Twenty years of experience with central softening in The Netherlands: Water quality – Environmental benefits – Costs

Jan Hofman[1], Onno Kramer[1], Jan Peter van der Hoek[1,*], Maarten Nederlof[2], Martijn Groenendijk[3]

[1] Waternet, P.O. Box 8169, 1005 AD Amsterdam
[2] Vitens Water Supply Company, P.O. Box 400, 8901 BE Leeuwarden
[3] Brabant Water, P.O. Box 1068, 5200 BC 's-Hertogenbosch

[*] Corresponding author: jan.peter.van.der.hoek@waternet.nl

Abstract

Central softening has been utilized by the Dutch water utilities since the late 1970s. It was introduced in the water treatment process as a method to supply water with an optimum water composition to prevent lead and copper release and to prevent excessive scaling. Twenty years of experience show that central softening is beneficial for public health, has significant environmental benefits and that it lowers social costs. Also enhanced consumer comfort is a result of distribution of water with low scaling potential. This paper will describe the water quality improvements and will quantify the benefits realized in practice.

Introduction

Central softening has been applied successfully in The Netherlands since the late 1970s. A long discussion and an intensive research effort to develop the softening technology preceded the break through at full scale (Graveland *et al.*, 1983, Van Ammers *et al.*, 1986). Since than, the installed softening capacity increased very rapidly (see Figure 1). Nowadays, almost all drinking water in The Netherlands is conditioned to an optimal water quality to prevent corrosion and excessive calcium carbonate scaling. In approximately 50 % of the production capacity, softening is required to meet realize the required water quality.

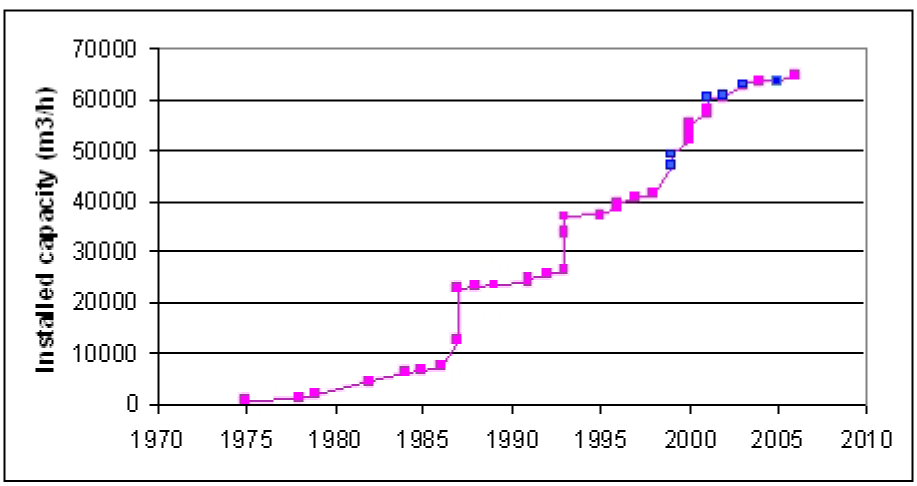


*Figure 1. Development of cumulative softening capacity in the Netherlands (Blue dots are nanofiltration plants) (*Mons *et al.,* 2006*).*

Figure 2 shows the distribution area's of the Dutch water utilities in 2005. The last decade this map has changed a lot due to company mergers. The number of water utilities has decreased significantly over the last years. It is expected that more companies will merge in the near future.

Figure 2. Distribution area's of the Dutch Water Supply Companies (situation 2005).

Waternet

Waternet (formerly Amsterdam Water Supply) produces drinking water for the City of Amsterdam and its surrounding municipalities. The total installed capacity is 101 million m^3 (annual production approximately 90 million m^3). The main raw water sources – both surface water – are the river Rhine and seepage water from the Bethune Polder. They are treated at two production plants: Leiduin (70 million m^3/y) and Weesperkarsel (31 million m^3/y). Central softening is applied at both plants since 1987.

Vitens

Vitens is the largest water supply company in the Netherlands, serving more then 4 million customers in the provinces Friesland, Gelderland and Overijssel with drinking water. A total capacity of 260 million m^3/year is produced from groundwater sources at 85 water treatment plants. Softening is applied at 24 treatment plants: 13 use fluidized bed pellet softeners (76 million m^3/y total production) and at 10 locations nanofiltration is applied. The total production capacity involving membrane filtration therefore is 23 million m^3/y. Nanofiltration is selected when hardness is to be removed in combination with color, sulphate or organic micro pollutants. For one water treatment plant, reverse osmosis is used to get a full barrier for hardness, sulphate and organic micro pollutants. The total production capacity of softened water is 100 million m^3/y, which is 38 % of the total annual drinking water production of Vitens. At some locations where naturally very soft water is treated, marble filtration is used to reach the optimum water composition.

Brabant Water

Brabant Water is located in the southern part of the Netherlands and produces 180 million m^3 drinking water annually. Also 10 million m^3/year industrial water is produced. The main source for industrial water is the river Meuse. At the moment 34 production locations are operated for the drinking water production, using groundwater as a source. At 4 locations central softening is applied (35 million m^3/y) using fluidized bed softeners. The newest plant is opened in 2005 in Nuland (9 million m^3/y). At 4 more locations, central softening plants are under construction

Table 1: Softening target values for drinking water.

Parameter[1]	Waternet	Vitens	Brabant Water
Total Hardness (mmol/l)	1.5	1.0 < TH < 1.5	< 1.43
TACC90 (mmol/l)	< 0.1	< 0.6	
PACC (mmol/l)			< 0.4
TIC (mmol/l)		> 1.5	
pH	8.3 - 8.4	7.8 < pH < 8.3	7.8 < pH < 8.3
Saturation Index	+0.35 < SI < +0.45	-0.2 < SI < +0.3	0 < SI < +0.3
Corrosion Index			< 1

[1] TACC90: Theoretical calcium carbonate scaling potential at 90°C; PACC: Practical calcium carbonate scaling potential; TIC: Total inorganic carbon.

(25 million m^3/year) with a total investment of 20 million Euros. At 6 locations (35 million m^3/y), naturally very soft ground water is treated with marble filtration, or milk of lime is added, to reach the optimum water composition.

Reasons for softening

Public health
Research in 1970s and 1980s has resulted in recommendations for the optimum composition of drinking water that aim at minimization of lead and copper release from the supply system and house installations, prevention of corrosion of asbestos cement and metal pipe materials and prevention of scaling (Van den Hoven and Van Eekeren, 1988). The recommendations strongly depend on inorganic water quality parameters such as acidity (pH) and total inorganic carbon (TIC) (all concentrations in mmol/l):

$$\max\left(\begin{matrix}7.8\\ \left(0.38 * TIC + 1.5\left[SO_4^{2-}\right] + 5.3\right)\end{matrix}\right) < pH < 8.3 \quad (1)$$

$$TIC > 2 \quad (2)$$

$$-0.2 < SI < 0.3 \quad (3)$$

$$CI = \frac{\left[Cl^-\right] + 2\left[SO_4^{2-}\right]}{TIC} < 1 \quad (4)$$

Here SI is the Langelier Saturation Index and CI is the corrosion index.

As lead and copper (and other heavy metals, e.g. nickel) are important factors for public health, softening plays a very important role in reducing these compounds in drinking water.

A second aspect on public health is found in the fact that many consumers will install home softening devices (Point-of-Use or Point-of-Entry). The effects of these POU/POE devices are that risks for public health increase. Poor maintenance will lead to poor microbiological water quality, especially when no persistent disinfectant is used during distribution (as in The Netherlands). Furthermore, the use of POU/POE devices may result in increased corrosivity of the water, leading to higher metal concentrations. Finally, the lack of adequate water quality monitoring when POU/POE devices are used, is a threat to public health.

Environmental benefits
The environmental benefits of central softening are realized in several aspects. The first important aspect is the reduction of calcium carbonate scale formation in water heating equipment. Absence of scale is required to have an optimum heat transfer in these devices. So prevention of scale formation by using softened water will prevent additional energy use and e.g. CO_2 emission.
The second aspect is the environmental burden by chemicals. Roughly three categories can be distinguished: 1) copper and other corrosion products, 2) compounds related to washing powder (detergents, phosphate(replacements)), 3) salt emission by POU/POE ion exchange devices.
Finally, the environment benefits from central softening because of the pellets waste stream can be controlled and reused in agriculture and steel production (Van Dijk and Wilms, 1991).

Social costs
The use of central softening will increase drinking water costs directly. On the other hand, consumers will have reduced costs for maintenance of warm water equipment and can use less amounts of washing powder. If these costs are taken into account, the additional drinking water

costs will outweigh the household costs. Furthermore, many people would install POU devices, which are expensive to buy and use. In general it is believed that the costs for society will be significantly less if central softening is used.

Esthetics and comfort

The fourth reason for softening is consumer convenience and comfort. By softening, staining and hard laundry can be prevented. Also, the water gets a better taste and no film formation on a glass of tea will occur.

Softening technology

Pellet softening

Softening in The Netherlands is mainly done in pellet softeners. Softening is initiated by addition of a base according to the following chemical reactions (Graveland *et al.*, 1983):

$$Ca^{2+} + 2HCO_3^- + Ca(OH)_2 \rightarrow 2CaCO_3 \downarrow + 2H_2O \qquad (5)$$

$$Ca^{2+} + HCO_3^- + NaOH \rightarrow CaCO_3 \downarrow + Na^+ + 2H_2O \qquad (6)$$

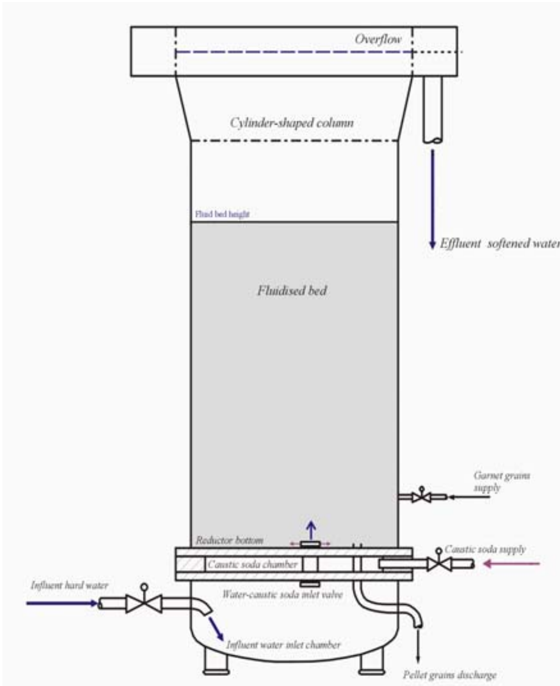


Figure 3. Schematic view of a flat bottom fluidized bed pellet softening reactor.

When lime is used for softening the bicarbonate content of the water is also reduced. For each mole of calcium, 2 moles bicarbonate will be removed. For sodium hydroxide softening, only one mole of bicarbonate is removed per mole of calcium and one mole of sodium is added to the water.

Calcium carbonate will crystallize at the surface of sand grains present in a fluidized bed. The sand grains will grow until a size of approximately 1 mm is reached. Pellets are abstracted from the fluidized bed periodically and new sand grains are added.

Figure 4. Two examples of pelletreactors. Left: Leiduin water treatment plant (Waternet); Right: Treatment plant Nuland (Brabant Water)

Figure 5. The Rodenmors nanofiltration plant (Vitens).

Several design variations of the reactor exist. These variations are mainly found in the bottom construction (flat bottom, conical bottom), the reactor feed construction (nozzles, tangential) and the base dosing equipment (nozzles, lances, dosing star). Figure 3 shows a schematic view of a flat bottom Amsterdam type reactor. Figure 4 shows examples of a flat bottom and a conical bottom reactor.
Although much experience is present nowadays to design reactors, the process is still studied fundamentally. Aspects as fluid bed management and process automation are important issues in this area (Rietveld *et al.*, 2005)

Nanofiltration as a softening technique
Nanofiltration is a membrane filtration technique that is especially suitable for hardness removal, because it removes calcium and magnesium almost completely. Also sulphate and organic matter (color) are removed effectively. When a complete removal of organic micro pollutants is desired, reverse osmosis is preferred because of the higher rejections.
Vitens applies nanofiltration on raw anaerobic groundwater (Nederlof *et al*, 2001; Nederlof *et al.*, 2003). The low hardness permeate is aerated and mixed with untreated raw water; the blending ratio is determined by the required hardness values. A post treatment with rapid sand filtration to remove iron and ammonia follows. Finally, the pH is corrected to obtain the optimal water composition.
The recovery of the nanofiltration is 80-90 %, using anti-scalants to prevent scaling of sparingly soluble salts. This means that 10-20 % of the feed stream has to be discharged as membrane concentrate to a local surface water.

Twenty years of central softening: results and experience

Water Quality
Softening is an important improvement for water quality. After softening total hardness of the water will be reduced to a value between 1 and 2.5 mmol/l. Depending on the softening base used, either the sodium concentration increases (NaOH) and/or the hydrogen carbonate content will be lowered ($Ca(OH)_2$).
Table 2 gives an overview to the hardness related water quality parameters. The data from Waternet (Leiduin) show that water is softened at a target value of 1.5 mmol/l. For Brabant Water the target hardness is somewhat lower: 1.4 mmol/l. For Vitens the target hardness is 1.0 mmol/l. In practice however, the hardness of the finished drinking water varies between 1.0 and 1.5

Table 2: Water quality parameters of raw and treated drinking water.

Technology		Waternet (Leiduin) Pellet softener, NaOH		Vitens (Rodenmors) Nanofiltration		Brabant Water (Nuland) Pellet softener, $Ca(OH)_2$	
Parameter	Unit	Raw[3]	Treat'd[3]	Raw	Treat'd	Raw	Treat'd
Ca	mg/l	76.8	43.1	100	53	94	56
Mg	mg/l	9.7	9.5	6.3	3.5	5.9	6.1
TH	mmol/l	2.3	1.49	2.8	1.5	2.5	1.6
Na	mg/l	46.6	76.4	34	21	99	77
Cl	mg/l	87.2	93.5	9	11	153	108
HCO_3^-	mg/l	197.0	157.2	341	200	308	199
SO_4^{2-}	mg/l	52.5	52.1	10	5	21	13
pH		7.89	8.35	7.0	7.9	7.3	7.8
$TACC_{90}$	mmol/l		0.32	0.95	0.5		0.97[4]
SI		0.37	0.48	-0.2	+0.26	0.04	0.16
CI [1]		1.1	1.4	0.06	0.13	0.8	1.0
Cu solub exp[2]				-	1.2		
Cu solub[3]	mg/l	2.21	1.21	4.6	1.3	3.59	1.55
Pb solub[3]	µg/l	166	102	298	168	249	179

[1] Corrosion index (see equation 4)
[2] Calculated plateau value (see equations 7 and 8)
[3] Five year average
[4] TACC at 10 °C

mmol/l. As expected, the pellet softening process reduces the calcium carbonate content in the water, leaves the magnesium concentration unchanged and increases the sodium concentration (in the case sodium hydroxide is used as base). Furthermore, the scaling potential of the water is reduced by approximately 20 %.

Copper and lead

One of the main reasons for introduction of central softening were the environmental and health effects of copper and lead release. Research by Van den Hoven and Van Eekeren (1988) resulted in two equations that predict the copper and lead solubility in stagnant water (16 hour plateau value):

$$Cu_{Max}(mg/l) = 0.52 \cdot TIC(mmol/l) - 1.37 \cdot pH + 2 \cdot [SO_4^{2-}](mmol/l) + 10.2 \quad (7)$$

$$Pb_{Max}(\mu g/l) = -141 \cdot pH + 12 \cdot T(^\circ C) + 1135 \quad (8)$$

For a long time, copper solubility was determined in a standardized copper test tube set up, with a a standard of 3 mg/l (plateau value). This standard was replaced in revision of the Dutch Drinking Water Decree by 2 mg/l in a random day time simple, corresponding to the EU drinking water directive (EC, 1998). This standard is considered to be less stringent than the old one.

The introduction of pellet softening in Nuland in 2005 (Brabant Water) showed that the copper emission reduced from 2.3 mg/l Cu to 1.8 mg/l Cu. This resulted in a reduction of 30 % of the total copper emission to the environment. At a production rate of 9 million m^3/y this is 4.5 tons.
At the water treatment plant Rodenmors (Vitens), almost a factor 3 reduction of copper solubility was observed after introduction of nanofiltration (see Figure 6).

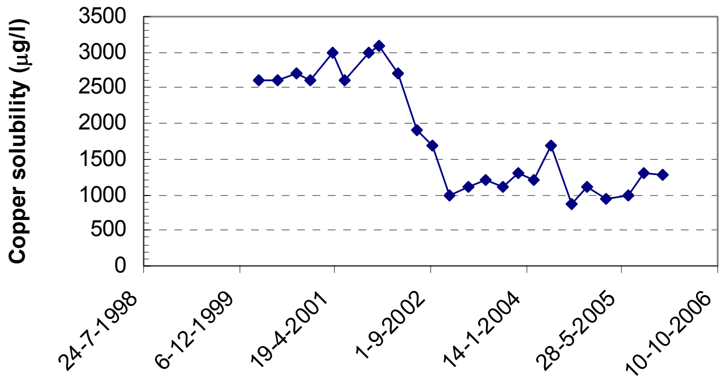


Figure 6. Copper solubility before and after the introduction of nanofiltration at the Rodenmors (Vitens) water treatment plant at the beginning of 2002.

As a result of the reduction of the copper and lead solubility, the concentration of these metals at the consumers tap is very low. Figure 7 shows the cumulative frequency distribution of copper and lead concentrations found in water samples in the distribution system in Amsterdam. The copper concentrations are always below the standard of 2 mg/l at the tap. For lead 90% of the observations is below 10 µg/l. This means that most of the time water fulfills the lead standard. On the other hand, in 10 % of the cases, the lead standard could not be complied with. In general it is seen that conditioning is not sufficient to comply with the lead standard. Therefore, lead pipe materials in the distribution system have been banned. The occasional high lead values found (up to 200 µg/l!), can to be awarded to the presence of old lead pipes in house installations, outside of the responsibility of the water supply company.

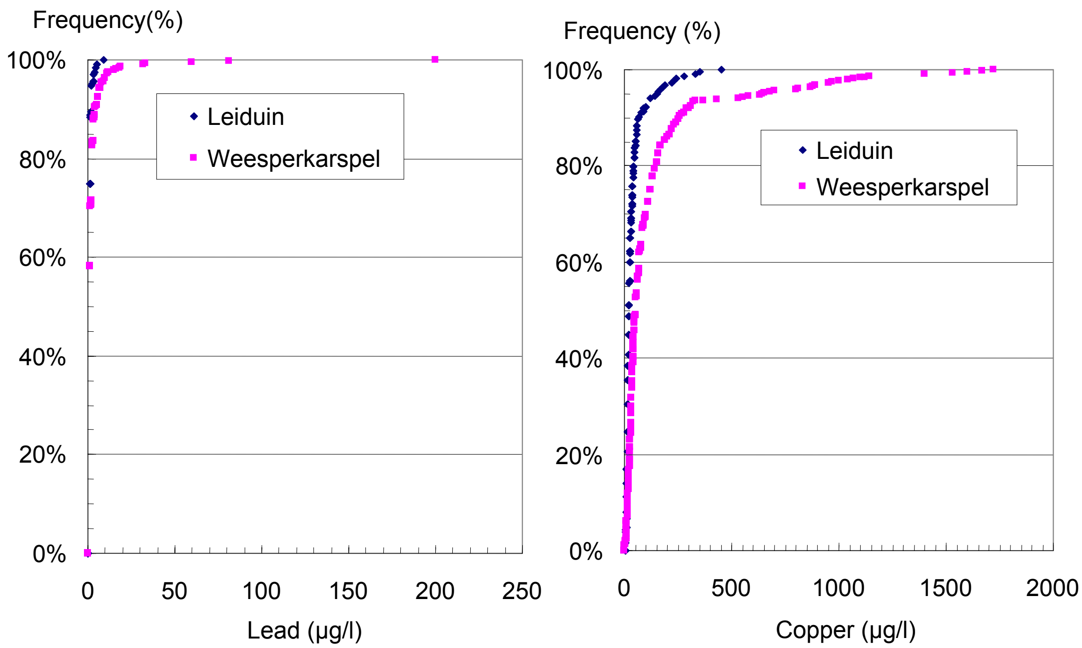


Figure 7. Frequency distributions of copper and lead concentrations found in the Amsterdam distribution area.

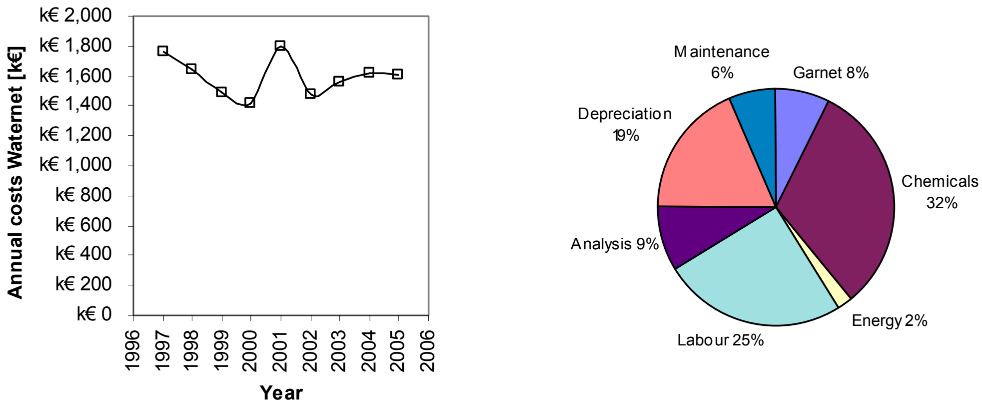


Figure 8. Total annual operation and maintenance cost and cost breakdown for softening at Waternet. Total installed capacity approximately 101 million m^3/y, average production 90 million m^3/y.

Costs

Central softening at large scale is relatively inexpensive. Figure 8 shows the annual costs for treatment of 101 million m^3/year (installed capacity). On average the costs were € 1.6 mln per year or approximately € 0.02 per m^3. The variations are mainly caused by variations in sodium hydroxide market price.

When central softening is applied at smaller scale, like the majority groundwater treatments in The Netherlands, the process will become more expensive. Operation and maintenance cost can increase to approximately € 0.25 per m^3. An average family (annual use 100 m^3) will therefore pay approximately € 2 to € 25 extra for their drinking water, due to the introduction of softening. In ground water treatment this typically contributes for 35 to 55 % to the total production costs of drinking water.

On the other hand, application of central softening leads to financial benefits. These benefits can be divided in direct savings at consumer level and social cost benefits. The direct cost reductions, because of lower maintenance on warm water equipment, less washing powder use, reduced staining of sanitary fittings, less energy demand and taste are estimated at approximately € 20 per year. Furthermore, costs for POU equipment, estimated at € 83 per year, can be added for comparison reasons, as is shown by a societal cost benefit study conducted by Brabant Water (Ruijgrok *et al.*, 2005; Van Nieuwenhuijze *et al.,* 2005). Similar savings are reported by Merkel (1998). In Germany, more POU equipment is used. He concludes that annual savings can be realized between €23 and € 190 per family of 4 persons. If POU investments are taken into account, savings can increase up to € 300.

Social or indirect cost savings can be realized by reduced sewerage treatment costs and reduction costs related to environmental issues (e.g. copper emission, sludge volume). These costs are difficult to quantify, but are generally believed to be significant.

Environmental benefits

The environmental benefits of softening are found in the reduction of copper emission, reduction of the environment with detergents and phosphates, and lower energy consumption in warm water equipment. It is difficult however to quantify and compare these effects. Application of Life

Cycle Analysis (LCA) gives a good and objective evaluation of the environmental benefits of softening (Lindfors *et al.,*1995; EC, 1992; Jensen *et al.*, 1997).
The methodology was applied to the softening system of Waternet by Regueira (2000). Environmental impact by the softening process itself included evaluation and quantification of NaOH, energy and garnet consumption, indicated by the blue production line in Figure 9. Below a total hardness of 1 mmol/l the environmental impact was estimated. It was assumed that the impact would deviate from linearity because chemical demand will probably increase at higher hardness removal levels.

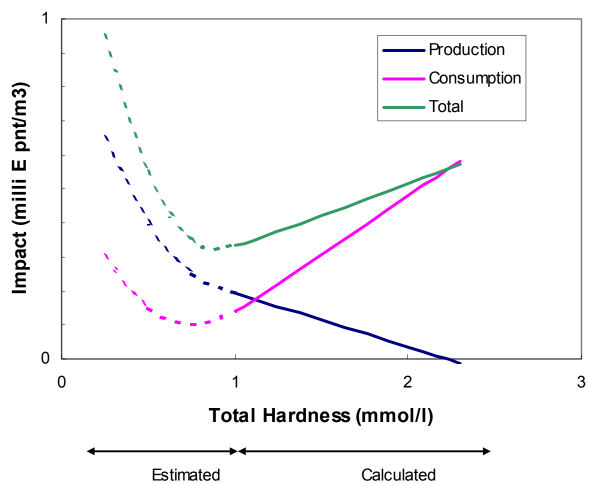


Figure 9. Optimization of the environmental impact by application of central softening (values indicative) (Regueira, 2000).

The effect of softening for the consumer was calculated by the effect on lead and copper release, the washing powder consumption and energy consumption for warm water. The three items were weighted for the amount of water consumed. The results are marked in Figure 9 by the pink line, whereas the green line represents the total environmental impact of softening. At higher hardness levels, the consumtion will decrease if the hardness decreases, because the metal solubility and the energy and chemical consumption will decrease. Below a certain value however the consumption line will increase again because the water at very low hardness levels is aggressive and and only very high pH values bring the water in equilibrium. Within the standardized pH limits the water remains aggressive at low pH and copper and lead release will increase again.

From the results it is concluded that there is a clear optimum level of total hardness. The exact position of this optimum level will depend on local situations and on the assumptions made in the LCA approach, clearly is below 2.5 mmol/l of total hardness.

Naturally very soft groundwaters

In the Netherlands, as in other countries, the amount of naturally very soft groundwater is significant for the production of drinking water. In many cases, marble filtration is applied or milk of lime is added to reach the optimum water composition. This is done only for conditioning of the drinking water to reduce copper and lead solutibility (see equation 1-4).
Due marble filtration only the amount of calcium in drinking water is increased and not the amount of magnesium. Marble filtration at large scale is relatively inexpensive: it is estimated at

Table 3: The effect of marble filtration to reach the optimum water composition.

Technology		Vitens (Eerbeek) Marble filtration		Brabant Water (Vessem) Marble filtration	
Parameter	Unit	Raw	Treat'd	Raw	Treat'd
Ca	mg/l	21	35	22	60
Mg	mg/l	1.8	1.8	5.8	5.8
TH	mmol/l	0.6	0.9	0.79	1.74
SO_4^{2-}	mg/l	11	11	65	65
HCO_3^-	mg/l	35	95	40	140
pH		6.6	7.9	6.1	7.7
SI		-2.3	-0.3	-2.7	-0.1
Cu solub (calc'd)	mg/l	1.7	0.4	3.5	2.2
Pb solub (calc'd)	µg/l	324	141	395	169

€ 0.04 per m^3. At smaller scale, like the majority groundwater treatments in the Netherlands, the process will become more expensive. Cost will increase to approximately € 0.10 per m^3. As the technology is comparable with a rapid sand filter, the technology is very robust.
Table 3 shows the effect of marble filtration on the water quality for two cases. From this table it can be concluded that naturally very soft water has about the same level of calcium (after marble filtration) as softened water by central softening. The final water quality depends on the saturation level of the raw water. Application of marble filtration will never exceed an SI=0.

Concluding remarks

Twenty years of experience with central softening and conditioning of drinking water in the Netherlands have well demonstrated the benefits for public health, the environment, costs and therefore society in general. Also, consumers benefit from having softened water at their tap. It reduces their overall costs and improves their comfort and leads to a more sustainable society.

The Dutch water utilities all strive to supply water with optimal conditioning. In approximately 50 % of the production capacity, softening is required to meet the guidelines for the optimal composition. This level is almost completely reached.

References

M. van Ammers, J.C. van Dijk, A. Graveland, P.A.N.M. Nühn; State of the art of pellet softening.; Water Supply, 4, (1986), p. 223-235.; Proceedings of the Specialized Conference on New Technologies in Water Treatment, organized by the International Water Supply Association, Amsterdam, 15 - 19 September, 1986.

J.C. van Dijk and D. Wilms, *Water treatment without waste material – fundamental and stat of the art of pellet softening,* Journal of Water Supply: Research and Technology – AQUA, Vol. 40(5), 1991, 263-280.

DWD, 2001, Waterleidingbesluit 2001, Staatsblad 2001, nr. 58, januari 2001

EC, 1998. COUNCIL DIRECTIVE 98/83/EC on the quality of water intended for human consumption, 3 november 1998. http://europa.eu.int/comm/environment/water/water-drink/index_en.html

M.Groenendijk, S. van de Wetering; *Hardness, how soft is that?*; H_2O, vol. 38, no 25/26. (2005), p 16 (in Dutch)

A. Graveland, J.C. van Dijk, P.J. de Moel, J.H.C.M. Oomen; Developments in water softening by means of pellet reactors.; Journal AWWA, 75, (1983), nr. 12, p. 619-625.

Th.J.J. van den Hoven and M.W.M. van Eekeren, *Optimal composition of drinking water,* Kiwa report no. 100, 1988

A.A. Jensen, L. Hoffmann, B.T. Moller, A. Smidt, K. Christiansen, J. Elkington and F. van Dijk, *Life cycle assessment: a guide to approaches, experiences and information sources,* Environmental Issues Series, no. 6, European Environment Agency, Copenhagen

L.G. Lindfors, K. Christiansen, L. Hoffmann, Y. Virtanen, V. Juntilla, O.J. Hanssen, A. Ronning, T. Ekvall and G. Finnveden, *Nordic Guidelines on Life-Cycle Assessment,* Nord 1995:20 Copenhagen. Nordic Council of Ministers

W. Merkel, *Zentrale Enthärtung von Trinkwasser. Wirtschaftliche Gesichtspunkte aus Sicht der Verbraucher*. In: *Zentrale Enthärtung und Entkarbonisierung von Trinkwasser- Stand des Wissens und neuere Entwicklungen*. Dokumentation zum 8. Mülheimer Wassertechnischen Seminar vom 11.01.1994. H. Overath & Borchers (Eds.). IWW Duisburg, Band 12, 1998

L.C. Rietveld, K.M. van Schagen, O.J.I. Kramer, *Optimal operation of the pellet softening process.* In: Proceedings of the AWWA Workshop

M. Mons, J. Hofman, S. Hesse, D. Gatel, M.-L. Nguyen, *Drinking water hardness; review of reasons and criteria for softening and conditioning of drinking water,* Kiwa report BTO 06.xxx (in preparation), 2006.

M.M. Nederlof, F. Regerschot, F.F. van Schaik, B.M. Rietman, *Implementation of nanofiltration on ground water at Water Supply Company Overijssel,* In Proceedings of the AWWA Membrane Technology Conference, San Antonio, Texas, 2001 (CDROM)

M.M. Nederlof, B. Rietman, P. Knappe, J.P.N. Kriek, *Operational experience with nanofiltration on anaerobic ground water for drinking water production.* In *Membrantechnik in der Wasseraufbereitung und Abwasserbehandlung*, T. Melin and M. Dohrmann Eds., 5. Aachener Tagung Siedlungswasserwirtschaft und Verfahrenstechnik, 2003.

R. van Nieuwenhuijze, E. Ruijgrok, P. Hiemstra; *Is an investment in central softening attractive ?*; H_2O, Vol. 38, No. 25/26 (2005), p. 37-39 (In Dutch).

J. M. Regueira, *Determining the optimal hardness level for the least environmental impact in the production and consumption of drinking water.* Ms.C.-thesis, IHE Delft, June 2000.

E.C.M. Ruijgrok, F. de Bruijn, P. Hiemstra, *Hard of zacht? MKBA drinkwaterontharding.* Report Witteveen en Bos raadgevende ingenieurs, no.HT249-2-P/ders2/003, november 2005 (in Dutch).

Draft Report

Well Softening Feasibility Study

Valencia Water Company
Santa Clarita, CA

April 2006

Kennedy/Jenks Consultants
Engineers & Scientists

Table of Contents

List of Tables

List of Figures

Executive Summary

Valencia Water Company (VWC) is one of five water purveyors that provide service to the Santa Clarita Valley. VWC has approximately 28,300 consumers and serves a portion of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Castaic, Stevenson Ranch, and Valencia. VWC provides a blend of local groundwater and imported State Water Project (SWP) water from Castaic Lake Water Agency (CLWA) to its potable water consumers. The groundwater is supplied by 18 active wells from two different aquifer systems within the Santa Clara River Valley Groundwater Basin. The two aquifer systems are the Alluvium and the Saugus Formation. The groundwater has high hardness that is not a regulated water quality parameter but is an important aesthetic parameter. The hard water supply has resulted in widespread use of residential water softeners. The self-regenerating type of water softener produces a high chloride, brine discharge to the wastewater system and is a primary cause of treated wastewater discharged to the Santa Clara River exceeding the impending discharge limitation for chloride of 100 mg/l. VWC has made significant investments in its water delivery system in order to improve the aesthetic quality of its water supply and reduce its hardness to acceptable consumer levels. Some of these investments have included replacement of old and inefficient wells, addition of CLWA turnouts in strategic locations to maximize blending and construction of additional transmission pipelines for both groundwater and import water to improve product delivery.

While VWC's system improvements have decreased the overall system hardness, the blended CLWA water and groundwater quality is still considered hard to very hard. In an effort to reduce the water hardness and increase customer satisfaction, VWC hired Kennedy/Jenks Consultants to prepare this feasibility study for wellhead softening. The objectives of this study are to address key technical and economic issues of wellhead softening prior to a decision to implement a project.

