GENERAL AGENDA ITEM # 1

Draft Report

Town of Cave Creek Water Master Plan

Prepared for

Town of Cave Creek, Arizona

March 2007

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Acronyms and Abbreviations

ACC	Arizona Corporation Commission
ac-ft/yr	acre-feet per year
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
CAP	Central Arizona Project
CC&N	Certificate of Convenience and Necessity
CCWC	Cave Creek Water Company
DHWC	Desert Hills Water Company
gpm	gallons per minute
MCL	maximum contaminant level
mg/L	milligrams per liter
MPA	Municipal Planning Area
ppb	parts per billion
PRV	pressure reducing valves
psi	pounds per square inch
Town	Town of Cave Creek
USEPA	United States Environmental Protection Agency
WTP	water treatment plant

SECTION 1

Introduction

The Town of Cave Creek, Arizona (Town) has recently acquired the assets of the Desert Hills Water Company (DHWC) and is incorporating its operation into the Town's municipal services. In addition, the Town has recently completed the acquisition of the Cave Creek Water Company (CCWC). This CCWC currently provides potable water service to the residents of the Town. This water system is supplied by both groundwater wells and surface water via a connection to the Central Arizona Project (CAP) Canal.

The objective of this project is to provide the Town with a comprehensive vision and master plan for accommodating the long-term water supply needs of the community. This master plan will take into consideration reasonable approaches for identifying, quantifying, and securing short- and long-term water resources to meet the projected requirements of the Town. It will also evaluate strategic and efficient options for developing the needed infrastructure consisting of pipelines, pumping facilities, and storage facilities to deliver water supply to the community considering the physical system characteristics of both the CCWC and the DHWC.

1.1 Study Overview

A study area map is presented on Figure 1-1. It includes the current Certificate of Convenience and Necessity (CC&N) boundaries for DHWC, CCWC and Sabrosa Water Company as provided by the Arizona Department of Water Resources (ADWR). The figure also shows the City of Phoenix Municipal Planning Area (MPA). Nearly half of the CC&N for DHWC falls within the City of Phoenix MPA. It is possible that the City of Phoenix will annex the land within its MPA in the future, prompting the sale and acquisition of all or part of DHWC into its water service area.

With the Town's acquisition of the DHWC and the CCWC, the CC&Ns will be dissolved by the Arizona Corporation Commission (ACC). This milestone will officially render the systems as municipally owned.

As part of the CCWC acquisition, the Town will operate the Sabrosa Water Company. The Sabrosa system is about 3.5 miles north of existing DHWC customers. The Sabrosa CC&N ranges in elevation from 2030 feet to 2190 feet.

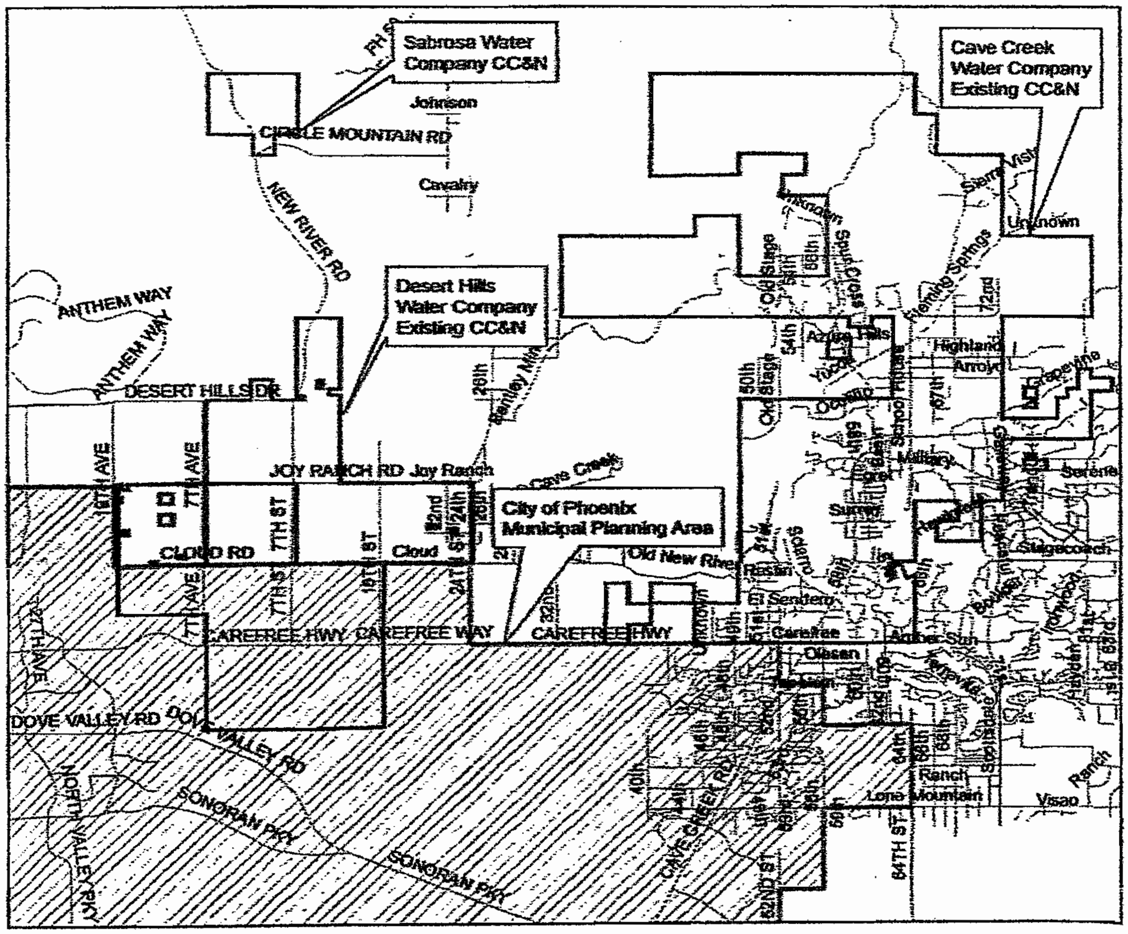
1.2 System Overview

1.2.1 Desert Hills Water Company

The DHWC began in 1970 and serves a population of about 4,000 people in a 6,800-acre area of unincorporated Maricopa County. The main source of water supply to the system has historically been groundwater. Two interconnections provide supplemental supply to areas within the DHWC system – one is from the CCWC at the eastern edge of the system, and the

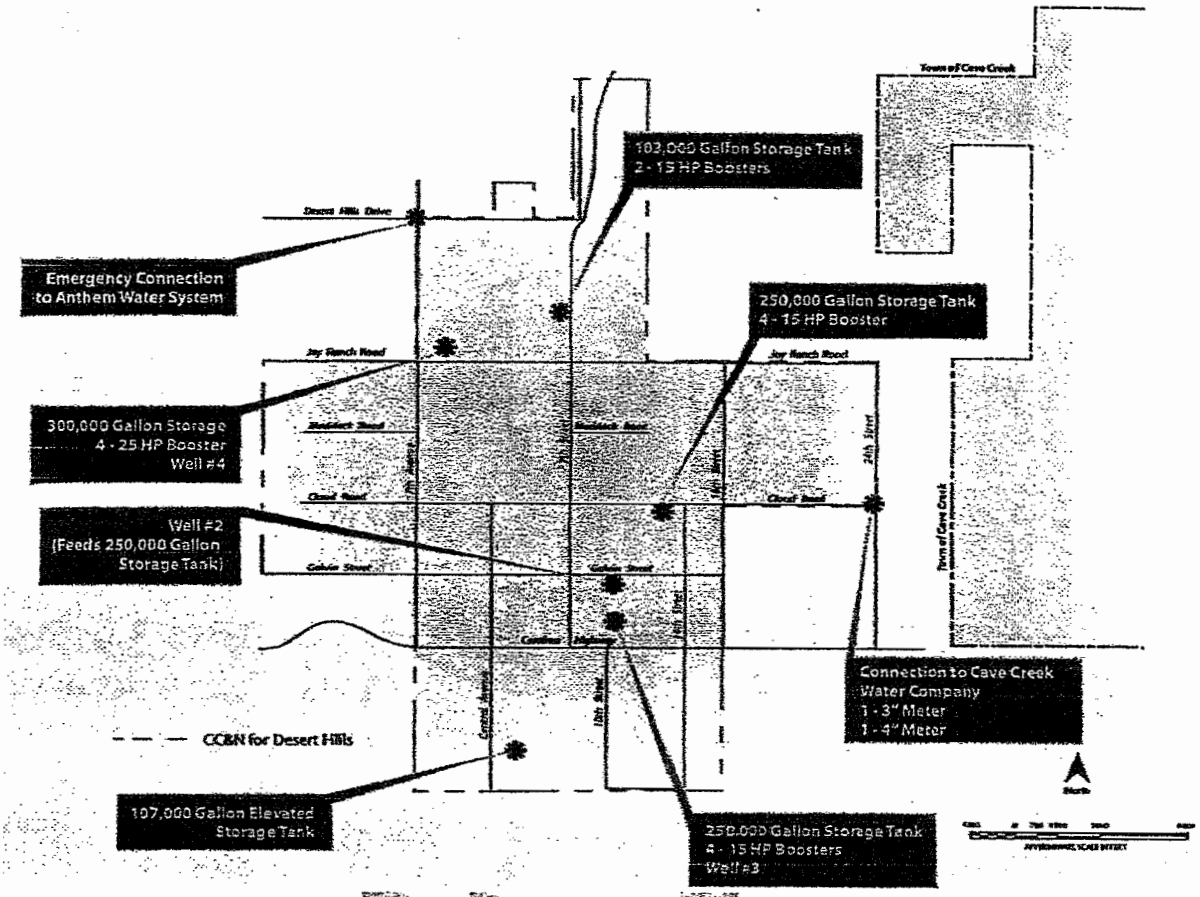
other is a temporary connection to the Anthem distribution system operated by Arizona American. Arizona American is also operating the DHWC system under contract to the Town.

