County Service Area 10A
Cayucos, California

Water System Master Plan
2003

County of San Luis Obispo
Public Works Department
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Executive Summary

The County of San Luis Obispo has prepared this Water System Master Plan for CSA 10A in Cayucos, California, in order to more effectively plan for capital improvement projects. The existing system analyzed under current and future demands against design criteria reveals deficiencies in the effectiveness of the system to meet the needs of the community it services.

Distribution system data was gathered from available maps, operators, and historical documents. Water usage data was also gathered from a variety of sources (the County Service Area 10 Water Treatment Facility, meter readings, planning documents, operators) in order to calculate water duty factors for normal demands, and peaking factors for maximum day demand and peak hour demand. Zoning and property data was gathered from planning documents, and County and Fire Department records in order to approximate how CSA 10A will look at build-out.

After gathering data and conducting fire-flow tests, EPANET, a water distribution system simulator, was employed to create a calibrated computer model of the CSA-10A system. This model was run under peak hour demands, maximum day demand plus commercial fire-flow demand, and maximum day demand plus residential fire-flow demand in order to reveal deficiencies in relation to piping design criteria. The EPANET present and build-out distribution system models created and utilized in this master plan are saved on an attached disk.

The existing system serves 708 residential meters with an average use of 80 gpd and 4 commercial meters with an average use of 667 gpd (although one meter is for the fire department and its use (21 gpd) was not averaged in). The network is unable to meet fire flow demands in several areas due to undersized lines and lack of available storage. There is also only one source of supply for CSA 10A: Whale Rock Reservoir.

Plans to replace the Cemetery water line with an 8-inch pipe and preliminary work to install a new storage tank were already in progress and budgeted for, respectively, during the creation of this master plan and the plan does provide additional support of the need for these projects. The estimated construction costs for these two projects are $110,500 and $278,400. Since there is currently only one route for flow from the storage tank, it is recommended to loop the waterline on Hacienda to provide an alternate route to and from the storage tank, at an estimated construction cost of $49,000. Additional capital projects recommended in this plan are to replace undersized water lines on Shearer, Gilbert, Richard and Stuart, and Chaney with 8-inch or 6-inch pipes with preliminary construction cost estimates of $650,000, $190,000, $195,000 and $145,000, respectively. These replacements will improve flow and aid in providing required fire flow protection. Looping the pipeline on Cerro Gordo, estimated at $62,000, would provide an alternate route for flow and increase circulation by eliminating a dead-ended pipe. All of the estimated costs are for construction only, and are in current dollars.

It is assumed that a part 6-inch and a part 8-inch line will extend on Gilbert from the dead end at the south end of Gilbert to the storage tank, and that an 8-inch line will extend to the end of Chaney at CSA 10A build-out. The build-out system will service 941 residential meters and 8 commercial meters. Three problems will still remain after the recommended improvements are made – adequate fire flow protection at the top of Chaney and Gilbert, inability to serve water at the top of Chaney and a need for a second source of water supply. Homes built at the top of Chaney and Gilbert will be in a different pressure zone, and given the high costs of changing the system to accommodate two pressure zones, it is recommended that these homes be equipped with sprinkler systems and/or pressure pumps. Consultants are currently working on a Supplemental Water Plan that would use water from Lake Nacimiento to supply a number of communities, including Cayucos.

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1.0 Introduction

1.1 Overview

The Cayucos Area Water Organization (CAWO) is comprised of 4 districts: the Paso Robles Beach Water Association (PRBWA), the Morro Rock Mutual Water Company (MRM), County Service Area 10A (CSA10A), and the Cayucos Cemetery District. CSA10A services 708 residential meters and 4 commercial meters[1]. The service area for CSA10A is shown in Figure 1.

The CAWO receives its water supply directly from Whale Rock Reservoir and is treated by the Cayucos Water Treatment Facility. Six wells are also available for raw water supply to the treatment facility: the CAWO well, Cayucos wells #2 and #3, Paso Robles well #1 and Morro Rock wells #1 and #3. All but the CAWO Well are normally off-line. The treated water passes through separate metered pipes before entering the distribution systems in order to distinguish use by the different districts. The allocation for CSA10A is 190 acre-feet per year (AFY) per the 1958 Whale Rock Agreement (amended 1996).

The County is facing some critical decisions involving the upgrade of key water system components. Deciding whether to expend capital improvement funds for system upgrades is difficult without an overall system master plan. Thus, the County has authorized its Public Works Department to create this CSA10A Water System Master Plan.

As part of this master plan, a hydraulic computer model of CSA10A's water system was developed to aid in identifying existing and future improvements. The existing system and build out system models are saved on an attached disk.

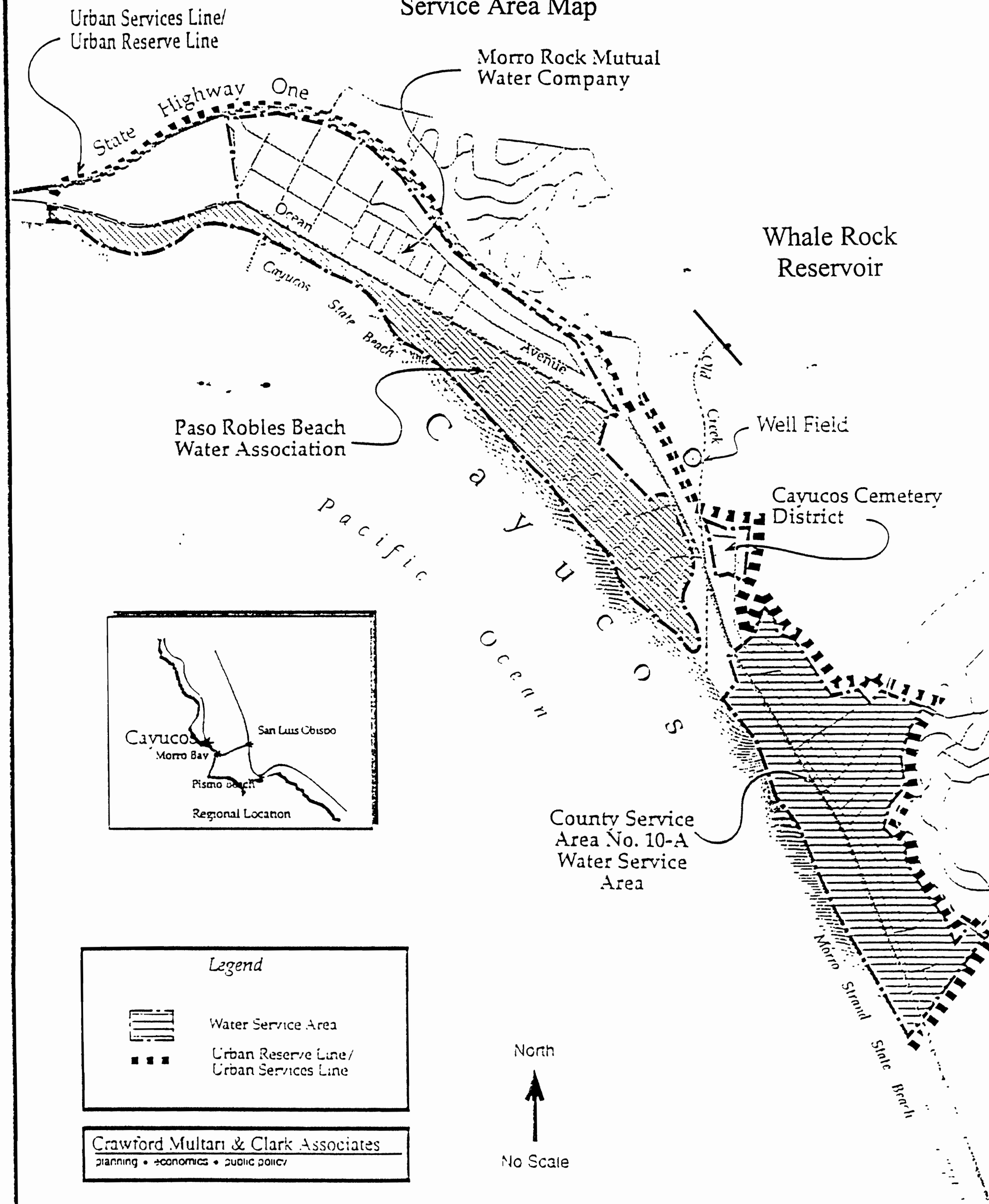
1.2 Goals and Tasks

The goals of this study are to identify improvements to the water distribution system required to meet existing and projected demands, and to develop a water facilities improvement program to aid the County in conducting long-term planning for CSA10A. Specific tasks that were undertaken to accomplish this include:

a. Data Collection and Review

Data was collected which included water consumption records, water production records, land use and operations plans, and supply, distribution and storage characteristics (see references).

