valley. The water is planned to arrive in the Cedar Valley at a pressure of 60 to 70 psi at the valley floor.

The following table summarizes the estimated various pipe length and sizes for the transmission lines that would be required to develop the District's full water right application in the Pine and Wah-Wah valleys (based upon a feasibility level of engineering analysis).

	Pipe length (feet)			
Pipe Size	Pine	Wah-Wah	Common	Total
8 inch	1,000	67,000		68,000
10 inch		1,000		1,000
12 inch				-
16 inch	114,000	14,000		128,000
18 inch		38,000		38,000
24 inch	42,260	20,000		62,260
30 inch				-
36 inch	128,446	165,000		293,446
42 inch			133,000	133,000

The following table summarizes the estimated construction costs used in the financial analysis section of this report (based upon a feasibility level of engineering analysis).

Well Development	$	25,500,000
Power		6,528,375
Easements		2,398,335
Transmission Lund		29,046,350
Wah Wah Valley Pipeline		34,374,317
Pine Valley Pipeline		32,377,509
Wah Wah Valley Pump Station		1,500,000
Pine Valley Pump Station		2,700,000
Pine Hydro Station		2,500,000
Contingency/Other Costs		12,800,000
Total	$	149,724,887

Financial Feasibility Analysis

The projected revenues included in this financial feasibility analysis include a wholesale bulk water fee and a per ac-ft water development fee. The wholesale water fee starts in year 2022 (projected project completion) at a rate of 80 cents per 1,000 gallons ($0.80/1,000 gallons) and is projected to increase annually at an estimated inflation rate of 3%. The water development fee in this financial analysis is, in concept, the projected development cost (measured in 2010 dollars) of developed and delivered water by the District. These projected project revenues are summarizes as follows.

(1) Water development fee of $5,542 per ac-ft.

(2) A wholesale bulk water rate of 80 cents per 1,000 gallons ($0.80/1,000 gallons) that would be annually increased for inflation, which for purposes of this financial analysis is assumed to be 3% annually.

The above water development fee and wholesale bulk water rate are both very favorable in relation to the District's *Long-term Cost of Water Schedule* included as Appendix A.[4]

The following graphic illustrates the results of the net present value (NPV) financial analysis (measured in 2010 dollars) of the above revenues offset by construction costs and future operation & maintenance expenses. At water development fees of greater than $5,542, the benefit-cost ratio is greater than 1:1.

GARY R. HERBERT
Governor
GREG BELL
Lieutenant Governor

State of Utah
DEPARTMENT OF NATURAL RESOURCES
Division of Water Rights

MICHAEL R. STYLER
Executive Director

KENT L. JONES
State Engineer/Division Director

June 2, 2010

CENTRAL IRON COUNTY WATER CONSERVANCY DISTRICT
C/O R. SCOTT WILSON
PO BOX 37
CEDAR CITY, UT 84721

Dear Applicant: RE: 14-118 (A76676) and 69-101 (A76677)

A hearing on the above-numbered applications has been scheduled for **9:00 AM** on **Wednesday, July 14, 2010**, in the Auditorium of Beaver High School located at 195 East Center Street, Beaver, Utah.

The applicant has requested that the parties to these applications visit the applicant's website www.cicwcd.org to review its position on how this application meets the criteria of Section 73-3-8 UCA and to preview much of the information that they may present at the hearing. It has been indicated that this information will be available about 30 days prior to the hearing and can be viewed by the public. Likewise, if the protesting parties desire to make available any technical information, including the groundwater modeling, for review before the hearing, they are encouraged to do so. The State Engineer does not endorse any of the positions or information that may be presented prior to the hearing but is simply trying to facilitate an exchange of information between the parties prior to the hearing.

Prompt attendance of all interested parties will be appreciated. This hearing may exceed the time limit expected, please plan your time accordingly.

Yours very truly,

John Mann, P.E.
Assistant State Engineer
for appropriation

JM:sn

cc: Copy to all Protestants on file with the State Engineer's office

D. Carol McCulley

President, BRAVE

(Save Beaver County, the Beaver River and Varied Estates: Varied Estates in this instance being Water Concerns)

PO Box 1108, Beaver, Utah, 84713

14 July, 2010

RE: 14-118 (A76676) and 69-101 (A76674)

State of Utah, Division of Water Rights

Kent Jones, Division Director

Dear Mr. Jones

There have been some very major developments planned in Western Beaver County, Utah, over the years.

There was the MX Missile Project and another was the Wah Wah Valley Space Vehicle Launch & Reentry Facility, March, 2000.

Beaver, Iron & Millard Counties joined together to form the Wah Wah Valley Interlocal Cooperation Entity, ICE, to work jointly.

One thing these counties knew is they had to cooperate for mutual growth. The main ingredient for the success of these projects was "WATER"!

We do not know what projects may be forthcoming in the future for Beaver County BUT we do know that if the Central Iron County Water Conservancy is successful in its bid to take thousands of acre feet of water from underneath the soil of Beaver County;

BEAVER COUNTY WILL NOT HAVE A FUTURE!!