Water Quality

Of VWC's active 18 wells, 4 are Saugus wells and 14 are Alluvial wells. The Alluvium aquifer generally underlies the entire Upper Santa Clara River and its several tributaries, and the Saugus Formation underlies practically the entire Upper Santa Clara River area. Water quality data for the existing wells, with sample data ranging from 1995 to 2005, shows that VWC wells had values between 300 and 700 mg/l total hardness as $CaCO_3$. Waters with hardness over 300 mg/l are considered very hard and can impact consumers by increasing soap usage, creating undesirable deposits on glassware, appliances and cars, and can impact industrial processes. CLWA water, which blends with the groundwater supply at varying ratios, has a typical hardness of 154 mg/l which is considered moderately hard. Even after blending, the product water being sent to the consumer is in the hard to very hard range. In order to decrease the effects of hard water seen by consumers and to eliminate the need for most home water softeners, a target goal of 150 mg/l hardness was set for purpose of this study.

Candidate Softening Technologies

This report reviews the following water softening technologies:

- Pellet Softening
- Ion Exchange
- Membrane Processes
    - Reverse Osmosis (RO)
    - Nanofiltration
    - Electrodialysis (ED) and Electrodialysis Reversal (EDR)

Pellet Softening utilizes chemical precipitation methods for removing calcium hardness. Water is first pretreated with either caustic soda or lime to increase the pH for calcium precipitation. The water is then injected at the bottom of a pellet reactor. The water fluidizes a bed of sand that is used as a nucleus for formation of calcium carbonate pellets. Treated water is collected at the top of the reactor and the pH is adjusted to stop the precipitation reaction. As the pellets grow, the larger pellets settle to the bottom of the reactor and are either removed in batch or taken out periodically during operation. As pellets are removed, additional sand is added. When the pellets are removed they are typically 1 mm in size and are easy to dewater. The dewatered pellets are the only waste stream from the pellet softener and can be beneficially used as a soil amendment, construction fill, animal feed additive and industrial uses. If no beneficial users are found, the pellets can also be sent to landfill. The treated water can often appear milky and will require treatment through a dual-media filter prior to distribution. The advantage to the pellet softening process is that it removes calcium hardness without reducing the supply water and with minimal waste. The disadvantage of pellet softening is that while some magnesium may be removed in the process, it is designed to remove only the calcium hardness causing the treated water total hardness to remain higher than the treatment goal of 150 mg/l.

Ion exchange is a physical/chemical process in which ions held electro statically on the surface of a solid phase are exchanged for ions of similar charge in solution. Once all the sites on the solid phase resin beads have been filled by contamination ions, the bed must then be regenerated by rinsing the column with a concentrated solution of the ions initially exchanged from the resin. The advantage of ion exchange is that it can remove almost all of the calcium and magnesium ions from the raw water. In fact, some of the raw water would need to be bypassed and blended with the treatment water to maintain a stable product water. The disadvantage of ion exchange is the cost associated with regeneration and regeneration waste disposal.

All of the membrane processes utilize a selective barrier that allows some constituents to pass while preventing others to do so. The movement of constituents across the membrane require a driving force which tends to require higher operational costs than traditional treatment methods. The Reverse Osmosis and Nanofiltration membranes both use pressure as their driving force. The main difference between the two is the membrane pore size. Nanofiltration membranes have a larger pore size so the constituents that can be removed are different than those for a reverse osmosis membrane. ED and EDR use electricity as the driving force. The processes use alternatively placed cation and anion transfer membranes to pull constituents through a membrane. There are two discharge streams from all the membrane processes. One is the treated water and the other is the concentrate that contains concentrated levels of the constituents being removed. This concentrate is often called brine and cannot be discharged to local wastewater treatment plants or storm drains. All of the membrane processes would effectively remove the groundwater hardness and much like ion exchange would require bypassing a portion of the raw water and blending with the treated water to maintain a stable product water. The advantage of the membrane process is that it is very effective at removing the total hardness. The disadvantages of the membrane process are that a significant portion of the well water is wasted in the concentrate flow which reduces overall well production and the high cost of brine disposal.

Recommended Softening Project

Due to cost and non-cost factors, pellet softening was chosen as the treatment process for VWC. Since pellet softening cannot reach the desired treatment goal of 150 mg/l on its own ion exchange was considered as a supplemental treatment to bring the ultimate treated quality as near to 150 mg/l as possible.

Wells were grouped into eight potential softening plant sites. Plants were assumed to have a post-treatment blending ratio of treated/CLWA water of 50/50. The exception to this is Plant E which has a groundwater/CLWA blending ratio of 90/10. It was found what with pellet softening alone, all treatment plants except Plant E could be treated to below 200 mg/l total hardness. Even though the total hardness for the plants is not below the treatment goal of 150 mg/l the calcium will be removed to 20 mg/l for all plants and should greatly decrease the effects of hardness normally visible to the consumers. The effects of magnesium hardness have not been previously studied to determine their effects on consumers.

Demonstration Plant

In order to confirm consumer acceptance of centralized softening and refine project costs, a full-scale demonstration plant is recommended. Well W9 was chosen as the demonstration site due to the availability of land, ease of isolation to a target consumer base and the treatment capacity.

Section 1: Introduction

This section presents a brief background of the need for a feasibility study of wellhead softening, study objectives, scope of services, and conduct of the study.

1.1 Background and Objectives

Valencia Water Company (VWC) serves a portion of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Castaic, Stevenson Ranch, and Valencia. Currently, VWC has approximately 28,300 customers. VWC provides a blend of groundwater and imported water to its potable water customers. The groundwater supplies have high hardness that is an important aesthetic water quality parameter and has resulted in widespread use of residential water softeners. The self-regenerating type of water softener produces a high chloride, brine discharge to the wastewater system and is a primary cause of treated wastewater discharges to the Santa Clara River exceeding the impending discharge limitation for chloride of 100 mg/l. In addition, imported water supplies from the State Water Project can vary year-to-year causing portions of VWC's service area to receive higher proportions of groundwater, particularly during dry year conditions.

To address these issues, VWC is considering wellhead softening to reduce the need for residential water softening and to equalize hardness throughout its service area. VWC successfully completed a pilot study of the pellet softening-ion exchange process for source water from two existing wells. To evaluate the water quality, process, siting, and economic issues associated with wellhead softening, VWC desires a feasibility study.

Accordingly, VWC authorized Kennedy/Jenks Consultants to prepare this feasibility study of wellhead softening. The primary objectives of the study are to address key technical and economic issues prior to a decision on implementation. These issues include:

- Softening process
- Treated water quality
- Treatment residuals
- Location for demonstration project
- Capital and O&M costs
- Rate impacts
- System impacts

To address these issues, the following scope of services was developed.

1.2 Scope of Services

The Scope of Services for the Feasibility Study of Wellhead Softening consists of the following:

1. Meet with VWC staff to identify the project objectives and project management procedures.

2. Summarize VWC's water supply strategy and current and future water sources.

3. Collect and review groundwater quality data and recommend treated water quality objectives. The treated water quality will remain non-corrosive.

4. Summarize VWC's previous water quality improvement programs.

5. Identify alternative water softening processes to meet the recommended water quality objectives

6. Review the pilot study for the pellet softening-ion exchange process.

7. Evaluate the alternative water softening processes based on economic and non-economic factors and recommend a preferred process.

8. Compare the recommended softening process with the no project alternative and an alternative that is based on blending imported water with groundwater.

9. Prepare a process flow diagram and recommend design criteria for the recommended process. Includes a description and size of each unit process, volume of generated waste streams, pellet disposal options and boosting requirements for treated water, if necessary.

10. Meet with VWC staff and establish siting criteria for a demonstration project, review data related to areas of self-regenerating water softener use, and recommend a demonstration project site.

11. Prepare a site layout to establish the area needed for the recommended demonstration site.

12. Estimate the capital and operation and maintenance costs for the demonstration project. Adequate process controls will be included to minimize manual operations.

13. Prepare an economic evaluation that estimates the project efficiency (i.e., cost per pound of chloride removed), and direct economic benefits (i.e., reduction in residential water softening costs).

14. Prepare a draft report summarizing the results of Tasks 1 through 13 and submit five (5) copies to VWC.

15. Incorporate VWC's comments and submit twenty-five (25) hard copies and 5 electronic copies on CD of a final report to VWC.

1.3 Conduct of the Study

This feasibility study is based on available data from VWC, information provided by equipment manufacturers, and analyses by Kennedy/Jenks Consultants. Initial activities focused on water quality and process evaluations. Subsequent activities were directed to a potential demonstration project and economic evaluations of the recommended softening process. The recommendations presented in this report are based on the technical and economic evaluations contained in this study and professional judgment.

Section 2: Water Sources and Quality

Treated water quality is dependent on the source water quality and treatment technologies used to treat VWC's water sources. This section describes VWC's water sources, water supply strategy which determines the blend of water sources delivered to customers, water quality of the sources and blended water, and treated water quality objectives. This information forms the basis for the selection of treatment technologies and the treated water quality.

2.1 Water Sources

VWC generally utilizes a blend of imported State Water Project (SWP) water purchased from the Castaic Lake Water Agency (CLWA) and local groundwater provided by VWC's wells. Groundwater is extracted by VWC from both the Alluvium and deeper Saugus Formation.

CLWA is a SWP contractor with an annual contractual Table A Amount of 95,200 af. Table A Amount (formerly referred to as "entitlement") is named for "Table A" in each SWP Contractor's Water Supply Contract. It contains an annual buildup in Table A Amounts of SWP water, from the first year of the Water Supply Contract through a specific year, based on growth projections made before the Water Supply Contract was executed. CLWA's original SWP Water Supply Contract with Department of Water Resources (DWR) in 1966 was for a maximum annual Table A Amount of 41,500 af. In 1991, CLWA purchased 12,700 af of annual Table A Amount from a Kern County water district and in 1999 purchased 41,000 af of annual Table A Amount from another Kern County water district, for a current total annual Table A Amount of 95,200 af.

VWC currently has six turnouts on CLWA's transmission system. VWC's historical purchases from CLWA are summarized in Table 2-1.

The sole source of local groundwater for urban water supply in the Valley is the groundwater Basin identified in the DWR Bulletin 118, 2003 Update as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin) (Basin No. 4-4.07). The Basin is comprised of two aquifer systems, the Alluvium and the Saugus Formation. The Alluvium generally underlies the Santa Clara River and its several tributaries, and the Saugus Formation underlies practically the entire Upper Santa Clara River area. There are also some scattered outcrops of Terrace deposits in the Basin that likely contain limited amounts of groundwater. Since these deposits are located in limited areas situated at elevations above the regional water table and are also of limited thickness, they are of no practical significance as aquifers and consequently have not been developed for any significant water supply.

VWC utilizes groundwater from both the Alluvium and Saugus Formation. Normally, extractions from the Alluvium exceed those from the Saugus Formation; however, during dry years, Saugus Formations extractions increase significantly. This pattern of water supply utilization is consistent with the 2005 Urban Water Management Plan for the Santa Clarita Valley. VWC's historical groundwater extractions are summarized in Table 2-1.

Table 2-1 Valencia Water Company Annual Water Supply Summary

Year	State Water Project	Alluvium	Saugus Formation	Recycled Water	**Total**
1980	0	5,995	2,206	-	**8,201**
1981	1,214	5,597	2,329	-	**9,140**
1982	3,060	3,415	897	-	**7,372**
1983	3,764	3,387	611	-	**7,762**
1984	4,140	4,975	854	-	**9,969**
1985	4,641	4,633	885	-	**10,159**
1986	5,051	5,167	1,427	-	**11,645**
1987	6,190	4,921	1,305	-	**12,416**
1988	7,027	4,835	2,300	-	**14,162**
1989	7,943	5,826	2,529	-	**16,298**
1990	7,824	5,232	3,516	-	**16,572**
1991	700	9,951	4,642	-	**15,293**
1992	6,338	6,615	2,385	-	**15,338**
1993	8,424	5,815	2,182	-	**16,421**
1994	7,978	5,847	2,565	-	**16,390**
1995	7,259	8,698	1,586	-	**17,543**
1996	6,962	12,433	326	-	**19,721**
1997	9,919	11,696	516	-	**22,131**
1998	9,014	10,711	149	-	**19,874**
1999	10,806	11,823	106	-	**22,735**
2000	12,004	12,179	1,007	-	**25,190**
2001	13,362	10,518	835	-	**24,715**
2002	15,792	11,603	965	-	**28,360**
2003	16,004	11,707	1,068	700	**29,479**
2004	18,410	9,862	1,962	448	**30,682**

Note: All values in Acre-Feet.
Data shown is from the 2004 Santa Clarita Valley Water Report.

2.2 Water Supply Strategy

VWC is one of four water purveyors that provide service to the Santa Clarita Valley. Total water demands in the Santa Clarita Valley were about 78,900 acre-ft (af) in 2004. VWC supplied approximately 30,700 af of this amount through water from alluvial wells, Saugus wells, SWP and recycled water. VWC serves approximately 28,300 service connections in a portion of the City of Santa Clarita and in the unincorporated communities of Saugus, Stevenson Ranch and Westridge. VWC currently has 18 active wells. VWC also has six Castaic Lake Water Agency turnouts throughout the distribution system to improve water quality through blending**.**

As part of VWC's overall strategy to improve the aesthetic quality of its water supply and reduce the hardness levels to acceptable consumer levels, VWC has made significant investments in its water delivery system. For example, a number of old and inefficient groundwater wells have been replaced as part of a well replacement program. New CLWA turnouts have been added increasing the company's capacity to deliver imported water. To the extent viable and financially prudent, these turnouts have been strategically located in the vicinity of groundwater wells in order to maximize blending. VWC has also added additional transmission pipelines to improve the delivery of both groundwater and imported water throughout the distribution system. These projects have reduced the impact of hard water associated with groundwater but are unable to achieve overall hardness levels generally acceptable to consumers. A list of these projects funded by Valencia is shown below:

1) Constructing the "S" Well Field, collector line and CLWA V7 Turnout

2) Construction of well 205, CLWA V8 Turnout and upgrade of existing transmission pipeline located in Valencia Blvd

3) Improvements to the Pardee Well Field and collector line

4) Improvements to the Panhandle Well Field and collector line

5) Construction of McBean Booster Station

These projects are part of an overall program to deliver VWC's customers with a consistent and high quality supply of water from source to tap.

2.3 Water Quality

VWC has 14 active Alluvial wells and 4 active Saugus wells. In addition, VWC has six turnouts from CLWA that are blended at varying ratios throughout the distribution system. Due to this variability there are a wide range of blended water quality possibilities throughout the VWC distribution system. The raw groundwater produced from each VWC well meets all drinking water standards and does not require treatment, other than chlorine disinfection, prior to distribution. While hardness is not considered a health concern, it is undesirable due to residues it creates from its reaction with soap or due to evaporation. In addition to leaving undesirable residues on items such as sinks, dishes and bathtubs, hardness causes the need for additional soap use and can cause scaling in water heaters leading to premature replacement. Water sources with hardness levels over 300 mg/l as $CaCO_3$ are classified as very hard. Based on water quality data from 1995 to 2005, the average hardness for all VWC wells exceeds 300 mg/l. In many cases, the hardness levels are much higher than 300 mg/l, and the maximum hardness sampled was 714 mg/l. CLWA water typically has hardness values around 155 mg/l which is classified as a moderately hard water. The CLWA water is used as blend water for the VWC wells and helps to considerably lower the overall system hardness. However, even after blending the hardness of the product water is still in the hard to very hard range.

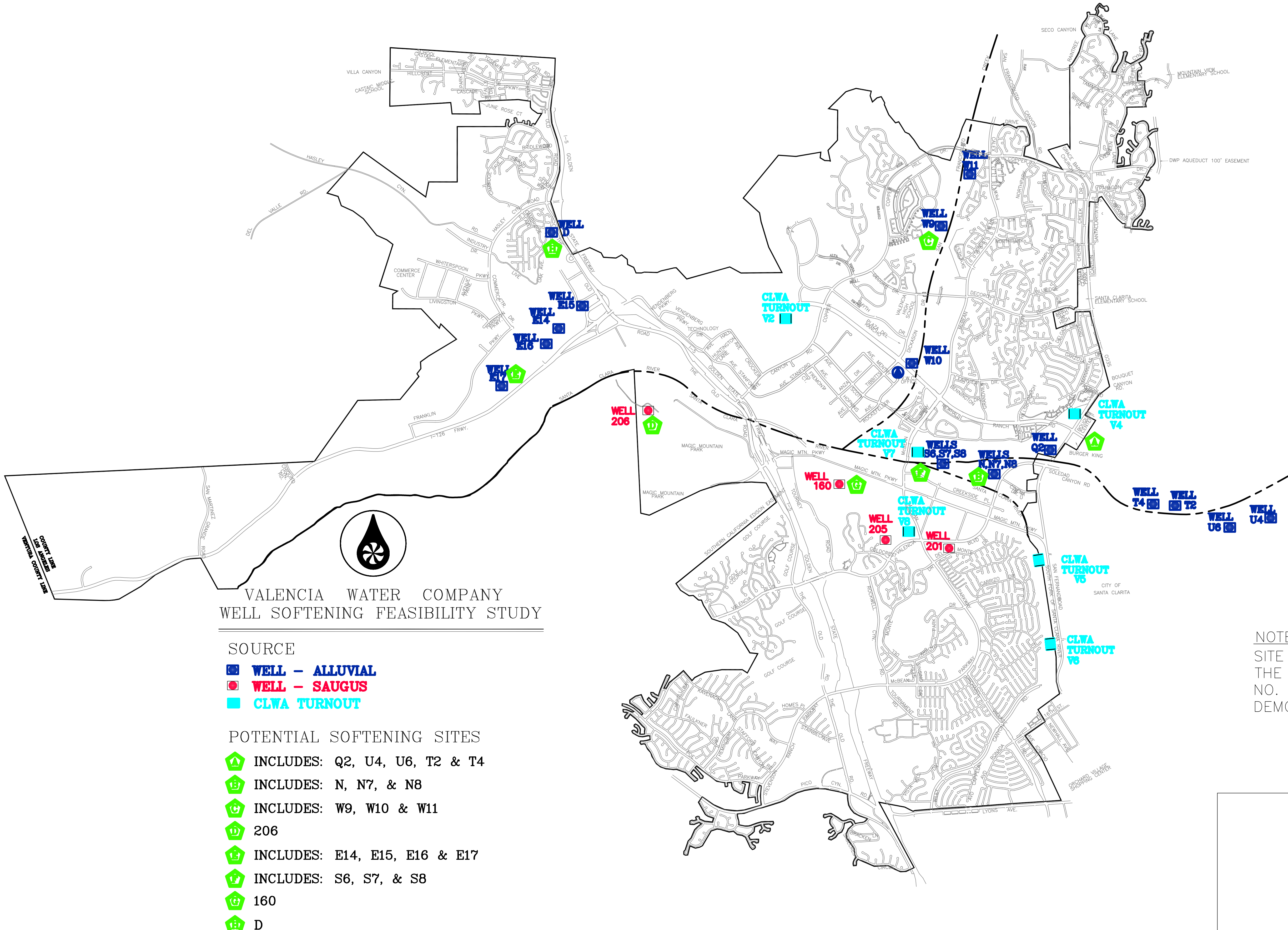
Since blending alone cannot reduce the hardness, water softening of the well water is being considered. Providing treatment at each individual wellhead would not be cost or operationally effective. Therefore, 8 potential softening sites were identified to treat both individual and clusters of wells. The sites are located based on proximity to wells and available space for plant construction. The potential locations are shown on Figure 2-1. The average water quality was determined for each well based on water quality data with varying sample points from 1995 to 2005. In the case where a site will treat multiple wells, a flow weighted average was used to determine the plant's raw water quality. A summary of the raw water qualities used for each plant site is presented in Table 2-2. For all plants, except Plant E, it is assumed that CLWA water would be blended with the well water at a ratio of 50/50. The wells at Plant E are assumed to have a well/CLWA ratio of 90/10. These flow splits are assumed in order to estimate the treated water quality.

2.4 Water Quality Objectives

The principal objective of VWC is to soften and improve the quality of groundwater delivered to its consumers. To date, VWC has provided new CLWA turnout locations and has adjusted CLWA blend rates in order to provide a higher quality of water to its consumers on a location by location basis. However, in most cases, even the combination of CLWA and well water is not sufficient to reduce the hardness of the local groundwater. While hardness is not a health issue, it is a nuisance that increases soap uses, creates undesirable deposits on glassware, appliances and cars, and impacts industrial processes. For this reason, many consumers have installed home water softening systems which add additional cost to the individual consumers and in some cases contribute to the ultimate discharge of treated wastewater with high chloride levels into the Santa Clara River.

Based on a cursory review of the aesthetic impacts associated with hardness, the relative impacts of calcium hardness versus magnesium hardness could not be determined. However, it is believed that impacts of magnesium hardness are less severe than those of calcium hardness. If verified, this observation would allow a higher total hardness objective for treated water that has predominantly magnesium hardness. Because the cost of calcium removal can be lower than that of magnesium removal, a higher total hardness objective could significantly reduce treatment costs.

In order to eliminate the need for home softeners, VWC set an initial treatment goal maximum for total hardness of 150 mg/l as $CaCO_3$. This treatment goal is for the total hardness which includes calcium and magnesium hardness, however treatment will primarily target calcium hardness. To avoid creating corrosive water, it was assumed that calcium hardness would not be removed below a level of 20 mg/l. In many cases removing only the calcium hardness to this level will not reduce the total hardness below the target of 150 mg/l as $CaCO_3$. Accordingly, provisions for the future addition of facilities to remove magnesium hardness are included in order to reduce the final product water to as close to the target total hardness of 150 mg/l as possible.



NOTE:
SITE D WILL ALSO BE THE SITE OF THE WELL NO. 9 DEMONSTRATION STUDY

Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Potential Softening Plant Sites

April 2006
K/J 0589044
Figure 2–1

P:\PW-Proj\2005\VWC - Well Softening\09_Report Prep\9.09_Report\9.09a_Draft\Figures\2006-01-24_For_Report\589044-2-1.dwg, 3/2/2006

Table 2-2 Historic Water Quality for VWC Wells[1]

			→	→	→	→	→	Plant A	→	→	→	Plant B	→	→	→	Plant C	Plant D	→	→	→	→	Plant E	→	→	→	Plant F	Plant G	Plant H
OWNER WELL NUMBER			Q2	U4	U6[2]	T4	T2		N	N7	N8[3]		W9	W11	W10		206[2]	E14[2]	E15[2]	E16[2]	E17[2]		S6	S7	S8		160	D
	WELL FLOW (gpm)		1,200	1,000	1,250	700	800	*4,950*	1,250	2,500	2,500	*6,250*	800	1,000	1,500	*3,300*	2,500	1,200	1,400	1,200	1,000	*4,800*	2,000	2,000	2,000	*6,000*	2,000	1,050
TOTAL DISSOLVED SOLIDS	mg/l	MAX	786.0	913.0	1220.0	688.0	567.0	*872.0*	697.0	830.0	790.0	*787.4*	617.0	740.0	668.0	*677.5*	780.0	900.0	890.0	950.0	960.0	*922.1*	794.0	776.0	923.0	*831.0*	850.0	870.0
TOTAL DISSOLVED SOLIDS	mg/l	AVE	679.0	685.3	1220.0	567.0	489.0	*770.4*	649.7	800.0	790.0	*765.9*	576.7	655.5	642.0	*630.3*	780.0	900.0	890.0	950.0	960.0	*922.1*	715.0	747.3	896.5	*786.3*	804.0	807.0
TOTAL DISSOLVED SOLIDS	mg/l	MIN	572.0	289.0	1220.0	414.0	418.0	*631.2*	555.0	770.0	790.0	*735.0*	528.0	571.0	618.0	*581.9*	780.0	900.0	890.0	950.0	960.0	*922.1*	644.0	690.0	870.0	*734.7*	758.0	744.0
SULFATE	mg/l	MAX	220.0	538.0	490.0	151.0	114.0	*325.5*	153.0	150.0	150.0	*150.6*	207.6	270.0	210.0	*227.6*	300.0	340.0	330.0	340.0	340.0	*337.1*	163.0	165.0	213.0	*180.3*	389.0	345.0
SULFATE	mg/l	AVE	181.0	374.3	490.0	120.2	94.0	*275.4*	148.0	150.0	150.0	*149.6*	197.2	270.0	201.7	*221.3*	300.0	340.0	330.0	340.0	340.0	*337.1*	160.7	164.3	211.5	*178.8*	358.5	311.0
SULFATE	mg/l	MIN	142.0	228.0	490.0	78.0	76.0	*227.5*	138.0	150.0	150.0	*147.6*	189.0	270.0	196.0	*216.7*	300.0	340.0	330.0	340.0	340.0	*337.1*	157.0	163.0	210.0	*176.7*	328.0	277.0
SPECIFIC CONDUCTANCE	Umho/CM	MAX	1163.0	1785.0	1950.0	1082.0	923.0	*1437.2*	1115.0	1260.0	1230.0	*1219.0*	926.0	1030.0	1009.0	*995.2*	1080.0	1240.0	1290.0	1390.0	1360.0	*1317.1*	1248.0	1231.0	1339.0	*1272.7*	1255.0	1300.0
SPECIFIC CONDUCTANCE	Umho/CM	AVE	1026.5	1465.3	1950.0	925.0	817.7	*1300.3*	1026.7	1175.0	1230.0	*1167.3*	908.0	977.0	972.7	*958.3*	1080.0	1240.0	1290.0	1390.0	1360.0	*1317.1*	1208.0	1177.3	1319.5	*1234.9*	1143.5	1173.0
SPECIFIC CONDUCTANCE	Umho/CM	MIN	890.0	1227.0	1950.0	737.0	745.0	*1180.7*	850.0	1090.0	1230.0	*1098.0*	898.0	924.0	940.0	*925.0*	1080.0	1240.0	1290.0	1390.0	1360.0	*1317.1*	1130.0	1070.0	1300.0	*1166.7*	1032.0	1046.0
SODIUM	mg/l	MAX	75.0	118.0	110.0	74.0	60.0	*90.0*	93.0	110.0	100.0	*102.6*	55.0	59.0	66.0	*61.2*	75.0	100.0	100.0	110.0	110.0	*104.6*	123.0	121.0	111.0	*118.3*	74.0	103.0
SODIUM	mg/l	AVE	66.2	96.7	110.0	64.2	55.2	*81.4*	86.3	105.0	100.0	*99.3*	50.6	58.5	62.3	*58.3*	75.0	100.0	100.0	110.0	110.0	*104.6*	106.3	106.0	103.0	*105.1*	69.5	96.5
SODIUM	mg/l	MIN	57.4	71.0	110.0	53.0	50.0	*71.6*	73.0	100.0	100.0	*94.6*	45.9	58.0	57.0	*54.6*	75.0	100.0	100.0	110.0	110.0	*104.6*	88.0	85.0	95.0	*89.3*	65.0	90.0
PH, LABORATORY		MAX	7.5	7.4	7.4	7.7	7.7	*7.5*	7.6	7.7	8.1	*7.8*	7.8	7.8	8.1	*7.9*	7.5	7.5	7.7	7.3	7.4	*7.5*	8.0	7.5	8.0	*7.8*	7.7	7.6
PH, LABORATORY		AVE	7.5	7.4	7.4	7.7	7.5	*7.5*	7.5	7.5	8.1	*7.7*	7.73	7.7	7.8	*7.7*	7.5	7.5	7.7	7.3	7.4	*7.5*	7.7	7.5	7.7	*7.6*	7.6	7.6
PH, LABORATORY		MIN	7.5	7.4	7.4	7.6	7.4	*7.4*	7.5	7.3	8.1	*7.7*	7.7	7.6	7.6	*7.6*	7.5	7.5	7.7	7.3	7.4	*7.5*	7.5	7.4	7.4	*7.4*	7.5	7.5
MAGNESIUM	mg/l	MAX	37.0	45.0	52.0	35.0	27.0	*40.5*	30.0	32.0	32.0	*31.6*	45.0	47.0	44.0	*45.2*	36.0	46.0	44.0	46.0	51.0	*46.5*	38.0	38.0	56.0	*44.0*	48.0	46.0
MAGNESIUM	mg/l	AVE	31.0	32.3	52.0	27.9	24.7	*35.1*	28.0	30.5	32.0	*30.6*	41.6	44.5	42.7	*43.0*	36.0	46.0	44.0	46.0	51.0	*46.5*	36.0	34.3	50.0	*40.1*	42.0	40.0
MAGNESIUM	mg/l	MIN	25.0	15.0	52.0	22.0	21.0	*28.7*	24.0	29.0	32.0	*29.2*	37.8	42.0	41.0	*40.5*	36.0	46.0	44.0	46.0	51.0	*46.5*	34.0	30.0	44.0	*36.0*	36.0	34.0
HARDNESS (TOTAL) AS $CACO_3$	mg/l	MAX	507.0	612.0	714.0	476.0	346.0	*550.1*	401.0	431.0	431.0	*425.0*	439.0	468.0	434.0	*445.5*	448.0	514.0	481.0	489.0	535.0	*502.5*	431.0	444.0	601.0	*492.0*	592.0	500.0
HARDNESS (TOTAL) AS $CACO_3$	mg/l	AVE	427.5	569.0	714.0	377.8	315.0	*503.2*	373.3	412.5	431.0	*412.1*	392.0	439.0	425.3	*421.4*	448.0	514.0	481.0	489.0	535.0	*502.5*	422.0	391.0	540.5	*451.2*	523.5	436.5
HARDNESS (TOTAL) AS $CACO_3$	mg/l	MIN	348.0	517.0	714.0	300.0	291.0	*458.6*	323.0	394.0	431.0	*394.6*	330.0	410.0	413.0	*392.0*	448.0	514.0	481.0	489.0	535.0	*502.5*	404.0	338.0	480.0	*407.3*	455.0	373.0
CHLORIDE	mg/l	MAX	69.0	107.0	93.0	97.0	81.0	*88.6*	93.0	130.0	130.0	*122.6*	36.0	37.0	52.0	*43.6*	34.0	75.0	88.0	89.0	74.0	*82.1*	141.0	132.0	129.0	*134.0*	28.0	80.0
CHLORIDE	mg/l	AVE	62.7	88.2	93.0	65.0	59.6	*75.3*	81.8	120.0	130.0	*116.4*	30.4	35.0	47.0	*39.3*	34.0	75.0	88.0	89.0	74.0	*82.1*	118.0	113.3	113.5	*114.9*	26.5	72.4
CHLORIDE	mg/l	MIN	56.4	56.5	93.0	41.0	43.0	*61.3*	59.3	110.0	130.0	*107.9*	23.2	33.0	39.0	*33.4*	34.0	75.0	88.0	89.0	74.0	*82.1*	81.0	76.0	98.0	*85.0*	25.0	64.8
CALCIUM	mg/l	MAX	139.0	204.0	200.0	130.0	94.0	*159.0*	109.0	120.0	120.0	*117.8*	99.0	110.0	101.0	*103.2*	120.0	130.0	120.0	120.0	130.0	*124.6*	110.0	112.0	145.0	*122.3*	158.0	120.0
CALCIUM	mg/l	AVE	118.5	173.3	200.0	101.1	87.7	*142.7*	102.3	115.0	120.0	*114.5*	91.0	102.5	99.3	*98.3*	120.0	130.0	120.0	120.0	130.0	*124.6*	108.7	99.3	132.5	*113.5*	140.5	106.5
CALCIUM	mg/l	MIN	98.0	145.0	200.0	84.0	82.0	*128.7*	89.0	110.0	120.0	*109.8*	80.1	95.0	98.0	*92.8*	120.0	130.0	120.0	120.0	130.0	*124.6*	106.0	86.0	120.0	*104.0*	123.0	93.0
ALKALINITY	mg/l	MAX	256.0	289.0	326.0	270.0	234.0	*278.8*	247.0	279.0	272.0	*269.8*	207.2	231.0	232.0	*225.7*	213.0	230.0	215.0	244.0	254.0	*234.1*	288.0	285.0	306.0	*293.0*	193.0	202.0
ALKALINITY	mg/l	AVE	251.5	282.7	326.0	241.5	218.3	*269.8*	241.0	269.0	272.0	*264.6*	203.4	209.5	222.3	*213.8*	213.0	230.0	215.0	244.0	254.0	*234.1*	246.7	240.0	305.5	*264.1*	192.5	192.0
ALKALINITY	mg/l	MIN	247.0	279.0	326.0	195.0	190.0	*256.8*	229.0	259.0	272.0	*258.2*	196.0	188.0	211.0	*200.4*	213.0	230.0	215.0	244.0	254.0	*234.1*	207.0	193.0	305.0	*235.0*	192.0	182.0

Notes:

[1]Maximum, Minimum and Average values were derived from sample data ranging from 1995 to 2005. Only sample dates providing data for all constituents were used. Any other sample dates were thrown out.

[2]Only one sample was taken for this well so maximum, minimum and average values are the same. The sample was taken in 2004.

[3]Only one sample was taken for this well so maximum, minimum and average values are the same. The sample was taken in 2003.

Section 3: Potential Softening Technologies

VWC's groundwater quality is characterized primarily by high levels of hardness. This section discusses potential softening technologies that can meet VWC's water quality objectives. The evaluation of these alternatives is presented in Section 4.

3.1 Water Softening Technologies

VWC is faced with high levels of hardness in its groundwater. Hardness is caused by calcium and magnesium ions. While there is no primary or secondary MCL for hardness, high water hardness can create poor water quality from a consumer's point of view because of calcite precipitation and excessive detergent use.

Many consumers in VWC's service area have installed regenerative water softeners in their homes and businesses. While the softeners do substantially reduce hardness levels, their regeneration process results in the discharge of high levels of chlorides to the sewer system. This chloride loading to the local wastewater treatment plants (WWTPs) has resulted in high chloride discharges to receiving waters. With the application of chloride TMDLs to the Santa Clara River, the WWTPs must reduce their chloride discharges. Eliminating the need for private softeners would reduce chloride discharges to the WWTPs and therefore to the Santa Clara River.

Treatment technologies that soften water include lime-soda softening, pellet softening, ion exchange process, and several membrane processes; however, because of the large amount of water treatment sludge produced and the land requirements, lime-soda softening is not considered an appropriate technology for VWC.

3.2 Pellet Softening

Pellet softening utilizes the same chemical principles as lime-soda softening, but does not produce an undesirable sludge. Instead, the pellet softening system consists of a gravity or pressure tank where calcium carbonate crystallizes on a suspended bed of fine sand and produces a sand-sized pellet which can be beneficially reused.