Figure 1
Cayucos Area Water Organization
Service Area Map



b. Demand Estimates

Existing land use information available on the County's Property Data Management System[2] was used to determine lot zoning and occupancy status.

Water duty factors for residential and nonresidential land uses were developed using historic water production and consumption data[3]. Peaking factors were determined for maximum day demand and peak hour demand from actual maximum day demand records[3] and applicable literature[4], respectively. Fire flow requirements were established by consulting Cayucos Fire Chief Bill Radke.

The Urban Services Line for CSA10A defines the limit of water service at build-out. Future average day, maximum day and peak hour demands could be determined after adding the amount of additional water customers at build-out.

c. Existing System Operations

Appropriate County employees and the Water Treatment Plant Operations Plan[5] were consulted to acquire an understanding of CSA10A water system operations.

d. Computer Modeling and Hydrant Testing

A computer model was developed to simulate water system performance under both existing and future demands using EPANET. The model was calibrated using results of fire hydrant flow tests performed by County staff.

e. System Deficiencies and Future Needs

A hydraulic analysis was performed to analyze both existing and projected demands. Upgrades were recommended where deficiencies were found. Recommendations for existing and future water supply, storage, back-up power and emergency needs were also made.

f. Recommended Upgrades/Opinion of Probable Cost

The cost and priority of recommended improvements to meet existing and projected water demands were established.

2.0 Existing System

2.1 Overview

A schematic of the CAWO water system is shown in Figure 2. Raw water from the Whale Rock Reservoir and usually the CAWO well is delivered to the water treatment facility and the final product water is stored in the clearwell. The water is then distributed to the CSA10A storage tank through one of two pumps. The distribution system is gravity fed from the tank, which is at an elevation of 225 feet.

Cayucos is a small coastal community, with older homes down near the coastline and newer homes making their way up the hills to the east where the storage tank sits. As more homes are built further up the hill, more water lines are extended and dead-ended. Additional dead-ends are located near the storage tank off of Hacienda Drive. The water system is shown in Figure 3. Looping these dead-ends into the system will improve circulation, increase flow capability, increase reliability and decrease unnecessarily high pressures.

2.2 Supply

Water Source:
Whale Rock Reservoir, located just northeast of the treatment facility, supplies raw surface water, and six groundwater wells are available for supplemental use during emergencies if the groundwater table is high enough to reach the well pump. Only raw water from the reservoir and sometimes the CAWO Well are used during normal operations. Figure 4 shows the piping at the treatment facility.

Raw water from the reservoir passes through two basket strainers and flows via a 10-inch line into the treatment facility. A pressure-reducing valve keeps the raw water entering at a constant pressure of about 15 psi. After the water is treated, it flows through meters and pipes respective to the purveyors in order to compare with allowable allocation as shown in Table 2.1.

Table 2.1 Whale Rock Reservoir Allocation to CAWO Members

CAWO Members	Allocation (AFY)
PRBWA	222
MRM	170
CSA 10A	190
Cemetery	18
Total	600

The groundwater wells and their characteristics are shown in Table 2.2. Prior to completion and start-up of the treatment facility, these wells pumped directly into their respective distribution systems. More stringent water quality regulations led

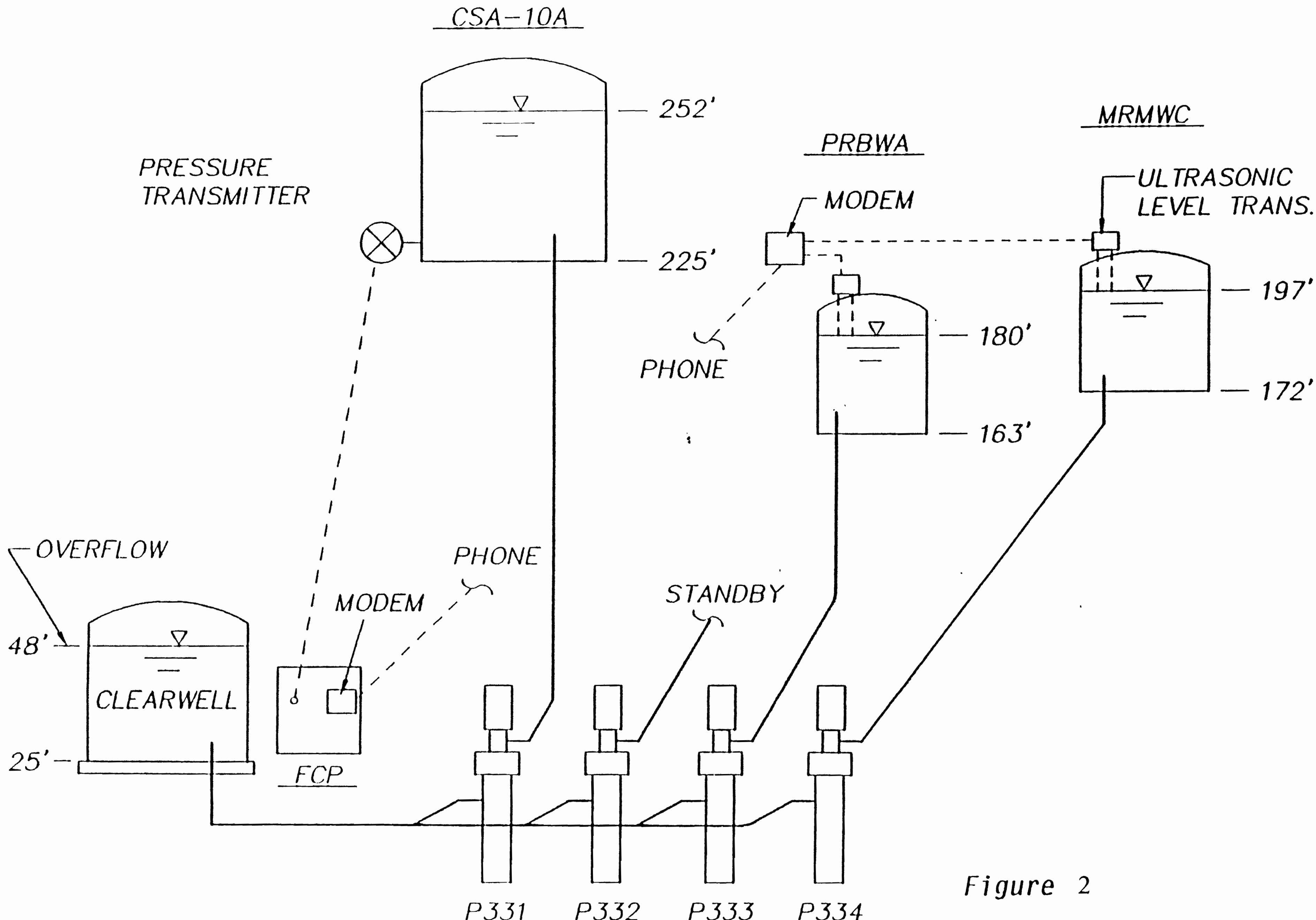


Figure 2

DISTRIBUTION SYSTEM
PUMPING AND STORAGE SCHEMATIC
CAYUCOS WATER TREATMENT PLANT

SPH associates

to the need for a treatment facility. The pumping capacity represents the amount of water that the well is able to produce if the groundwater table is high enough. Additional information on the wells and their capabilities is in Appendix A.

Table 2.2 Groundwater Well Characteristics

Well Name	Pumping Capacity* (GPM)	Pump Information
CAWO Well	140	Sta Rite, 15 Hp submersible motor
Cayucos Well #2	75	General Electric, 10 Hp vertical motor, turbine pump
Cayucos Well #3	140	Franklin Electric, 15 Hp submersible motor, Grundfos submersible pump
Paso Robles #1	150	7 ½ Hp
Morro Rock #1	100	7 ½ Hp
Morro Rock #3	170	15 Hp

* Provided there are sufficient levels in the groundwater basin.

High Service Pumps:

Two high-service pumps, one for active use and one for standby, are used to pump water into the CSA10A distribution system and storage tank. The general characteristics of these two pumps are shown in Table 2.3. The pumps are controlled based on the water level in the storage tank. There is also a pump speed control loop in order to ensure that the minimum detention time is available within the onsite clearwell.