Most Sincerely,

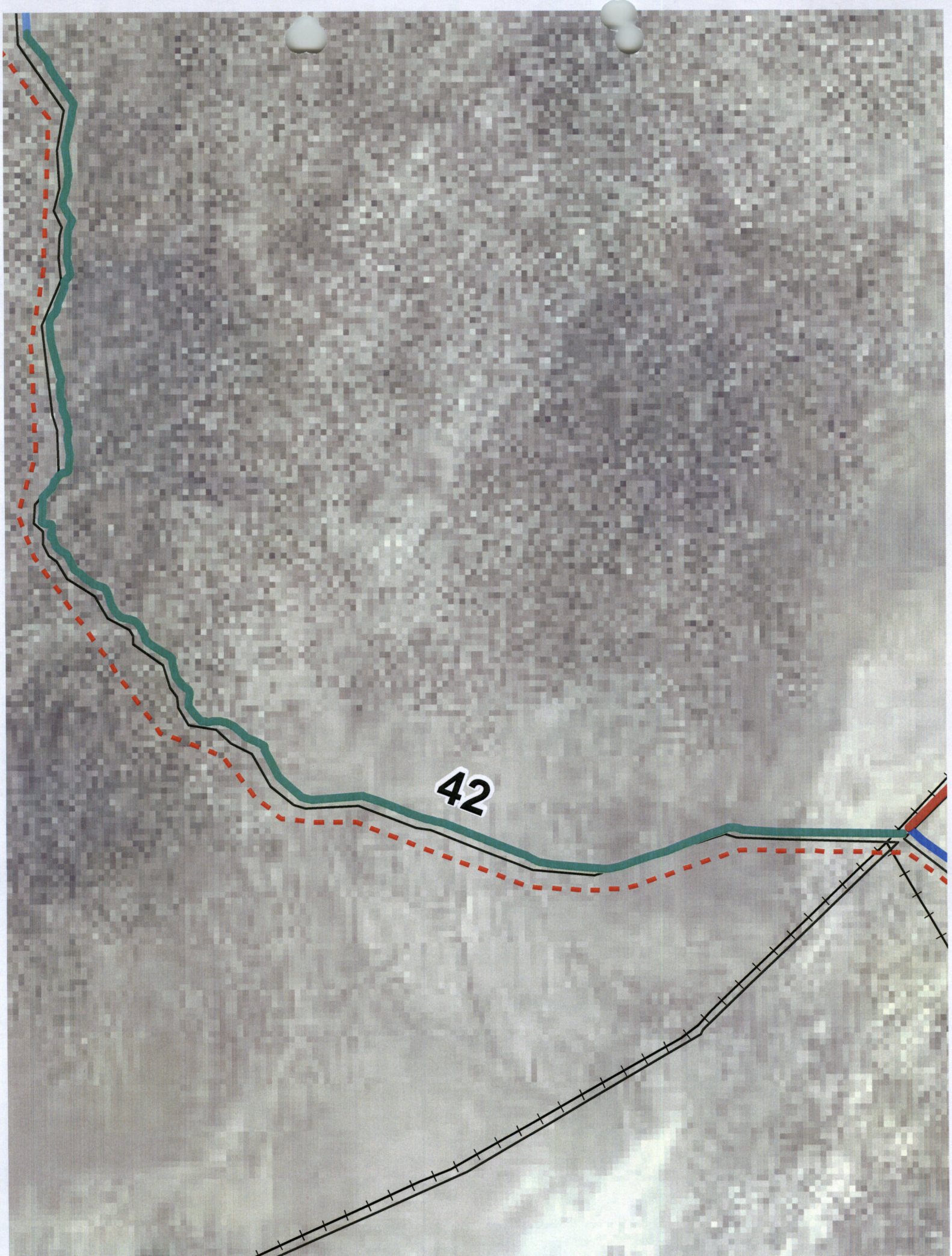
D. Carol McCulley

President, BRAVE

Appendix D

Stanley Consultant's

December 1, 2008 Letter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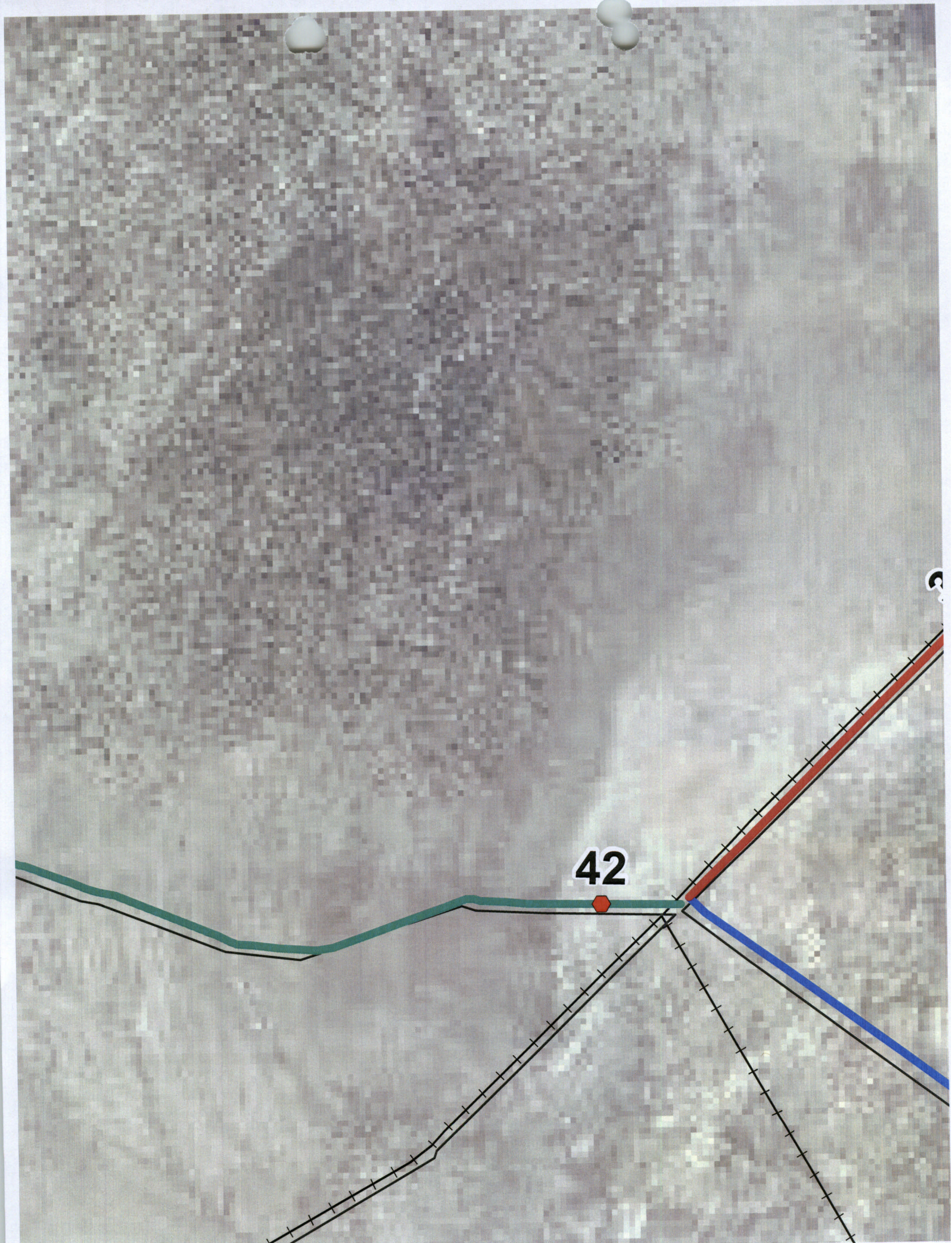
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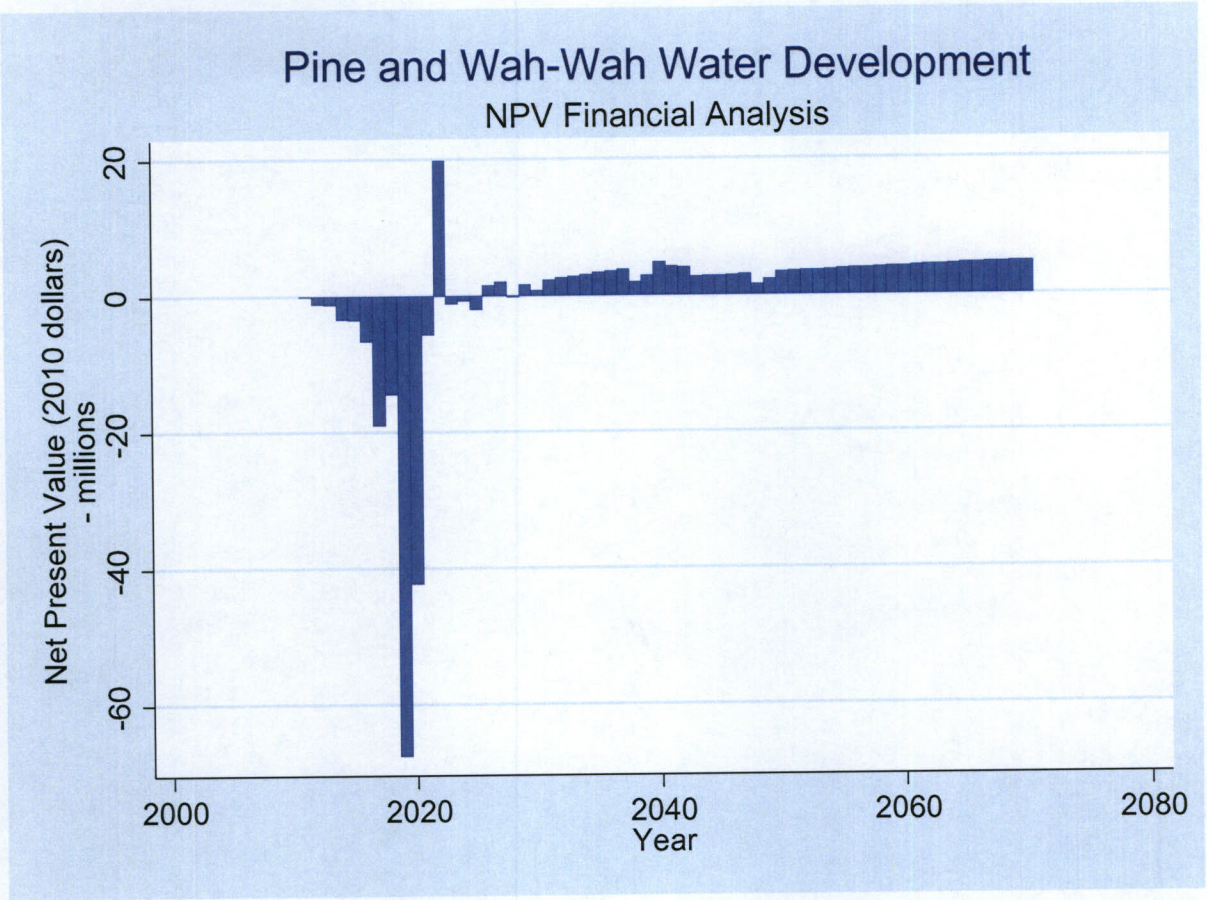


Un-appropriated Water

The District has researched numerous studies and technical publications by the USGS and the State Engineers Office as well as other available data relating to the geology, hydrogeology, water rights and groundwater resources of Pine and Wah-Wah Valleys. The existing data supports the Districts position that there is sufficient un-appropriated water to supply the District's applications currently before the State Engineer. The District's research of existing water rights also shows that only a very small portion of the available groundwater resources is being used under existing water rights. Evidence of sufficient un-appropriated water has also been presented to the State Engineer in previous water right applications and hearings in Pine and Wah-Wah Valleys. The District's findings supporting their applications will be presented in detail in the upcoming water right hearing before the State Engineer.

Conclusions

- The District's future water demand justifies the Pine and Wah-Wah Valleys Water Project.
- The financial analysis indicates that the project has a net benefit-cost ratio of greater than 1:1. When compared to other water development options (including the Lake Powell