First, the water is pretreated with either caustic soda or lime to increase the pH for precipitation of calcium hardness. The mixture is injected at the bottom of the reactor in a very turbulent and efficient mixing zone and the flow moves quickly upward through the now-fluidized bed. The calcium carbonate precipitate forms on the sand grains to form pellets with the sand at the nucleus up to 5 times as big as the original sand grains. Effluent is collected at the top of the unit requiring pH adjustment to stop the precipitation reaction. When the sand and calcium carbonate form a large particle, the larger heavier pellets accumulate at the bottom of the reactor and are removed and replaced by new grains of sand. The pellets, rather than sludge, are the solid by-product generated from the process.

This treatment method primarily removes calcium hardness, as only a small amount of magnesium hardness (less than 10 percent of the calcium hardness removed) can be incorporated into the calcium carbonate precipitate. Additional magnesium removal is not practical as it would require increasing the pH to produce magnesium hydroxide that may cause fouling of the reactor bed. Iron removal can be accomplished concurrently, while manganese usually requires post-treatment.

Pellet softener systems originated and are commonly utilized in Europe, but they are not widely utilized in the United States. There are 200 municipal installations in Europe and approximately 50 industrial installations and at least one municipal installation operating in the United States.

The benefits of pellet softening include:

- Effectively reduces calcium hardness and TDS.
- Can replace individual residential zeolite softeners that discharge high chlorides to WWTP.
- Relatively small size of unit.
- Relatively low installation cost.
- Residual pellets are easily dewatered, and then can be applied for use as agricultural lime, acid wastewater neutralizer and animal feed additive. In addition, pellets can be reused as road fill and pipeline backfill.

Either caustic soda (NaOH) or lime ($Ca(OH)_2$) can be used as the pretreatment chemical for raising pH. Generally, caustic soda is easier to handle and only half the pellet volume is produced. For lime applications, milk-of-lime produced with decarbonated water is usually less problematic, and significant operator attention may be required to ensure that the lime feed systems do not clog.

A potential advantage of lime softening is that it removes more calcium with lower chemical doses and creates only calcium carbonate and water as the finished product if sufficient inorganic carbon is present. However, this is not the case with the Valencia groundwater and soda ash would need to be added to achieve the desired calcium goal. This will add some sodium to the treated water. The lime softening reactions are as follows:

$$Ca(OH)_2 + H_2CO_3 => CaCO_3 + 2H_2O$$

$$Ca(OH)_2 + Ca^{2+} + 2HCO_3 => 2CaCO_3 + 2H_2O$$

$$Ca^{2+} + Na_2CO_3 => CaCO_3 + 2Na^+$$

However, since lime is more difficult to store and handle and because some soda ash will be required, caustic soda is preferred. The disadvantage of caustic soda is that it contains sodium and increases the sodium concentration more than the lime-soda ash combination will. The caustic soda softening reactions are as follows:

$$2NaOH + Ca^{2+} + H_2CO_3 => CaCO_3 + 2Na^+ + 2H_2O$$

$$NaOH + Ca^{2+} + HCO_3^- => Na^+ + CaCO_3 + H2O$$

Treated water from the pellet softening system will have a higher pH than the raw water and can be controlled using a pH set point. The pH will be adjusted to a pH around 8.3 by addition of CO_2 prior to filtration. In addition, the treated water often appears milky, especially if lime is used and filtration will be required prior to distribution.

3.3 Ion Exchange

Ion exchange is a physical/chemical process in which ions held electrostatically on the surface of a solid phase are exchanged for ions of similar charge in solution. The solid ion exchange particles are typically either naturally occurring inorganic zeolites or synthetically produced organic resins. The synthetic organic resins are the predominant type used today because their characteristics can be tailored to specific applications. Ion exchange is commonly used in drinking water treatment for softening, where calcium and magnesium ions are exchanged for sodium ions, and removal of arsenate, selenate, chromate, and nitrate.

Most applications of ion exchange use a system with a fixed-bed column of exchange resin. Feed water is continually passed through a bed of ion exchange resin beads in a downflow or upflow mode until the resin is exhausted and cannot accomplish any further ion exchange. Exhaustion occurs when all the sites on the resin beads have been filled by contaminant ions. The bed can then be regenerated by rinsing the column with a concentrated solution of the ions initially exchanged from the resin, known as a regenerant. Regenerant can be reused and it is sometimes advantageous to do so.

Ion exchange resins are classified as cation exchangers, which have positively charged mobile ions available for exchange, and anion exchangers, whose exchangeable ions are negatively charged. Both anion and cation resins are produced from the same basic organic polymers.

3.4 Membrane Processes

Membrane desalting processes should be considered when the concentration of one or more dissolved constituents in the water exceeds the desired water quality. Membranes should also be considered for applications other than dissolved solids removal. Some specific applications of membrane processes are: organic and THM precursor removal, inorganic and radionuclide contaminant removal, and reuse of wastewater.

Membranes are a selective barrier, allowing some constituents to pass, while preventing others from doing so. The movement of constituents across a membrane requires a driving force, such as pressure, concentration, electric potential, or temperature. Membrane processes are very effective at removing many contaminants, including TDS, iron, manganese, and hardness. Membrane processes include reverse osmosis (RO), nanofiltration, ultrafiltration, microfiltration, and electrodialysis (ED) /electrodialysis reversal (EDR). They tend to have higher capital costs and operational costs than traditional treatment technologies. Also, power costs can be substantial.

For VWC's potential softening application, ultrafiltration and microfiltration are not appropriate as primary treatment processes because these processes will not remove dissolved calcium and magnesium. However, they could be considered for secondary treatment processes to remove particulate calcium and magnesium after precipitation. The remaining membrane processes are described below.

3.4.1 Reverse Osmosis

Osmosis is a natural process whereby water diffuses through a semi-permeable membrane from a solution of lower concentration to one of higher concentration. The membrane readily passes water but acts as a barrier to solutes (dissolved solids). At equilibrium conditions, the pressure differential across the membrane is called the osmotic pressure. In RO, a pressure greater than the osmotic pressure is applied to the more concentrated solution, to produce a less concentrated solution.

The RO feedwater is typically treated to remove large particles and conditioned to help prevent scaling in the membranes. High pressure RO feed pumps boost the feed pressure to above the osmotic pressure of the source water. Two flows exit the membranes: the combined product (permeate) and the combined concentrate (reject). The recovery of the RO system is the ratio of the product water to the feed water and can range from 50 to 85 percent depending upon the quality of the source water. The maximum allowable recovery depends on the water's scaling potential, which is a function of the feedwater quality. This ratio is maintained by the use of a control valve on the reject piping. This valve controls the flow rate of the reject, thus forcing the permeate flow rate to the desired value.

Membranes are typically composed of cellulose acetate or Thin-Film Composite, which includes polyamide membranes with asymmetric polyamide support structures and composite membranes with thin-film polyamide or other membrane materials on a porous support structure. Use of each membrane material has advantages and disadvantages.

RO membrane elements are placed inside pressure vessels in several different configurations: hollow fiber, spiral wound, tubular, and plate-and-frame. In the past 20 years, the hollow-fiber and spiral wound configurations have become industry standards for RO water treatment. Most of the major RO systems built in the last 5 years have incorporated spiral-wound membranes. This predominance has resulted from recent advances in membrane technology, which has been more easily translated into commercial flat-sheet membranes than into the hollow-fiber configuration.

Depending on the desired capacity of an RO system, one or more pressure vessels containing RO membranes are used to form a modular block. Pressure vessels within an RO block can be arranged in parallel, in series, or both depending on the design requirements. Often this membrane-pressure vessel arrangement is called a membrane array or a pressure vessel array.

3.4.2 Nanofiltration

The nanofiltration (NF) membrane is considered a separate membrane category and is generally utilized for softening applications. The term nanofiltration was first used for membranes with pores of 1 nm (10^{-9} m). A review of NF membrane specifications indicates that the membranes exhibit an NaCl rejection of 45-92 percent and a divalent ion (calcium and magnesium) rejection of about 98 percent. As a result, these membranes are quite capable of removing hardness components from water. They also exhibit good rejection (79-99 percent) for organic molecules with a molecular weight of 200 or more. This latter attribute makes the membranes useful for color removal as well as softening. These rejections are achieved at low operating pressures of 70-140 psig with flows of at least 20 gpd/sq. ft.

3.4.3 Electrodialysis and Electrodialysis Reversal

ED and EDR processes are often considered as an alternative to RO for brackish water conversion. However, unlike the RO process, these processes are generally not effective for the removal of dissolved organic or microbiological contaminants. ED is an electrically driven process that induces the ions to migrate through the membrane, thus removing salt from bulk water feed solution. The process uses alternatively placed cation (+) and anion (-) transfer membranes in a DC current path. A current passing through the membrane array transfers ions (dissolved salts in water, each containing positive or negative electrical charges) through membranes selectively by means of ion electrical exchange - cation or anion. The alternating compartments between membranes become depleted or concentrated in salts or ions. The cell pairs are arranged in stacks, and the desired salinity reduction can be achieved by passing the dilute stream through the appropriate number of cell pairs and stages.

The EDR process is based on the classical ED process in which water flows between alternately placed cation and anion transfer membranes at low hydraulic pressure. The two processes differ in the application of the theory to hardware design and operation. In ED, the electrical current flow is always in the same direction and the dilute and concentrate cells remains fixed. In EDR, the electrical polarity is reversed periodically (typically two to four times per hour). This results in a reversal of ion movement and provides electrical flushing of scale-forming ions from the membrane surfaces. This electrical flushing can control scaling and fouling of membranes and reduce pretreatment needs. High water recoveries are achieved through controlled recirculation and blowdown of the concentrate stream. The EDR units may be able to operate at higher levels of supersaturation of sparingly soluble salts than the ED process, thus giving the EDR process an expanded range of application.

3.4.4 Pretreatment Requirements

To evaluate the pretreatment requirements for the candidate softening processes, the typical water quality analysis was provided to several membrane and equipment suppliers. The results of these evaluations indicates that cartridge filtration is recommended prior to all (RO, NF and ED/EDR) of the processes. Based on these evaluations, the pretreatment requirements appear to be minimal.

3.5 Candidate Softening Processes

Pellet softening, ion exchange, reverse osmosis, nanofiltration, electrodialysis and electrodialysis reversal will all be considered as candidate softening processes for the following section.

Section 4: Evaluation of Candidate Softening Technologies

The previous section provided an overview of the potential softening technologies. This section presents an economic and non-economic evaluation of these treatment technologies, including the projected economic benefits of water softening. Recommended softening technologies for VWC are presented.

4.1 Overview of Candidate Softening Technologies

4.1.1 Pellet Softening

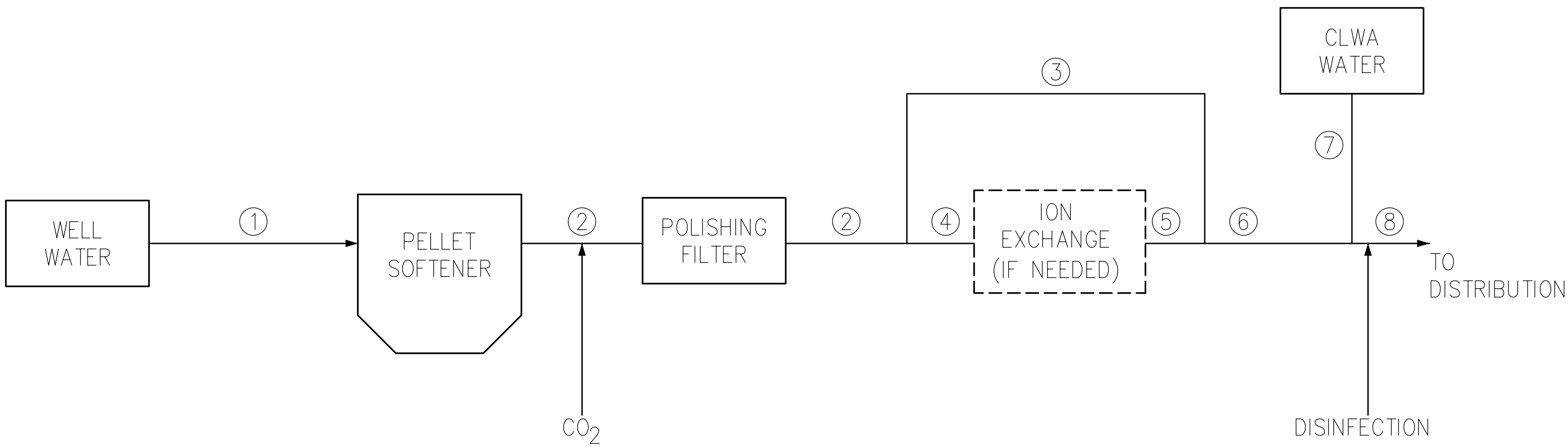
VWC performed pellet softening on a pilot scale for raw water from one alluvial well and one Saugus well. The pilot study train consisted of a softening column, a recarbonation tank, a dual-media polishing filter and ion exchange as needed. The pilot successfully treated the Saugus well with pellet softening only while some ion exchange was required for the alluvial well to meet the target hardness of 150 mg/l. The pilot study used Caustic soda to adjust the pH prior to the pellet softener and used carbon dioxide to lower the pH of the treated water. Due to the success of caustic soda in the pilot study, lime will be ruled out as a pretreatment option for the full scale pellet softening process.

Water from each well was run through the pilot plant for two 24 hour periods. Each 24 hour period used a different flow rate. The optimum pH for softening of both wells was found to be 9.6 to 9.8. Results showed that running the pellet softener at a higher pH actually increased the residual hardness. For both alluvial well flow rates, the percent removal for total hardness was found to be approximately sixty percent from raw water to polishing filter effluent. This decrease was not enough to reach the target hardness level so ion exchange was required. The results of the pellet softening study will be used to aid in design of full scale pellet softening treatment sites. Application of pellet softening on a full scale system is discussed further below.

For the plant model waters discussed in Section 2.3, it was determined that the water quality objectives could not be met with the pellet softening process alone. For all plants the pellet softening process will have to be followed by partial ion exchange to reach a total hardness of 150 mg/l. The goal is to minimize the amount of ion exchange needed since the ion exchange recharge process creates a brine that will need to be stored and hauled away periodically.

Because the treated well water will be blended with the CLWA water which has an average total hardness around 155 mg/l, the well water would have to be treated below the treatment goal so that when the treated well and CLWA waters are blended the product water will still meet the total hardness treatment goal. This will require that the ion exchange unit treat anywhere from 0.1 to 1.7 mgd additional flow to reach the treatment goal. A proposed flow diagram is shown on Figure 4-1.

The pellet softening process requires a caustic soda (NaOH) storage and feed system, a sand storage and feed system, a carbon dioxide feed system for pH adjustment after pellet softening and a polishing filter. Elements of the ion exchange process are discussed in the following section.



Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Conceptual Flow Diagram
Pellet Softening/ Ion Exchange
of Well Water

April 2006
K/J 0589044

Figure 4-1

P:\PW-Proj\2005\VWC - Well Softening\09_Report Prep\9.09_Report\9.09a_Draft\Figures\2006-01-24_For_Report\589044-4-3.dwg, 3/3/2006

4.1.2 Ion Exchange

Ion exchange alone is capable of meeting the hardness treatment goals for all wells, however due to the undesirable production of brine, ion exchange will only be considered as a supplement to the pellet softening process.

Ion exchange units are typically supplied in duplicate so that one set of units can handle the full rated flow while the other(s) are being regenerated. Regeneration is done periodically and varies based on the total hardness being treated. While the regeneration process does not create a constant stream, the brine cannot be sent to the sewer system and would have to be stored and hauled away. This makes ion exchange alone an unattractive treatment option. However, as discussed in previous sections, pellet softening does not meet the treatment goals so in all cases, ion exchange could be used as a supplemental treatment process. Use of redundant ion exchange units can be eliminated by scheduling regeneration during the time when production is shutdown and/or by allowing increased hardness during regeneration.

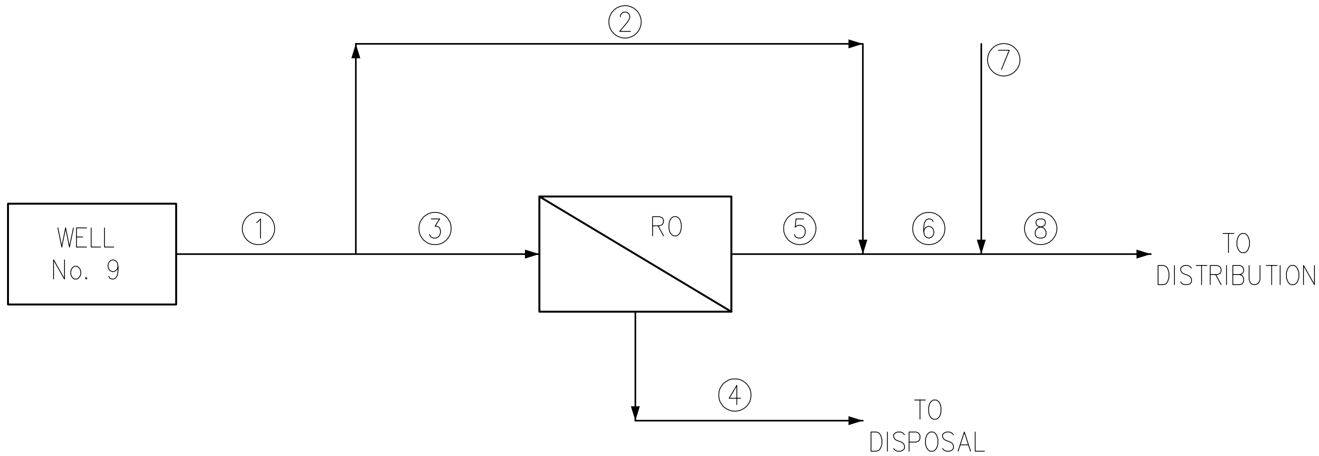
Once the well water has been treated through the pellet softener, pH adjusted with carbon dioxide and run through the polishing filter, it will then be partially treated through the ion exchange unit. A portion of the pellet softened water will be bypassed around the ion exchange unit so that the treatment goal can be reached without creating an excess of regeneration waste from the ion exchange process.

4.1.3 Reverse Osmosis

The low pressure RO membrane process can remove more than 95 percent of the salts and other minerals in the source water, producing extremely high quality permeate water. As discussed previously, the RO permeate will be blended with a bypass stream to achieve hardness within the desired range. Figure 4-2 shows the required flow split for each of the proposed treatment plants. Based on typical removal rates for low pressure RO membranes, estimated treated water quality is provided in Table 4-1.

An RO treatment facility would require pretreatment and possibly some level of post-treatment. Pretreatment consists of antiscalant addition and cartridge filters. The antiscalant is added continuously to the RO feed water to help prevent scale formation and build-up on the membrane surface. The cartridge filters remove large suspended solids to protect and prevent damage to the RO membrane elements. Redundant chemical feed equipment and cartridge filters would be provided to prevent loss of treatment capability in the event of maintenance or equipment failure.

After pretreatment, booster pumps are required to increase the pressure of the RO feed to approximately 100 to 130 psig. Booster pumps would be in-line centrifugal booster pumps and would be controlled by variable speed drives. The RO equipment includes membrane process units or skids, a membrane clean in place (CIP) system and related system controls. The number of skids required is dependant on the required plant flow.



STREAM NUMBER	1	2	3	4	5	6	7	8
STREAM NAME	WELL SUPPLY	SYSTEM BYPASS	RO SYSTEM FEED	RO SYSTEM CONCENTRATE	RO SYSTEM PERMEATE	BLENDED PRODUCT	CLWA WATER	TO DISTRIBUTION
PLANT A	7.1	1.7	5.4	1.1	4.3	6.0	7.1	13.2
PLANT B	9.0	2.7	6.3	1.3	5.0	7.7	9.0	16.7
PLANT C	4.8	1.4	3.4	0.7	2.7	4.1	4.8	8.9
PLANT D	3.6	1.0	2.6	0.5	2.1	3.1	3.6	6.7
PLANT E	6.9	1.7	5.2	1.0	4.2	5.9	0.8	6.7
PLANT F	8.6	2.3	6.4	1.3	5.1	7.4	8.6	16.0
PLANT G	2.9	0.7	2.2	0.4	1.8	2.5	2.9	5.4
PLANT H	1.5	0.4	1.1	0.2	0.9	1.3	1.5	2.8

Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Conceptual Flow Diagram
Reverse Osmosis

April 2006
K/J 0589044
Figure 4-2

Table 4-1 RO Treated Water Quality

	Plant A		Plant B		Plant C		Plant D	
	RO Treated	Well/CLWA Blend	RO Treated	Well/CLWA Blend	RO Treated	Well/CLWA Blend	RO Treated	Well/CLWA Blend
Calcium (Ca)	0.14	31.63	0.11	31.41	0.10	28.29	0.12	30.46
Magnesium (Mg)	0.04	12.70	0.03	13.01	0.04	14.80	0.04	13.34
Sodium (Na)	0.33	37.22	0.40	42.48	0.23	35.54	0.30	37.45
Chlroide (Cl)	4.53	48.63	6.98	57.96	2.36	43.99	2.04	42.81
Sulfate (SO_4)	2.76	59.51	1.50	47.16	2.21	57.82	3.00	67.29
Total Hardness (as $CaCO_3$)	0.51	149.11	0.41	149.39	0.42	148.79	0.45	148.45
TDS	38.64	255.93	38.30	277.00	31.52	250.10	39.00	268.27

	Plant E		Plant F		Plant G		Plant H	
	RO Treated	Well/CLWA Blend	RO Treated	Well/CLWA Blend	RO Treated	Well/CLWA Blend	RO Treated	Well/CLWA Blend
Calcium (Ca)	0.12	34.04	0.11	29.51	0.14	30.55	0.11	29.03
Magnesium (Mg)	0.05	13.40	0.04	13.94	0.04	13.37	0.04	14.13
Sodium (Na)	0.42	32.12	0.42	41.87	0.28	35.30	0.39	41.08
Chlroide (Cl)	4.93	31.66	6.89	56.12	1.59	41.21	6.81	56.41
Sulfate (SO_4)	3.37	91.36	1.79	49.26	3.58	68.62	2.12	55.19
Total Hardness (as $CaCO_3$)	0.50	143.90	0.45	148.91	0.52	148.82	0.44	148.96
TDS	46.11	290.55	39.31	269.29	40.20	256.60	40.35	276.51

The CIP system is used to periodically remove scale build-up on the membranes to restore performance. The frequency of cleaning is highly dependent on incoming water quality and is generally based on pressure drop across the membrane and/or effluent water quality. For the high quality source water in our scenario the CIP system may be used as infrequently as once per year. The CIP system consists of one or more CIP tanks which are used to mix and store the chemical solution during the cleaning process and the CIP pump which circulates the chemical solution through the membrane elements. The cleaning chemicals are typically stored separately in drum containers or other bulk storage until needed for CIP.

RO permeate water is corrosive to pipes due to low pH and low levels of alkalinity and hardness. Typically, carbon dioxide would be stripped from the permeate to reduce buffer capacity and to raise the pH. In addition, sodium hydroxide could be added for pH adjustment and zinc orthophosphate could be added to prevent corrosion in the distribution system. However, for the purposes of this study, the blended water is assumed to create an adequately non-corrosive water so postreatment will not be considered in our analysis. A conceptual process flow diagram for the RO process is provided on Figure 4-2**.**

4.1.4 Nanofiltration

The nanofiltration (NF) process is very similar to the RO process. The main difference is that the NF membranes have a larger pore size than RO membranes so the rejection rates for the various constituents will be slightly different. However, the NF process will efficiently remove hardness below the treatment goal. As shown on Figure 4-3, a bypass line will be provided for the NF to reach the ultimate treatment goals. The NF process is preferable to the RO membranes due to higher water recovery rates. The total RO brine production for all plants would be approximately 6.5 mgd whereas the NF brine production would only be around 3.6 mgd.

Nanofiltration would require the same pretreatment as the RO process. The NF would also require booster pumps and a CIP system. A conceptual flow diagram for the NF process is shown on Figure 4-3.

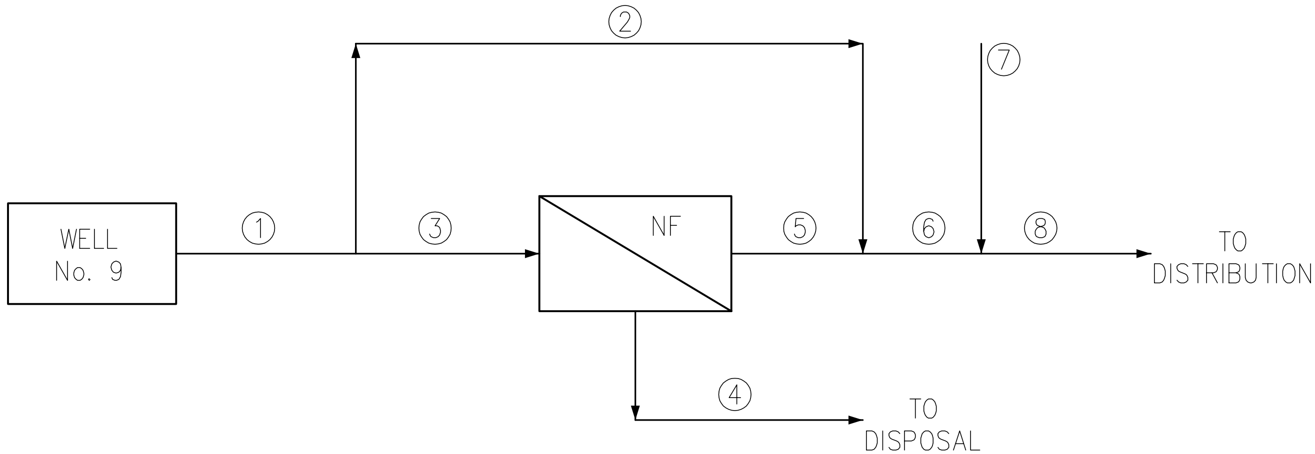
4.1.5 Electrodialysis and Electrodialysis Reversal

Electrodialysis and electrodialysis reversal are used less frequently than RO and NF. ED and EDR are generally more expensive than RO and would create a constant brine stream similar to that of RO and will therefore not be considered further.

4.2 Treated Water Quality

As shown above, membrane processes can treat each plant to the treatment goal and even requires bypassing some of the raw water in order to maintain a non-corrosive treated water.

Since pellet softening was found to be the only practical treatment technology, pellet softened water quality was estimated for each plant. None of the plants were able to reach the target hardness goal with pellet softening alone. Part of the pellet softening effluent would need to be treated through ion exchange in order to reach an ultimate treated and blended hardness goal of 150 mg/l.



STREAM NUMBER	1	2	3	4	5	6	7	8
STREAM NAME	WELL SUPPLY	SYSTEM BYPASS	NF SYSTEM FEED	NF SYSTEM CONCENTRATE	NF SYSTEM PERMEATE	BLENDED PRODUCT	CLWA WATER	TO DISTRIBUTION
PLANT A	7.2	1.4	5.8	0.6	5.2	6.5	7.1	13.6
PLANT B	9.0	2.3	6.7	0.7	6.0	8.3	9.0	17.3
PLANT C	4.8	1.2	3.6	0.4	3.2	4.4	4.8	9.2
PLANT D	3.6	0.8	2.8	0.3	2.5	3.3	3.6	6.9
PLANT E	6.9	1.3	5.6	0.6	5.0	6.3	6.9	13.2
PLANT F	8.7	1.9	6.8	0.7	6.1	8.0	8.6	16.6
PLANT G	2.9	0.5	2.4	0.2	2.2	2.7	2.9	5.6
PLANT H	1.5	0.3	1.2	0.1	1.1	1.4	1.5	2.9

Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Conceptual Flow Diagram
Nano Filtration

April 2006
K/J 0589044
Figure 4–3

Based on historical data, the CLWA typical hardness is 154 mg/l. While data from the Santa Clarita Valley 2005 Water Quality Report (2005 Annual Report) shows a typical hardness of 122 mg/l for CLWA water, the more conservative typical value of 154 mg/l was used to estimate treated water quality. The treated water quality estimates are summarized in Table 4-2 below

Table 4-2 Estimated Treated Water Total Hardness (mg/l)

	Plant A	Plant B	Plant C	Plant D	Plant E	Plant F	Plant G	Plant H	W9
Pelled Softened Well									
Flow (gpm)	4,950	6,250	3,300	2,500	4,800	6,000	2,000	1,050	800
Total Hardness as $CaCO_3$	194.2	175.0	226.7	197.5	241.3	214.6	222.5	214.2	220.8
CLWA Water									
Flow (gpm)	4950	6250	3300	2500	533.3	6000	2000	1050	800
Total Hardness as $CaCO_3$	154.2	154.2	154.2	154.2	154.2	154.2	154.2	154.2	154.2
Combined CLWA/Treated Well									
Flow (gpm)	9,900	12,500	6,600	5,000	5,333	12,000	4,000	2,100	1,600
Total Hardness as $CaCO_3$	174	165	190	176	233	184	188	184	188

Based on the estimates shown in Table 4-2, with the exception of Plant E, all plants can be treated to within 50 mg/l of the hardness goal with pellet softening alone. The pellet softener may be able to remove some additional calcium hardness by dosing more caustic but a minimal level of calcium in the treated water is required to maintain a stable water that is neither corrosive nor scaling.

In order to reach the original treatment goal of 150 mg/l total hardness, ion exchange would be required at all plants. However, providing ion exchange for all plants significantly increases project costs and reduces the cost-effectiveness of hardness removal. Since a large portion of the cost increase is due to brine disposal costs, one way to reduce the overall cost is to reduce the amount of brine sent to disposal. There are four parts of each regeneration cycle. The first is the backwash cycle which lasts about 10 minutes and produces the highest volume of all the cycles (approximately 3.5 bed volumes). This water could be sent to a waste recovery tank and used for filter backwash, regeneration backwash or saturator dilution. The next part of the regeneration cycle is the salt regeneration cycle which lasts about 30 minutes and generates a little over two bed volumes of waste water. The last 1/3 of the regeneration cycle can typically be captured and reused for the next regeneration cycle. In addition the first ½ bed volume of the cycle can be sent to the recovery tank since it is clean water left over from the backwash cycle. The last two parts of the regeneration process are the slow rinse and fast rinse which combined create a little under 3.5 bed volumes of waste. Only the first part of each rinse must be sent to waste, so approximately 2.5 bed volumes from both rinses combined can be send to the same waste recovery tank as the backwash cycle and reused.

Table 4-3 below summarizes the volume of water that can be captured and re-used according to the discussion above. There would be additional capital costs to provide the storage tanks and controls for capturing and re-using flow but this would allow for a considerable annual O&M cost savings while still reaching the treatment goal of 150 mg/l of total hardness.

Table 4-3 - Brine Production/Disposal Summary

	Plant A	Plant B	Plant C	Plant D	Plant E	Plant F	Plant G	Plant H
Ion Exchange Total Waste Water (gal/day)	52,936	44,033	58,626	28,235	98,126	84,541	32,988	15,742
Truck Loads per day for Total Waste[1]	11	9	12	6	20	17	7	4
Disposal Cost per year Total Flow[2]	**$ 1,999,800**	**$ 1,072,100**	**$ 1,673,400**	**$ 687,500**	**$ 3,377,500**	**$ 1,916,300**	**$ 858,500**	**$ 541,900**
Backwash Waste Recovered (gal/day)	20,708	17,226	22,934	11,046	38,387	33,072	12,905	6,158
Regeneration Recovered (gal/day)	4,659	3,876	5,160	2,485	8,637	7,441	2,904	1,386
Rinse Recovered per Day (gal/day)	1,817	1,512	2,012	969	3,368	2,902	1,132	540
Volume to Waste (gal/day)	25751	21420	28519	13735	47734	41125	16047	7658
Revised Truck Loads per day	6	5	6	3	10	9	4	2
Disposal Cost per year w/ Recovery Tanks[2]	**$ 972,900**	**$ 521,500**	**$ 814,100**	**$ 334,400**	**$ 1,643,000**	**$ 932,200**	**$ 417,700**	**$ 263,600**
Monthly Savings	*$ 85,575*	*$ 45,883*	*$ 71,608*	*$ 29,425*	*$ 144,542*	*$ 82,008*	*$ 36,733*	*$ 23,192*

[1]Based on 5,000 gallon trucks.

[2]Based on a disposal cost of $0.23 per gallon. Flow adjusted based on average annual well production.

4.3 Treatment Residuals

4.3.1 Pellet Softening

The two main residuals from pellet softening are the calcium/sand pellets and the spent filter backwash water.

Calcium hardness is removed in the pellet softener in the form of calcium carbonate pellets that form around a sand nucleus. The larger pellets migrate to the bottom of the pellet softener where they can either be taken out in batch or periodically during operation. The pellets are typically close to 1 mm in size when removed. The pellets are solid crystalline structures and are easily dewatered. The amount of pellets produced in a day is dependent on the calcium hardness influent and the chemical dosing. The estimated average calcium removal for the proposed pellet softening plants is between 80 and 125 mg/l. Assuming that 5% of the pellets will be the sand nuclei this will produce anywhere between 0.1 to 3 cubic yards of pellets per day depending on the plant. Pellets will be discharged into a roll-off bin for draining and hauling. Two 10 cubic yard bins are recommended so that one is always available while the other is being emptied. The pellets can be used as a soil amendment, used in construction, recycled for other beneficial uses (e.g., animal feed additive, alkalinity supplement), or sent to a landfill. Further research will be required to find possible beneficial users in the Santa Clarita area. If no beneficial users are found, the pellets can be sent to the local landfill.

The filter backwash water can be discharged to the local sewer if capacity and location allow. If there is no sewer nearby or capacity is not available, another option would be to collect filter backwash in a settling tank. Solids will settle to the bottom of the tank where they will need to be periodically collected and disposed of. Clear water can be decanted off the top of the tank and sent back through the treatment train. The decanted water can also be discharged to local storm drains or waterways if an NPDES permit is obtained from the Los Angeles Regional Water Quality Control Board (LARWQCB). Methods of disposal will be site specific and will need to be determined on a plant by plant basis.