Table 2.3 Characteristics of CSA10A High Service Pumps

Pump Name	Design Pumping Head*	Design Pumping Capacity	Pump Speed	Speed Control	Pump Make	Horsepower
P331	348 ft	400 gpm	1750 rpm	Variable Frequency Drive	Johnston 7 stage	46 Hp
P332	348 ft	400 gpm	1750 rpm	Variable Frequency Drive	Floway 7 stage	50 Hp

*Static lift is 210 feet. Reconsider pump design point when replacing in the future.

Clearwell Tank:

The clearwell tank, located at the treatment facility, stores the water for disinfection contact time before distribution to CSA10A. The clearwell sits at an elevation of 25 feet with an overflow at 48 feet and a capacity of 250,000 gallons. Erected in 1996 during the construction of the treatment facility, the clearwell is a welded steel tank with a 14-inch overflow, 10-inch inlet and a 12-inch outlet. The tank is still fairly new, exhibiting only spots of corrosion at the time of its inspection on January 4, 2001.

2.3 Distribution and Transmission Pipelines

Water is transmitted to CSA10A from the 12-inch ductile iron clearwell outlet pipeline to either pump P331 or P332, whichever is online, and out the 8-inch to 4-inch to 8-inch asbestos-cement (AC) pipeline to the distribution system. As Figure 3 shows, most of the distribution pipelines are 6-inch AC. Sections on Santa Barbara Street, Oroville Street, Cerro Gordo Street, and Chaney Avenue are 6-inch polyvinyl chloride (PVC). Sections on Shearer Avenue, Chaney Avenue, Gilbert Avenue, Stuart Court, and Richard Avenue are 4-inch AC pipe.

The 8-inch AC inlet/outlet of the storage tank splits into a dead-ending 6-inch AC pipeline and an 8-inch AC pipeline that connects to the main distribution system on Hacienda Drive. Pipelines also dead-end at the end of Stuart Court, at the south end of Studio Drive, on Cerro Gordo Street, Hacienda Drive, Gilbert Avenue and Chaney Avenue. Most of the dead-ends are due to the end of development on that particular street.

The pipelines were originally installed in the early 1970s and consisted of the 6- and 4-inch AC pipelines. Newer pipeline installations are made of PVC, as exemplified by the Santa Barbara and Oroville 1998 pipeline replacements and Cerro Gordo Street and Chaney Avenue extensions.

2.4 Storage

The 210,000-gallon storage tank, at an elevation of 225 feet and with an overflow at 253 feet, is located at the top end of Hacienda Drive and provides gravity flow to the CSA10A distribution system. Erected in 1953 and moved to its present location in 1971, the storage tank is welded steel with a 6-inch overflow, and an 8-inch common inlet and outlet. This tank was also inspected on January 4, 2001 and the company made many recommendations for repair, such as new interior and exterior coatings, and safety rails and ladders.

3.0 Existing and Projected Water Demands

3.1 Historic Demand

Historic water production and service meter data from 1997 to 2001 for CSA10A was obtained from County meter records[1], the Water Treatment Facility[3], and Water Management Plan Updates prepared by Boyle Engineering every year[6]. From this data, the historic average per meter water use was estimated as shown in Table 3.1. The gross per meter use (including both residential and non-residential consumption) ranged from 0.17 AFY per meter to 0.19 AFY per meter.

Table 3.1 Historic Water Use

	1997	1998	1999	2000	2001	Avg
# of Residential Meters	683	689	689	706	708	
# of Commercial Meters	4	5	6	6	4	
# of Meters	687	694	695	712	712	
CSA10A Production (AFY)	118.37	128.41	133.88	130.98	128.66	128
Gross AFY per meter	0.17	0.185	0.19	0.18	0.18	0.18

3.2 Existing Demand used for Planning

Commercial Consumption:

The four commercial meters in 2001 were identified and their consumption for the year was 2.34 acre-feet, which is 1.81% of the total production. This percentage was used to estimate the commercial meter consumption for prior years since historical usage data was not available. Calculations are shown in Appendix B and the results are summarized in Table 3.2 below.

Residential Consumption:

Residential consumption was determined after subtracting the estimated commercial consumption from the overall production records as shown in Table 3.2. Production records, rather than consumption records, are used in order to calculate a conservative estimate of historical water use.

Table 3.2 Residential Consumption Determination

	1997	1998	1999	2000	2001
# of Residential Meters	683	689	689	706	708
Production (AFY)	118.37	128.41	133.88	130.98	128.66
Commercial Consumption Estimate (AFY)	2.14	2.30	2.41	2.36	2.34
Residential Consumption (AFY)	116.23	126.11	131.47	128.62	126.32
Residential Consumption (AFY per meter)	0.17	0.18	0.19	0.18	0.18

Water Duty Factor Determination:
In order to create a computer model of the existing system, water duty factors for each "node" (the place where multiple pipes meet or the place of central demand) in the system need to be established. Most of the nodes in the CSA10A system are for residential water duty factors. Some nodes require the addition of multi-family residential and commercial water duty factors to the demand in that area. Since there are relatively few meters that are multi-family residential and commercial, time was taken to locate them throughout the CSA 10A system. Water duty factors are summarized in Table 3.3.

Table 3.3 Water Duty Factors

Category	Water Duty Factor
Residential	100 gpd/meter
Multi-Family Residential	80 gpd/unit
Commercial	667 gpd/meter

The calculated average residential usage per meter, 80 gpd/meter (after converting the average residential usage of 0.18 AFY to gpd), is lower than the average residential demand factor of 92 gpd/meter published in a Holding Capacity Analysis of the CAWO. In this document, a 10% factor was added to the calculated demand values for a San Luis Obispo County Board of Supervisors-required "planning cushion"[7]. In order to create a conservative model for the future (i.e. increasing occupancy rates) and to more closely approximate the published data, the calculated water duty factor for residential areas was increased 25% to 100 gpd/meter.

The published demand factor for multi-family residential meters is 68 gpd/unit. Again, to create a conservative model for the future, the calculated average residential usage per meter (80 gpd/meter) was used as the water duty factor for multi-family residential demand on a per unit basis.

Average 2001 consumption information was used to estimate commercial water duty factors as shown in Appendix B.

3.3 Build-Out Demand

The County Estero Area Plan[8] and vacant lot information from County[2] and Fire Department records[9] were used to evaluate build-out demand for CSA 10A by locating empty lots and determining their zoning. The Estero Area Plan also delineates an Urban Services Line (USL) that was used to define the build-out area for projecting demand in CSA 10A. Vacant lots within the USL were identified and assigned Table 3.3 water duty factors based on their zoning in order to complete a computer model of the water system for build-out demand. The maximum number of units allowed in a multi-family residential area was used for calculating demand at that lot. The average of the commercial readings from 2001 was used for demand at empty commercial lots, assuming businesses similar to existing businesses will occupy the lots.

There are currently 224 vacant lots zoned residential, 1 vacant lot zoned multi-family residential (5 units maximum), and 4 vacant lots zoned commercial within the USL. Many of the lots are vacant due to unstable slopes and the limited total number of water will-serves being issued.

3.4 Fire Flow Requirements

The Uniform Fire Code establishes minimum fire hydrant flow criteria for particular buildings or zones. Cayucos Fire Chief Bill Radke recommended the fire flow requirements at a residual pressure of 20 psi for the types of developments in CSA 10A as shown in Table 3.4. The recommended fire hydrant spacing for Cayucos is 500 feet.

Table 3.4 Fire Flow Requirements

Type of Development	Fire Flow (gpm)	Duration (hrs)
All Residential	1,000	2
Commercial – Small Retail	2,000	2

3.5 Peaking Factors

In order for the water system to accommodate maximum demands, peaking factors need to be applied to the average daily demands developed in preceding sections. The maximum use of 170,000 gallons for July 4th, 2001 was used to determine the daily peaking factor. The CSA 10A distribution should be able to supply the maximum day demand plus fire flow requirements.

Minimum pressures within the system under normal operating conditions are estimated by using a peak hour demand. Since peak hour demand information was not available, the manual entitled "Distribution Network Analysis for Water Utilities" by the American Water Works Association[4] was consulted. The manual suggests that typical peak hour demands range from 1.3 to 2.0 times the maximum day demand. Since Cayucos is a coastal community experiencing mild summer days, a peak hour demand of 1.6 times the maximum day demand was used to estimate peak hour demands.

Calculations of the daily peaking factor and peak hour demand are shown in Appendix C and the results are summarized in Table 3.5. Using historical data, rather than the water duty factors listed above, to calculate the daily peaking factor produces a more conservative result.

Calculations of the peak hour demand and maximum day demand for CSA 10-A build-out are also shown in Appendix C and the results are included in Table 3.5.