Pipeline and waste water reclamation), this water development project is financially feasible for the District.

- The project is technically feasible and poses few construction challenges.
- There is un-appropriated water to develop in both the Pine and Wah-Wah valleys.
- The District's Pine and Wah-Wah water filing include stock watering that will enhance existing grazing and wildlife uses in both of these valleys.

References

1. Utah Geologic Survey, Power Point Presentation Central Iron County Water Conservancy District Board Meeting, March 18, 2010, *Progress Report UGS/CICWCD/ENOCH/CEDAR VALLEY Land Subsidence and Earth Fissure Investigation,* Retrieved May 5, 2010 from http://cicwcd.org.

2. Stanley Consultant, *Letter to the Central Iron County Water Conservancy District, December 1, 2008.* Retrieved May 5, 2010 from http://cicwcd.org.

3. Nolte Engineering, Power Point Presentation Central Iron County Water Conservancy District Board Meeting, March 18, 2010, *Future Water Needs*, Retrieved May 5, 2010 form http://cicwcd.org.

4. Long-term Cost of Water Schedule "WWTP Reclaimed Water". Various plans have been proposed for this regional waste water reclamation. The estimated water that could be reclaimed from the regional waste water treatment plant effluent is limited to capturing evapotranspiration losses. MWH estimates in their Lake Powell Pipeline Water Needs Assessment (August, 2008) that the amount of net gain to the Cedar Valley basin from this water source would be 2,470 ac-ft/yr.