FIGURE 1-1
DHWC, CCWC and Sabrosa Water Company Existing CC&N Boundaries
Town of Cave Creek Water Master Plan



The major water system components include three active groundwater wells, four ground storage tanks (with hydropneumatic tanks), one elevated storage tank, and four booster stations. An overview of the system is shown on Figure 1-2.

FIGURE 1-2
DHWC System Overview
Town of Cave Creek Water Master Plan



Details regarding DHWC wells, storage tanks, and booster station facilities are shown in Tables 1-1 through 1-3.

TABLE 1-1
Active Wells
Town of Cave Creek Water Master Plan

Well Name	ADWR ID No.	Drill Date	Casing Depth (feet)	Casing Diameter (inches)	Pump HP	Pump Yield (gpm)	Meter Size (inches)
Well #2	55- 631199	1972	800	8	60	200	4
Well #3	55- 087697	1981	800	8	20	100	4
Well #4	55- 559936	1997	1,000	10	75	380	4

Note:
gpm = gallons per minute

TABLE 1-2
Storage Tanks
Town of Cave Creek Water Master Plan

Tank Location	Quantity	Capacity (gal)
Dove Valley Rd. & Central Ave. (Elevated)[a]	1	107,000
7th St. & Joy Ranch Rd.[a]	1	103,000
10th St. & Carefree Hwy.[a]	1	250,000
14th Street & Cloud Rd.	1	250,000
3rd Ave. & Joy Ranch Rd.[a]	1	300,000
	Total	1,010,000

[a]Capacity obtained from DHWC system map prepared by RBF Engineers, revised January 2004.

TABLE 1-3
Booster Stations
Town of Cave Creek Water Master Plan

	Booster Pumps		Pneumatic Tanks	
Booster Station Location	Quantity	Horsepower	Quantity	Capacity (gallons)
10th St. & Carefree Hwy.	4	15	1	5,000
7th St. & Joy Ranch Rd.	2	15	1	5,000
14th Street & Cloud Rd.	4	15	1	5,000
3rd Ave. & Joy Ranch Rd.	4	25	1	5,000

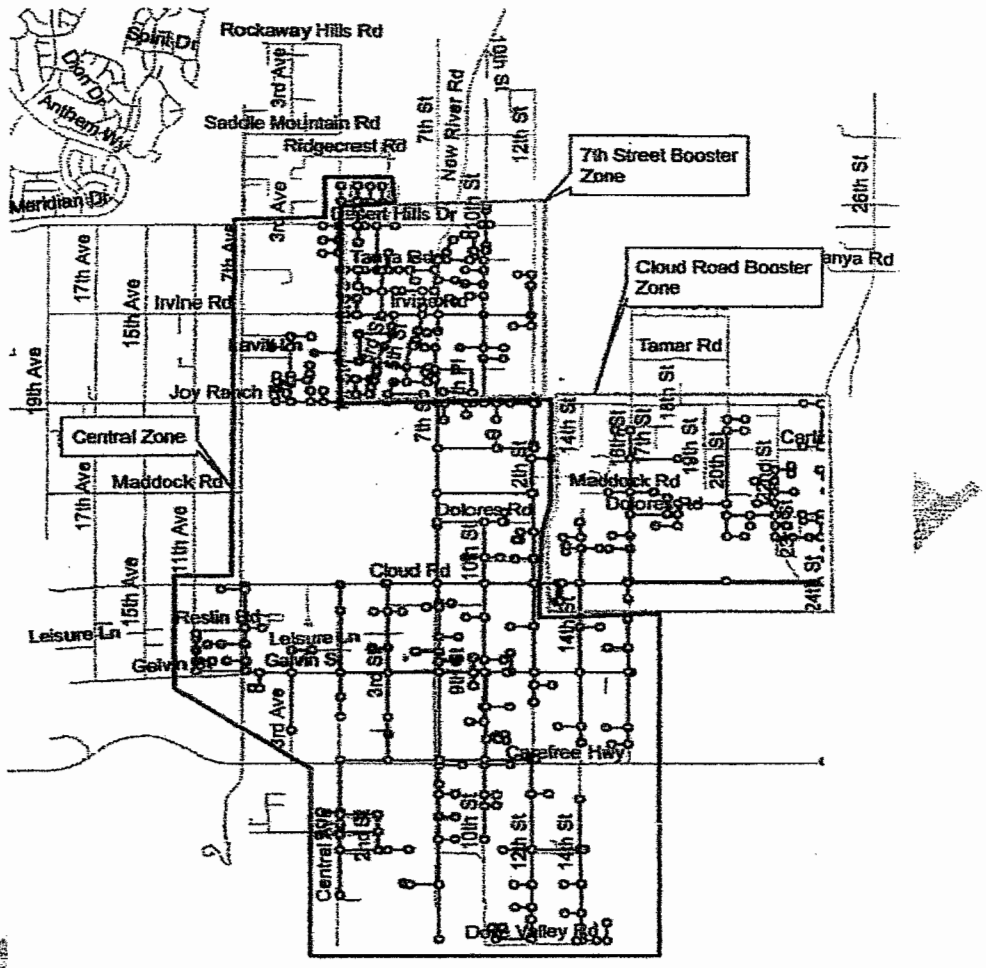
The distribution system is divided into three pressure zones: Central, 7th Street Booster, and Cloud Road Booster. A pressure zone map is shown on Figure 1-3.

The well water supplies are all within the Central pressure zone. Wells #2 and #3 are pumped to the 250,000-gallon ground storage tank near the DHWC office near 10th Street and Carefree Highway. Water from this tank is pumped into the distribution system. Water from Well #4 is pumped to the 300,000-gallon ground storage tank near 3rd Avenue and Joy Ranch Road. A booster station at this site pumps water from the tank into the distribution system. An elevated tank on the south side of the system off of Central Avenue floats on this pressure zone.

A 103,000-gallon ground storage tank is located near 7th Street and Joy Ranch Road is filled from the Central Zone. Water from this tank is pumped into the distribution system from an onsite booster station to the 7th Street Booster Zone.

The 250,000-gallon ground storage tank near 14th Street and Cloud Road is also filled from the Central Zone. Water from this tank is pumped into the distribution system from an onsite booster station to the Cloud Road Booster Zone.

FIGURE 1-3
Pressure Zone Boundaries
Town of Cave Creek Water Master Plan



1.2.2 Cave Creek Water Company

The CCWC serves a population of about 4,500 people including residents of the Town, certain residents of the Town of Carefree, and residents in unincorporated Maricopa County. The CCWC historically had a CAP allocation of 1,600 acre-feet per year (ac-ft/yr), but purchased additional water from the Berneil system to increase its allocation to 1,800 ac-ft/yr for 2007. As part of the Arizona Water Settlement Act, it is highly likely that CCWC will increase its allocation to 2,606 ac-ft/yr by the end of 2007.

The major water system components include seven active groundwater wells, nine storage tanks, 16 pressure tanks, 33 booster pumps, 1 surface water treatment plant (WTP), and about 100 miles of distribution mains (2 to 16 inches).

TABLE 1-4
Cave Creek Water Company Wells
Town of Cave Creek Water Master Plan

Well Name	ADWR ID No.	Drill Date	Casing Depth (feet)	Casing Diameter (inches)	Pump HP	Pump Yield (gpm)	Meter Size (inches)
Active Wells							
Faber	55-521032	1987	800	12	25	100	3
Neary	55-625095	1971	260	8	10	50	3
Vermeersch	55-518050	1988	700	10	40	300	3
Hazelton	55-518052	1988	1000	8	15	100	3
Pee Wee	55-625099	1980's	84	8	--	--	--
Wright I	55-625094	1970's	292	10	15	50	3
Wright II	55-516266	1980's	357	8	10	80	3
Inactive Wells							
Rockaway	55-625097	1970's	420	8	3	--	1
Carol Heights	55-625096	1970's	750	10	--	--	--
Triangle	55-636529	1970's	213	--	--	--	--
Linda Drive	--	1977	322	--	--	--	--
--	55-625798	1970's	210	10	7.5	80	3

TABLE 1-5
CCWC Storage Tanks
Town of Cave Creek Water Master Plan

Tank Location	Capacity (gallon)[a]
Neary	110,000
Linda	200,000
Wright 1	110,000
Wright 2	40,000
Carol Heights 1	110,000
Carol Heights 2	15,000
Rockway Hills 1	110,000
Rockway Hills 2	15,000
Total	710,000

[a]Capacities obtained from May 2006 Water Master Plan.

TABLE 1-6
CCWC Booster Stations
Town of Cave Creek Water Master Plan

Booster Station Location	Booster Pumps		Pneumatic Tanks	
	Quantity	Horsepower	Quantity	Capacity (gallon)
Neary	3	15	1	5,000
Sentinel	3	15, 15, 30	2	1,000 & 5,000
Wright I, II	2	30	1	5,000
Carol Heights	2	30,15	1	5,000
Rockaway	1	--	2	1,000 & 5,000
Carriage Drive	2	15,10	2	1,000
Ocotillo Ridgel	3	50,30,15	2	300 & 5,000
Hawksnest	4	5	1	1,000
Galloway	3	30,30,15	2	1,000 & 5,000
Linda Drive	6	50 (2), 30 (4)	1	5,000
Ocotillo Ridge II	3	30,15,15	--	--
School House Rd. South Booster Station	3	1, 1, 3	2	300 & 1,000[a]

[a]School House Road South Booster Station is not included in the model.

Note:

Source: May 2006 CCWC Water Master Plan.

The CCWC system typically operates by supplying CAP water to its customers. The 16-inch raw water transmission line extends about 12.5 miles from the CAP canal to the WTP. A raw water intake pump station and three inline booster stations lift the water from the canal to the WTP (with an elevation change of about 600 feet from the canal to the WTP). There are no raw water storage facilities, but there are two finished water storage tanks at the WTP with a total capacity of about 150,000 gal.