Table 3.5 Peaking Considerations

	Average Day Demand (gal/day)	**Maximum Day Demand** (gal/day)	**Daily Peaking Factor**	**Peak Hour Peaking Factor**	**Peak Hour Demand** (gal/hr)
Current	58,000	170,000	3	1.6	11,500
Build-Out	91,815	275,445	3	1.6	18,363

4.0 Computer Model

4.1 Model Development

A computer model of the CSA10A water distribution system was created in order to help analyze the water system's capabilities and needs.

The EPA-developed computer software, EPANET, was used to model the water system. EPANET uses the Hazen-Williams formula as the basis for calculating head loss. The model consists of one reservoir (the clearwell tank at the treatment facility was modeled to provide unlimited water), one storage tank, one high-service pump, 97 pipes, and 79 nodes. Table 4.1 outlines what required information was input into the model for the system components.

Table 4.1 System Input

Tanks	Name, Elevation, Initial Level, Minimum Level, Maximum Level, Diameter
Pump	Name, Pump Curve
Pipes	Name, Length, Diameter, Hazen-Williams C-Factor
Nodes	Name, Elevation, Base Demand

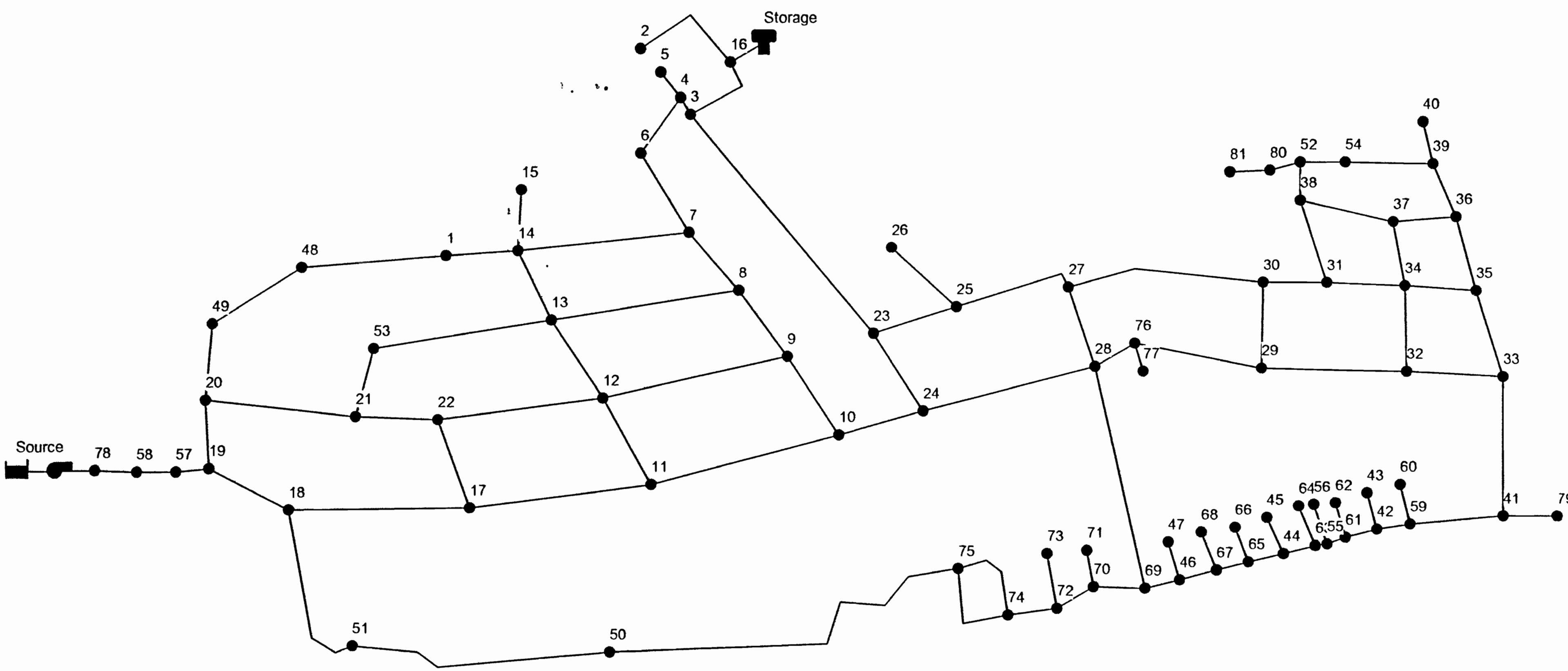
A skeletal diagram of the distribution system was created as the model using available maps and operator input while a consolidated, electronic map of the system was created for this report. Operators were asked to provide the operational characteristics for the tanks and pumps. Pipe names were assigned based on the street names, diameters were obtained from maps and operators, and lengths were scaled off of available maps. The C-factors were determined from pipe material and installation date, and are 120 for AC pipes and 140 for PVC pipes. Nodal elevations were estimated using available topographic maps. An example calculation for the base demand at a node is in Appendix D. Figure 5 shows the plot of node numbers and piping used for the EPANET Model.

4.2 Model Calibration

Fire-flow tests were performed on three hydrants throughout CSA10A in order to use actual field conditions to calibrate the model. First, static pressure, taken at a residual hydrant, and other conditions, such as weather, tank levels and pump status, are noted on a Fire-Flow Test Form. Pressure is taken at a residual hydrant while a flow hydrant is completely opened. Simultaneously, pressure is measured with a pitot-tube at the midpoint of the discharge at the flow hydrant. The pitot-tube pressure and the hydrant's outlet characteristics are used to calculate the observed flow.

The model analysis was run using average base demand conditions. The resulting model-calculated pressures at the residual hydrant-node locations were compared to field-measured static pressures. The pipe and nodal characteristics of the model, such as the Hazen-Williams C-factor, the elevation or the base demand, were adjusted until the model-calculated static pressures matched the field-

Figure 5: Existing CSA-10A Water System Computer Model



measured static pressures. Next, the observed flow was set as the base demand at the flow hydrant-node, and the model analysis was run, once for each observed flow condition at each flow hydrant-node. The residual pressure calculated by the model at the residual hydrant-node was compared to the field-measured residual pressure. The model is considered calibrated if the model-calculated static pressure is within 5 psi of the field-measured static pressure, and if the model-calculated residual pressure is within 7 psi of the field-measured residual pressure.

4.3 Calibration Results

The three fire hydrants tested were located on Studio, Santa Barbara and Adoree. The test on Adoree yielded unrealistic results, possibly due to an inaccurate pitot pressure reading, so the test results from a test performed in 1999 were used. Table 4.2 summarizes the field-measured results and the computer model-calculated results.

Table 4.2 Field-Measured and Calculated Results

Location	Adoree	Santa Barbara	Studio
Static Pressure (psi)	50	77	93
Model Static Pressure (psi)	54	76	98
Residual Pressure (psi)	30	65	76
Model Residual Pressure (psi)	23	63	74
Observed Flow (gpm)	856	1061	1300

4.4 Build-Out Model

After calibrating the model, a build-out model was created for running simulations under future demands. A half 6-inch and half 8-inch water line was extended along Gilbert to the storage tank, an 8-inch water line was extended to the top of Chaney, and an 8-inch water line was extended along Cerro Gordo to Hacienda, as an assumption of future development inside the USL. Appropriate base demands were assigned to lots according to their zoning.

5.0 Design Criteria

The criteria used to evaluate the ability of the CSA 10A water distribution system to meet build-out demands are outlined below, and are referenced from (4).

5.1 Supply System

The source of supply should adequately meet customer needs. The high service pumps should be sized to provide maximum-day demand with the largest source of supply out of service. The system should also be able to replenish fire storage over 72 hours during maximum day demand conditions.

5.2 Piping System

Pipe segments are considered deficient, or limiting, if the following conditions exist during any demand condition:

- Velocities greater than 5 feet per second (fps)
- Head losses greater than 10 feet per 1000 feet (ft/Kft)

A velocity of 10 feet per second is acceptable only if the head loss criteria are met. Pipelines displaying these conditions usually prevent the system from providing adequate flow and/or pressure, and may be improved by appropriate pipe sizing or routing.

Section 64566 of Title 22 of the California Code of Regulations[10] requires that any changes to the water system should result in an operating pressure of 20 psi under peak hour demand and average day demand plus fire-flow demand conditions. Pressure is considered unacceptable if it falls below 30 psi for peak hour demands, and below 20 psi for maximum day demand plus fire flow demand. Negative pressures indicate that the system is unable to provide the needed flow to meet demand at that location.