5. Montgomery, Watson, and Harza (MWH), Lake Powell Pipeline Water Needs Assessment, August, 2008. Retrieved May 5, 2010 from http://www.water.utah.gov.

Appendices

Appendix A: District's Long-Term Cost of Water Schedule.

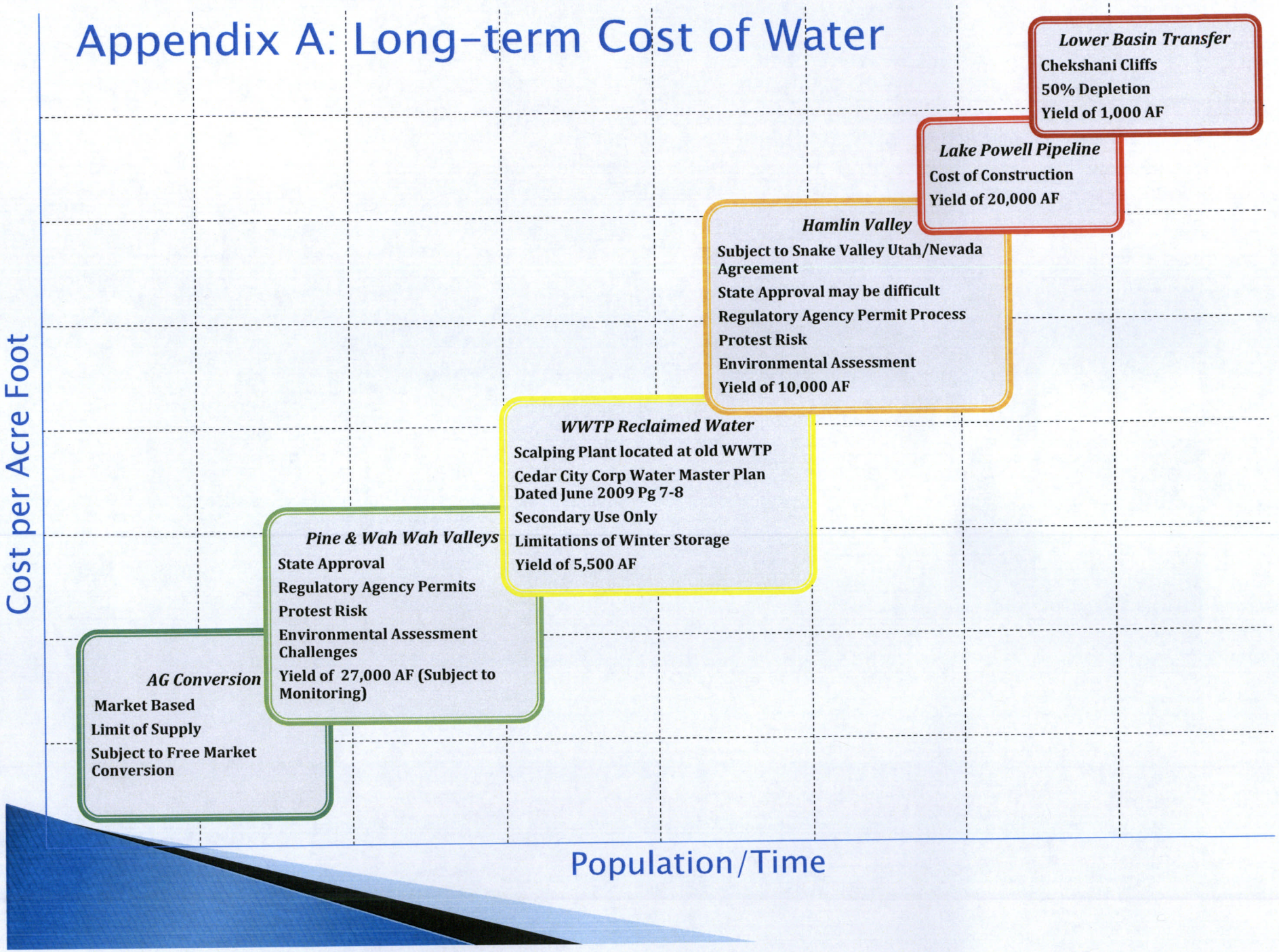
Appendix B: Project map showing well networks, water collection lines, and common transmission lines to District.

Appendix C: Project map showing well networks, water collection lines, and common transmission lines to District with power transmission lines included.

Appendix D: Stanley Consultant's letter December 1, 2008.

Appendix E: Nolte Engineering's power point presentation to the District's Board of Directors on April 15, 2010.

Appendix A: Long-term Cost of Water



WEST YOST ASSOCIATES
Consulting Engineers

Kenneth L. Loy, P.G., C.E.G., C.H.G.

Professional Registrations

Professional Geologist: California No. 7008

Certified Hydrogeologist California No. 720

Certified Engineering Geologist California No. 2214

Education

M.S., Geohydrology , University of Arizona, Tucson, Arizona; 1990

B.S., Geophysics, University of Arizona, Tucson, Arizona; 1986

Professional Affiliations

National Ground Water Association

Association of Engineering Geologists

Groundwater Resources Association

Association of California Water Agencies

Continuing Education

Master's Certificate in Project Management, The George Washington University, Washington, DC; 1994

Karst for Environmental and Engineering Applications, University of Tennessee, Knoxville, Tennessee

40-Hour Health and Safety Training: OSHA (29 CFR 1910.120)

Hazardous Waste Supervisor Training: OSHA (29 CFR 1910.120)

Presentations

Loy, K.L., 2007, "Construction of 32-inch Diameter Blind Shafts in Granodiorite," presented at the Association of Environmental and Engineering Geologists 50th Annual Meeting, Los Angeles, California, September 2007.

Loy, K.L., 2007, "Application of IWFM to the Evaluation of

Ken Loy is a certified hydrogeologist and engineering geologist with 20 years of experience in engineering consulting with emphasis on hydrogeologic and water quality characterization, data analysis, and modeling. Ken has characterized hydrogeologic conditions, assessed land and water use practices and applied numerical groundwater flow models in conjunctive use evaluations, groundwater impacts analyses and water supply planning efforts. He has performed numerous water quality evaluations and has used numerical flow and transport models to evaluate the movement of groundwater contaminants. He has been involved in several land subsidence evaluations, designed wells, and provided design services during construction of wells.