From the finished water tanks, water is transmitted to three booster stations: Wright, Neary, and Linda. A pressure zone schematic is shown on Figure 1-4 and a map of the system is shown on Figure 1-5 along with the Town boundary. About one quarter of Town of Carefree's residents are served by the CCWC.

The pressure zone schematic shows the interconnection of the water system and major facilities (booster stations and pressure reducing valves [PRVs]) that transmit water to customers. The elevation range (in feet) of the lowest to highest junction in the water model is shown for each pressure zone; the model does not depict every customer connection, so some customers may be higher or lower than the depicted range.

The Wright and Linda booster stations are both capable of pumping water to Zones 4 and 7; the Neary booster station pumps to Zone 4 only. Water is delivered to Zone 1 via PRVs from Zone 4, and water is pumped from Zone 4 to Zone 3. From Zone 3, water is delivered to Zone 2 via PRV. Water is pumped to Zone 5 via the Carriage booster station from Zone 4, and water from Zone 7 is pumped via the Galloway booster station to Zone 10. The Carol

Heights booster station serves Zone 8 with suction from Zone 7, and Zone 9 is supplied via booster from Zone 8. The Hawksnest booster station serves Zone 11 with suction from Zone 10. Zone 12 is supplied by a booster station with suction from Zone 10, and Zone 13 is supplied via booster from Zone 12.

FIGURE 1-4
System Schematic
Town of Cave Creek Water Master Plan

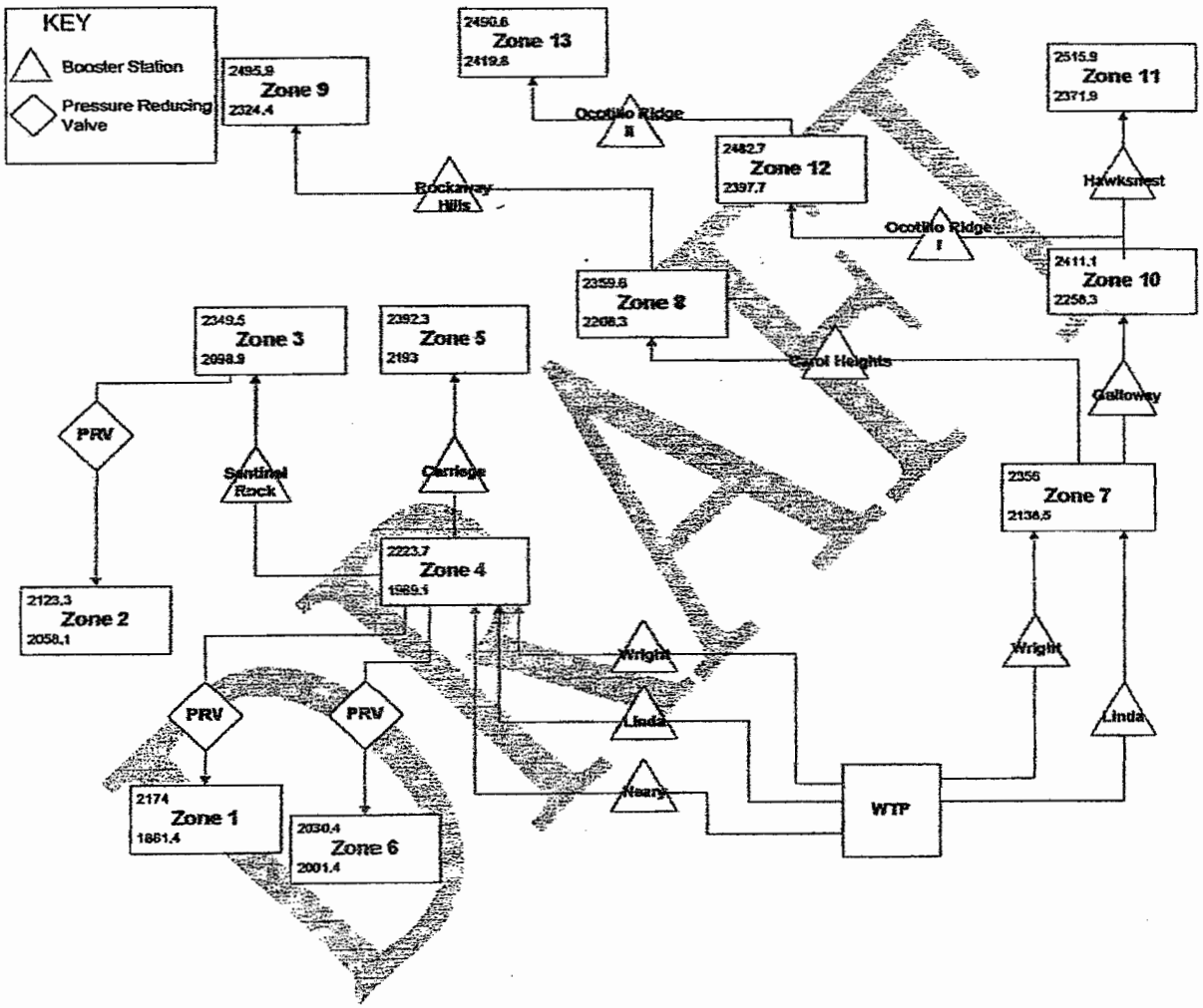
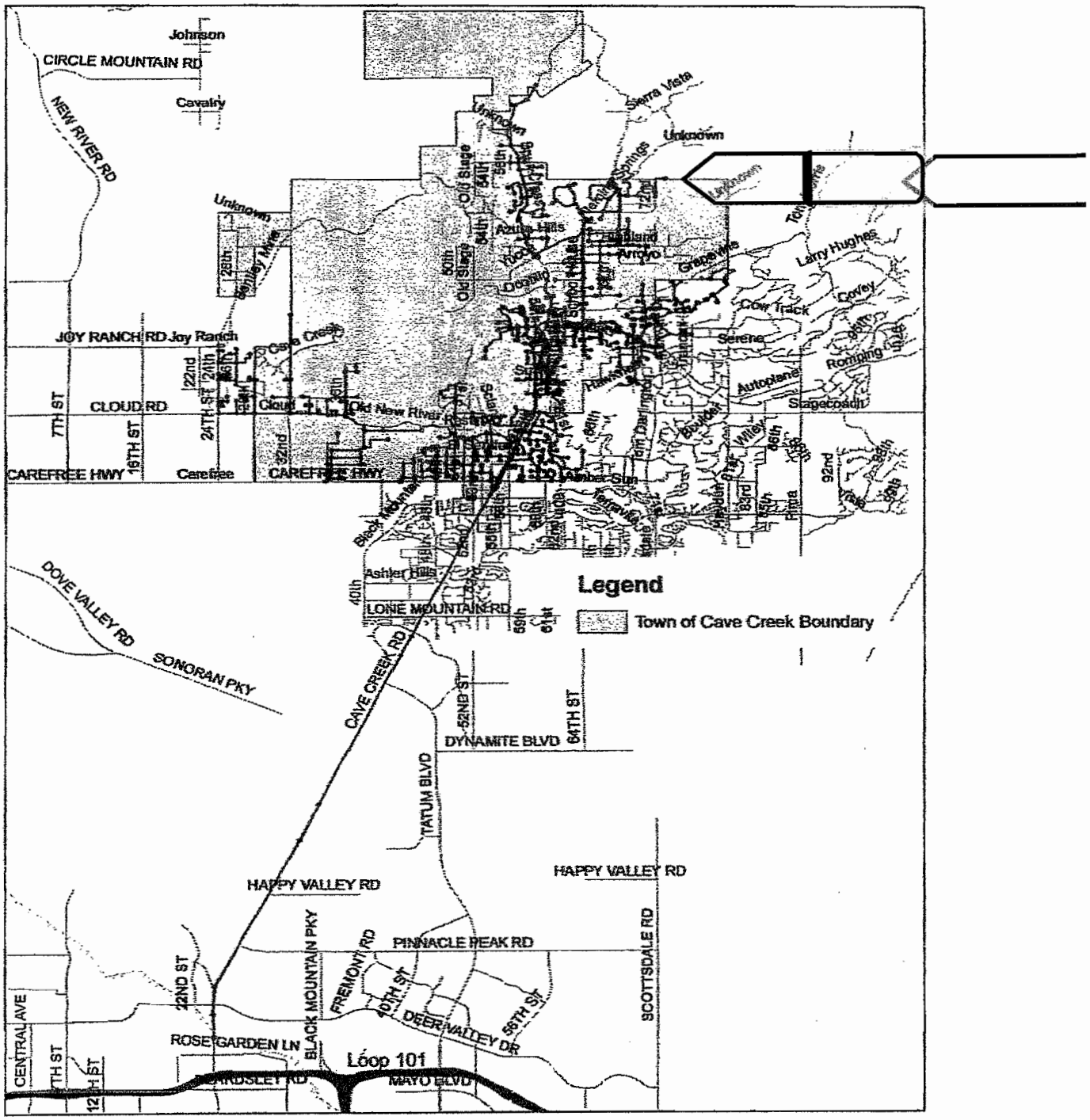


FIGURE 1-5
CCWC System Map
Town of Cave Creek Water Master Plan



SECTION 2

Water Supply Requirement Evaluation

The objective of this task is to identify future water requirements of the Town, including the service areas of the CCWC and DHWC. CH2M HILL worked with Town staff to update the projected demands in both water systems. Future demands were developed for 2010 (short term) and for 2030 (long term). Future demands for the water system were based on land use and future development data provided by the Town. In addition, CH2M HILL evaluated future demand requirements for the Town of Carefree and Sabrosa Water Company.

2.1 Customer Projections by Service Area

2.1.1 Cave Creek Water Company

The customer projections for CCWC were estimated using the population projections calculated in the October 2006 Sanitary Sewer Master Plan. A graphical representation of the CCWC customer projections (housing units) is provided on Figure 2-1, which includes 2,639 and 4,365 customers in 2010 and 2030, respectively. Using the sewer master plan projections and a multiplication factor of 2.4 persons per dwelling unit provided by the Town (Larry Sahr, 2007) the estimated CCWC population is 6,334 and 10,476 in 2010 and 2030, respectively. The customer projections include those that reside within the Town of Carefree and are served by CCWC.