4.3.2 Ion Exchange

The ion exchange resin must be periodically regenerated or replaced to provide continuous hardness removal. The regeneration would be performed on site using a sodium chloride brine solution. The regeneration process produces a liquid waste of brine with the calcium and magnesium ions removed from the resin. The frequency of regeneration will be dependent on the amount of flow treated and the total hardness treated. Therefore, the amount of waste produced will vary from plant to plant. The regeneration waste would be stored in a tank on site and hauled away on a daily basis. Some of the water from the regeneration cycle can be captured and re-used as discussed in Section 4.2 above.

4.3.3 Reverse Osmosis

The reverse osmosis processes produces a continuous reject stream of a solution containing concentrated amounts of the constituents removed by the membranes. The concentrated reject stream must be disposed of through evaporation or sent to an ocean outfall. Evaporation would require large ponds that are prohibited by available land and aesthetic issues in the surrounding area. A brine line would be the most likely disposal method for this project. However, construction of a brine line solely for softening would be economically infeasible. Accordingly, until a brine line is constructed for other purposes, reverse osmosis, as well as other membrane processes are not feasible.

4.3.4 Nanofiltration

Similar to reverse osmosis, nanofiltration generates a concentrated reject stream. The discharge options for the brine would be the same as those discussed above.

4.3.5 Electrodialysis and Electrodialysis Return

As with the other membrane technologies, the ED/EDR process would produce a concentrated reject stream that would need to be dealt with in the same manner as discussed above.

4.4 Recommended Softening Project

Based on both economic and non-economic factors, the pellet softening process is recommended as the primary softening method at all sites. Supplemental ion exchange can be added in the future, if necessary. The specific process is discussed below.

4.4.1 Summary of Process Evaluation

Based on the evaluation of candidate treatment processes, pellet softening is recommended as the primary softening process. It is also recommended that provisions to supplement pellet softening with ion exchange be incorporated so that lower hardness levels can be reached, if necessary to meet customer expectations and the objectives. Although, pellet softening alone cannot reach the total hardness goal of 150 mg/l, blending with CLWA water will allow the treated water quality to be within 50 mg/l of the treatment goal, with the exception of Plant E. Utilizing ion exchange as a supplemental process will significantly increase project costs. Accordingly, the recommended softening process is pellet softening with caustic soda addition and carbon dioxide post-treatment followed by dual media pressure filters for polishing and disinfection. Plants should be designed to allow for future addition of ion exchange if needed.

Treated water from Plant E can have a blending rate up to 10/90 CLWA water to well water. Because this ratio is limited, pellet softener effluent is estimated to be over 80 mg/l above the total hardness treatment goal. In order to get closer to the treatment goal, Plant E will require additional treatment through ion exchange. Accordingly, Plant E will have pellet softening with caustic soda pretreatment and carbon dioxide post-treatment followed by dual media pressure filters for polishing, ion exchange and disinfection.

4.4.2 Post-Treatment Requirements

All of the plant sites will require disinfection before final distribution. Currently, disinfection is provided at each wellhead. If possible, the individual disinfection systems from each well will be relocated to the plant sites. At plants D, G, E and H the individual well disinfection systems should suffice for the plant locations since these sites will treat a single well. The remaining plants are a combination of multiple wells and may require design of a new disinfection system to treat the combined plant effluent flow.

4.6 Alternative Project

In order to reduce overall project costs, an alternative project was evaluated. The alternative project will treat most, but not all wells and assumes treating only calcium hardness using pellet softening. Provisions to add ion exchange in the future could also be included. The alternative project has an overall treatment goal to 200 mg/l total hardness, however the same amount of calcium hardness will be removed as in the prior alternative.

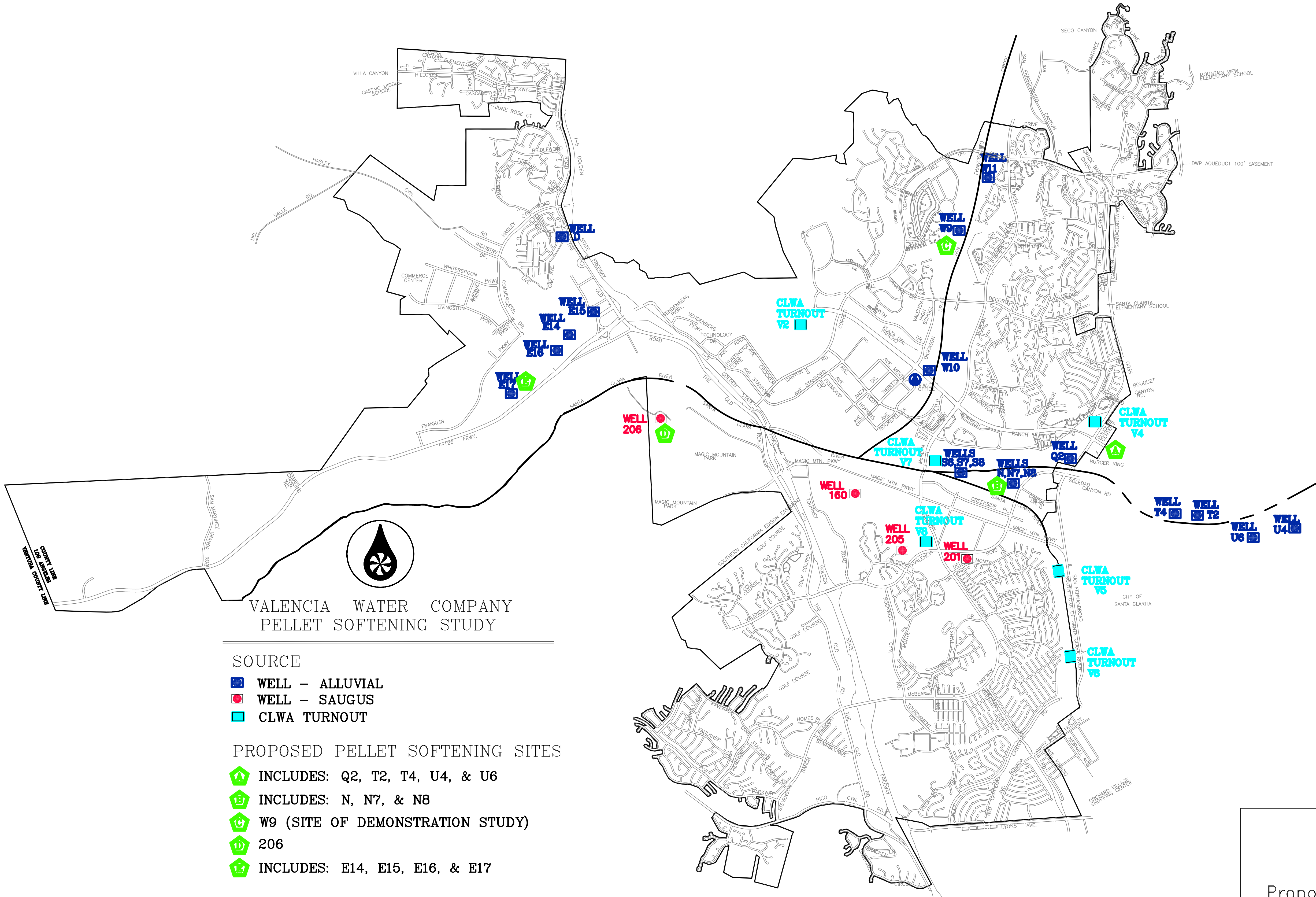
Figure 4-4 shows the proposed well softening plant locations for the alternative project. The estimated treated water quality for each plant is summarized in Table 4-5 below.

Table 4-5 Alternative Project Estimated Treated Water Quality

Description	Plant A	Plant B	Plant C (Demonstration)	Plant D	Plant E
Wells	**Q2, T7, U4, U6**	**N, N7, N8**	**W9**	**206**	**E14, E15, E16 & E17**
Pelled Softened Well					
Flow (gpm)	4,950	6,250	800	2,500	4,800
Total Hardness as CaCO3	194.2	175.0	220.8	197.5	241.3
CLWA Water					
Flow (gpm)	4950	6250	800	2500	533.3
Total Hardness as CaCO3	154.2	154.2	154.2	154.2	154.2
Combined CLWA/Treated Well					
Flow (gpm)	9,900	12,500	1,600	5,000	5,333
Total Hardness as CaCO3	174	165	188	176	233

Table 4-5 demonstrates that all plants, with the exception of Plant E, can meet the revised treatment goal of 200 mg/l total hardness. However, due to the cost of ion exchange, Plant E will only be treated with pellet softening. Even though the total hardness of Plant E is above 200 mg/l, the calcium hardness will be reduced to the same level as the rest of the softening plants (a minimum of 20 mg/l calcium for water stability). The treated water values assume calcium removal only. In practice, some magnesium may be removed in both the pellet softener and polishing filter processes, which would further decrease the treated water hardness. However, this will be determined by operational experience.

The estimated capital and operating costs for the alternative project are shown in Table 4-6 below.



Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Alternative Project
Proposed Softening Plant Sites

April 2006
K/J 0589044
Figure 4-4

4.7 Projected Economic Benefits of Water Softening

Higher quality water can result in identifiable economic savings to the water consumer stemming from the elimination or reduction in the need for home softening. In addition, because one of the objectives of water softening is to reduce chloride discharges from home self-regenerating water softeners, reduced expenditures for wastewater treatment and thereby, lower rates may also result from centralized water softening. The potential economic benefits created by lower wastewater rates are not included in this feasibility study.

The willingness of people to pay for softer water is amply demonstrated by the number of home water softeners in operation throughout VWC's service area. Savings in cleaning material costs and increased life of plumbing and appliances are tangible advantages of softer water. However, water users often pay many times more than the tangible savings for the convenience and the other intangible factors associated with softer water.

There is generally a relationship between the hardness of a particular water supply and the proportion of the households who will use softening equipment. Studies carried out in Wisconsin during 1961 and described in the paper *Economics of Water Softening* by Louis R. Howson, published in the Journal of the American Water Works Association in February 1962, indicated the relationship between water hardness and percentage of households using softening equipment. The Orange County Water District carried out similar studies in its service area, the results of which were reported in the District's May 1972 report *Water Quality and Consumer Costs*. Although contacts with water softening companies did not produce meaningful statistical information, it is estimated that 70 to 80 percent of the customers in the Subregion utilize water softeners. The relationship between hardness and use of water softeners in the Wisconsin and Orange County studies are summarized below.

	Percentage of Households Softening			
		Orange County Study		
Hardness mg/L	**Wisconsin Study**	**$20,000 to $25,000 House Value (1972)**	**$25,000 to $30,000 House Value (1972)**	**All Areas**
100	0	0	2	13
150	10	5	2	17
200	30	11	17	21
250	50	17	24	24
300	70	23	32	28
350	90	29	39	32

The extent of water softening in any particular area will depend not only on the hardness of the water supply, but also upon factors such as regional preferences, quality of water to which the users are accustomed, socioeconomic level of residents of the area, intensity of promotion for sales and rentals of softeners, etc. Accordingly, these relationships would be viewed as a general guide.

For given reduction in water hardness, householders would realize savings as follows:

1. A portion of the homeowners would terminate their water softening as a result of the improvement in quality and the savings to these users would be the total cost of water softening (less any increase in cost of cleaning products resulting from abandonment of softening).

2. A portion of the homeowners would continue to maintain their softeners in operation, but the costs would be reduced because less frequent regeneration of the softening units would be required.

3. For those homeowners without water softeners, the saving would be reflected in the reduction in cost of cleaning products.

In its October 2002 Santa Clarita Valley Joint Sewerage System Chloride Source Report, the Los Angeles County Sanitation Districts (LACSD) conducted a survey of households in selected neighborhoods in the Santa Clarita Valley. Of the neighborhoods in VWC's service area, 54 percent of both Valencia and Stevenson Ranch had home water softeners. However, in

Valencia, only 14 percent had the self-regenerating type and 40 percent had the exchange type whereas in Stevenson Ranch, 51 percent had the self-regenerating type and 3 percent had the exchange type. Based on this survey, LACSD concluded that the neighborhoods built after 1997 had a significantly higher level of self-regenerating water softener use than older neighborhoods, reaching 51 to 61 percent of households built after 1997. Use of exchange type softeners exhibited the reverse trend, having only 3 to 4 percent use in neighborhoods build after 1997. The survey also found that approximately half of those with self-regenerating water softeners utilized time intervals rather than demand as the basis for regeneration. Salt usage ranged from 1.0 to 3.3 bags (12 to 40 pounds per day) per month.

A telephone survey of the City of Simi Valley, California was conducted in 1991 to evaluate the use of household water softeners. The survey concluded that 24 percent of the households in this area have water softeners.

Because the City of Simi Valley only receives State water, it is anticipated that water softener use in VWC's service area will decline from approximately 54 percent to 24 percent. Based on contact with distributors of water softening equipment, the estimated cost of each residential water softener is approximately $300 per year. Based on an estimated 28,300 services in the VWC service area, the estimated economic benefits from reduced water softener use are $2,610,000 per year.

In addition, LACSD has estimated that the cost of wastewater treatment and a brine line to Ventura to comply with the discharge limitation for chloride is a capital cost of $422 million (2002) and an operation and maintenance cost of $17 million (2002). Adjusting for inflation at 4 percent per year and amortizing at 6 percent over 30 years the total annual cost of additional treatment and disposal is $47.2 million (2006) per year. Assuming that VWC customers represent 45 percent of the wastewater contribution, the avoided wastewater costs to VWC customers could total $21.2 million per year, depending on the level of home water softener removal.

Based on these estimates the benefits of water softening of VWC wells could be as high as $23.8 million per year.

Section 5: Evaluation of Potential Demonstration Sites

The previous section identified the recommended softening technology for VWC's well/wellfields. This section evaluates alternative well/wellfield locations for a wellhead softening demonstration project.

5.1 Objectives of the Water Softening Demonstration Project

The main objective of the demonstration project is to confirm consumer acceptance of a centralized softening system. The demonstration plant will be a full scale treatment plant for one well with a service area that can be sufficiently isolated. The full scale plant will treat raw well water from one well with pellet softening technology and will distribute the treated water to a defined service area. During plant operation, the goal will be both to optimize the treatment process itself based on defined water quality goals and to survey consumers within the service area to determine if the centralized water will sufficiently increase consumer satisfaction. The ultimate goal is to convince individual residents to remove their home softening systems. The demonstration project will also be used to help predict rate impacts for the overall well softening project.

5.2 Candidate Demonstration Sites

Of VWC's 18 active wells, three were selected as possible demonstration sites in consultation with VWC staff. Two alluvial well sites and one Saugus well site were chosen. The two alluvial well sites were Well D and Well W9. The one Saugus well selected was Well 205. These wells are discussed below.

5.3 Criteria for Selection of a Demonstration Site

The demonstration sites were selected on the following criteria:

- Available land near well for demonstration site.
- Ability to isolate source to specific customers.
- Well flow in relation to selected treatment option.
- Target population fitting to the Los Angeles County Sanitation District's (LACSD) softener usage information.

5.4 Evaluation of Candidate Demonstration Sites

Well D produces 1,050 gpm of water and serves VWC pressure Zone I. Well D has an average total hardness of 436.5 mg/l as $CaCO_3$ which is the highest total hardness of the three selected wells. Well D has a flow that can be treated with a single pellet softener but would be difficult to isolate to a single service area. Accordingly, well D is an undesirable site for the demonstration project.

Wells 205 and W9 both serve VWC pressure Zone IIA North. Well 205 produces 2,700 gpm with and average total hardness of 375 mg/l. A demonstration plant for Well 205 would be almost double the size for a plant to treat Well D or W9. The fact that it would be difficult to isolate Well 205 to a single service area makes it a less desirable demonstration site than well W9.

Well W9 produces 800 gpm with an average total hardness of 392 mg/l. Well W9 would require the smallest size scale plant based on well flow and was the easiest to isolate of the three. In addition the Well No. 9 site has ample land available and has a pumping capacity that works well with the chosen treatment. The service area of well W9 also fits with the LACSD softener usage survey.

5.5 Demonstration Site Water Quality

As discussed above, Well W9 has been selected as the best potential demonstration site. For the demonstration study it is assumed that only well water will be treated. CLWA water will not be available for blending at the demonstration plant. In order to estimate the plant size and dosing requirements a model water for Well W9 was created and is shown in Table 5-1.

Table 5-1 Demonstration Plant (Well W9) Model Water Quality

Calcium	mg/l	91
Magnesium	mg/l	40
Sodium	mg/l	50
Potassium	mg/l	4
Total Alkalinity	mg/l	207
Chloride	mg/l	30
Sulfate	mg/l	199
Nitrate-N	mg/l	11
Fluoride	mg/l	0.4
pH		7.6
Hardness as $CaCO_3$	mg/l	394
TDS	mg/l	540

Note: Based on sample data for VWC wells from 1995 to 2005.

Section 6: Recommended Softening Demonstration Project

The previous section identified the recommended softening technology and site for the demonstration project. This section provides a more detailed description of the recommended softening demonstration project and the estimated capital and O&M costs for the demonstration project.

6.1 Description of the Softening Demonstration Project

The proposed softening demonstration study will consist of the following elements: caustic soda storage and feed system, one pellet softening reactor including sand feed and pellet removal system, carbon dioxide feed system, two dual media pressure filters with backwash supply tanks and pumps, a containment sump with pumps for the self-draining pellet collection bins and provisions for the future addition of ion exchange units. A proposed process flow diagram is shown on Figure 6-1, a proposed site layout is shown on Figure 6-2 and a proposed site location is shown on Figure 6-3.

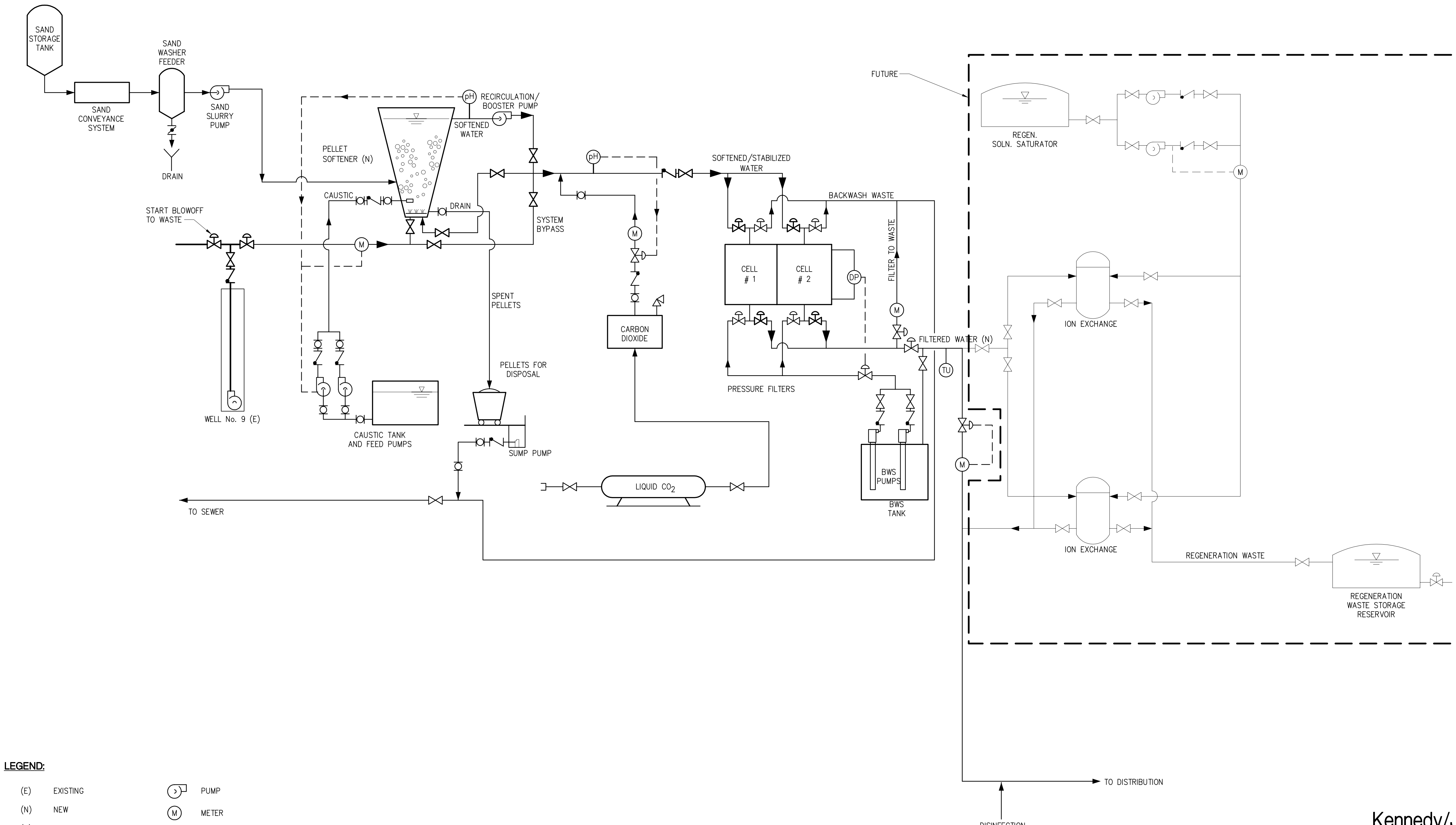
The pellet softening system was estimated to produce approximately 5,370 pounds of pellets per day. This would occupy a volume of approximately 2,900 gallons per week. Since the pellets drain quickly, they will be piped into self draining storage bins. Two 10 cubic yard bins are recommended for operational flexibility. Each bin would hold approximately a one to two week supply of pellets. The bins will be placed on a sloped concrete storage area with a sump and a drain. The sump pumps were sized to pump 5 gpm and will be triggered by level indicators

For an 800 gpm plant, it was determined that a little over 22,600 gallons of water would be required per backwash of each polishing filter. For this application, it is assumed that the filter run time will be around 100 hours which means that each filter will need to be backwashed once every 4 days. The filter backwash timing can be staggered so that one filter backwash will occur every two days. In order to supply enough water to backwash, flow will need to be diverted from the filter effluent to a backwash supply tank at a constant rate of 8 gpm. Backwash supply pumps will be provided to pump from the backwash supply tank to the filters.

The backwash waste water will most likely need to be captured on site before discharging. For the proposed demonstration site three discharge options were considered. One option would be to discharge to the local sewer. Backwash water would not be required to be settled before discharging to the sewer but since a backwash cycle creates a large amount of water in a short amount of time, the water would probably need to be captured in a backwash waste tank and sent to the sewer at a set flow rate to avoid surcharging the sewer system. A connection and discharge permit would be required to connect to the sewer. The permit will specify the maximum allowable discharge.

Another option would be to obtain a NPDES permit from the Los Angeles Regional Water Quality Control Board (LARWQB). The NPDES will most likely require settling of solids before discharging to the storm drain system or to the neighboring San Francisquito Creek. The permit will also set discharge limits and will set up testing and reporting requirements. The backwash water will most likely be able to meet the effluent limitations for all constituents as set by the LARWQCB.

A third option would be to capture the backwash water in a storage tank and use it for dust abatement for the nearby construction. This method would be dependent on construction activities and may not be as reliable as the other two options.



LEGEND:

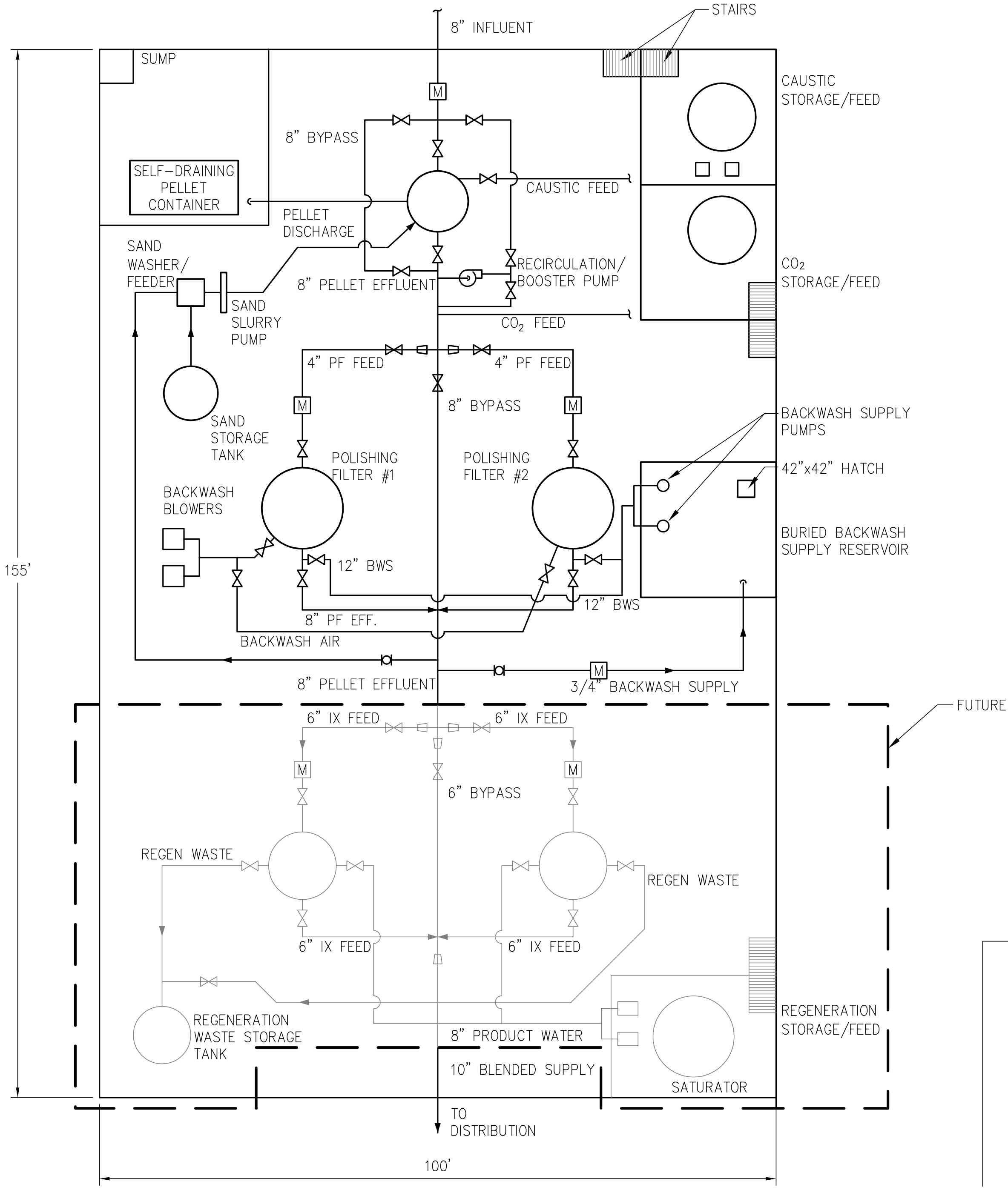
(E)	EXISTING	PUMP	PUMP
(N)	NEW	M	METER
(R)	RETROFIT	Cl	CHLORINE
———	MAIN PROCESS	pH	pH
———	ANCILLARY PROCESS	TU	TURBIDITY
——►	DIRECTION OF FLOW	DP	DIFFERENTIAL PRESSURE
– – – –	CONTROL SIGNAL		CONTROL VALVE

Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Conceptual Process and Instrumentation Diagram Pellet Softening Facility

April 2006
K/J 0589044
Figure 6–1



Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Proposed Demonstration Site Layout

April 2006
K/J 0589044

Figure 6-2

P:\PW-Proj\2005\VWC - Well Softening\09_Report Prep\9.09_Report\9.09a_Draft\Figures\2006-01-24_For_Report\589044-6-2.dwg, 3/2/2006

Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Proposed Demonstration
Site Location

April 2006
K/J 0589044

Figure 6-3

P:\PW-Proj\2005\VWC - Well Softening\09_Report Prep\9.09_Report\9.09a_Draft\Figures\2006-01-24_For_Report\589044-6-3.dwg, 3/2/2006

Section 7: Implementation Plan

The full scale demonstration plant is essential for verifying the effectiveness of the recommended demonstration technology and quantify in the willingness of customers to remove home water softeners as the basis for implementing additional wellhead softening facilities. This section discusses the implementation issues associated with the recommended wellhead softening facilities.

7.1 Recommended Plan

The primary objective of the recommended plan is to improve water quality sufficiently to allow VWC customers to remove a significant number of home water softeners.

The plan would implement wellhead softening at well clusters that minimize system operational impacts. Except at Plant E, the recommended treatment process is pellet softening with the provision to add supplemental ion exchange in the future.

A phased implementation plan is recommended. Initially, a demonstration project is recommended at Well W9. This well has a capacity of 800 gpm and is blended with CLWA water. The treated water hardness is estimated to be 172 mg/l and will predominantly be magnesium hardness. It is recommended that VWC conduct a proactive customer outreach program in the area and monitor the willingness of customers to remove or discontinue using home water softeners with the delivered water quality. The results can be used to determine if supplemental softening is necessary or if additional phases of the centralized softening program should be discontinued.

7.2 Permit Requirements

To construct and operate the recommended treatment systems, several permits and approvals will be necessary. The following paragraphs discuss the key permits and approvals.

7.2.1 Conditional Use Permit

Valencia Water Company holds existing easements for all proposed softening plant sites. Therefore, there will not be a need to obtain any new conditional use permits.

7.2.2 Department of Health Services

VWC has a current DHS permit for operation and distribution of potable water. In order to operate the proposed treatment plants, VWC would need to submit the design and a permit amendment application to DHS. Submittal of this feasibility study is also recommended. DHS approval for the amendment could require three to six months for approval.

7.2.3 Public Utilities Commission

In order to include the costs of the proposed treatment plants in its tariffs, VWC will have to file a Rate Change request with the Public Utilities Commission.

7.2.4 Hazardous Waste Storage and Use

Since the proposed treatment plants will be storing and using sodium hydroxide in excess of the listed amount in the Los Angeles County Fire Code, design plans would need to go through plan check with the Los Angeles Fire Prevention Division. Plan check will take approximately 2 to 3 weeks. Plan check is preformed by the local division listed below:

Los Angeles County Fire Department – Fire Prevention Division
North Region Santa Clarita
23757 Valencia Blvd.
Valencia, CA 91355
(661) 286-8821

7.2.5 Hazardous Waste Disposal

7.2.6 Discharge Permits

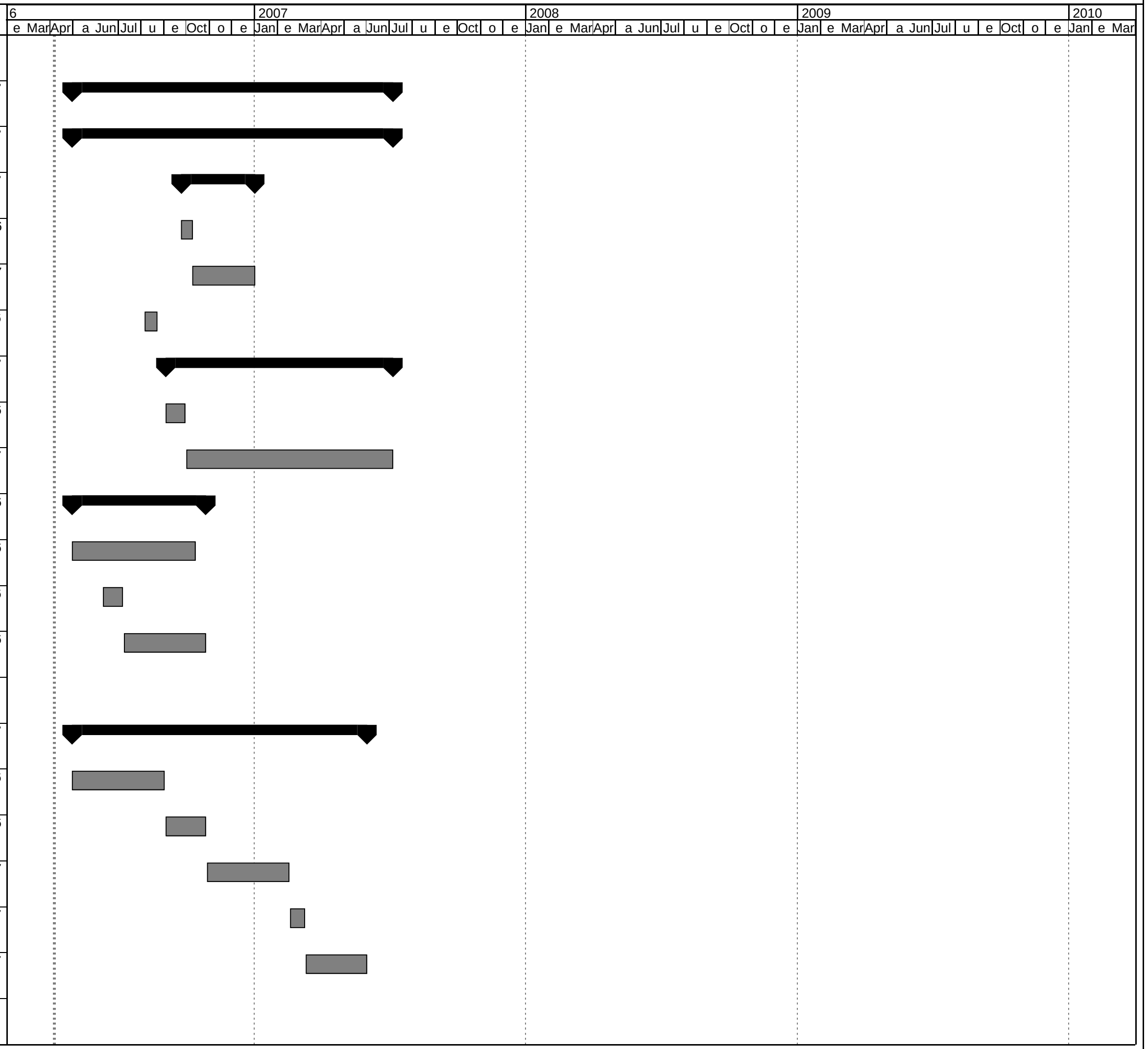
Stormwater was not discussed in this report but will need to be considered in final design. An NPDES permit from the LARWQB will be required if runoff and or backwash waste water from the plant is diverted to the local storm drain or creek/river system. In addition, if any site wastes such as polishing filter backwash waste or pellet drain sump water is discharge to the local sewer, a permit will need to be obtained from the Los Angeles County Sanitation District.