PROJECT EXPERIENCE

Municipal Well Design and Construction, Sacramento County Water Agency, Sacramento County. Principal Hydrogeologist and Project Manager for the design and design services during construction of three 1,500-foot production wells and a 1,500-foot, stainless steel, dual completion monitoring well located in Elk Grove. The wells were constructed as part of a new development but are the property of Sacramento County Water Agency (SCWA). In addition to serving the needs of the new development, the wells will also replace SCWA supply lost as a result of the implementation of the 10-mg/l federal MCL for arsenic. The effort resulted in a new 6,000-gpm potable groundwater supply in a rapidly developing area of Sacramento County. Typical production depths in the region yield groundwater with arsenic concentrations that can approach the pending 10-µg/l federal MCL. Deeper zones can contain concentrations of manganese and iron that exceed secondary MCLs and require treatment. Increasing salinity with depth places an additional constraint on groundwater production. Hydrogeologic and geochemical evaluations were performed to identify groundwater production depths that optimized water quality, while achieving production requirements. The completed wells met drinking water standards without treatment. *Reynen & Bardis Communities, Sacramento, California.*

Municipal Well Design and Hydrogeologic Consulting Services. Principal hydrogeologist supporting the City of Woodland's (City) municipal well design efforts and efforts to expand and improve the quality of its groundwater supply. The City depends completely on groundwater, which is produced from an intermediate depth. The City sought to expand its groundwater production to meet projected water demands and improve water quality by constructing new wells in a deeper aquifer zone, which, locally, has superior water quality. Ken led the effort to evaluate hydrogeologic conditions and groundwater quality, design the wells, and provide hydrogeologic support during construction. Ken used aquifer zone sampling test resulted from multicompletion monitoring wells and other subsurface information to calculate blended water quality from multiple aquifer zones, which individually exceeded water quality standards for nitrate, arsenic and manganese. He developed a well design to draw water from selected zones predicted to result in blended water quality that would not require treatment. The constructed well does not require treatment for public, potable supply. Ken has assisted the City in well siting prepared Drinking Water Source Assessment Reports and is preparing a groundwater management plan for the City. Ken also used analytical element modeling to assess potential groundwater impacts caused by the City's new wells. Ken developed a working relationship with the California Department of Water Resources (DWR), Central District. DWR provides in-kind services, including geologic logging and chemical analysis at no cost to the City. *City of Woodland, California.*

EXHIBIT
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Conjunctive Use in Solano and Yolo Counties," presented at the California Water and Environmental Modeling Forum Annual Meeting, February 2007.

Loy, K.L., 2005, "Hydrogeology of the Squaw Valley Groundwater Basin, California", presented at the Association of Engineering Geologists 48th Annual Meeting, Las Vegas, Nevada, September 2005.

Bogle, F.R., L. Haines, and K.L. Loy, 1999, "Hydrogeologic Investigation of a Fold and Fault Controlled Karst Groundwater Basin, Hamilton County, Tennessee," presented at the National Groundwater Association 51st National Convention, December 1999.

Loy, K.L., J.L. Lin, and J.A. Matos, 1998, "Analysis of Groundwater Remedial Options using Analytical and Numerical Modeling and Computer Visualization," presented at the National Groundwater Association 50th National Convention, December 1998.

Bogle, F.R. and K.L. Loy, 1995, "The Application of Thermal Infrared Thermography in the Identification of Submerged Springs in Chickamauga Reservoir, Hamilton County, Tennessee," The Fifth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, Gatlinburg, Tennessee, April 1995.

Johnson, R.A. and K.L. Loy, 1992, "Seismic Reflection Evidence for Seismogenic Low-Angle Faulting in Southeastern Arizona," Geology 20, no. 7: 597–600.

City of Davis Wastewater Treatment Plant Groundwater Monitoring and Reporting Program and Reuse Evaluation. Project manager for assessment of background groundwater quality, comparison of site and background groundwater quality, and development of continuing investigations of background groundwater quality. Principal hydrogeologist for the evaluation of potential wastewater reuse options, including evaluation of reuse areas and storage sites. This ongoing effort involves evaluation of regional groundwater quality to assess the effects of predevelopment environmental conditions and current land use on groundwater quality. Site data have been evaluated with respect to background conditions and water quality goals, and plans for further, more detailed spatial analysis of background groundwater quality are being developed. These plans include evaluation of baseline groundwater quality and geophysical conditions in the potential reuse areas. The work is being conducted to meet Central Valley Regional Water Quality Control Board requirements and schedules. *City of Davis, California.*

Flag City Wastewater Treatment Plant Groundwater Monitoring and Reporting Program. Principal Hydrogeologist responsible for quarterly and annual groundwater reporting. Prepared quarterly and annual reports using monitoring data collected by San Joaquin County. Developed and implemented the background groundwater monitoring program. Used nonparametric statistics to compare background and site groundwater data. Compared site groundwater data to published water quality goals. Negotiated with Regional Board staff to develop and implement clean closure approach for the effluent storage ponds after use of the wastewater treatment plant was discontinued in summer 2008. *County of San Joaquin, San Joaquin County, California.*

Wastewater Facilities Assessments for the California Department of Corrections and Rehabilitation. Principal hydrogeologist during evaluation of wastewater facilities at correctional facilities in a wide range of geologic environments. Assessed groundwater conditions, and potential groundwater quality impacts with respect to Regional Water Quality Control Board Waste Discharge Requirements. Assessed groundwater/surface water interactions with respect to recent court decisions and Regional Board permit actions. Evaluated alternative disposal options, including reuse. Prepared reports documenting findings and recommended action plans. Various sites. *California Department of Corrections and Rehabilitation, Sacramento California.*

City of Santa Rosa Municipal Well Design and Hydrogeologic Consulting Services. Principal hydrogeologist supporting the City of Santa Rosa's efforts to identify and evaluate potential municipal well sites and to design municipal production wells meeting the City's production and water quality requirements. Ken assisted the City in evaluating the hydrogeology of the groundwater basin, assessing municipal and private wells, selecting and evaluating potential municipal well sites, and developing a test drilling and well construction program for two of the sites, which were located in City parks. Test drilling and well construction were conducted with measures to mitigate sound and light pollution and to protect public safety. Geologic and geophysical logging was conducted in partnership with the United States Geological Survey at no additional cost to the client. Aquifer testing and chemical analysis were conducted in the test-production wells to assess yields, hydraulic parameters and groundwater quality, with respect to drinking water standards. Analytical element modeling was used to assess potential groundwater impacts to other wells in the vicinity. *City of Santa Rosa, California.*