5.3 Storage System

The most limiting demand condition for system storage is maximum day demand plus fire flow demand. The tank needs to meet three volume requirements: equalization storage, emergency storage, and fire storage.

Equalization Storage: This storage is required to meet water system demands in excess of what supply can provide during peak demand conditions. The equalization storage volume can be estimated by assuming that demand in excess of rate of supply occurs for 14 hours during the day, and therefore equals:

(Peak Hour Demand – Rate of Supply)*14 hrs

Emergency Storage: This is a volume of water to be available to sustain sanitary needs in the event that an emergency cuts off the normal water supply. The amount of time to restore the normal water supply was estimated at 72 hours, and the basic sanitary demand per capita was estimated to be 50 gallons per day.

Fire Storage: This storage is required to meet the highest fire-flow demand in the CSA10A water system, which is for commercial fire protection: 2000 gallons per minute for 2 hours.

6.0 Ability of Existing System to Meet Existing Demands

The model was run under existing conditions for peak hour demand, maximum day demand plus commercial fire flow demand, and maximum day demand plus residential fire flow demand at three locations. The results from the model runs were compared with the design criteria for the supply, piping, and storage systems. Current system deficiencies were identified in order to help prioritize capital improvement projects.

6.1 Supply System

The average yearly usage in CSA 10A was 128 acre-feet from 1997 to 2001, leaving an average 62 acre-feet per year in its 190 acre-feet allocation for outstanding requests for water service and unanticipated deviations from the average.

The Whale Rock Reservoir is currently the only reliable source of supply water to the treatment plant. The groundwater well supply is dependent upon the levels in the groundwater basin. Assuming supply from the Reservoir was unavailable through the conveyance piping, Reservoir water was released to the creek, the wells were able to supply the maximum amount of water according to Table 2.2, and the maximum day demand required by all of the CAWO districts was 373 gpm[3], the groundwater wells would produce enough flow to meet demands (775 gpm). However, if Whale Rock Reservoir water was unavailable due to drought or unreliability, Cayucos would have no alternative source of water.

The high-service pumps are adequate for current maximum day demand since their design flow is 400 gpm and maximum day demand is 118 gpm. If there were a fire in a commercial zone, 240,000 gallons would theoretically be used from the storage tank. The rate needed over 72 hours to replenish 240,000 gallons is 55 gpm. Therefore, the design flow of 400 gpm is adequate to supply 173 gpm.

6.2 Piping System

Under peak hour demand conditions, the model indicated that through a 4-inch section of piping at the cemetery, velocity was well over 5 fps, head loss was well over 10 ft/Kft and pressures were 150 psi. This section of piping is located between two 8-inch sections of piping. Services at the end of Chaney receive about 20 psi during peak hour conditions.

The CSA-10A system could not operate under maximum day demand plus commercial fire-flow conditions for 2 hours with a minimum pressure of 20 psi. The model showed that negative pressures occurred immediately when the demand at Thalberg and South Ocean was set to 2000 gpm to simulate fire flow demand for a commercial zone. It also showed that the tank emptied after an hour and forty-five minutes.

Residential fire-flow demands were simulated at three locations: at the end of Stuart, at Chaney and Gilbert, and at Chaney and Studio. None of the locations were able to sustain the required fire-flow of 1000 gpm for 2 hours at 20 psi without violating head loss and velocity criteria. Negative pressure occurred at the end of Chaney during the two simulations on Chaney, and fell below 20 psi during the Stuart simulation. A flow of 1000 gpm at the end of Stuart was not possible at all.

Appendix E summarizes the pipe locations where the head loss was greater than the 10 ft/Kft criteria for all fire-flow demand simulations.

The locations of the fire flow demand were converted to reservoirs with a hydraulic grade line of the nodal elevation plus 20 psi in order to determine the maximum flow available at 20 psi for 2 hours. The results are shown in Table 6.1. These results show that it is not possible to reach a flow of 1000 gpm at the end of Stuart, or a flow of 2000 gpm at South Ocean and Thalberg.

Table 6.1 Maximum Flow Available at 20 psi

Test	**Location**	**Result (gpm)**
Commercial	S. Ocean and Thalberg	1632 to 1534
Residential	End of Stuart	474 to 460
Residential	Gilbert and Chaney	1039 to 977
Residential	Studio and Chaney	1467 to 1402

It can be concluded that the existing distribution system is not capable of meeting recommended fire flows throughout much of the service area.

6.3 Storage System

Appendix F shows the calculations for the current storage requirements for CSA 10A. Table 6.3 below summarizes the results according to storage design criteria. The current storage capacity is deficient by 281,000 gallons.

Table 6.2 Current Storage System Requirements

Required Storage	**Volume (gallons)**
Equalization	20,000
Emergency	231,000
Fire	240,000
Total Required Storage	491,000
Current Storage	210,000
Additional Storage Needed	281,000

7.0 Ability of Existing System to Meet Build-Out Demands

The model was run under build-out conditions for peak hour demand, maximum day demand plus commercial fire flow demand, and maximum day demand plus residential fire flow demand at four locations. All model fire-flow simulations were run at the same locations as the current demand model-runs, with an additional residential fire flow simulation at a fire hydrant on the projected Gilbert pipeline. The results from the model runs were again compared with design criteria for the supply, piping, and storage systems.

7.1 Supply System

The average yearly usage at CSA 10A build-out, with a 10% planning cushion, is estimated to be 203.5 acre-feet, 13.5 acre-feet above the current allocation from Whale Rock Reservoir. Other planning documents predict needs at build-out to be up to 240 acre-feet.[6, 7]

The maximum day demand for build-out is 62% more than present maximum day demand. Assuming the maximum day demand for all of the CAWO districts will be 62% more (604 gpm), the groundwater wells would still produce enough flow to meet demands (775 gpm), given the Reservoir releases water to the creek. However, an alternative source of water supply will be needed if the Whale Rock Reservoir water is unavailable or if adequate conditions for operating the groundwater wells are not met.

The maximum day demand at build-out is 191 gpm, and the required flow to replenish 240,000 gallons over 72 hours for fire protection is 55 gpm. Therefore, the high service pumps would still be able to provide adequate flow for maximum day demand conditions plus fire storage replenishment (246 gpm) since their design flow is 400 gpm.

7.2 Piping System

Under peak hour demand conditions at build-out, the model still indicates that design criteria are violated through a 4-inch section of piping at the cemetery. Velocity was over 5 fps (11), head loss was well over 10 ft/Kft (133) and pressures were inoperably high at 150 psi. Pressures at the ends of Chaney and near Hacienda and Gilbert are slightly below 20 psi, and flows necessary to meet demands at the very top of Chaney are not possible due to the elevation.

Again, as to be expected from the model runs with current demands, the requirements for commercial fire flow protection were not met without emptying the tank after an hour and forty-five minutes and immediately violating pressure requirements. Head losses were decreased due to the increase of piping and pipe looping at build-out, but still violated the 10ft/Kft criteria in many locations.

Residential fire-flow demands were simulated at four locations: at the end of Stuart, at Chaney and Gilbert, at Chaney and Studio, and at hydrant on Gilbert. None of the locations were able to sustain the required fire-flow of 1000 gpm for 2 hours at 20 psi without violating head loss and pressure criteria. A flow of 1000 gpm at the end of Stuart was not possible at all. Appendix E summarizes the pipe locations where the head loss was greater than the 10 ft/Kft criteria for all fire-flow demand simulations.

The locations of the fire flow demand simulations were converted to reservoirs with a hydraulic grade line of the nodal elevation plus 20 psi in order to determine the maximum flow available at 20 psi for 2 hours. The results are shown in Table 7.1. These results show that it is not possible to reach a flow of 1000 gpm at the end of Stuart.

Table 7.1 Maximum Flow Available at 20 psi

Test	Location	Result (gpm)
Commercial	S. Ocean and Thalberg	2793 to 2598 (1hr 10min)
Residential	End of Stuart	475 to 457
Residential	Gilbert and Chaney	1715 to 1509
Residential	Studio and Chaney	1791 to 1680
Residential	Gilbert – Projected Waterline	1996 to 1463

7.3 Storage System

Appendix F shows the calculations for the build-out storage requirements for CSA 10A. Table 7.2 below summarizes the results according to storage design criteria. The current storage capacity to meet build-out storage requirements is deficient by 352,000 gallons.