7.3 Recommended Priorities for Future Softening Facilities

As illustrated in Section 4, it is not economically feasible to construct treatment facilities for all wells. Therefore, the alternative project is recommended for implementation after the demonstration plant has successfully operated. The alternative project decreases the total number of softening plants from eight to five. In order to space out the cost impacts, it is recommended that the alternative project softening plants be built in phases.

Figure 7-1 Implementation Schedule by Phase

ID		Task Name	Duration	Start	Finish
1					
2		**DEMONSTRATION STUDY**	**310 days**	**Mon 5/1/06**	**Fri 7/6/07**
3		**Permitting**	**310 days**	**Mon 5/1/06**	**Fri 7/6/07**
4		**Conditional Use Permit**	**71 days**	**Mon 9/25/06**	**Mon 1/1/07**
5		Prepare/Submit Permit	11 days	Mon 9/25/06	Mon 10/9/06
6		City/County Planning Approval	3 mons	Tue 10/10/06	Mon 1/1/07
7		Fire Department Plan Check	2.5 wks	Mon 8/7/06	Wed 8/23/06
8		**Public Utilities Commision**	**220 days**	**Mon 9/4/06**	**Fri 7/6/07**
9		PUC Rate Case Submittal	4 wks	Mon 9/4/06	Fri 9/29/06
10		PUC Rate Case Approval	10 mons	Mon 10/2/06	Fri 7/6/07
11		**DHS Approval**	**130 days**	**Mon 5/1/06**	**Fri 10/27/06**
12		DHS Coordination	6 mons	Mon 5/1/06	Fri 10/13/06
13		Permit Ammendment Preparation	1 mon	Mon 6/12/06	Fri 7/7/06
14		Permit Ammendment Approval	4 mons	Mon 7/10/06	Fri 10/27/06
15					
16		**Design/Construction/Operation**	**285 days**	**Mon 5/1/06**	**Fri 6/1/07**
17		Plant Design	4.5 mons	Mon 5/1/06	Fri 9/1/06
18		Bidding & Contracting	2 mons	Mon 9/4/06	Fri 10/27/06
19		Construction	4 mons	Mon 10/30/06	Fri 2/16/07
20		System Startup	3 wks	Mon 2/19/07	Fri 3/9/07
21		System Operation	3 mons	Mon 3/12/07	Fri 6/1/07
22					

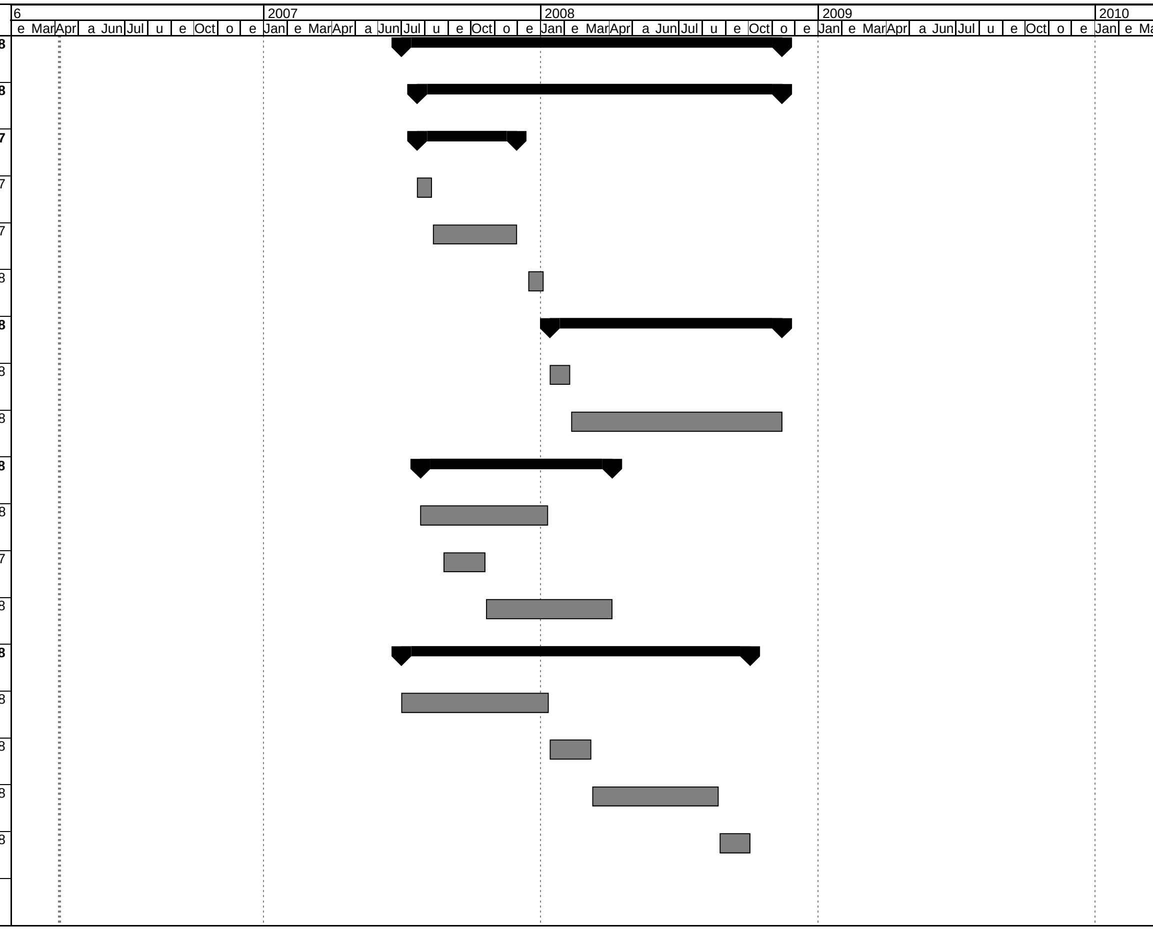


Project: Project_Schedule_ALTERNAT
Date: Wed 4/5/06

Task	Milestone	Rolled Up Task	Rolled Up Progress	External Tasks	Group By Summary
Progress	Summary	Rolled Up Milestone	Split	Project Summary	Deadline

Figure 7-1 Implementation Schedule by Phase

ID		Task Name	Duration	Start	Finish
23		**PHASE 1 - ALTERNATIVE PLANTS B, C, D & F**	**360 days**	**Mon 7/2/07**	**Fri 11/14/08**
24		**Permitting**	**345 days**	**Mon 7/23/07**	**Fri 11/14/08**
25		**Conditional Use Permit**	**95 days**	**Mon 7/23/07**	**Fri 11/30/07**
26		Prepare/Submit Permit	15 days	Mon 7/23/07	Fri 8/10/07
27		City/County Planning Approval	4 mons	Mon 8/13/07	Fri 11/30/07
28		Fire Department Plan Check	3 wks	Mon 12/17/07	Fri 1/4/08
29		**Public Utilities Commision**	**220 days**	**Mon 1/14/08**	**Fri 11/14/08**
30		PUC Rate Case Submittal	4 wks	Mon 1/14/08	Fri 2/8/08
31		PUC Rate Case Approval	10 mons	Mon 2/11/08	Fri 11/14/08
32		**DHS Approval**	**181 days**	**Fri 7/27/07**	**Fri 4/4/08**
33		DHS Coordination	6 mons	Fri 7/27/07	Thu 1/10/08
34		Permit Ammendment Preparation	2 mons	Mon 8/27/07	Fri 10/19/07
35		Permit Ammendment Approval	6 mons	Mon 10/22/07	Fri 4/4/08
36		**Design/Construction/Operation**	**330 days**	**Mon 7/2/07**	**Fri 10/3/08**
37		Plant Design	7 mons	Mon 7/2/07	Fri 1/11/08
38		Bidding & Contracting	2 mons	Mon 1/14/08	Fri 3/7/08
39		Construction	6 mons	Mon 3/10/08	Fri 8/22/08
40		System Startup	1.5 mons	Mon 8/25/08	Fri 10/3/08
41					

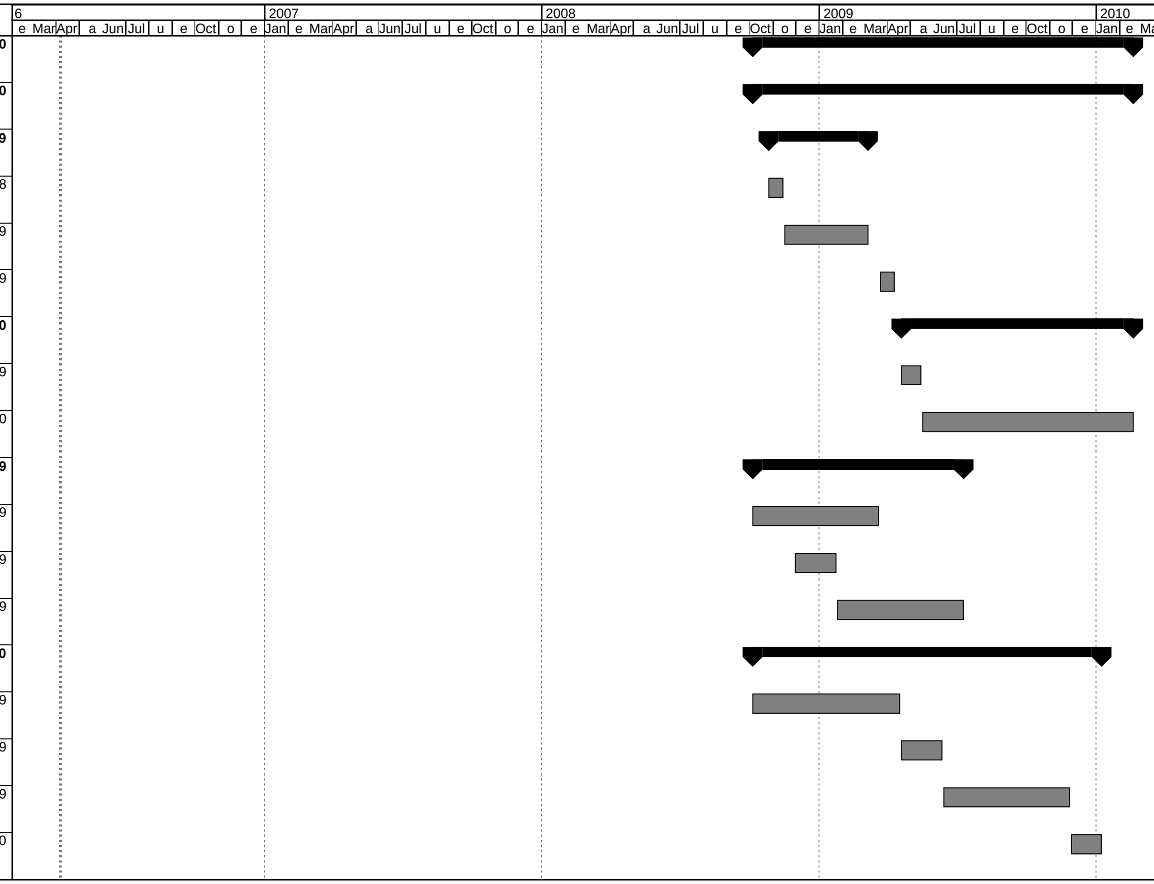


Project: Project_Schedule_ALTERNAT
Date: Wed 4/5/06

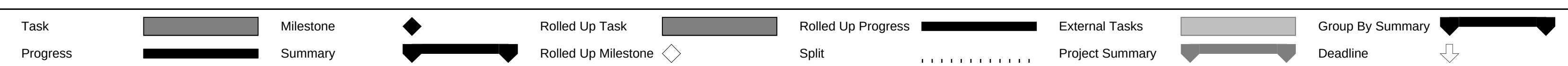
Task	Milestone	Rolled Up Task	Rolled Up Progress	External Tasks	Group By Summary
Progress	Summary	Rolled Up Milestone	Split	Project Summary	Deadline

Figure 7-1 Implementation Schedule by Phase

ID	Task Name	Duration	Start	Finish
42	**PHASE 2 - ALTERNATIVE PLANTS A & E**	**360 days**	**Mon 10/6/08**	**Fri 2/19/10**
43	**Permitting**	**360 days**	**Mon 10/6/08**	**Fri 2/19/10**
44	**Conditional Use Permit**	**95 days**	**Mon 10/27/08**	**Fri 3/6/09**
45	Prepare/Submit Permit	15 days	Mon 10/27/08	Fri 11/14/08
46	City/County Planning Approval	4 mons	Mon 11/17/08	Fri 3/6/09
47	Fire Department Plan Check	3 wks	Mon 3/23/09	Fri 4/10/09
48	**Public Utilities Commision**	**220 days**	**Mon 4/20/09**	**Fri 2/19/10**
49	PUC Rate Case Submittal	4 wks	Mon 4/20/09	Fri 5/15/09
50	PUC Rate Case Approval	10 mons	Mon 5/18/09	Fri 2/19/10
51	**DHS Approval**	**200 days**	**Mon 10/6/08**	**Fri 7/10/09**
52	DHS Coordination	6 mons	Mon 10/6/08	Fri 3/20/09
53	Permit Ammendment Preparation	2 mons	Mon 12/1/08	Fri 1/23/09
54	Permit Ammendment Approval	6 mons	Mon 1/26/09	Fri 7/10/09
55	**Design/Construction/Operation**	**330 days**	**Mon 10/6/08**	**Fri 1/8/10**
56	Plant Design	7 mons	Mon 10/6/08	Fri 4/17/09
57	Bidding & Contracting	2 mons	Mon 4/20/09	Fri 6/12/09
58	Construction	6 mons	Mon 6/15/09	Fri 11/27/09
59	System Startup	1.5 mons	Mon 11/30/09	Fri 1/8/10



Project: Project_Schedule_ALTERNAT
Date: Wed 4/5/06



Kennedy/Jenks Consultants

Engineers & Scientists

200 New Stine Road
Suite 205
Bakersfield, California 93309
661-835-9785
Fax 661-831-5196

180 E. Fourth Street
Suite 500
Chico, California 95928
530-891-9293
Fax 530-891-9283

P.O. Box 771
21 First Street N.W., Suite 17
Choteau, Montana 59422
406-466-5930
Fax 406-466-5931

32001 32nd Avenue South
Suite 100
Federal Way,
Washington 98001
253-874-0555
Fax 253-952-3435

2151 Michelson Drive
Suite 100
Irvine, California 92612
949-261-1577
Fax 949-261-2134

1020 N. Center Parkway
Suite F
Kennewick, Washington 99336
509-734-9763
Fax 509-734-9764

840 Grier Drive
Suite 300
Las Vegas, Nevada 89119
702-270-3610
Fax 702-270-3611

600 Wilshire Boulevard
Suite 1232
Los Angeles, California 90017
213-538-1232
Fax 213-538-1262

1000 Broadway
Suite 415
Oakland, California 94607
510-663-3960
Fax 510-663-6210

2191 East Bayshore Road
Suite 200
Palo Alto, California 94303
650-852-2800
Fax 650-856-8527

3101 North Central Avenue
Suite 1550
Phoenix, Arizona 85012
602-274-0886
Fax 602-274-0764

200 S.W. Market Street
Suite 500
Portland, Oregon 97201
503-295-4911
Fax 503-295-4901

5250 West 94th Terrace,
Suite 112
Prairie Village, Kansas 66207
913-385-7299
Fax 913-385-9222

5190 Neil Road
Suite 210
Reno, Nevada 89502
775-827-7900
Fax 775-827-7925

10850 Gold Center Drive
Suite 350
Rancho Cordova, California 95670
916-858-2700
Fax 916-858-2754

2180 South 1300 East
Suite 680
Salt Lake City, Utah 84106
810-474-9615
Fax 810-474-9621

16855 West Bernardo Drive
Suite 360
San Diego, California 92127
858-676-3620
Fax 858-676-3625

622 Folsom Street
San Francisco, California 94107
415-243-2150
Fax 415-896-0999

711 Third Avenue
Suite 790
Seattle, Washington 98104
206-652-4905
Fax 206-652-4927

698 East Wetmore Road
Suite 440
Tucson, Arizona 85705
520-293-0669
Fax 520-293-0699

1000 Hill Road
Suite 200
Ventura, California 93003
805-658-0607
Fax 805-650-152

Kennedy/Jenks Consultants

2355 Main Street, Ste 140
Irvine, CA 92614
949-261-1577
949-261-2134 (Fax)

Final Report
Groundwater Softening Demonstration Project

26 October 2009

Prepared for

Valencia Water Company
24631 Avenue Rockerfeller
Valencia, CA 91385

K/J Project No. 0889019

Table of Contents

Table of Contents (cont'd)

List of Tables

List of Figures

List of Appendices

Acronyms, Symbols and Abbreviations

$/AF	Dollars per acre foot
$/gal	Dollars per gallon
$/hr	Dollars per hour
$/lb	Dollars per pound
$K	Thousand dollars
$M	Million dollars
%	Percent
“	inch
AFY	Acre feet per year
AWS	Automatic water system
BTU	British Thermal Unit
$CaCO_3$	Calcium carbonate
Cl	Chloride
CLWA	Castaic Lake Water Agency
CO_2	Carbon dioxide
fps	Feet per second
gal	Gallon
gpcd	Gallons per capita per day
gpd	Gallons per day
gpm	Gallons per minute
GWSDP	Groundwater Softening Demonstration Project
kg	Kilogram
LACSD	Los Angeles County Sanitation Districts
lb/MG	Pounds per million gallons
lbs/hr	Pounds per hour
LLC	Limited liability corporation
mg/L	Milligrams per liter
Na	Sodium
NaOH	Sodium hydroxide aka caustic soda, caustic
NPDES	National Pollution Discharge Elimination System
NSF	National Sanitation Foundation
O&M	Operations and maintenance
P&ID	Process and instrumentation diagram

ppd	Pounds per day
psig	Pounds per square inch, gauge
RSD	Relative standard deviation
SAR	Sodium adsorption ratio
SCADA	Supervisory control and data acquisition
SCVSD	Santa Clarita Valley Sanitation District
SRWS	Self regeneration water softener
TDS	Total dissolved solids
VFD	Variable frequency drive
VWC	Valencia Water Company
WQIP	Water Quality Improvement Plan

Executive Summary

Project Background

In 2006 Kennedy/Jenks Consultants prepared a feasibility study to evaluate centralized softening of Valencia Water Company's (VWC's) groundwater supply. The study analyzed various softening technologies (i.e., membrane filtration, ion exchange, pellet softening) and concluded that the most feasible technology was "pellet softening." After doing a pilot study of the pellet softening technology, VWC decided to conduct a Groundwater Softening Demonstration Project (GWSDP). In July 2007, this project was reviewed and approved for construction by the California Public Utilities Commission (Commission) [Decision 07-06-024, *Opinion On Application for General Rate Increase of Valencia Water Company*, California Public Utilities Commission, June 2007].

This report provides a description of the facilities that were brought on-line on 11 September 2008. It also summarizes the results of eight months of routine operation (January to August 2009 [demonstration phase]), the consumers' reaction to the treated water, describes a water quality improvement plan (WQIP), a pellet softening treatment implementation plan, and a capital and O&M cost estimate. The WQIP uses a combination of blending and treatment to provide softer water to all it customers. This report focuses on the treatment portion of the WQIP.

Description of Pellet Softening

The GWSDP utilizes the following chemical reaction with the CaCO3 crystallizing on the fluidized sand. The following is the process flow schematic (Figure 1).

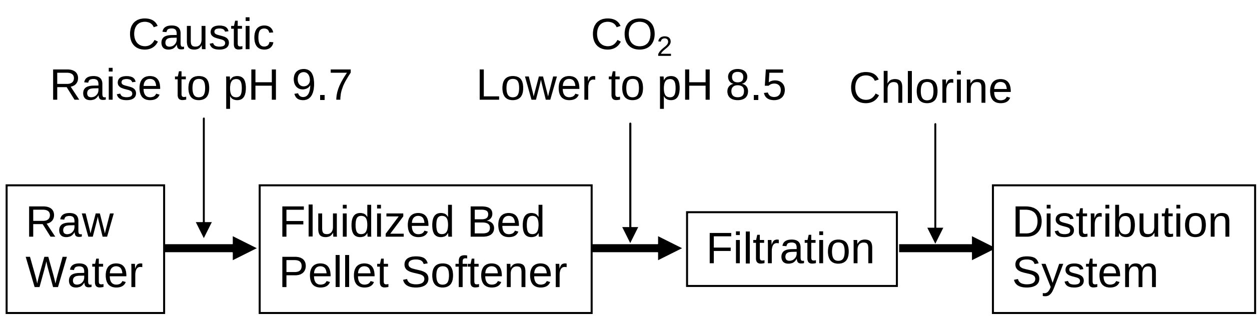


Figure 1: Process Flow Schematic of Pellet Softening

Description of GWSDP Facilities

The facilities were installed at Well W9 for a "bid" cost of $1.3 million. The single speed, high discharge head well pump was replaced with a pump with lower discharge head and a variable speed drive. The treatment system consisted of one (1) ProCorp Enterprises, LLC Pellet Reactor Water Softening System (PRWSS), caustic soda and carbon dioxide chemical feed units for pH adjustment, and a Yardney MM5460-6A multimedia filtration system with a Nema 4x controller. An existing Hammonds Technical Services Model HTS 80P Tablet Chlorinator that provides a free chlorine residual between 0.20 to 2.00 mg/L was relocated to just after the booster pump. Two pellet storage bins are used for dewatering the pellets and receives the filter backwash water. The water from these bins is permitted by the Regional Water Quality Control Board for local irrigation.

The GWSDP was operated 24/7 to ensure that the target service area always received pre-softened water. The study area is in the Decoro Highlands development known as the Copperhill Community. The Copperhill Community comprises 419 residential and multi-residential connections, one (1) community recreation center connection, and eight (8) landscape connections.

Description of Operational Periods

On 11 September 2008 the plant was started up. From the start date through 1 December 2008 the plant went through a startup and shake down period. The demonstration phase, i.e., after the staff was trained and operations became routine, was from 1 January 2008 to 30 August 2009. Since there were a number of shut downs of the plant in January and February, water quality and operations and maintenance data used data from 1 March to 30 August. Within this period there were two operational periods, 5 feet bed expansion (1 March to 16 July) and 7 feet bed expansion (17 July to 30 August) with dramatically improved treated water quality during the 7 feet bed expansion operating period.

Equipment Reliability

During this demonstration phase, the system was operational 98 percent of the time (115 hours off line for maintenance out of 5,808 potential hours of operation). From 1 March to 31 August, the facilities were operational 98 percent of the time (4253 hours on-line out of a possible 4320 hours).

Water Yield

The average water yield for this facility was 99.8 percent making this process extremely efficient from a water treatment perspective. Other softening technologies such as membranes and ion exchange have an 80 and 98 percent water yield, respectively.

Operations and Maintenance Costs

During the demonstration phase there were two periods: 1) 1 March to 16 July when the pellet bed was operated at 5 feet or expansion; and 2) 17 July to 30 August when the pellet bed was operating at 7 feet of expansion. Because the treatment became more efficient for removing calcium hardness by almost 10 percent (~71 versus 82 percent calcium hardness removal) this later period was used for developing the O&M costs (See Table 1).

Table 1: Average O&M Costs from the GWSDP, 17 July – August 2009

Component	Unit Cost*	Usage during Demonstration	Average Monthly Cost	Average Delivered	
				$/AF	Percent
50 % NaOH ($/gal)	$1.76	220 gpd	$11,644	$113.04	68.8%
CO_2 ($/lb)	$0.21	350 ppd	$2,236	$21.71	13.2%
Sand ($/lb)	$0.056	143 ppd	$244	$2.37	1.4%
Labor ($/Hr)	$ 28	55 hour/month	$1,540	$14.95	9.1%
A-1 Grit Pellet Credit		$500/month	($500)	-$4.85	-3.0%
Bin Rental		$672/month	$672	$6.52	4.0 %
Pellet Transport ($/trip)	$683	1.6 trips/month	$1,093	$10.61	6.5%
			Total	$164.35	100.00 %

The O&M costs were based on using 50 percent caustic. The O&M for the GWDSP as currently configured is $164/AF. There would be another $11/AF (rounded) reduction if VWC was successful in making changes to the pellet disposal cost (VWC buys the bins and A-1 Grit provides the transportation to and from Riverside and continues the $500 per month for the pellets). Under this scenario the treated water cost would be $153/AF (rounded).

Treated Water Quality

Influent calcium hardness averaged 193 mg/l as $CaCO_3$ during the 1 March to 16 July 2009 and the effluent calcium hardness averaged 55 mg/L for an average of 71.5 percent removal. Since 17 July 2009, the calcium hardness averaged 36 mg/l as $CaCO_3$ which was equivalent for almost a 10 percent higher removal.

Table 2: Typical Raw and Treated Water Quality of GWSDP, March to August 2009

Parameter	Average Weekly Raw Water, 1 Mar -30 Aug	Average Daily Treated Water Quality	
		1 Mar – 16 July	17 Jul – 30 Aug
Total Hardness (mg/l $CaCO_3$)	394	193	182
Calcium Hardness (mg/l $CaCO_3$)	192	55	36
Removal (%)		71.5	82.4
pH at top of column (units)	7.7	9.3	9.8

Process Reliability

The effluent calcium hardness from the 1 March to 16 July operating period also had more variation, ranging from 33 to 85 mg/L as $CaCO_3$ This is in contrast to the 17 July to 30 August operating period which had a calcium hardness ranged from 33 to 38 mg/l as $CaCO_3$. This dramatic change was a result of allowing the bed to expand to 7 feet instead of the 5 feet during the March through mid-July operating period. The caustic feed rate has not increased and the pH at the top of the column has increased to an average of 9.8.

This change in operations had three benefits: 1) a lower treated water total hardness which is the water quality parameter that is of most importance to the customer; 2) less variation in the calcium hardness which reduces the requirement of an equalization tank; and 3) lowered operating cost due to using less caustic.

Wastewater Water Quality

There were two pre-installation wastewater sampling events (18-25 July 2006 and 10-17 March 2008) performed by the Los Angeles County Sanitation Districts (LACSD) who administer the Santa Clarita Valley Sanitation District (SCVSD) responsibility to characterize the wastewater chloride levels. There was one sample event performed by LACSD, 9 January 2009 characterizing the wastewater after the installation of the GWSDP. The chloride reduction using these data are shown in Figure 2. Using this information it is estimated that 71 pounds per day or approximately 13 tons per year less chloride would be added to the wastewater from the study area..

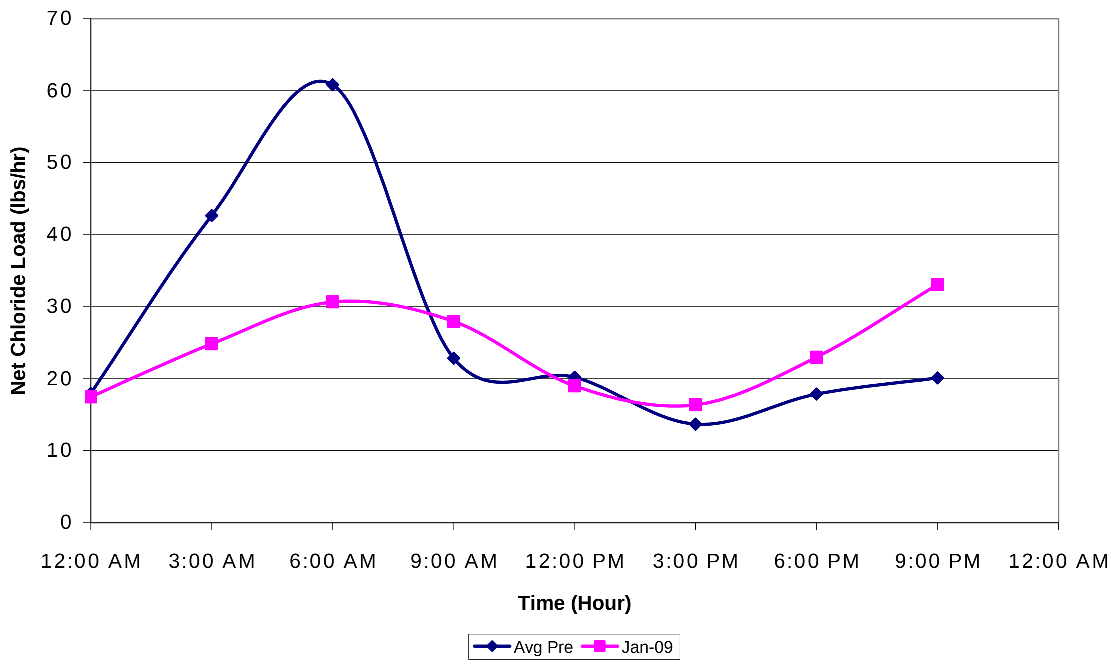


Figure 2: Net Wastewater Chloride Loading for Pre and Post Installation Periods

Outreach Findings

There were two outreach surveys prior to the installation of the GWSDP, one in 2006 and another in September 2008. The post-installation survey was performed in June-July 2009.

The pre-installation surveys indicated that 57 (2006) and 52 (2008) percent of the service connections in the study area had some type of automatic water softener. The post-installation survey indicated that this had dropped to 14 percent, about half of these with exchange tanks that still can be used in the City of Santa Clarita after June 2009.

Overall, residents are satisfied with the pre-softened water with 73 percent stating they would recommend the water to their friends and 94 percent rating the water as the same or better than their previous tap water. While many wish for "perfect" water or water identical to their SRWS, the general consensus is that the community welcomes the pre-softened water, especially since they cannot use a SRWS after June 30. Some residents noted paying a small monthly fee for pre-softened water is less expensive than purchasing a new salt-free alternative unit. The pre-softened water appears to solve residents' highest ranking reasons for using a SRWS—calcium scale and dry skin.

Customer's Willingness to Pay

The survey indicated that 74 percent were willing to pay for pre-softened water, 18 percent said no, and 8 percent were unsure. Of those that were willing to pay, 23 percent (1/3 of the 74 percent that said yes, willing to pay) stated their reasonable cost that they were willing to pay. The average "reasonable" cost was $17.50 per month with a range of $5 to $60 per month.

Annual Monetized Project Benefits

The annual saving for VWC customers when all the treatment facilities are completed is estimated to be $4.4 million. These savings are from customers removing their SRWS, reduced O&M for exchange tanks, using less soap and detergents, more efficient water heaters, and longer life cycles for water heaters.

One-time Monetized Project Benefits

There would be a one time savings that is estimated to be $11.4 million from the chloride reduction of providing pre-softened water. These savings are avoided costs for the treatment facilities of the Santa Clarita Valley Sanitation District at the Valencia Wastewater Reclamation Plant.

Non-monetized Project Benefits

There are additional areas of savings that will accrue to VWC customers that is difficult to establish a reasonable cost because there is no literature. These are described below

1. Reducing the hardness of the water supply will also generate savings to customers from impact on scale on fixtures and piping. Examples are scale from the hard water causes gaskets to leak water from dishwashers and washing machines requiring more repairs; and scaling of piping, shut off valves, and kitchen and bathroom fixtures requiring more maintenance or shorter a lifespan and more costs associated with replacement.

2. More replacement of clothes or fabrics due to the inability to remove all the soil and dirt using harder waters causing the graying of white fabric and the loss of brightness in colors.
3. Aesthetic benefits such as less calcium scale, less dry skin (eczema and eczema-like symptoms), softer skin and less soap and shampoo residue.

System Implementation Plan

The VWC Water Quality Improvement Plan (WQIP) utilizes blending and treatment to deliver a more uniform water quality that is softer than the currently served water. Blending is the first treatment option typically considered when meeting non-compliance water quality goal. This approach typically is the lowest cost and simplest to operate. Whether softer water is achieved via pellet softening or blending, this plan, when fully implemented will result in a more uniform water quality delivered throughout VWC's service area. With this approach, it is reasonable to expect that all customers will receive varying percentages of naturally hard groundwater from time to time (Decision 07-06-024, *Opinion On Application for General Rate Increase of Valencia Water Company*, California Public Utilities Commission, June 2007).

Softer Water through Blending

A blending approach will be used for Wells S6, S7, S8, each with a rated capacity of 2,000 gpm. Two wells (S7 and S8) are already blended with imported water from Castaic Lake Water Agency (CLWA) turnout V7 before entering the distribution system. Modifications are necessary at the V7 turnout in order for S6 to be blended with imported water.

There is insufficient land for treatment system for Well W10 which is rated at 1,500 gpm, however, CLWA turnout V2 is located north of the well and provides blending with imported water within the distribution system.

Softer Water through Treatment

Based on the findings of the outreach surveys and the estimated capital and O&M costs developed from the GWSDP, it is recommended that VWC implement the softening treatment component of their WQIP.

The same approach is recommended that was taken for the GWSDP, i.e., implement this technology in manageable increments (pilot study first, then a reasonable demonstration project). This phased approach allows VWC to identify and learn from design and operational issues. These lessons learned then can be incorporated into their plants that will be built after 2015.

When fully implemented, the project will essentially treat approximately 27,150 gpm out of total capacity of 34,650 gpm, or 78 percent of the company's available groundwater capacity. The capacity from three Saugus wells (160, 201, and 205) is not included in this total (the 34,650 gpm) because they are reserved for droughts and are infrequently used.

Table 3 is a summary of the roll out schedule, the cumulative percent of groundwater capacity, and estimated capital cost of the fully implement system. This schedule was selected for several reasons that include 1) the rate of capital expenditures; 2) capacity to integrate these systems with the VWC staff resources (training, availability, etc.); 3) desire to obtain operating experience with small, medium, and large systems; 4) the impact of bring these systems on-line on the water rates; and 5) providing soft water to the most customers in a timely manner.