2.1.2 Desert Hills Water Company

The customer projections for DHWC were calculated based on 1,627 customers in 2005, as reported by the 2005 ACC Utility Divisions 2005 Annual Report. As indicated by the Town, an annual 3 percent forecasted rate of growth was then applied between the years 2005-2030. This resulted in 2,343 and 4,234 customers in 2010 and 2030, respectively (Figure 2-1).

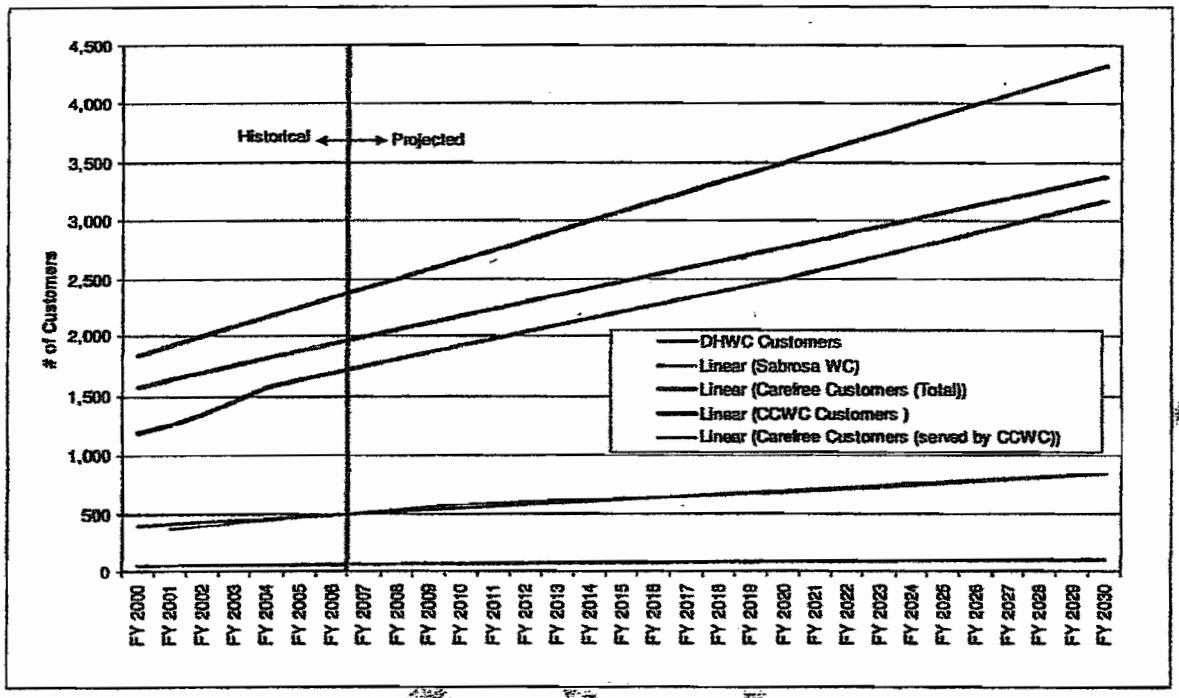
2.1.3 Town of Carefree

The customer projections for the Town of Carefree were calculated using the Town of Carefree General Plan 2020. According to the plan, population projections were estimated by the Arizona Department of Economic Security, and included populations of 4, 611 and 5,384 (in 2010, and 2020). The report also stated a build-out population of 6,496, which was used for the 2030 population. The corresponding number of customers was then calculated using a ratio of 1.97 people per customer housing unit based on the General Plan. This resulted in 2,341 and 3,297 connections in 2010 and 2030, respectively, and includes customers served by both CCWC and Carefree Water Company. The number of Carefree customers served by CCWC was calculated by multiplying the total projected connections by 25 percent (Figure 2-1).

2.1.4 Sabrosa Water Company

The customer projections for Sabrosa Water Company were calculated using the 2001 ACC Utility Divisions Annual Report (69 customers). Using Sabrosa's CC&N boundary, the estimated maximum number of customers at buildout based on existing lot count was determined to be 113 (Figure 2-1).

FIGURE 2-1
Customer Projections by Service Area
Town of Cave Creek Water Master Plan



2.2 Water Demand Projections

Historical water demands were based on available public data acquired from the ACC's Annual Reports for the CCWC and DHWC. Demand projections for these two companies were assumed to parallel the projected population growth discussed previously. The historical and projected demands for the Carefree Water Company were obtained from the 2002 Town of Carefree General Plan 2020 Adoption Report.

The following equations were used for demand calculations, as per the May 2006 CCWC Master Plan:

$$\text{Peak Hour} = \text{Max Day} * 1.7 \quad (1)$$

$$\text{Max Day} = (\text{Average Day} * 2.0) + \text{Lost} \quad (2)$$

The resulting demand calculations are included graphically for CCWC and DHWC on Figures 2-2 and 2-3, respectively.

FIGURE 2-2
CCWC Demands
Town of Cave Creek Water System Master Plan

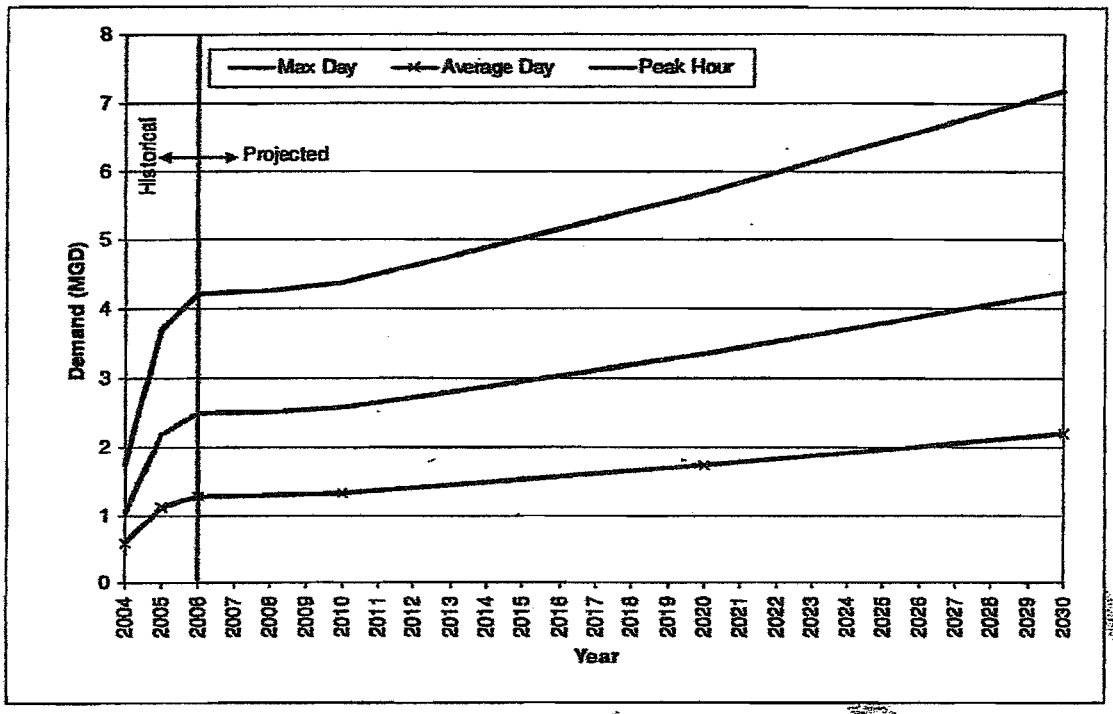
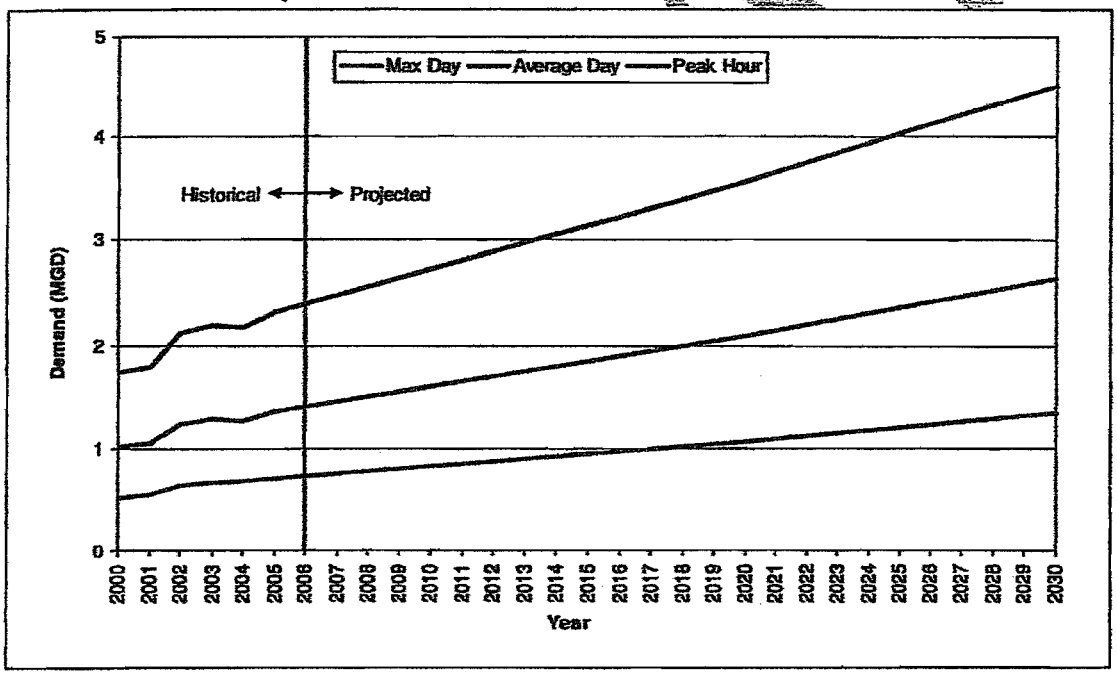