Table 7.2 Storage System Requirements at Build-Out

Required Storage	Volume (gallons)
Equalization	20,000
Emergency	302,000
Fire	240,000
Total Required Storage	562,000
Current Storage	210,000
Additional Storage Needed	352,000

8.0 Recommended Capital Improvements

Recommended capital improvements to the CSA-10A system were developed after evaluating deficiencies in supply, distribution and storage based on current capital project activity, changes that would have the greatest improvement to overall system capability, operator recommendations and cost analyses. A summary of the recommended projects in order of priority, and construction costs in current dollars, are in Table 8.1. Appendix G contains the cost estimating data used for evaluating each project. Figure 6 shows the proposed future water distribution system including master-planned improvements and assumed build-out conditions.

8.1 Current Projects

Section of the Cemetery Pipeline:
The County is currently in the process of replacing the 4-inch section of pipeline at the Cemetery with an 8-inch pipeline. This project will include replacing a portion of the existing 8-inch AC pipe. The path of the pipeline will be different than what exists, and the length will increase to approximately 2200 feet from the treatment plant to the tie-in location on the existing 8-inch AC pipe.

The existence of the 4-inch section of pipeline limits how much water can be pumped into the system. Flows greater than about 200 gpm create inoperably high pressures due to the head loss associated with flow through an 8-inch to 4-inch to 8-inch section of pipeline. The model repeatedly demonstrated this problem in all demand simulations.

Replacing the pipeline will allow the pump to operate at a higher efficiency for daily operations and at maximum flow for high demands while maintaining operable pressures. This replacement also moderately improves the amount of flow available for fire flow protection, but there are additional limitations throughout the system that limit its availability to certain areas.

New Storage Tank:
The County has an approved budget for preliminary work to install a new storage tank for the CSA-10A system. Activities will include evaluating potential sites and investigating the requirements of obtaining property. According to required storage calculations, the County would need to purchase a tank with a capacity of approximately 352,000 gallons in order to meet build-out needs. Required storage is currently deficient by 281,000 gallons.

The best location for the new storage tank may be next to the existing tank. Operationally, having the tanks together and using the existing water line would be ideal. Unfortunately, the elevation of the tanks would not be high enough to service homes built at the top end of Chaney and to maintain appropriate

Table 8.1
CSA 10A
Priority of Capital Improvement Projects

	Project Description	Construction Cost	Justification
1	Replace Cemetery Waterline	$110,500	4-inch line does not allow pumps to operate at design output, does not effectively deliver water to distribution system
1	New Storage Tank	$278,400	Deficient storage according to design standards
2	Loop Hacienda	$64,000	Alternate route in case main route breaks; landslide area
2	Replace Shearer Waterline	$649,440	4-inch line limits fire flow to southern section of CSA 10A
2	Replace Gilbert Waterline	$190,320	4-inch line limits fire flow; operational difficulties with current alignment
2	Replace Stuart and Richard Waterline	$195,000	4-inch lines limit fire flow
3	Replace Chaney Waterline	$144,160	High head losses through 4-inch line
3	Loop Cerro Gordo Waterline	$62,160	Eliminates dead-end, improves circulation
	Totals	$1,693,980	

ENR: 6588.7 as of 9/2/02
Inflation Rate: 5%

Prepared by: Courtney Howard
1/22/2003

pressures on parts of Gilbert at build-out. Putting the new storage tank at a higher elevation to accommodate demand at higher elevations would create another pressure zone, which would necessitate making dramatic, expensive changes to the system. It is therefore recommended that houses built at elevations where pressures during fire flow conditions are below 20 psi (about 175 feet) be equipped with sprinkler systems. Required fire flow would be reduced to 500 gpm. Homes built at the top end of Chaney would not be able to have water service according to the computer model. Although there is currently no sprinkler ordinance in Cayucos, as build-out to higher elevations continues, a move toward such an ordinance in the future is very likely. Current problems with meeting fire flow at residences are mitigated with the use of pressure pumps and sprinklers.

Since determining the new tank location, acquiring property, designing and installing the tank would take several years, in all probability, some of the following recommended projects would be completed before the new storage tank was put in. In addition, due to the lack of water availability and unstable slopes, build-out will be slow. Therefore, the benefits of the recommended projects are primarily based on the existing system.

8.2 Recommended Projects

1. <u>Loop Hacienda Water Line from Storage Tank:</u>
This project is a high priority because there is only one line from the storage tank to the distribution system. Looping this 6-inch pipeline would allow another route for supply from the tank if the other pipeline was inoperable. The pipeline has broken due to landslides in the past. Looping also eliminates dead ends and improves circulation. In addition, the project would be relatively inexpensive because the length of pipe needed to loop on Hacienda is only about 400 feet. The design of the pipe line would need to account for a drainage gulley crossing and a nearby sewer line. Construction may be difficult due to the steep slope of the hillside and narrow width of the road, as shown in Figures 7 and 8 below.

Figures 7 and 8: Hacienda Looping Area

2. <u>Replace 4-inch Water Line on Shearer</u>:
A project of equal importance is replacing the 4-inch water line on Shearer Avenue with an 8-inch water line. The pipe line is old and undersized, causing operational difficulties. Model runs also show high head losses during fire-flow demand simulations, minimizing the amount of flow to the south end of the distribution system.

3. <u>Replace 4- and 6-inch Water Line on Gilbert:</u>
Operational difficulties associated with the 4-inch section of the water line on Gilbert are depth, alignment and breaks. As houses are being developed, the land has been built up over the pipe and the alignment goes under driveways. In Figure 9, the path of the waterline is on the left, under driveways and retaining walls. The pipeline is also undersized, as shown by the high head losses during fire-flow demand simulations. The short 6-inch pipeline, as shown in Figure 10, should be resized and realigned to promote proper fire flow as well. An 8-inch replacement pipe line is recommended.

Figure 9: 4-inch Section of Gilbert

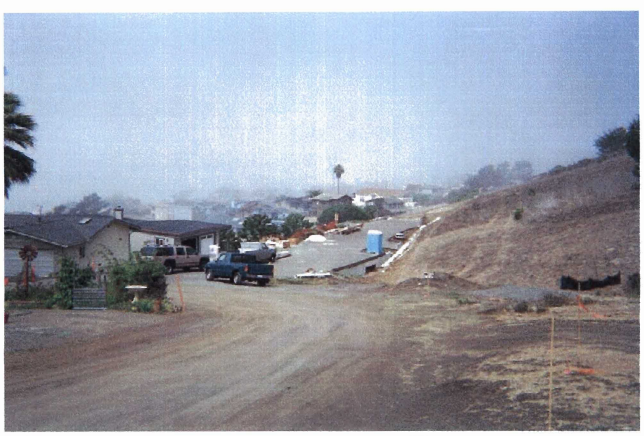


Figure 10: 6-inch Section of Gilbert

4. <u>Replace 4-inch Water line on Stuart and Richard:</u>
The 4-inch water lines on Stuart and Richard (Figures 11 and 12, respectively) do not allow the required fire flow to reach properties at the top of Stuart. The project would also allow for an appropriate alignment in a straight line, away

from private properties. An 8-inch replacement line on Stuart and a 6-inch replacement line on Richard would minimize head losses and provide adequate flow for fire protection. Currently, there is only a wharfhead, as shown in Figure 13, at the top of Stuart.

Figure 11: 4-inch on Stuart

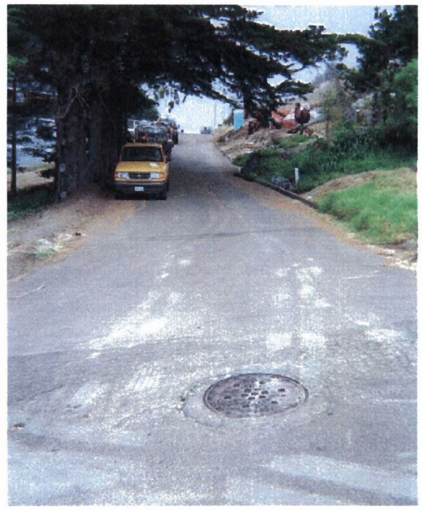


Figure 12: 4-inch on Richard

Figure 13: Wharfhead at the top of Stuart

5. <u>Replace 4-inch Water Line on Chaney:</u>

Fire flow simulations at the end of Studio show a high head loss across the 4-inch section of water line that crosses Highway 1 from Chaney, as shown in Figure 14. Unfortunately, construction would be difficult due to the heavy traffic on Highway 1, and the 4-inch water line is encased in a 10-inch pipe casing. A determination will need to be made if a larger diameter pipe can be pushed through the existing metal casing or if it would be completely replaced. The stretch of 4-inch piping on Chaney between Shearer and Ocean goes under a retaining wall that crosses the street. The difficulties associated with this project put it at a lower priority. For modeling and cost estimating purposes, it is assumed that the metal casing will be replaced to accommodate a new 8-inch pipeline.