Table 3: Summary of Treatment Plant Roll Out and Estimated Capital and O&M Costs

Treatment Plant	Rated Capacity (GPM)	Startup Date	Production (AFY)	Cumulative Percent Treated of Groundwater Capacity	Capital (2009 $M)	Annual O&M ($K)
Existing						
Copperhill	800	2008	950	3%	On-line	On-line
Planned						
Live Oak	2,450	2012	1,680	12%	$3.3	$212
Magic Mountain	5,000	2012	2,350	30%	$5.0	$317
Belcaro	1,000	2014	800	33%	$1.5	$96
Pan Handle	4,650	2014	3,450	50%	$5.0	$497
Pardee Ball Field	6,250	2017	2,970	73%	$5.6	$373
Commerce Center	3,400	2019	3,525	76%	$5.0	$442
Castaic Junction	3,600	2021	3,525	78%	$5.0	$442
Total of Planned	***26,350***		***18,300***	***78 %***	***$30.4***	***$2,379***

Cost Benefit Analysis

The estimated annual cost for implementing the pre-softening technology throughout most of the VWC system is $5.56 million. The estimated annual benefit for the customers of VWC is $5.46 million. The analysis presented in this report indicates that the cost benefit ratio is approximately1:1.

It should be noted that the benefits in this study were recognized using conservative assumptions. The first is that only $1 per month per service connection was estimated as a savings for lower soap and shampoo usage. In addition, monetary estimate was developed some many of the aesthetic water quality impacts like less dry and smoother skin were not included on the benefit side. Lastly, the reduced O&M from the desalting technology that is being designed and constructed by LACSD was also not included. There will be less chlorides, some 13 tons per year of chloride less as determined in the study from only 419 service connections. This reduces the operation costs for LACSD, but this study did not monetize this saving which would translate to lower sewer bills to VWC customers.

Section 1: Background and Report Organization

The Valencia Water Company (VWC) is a retail public water system that serves a portion of the City of Santa Clarita and portions of unincorporated communities of Castaic, Newhall, Saugus, Stevenson Ranch, and Valencia. VWC service area is about 25 square miles and is located approximately 40 miles northwest of downtown Los Angeles, within the upper Santa Clara River watershed.

The current VWC system consists of 21 wells, 22 reservoirs, 16 booster stations, five pressure zones, six surface treated water connections with Castaic Lake Water Agency, one emergency connection with Newhall County Water District-Newhall System, and three emergency connections with Santa Clarita Water Division. The sources of water are evenly split between groundwater and surface water. VWC serves an estimated population of 110,000 through approximately 29,000 active metered service connections (VWC, personal communication 2009). The average customer uses 15,396 gallons per month within this service district (Exhibit 8, Water Quality Improvement Program, Attachment H to Application No. 06-07-002 filed July 3, 2006).

1.1 Project Background

Local groundwater produced in the Santa Clarita Valley contains high concentrations of naturally occurring minerals such as calcium and magnesium; as such, many customers have identified problems with clogged pipes, hot water heaters, washing machines and dishwashers. Customers have addressed these problems by installing in-home water softening devices at their own expense. It is estimated, based on previous customer surveys conducted by VWC that over half of the customers in their service area have installed a self regeneration home water softening device that discharge a brine (chloride) solution to the sanitary sewer system. Although these in-home devices produce soft water, they are expensive to maintain and many discharge high concentrations of minerals and salts (or chlorides) to the sewer system that end up in the Santa Clara River. The river then flows through an agriculturally rich region primarily growing strawberries. The irrigation water used from the Santa Clara River is then used to irrigate this high value crop which is highly chloride sensitive. These discharges are a serious environmental concern and salt based in-home water softening devices are one of the largest sources of chlorides discharged to the river.

The Santa Clarita Valley Sanitation District (SCVSD), owner of the local wastewater treatment plants (operated by Los Angeles County Sanitation Districts [LACSD]), is considering installing expensive treatment equipment and brine line to remove these salts from the wastewater before the effluent is discharged to the river. It is estimated that additional treatment will cost $74 million (Measure S information, 2008). VWC customers and Santa Clarita Valley residents would see their sewer rates increase dramatically to pay for this new wastewater treatment system.

In 2006, VWC retained Kennedy/Jenks Consultants to prepare a Feasibility Study to soften VWC's groundwater supply. The study analyzed various softening technologies (i.e., membrane filtration, ion exchange, pellet softening) and concluded that the most feasible technology was "pellet softening." In order for VWC to determine if softening its groundwater supply will provide acceptable water quality for its customers, VWC has decided to conduct a Groundwater Softening Demonstration Project (GWSDP). In July 2007, this project was reviewed and approved for construction by the California Public Utilities Commission (Commission) [Decision 07-06-024, *Opinion On Application for General Rate Increase of Valencia Water Company*, California Public Utilities Commission, June 2007]. This report summarizes the results of nine months of operation (December 2008 to August 2009) and provides a description and cost estimate of fully implementing this technology at key locations within the VWC system.

The primary goal of the GWSDP is to demonstrate the usefulness of centralized pellet softening technology at a potable well toward improving water quality at the customer's tap. An important secondary goal will be to determine the environmental and financial benefits derived from implementing full scale groundwater softening operations. If successful, the project would provide multiple benefits to VWC's customers and the overall community. VWC's project in combination with other source control measures would be an efficient means of reducing the amount of chlorides discharged to the Santa Clara River.

VWC selected well W9 for the location of the GWSDP based on the following criteria.

1. The ability to supply a specific number of customers with pre-softened water.
2. The well has comparable total hardness concentrations as compared to VWC's other Alluvial well as indicated in Table 1.
3. The well is located in an area easily accessible and requires minimum site preparation.
4. LACSD has determined that the chloride levels leaving the Copperhill area are extremely high. LACSD measured the chloride levels in sewer flows to determine the net reduction as a result of the implementing the GWSDP.

The total hardness monthly averages from Well W9 and all the VWC wells for 2006 and 2007 are summarized in Table 4. A Student's paired "t" test indicates that there were no statistically significant difference between the total hardness of Well W9 and the average of all the rest of the VWC wells for 2006 and 2007. There were no significant differences between averages of Well W9 for 2006 and 2007. There were no significant differences between the averages of all VWC wells for 2006 and 2007.

Table 4: Comparison of Monthly Averages of Total Hardness between Well W9 and All VWC Wells, 2006 to 2007

Year	Total Hardness, W9, (mg/L as CaCO3)	Min	Max	Total Hardness, All Wells (mg/L as CaCO3)	Min	Max
2006	364	329	412	358	323	408
2007	363	296	392	355	329	394

VWC began shake down and start up operating the Project in September 2008. This well head treatment facility, located at Well W9, is planned to be operated for one year and is being delivered to 419 service connections in the Decoro Highlands development known as the Copperhill Community of Valencia.

1.2 Report Authorization and Objectives

Kennedy/Jenks Consultants was authorized in a letter dated 16 April 2008 to proceed with VWC Job Number 6589. The objectives and associated technical scope of work tasks (Tasks 2-3 and 5-10) for this project are summarized below.

1. Describe the Project
2. Describe the customer survey and public outreach program and assess the customer acceptance of the centralized pellet softened water(Task 3 and 5);;
3. Describe the delivered water quality of Well W9, before and after pellet softening (Task 6 and 9);
4. Describe the sewer sampling and analysis program and summarize the wastewater chloride water quality results for the pre and post centralized pellet softening conditions (Task 2 and 7);
5. Summarize the performance of the Project with respect to water quality and treatment costs (Task 8 and 9); and
6. Evaluate a full-scale centralized water softening roll out for the VWC with capital and O&M costs as well as the expected chloride reduction to the wastewater collection system (Task 10).

1.3 Report Organization

The description of the sections in this report is presented below.

- Section 1 provides a project background and scope;
- Section 2 describes the facilities at Well W9;
- Section 3 summarizes performance of the GWSDP;
- Section 4 summarizes the performance of the GWSDP from a raw, treated and wastewater water quality perspective;
- Section 5 summarizes the outreach and customer survey information;
- Section 6 presents and evaluation of the full-scale centralized water softening roll out for the VWC that includes capital and O&M costs as well as the benefits of delivering softer water.
- Section 7 provides a recommended roll out schedule for the seven additional centralized softening plants.

.

Section 2: Physical Description of GWSDP

This section describes the project area, pellet softening process, and the physical facilities at Well W9.

2.1 Project Area

Figure 3 is a plan view of the study area known as the Decoro Highlands development known as the Copperhill Community. The Copperhill Community comprises 419 residential and multi-residential connections, one (1) community recreation center connection, and eight (8) landscape connections. This area has been receiving the softened water from Well W9 since December 2008.

Figure 3: Project Area Receiving Well W9 Softened Water

2.2 Project Time Line

Table 5 summarizes the project time line for a variety of activities. The startup and shakedown period was from 12 September to 31 December 2008. The demonstration phase was from 1 January to 31 August 2009 that can be subdivided into two operational periods: 1) Five (5) feet pellet bed; and 2) seven (7) foot pellet bed. The treated water quality was dramatically lower in calcium hardness during the 7 foot pellet bed operational period. This will be the operational mode from this point forward for the GWSDP facility.

Table 5: Project Time Line

Date	Project Phase	Activities
Prior to 12 September 2008	Pre-installation of GWSDP	Pre installation Copperhill customer survey Pre-installation wastewater characterization Pre-installation distribution water quality characterization
12 September - 31 December 2008	Shake down and Startup	Learning how to operate systems, optimizing equipment, coordination of vendor supplies
1 January – 15 July 2009	Operational using 5 feet bed expansion	Post installation Copperhill customer survey Water being provided, but not softest and plant under routine operations.
16 July - present	Operational using 7 feet bed expansion	Softest water being provided under optimized plant conditions

2.3 Description of Well W9

The well is located at 25001 Decoro Drive, Santa Clarita, CA which is approximately 2,200 feet north of Decoro Drive and 2,500 feet west of McBean Parkway. The area is described as being flat on undeveloped land.

Well W9 was drilled in 1990 to a depth of 160 feet and draws from the Alluvial formation of the basin. It has a 52 foot annular seal and a 14 inch diameter casing. The perforations are between 70 and 130 feet below ground surface (bgs). The most recent static water level was taken in December 2007 at a depth of 33.8 feet bgs. The most recent pumping level was taken in December 2007 and is at a depth of 45.7 feet bgs. Well W9 has an approved capacity of 800 gpm. The well has been recently rehabilitated and a new motor and pump assembly has been installed.

Well W9 has been in operation for municipal supply service since 1990 and supplied on average approximately 950 acre feet per year (AFY) with a rated capacity of 800 gpm. Most recent general mineral and general physical results from well W9 are from July of 2006 and are shown in 6. The latest results for volatile organic chemicals collected in October 2007 yielded results less than the detection limits for the purposes of reporting required by the California Department of Public Health.

The well was equipped with a Hammonds Technical Services Model HTS 80P Tablet Chlorinator with the capacity of providing a free chlorine residual between 0.20 to 2.00 mg/L. A chlorine residual analyzer is also part of this system and is centrally controlled and monitored through a Supervisory Control and Data Acquisition (SCADA.) system. This system was relocated and became part of the GWSDP.

2.4 Pre-Installation Raw Water Quality Characterization

The general mineral and general physical water quality results for samples taken in July 2006 are summarized in Table 6. The results indicate that this well can be characterized as a sodium bicarbonate/calcium-magnesium sulfate water.

Table 6: W9 Water Quality Characterization of General Mineral and Physical Parameters (July '06)

Constituent	Value (mg/L)
Major Cations	
Calcium	85.1
Magnesium	35.7
Sodium	46.2
Potassium	1.78
Major Anions	
Alkalinity as $CaCO_3$	220
Bicarbonate	268
Sulfate	158
Chloride	33.9
Nitrate as NO_3	9.15
Fluoride	0.63
General Physical	
Total Dissolved Solids	603
Total Hardness as $CaCO_3$	360
Specific Conductance	854
pH	7.48
Color	<5
Odor	1
Turbidity	0.06
Langelier Index at 60^{o}C	1.51

2.5 Description of Pellet Softening Treatment System at Well W9

2.5.1 General Description of the Pellet Softening Process

Pellet softening utilizes the same chemical principles as lime-soda softening, but does not produce an undesirable sludge. Instead, the pellet softening system consists of a gravity or pressure tank where calcium carbonate crystallizes on a suspended bed of fine sand. The calcium carbonate coated pellets become as much as 5 times larger and when removed from the system are easily dewatered and frequently beneficially reused.

The first step in the process is the injection of sodium hydroxide (caustic) into the raw water to increase the pH to 9 - 10. The mixture is injected at the bottom of the reactor in a very turbulent and efficient mixing zone and the flow moves quickly upward through the now-fluidized bed. The increase in pH causes calcium carbonate to precipitate and adhere to the sand grains forming pellets. These larger heavier pellets accumulate at the bottom of the reactor and are removed. Periodically, new sand is added as a replacement. The pellets, rather than sludge, are the solid by-product generated from the process.

This treatment method primarily removes calcium hardness, as only a small amount of magnesium hardness (less than 10 percent of the calcium hardness removed) can be incorporated into the calcium carbonate precipitate. Additional magnesium removal is not practical as it would require increasing the pH to produce magnesium hydroxide that may cause fouling of the reactor bed. Iron removal can be accomplished concurrently, while manganese usually requires post-treatment.

To prevent additional scaling within the distribution system the pH is lowered. Fines may be generated from abrasion of the pellets or non-crystallized calcium carbonate. So a typical plant will include filtration and a disinfection step after pH adjustment.

Pellet softener systems originated and are commonly utilized in Europe, but they are not widely utilized in the United States. There are 200 municipal installations in Europe and approximately 50 industrial installations and at least one municipal installation operating in the United States.

The benefits of pellet softening include:

- Effectively reduces calcium hardness up to 80 percent
- In some cases, total dissolved solids (TDS) is also modestly reduced;
- Can replace individual residential ion exchange softeners that discharge high chloride brines to the sewers;
- Relatively compact foot print;
- Relatively low capital cost;
- Relatively low labor required for O&M during normal operations; and
- Pellets are easily dewatered
- Potentially, pellets can be reused (agricultural lime, acid wastewater neutralizer, animal feed additive and road fill and pipeline backfill).

Caustic soda is preferred to increase the pH because the lime and soda ash approach requires significantly more O&M labor. This is the approach that was selected for used at the Well W9 facilities. The disadvantage of caustic soda is that it contains sodium and increases the sodium concentration as compared to lime-soda ash addition. The caustic soda softening reactions are as follows:

$$NaOH + Ca^{2+} + HCO_3^- \Rightarrow Na^+ + CaCO_3 + H_2O$$

2.5.2 W9 Pellet Softening Facility Description

The GWSDP demonstration phase was planned to last from 9 to 12 months. The system was designed to treat an average flow of approximately 800 gpm and is located on land adjacent to well W9. The intent is to operate these facilities continuously, i.e., 24/7 for the duration of the project to ensure that the Copperhill community only gets softened water.

2.5.2.1 Redundancy Requirements for the GWSDP

Because centralized softening is not a treatment requirement for compliance with Title 22, if there are mechanical issues, this treatment system can be bypassed. As a result of this operational philosophy, redundancies typically designed into Title 22 compliance treatment facilities are not necessary for the demonstration facilities. The design criteria for the facilities described in Section 6 of this report were developed with this approach.

2.5.2.2 GWSDP Equipment Description

The system incorporates one (1) ProCorp Enterprises, LLC Pellet Reactor Water Softening System (PRWSS), caustic soda and carbon dioxide chemical feed units for pH adjustment, and a Yardney MM5460-6A multimedia filtration system with a Nema 4x controller. Figure 4 is a process flow diagram of the GWSDP that was installed at Well W9. The GWSDP Layout and P&ID drawings are provided in Appendix A of this report. The facility was enclosed with chain link fencing.

2.5.2.3 Description of pH Adjustment and Pellet Softener

Source water from W9 is fed up through the vessel upon which the pH will be adjusted using NSF approved caustic to approximately 9.8 thereby initiating the precipitation reaction. The caustic is stored on-site in a 4,400 gallon double walled container adjacent to the pellet softening vessel. The pellet vessel is twenty-three (23) foot tall. The vessel details and cross section are provided in Appendix A.

The vessel is filled with #30 pre-washed National Sanitation Foundation (NSF) approved silica sand to a depth of approximately four and a half (4.5) feet. The sand bed is fluidized with groundwater from well W9 to an additional height of approximately five to seven feet in the pellet softener. As the water enters the pellet softener a flow velocity of 0.073 feet per second (fps) is maintained. This velocity allows for laminar flow through the lower portion of the vessel and prevents sand from carrying over through the top. Laminar flow is important in order for the chemical reaction to occur in the lower portion of the vessel and not in the upper portion. The flow through the top of the vessel is maintained at approximately 0.023 fps.

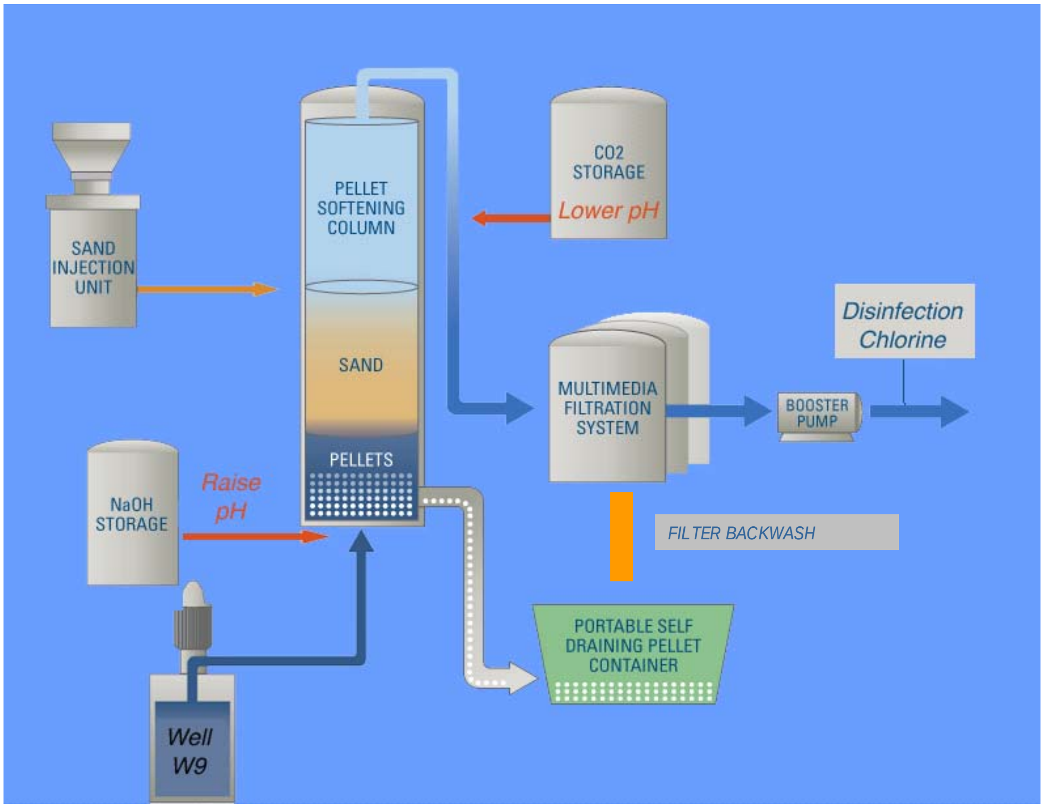


Figure 4: Well W9 Process Flow Diagram (Alvord, 2009)

2.5.2.4 Filtration

The pellet softened effluent may appear milky due to fines from calcium carbonate that does not form on the pellets or the mechanical abrasion of the fluidized calcium coated sand. In addition, this process prevents any sand carry over. The filtration process ensures delivering a low turbidity water to the distribution system.

The pellet softened water at W9 uses a filtration system (manufactured by Yardney) consisting of six (6) 54" diameter x 60" side shell tank system. There are two (2) parallel trains of three (3) multimedia filters in parallel to allow for backwashing without shutting down the treatment process. The filters have a flow rate design of 480 to 1,432 gpm, a working pressure of 65 psi, and a maximum pressure rating of 80 psi. Pressure entering the filters will typically be no more than 40 psig. The surface loading rate is 10.48 gpm per square foot. The NSF approved filtration media are provided in Table 7.

Table 7: NSF Approved Filter Media of Each Pressure Filter

Media Material	Media Volume (cubic feet)
½” x ¾” Crushed Rock	95
Coarse mm Garnet	8
Fine mm Garnet	24
Anthracite	24

The back washing criteria can be based on pressure drop across the filters, total volume of treated water, or elapse time, e.g., every seven (7) days. Since the softened water entering the filters has been low in turbidity and suspended solids, the manufacturer recommended to backwash the filters a minimum of every seven (7) days, if the pressure differential settings or total filtered water volume have not been reached.

2.5.2.5 Final Chlorination

All water softened by the GWSDP is continuously and reliably chlorinated to a minimum of 0.2 mg/L. Well W9 is equipped with a calcium hypochlorite chlorinator made by Hammonds Technical Services Model HTS 80P Tablet Chlorinator. It has a capacity producing a treated water effluent that is between 0.20 to 2.00 mg/L free chlorine. A chlorine residual analyzer is also part of this system and is centrally controlled and monitored through a Supervisory Control and Data Acquisition (SCADA.) system.

2.5.3 Pumping to the Distribution System

The original Well W9 well pump was 130 HP. It was changed out to a variable frequency drive 30 HP pump and motor assembly operating with a static head pressure of 40 psig. In addition, there is a pressure gauge on the inlet to the pellet softening facility and a pressure differential switch on the top of the vessel to monitor pressures through the system. These features prevent pressure build up within the system and will turn off the well pump should the pressure exceed the high pressure shut off value. These pressures can be monitored locally and remotely.

The water leaving the filtration system is boosted with a 125 HP pump to deliver the water to the system. There was a net 25 HP increase (19 percent) in the total HP at this facility. However, because the inlet pump has a VFD, the increase in electrical cost was expected to be less than the 19 percent increase in HP.

2.5.4 Treatment Residuals

2.5.4.1 Blow Down of Pellets from Pellet Softener

The pellets are manually discharged daily from the pellet softener vessel into two (2) eighteen (18) cubic yard Baker Tank roll-off bins in the form of a “water slurry.” Pellet are removed while the pellet softener is in operation. The Baker tanks have a 3” diameter slotted pipe that runs down the center line at the base of the bins to collect the drained water. At the end of the slotted pipe there is a shut off ball valve. To drain the bins, the valve is opened and the water is permitted (NPDES) for use as provide local irrigation.

The bins are rented on a monthly basis and also contract by Baker Tank to transport the pellets to the disposal site. Initially, VWC was providing the pellets to A-1 Grit free of charge as well as paying for the hauling costs. However, as of May 2009, VWC has been receiving $500 a month payment for the pellets from A-1 Grit.

2.5.4.2 Filter Backwash

Each filter is backwashed for two (2) to three (3) minutes at a rate of approximately 240 gpm. Typically, the elapse time criteria initiated the backwash cycle. The backwash water is sent into the pellet roll-off bins and reused for local irrigation in compliance with the facility’s NPDES permit.

Section 3: Demonstration Softening Facility Performance

This section summarizes the performance of the GWSDP. The operating period that was selected for most of the operational elements discussed in this section was March to May 2009. It was determined that after this period the GWSDP operations were relatively stable. This section also summarizes changes made to the physical facilities or notes changes to the management of the systems or operations up through May 2009. The last part of this section summarizes the O&M Costs of the GWSDP that were derived from this period expect as noted. The performance of the pellet softener from a water quality perspective is discussed in Section 4.

3.1 Reliability and Water Production

3.1.1 Physical Equipment Reliability

Table 8 shows the number of non-operational hours which is an indication of equipment reliability. By May of 2009, the operations were very reliable, being on-line 100 percent of the time. In August there was a 0.5 day shut down.

Table 8: Summary of Quantities of Raw Water Treated by GWSDP from January to May 2009

Raw Water Treated	1/09	2/09	3/09	4/09	5/09	6/09	7/09	8/09
Average Daily Flow, (MGD)	1.15	1.13	1.19	1.17	1.17	1.15	1.13	1.16
Average Daily Flow Minimum (MGD)	0	0.	0.83	0	0.83	0.90	0.78	0
Average Daily Flow Maximum (MGD)	1.45	1.56	1.64	1.49	1.50	1.56	1.42	1.48
Non-Operational Hours*	31	17	0	55	0	0	0	12

*See Section 3.1.2 for reasons for shutdowns

3.1.2 Reasons for Shutdown of Treatment System

A summary of the reasons for the shutdown of the facility is provided below

- 4 January the NaOH level in the storage tank became too low and the system was shut down. It was back up and running on the 5th, which was the scheduled NaOH delivery date.

- 19 January the system was shut down because of clogged NaOH injectors. It was back up and running on the 20th.

- 20 February the system was shut down because of a broken NaOH injector line. It was replaced and back up and running on the 21 February.
- 31 March the sand/pellet bed was completely evacuated unintentionally by our treatment operator. The system was diverted to flow to waste on 1 April and remained off until 3 April.
- 30 August the stator on the caustic pump failed. It was replaced and the system was back up and running on the 31 August.

3.1.3 Raw Water Treated by GWSDP

Table 8 presents the monthly average daily raw water that was treated by the GWSDP for the period January to August 2009. Over this period the average daily production was 1.14 MGD and the raw water treated during this period was 633 AF.

3.1.4 Net Water Production

Table 9 presents the information for the number of times water was released from the bins, the amount, and the summary statistics for the wastewaters generated by this process from the pellet dewatering and the filter backwash.

Table 9: Summary of Wastewater Releases from GWSDP from March to August 2009

Element	Pellet Dewatering	Filter Backwash
Total Releases	96	89
Average Releases/Month	16	15
Average Monthly Volume/Release (gal)	870	3,622
Minimum Volume Released (gal)	374	748
Maximum Volume released (gal)	2,992	11,968

Table 10 summarizes the information used to determine the water yield for this process. The average net water production from this process was ~99.8 percent for March to August 2009. It should be noted that the typical water yields for membrane softening ranges between 80-90 percent and 98 percent for ion exchange softening, the two more common softening technologies.

Table 10: Summary of Representative Monthly Wastewater Volumes and Water Yields for GWSDP, March to August 2009

Month	Pellet Dewatering (gallons)	Filter Backwash (gallons)	Total Monthly Raw Water (gallons)	Total Monthly Water Delivered (gallons)	Water Yield (%)
March	13,464	38,896	37,030,000	36,977,640	0.14%
April	13,090	75,548	35,020,000	34,931,362	0.25%
May	13,464	23,188	36,360,000	36,323,348	0.10%
June	11,220	53,856	35,660,000	35,594,924	0.18%
July	12,716	80,036	35,004,000	34,911,248	0.26%
August	23,936	32,164	34,827,000	34,770,900	0.16%
Average	14,648	50,615	35,650,167	35,584,904	0.18%

3.2 Changes to Caustic Feed System

Initially, because of the winter temperature during the shake down and startup period of this project, 25 percent caustic was used. Near freezing air and ground temperatures, the viscosity of 50 percent caustic increases significantly and the reliability of feeding the correct amount of caustic becomes problematic. As spring arrived and ambient and ground temperatures rose, VWC switched to 50 percent caustic because it is ~10 percent cheaper.

3.3 Changes to Carbon Dioxide System

Initially, Gordon Woods Welding and Supply provided the CO_2 in 384 lb cylinders. Daily consumption was about 1 cylinder a day. There was at least one incident when the facility had to be shut down because of the lack of CO_2 at the site.

On 13 April 2009 AirGas which had acquired Gordon Woods Welding and Supply installed a 2000HP MicroBulk cylinder (~1,500 liters). The system incorporates a telemetry system to their facilities so that AirGas can monitor the usage and schedule to refill the tank as it gets low. This change in CO_2 handling has increased the reliability of the facility.

3.4 Changes to Pellet Storage and Disposal

Approximately 2000 pounds of pellets were removed daily from the pellet softener. This is equivalent to generation rate of approximately 2.16 lb wet solids per kg of calcium hardness removed.

The bins for on-site storage and transport for disposal are rented from Baker Tank and same company is also contracted to transport the pellets to the A-1 Grit Company located in Riverside, California. The pellets are transported about every 19 days to A-1 Grit for reuse in roofing materials.

3.5 Operations and Maintenance of the GWSDP

3.5.1 Caustic Use

A major portion of the treatment costs per AF is associated with pH adjustment by caustic. The O&M cost is highly dependent on the average calcium hardness removed by the pellet softener which is directly related to the amount of caustic used and therefore the cost for caustic. Table 11 shows the typical water quality characteristics of Well W9 as the reference point for the O&M costs summarized in this section.

Influent calcium hardness averaged 193 mg/l as $CaCO_3$ during the 1 March to 16 July 2009 and the effluent calcium hardness averaged 55 mg/L for an average of 71.5 percent removal. Since 17 July 2009, the calcium hardness averaged 36 mg/l as $CaCO_3$ which was equivalent for almost a 10 percent higher removal. The effluent calcium hardness from the 1 March to 16 July operating period also had more variation, ranging from 33 to 85 mg/L as $CaCO_3$ This is in contrast to the 17 July to 30 August operating period which had a ranged from 33 to 38 mg/l as $CaCO_3$. This dramatic change was a result of allowing the bed to expand to 7 feet instead of the 5 feet during the March through mid-July operating period. The caustic feed rate had increase slightly, from an average of 117 ppm to 129 ppm while the pH at the top of the column has increased from an average of 9.3 to 9.8.

This change in operations had two benefits: 1) a lower treated water total hardness which is the water quality parameter that is of most importance to the customer; and 2) less variation in the calcium hardness which reduces the requirement of an equalization tank to moderate fluctuations in water quality.

Table 11: Typical Raw and Treated Water Quality of GWSDP, March to August 2009

Parameter	Average Weekly Raw Water, 1 Mar -30 Aug	Average Daily Treated Water Quality	
		1 Mar – 16 July	17 Jul – 30 Aug
Total Hardness (mg/l $CaCO_3$)	394	193	182
Calcium Hardness (mg/l $CaCO_3$)	192	55	36
Removal (%)	51.3	71.5	82.4
pH at top of column (units)	7.7	9.3	9.8

3.5.2 Sand Use

The average sand use during the GWSDP was about 143 lb/day (~ 1 lb/MG of water treated). Approximately 170 mg/l as $CaCO_3$ of calcium hardness was removed to achieve treated water quality goal of 50 mg/L of calcium hardness as $CaCO_3$ (i.e. about 0.15 lb sand/kg calcium hardness removed).

3.5.3 Carbon Dioxide Use for pH Adjustment

On average for the 1 March to 16 July operating period, the pH after the pellet softener was 9.3 and after pH adjustment with carbon dioxide it was 8.3. Carbon dioxide consumption was about 243 pounds per MGD treated. For the 17 July to 30 August operating period the pH after the pellet softener was 9.8 and after pH adjustment with carbon dioxide it was 8.3. The carbon dioxide usage rate was 330 pounds per day or 260 pounds per MGD treated.

3.5.4 O&M Labor Use

The facility required minimal maintenance during the GWSDP. The facility was taken out of service due to the following conditions:

- Low levels of treatment chemicals (caustic or CO_2)
- Distribution pressure issues
- Routine maintenance of the caustic injection system

A certified treatment operator visits the site daily for visual inspections. The following is a list of items during routine daily inspections.

1. Visually check for any leaks in all the piping, softening vessel, filtration units, chemical storage, and associated appurtenances.
2. Monitoring the level in the NaOH storage containment and visually check the chemical delivery system.
3. Monitor the pressure gauges and visually check the CO2 delivery system.
4. Visually check pressure gauges on the softening vessel and filtration units.
5. Monitor the pellet storage bins to ensure that they are dewatering completely and verify the capacity in the bins.
6. Monitor the chlorinator system and add chlorine as needed.
7. Verify site security.

The four (4) caustic soda injectors are removed one (1) at a time on a monthly basis to determine if calcium carbonate scale has occurred. If calcium carbonate scale has occurred the injectors are cleaned with a dilute vinegar solution and disinfected the components prior to being put back into service.

The three (3) pH sensors were calibrated monthly for the first three (3) months to ensure their accuracy. The checked values were comparable so now they are calibrated on an as-needed basis.

The labor requirements for the above described activities for the GWSDP are summarized in Table 12.

Table 12: Labor Estimate for GWSDP and Full-Scale Plants

GWSDP Activity	Total Hours/Month
Daily sampling and analysis for Calcium and Total Hardness	15
Discharge of pellets	30
On-site support during filling of caustic tanks by vendor	4
Maintenance of pH probes	4
On-site support during pellet disposal by vendor	2
Total	55

3.5.5 Pellet Generation Rate and Pellet Disposal Costs

The bins for on-site storage and transport for disposal are rented from Baker Tank for a monthly fee of $672. This same company is also contracted to transport the pellets to the A-1 Grit Company located in Riverside, California at a $105/hour rate and the average delivery time is 6.5 hours ($685/round trip). The pellets are transported every 19 days and initially, there was no disposal charge from A1-Grit. As of May 2009, VWC has been receiving $500 a month for the pellets from A-1 Grit.

From 1 March to 31 August VWC has spent $10,197 for this six month period, which averages out to $1,700 per month. Subtracting $500 per month from A-1 Grit for their recycling of the pellets generates a cost of $1,200 per month for the pellet disposal.

3.5.6 Summary of O&M Treated Water Costs

Over the 1 March – 30 August 2009 period, the GWSDP was operated 24/7 except for 31 August which experienced a 12 hour shut down.

On 17 July the level of the pellets in the pellet softener was allowed to expand from 5 feet to 7 feet. As a result the effluent calcium hardness dropped an additional 35 percent to 36 mg/L as $CaCO_3$ (See Table 11). As a result of this change in performance, the O&M cost for caustic is primarily derived from data collected from this period. Only data from 17 July to 30 August 2009 was used to estimate O&M costs due to the shutdown on 31 August. The carbon dioxide records are kept on a monthly basis and there is not enough data to determine whether there was a significant change in its usage.

The daily average raw water flow was ~780 gpm (1.12 MGD) and the GWSDP treated an average of 104.8 AF of raw water per month. Based on the average water (Table 8, 0.18 percent) the monthly average delivered water production was 103 AF.