FIGURE 2-3
DHWC Demands
Town of Cave Creek Water System Master Plan



SECTION 3

Water Resource Evaluation

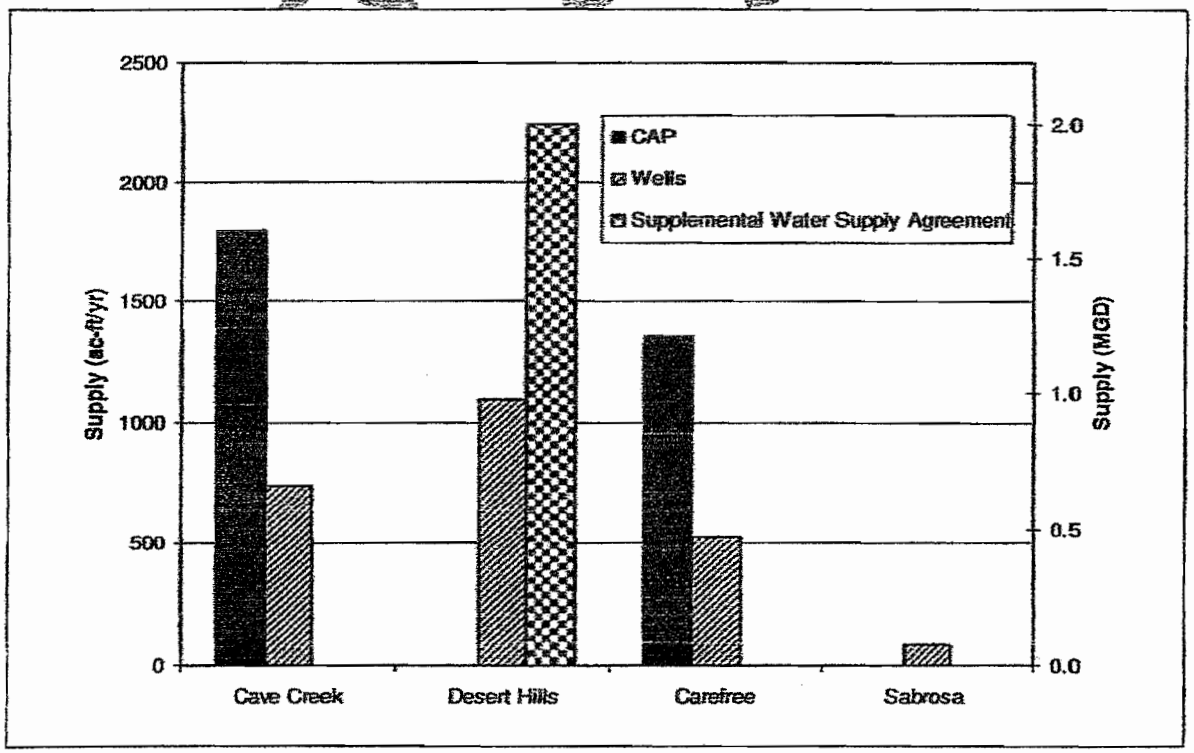
The objective of this task was to identify existing water supply sources and to identify additional water supply alternatives such as renewable water sources from both systems to meet future water needs.

3.1 Water Supply Evaluation

The objective of this task was to assess the existing water supplies available to each water system service area. CH2M HILL quantified the available volume of supply and assessed the water quality with respect to regulatory and aesthetic concerns.

The total system water supply (in ac-ft/yr and million gallons per day [mgd]) is provided per service area on Figure 3-1. The well supplies assume that wells are operating at full capacity at all times. DHWC also has an agreement in place with Arizona American to provide up to 2 mgd of water from the Anthem system through 2010.

FIGURE 3-1
Total System Water Supply by Service Area and Source
Town of Cave Creek Water System Master Plan



3.1.1 Water Quality

The CCWC and DHWC are required to meet required Federal and State drinking water regulations. The federal Safe Drinking Water Act sets the minimum standards for health and aesthetic water quality. These standards are known as maximum contaminant levels (MCL), which are a measurement of water quality. The Arizona Department of Environmental Quality (ADEQ) is responsible for administrating the Arizona Environmental Quality Act for the state, which adopted the federal water quality requirements for the treatment, storage, and distribution of water.

In review of the Water Quality Reports submitted by CCWC to ADEQ, the CCWC is required to monitor and report surface water treatment compliance monthly, measure nitrate (as N) and nitrite (as N) quarterly, test for inorganic chemical compounds such as arsenic yearly, and test for trihalomethanes every three years. For 2003 and 2004, all samples tested came in below the MCLs for each component and thus, the system is in compliance.

CH2M HILL also requested a summary of the Water Quality Reports submitted by DHWC to ADEQ from 2002 to 2006. DHWC is required to monitor and report bacterial compliance monthly, measure nitrate (as N) annually and nitrite (as N) every nine years. They are also required to test for inorganic chemical compounds, volatile organic compounds, synthetic organic compounds and radiochemicals every three years. Trihalomethanes are currently tested annually until compliance is met and then testing will be done triannually. Upon review of data provided by ADEQ for 2002 through 2006, all samples tested were at or below the MCLs for each component with the exception of arsenic levels found in one point of entry to the system.

Of particular interest are the arsenic levels found in the potable water supply wells due to the recent regulatory changes in MCLs of arsenic in drinking water. In October 2001, the U.S. Environmental Protection Agency (USEPA) announced its decision to require public water systems to lower the allowable arsenic content in drinking water from 50 parts per billion (ppb) (0.050 milligram per liter [mg/L]) to 10 ppb (or 0.010 mg/L) by January 23, 2006. After this date, systems must begin monitoring and complete initial monitoring by December 31, 2007.

The levels of arsenic in each well reported to the ACC in 2004, and 2005 by CCWC are compiled in Table 3-1.

TABLE 3-1
Average Arsenic Level of CCWC Wells
Town of Cave Creek Water Master Plan

	2005 Arsenic Level		2004 Arsenic Level	
Well	mg/L	ppb	mg/L	ppb
Vermeersch	0.230	230	0.280	280
Hazelton	0.056	56	0.051	51
Faber	0.280	280	0.920	920
Neary	0.016	16	0.016	16
Pee Wee	<0.003	< 3	0.0076	7.6
Rockaway	0.015	15	0.015	15
Wright I	0.010	10	0.010	10
Wright II	0.012	12	0.012	12

According to the 2004 and 2005 Annual ACC Reports submitted by CCWC, the range of arsenic in the eight production wells used in 2005 was 0.01 mg/L to 0.280 mg/L, a significant improvement over the range in 2004 of 0.01 mg/L to 0.92 mg/L. Because these levels are much greater than the MCLs specified, the change in the arsenic regulation has had a significant impact on CCWC. CCWC has invested in arsenic treatment equipment at the WTP to use these wells for water production. Currently, the well supply may not treated and delivered at the same time as the CAP supply, therefore, use of groundwater supplies is limited.

Arsenic levels detected at the point of entry to the system were also higher than the new 0.01 mg/L limit. In 2003, the level was 0.011 mg/L, and the level increased to 0.025 mg/L in 2004, which is an indicator that blending well and CAP water might not be a viable method to maintain new regulatory standards, and additional arsenic treatment at the point of entry may be required in the future.

The levels of arsenic in each well reported to the ACC in 2004 and 2005 by DHWC are compiled in Table 3-2.

TABLE 3-3
Average Arsenic Level of DHWC Wells
Desert Hills Water Company

	2005 Arsenic Level		2004 Arsenic Level	
Well	mg/L	ppb	mg/L	ppb
Well 2	0.008	8	0.008	8
Well 3	0.009	9	0.009	9
Well 4	0.012	12	0.012	12

According to the 2005 Annual ACC Report submitted by DHWC, Well #4 exceeded the MCL with a value of 12 ppb. However, Well #2 and Well #3 are both below the MCL. The change in the arsenic regulation might have an impact on DHWC and potentially require the development of a compliance strategy, which might require additional investment to maintain the use of the well for water production. Arizona American, the operator of the DHWC system under contract to the Town, is currently employing a strategy of blending Well #4 with the Anthem supply to mitigate the arsenic impact to deliver water to the system that is below the MCL.

3.2 Water Treatment Capacity Evaluation

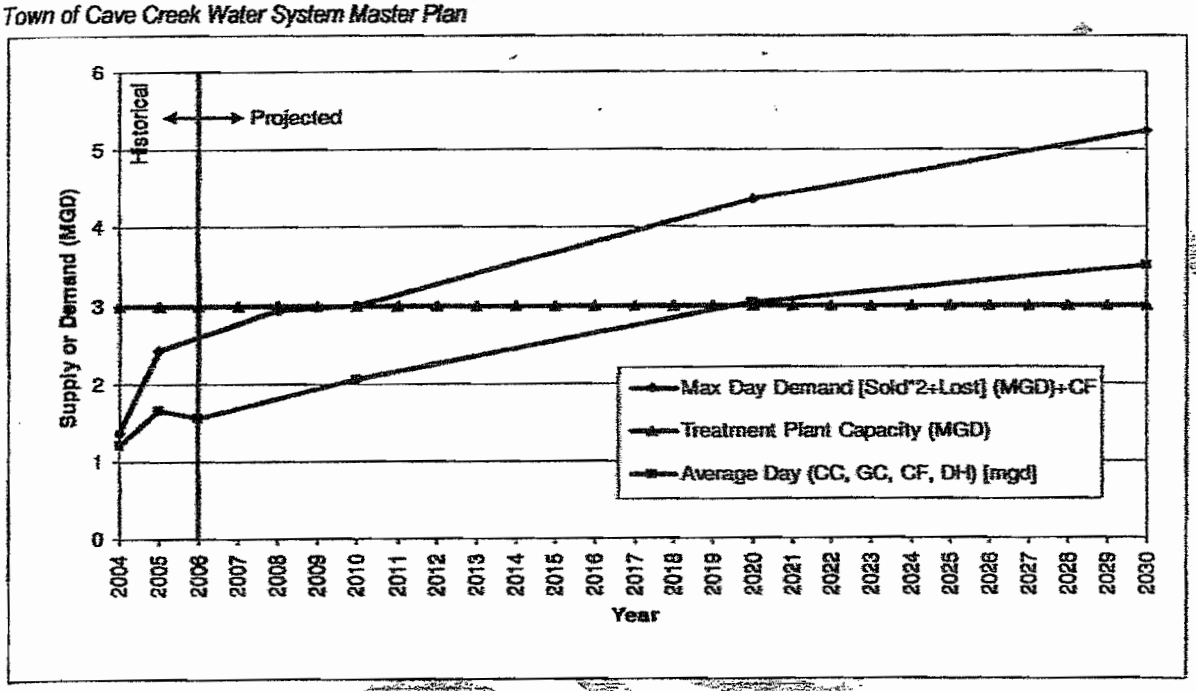
The objective of this task is to develop water treatment capacity requirements to ensure short-and long-term water demands are met.