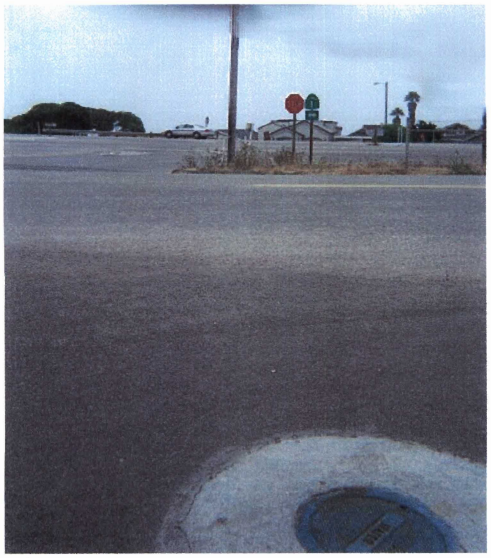


Figure 14: 4-inch Crossing at Highway 1

6. Loop Cerro Gordo Water Line to Hacienda:

Looping the Cerro Gordo water line to Hacienda would decrease head losses and eliminate a dead end. Unfortunately, the alignment would be parallel to a drainage gulley as shown in Figure 15, contributing to design, construction and operational difficulties in relation to wet weather. The gradual build-out of the street, and the requirement that developers extend the water line, put this project at a lower priority.

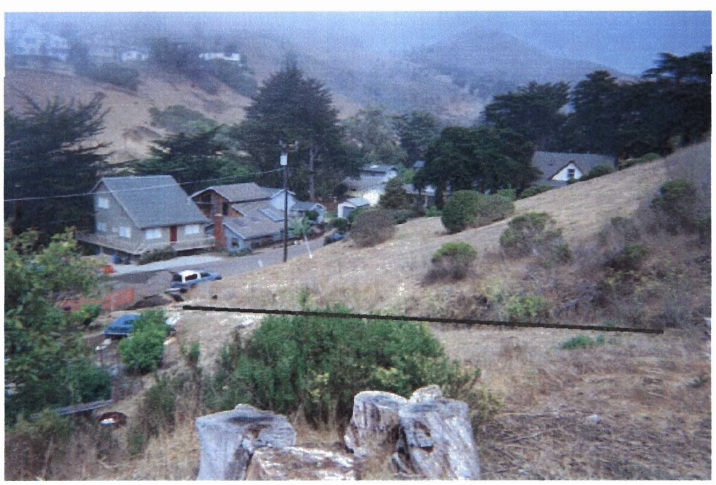


Figure 15: Cerro Gordo Loop near Drainage Gulley

8.3 Other Capital Projects

Verify / Install Fire Hydrants 500 ft Apart:

It is currently unknown if proper fire hydrants are located throughout the system at 500 feet apart maximum. It is recommended that a survey be taken to assess whether the criteria is met and install hydrants where needed.

Supplemental Water:
The County has hired a consultant to investigate the options of supplemental water for several distribution systems in the County, including CSA 10A. Whale Rock Reservoir is the only source of water for Cayucos. After identifying the source of supplemental water and developing the necessary infrastructure, more water services will be allowed in CSA 10A. As it stands now, only a certain percentage of vacant lots within the USL are promised water service when they are ready.

References

1 County of San Luis Obispo. *Quarterly Meter Readings – CSA10A*. 2 years worth kept by Terry Robertson in the Public Works Department; the rest archived.

2 County of San Luis Obispo. *Property Management System*. January 2002.

3 Production and Delivery Data as read from meters at the CAWO Water Treatment Plant January 1997 to December 2001.

4 American Water Works Association. *Distribution Network Analysis for Water Utilities, Manual 32.* First Edition, 1989.

5 SPH Associates. *Operations Plan, Water treatment Facilities Cayucos Area Water Organizations, Cayucos, CA*. January 1997.

6 Boyle Engineering Corporation. *Water Management Plan Update 1997 – 2001.*

7 Crawford, Multari and Clark Associates. Analysis of Holding Capacity and Projection of Future Water Demand. August 1997.

8 San Luis Obispo County Planning Department. *County Estero Area Plan.* November 5, 1996.

9 Vacant lots in Cayucos prepared by the Cayucos Fire Department on July 2001.

10 California Code of Regulations, Title 22. June 2001.

Appendix A
Description of Cayucos Groundwater Wells

The CAWO Well is routed to the treatment facility through a 4-inch line such that the groundwater can receive proper disinfection contact time prior to delivery to consumers. At the treatment facility, the yard valving allows CAWO Well water to be discharged directly into the Clearwell Tank for meeting contact time requirements.

Groundwater from Cayucos Wells #2 and #3 can be pumped into the treatment facility through pipelines (2) and (3) as shown in Figure 4, though this is not normal operating procedure. A removable spool section prevents well water from being discharged to the CSA10A system directly. However, in an emergency, the red-painted spool can be put back in place and groundwater pumped through pipeline (6) and into the main header to the CSA10A distribution system. Special consideration to the treatment of the groundwater from these wells is required before it enters the treatment system and the Department of Health must give special permission for the groundwater to go directly into the CSA10A distribution system.

The PRBWA and MRM wells are plumbed through a 4-inch inter-tie into pipeline (2) at the discharge of the Cayucos wells. This alternative groundwater source is the least desirable choice based on poor raw water quality and manual control requirements. The water may also need pretreatment before entering the system.

Appendix B
Calculation of Commercial Water Duty Factor

Usage at Commercial Meters 2001

Address	Meter Reading (100 ft^3)	Reading Date	Use (100 ft^3)	Days	Average Use per Day (ft^3/d)
3082 Studio Drive	3410	1/3/01			
	3766	1/4/02	356	366	97.3
3302 South Ocean	4058	1/5/01			
	4415	1/4/02	357	367	97.5
Old Highway 1 and Chaney Avenue	5782	1/5/01			
	5867	1/4/02	85	366	23.2
2803 South Ocean	5911	1/5/01			
	6047	7/11/01	136	187	72.7
	6111	9/4/01	200		
	6111/0	11/4/01			
	19	1/4/02	19		

Total Commercial Use (TCU)

TCU $= (356 + 357 + 85 + 136 + 200 + 19) \times 100 ft^3/Y = 101700\ ft^3/Y$
$= 101700\ ft^3/Y \times 2.3 \times 10^{-5}\ AF/\ ft^3$
$= 2.34$ AFY

Percent as Commercial Use

Total Production 2001 = 129 AF
% Commercial = 2.34 AF / 129 AF x 100 = 1.81%

Year	Total Production (AF)	Commercial Use[1] (AF)
1997	118	2.14
1998	128	2.30
1999	134	2.41
2000	131	2.36

[1] Commercial Use = Total Production x 1.81%

Commercial Water Duty Factor (CWDF)

CWDF = Average of the Average Uses per Day (not including the irregular usage at the fire station on Old Highway 1 and Chaney Avenue)

CWDF $= (97.3 + 97.5 + 72.7)\ ft^3/d / 3 = 89.2\ ft^3/d$ / meter
$= 89.2\ ft^3$/d/meter x 7.48 gal/ ft^3 = 667.2 gal/d/meter

Appendix C
Peaking Factors

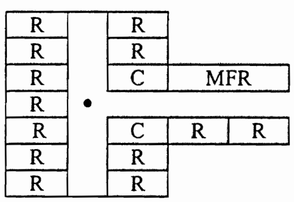
Current:
Maximum Day Demand, July 4, 2001 = 170,000 gpd

Daily Peaking Factor	= Maximum Day Demand / Average Day Demand
Average Day Demand	= 128 AFY (1 Y / 365 d) (1 gallon / 6.07×10^{-6} AF) = 58,000 gpd
Daily Peaking Factor	= 170,000 gpd / 58,000 gpd = 3.0
Peak Hour Peaking Factor	= 1.6
Peak Hour Demand	= Peak Hour Peaking Factor x Maximum Day Demand = 1.6 x 170,000 gpd x (1 d / 24 hr) = 11,500 gallons/hr

Build-Out:
224 Residential Meters * 100 gpd/meter = 22,400 gpd
5 Multi-Family Residential Units * 80 gpd/unit = 400 gpd
4 Commercial Meters * 667.2 gpd/meter = 2,668 gpd

Average Day Demand	= 58,000 gpd + 25,468 gpd = 83,468 gpd
Plus 10% Planning Cushion	= 91,815 gpd
Maximum Day Demand	= 91,815 gpd * 3 = 275,445 gpd
Peak Hour Demand	= 275,445 gpd * 1.6 * (1 d / 24 hr) = 18,363 gph