Since the full scale implementation of the GWSDP will use 50 percent caustic, this was the only scenario presented in for this costs. Table 13 summarizes the treated water costs which is $164/AF. There would be another $11/AF (rounded) reduction if VWC was successful in making changes to the pellet disposal cost (VWC buys the bins and A-1 Grit provides the transportation to and from Riverside and continues the $500 per month for the pellets). Under this scenario the treated water cost would be $153/AF (rounded).

Table 13: Average O&M Costs from the GWSDP, 17 July – August 2009

Component	Unit Cost*	Usage during Demonstration	Average Monthly Cost	Average Delivered	
				$/AF	Percent
50 % NaOH ($/gal)	$1.74	220 gpd	$11,644	$113.04	68.8%
CO_2 ($/lb)	$0.21	350 ppd	$2,236	$21.71	13.2%
Sand ($/lb)	$0.056	143 ppd	$244	$2.37	1.4%
Labor ($/Hr)	$ 28	55 hour/month	$1,540	$14.95	9.1%
A-1 Grit Pellet Credit		$500/month	($500)	-$4.85	-3.0%
Bin Rental		$672/month	$672	$6.52	4.0 %
Pellet Transport ($/trip)	$683	1.6 trips/month	$1,093	$10.61	6.5%
			Total	$164.35	100.00 %

Section 4: Water Quality

This section summarizes the water quality elements of this project. The locations include the raw and treated water from the GWSDP, the distribution system, and finally the wastewater. Each of these subsections that first summarize the methodology which was generally had a sampling and analysis plan and then is following the results and discussion.

4.1 GWSDP Water Quality

4.1.1 Sampling Plant for GWSDP Raw and Treated Water

The sampling plan that was used during this study is summarized in Table 14. In addition, pH was measured in the field with approved Hach handheld devices.

Table 14: Sampling Plan for Raw and GWSDP Treated Sampling Locations

		Monitoring Requirement	
Type	**Site Name**	**Chemical**	**Frequency**
Raw Water	Well W9	Calcium	Weekly
		Chloride	Weekly
		Magnesium	Weekly
		Sodium	Weekly
		Total Dissolved Solids	Weekly
		Total Hardness	Weekly
		Alkalinity	Weekly
Treated Water (prior to chlorination)	GWSDP Treated Water	Calcium	Weekly
		Chloride	Weekly
		Magnesium	Weekly
		Sodium	Weekly
		Total Dissolved Solids	Weekly
		Total Hardness	Weekly
		Alkalinity	Weekly

4.1.2 Changes in Water Quality from Treatment by GWSDP

When using pellet softening technology with caustic pH adjustment there will be a number of raw water quality changes that will occur in the resultant treated water. For example, one would expect the sodium to increase from the caustic addition that is responsible for the precipitation of calcium carbonate on the sand.

Table 15 summarizes the changes in water quality observed during the initial phases of the GWSDP. Comments are included in this table to assist in the understanding of the observed changes in the concentrations or percentages.

Table 15: Summary of Water Quality for Raw and GWSDP Treated Water after chlorination

Parameter	Average Raw	Average Treated	Change	Comment
Dates for Water Quality Samples	22 Dec 08-18 Feb 09	1 Dec 08-25 Feb 09		
Samples	8	12		
pH	7.46	7.92		
Calcium (mg/L)	84	21	63	Decrease due to pellet softening
Magnesium (mg/L)	36	37	1	No change, pellet softening not effective in removing Mg
Sodium (mg/L)	49	116	67	Increase due to use of caustic (NaOH) for raising pH
Alkalinity (mg/L as $CaCO_3$)	226	212	14	No change, within analytical precision
Chloride (mg/L)	39	45	6	No change, within analytical precision
TDS (mg/L)	547	525	22	Drop due to pellet softening
Total Hardness (mg/L as $CaCO_3$)	358	198	160	Drop due to pellet softening
Calcium Hardness (mg/L as $CaCO_3$)	209	53	156	Drop due to pellet softening
Percent Calcium Hardness	58.4%	26.4%	-26	Drop due to pellet softening
Magnesium Hardness (mg/L as $CaCO_3$)	150	145	5	No change, pellet softening not effective in removing Mg
SAR	1.13	3.53	2.4	Although SAR has increase due to addition of caustic, still in acceptable range

The "changes" in white indicate that the values are essentially the same from an analytical perspective. For these analyses the typical analytical precision is about $\pm$ 5 to 10 percent. The "changes" in green are considered beneficial to the consumer. Beneficial changes include the following:

- Drop in total and calcium hardness
- Drop in total dissolved solids

The "changes" in pink indicates a negative benefit to the consumer. The only negative impact to consumers is the increase of sodium in the treated water. Although the sodium adsorption ratio (SAR) increases, the ratio is still in an acceptable level. The SAR would have to more than double to create some issues with the use of this water for irrigation of plants in very clayey soils (A high SAR [>8] renders a soil impermeable to air and water and when wet becomes plastic and sticky. Typically, this impact may be counter acted by the addition of gypsum to the soil).

4.1.3 Hardness Reduction by GWSDP

As previously noted, the performance of the GWSDP noticeably improved when the pellet bed was allowed to expand to seven feet. This occurred on 17 July 2009. As a result of this operational change, the water quality discussion is divided into the pre and post seven foot pellet bed operational periods.

4.1.3.1 Operating Period 1 March to 16 July 2009

Table 16 summarizes the concentrations of total and calcium hardness as calcium carbonate for the operating period 1 March to 16 July 2009. Over this period the average raw water total hardness was 351 mg/L as $CaCO_3$ and the average treated total hardness was 193 mg/L as $CaCO_3$, both with a relatively standard deviation (RSD) of less than 10 percent. This reduction represented a 45 percent removal of total hardness.

Over this same period the raw water calcium hardness was 176 mg/L as $CaCO_3$ while the treated water calcium hardness was 55 mg/L as $CaCO_3$. The treated water calcium hardness had a much larger variation due the treatment process.

Table 16: Summary Descriptive Statistics of the Weekly Total and Daily Calcium Hardness of the GWSDP, March to 16 July 2009

	Total Hardness (mg/L as $CaCO_3$)			Calcium Hardness (mg/L as $CaCO_3$)		
	Weekly Raw	**Daily Treated**	**% Removed**	**Weekly Raw**	**Daily Treated**	**% Removed**
Samples	17	136		17	136	
Average	351	193	44.9%	176	55	68.7%
RSD (%)	5.3%	9.3%		5.3%	19.2%	

In addition to the equipment reliability that was discussed in the O&M section, one would also like to see a relatively stable treated water quality which is reflective of a stable reaction kinetics and process control. A measure of the stability of the treated water quality is to examine the relative standard deviation (RSD) expressed as a percent, i.e., the standard deviation that is derived from the average divided by the average value expressed as percent. The observed variation of the water quality has two components, analytical and process reliability.

The RSDs of the total and calcium hardness of raw waters is probably more reflective of the analytical variability which is ~ 5 percent for the raw water total and calcium hardness. This is within the acceptable range of analytical variability for these tests.

Assuming there is about a 5 percent analytical variation, the treatment adds almost another 4 percent and 14 percent additional variation to the total and calcium hardness, respectively. In both cases the RSD is equivalent to about $\pm$ 10 mg/L of total and calcium hardness as $CaCO_3$ to the treated water.

There are two potential approaches to reduce the RSD of the treated water. One is to have a large clear well after chlorination would "average" the treated water quality. The other is to improve the caustic feed system to more tightly control the pH in the pellet softener.

4.1.3.2 Operating Period 17 July to 30 August 2009

The total and calcium hardness data for this operating period is summarized in Table 17. The weekly data set for the raw water is very small as compared to the 1 March to 16 July operating period which may account for the less variability of the total and calcium hardness. During this period, the treated calcium hardness had more variability than during the 1 March to 16 July. Examining Figure 5, one can see a very steady operational period that lasts for about two weeks followed by an unstable period of about two weeks. This is then followed by another period of relative stability. This pattern is reflective of the large RSD of the treated calcium hardness shown in Table 17.

These changes in treated effluent are a response to pH control in the pellet softener. More pH readings (every 5 – 10 minutes) are needed to examine this issue in more detail.

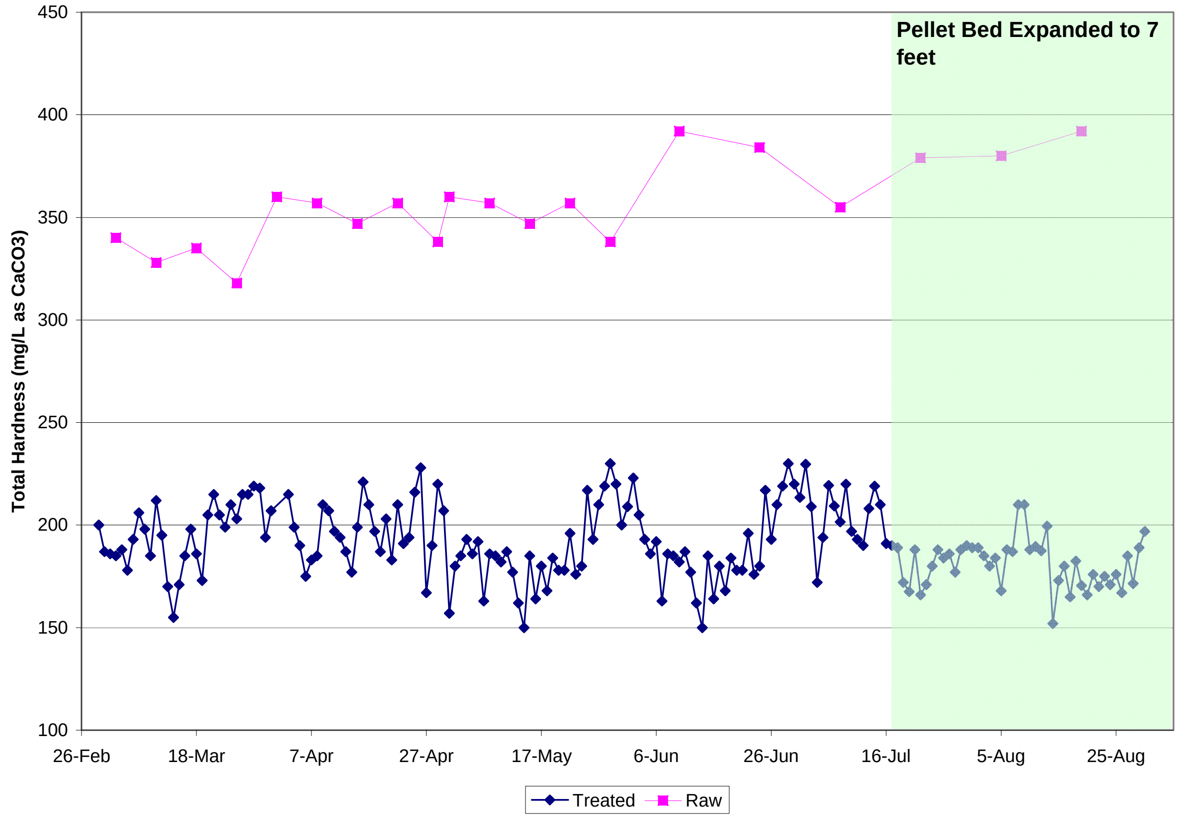


Figure 5: Weekly Raw and Daily Treated Total Hardness of the GWSDP (March to May 2009)

Table 17: Summary Descriptive Statistics of the Weekly Total and Daily Calcium Hardness of the GWSDP, 17 July to 30 August 2009

	Weekly Total Hardness (mg/L as CaCO3)			Daily Calcium Hardness (mg/L as CaCO3)		
	Raw	**Treated**	**% Removed**	**Raw**	**Treated**	**% Removed**
Samples	3	45		3	45	
Average	384	181	52.8%	192	34	82.4%
RSD (%)	1.9%	6.5%		1.9%	30.7%	

Another means of obtaining a sense of the process stability is to examine the daily fluctuations of the measured total and calcium hardness. Figure 5 presents the total hardness behavior for the March to May 2009 period. Figure 6 presents the calcium hardness behavior for the same operational period.

Figure 5 indicated that for the total hardness, the raw water generally fluctuates about $\pm$ 15 mg/L as $CaCO_3$ in absolute terms whereas the treated water fluctuates about $\pm$ 25 mg/L as $CaCO_3$. Figure 6 indicate that for the calcium hardness, the raw water generally fluctuates about $\pm$ 10 mg/L as $CaCO_3$ in absolute terms whereas the treated waters fluctuates about $\pm$ 20 mg/L as $CaCO_3$.

It can be concluded that under the current operating and design scenario, the GWSDP generates variability of the treated water total and calcium hardness. One would expect to observe this type of fluctuation in the distribution system serving the Copperhill community. Having a storage tank after the softening process would dampen this variability in hardness of the treated water.

A closer examination of the operating period between 17 July and 30 August was performed to determine the variability of the hardness. Figure 7 is a plot of the treated calcium hardness versus the pH at the top of the column. The data presented in Figure 7 indicates that there is a reverse correlation between the softener effluent and pH at the top of the column, i.e., as the pH increase, the calcium hardness drops. This was an expected behavior as indicated in the chemical reaction equation presented in Section 2.5.1. Good control of the pH at the top of the column will result in less variability of the treated water calcium hardness.

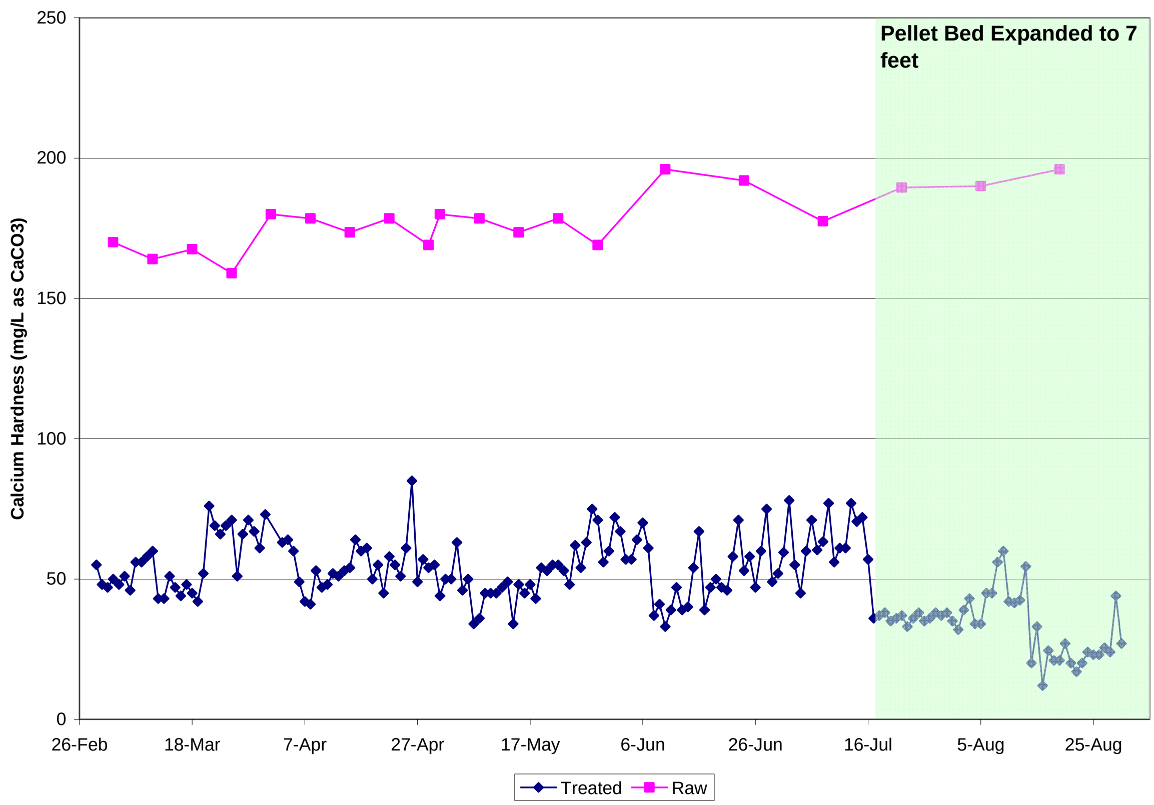


Figure 6: Weekly Raw and Daily Treated Calcium Hardness of the GWSDP (March to August 2009)

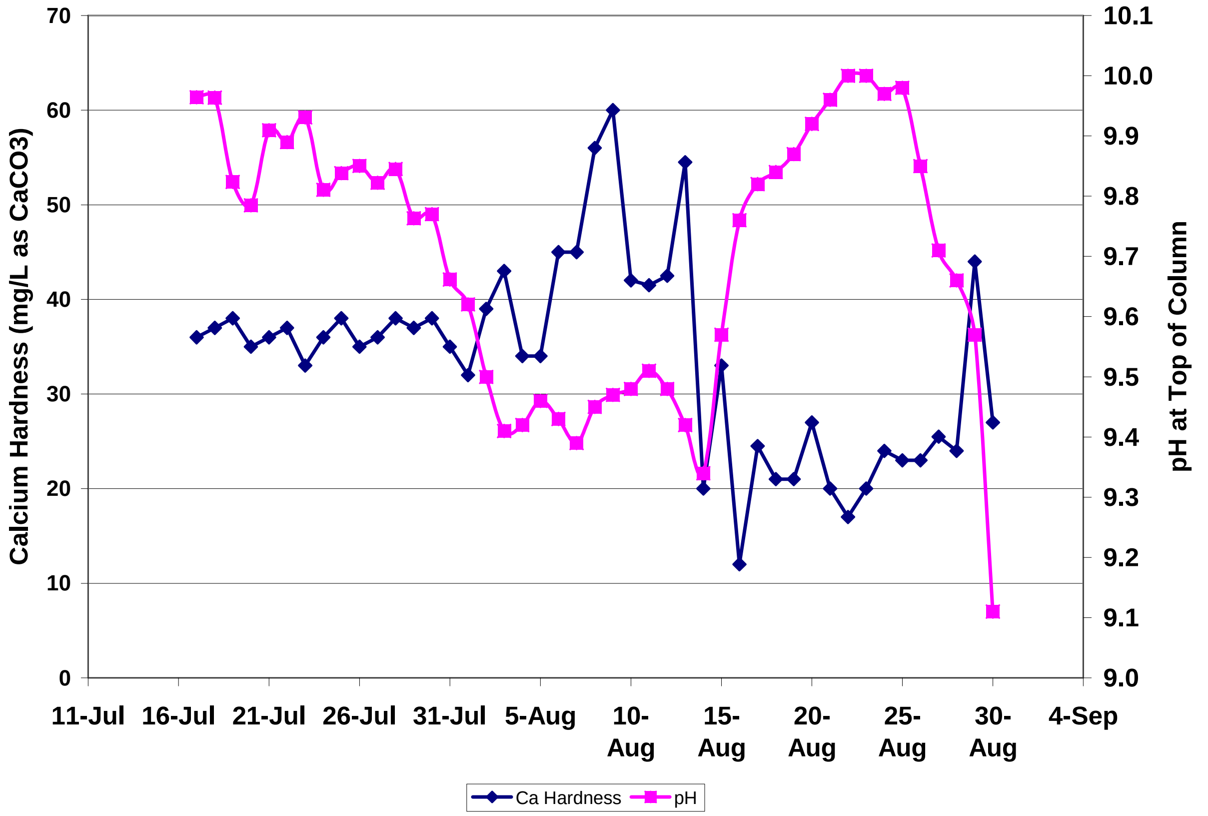


Figure 7: Treated Water Calcium Hardness Variation versus pH at the Top of the Column, 17 July to August 30

4.2 Distribution System Water Quality Characterization

VWC monitored various locations within the Copperhill Community to asses the water quality that the consumers received prior to the beginning of the GWSDP to establish a water quality baseline for the current supply being delivered to the Copperhill Community. VWC collected weekly samples throughout the GWSDP area during the first few weeks to ensure the delivered water quality is consistent with the water quality leaving the treatment facility. Then, several samples were collected during the duration of the project to monitor the quality of the water within the project area. VWC only used Environmental Laboratory Accreditation Program approved laboratories for these analyses.

Table 18 presents the weekly average results from 21 July to 10 September 2008 of the pre-installation water quality of the Copperhill Community distribution system. On 11 September 2008, the GWSDP was brought on line into the distribution system.

Table 19 presents the weekly average water quality from 1 December 2008 to 25 February 2009. The GWSDP was operating 24/7 as indicated by the similar water quality from the treated W9 samples as compared to the distribution system samples. The treated W9 water is dramatically different in total hardness, calcium, and sodium than the raw, untreated W9 water. There was a small decrease in the TDS and alkalinity.

4.3 Impacts on Wastewater Water Quality

Below is a description of the approach that was used to estimate the impact of the centralized softening facility on the wastewater generated from the study area. The three related equations were used to calculate the net chloride change in the wastewater.

Pre-installation Condition

Wastewater chloride **–** Distribution water chloride	=	Chloride increase from internal household use that becomes wastewater **+** SRWS regeneration brine

Post-installation Condition

Wastewater chloride **–** Distribution water chloride	=	Chloride increase from internal household use that becomes wastewater

Net Chloride Change from GWSDP

Post-installation **–** Pre-installation	=	Net Chloride decrease due to removal of SRWS regeneration brine

The pellet softening system should not affect the distribution water chloride unless the chlorination practice was different in the pre and post-installation periods. It is assumed in this approach that the chloride increase from internal household use that becomes wastewater was constant in the pre and post-installation periods. Since the SRWS should be removed from the homes in the study area during the post-installation period, the net reduction in chloride then becomes the difference in wastewater chloride between the pre and post-installation periods.

Table 18: Average Weekly Pre-Installation Distribution Water System Water Quality Results, 21 July to 10 September 2008

Sample Location	pH	Magnesium	Calcium	Chloride	Total Hardness	TDS	Na	Alkalinity
Astor Racing Court	7.50	41	102	36	425	657	55	
Copperstone Dr. / Copperhill Dr.	7.50	38	93	41	387	651	56	
Decoro/Dickason	7.45	37	95	53	387	684	64	
English Rose Place	7.45	38	99	48	403	671	61	
Kirby Court	7.51	39	101	41	412	643	56	
Lavender Place	7.47	40	94	36	399	649	53	
Montevista Circle	7.51	37	96	41	391	609	56	
Well W-9 Raw Water	7.61	37	79	39	348	593	58	220

Table 19: Average Weekly Post-Installation Distribution Water System Water Quality Results, 1 December 2008 to 25 February 2009

Sample Location	pH	Magnesium	Calcium	Chloride	Total Hardness	TDS	Na	Alkalinity
Decoro/Dickason	7.93	36	24	41	206	523	108	
Kirby Court	7.94	36	23	41	206	517	110	
Lavender Place	7.93	35	25	43	206	489	112	
Montevista Circle	7.97	35	26	43	208	511	107	
Astor Racing Court	7.96	35	22	43	198	517	110	
English Rose Place	7.95	35	31	43	220	515	107	
Copperstone Dr. / Copperhill Dr.	8.00	34	30	40	214	506	105	
Well W-9 Finished Water	7.92	37	21	45	198	525	116	212
Well W-9 Raw Water	7.45	37	97	39	404	551	49	228

4.3.1 Wastewater Water Quality Characterization

To assess the potential reduction in the chloride levels, VWC worked with the Santa Clarita Valley Sanitation District (SCVSD) to monitor chloride levels in the wastewater from the Copperhill Community. The SCVSD collected the wastewater samples and measured the wastewater flows. The LACSD Laboratory at Whittier, California performed the water quality analyses. The sampling dates, location, and sampling approach is summarized in Table 20.

Table 20: Summary of SCVSD Sampling to Characterize the Wastewater from the Study Area

Sampling Event	Date Sampled	Location Description	Sample Type
Pre-installation 18-25 July 2006	7 days	Sanitary Sewer Manhole near Valencia High School	1 hour grab
Pre-installation 10-17 March 2008	7 Days	Sanitary Sewer Manhole near Valencia High School	3 hr composite grab
Post-installation 26-29 January 2009	5 Days	Sanitary Sewer Manhole near Valencia High School	Hourly Grab

Flow were measured in manhole during sampling events.

4.3.2 Net Change in Wastewater Chlorides from the Demonstration Centralized Softening Facility

For the pre-installation, the July 2006 and March 2008 results were averaged and compared with the 2009 results. These findings are summarized in Table 21 and the presented in Figure 8. The chloride reduction from the centralized softener is estimated to be 71 pounds per day or approximately 13 tons per year.

Table 21: Comparison of Pre and Post Chloride Loading to Wastewater

Time of Samples (Hour)	Avg. Pre Install Cl (lbs/hr)	Post Install Cl, (lbs/hr)	Difference (lbs/hr)
0:00	17.9	17.5	0.5
3:00	42.6	24.8	17.8
6:00	60.8	30.6	30.2
9:00	22.8	27.9	-5.1
12:00	20.2	19.0	1.2
15:00	13.7	16.3	-2.7
18:00	17.9	23.0	-5.1
21:00	20.1	33.1	-13.0
Average	27.0	24.0	3
Estimated 24 hour Total	648	577	71

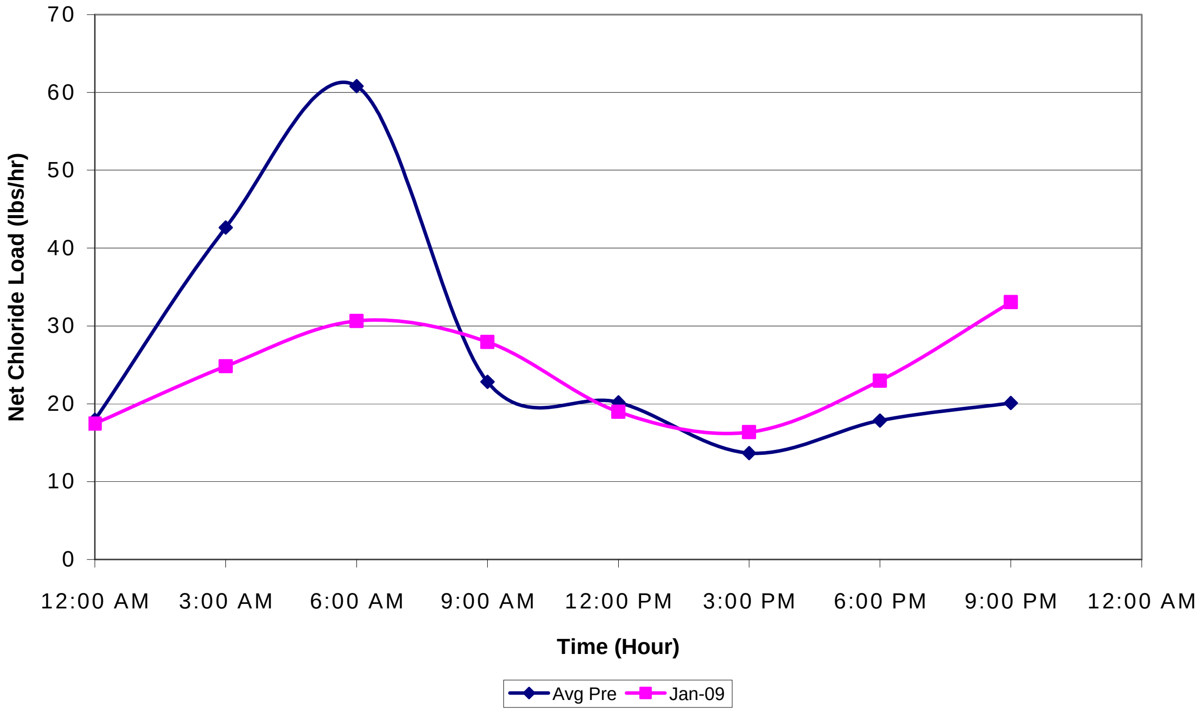


Figure 8: Net Wastewater Chloride Loading for Pre and Post Installation Periods

Section 5: Outreach and Customer Survey

This section summarizes the outreach efforts performed by consultants to VWC. There were two pre-installation efforts, one by Meyer Marketing Intelligence and another by O'Rorke, Inc (O'Rorke). There was one post-installation effort performed by O'Rorke. To the degree possible, much of this section was taken from their respective documents that were provided to Kennedy/Jenks Consultants.

5.1 Pre-installation Outreach– Meyer Marketing Intelligence

The first pre-installation was performed by Meyer Marketing Intelligence in September-October 2006. Below is a brief description and summary of their report dated November 2006. Their report as submitted to VWC is provided in Appendix B.

5.1.1 Overview and Methodology

A marketing research consultant, Meyer Marketing Intelligence, developed a questionnaire to be administered over the telephone, copy of which is presented in Appendix B. Out of a total of 419 Copperhill community customers in the database with telephone numbers, 162 interviews were completed.

The interviews were approximately 5 minutes in length and the customers were told the research was being conducted on behalf of VWC in order to gauge customers' reactions towards the project as well as determine the usage of water softening systems either via a monthly service or AWSs. The objectives of the survey were the following:

- Ascertain the number of customers in that region with either a monthly water softening service or AWS.
- Determine customers' willingness to either discontinue their monthly service or disconnect their AWS during a test period in which VWC would provide softer water.

The majority of the interviews were conducted in September 2006; however, there were a few that occurred in the second-half of October 2006.

5.1.2 Findings

Below are the findings from the Meyer Marketing Intelligence memo summarizing their survey.

- Fifty seven (57) percent of the Copperhill community customers had some type of water softening system – either a monthly service with tanks exchanged or an SRWS.
- Customers appear to be receptive to receiving softer water from VWC.
- Customers in the Decoro Highlands are currently noticing spots on their dishes, glasses, or shower doors indicating the water is hard in the area.
- Even customers with a water softening system are still noticing water spots on their dishes, glasses, or shower doors.

- However, before agreeing to discontinue a monthly service or disconnect a SRWS they need more information including cost implications, chemicals used, and how to handle their existing system either through a monthly service or a SRWS.

5.2 Pre-installation Outreach Efforts – O'Rorke

The O'Rorke outreach survey was done in September 2008. Below is a brief description and summary of their report. Their report as submitted to VWC is provided in Appendix B.

5.2.1 Overview and Methodology

Following the launch of VWC's Demonstration Softening Project, staff from the VWC, LACSD, and O'Rorke completed two rounds of door-to-door outreach September 19-20 in the Copperhill community. The goal was to inform residents about the project and to conduct surveys on hard water issues as well as to reach each of the 419 homes at least once.

Despite many residents' hesitation to open their door to potential solicitors, the community's overall response to the outreach was very positive. The majority of residents seemed to be aware of the negative environmental impact tied to SRWS, and pleased to hear about the GWSDP.

A total of 134 surveys were conducted in person, with six additional surveys submitted online at www.valenciawater.com. A copy of this survey is in Appendix B. Residents that submitted the survey during the door-to-door outreach received a Baskin Robbins coupon while those that submit the survey online will receive a Starbucks gift card. On the second day, a door hanger (a copy is in Appendix B) was left at those homes where no one answered the door. In cases where residents did not know the answer, the answer to the question was left blank.

In cases where residents had open garages but did not answer the door, staff noted whether the home had a visible water softener. The outreach staff observed that 95 homes have a water softener, and 15 of those have a portable exchange tank.

5.2.2 Occurrence of Home Softeners in Copperhill Community

Figure 9 summarizes the results of the 140 surveys. The most prevalent configuration of a home softening unit is a SRWS that is customer maintained. The least prevalent configuration is a customer that rents an exchange tank unit. Nearly 30 percent of residents with a water softener moved into a home with it already installed.

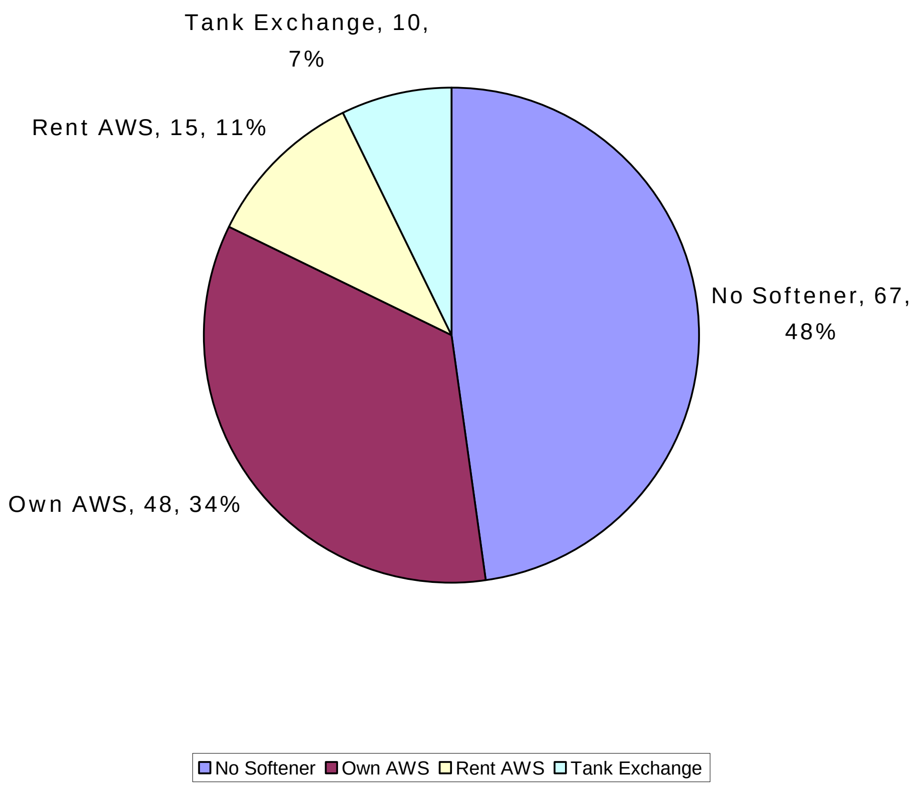


Figure 9: Distribution of Copperhill Community Softeners

5.2.3 Willingness to Pay for Centralized Softening Facilities

There were 138 survey results concerning the customer's willingness to pay for VWC to provide softened water from a centralized facility. These results are summarized on Figure 10. Fifty-one (51) percent of the customers from this community indicated that they would be willing to pay for pre-softened water as part of their water bill and did not set a cost condition. Twenty three percent of the 138 surveys indicated that they were willing to pay provided the costs were reasonable. A portion of the unsure (8 percent) required more information before they could offer an opinion. It is estimated that almost 80 percent, when provided with more information may be willing to pay for pre-softened water. Of the surveyed customers who provided an opinion on their reasonable cost, the average reasonable cost was $17.50 per month with a range of $5-$60 per month.