Lower San Joaquin River Water Transfer Feasibility Study. Principal hydrogeologist and project manager for the analysis of water transfer alternatives for a 3,500-acre agricultural property located on the lower San Joaquin River. Efforts included evaluation of pre-1914 rights, appropriative licenses and riparian rights; evaluation of possible mechanisms by which water could be made available, including crop shifting, idling and groundwater substitution; and identification of potential buyers. Evaluated groundwater resources for the property and designed and implemented a test drilling, monitoring well construction and groundwater quality sampling program. The California Department of Water Resources, Central District provided geological and analytical services during the drilling program at

no cost to the client. Recent activities include negotiations with a potential buyer and preparation of a Petition for Temporary Urgency Change, which will be submitted to the State Water Resources Control Board. *Confidential Client, California.*

Upper Sacramento Valley Well Construction and Aquifer Testing. Principal hydrogeologist and project manager for investigation and hydraulic testing of the Lower Tuscan Aquifer. Scope of services include providing technical support to legal challenges; developing a phased, multi-year aquifer test work plan; providing geologic expertise during drilling of three, 1500-foot test holes extending to the base of fresh water, designing five 1,500-foot production wells; overseeing construction of the production wells; and implementing the aquifer test work plan. The work is conducted in association with the California Department of Water Resources, Northern District. *Stony Creek Fan Partners, California.*

Hydrogeologic Consulting Services. Ken was the principal hydrogeologist and project manager on this effort to evaluate the feasibility of using groundwater as a supplement to Reclamation District 2068's existing Delta water supply. Ken led the effort to assess the availability and quality of groundwater, the potential for impacts to stakeholders and the environment, and the costs of developing a conjunctive use program. These efforts included obtaining and evaluating available hydrostratigraphic, geophysical and water level and quality data; drilling and logging test borings; constructing nested monitoring wells; conducting aquifer testing; performing quarterly water level monitoring and semiannual water quality sampling; establishing and performing the initial survey of a land subsidence benchmark tied to the Yolo County Subsidence Monitoring Network; performing IWFM modeling to assess the effects of full-scale groundwater production on groundwater elevations; preparing a feasibility study report; preparing a groundwater management plan; and conducting community outreach. *Reclamation District 2068, Yolo and Solano Counties, California.*

Placer County Regional University Water Planning Studies and Modeling. Ken is the principal hydrogeologist and project manager for water, recycled water, and wastewater planning studies for the Regional University project in Placer County. The water supply strategy calls for initial reliance on groundwater with a gradual transition to an integrated supply of treated surface water, groundwater, and recycled water. Groundwater impacts were assessed using MODFLOW and IGSM. A MODFLOW model was developed using the conceptual model for the regional-scale IGSM. Drawdown for various scenarios was then modeled using MODFLOW application and superimposed on the IGSM results to assess project impacts. *KT Communities, Placer County, California.*

Hydrogeologic Characterization and Modeling. Ken was the principal hydrogeologist and project manager on a multi-year study of the Squaw Valley watershed. These efforts included analysis of annual snow pack, stream gauging, development of rating curves, groundwater level monitoring, water quality analysis and monitoring well installation using the resonant sonic method. A conceptual model of the groundwater basin was developed, and MODFLOW was used to estimate the yield of the aquifer under a range of hydrologic conditions and pumping scenarios. Tools were developed for estimating the available groundwater supply based on snowpack thickness and stream flow. *Squaw Valley Public Service District, California.*

Groundwater Impact Analysis and Modeling. Ken was the principal hydrogeologist and project manager during assessment of potential groundwater impacts due to a proposed gravel mine in Dry Creek, Sacramento County. Ken analyzed the geology, land use and water use of the area and developed a conceptual site model that was used to assess potential impacts to groundwater levels, groundwater quality and flow in Dry Creek. The assessment was performed using IGSM and a water balance approach. IGSM was used to assess potential impacts at a regional scale. The water balance was used to assess localized affects, including to a perched aquifer in Dry Creek stream channel deposits. *Sacramento County Department of Environmental Review and Assessment.*

Groundwater Modeling and Conceptual Design. Developed and implemented a

program of numerical flow and transport groundwater modeling, conceptual engineering design and cost estimating to select a protective, minimum present-worth design from a range of possible groundwater treatment system configurations. The key component of the approach was evaluation of a range of extraction and injection scenarios using analytical and three-dimensional groundwater flow (MODFLOW) and transport (MT3D) modeling of a multiple aquifer system spanning the Laguna and Mehrten Formations. The models included an extensive public supply well field and predicted the effect of groundwater withdrawals on contaminant transport to the wells. *AFCEE, Sacramento, California.*

Hydrogeologic Consulting Services for the University of California and City of Davis. Ken was the principal hydrogeologist and project manager for aquifer testing of deep municipal wells operated by UC Davis and the City of Davis. The effort included design of the tests; procurement, installation and operation of data loggers; data collection; and aquifer test analysis. The largest test involved pumping at a rate of approximately 2,500 gallons per minute for nearly two weeks. The aquifer test data were corrected for background water level trends, fluctuations in barometric pressure due to storm events, and earth tides prior to calculation of the hydraulic properties of the aquifer. Ken also participated in the evaluation of aquifer recharge characteristics using standard water quality analyses, stable isotopes, and carbon-14 dating. Ken worked with UC Davis/City operations staff to coordinate pumping tests with ongoing water system operations. *Cities of Davis and Woodland, California and University of California at Davis.*

Hydrogeologic Consulting Services. Ken was the principal hydrogeologist and project manager for the City of Petaluma's groundwater feasibility study. This work included providing hydrogeologic support during construction of new municipal production wells, evaluation of the condition and capacity of existing wells, assessment of the hydrogeology of the groundwater basin, and aquifer testing. The City currently relies on surface water supply from the Sonoma County Water Agency to meet water demands. The reliability of this supply is currently in question; particularly in regards to expansion of the supply to meet increasing needs as the City grows. Ken led the effort to evaluate integration of groundwater into the City's planning to meet increasing demands, either as a permanent supply or to meet peaking and/or emergency supply needs. Potential supply deficits that could be faced by the City in the future and the water quality issues associated with use of existing and proposed wells were considered in the development of alternatives for conjunctive use of surface and groundwater to meet future demands. The work also included the development of long-term objectives for the City for management of its underlying groundwater basin; development of long-term policies to protect the quality and production; and recommendations for groundwater monitoring. *City of Petaluma, California.*