Appendix D
Example of Demand at a Node



13 Residential Meters @ 100 gpd/meter = 1300 gpd
2 Commercial Meters @ 667 gpd/meter = 1334 gpd
1 Multi Family Residential Property with 10 units @ 80 gpd/unit = 800 gpd

Total Demand at the Node = 3434 gpd

Appendix E
Locations of Pipe Segments Exceeding Maximum Head Loss Criteria During Maximum Day Demand Plus Commercial or Residential Fire Flow Demand Hydraulic Model Runs

Present Model:

Commercial Model – Thalberg and South Ocean

Pipe Description	Nodes	Range of Head Loss in Pipelines between Nodes (ft/Kft)
4-inch in Cemetery	58-57	168
4-inch on Chaney	35-41	18-160
6-inch on S. Ocean	10-33	43-116
4-inch on Shearer	23-31	17-111
6-inch on Hacienda	4-24	20-64
6-inch on Old Creek	4-10	18-57
8-inch from Storage Tank	16-3	54
6-inch on Thalberg	29-30	26
6-inch on Studio	18-41	22-28
6-inch on S. Ocean	18-19	19
4-inch on Stuart	12-14	14-15

Residential - End of Stuart

Pipe Description	Nodes	Range of Head Loss in Pipelines between Nodes (ft/Kft)
4-inch on Stuart	13-15	66-621
4-inch at the Cemetery	58-57	139
4-inch and 6-inch on Richard	1-7	24-33
6-inch on Hacienda and Old Creek	3-7	18
8-inch from Storage Tank	16-3	11

Residential – Chaney and Gilbert

Pipe Description	Nodes	Range of Head Loss in Pipelines between Nodes (ft/Kft)
4-inch at the Cemetery	58-57	138
4-inch on Shearer	23-31	28-93
4-inch and 6-inch on Chaney	41-39	12-62
6-inch on S. Ocean	10-32	14-32
4-inch on Gilbert	54-39	23
6-inch on Davies	38-52	23
6-inch on Haines	32-37	13-19
6-inch on Hacienda	3-23	15
8-inch from Storage Tank	16-3	11

Residential – Chaney and Studio

Pipe Description	Nodes	Range of Head Loss in Pipelines between Nodes (ft/Kft)
4-inch on Chaney	41-35	17-141
4-inch on Cemetery	58-57	138
4-inch on Shearer	23-31	13-32
6-inch on S. Ocean	10-29	13-31
6-inch on Studio	69-41	29-30
6-inch on Hacienda	3-23	15
8-inch from Storage Tank	16-3	11

Build-Out Model:

Commercial – Thalberg and South Ocean

Pipe Description	Nodes	Range of Head Loss in Pipelines between Nodes (ft/Kft)
4-inch on Shearer	25-31	37-155
4-inch in Cemetery	58-57	144
8-inch from Storage Tank	16-3	14-60
6- and 8- inch on Gilbert	86-39	14-55
6-inch on Adoree	31-52	25-51
6-inch on S. Ocean	10-32	13-48
6-inch on Thalberg	29-30	43
6-inch on Hacienda	3-88	28
4-inch on Chaney	33-41	27
6-inch on Haines	32-34	13

Residential - End of Stuart

Pipe Description	Nodes	Range of Head Loss in Pipelines between Nodes (ft/Kft)
4-inch on Stuart	13-15	68-621
4-inch at the Cemetery	58-57	136
4-inch and 6-inch on Richard	1-7	23-34
8-inch from Storage Tank	16-3	13
6-inch on Hacienda and Old Creek	3-7	12

Residential – Chaney and Gilbert

Pipe Description	Nodes	Range of Head Loss in Pipelines between Nodes (ft/Kft)
4-inch at the Cemetery	58-57	133
4-inch and 6-inch on Chaney	39-36, 35-41	42, 19-23
4-inch on Gilbert	54-39	34
6-inch on Davies	37-36	25
6-inch on Gilbert	80-81	20
8-inch from Storage Tank	16-86	13
4-inch on Shearer	25-37, 34-35	12, 11

Residential – Chaney and Studio

Pipe Description	Nodes	Range of Head Loss in Pipelines between Nodes (ft/Kft)
4-inch on Chaney	41-35	22-167
4-inch on Cemetery	58-57	134
6-inch on Studio	69-41	24-26
4-inch on Shearer	25-37	15
8-inch from Storage Tank	16-86	13
6-inch on Gilbert	80-81	12
6-inch on S. Ocean	24-28, 32-33	11

Residential – Fire Hydrant on Gilbert

Pipe Description	Nodes	Range of Head Loss in Pipelines between Nodes (ft/Kft)
4-inch on Cemetery	58-57	132
8-inch from Storage Tank	16-86	13
4-inch on Shearer	30-31	12

Appendix F
Calculation of Storage Requirements

Calculations of Current Required Storage Volumes

Equalization Storage:

Assume that demand in excess of average maximum day demand occurs for 14 hours during the day.

Equalization Storage = (Peak Hour Demand – Rate of Supply)*14 hrs

Peak Hour Demand = 11,520 gph

Rate of Supply = 800 gpm * 0.8 = 640 gpm = 38,400 gph

Since the rate of supply is greater than the peak hour demand, a volume of storage to minimize pump cycling to approximately 30 minutes should be required.

640 gpm * 30 min = 20,000 gallons

Emergency Storage:

Minimum sanitary supply = 50 gallons per capita for 3 days

Currently:
702 Residential meters
6 Multi-family Residential Meters (27 Units)
2.1 capita per household per Water Management Update 2001

(702 + 27) households * 2.1 capita/household = 1,531 capita
1,531 capita * 50 gallons/capita * 3 days = 231,000 gallons

Fire Storage:

Highest fire-flow demand: 2,000 gpm for 2 hours
2,000 gpm * 60 min/hr *2 hr = 240,000 gallons

Total Current Required Storage = 20,000 + 231,000 + 240,000 = 491,000 gallons
Existing = 210,000 gallon tank Need = 281,000 gallon tank

Calculations of Required Storage Volumes at Build-Out

Equalization Storage:

Assume that demand in excess of the rate of supply occurs for 14 hours during the day.

Equalization Storage = (Peak Hour Demand – Rate of Supply)*14 hrs

Peak Hour Demand = 18,363 gph

Rate of Supply = 800 gpm * 0.8 = 640 gpm = 38,400 gph

Since the rate of supply is greater than the peak hour demand, a volume of storage to minimize pump cycling to approximately 30 minutes should be required.

640 gpm * 30 min = 20,000 gallons

Emergency Storage:

Minimum sanitary supply = 50 gallons per capita for 3 days

At Build-Out:
- 926 Residential meters
- 7 Multi-family Residential Meters (32 Units)
- 2.1 capita per household per Water Management Update 2001

(926 + 32) households * 2.1 capita/household = 2,012 capita
2,012 capita * 50 gallons/capita * 3 days = 302,000 gallons

Fire Storage:

Highest fire-flow demand: 2,000 gpm for 2 hours
2,000 gpm * 60 min/hr * 2 hr = 240,000 gallons

Total Required Storage at Build-Out = 20,000 + 302,000 + 240,000 = 562,000 gallons
Existing = 210,000 gallon tank Need = 352,000 gallon tank

Appendix G
Construction Cost Estimates of Recommended Capital Improvement Projects

Project	Lineal Feet of Waterline Replaced	Bid or Engineer's Estimate	$/LF[1]
Cemetery Pipe	1940	$110,500	$57
New Tank[2]	NA	$278,400	NA
Hacienda	400	$64,000	$160
Chaney - Regular	204	$48,960	$240
- Bore & Jack, metal casing	280	$95,200	$340
Cerro Gordo	518	$62,160	$120
Stuart	533	$127,920	$240
Richard	333	$66,600	$200
Gilbert	793	$190,320	$240
Shearer	2706	$649,440	$240

1 Per Christine Ferrara on 9/25/02:

For projects in pavement	$200/LF	6-inch
	$240/LF	8- to 10-inch
For projects not in pavement	$120/LF	6-inch
	$160/LF	8- to 10-inch
For bore and jack, metal casing	add $100/LF	

2 New Tank

Property	$20,000	4 Parcels (Assessor's Values approx. $6000 for 2 parcels)
75ft of waterline	$12,000	$160/LF
Foundation Work	$50,000	1/3 of the tank cost
Tank	$150,000	Superior Tank Quote, welded steel tank
Subtotal	$232,000	
Total with 20% Contingency	$278,400	

Per Merilee Whilhelm on 9/25/02:

Inflation Rate 5%

ENR 9/2/02 6588.7

C. Howard
1/22/2003