A comparison of CCWC's demand versus the treatment plant capacity is shown on Figure 3-2. This figure depicts the maximum day demand for treatment capacity, which includes water sold and lost in Cave Creek, and the demand for Carefree, (which is 300 ac-ft/yr through 2010 and increases to 700 ac-ft/yr from 2011 through 2030). Water treated for Carefree is "wheeled" by CCWC and is included in Carefree's CAP allocation.

This figure shows that the maximum day demand exceeds the treatment plant capacity of 3 mgd by 2010, with projected demands extremely close to available capacity by 2008. This figure also depicts the average day demand for treatment capacity, which includes the demand for Cave Creek, Rancho Manana golf course, Carefree and Desert Hills (historical water delivered to DHWC only). The demand for Carefree under average day conditions is the same as described for maximum day conditions above, and it is part of Carefree's CAP allocation.

The Town should take immediate steps to increase capacity of the WTP to meet maximum day demands to at least 3.5 or 4 mgd in 2007. In the long term, the WTP capacity should be increased to just over 5 mgd to meet maximum day projected demands.

FIGURE 3-2
CCWC Demand versus Treatment Plant Capacity
Town of Cave Creek Water System Master Plan



3.3 Water Supply Alternatives

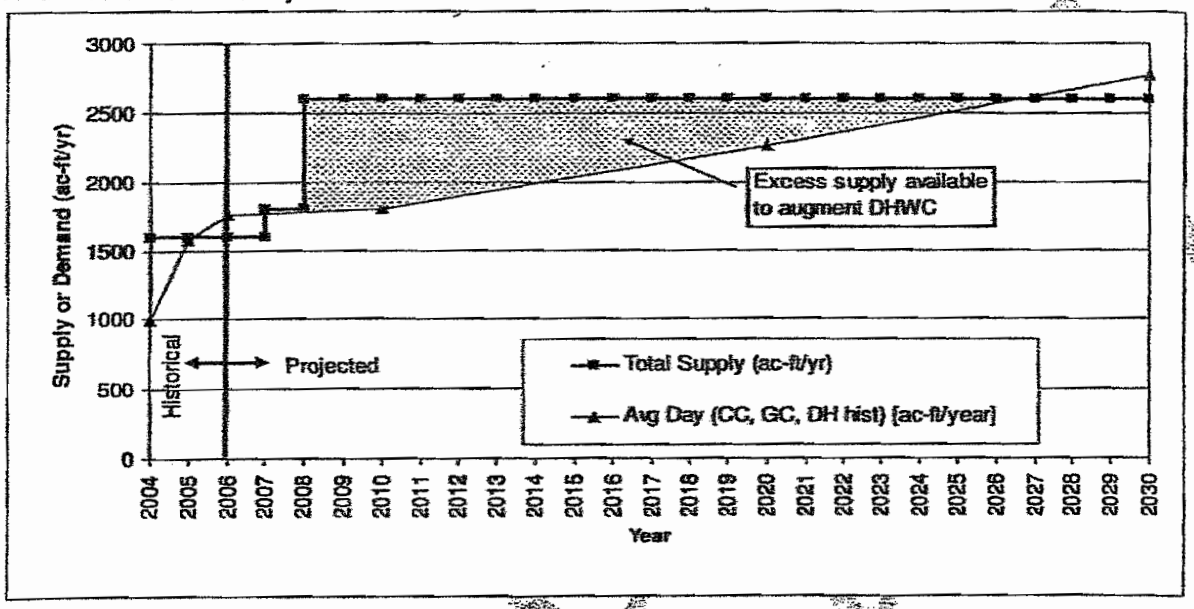
The objective of this task is to develop strategic water supply alternatives to ensure short- and long-term water needs are met. It includes the evaluation of using additional potential water supplies, which may result from the Town's efforts to obtain additional water rights if necessary.

A comparison of CCWC's system projected demand versus the current and projected CAP supply is shown on Figure 3-3. This figure depicts the average day demand, which includes Cave Creek customers, Rancho Manana golf course and Desert Hills. Deliveries to Desert Hills from CCWC are historical only in this graphic.

The average day demand exceeds the total supply after 2027. The Town should closely monitor its CAP allocation in 2007 and take steps to ensure that the Arizona Water Settlement Act supply is available by 2008. The addition of the CAP allocation from the Arizona Water Settlement Act provides CCWC with excess supply from 2008 through 2027. This excess may be used to augment supply to DHWC through the existing connection with CCWC. Both systems are being operated by Arizona American under contract to the Town, so no third-party coordination is required to deliver water from CCWC to DHWC.

After 2008, the Town may want to consider evaluating deliveries to Carefree and the Rancho Manana golf course. One option for the golf course supply would be diverting the untreated well water supply to the course. The Town should also consider purchasing additional CAP water from other sources by 2027 to meet its future demand requirements.

FIGURE 3-3
CCWC Demand versus Total CAP Supply
Town of Cave Creek Water System Master Plan

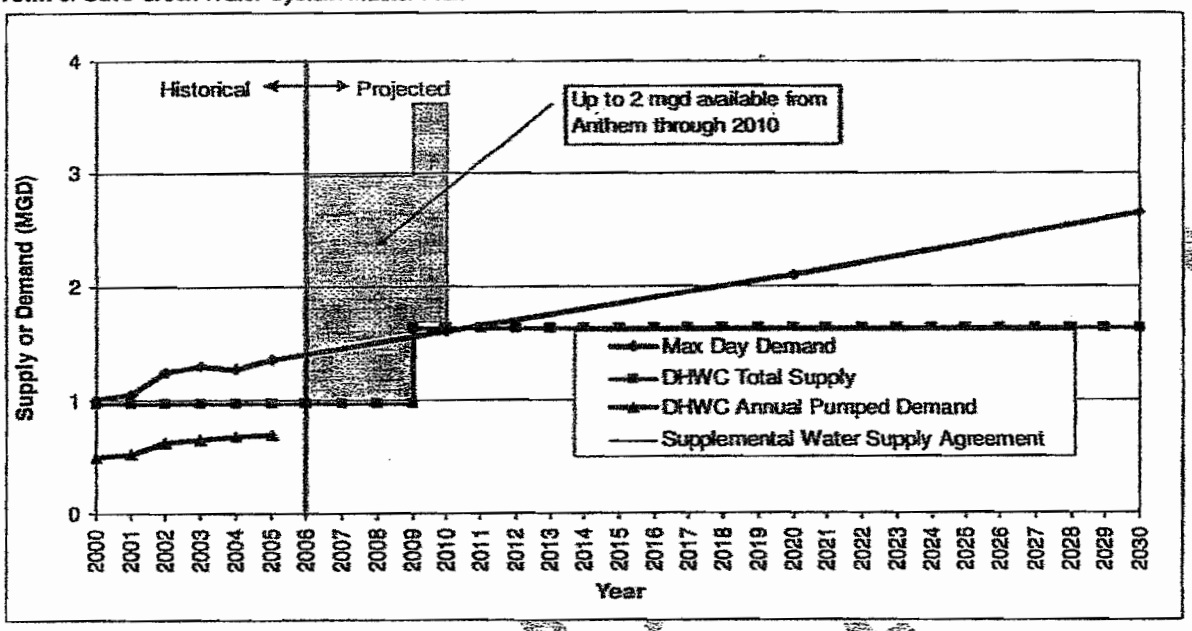


A comparison of DHWC's system demand versus DHWC's supply is shown on Figure 3-4. DHWC's total supply includes existing wells as well as the construction and successful development of a 450 gpm groundwater well from the planned Cielo Grande development (Technical Specifications for Construction, Development, Testing, and Equipping of One New Municipal Water Supply Well for Columbia Communities in the DHWC Service Area, Errol L. Montgomery & Associates, July 2006) by 2009. The supply assumes that groundwater wells are operating at full capacity at all times.

Figure 3-4 also depicts the quantity of water pumped annually by DHWC (as reported in the system's ACC annual utility reports). In past years, the deficit in supply has been provided through the purchases of additional water from Anthem or CCWC. Up to 2 mgd of treated water is available from Anthem via an agreement in place through 2010.

The DHWC system has several options available to further augment its future supply. One option is constructing a permanent connection to the Anthem community. As part of development agreements, another option is for the Town to impose developers to provide additional supplies by drilling new wells and constructing storage facilities, similar to the planned Cielo Grande development. As needed, another option is for the Town to augment supply to DHWC via the existing connection to the CCWC system. As noted in Figure 3-3, CCWC will have an excess of CAP water available to deliver to DHWC via the existing system connection. A longer term option to augment reliability and redundancy is to construct a connection to a neighboring municipality to "wheel" the Town's CAP allocation for delivery to either DHWC or CCWC.

FIGURE 3-4
Desert Hills Demand versus Desert Hills Supply
Town of Cave Creek Water System Master Plan



SECTION 4

Water System Assessment

The objective of this section is to identify a short- and long-term strategy to convey water to all customers in both water systems. CH2M HILL has also developed a recommendation for a Capital Improvement Program.