Groundwater Management Planning. Ken was the principal hydrogeologist and project manager during evaluation of SB 1938 basin management objectives for the Solano Sub-basin. Some of the sub-basin stakeholders adopted groundwater management plans in the late 1990's. Ken supported Solano County Water Agency's efforts to evaluate the existing groundwater management plans and identify basin management objectives that the stakeholders held in common. The effort involved reviewing existing groundwater management plans, agreements and technical studies, and meeting with the stakeholders to develop consensus on basin management objectives. The outcome of the effort was a technical document that is available to guide preparation of individual SB 1938 groundwater management plans by sub-basin stakeholders. *Solano County Water Agency, California.*

Groundwater Management Planning. Ken was West Yost Associate's principal hydrogeologist and project manager during preparation of a SB 1938 groundwater management plan for UC Davis and the City of Davis. UC Davis and the City rely solely on groundwater for potable supply. The groundwater management plan was prepared and adopted jointly and has been implemented by the two agencies to help manage groundwater salinity, groundwater levels and land subsidence. *University of California, Davis, and City of Davis, California.*

Hydrogeologic Characterization/Groundwater Management Planning. Ken was the principal hydrogeologist during evaluation of groundwater resources in Dunnigan Water District. Ken evaluated and documented hydrogeologic conditions including aquifer hydraulic properties, recharge sources and potential, historical variations in storage with hydrologic conditions, water quality, typical well construction and typical well yield. Ken also provided recommendations supporting preparation of a SB 1938 groundwater management plan, including recommended groundwater monitoring locations, stream gauging locations and recommendations for the content of the plan. *Davids Engineering, California.*

Groundwater Management Planning. Ken was the principal hydrogeologist and project manager during preparation of a SB 1938 groundwater management plan for Reclamation District 2068. The adopted plan includes DWR's required and recommended components for SB 1938 groundwater management plans. Currently, the District does not use groundwater, and the plan is used to guide baseline data collection, including groundwater levels, groundwater quality and land subsidence potential. The groundwater management plan can also be used in the future, if the District chooses to adopt a conjunctive use program. *Reclamation District 2068, California.*

ASR Well Evaluation. Evaluated the historical and projected supply and demand with and without the ASR project, developed a summary of the hydrostratigraphy, aquifer hydraulic parameters, and groundwater flow and quality characteristics obtained from published and unpublished reports and California Department of Water Resources (DWR) records. Developed a preliminary conceptual model of the groundwater basin, estimated the potential storage of the basin and evaluated the potential yield of an ASR well and its affect on storage in the groundwater aquifer near Yountville. Evaluated water quality information to assess the potential for adverse effects due to chemical reactions between recharged treated surface water, groundwater, and the aquifer. Selected possible ASR well sites, and developed a conceptual design, conceptual implementation plan and budgetary cost estimate for the ASR system. Identified potential sources of funding for construction of the ASR system and prepared a construction grant application for funding under the Groundwater Storage Program of the Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act (Proposition 13). *Town of Yountville, California.*

Groundwater Resource Study. Evaluated potential for development of a new nonpotable groundwater supply beneath the San Mateo Plain, southwestern San Francisco Bay region. Interviewed staff at USGS, local universities and regulatory agencies to identify and obtain site-specific subsurface information for the project site. Evaluated the potential well yield and water quality and assessed the risk of saltwater intrusion and land subsidence should the resource be developed. *Confidential client, Redwood City, California.*

Land Subsidence Study. Evaluated land subsidence caused by groundwater withdrawal in the Chino Basin, southern California. Used well construction information, geophysical logs, groundwater production and elevation records, land survey information and interferometric synthetic aperture radar (InSAR) to assess the historical magnitudes and rates of land subsidence. Performed a qualitative evaluation of the risks of further subsidence over a range of hypothetical scenarios in which groundwater production and artificial recharge were increased through the year 2020. *Confidential client, Pasadena, California.*

Land Subsidence Studies. Research assistant participating in USGS land subsidence studies using wellhead and extensometer measurements, microgravity and GPS. Participated in establishing land subsidence monitoring networks in Avra Valley, the Tucson Basin and the Picacho Basin (upper and lower Santa Cruz River basins). Research assistant for projects involving collection, processing and interpretation of geophysical data used to characterize engineering properties at proposed Superconducting Supercollider sites in Arizona. Managed the University of Arizona's geophysical database. *University of Arizona, Tucson, Arizona.*

Groundwater Investigations. Conducted geologic, hydrogeologic and geophysical evaluations in the eastern United States and Virgin Islands. Responsibilities included development of project objectives, investigation design, data collection and interpretation, report preparation, and task management. Hydrogeologic activities included: geologic mapping and structural analysis of Valley and Ridge structures; design and implementation of bedrock drilling programs; dye trace testing in fractured bedrock and karst aquifers; groundwater flow and transport modeling; aquifer test analysis; and providing input to engineering design. Geophysical activities included location and delineation of buried structures using electromagnetic induction, magnetics and ground penetrating radar. *Various clients, Eastern United States.*

Hydrogeologic Investigations. Conducted environmental and hydrogeologic investigations on Terceira, Azores Archipelago, Portugal. Conceived and developed work plans for vanguard hydrogeological investigations at this remote volcanic island after performing extensive background research in Portuguese technical references and European Economic Community environmental regulations. *United States Air Force.*

Hydrogeologic Investigations. Conducted geologic, hydrogeologic and geophysical characterization projects in California. Responsibilities included survey design, data collection and interpretation, and report preparation. Hydrogeologic efforts included aquifer test analysis and drilling and stratigraphic logging. Geophysical activities included fault studies and assessment of engineering properties using seismic refraction (GRM), resistivity, and induced polarization. *Various clients, Southern California.*

Groundwater Flow and Transport Modeling. Project manager for the characterization and remediation of arsenic, copper, and hexavalent chromium at a former wood pressure treating facility. Evaluated the nature and extent of contamination in soil and groundwater, established background concentrations, developed remediation approaches, and managed design efforts. Conducted flow and transport modeling (MODFLOW and MT3D) to support evaluation and modification of the groundwater treatment plant. Evaluated a variety of scenarios to minimize the volume of treated water injected into the aquifer. Evaluation of the hypothetical modifications allowed the client and the Regional Board to make risk management decisions regarding the overall water balance of the site, plume capture, chemical processes applied at the treatment plant and discharge options for the treated effluent. *Confidential client, Merced, California.*

PCB Transport Modeling. Evaluated transport of PCBs in the vadose zone and groundwater. Performed vadose zone and groundwater flow and transport modeling to assess the potential for PCB transport from contaminated soil to groundwater production wells in the vicinity. Performed research on PCB transport properties for use in the modeling effort and presented the results to the California Department of Toxic Substances Control. *Confidential client, Pico Rivera, California.*

Benzene Transport Modeling. Evaluated benzene transport in the vadose zone. Developed a vadose zone model to simulate the effects of precipitation, surface runoff, evapotranspiration, infiltration to groundwater and gas phase diffusion on the transport of benzene to a deep aquifer used for water supply. Used time-dependant site-specific weather information and site- and chemical-specific transport parameters to develop the model. *Confidential client, Carson, California.*

Radiological Site Characterization. Designed and implemented a statistical sampling approach that was used to assess the degree and extent of reactor-generated radionuclides in the environment, including Humboldt Bay. The results of the characterization were used as part of the basis for estimating the cost of decontamination and decommissioning of the nuclear power plant. At the conclusion of the study it was possible to distinguish between areas likely to require remediation, areas that were affected by plant operations but were unlikely to require remediation, and areas in which no effects were measurable. *PG&E, Eureka, California.*

Remedial Investigation/Feasibility Study. Hydrogeologist for Remedial Investigation/Feasibility Study (RI/FS) of the Laboratory for Energy Related Health Research (LEHR) Superfund Site, Davis, California. Evaluated the degree and extent of

nitrate, TDS, hexavalent chromium, and chloroform in the unsaturated zone and groundwater. Evaluated records of historical operations and chemical analytical results for unsaturated zone soils to assess potential sources of contamination. Evaluated hydrogeologic information, chemical analytical results for groundwater, and fate and transport processes to delineate the degree and extent of groundwater contamination. Evaluated neighboring supply wells for potential impacts. The information developed was used to assess the effectiveness of remediation approaches, and to plan additional investigations and new groundwater remediation approaches that would be compliant with California Regional Water Quality Control Board, Central Valley Region Waste Discharge Requirements. *University of California, Davis, California.*

Unocal (Former PureGro) Fertilizer Facility. Project manager for the investigation and remediation of ammonia, nitrate, and organochlorine pesticides in soil and groundwater. Investigated the nature, degree, and extent of contamination and submitted compliance reports to the California Regional Water Quality Control Board, Central Valley Region. Established background concentrations in groundwater. Performed a survey of neighboring supply wells, assessed the potential for impacts, and sampled susceptible wells. Evaluated and estimated capital costs for corrective action. *Walnut Grove, California.*

Recycled Water Study. Evaluated the use of recycled water generated by the Sacramento Regional Wastewater Treatment Plant. Developed a projected water balance to the year 2030 for Sacramento County to assess potential changes in surface water and groundwater supply with and without the use of recycled water. Evaluated how the changes in supply might affect net surface water flows and groundwater elevations under climate conditions ranging from wet to critically dry. Evaluated the projected cost of recycled water relative to the cost of other water supplies, which included the projected costs of increasingly stringent treatment requirements. Identified and evaluated options for the best use of recycled water. Options included stabilization of groundwater elevations in high demand areas, areas critical for maintenance of instream flows, and areas in which groundwater quality could potentially be improved. *Sacramento Regional County Sanitation District, Sacramento, California.*

Wastewater Treatment Plant Groundwater Investigation. Principal hydrogeologist for evaluation of potential groundwater impacts at the City of Lodi's White Slough Pollution Control Facility. The primary goal of this ongoing effort is to determine whether facility operations and land application of treated effluent and biosolids have impacted groundwater relative to background conditions. A major challenge of the project was to establish these background conditions. Land use in the area includes intensive agricultural and dairy operations, which have affected water quality. Ken evaluated land and water use information and existing groundwater quality in the region to develop the basis for defining background conditions. He evaluated potential sources of contamination and waste streams at the facility, site-specific hydrogeologic conditions and groundwater quality to prioritize potential sources of

groundwater contamination and identified groundwater transport pathways and seepage rates. Results of the study will be used to determine whether improved treatment and control measures are needed. *City of Lodi, California.*

City of Galt Wastewater Treatment Plant Groundwater Investigation. Project manager for the City's Groundwater Monitoring and Reporting Program. The program addresses the wastewater treatment facilities and the surrounding lands, which are irrigated with plant effluent and used for biosolids disposal. Initiated the program by negotiating with the California Regional Water Quality Control Board, Central Valley Region, and developing the work plan defining well locations, analytical parameters, monitoring protocols, and schedule. No revisions to the work plan were required after the subsequent issuance of Waste Discharge Requirements. Analytical parameters include ammonia, nitrate, coliform, and metals. Established background monitoring locations that have been accepted by the Regional Board. Plant operations result in year-round mounding of groundwater, making placement of upgradient background wells impractical. Instead, background well locations were

selected based on groundwater transport and land use considerations. Evaluated the potential for impacts to neighboring supply wells; used nonparametric statistical methods to evaluate whether the monitored constituents exceeded background concentrations. *City of Galt, California.*

Mountain House Wastewater Treatment Plant Pond Evaluation.

Hydrogeologist for the evaluation of secondary treated effluent storage ponds. Leakage was observed shortly after the ponds were constructed. Ken evaluated as-built geotechnical data, groundwater quality data and groundwater modeling results to assess the potential future impacts of leakage; the likelihood that newly constructed ponds would meet California Regional Water Quality Control Board, Central Valley Region Waste Discharge Requirements; and potential remedial solutions. Results of the evaluation led to lining of the ponds. *San Joaquin County, California.*