4.1 Hydraulic Model Development

CH2M HILL obtained a WaterCad (Bentley) water model for the CCWC system from Global Water Resources, the former owner of CCWC. This model was developed and calibrated by RBF Consulting. However, no water model had been developed for the DHWC system. CH2M HILL developed a water model and calibrated the model for the DHWC system using InfoWater software, an MWH Soft modeling software. The calibrated Desert Hills water model was combined with the Cave Creek water model and then the combined water model was upgraded to WaterGEMs (Bentley).

4.1.1 Desert Hills Water Model Development

Typically a water model consists of the following elements:

- **Junction** - Junctions are points placed at the intersection of two or more pipes (intersections or tees), at points of water consumption or inflow, at points where specific analysis values (e.g., pressure, concentration) are desired, and at points where pipe attributes (e.g., diameter, material) change.
- **Pipe** - A pipe conveys water from one junction node to another.
- **Pump** - A pump imparts energy to a fluid thereby raising its hydraulic head. A pump curve that describes the head imparted to a fluid as a function of its flow rate through the pump is needed for hydraulic analysis.
- **Valve** - A valve regulates either flow or pressure in a distribution system.
- **Tank** - Tanks are nodes with storage capacity, where the volume of stored water can vary with time during an extended period simulation.
- **Reservoir** - Reservoirs are nodes that represent an infinite external source or sink of water to the network. They are used to represent external water sources, such as treatment plants, wells and water import points.

The AutoCad drawings received from the DHWC were used to develop the model network in InfoWater, which is a GIS integrated water model software developed by MWH Soft. The model was checked for connectivity, crossing/intersecting pipes, parallel pipes, and nodes in close proximity. The coordinates of the model network were adjusted to "NAD _1983_StatePlane_Arizona_Central_FIPS_0202_IntlFeet" using Spatial Adjustment in

ArcGIS. The junction node elevations were derived from the contour GIS shapefiles obtained from Maricopa Flood Control District using Elevation Extractor in InfoWater.

The Desert Hills Water Model consists of approximately 500 pipes, 430 junction nodes, 3 groundwater wells, 1 water import point (i.e., Anthem), 5 storage tanks, and 4 booster stations. Not all of the valves were modeled, but only those that split pressure zones. Thirteen valves were included in the model.

4.1.2 Desert Hills Water Model Calibration

The Desert Hills Water Model was calibrated using the demand data and pressure recorder data obtained from Arizona American. October 26, 2006 was selected for model calibration because there were most pressure recorder data on this day. The water consumption on this day was 590 gpm.

The following assumptions were made for the model calibration:

- The Central Zone is the main pressure zone which has 3 groundwater wells (i.e., Well 2, Well 3, and Well 4), 1 water import point (i.e., Anthem) and three storage tanks (i.e., Well 4 Tank, Central Tank, and Carefree Highway Tank). This Zone feeds the 7th Street Booster Zone and Cloud Street Booster Zone by filling the tanks located at the same site as the boosters.
- Except at the Carefree Highway Booster Station where three pumps were on, only one pump was on at each of the following boosters: Well 4, 7th Street, and Cloud Street.
- The Cloud Street Tank was drawn down and being filled.

First, the meter reading data in July 2006 was joined to the attribute table of a GIS shapefile containing the spatial meter locations. The meter reading changes from the previous month were spatially allocated to the model junction nodes using Demand Allocator in InfoWater. Second, a global multiplier was applied to the demands obtained from the first step so that the total demand in the model matched the water consumption on the calibration day. Third, the model controls for the system facilities were adjusted to match the settings described above. Finally, the model was run and the pressure data from the model simulation was compared to the field pressure recorder data on the calibration day.

The model calibration results are presented in Table 4-1. Three out of four locations have pressure differences less than 10 pounds per square inch (psi) and one location has a pressure difference less than 15 psi. Based on limited available data, CH2M HILL felt the model adequately represented observed field conditions.

TABLE 4-1
Model Calibration Results
Town of Cave Creek Water Master Plan

Location	Field Average Pressure (psi)	Model Pressure (psi)	$\lvert\Delta P\rvert$ (psi)
Anthem	60	51	9
7th Street Booster	94	101	7
Central Avenue and Joy Ranch Road	45	58	13
Well 3	68	71	3

4.1.3 Model Combination and Upgrading to WaterGEMs

WaterGEMs is a GIS integrated water model software developed by Bentley, the same company that developed WaterCad. CH2M HILL opted to use WaterGEMs to develop the combined water model based on the following considerations:

- WaterGEMs and WaterCad have similar functions and modeling capabilities. Modelers who are familiar with WaterCad can easily learn how to use WaterGEMs. Because the Cave Creek Water Model was developed in WaterCad, it is logical choice to use WaterGEMs for the combined model.
- WaterGEMs has more new functions and modeling capabilities than WaterCad, especially its GIS integration feature which makes the model presentation very powerful.

The Cave Creek Water Model was upgraded to WaterGEMs first. Next, the Desert Hills Water Model was exported from InfoWater to EPANET, since WaterGEMs has the capability of importing EPANET files. Having the Cave Creek Water Model open in WaterGEMs, the Desert Hills Water Model was imported as a submodel as an EPANET input file. CH2M HILL combined the model elements such that the systems could be operated to serve water from CCWC to DHWC.

CH2M HILL also briefly validated the information in the CCWC WaterCad model provided by Global Water Resources once it was upgraded to WaterGEMs. As part of the validation, junction elevations were compared to Maricopa County's GIS elevation contours. A summary of modifications, mostly minor, made to junction elevations is available in Appendix A.

4.1.4 Model Scenarios

The water model contains several scenarios to evaluate the systems under varying demand conditions. The scenarios are grouped into three categories: near term (2008), year 2010 and year 2030. In each category, the model was run with average day, maximum day, maximum day plus fire flow and peak hour demands for a total of 12 scenarios.

4.2 Transmission Assessment

More info to be added regarding size and location of future facilities based modeling results...

4.3 Storage Assessment

Storage was assessed throughout the systems using the following equations:

$$\text{Storage for DHWC} = \text{PH-MD} + \text{Fireflow} \quad (3)$$

$$\text{Storage for CCWC} = \text{PH-MD} + \text{Fireflow} + \text{Emergency Storage} \quad (4)$$

Where:

Peak Hour = Max Day *1.7

Max Day = Average Day (Sold) *2.0 + Lost

Fireflow (10-hour duration) = $(1.47(P)^{0.5}[1-0.01(P)^{0.5}])$, where P is in 1,000s of people

Emergency Storage = Max Day*10 percent

TABLE 4-2
Projected Storage Requirements
Town of Cave Creek Water System Master Plan

Storage Requirements	DHWC (million gallons)	DHWC (million gallons) [County Requirement]	CCWC (million gallons)	CCWC (million gallons) [County Requirement]
Existing		1.01		0.71
2010	2.5	1.2	3.5	1.8
2020	3.1	1.6	4.4	2.3
2030	3.7	2.0	5.3	3.0

This approach for calculating storage requirements is more conservative than Maricopa County's requirement (both with and without the Emergency storage volume) of adequate storage to meet the average day of the maximum month. The County's method would project a little more than half of the storage volume presented in Table 4-2 above and is included for reference. The County requirement was calculated by developing seasonal water use curves to determine the multiplier of average day usage to maximum month. The seasonal water use curves for DHWC and CCWC are included in Appendix B. DHWC currently meets the County's storage requirement, but will need to construct additional storage facilities to meet the requirement in the future.

CH2M HILL used a more conservative approach for the CCWC storage assessment due to the large elevation changes across the system (resulting in multiple pressure zones) and the infeasibility of being able to construct storage facilities in every pressure zone. On the contrary, the DHWC has fewer pressure zones with less elevation change across the system, allowing several storage facilities to be constructed in its major pressure zone.

Based on current storage capacities, both systems are well short of meeting the projected storage requirements. The Town has several sites planned for the construction of future storage facilities. These include additional storage near the WTP, a site in Carefree, Cahava Springs, and in the Spur Cross Ranch area. DHWC will need to develop additional storage facilities to meet its needs, and the Town may consider adding conditions for developers to participate in these facilities as part of development agreements.

Tank Site

More info to be added regarding capacity and location of future facilities based modeling results...

4.4 Capital Improvement Program

Need to fully flesh out CIPs and get cost information from estimators...

ID	Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material
Desert Hills						
2008 Improvements						
Cielo Grande Pipes						
3061	DHP-1413	654	3052: DHJ-905	3055: DHJ-906	8	Ductile Iron
3064	DHP-1415	1,020	3055: DHJ-906	3060: DHJ-911	8	Ductile Iron
3065	DHP-1416	838	3056: DHJ-907	3057: DHJ-908	8	Ductile Iron
3066	DHP-1417	886	3058: DHJ-909	3059: DHJ-910	8	Ductile Iron
3067	DHP-1418	1,545	3055: DHJ-906	3058: DHJ-909	8	Ductile Iron
3068	DHP-1419	747	3058: DHJ-909	3056: DHJ-907	8	Ductile Iron
3069	DHP-1420	423	3056: DHJ-907	2277: DHJ-548	8	Ductile Iron
3054	DHP-1412	844	3052: DHJ-905	1979: DHJ-400	6	Ductile Iron
3072	DHP-1422	1,335	3070: DHJ-913	3052: DHJ-905	6	Ductile Iron
Permanent Anthem Connection						
2902	DHP-1232	2,266	2430: DHANTHEM	2326: DHJ-1219	8	Ductile Iron
3071	DHP-1421	1,973	2326: DHJ-1219	3070: DHJ-913	8	Ductile Iron
3074	DHP-1423	4,721	3070: DHJ-913	3073: DHJ-914	8	Ductile Iron
3075	DHP-1424	1,116	3073: DHJ-914	2437: DHT-5	8	Ductile Iron
2010 Improvements						
Incorporate customers NE of Desert Hills Dr/Central into 7th St Booster Zone						
DHP-1237 New pipe	close pipe					
3153	DHP-1461	700	3150: DHJ-932	1955: DHJ-130	8	Ductile Iron
Las Campanas Dev						
3100	DHP-1435	443	2327: DHJ-461	3099: DHJ-921	8	Ductile Iron
3101	DHP-1436	838	3099: DHJ-921	2343: DHJ-555	8	Ductile Iron
3102	DHP-1437	611	2037: DHJ-581	3098: DHJ-920	8	Ductile Iron
3103	DHP-1438	727	3098: DHJ-920	3099: DHJ-921	8	Ductile Iron
Desert Hills Ranch Dev						
3090	DHP-1427	1,222	2284: DHJ-610	3085: DHJ-915	8	Ductile Iron
3091	DHP-1428	1,312	3085: DHJ-915	3086: DHJ-916	8	Ductile Iron

ID	Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material
3092	DHP-1429	1,154	3086: DHJ-916	3088: DHJ-918	8	Ductile Iron
3093	DHP-1430	1,494	3088: DHJ-918	3089: DHJ-919	8	Ductile Iron
3094	DHP-1431	1,218	3089: DHJ-919	2027: DHJ-566	8	Ductile Iron
3095	DHP-1432	1,161	3085: DHJ-915	2005: DHJ-570	8	Ductile Iron
3096	DHP-1433	685	2005: DHJ-570	3087: DHJ-917	8	Ductile Iron
3097	DHP-1434	620	3087: DHJ-917	3088: DHJ-918	8	Ductile Iron
Apache Peak III Dev						
3110	DHP-1441	487	2245: DHJ-551	3105: DHJ-923	8	Ductile Iron
3111	DHP-1442	705	3105: DHJ-923	3104: DHJ-922	8	Ductile Iron
3112	DHP-1443	559	3105: DHJ-923	3106: DHJ-924	8	Ductile Iron
3113	DHP-1444	720	3106: DHJ-924	3107: DHJ-925	8	Ductile Iron
Cloud Rd Booster Zone Piping						
3134	DHP-1453	1,303	1957: DHJ-132	3133: DHJ-929	8	Ductile Iron
3135	DHP-1454	786	3133: DHJ-929	2093: DHJ-334	8	Ductile Iron
3137	DHP-1455	1,930	2086: DHJ-333	3136: DHJ-930	8	Ductile Iron
3139	DHP-1456	1,295	3136: DHJ-930	3138: DHJ-931	8	Ductile Iron
3140	DHP-1457	472	3138: DHJ-931	2406: DHJ-411	8	Ductile Iron
Looping W/O Central Ave						
3123	DHP-1445	1,682	2014: DHJ-594	3122: DHJ-926	8	Ductile Iron
3125	DHP-1446	941	3122: DHJ-926	3124: DHJ-927	8	Ductile Iron
3126	DHP-1447	1,199	3124: DHJ-927	2028: DHJ-567	8	Ductile Iron
Looping S/O Carefree Hwy						
3132	DHP-1452	776	2319: DHJ-343	2015: DHJ-593	8	Ductile Iron

2030 Improvements

Add'l elevated storage tank (750k) and associated piping to connect to 10th St Office tank

New tank and boosters for new pressure zone

Distribution piping

New well, storage, booster on west side of Central Zone

Well 10" casing, 1000 ft deep, 450 gpm

Cave Creek

2008 Improvements

New 8 inch to replace old pipe on Carefree Hwy

1900	P-1407	1,182	744: J-745	742: J-743	8	Ductile Iron

ID	Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material
Create new Pressure Zone						
PRV-14	75 psi	on old new river e/o 36th St				
PRV-17	75 psi	on Carefree Hwy				
new pipe to replace old pipe on Cave Creek rd						
1849	P-1345	444	857: J-829	858: J-832	8	Ductile Iron
1850	P-1346	1,452	833: J-865	886: J-892	8	Ductile Iron
increase WTP capacity from 3 mgd to 4 mgd (Trident treatment unit)						
no model data for this line item						
2010 Improvements						
PRV-15	on Cloud Rd w/o 32 St to reduce pressure in that area					
PRV-16	on Spur Cross/Yucca for redundant connection betw Zones 4 & 7					
piping on Cahava Ranch/Morning Star						
piping in Zone 8						
Spur Cross tank(s)						
38th St booster						
32nd St booster						
2030 Improvements						
Cahava Springs Tank, piping, booster						
new PZ on north side w/booster						
Add'l piping s/o Cahava Springs Tank						
New raw water transmission, boosters						

Spur Cross Tank

SECTION 5

Conclusion

Summary comments will be included herein when final modeling results with concurrence from the Town and cost information is available...

Appendix A

TABLE A-1
Elevation Revisions in CCWC Model

Junction	Initial Elevation	Revised Elevation GIS Contour
J-872	2099.41	2105.41
J-731	2098.62	2100.62
J-134	2099.41	2101.41
J-762	2118.77	2125.77
J-139	2119.42	2125.42
J-313	2129.72	2149.72
J-312	2137.17	2141.17
J-630	2139.73	2142.73
J-626	2179.76	2180.76
J-604	2179.46	2180.46
J-93	2206.17	2196.17
J-889	2178.84	2180.84
J-129	2178.84	2180.84
J-868	2149.84	2160.84
J-844	2158.79	2165.79
J-825	2181.36	2179.36
J-165	2158.63	2161.63
J-172	2165.32	2155.32
J-806	2164.11	2154.11
J-690	2179.23	2185.23
J-276	2179.13	2181.13
J-605	2219.36	2226.36
J-830	2194.95	2204.95
J-867	2178.74	2188.74
J-316	2158.89	2163.89
J-867	2188.74	2208.74
J-870	2198.23	2218.23
J-270	2199.9	2209.9
J291	2179	2183
J-24	2218.96	2221.96
J-27	2219.16	2221.16
J-78	2258.79	2261.79
J-881	2238.85	2240.85
J-92	2260.79	2259.79
J-91	2238.85	2240.85
J-838	2238.85	2240.85
J-854	2296.92	2279.92
J-854	2296.92	2279.92
J-649	2279.17	2281.17
J-618	2279.3	2291.3

TABLE A-1
Elevation Revisions in CCWC Model

Junction	Initial Elevation	Revised Elevation GIS Contour
J-81	2279.23	2291.23
J-88	2299.41	2310.41
J-617	2299.28	2301.28
J-20	2299.54	2301.54
J-8	2366.31	2356.31
J-8	2366.31	2356.31
J-749	24418	2419.8
J-4	2423	2419.23
J-322	1937.99	1953
J-771	1918.73	1920.73
J-338	1919.49	1921.49
J-770	1919.88	1921.88
J-775	1918.5	1923.5
J-349	1939.96	1940.96
J-346	1939.96	1940.96
J-340	1939.34	1940.34
J-768	1939.73	
J-335	1939.57	1940.57
J-334	1939.96	
J-331	1939.44	1940.44
J-328	1959.38	1960.38
J-418	2020.7	2000.7
J-420	2048.39	2038.39
J-419	2043.96	2033.96
J-557	1999.7	2000.7
J-859	2038.81	2040.81
J-458	2019.98	2035.98
J-457	2024.51	2019.51
J-461	2038.85	2040.85
J-794	2099.8	2103.8
J-576	2099.8	2103.8
J-583	2119.98	2128.98
J-795	2139.76	2140.76
J-700	2118.34	2128.34
J-150	2118.34	2128.34
J-820	2118.34	2128.34
J-151	2118.57	2123.57
J-597	2142.03	2132.03
J-593	2079.3	2081.3
J-588	2099.31	2100.31

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FIGURE B-1
DHWC Seasonal Water Use Curve
Town of Cave Creek Water System Master Plan

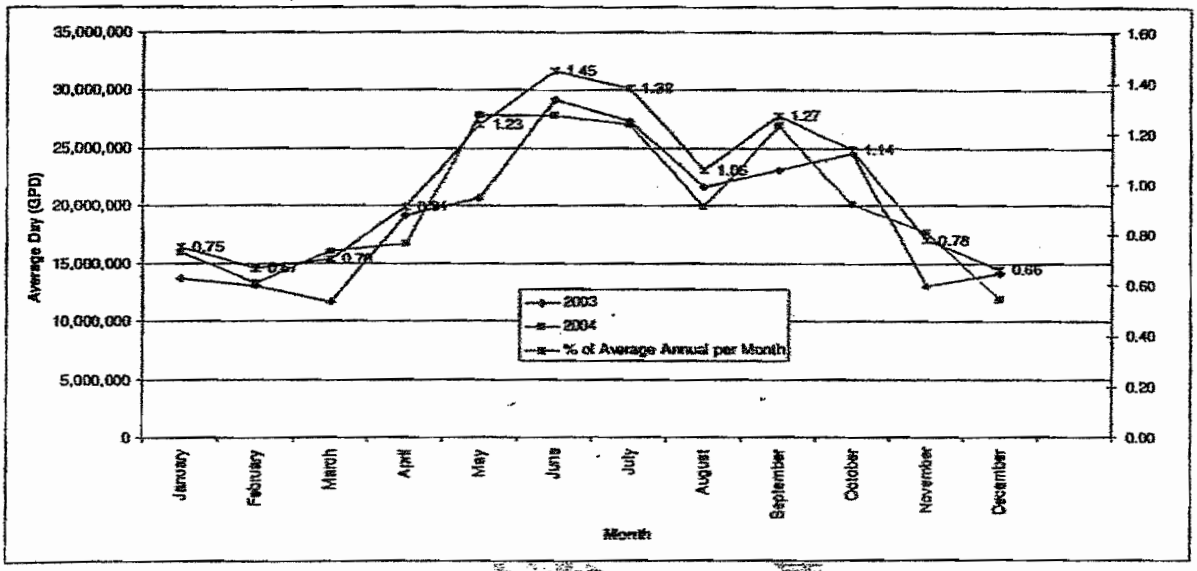

FIGURE B-2
CCWC Seasonal Water Use Curve
Town of Cave Creek Water System Master Plan