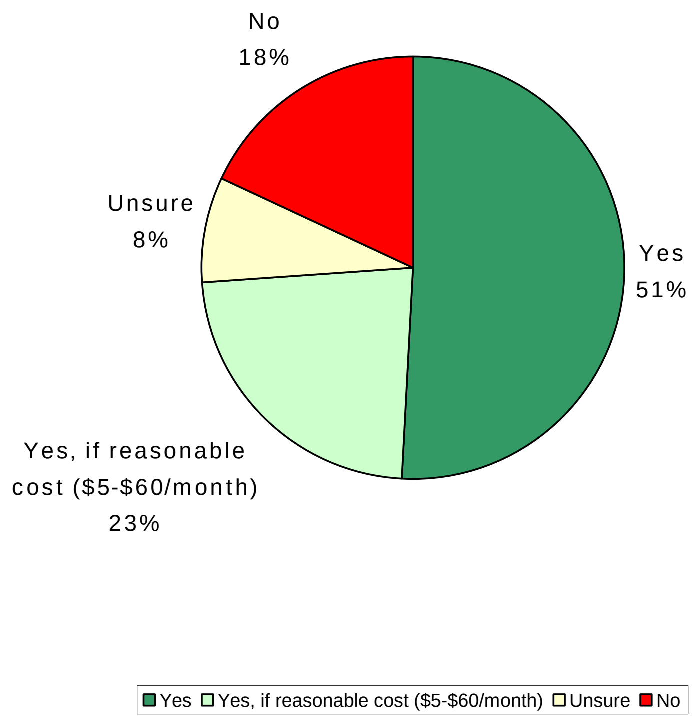


Figure 10: Copperhill Customer's Willingness to Pay

5.2.4 Other Findings

Below are other findings summarized from a memo provided by O'Rorke that summarized their survey.

- Most named spots on dishes and glasses and the general hardness of the water as the major reasons they use a water softener.

- Of those with a water softener in home, 90 percent are willing to disconnect their unit during the test period, but many are hesitant to permanently disconnect until Valencia confirms whether they will continue to provide pre-softened water after the GWSDP period.

- Of those with a SRWS, 90 percent are willing to disconnect during the test period. When asked what would encourage residents to permanently disconnect their softener, most cited rebate programs, saving money, and Valencia offering pre-softened water as the top motivators.

- Many residents were already excited about the project after reading the Copperhill HOA newsletter, while others hadn't heard of it but still were open to the idea. The primary concerns were cost and whether the project will really provide water similar to what they receive from their water softener. Residents were willing to set their water softener to bypass, but not necessarily remove their units.

- Regarding the perception of hard water, 83 percent of residents consider their water to be hard. Most residents use their water softener because they noticed spots on their dishes and shower doors, and continue to see lines around their toilet, dishwasher and washing machine. If residents did not use a water softener, they anticipate they would experience calcium build-up, dry itchy skin and poor taste. While residents are excited to receive pre-softened water, many are skeptical about how soft the water really is.

- Most did not notice the change in the current hardness of their water since they were unaware they were receiving pre-softened water, and will now pay attention to see if there are any differences in their water quality. Some residents without water softeners in their homes noticed they no longer had rings in their bath tubs. In addition, a few respondents noticed that their hair is better and believed it was tied to the pre-softened water.

- As a whole, Copperhill residents seemed to be well informed on the subject of hard water. Many were willing to discuss the project, and are willing to participate in future outreach efforts.

- Of those homes with a water softener, 86 percent claim cost savings would motivate the permanent disconnection of their water softener. When asked whether residents would be willing to sign a pledge to discontinue use of their water softener, 60 percent said yes, 30 percent said no, and 10 percent were undecided. Of AWS users, 37 (59 percent) are willing to sign a pledge to discontinue use

5.3 Post-Installation Outreach – O'Rorke

The O'Rorke outreach survey was performed from April to June 2009. Below is a brief description and summary of their report. Their report, "Valencia Water Company Groundwater Softening Demonstration Project Follow-up Survey Report" as submitted to VWC on 16 July 2009 is provided in Appendix B.

5.3.1 Methodology

O'Rorke conducted two rounds of follow up surveys to obtain resident feedback on the pre-softened water provided by VWC as part of the GWSDP. A total of 118 follow up surveys were completed, representing 27 percent of the Copperhill community, which meets the sample required by the California Public Utilities Commission. Twenty-one of the surveys were completed via phone throughout the month of April and the remaining 97 were completed during the door-to-door outreach conducted on May 31 and June 2. The following report represents the combined results.

5.3.2 AWS Hook up Status

A total of 118 surveys were completed over the phone or in person. Of those surveyed, 80 residents (~68 percent) do not currently have an automatic water softener (AWS) or have unplugged their AWS since the project launch (See Figure 11).

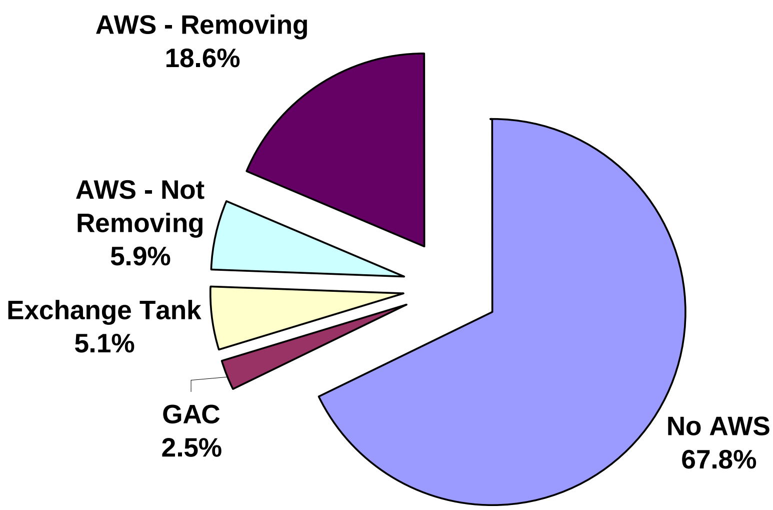


Figure 11: Status of AWS for Surveyed Accounts, June 2009

Thirty-eight residents (32 percent) currently use a water softener and of those, six residents reported use of an exchange tank and three use a carbon based system. The remaining 29 use an AWS. Twenty two (22) of those residents currently using a water softener said they would disconnect right away to try the pre-softened water. Two residents were provided a rebate application during door-to-door outreach. Of those that do not plan on removing their AWS, three residents said it was due to health concerns, including eczema.

Thirty-nine percent of respondents cited the launch of the GWSDP as the primary reason they disconnected their AWS, while 61 percent named other reasons, including the rebate program and the ordinance banning softeners.

5.3.3 Opinions on Water Quality Changes

Opinions on the water quality changes from pre to post-installation of the GWSDP are summarized on Figure 12. When asked how the water compares to the water they received prior to the launch of the GWSDP 20 percent of respondents said they have no opinion, some because they were new to the area (67 percent) and did not have anything to compare to the pre-softened water. Those residents' results are not included in the final percentages. Additionally, three of the fourteen new residents currently use a pre-installed water softener and could not fully comment on the pre-softened water.

Approximately 33 percent said the water is much better or somewhat better than water received prior to September 2008. Approximately 42 percent of respondents think the water is the same—however, 8 residents are previous AWS users and another 8 currently use an exchange tank or a salt-free unit. Less than five percent (6 respondents) of the 118 surveyed respondents responding to the hardness of their water said the pre-softened water is somewhat worse or extremely worse compared to the softened water they previously received from their AWS.

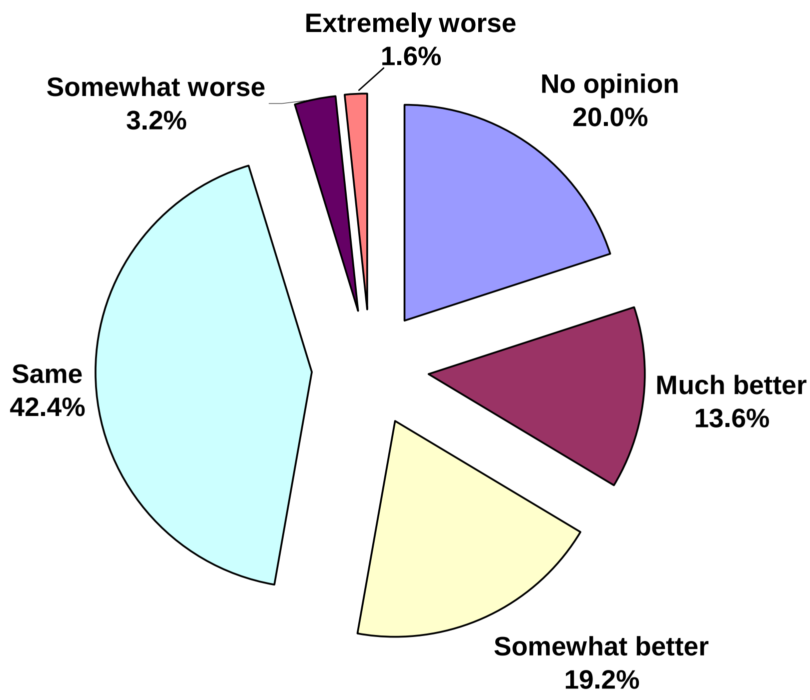


Figure 12: Customers' Opinion on Water Quality Changes, June 2009

The reported changes reported by residents since the start of the GWSDP are summarized on Figure 13. The most commonly reported change was fewer spots and calcium scale on pipes and appliances (34 percent) and softer skin (14 percent).

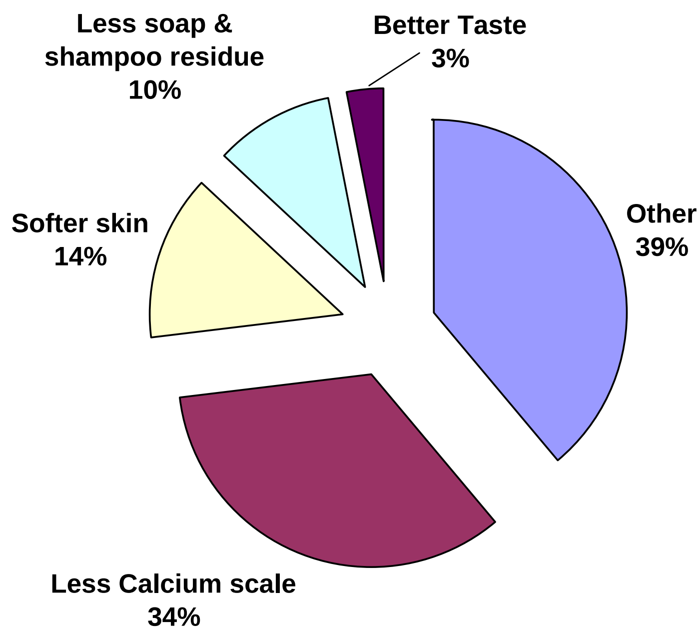


Figure 13: Changes Noticed by Customers Due to GWSDP

Most residents had strong opinions about how they like about their water, and provided feedback ranging from "it could be better" to "don't get rid of it!" Seventy-three percent of respondents said they would recommend pre-softened water to friends and neighbors. Of those, 17 percent are new residents to Copperhill. Respondents noted the following changes in their water since the launch of the GWSDP.

- One resident shared how much her family liked the new water and explained how they used to buy bottled water for drinking but now exclusively drink tap water. She was very enthusiastic about the project and said that she hopes Valencia continues providing the pre-softened water.

- A resident who previously used an SRWS said that while he thought the SRWS worked better, the pre-softened water is better than not having a softener at all and added it would be “horrible to not have anything.”

- Another mentioned she didn’t like salt-softened water as it had a slimy feeling and likes the pre-softened water she is receiving now better than the water previously softened by her SRWS.

- One resident said she noticed less calcium build-up in her dishwasher, softer skin and a better taste in the water.
- Another mentioned that although his water is not as soft as with his SRWS, it is much better than the original tap water. He has noticed less calcium build-up and less soap and shampoo residue since the launch of the project.
- Another resident commented that his pre-softened water is better than the hard tap water and produces less calcium build-up.
- One resident noted her laundry was better and cleaner since the project began is September.
- Another resident noted there is more calcium in the water compared to the water received through her SRWS, but less than with original tap water. She also commented that the water is also not as slippery as it was with a SRWS.
- One resident commented there is less calcium build-up, and it’s better than the original tap water and it tastes better than water softened by a SRWS.
- One resident commented, "I don’t know why anyone wouldn't be happy with the water," and added that she likes the pre-softened water better than the water she previously received from a SRWS.

In addition, there have been a number of statements from the GWSDP that endorse the improved water quality from an aesthetics perspective. Two are presented below (Alvord 2009).

- Rosalie Goldenberg:

  “I love it! It’s much better than the AWS-treated water. I don’t know why anyone wouldn’t be happy with the water.” Better hair, softer skin, less buildup.

- Benice Haney:

  “I first noticed that my dishes were squeaky clean straight out of the dishwasher. Then I realized my hair and skin were so much softer. Once I discovered that Valencia was providing our house pre-softened water, I took a risk that paid off—I now don’t have to use all those extra products to keep my laundry white!”

5.3.4 Distribution of Willingness to Pay

Thirty four respondents provided opinions regarding their willingness to pay for pre-softened water as part of their monthly bill. Figure 14 summarize these opinions. Residents considered the wide range of $1 to $20 per month as a reasonable increase, with the average response being approximately $10 per month. Some did not want to pay a fee unless the water improved while others in this group simply were not concerned with the hardness or softness of their water.

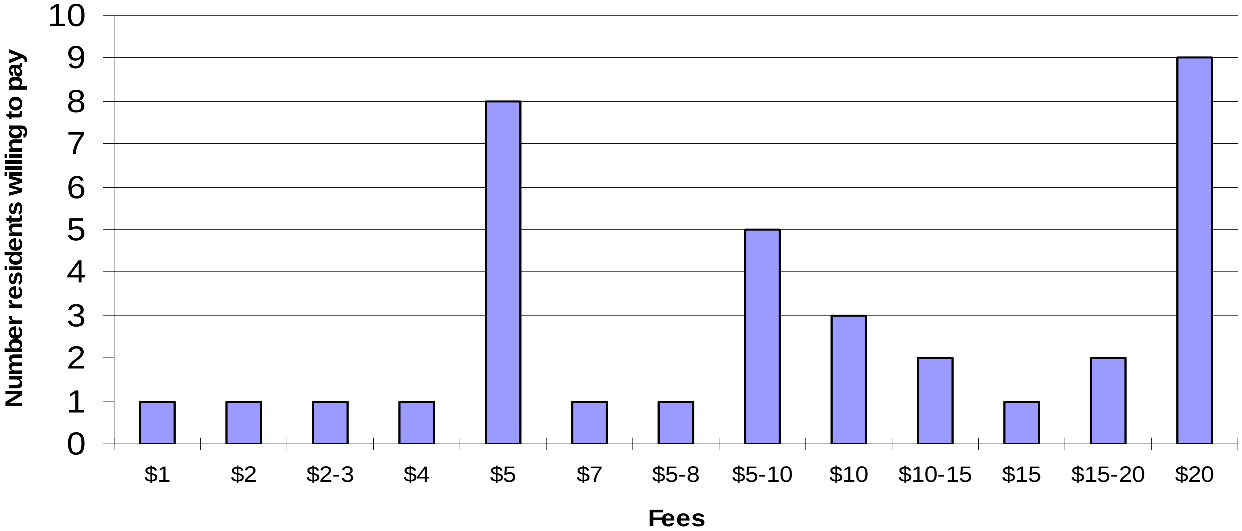


Figure 14: Distribution of Responses for Their Willingness to Pay Extra per Month for Pre-Softened Water

5.3.5 Differences between Pre and Post-Installation O'Rorke Surveys

There is a notable increase in awareness between the project launch survey and follow up survey. For example, with the launch survey 71 percent of residents reported they still used a water softener or exchange tank whereas with the follow up survey, only 32 percent reported continued use of a water softener or exchange tank, showing that residents are well educated about the need to disconnect and try the pre-softened water. The importance of education is well represented by the 13 residents who completed both the initial project launch survey and this survey. These residents were engaged at the time of the project launch and as a result were able to provide more thorough responses to the follow up survey and are perhaps the best representation of water acceptability as they were able to judge water from inception.

An analysis of the responses from residents that completed both surveys shows a generally high level of satisfaction with the project. Sixty-nine percent of those respondents still used a water softener at the time of the launch survey and all have disconnected since then. Nearly half of the respondents (46 percent) disconnected their water softener due to the launch of the GWSDP. Forty-five percent of the respondents described the pre-softened water as being much better or somewhat better than the water their home used prior to the GWSDP. Fifty-five percent of respondents considered the water to be the same. Of this group, no residents described the water as being worse than before the GWSDP. Ninety percent of the respondents would recommend the pre-softened water to their friends and neighbors. Willingness to pay fees for pre-softened water remains constant, with 73 percent saying they would pay at the time of the project launch and 75 percent stating they would pay for satisfactory pre-softened water on the follow up survey.

5.3.6 Post-Installation Survey Conclusions

Overall, residents are satisfied with the pre-softened water with 73 percent stating they would recommend the water to their friends and 94 percent rating the water as the same or better than their previous tap water. While many wish for "perfect" water or water identical to their SRWS, the general consensus is that the community welcomes the pre-softened water, especially since they cannot use a SRWS after June 30. Some residents noted paying a small monthly fee for pre-softened water is less expensive than purchasing a new salt-free alternative unit. The pre-softened water appears to solve residents' top problems reasons for using a SRWS—calcium scale and dry skin.

Section 6: System Wide Implementation

VWC utilizes a diverse mix of water supplies in order to provide reliable service to its customers. However, differences in water quality between the sources can cause uneven distribution of different water qualities within its service area. The major issue that confronts VWC involves its groundwater sources from two local aquifers. They are high in total hardness (usually greater than 350 mg/l) when compared with imported water (approximately 150 mg/l) delivered from the State Water Project (SWP). Over the years, VWC has received more customer complaints about hard water than any other type of water quality concern. It remains by the far the greatest number of customer complaints received by the company.

6.1 Water Quality Improvement Plan (WQIP)

The goal of the VWC Water Quality Improvement Plan is to deliver a more uniform water quality that is softer than the currently served water. The approach to achieve this goal is to use blending and treatment. Blending is the first treatment option typically considered when meeting non-compliance water quality goal. This approach typically is the lowest cost and simplest to operate. Whether softer water is achieved via pellet softening or blending, this plan, when fully implemented will result in a more uniform water quality delivered throughout VWC's service area. With this approach, it is reasonable to expect that all customers will receive varying percentages of naturally hard groundwater from time to time (Decision 07-06-024, *Opinion On Application for General Rate Increase of Valencia Water Company*, California Public Utilities Commission, June 2007).

The blending approach of the WQIP uses the SWP water to blend with well water to meet a similar total hardness as the pellet softening treated water. Since 2006, Valencia has evaluated and tested pellet softening technology to determine if it's feasible and cost effective to soften groundwater at the company's various well fields for the treatment portion of the plan.

Following a successful demonstration project, the VWC has determined that seven additional pellet softening treatment plants are needed to treat the majority of groundwater delivered by Valencia's existing and future planned production wells. When fully implemented, the project will essentially treat approximately 27,150 gpm out of total capacity of 34,650 gpm, or 78 percent of the company's available groundwater capacity. The capacity from three Saugus wells is not included in this total (the 34,650 gpm) because they are reserved for droughts and are infrequently used.

There are three Saugus wells that were not included in this analysis because they are kept in reserve for drought periods and are infrequently used. Further discussion of these wells are provided below:

6.1.1 Softer Water through Blending

Blending instead of well head softening will be the approach for four alluvial wells that comprises an estimated 22 percent (7,500 gpm) of Valencia's well capacity. These wells will be blended with imported water supplies within the distribution system resulting in beneficial reduction in total hardness.

6.1.1.1 “S” Well Field

Located in the community of Bridgeport, Valencia’s S wells (S6, S7, S8) are located along the community’s Paseo trail system that straddles the Santa Clara River on one side and the Bridgeport Community on the other side. Two wells (S7 and S8) pump groundwater into a transmission pipeline and then combine with imported water from Castaic Lake Water Agency’s (CLWA’s) gravity fed turnout (V7) before the blended water enters distribution system (pressure zone 1). S6 pumps directly into a higher pressure zone (pressure zone IIA North) without blending with imported water from CLWA turnout V7, which is located close to the well. Modifications are necessary at the V7 turnout in order for S6 to be blended with imported water.

6.1.1.2 “W10” Well

VWC’s alluvial well W10 is located off of Newhall Ranch Road near San Francisquito Creek. There is insufficient land surrounding the well to accommodate a pellet softening treatment system. CLWA turnout V2 is located north of the well and provides blending within the distribution system.

6.1.2 Softer Water through Treatment

This section describes this implementation and the associated capital costs. The proposed full-scale treatment plants are listed in Table 22 and their locations, except for Castaic Junction are shown in Appendix A. For the Castaic Junction location see Section 6.1.2.7.

Table 22: Proposed Additional Water Softening Treatment Plants

Plant Name	Wells Treated	Rated Capacity (GPM)	Start Up Date
Live Oak	D, E15	2,450	2012
Magic Mountain	206, 207	5,000	2012
Belcaro	W11	1,000	2014
Pan Handle	Q2, T7, U4, U6	4,650	2014
Pardee Field	N, N7, N8	6,250	2017
Commerce Center	E14, E16, E17	3,400	2019
Castaic Junction	G1, G2, G3	3,600	2021

A typical process and instrumentation diagram (P&ID) for a centralized pellet softening facility is presented in Appendix A. Preliminary site layouts were developed for all the plants (presented in Appendix A) to help develop the capital costs. Each plant is briefly described below.

6.1.2.1 Live Oak

This site will treat water from two existing wells, Well D and Well E15. This plant is rated for a flow of 2,450 gpm and a maximum total hardness of 498 mg/l as $CaCO_3$. While 464 mg/L as $CaCO_3$ is the average hardness of these two wells, Well D has had total hardness levels in excess of 500 mg/L. If well D was to run without dilution from E15, the caustic usage and pellet production would increase during that time period.

The existing well pump will be de-rated to allow only enough head to get through the treatment system. A booster pump will be added to get the treated water into the distribution system at a pressure of 145 pounds per square inch, gauge (psig).

Water from the dewatering pellet bin and multimedia filter backwash is based on annual production rate of 1680 AFY. Water from the dewatering pellet bin and multimedia filter backwash is estimated to be approximately 2,700 gallons per day. Under final design it will need to be determined how best to dispose of this water. Capital costs for this system are not included in this estimate.

6.1.2.2 Magic Mountain

This site will treat water from two existing wells – 206 and 207. While 207 is in place, it is not currently in production, but will be by the time Plant 3 would be constructed. This plant is rated for a flow of 5,000 gpm and a maximum total hardness of 481 mg/l as $CaCO_3$. This treatment site is in a commercial land use area and will require construction of a new pipeline to bring flow from wells 207 and 206 to the proposed treatment plant site.

The existing well pumps will be de-rated to allow only enough head to get through the treatment system. A booster pump will be added to get the treated water into the distribution system at a pressure of 185 psig.

Water from the dewatering pellet bin and multimedia filter backwash is estimated to be approximately 3,800 gallons per day. Under final design it will need to be determined how best to dispose of this water. Capital costs for this system are not included in this estimate.

6.1.2.3 Belcaro

This site will treat water from one existing well – W11. This plant is rated for a flow of 1,000 gpm and a maximum total hardness of 468 mg/l as $CaCO_3$. The treatment site is in a residential area and may require public acceptance prior to construction.

The existing well pump will be de-rated to allow only enough head to get through the treatment system. A booster pump will be added to get the treated water into the distribution system at a pressure of 145 pounds per square inch, gauge (psig).

Water from the dewatered pellet and multimedia filter backwash is estimated to be approximately 1,300 gallons per day. Under final design it will need to be determined how best to dispose of this water. Capital costs for this system are not included in this estimate.

6.1.2.4 Pan Handle

This site will treat water from four existing wells – Q2, T7, U4 and U6. This plant is rated for a flow of 4,650 gpm and a maximum total hardness of 565 mg/l mg/l as $CaCO_3$. While 546 mg/L as $CaCO_3$ is the average hardness of the three sites, wells U4 and U6 have seen total hardness values in excess of 700 mg/l as $CaCO_3$. If either of these wells were to be run without dilution from Q2 or T7, the caustic usage and pellet production would increase during that time period.

This treatment site is in a commercial area and has existing piping from the four proposed wells to the treatment site. The existing well pumps will be de-rated to allow only enough head to get through the treatment system. A booster pump will be added to get the treated water into the distribution system at a pressure of 150 psig.

Water from the dewatering pellet bin and multimedia filter backwash is estimated to be approximately 5,500 gallons per day. Under final design it will need to be determined how best to dispose of this water. Capital costs for this system are not included in this estimate.

6.1.2.5 Pardee Field

This site will treat water from three existing wells – N, N7 and N8. This plant is rated for a flow of 6,250 gpm and a maximum total hardness of 434 mg/l as $CaCO_3$. This treatment site is in a commercial land use area and has existing piping from the four proposed wells to the treatment site.

The existing well pumps will be de-rated to allow only enough head to get through the treatment system. A booster pump will be added to get the treated water into the distribution system at a pressure of 170 psig.

Water from the dewatering pellet bin and multimedia filter backwash is estimated to be approximately 4,800 gallons per day. Under final design it will need to be determined how best to dispose of this water. Capital costs for this system are not included in this estimate.

6.1.2.6 Commerce Center

This site will treat water from four existing wells – E14, E16, and E17. This plant is rated for a flow of 3,400 gpm and a maximum total hardness of 511 mg/l as $CaCO_3$. This treatment site is in a commercial land use area. Required raw water piping to this treatment plant has not been included in this estimate.

The existing well pumps will be de-rated to allow only enough head to get through the treatment system. A booster pump will be added to get the treated water into the distribution system at a pressure of 160 psig.

Water from the dewatering pellet bin and multimedia filter backwash is based on annual production rate of 3525 AFY. Water from the dewatering pellet bin and multimedia filter backwash is estimated to be approximately 5,700 gallons per day. Under final design it will need to be determined how best to dispose of this water. Capital costs for this system are not included in this estimate.

6.1.2.7 Castaic Junction

This site will treat water from three proposed wells – G1, G2, and G3. This plant is rated for a flow of 3,600 gpm. The Castaic Junction Plant is proposed for start-up in 2021. This plant will treat several wells to be drilled in the Castaic Junction area south of Highway 126. Since these wells are not yet install, E15 was used to estimate the anticipated water quality. The maximum total hardness of 497 mg/l as $CaCO_3$ was the assigned value for this plant.

Water from the dewatering pellet bin and multimedia filter backwash is based on annual production rate of 3,525 AFY. Water from the dewatering pellet bin and multimedia filter backwash is estimated to be approximately 5,700 gallons per day. Under final design it will need to be determined how best to dispose of this water. Capital costs for this system are not included in this estimate.

6.1.3 Assumption of Water Quality for Development of Full Scale Designs

Water quality data, dating from 1985 through 2008 were obtained for as many of the wells as possible. The water quality values assigned to each treatment plant for design and O&M purposes are summarized in Table 20. The wells were found to have anywhere from 1-12 sample dates, with varying constituents reported at each sample event. Well 207 is not yet in service so no water quality data were available for this well. Therefore, the water quality estimates for the Magic Mountain plant are based entirely on the water quality data for Well 206.

In order to determine the design parameters for the pellet softener size, chemical feed pumps and pellet dewatering and storage facilities for each treatment plant, a worst case water quality for each plant was determined. For each well, the maximum total hardness event was selected as the worst case scenario. The overall water quality for this sampling event was then used as the design water quality for that well.

In order to estimate the maximum flow scenarios, it was then assumed that all wells were operating at their maximum rated capacity. Water quality as shown in Table 23 was used to size the equipment and chemical feed systems for all the plants. This same approach was taken to estimate O&M costs except where noted.

Table 23: Assumed Water Quality for Softening Plants

Plant Name	Live Oak	Magic Mtn	Belcaro	Pan Handle	Pardee Field	Commerce Center	Castaic Junction
Rated Capacity (gpm)	2,450	5,000	1,000	4,650	6,250	3,400	3,600
Sodium (mg/L)	104	74	59	86	96	149	104
Calcium (mg/L)	120	130	110	140	120	120	120
Magnesium (mg/L)	45	38	47	40	32	47	45
Alkalinity (mg/L)		233	231	258	268	249	222
Chloride (mg/L)	88	48	37	79	121	80	88
Sulfate (mg/L)	328	290	270	309	154	470	315
Total Hardness (mg/L as CaCO3)	498	481	468	565	434	511	497
pH (units)	7.4	7.5	7.6	7.7	7.6	7.4	7.4
Total Dissolved Solids (mg/L)	973	780	740	893	777	1374	1066
Specific Conductance (µmho/cm)	1296	1010	1030	978	1204	1861	1293

6.1.4 Summary of Assumption for Developing Capital Costs

The following assumptions were used in preparation of the capital costs:

- All plant equipment was sized for the total rated capacity of each well to be treated.
- Pellet softening and chemical equipment were sized using W9 water quality as shown in Table 20.
- One duty booster pump was assumed for costing purposes.
- For all plants, the existing well-pump will be de-rated for a lower head requirement. This cost was assumed to be similar as the cost required to modify the existing demonstration plant site.
- Chemical storage systems were sized to hold a minimum of 15 days of chemical supply assuming 24-hour operation at the rated plant capacity.
- Two 18 cubic yard, roll-off, pellet storage bins were assumed for each site. This provides for approximately 10 days to over a month of storage per bin.

- Discharge permitting cost for of pellet dewatering and filter backwash is covered by the indirect project costs.

The capital cost estimates include both the actual construction ("bid") costs and the indirect costs associated with implementing the project. Table 24 summarizes the cost factors used to develop the "bid costs" and total capital costs.

Table 24: Cost Factors and Assigned Values

Capital Parameter	Value (%)	Basis
Electrical and instrumentation	15	Process train costs
Contractor's overhead and profit	20	Direct construction cost
Contingency	10	Direct construction cost
Average Indirect costs estimated by VWC	4	Construction "bid" cost

Capital costs include costs related to purchase and installation of process and residuals handling equipment, site preparation, structural work, and other construction costs a contractor includes in a "bid cost" for a treatment facility such as mobilization, overhead and profit, and contingencies to account for uncertainties and unforeseen expenses.

Indirect capital costs include such expenses as engineering design and construction management, financial, legal, and administrative services, interest during construction, environmental impact reports, and permits. These costs have been estimated by VWC based on the construction of the GWSDP and their prior experience.

The estimates of probable capital costs at this planning level will have a -30% to +50% accuracy level. They were prepared according to the guidelines established by the American Association of Cost Estimating Engineers for an order of magnitude estimate.

6.1.5 Summary of Capital Costs

The estimated capital costs in 2009 dollars and the dollars of the year that the plant is projected to be built are summarized in Table 25. The 2009 dollar estimates were adjusted using 3.5 percent per year was used to estimate the cost for the year that the facilities were to be constructed. Detailed cost estimates for each plant are provided in Appendix C.

Table 25: Summary of Proposed Capital Cost by Plant and Schedule of Construction

Plant	2009 ($million)	On-line Schedule
Live Oak	$3.3	2012
Magic Mountain	$5.0	2012
Belcaro	$1.5	2014
Pan Handle	$5.0	2014
Pardee Field	$5.6	2017
Commerce Center	$5.0	2019
Castaic Junction	$5.0	2021
Total 2009 $	**$30.4**	

6.2 Operations & Maintenance Costs

6.2.1 Background

The O&M cost for the 800 gpm design flow rate of the GWSDP is summarized in Table 13 of Section which was developed by VWC. Table 26 summarizes the O&M unit cost and any adjustments that were to Table 13 for estimating the O&M of the future plants.

6.2.2 Caustic Use

Since 17 July when the pellet bed was operated at 7 feet instead of 5 feet, the effluent calcium hardness was statistically significantly reduced using statistically significantly less caustic (See Table 27). The caustic dosing rate of 129 mg/L was developed from the W9 operational data during this period. The caustic dose to calcium hardness was then proportioned based on the calcium hardness on Table 23. In some cases, the caustic dose will vary depending on the combination of wells being pumped. The wells with very high calcium hardness are noted in the descriptions of each treatment plant (Sections 6.1.2.1 to 6.1.2.7).

Brenntag, a VWC supplier of caustic is charging $1.60 per gallon of 50 percent caustic. This is the cost that was used for projecting the O&M cost. This is $0.14 less than the cost of caustic for the GWSDP and is due to the increased quantities that will be purchased.

Table 26: Estimated O&M Chemical, Labor, and Pellet Disposal Costs

Component	Unit Cost	Usage during Demonstration	Assumption for system-wide implementation
Caustic (50%)	$1.60/gallon*	220 gpd	Lower caustic unit cost than GWSDP ($1.74/gallon), usage rate adjustment based on raw water hardness
CO_2	$0.20/lb	316 lb/MG	Slightly lower CO_2 unit cost than GWSDP ($0.21/lb), no usage rate adjustment
Sand	$0.03/lb	143 ppd	Slightly lower unit cost than GWSDP ($0.056/lb), usage rate adjustment based on raw water hardness
Labor	$ 28/hour	55 hrs/month	Adjusted for plant size
Pellet Disposal	$500/month per plant	0.3 ton/day	A-1 Grit pays VWC $500/month income per plant as well as the transport of bins to their Riverside facility

Table 27: Summary of Water Quality Parameters and Caustic Use for Seven and Five Foot Pellet Beds

Daily Average	5 foot Pellet Bed 1 Mar – 16 Jul	7 foot Pellet Bed 17 Jul – 30 Aug
Raw Water Calcium Hardness (mg/l $CaCO_3$)	176	192
Treated Water Calcium Hardness (mg/l $CaCO_3$)	55	33
pH	9.3	9.7
Caustic Feed Rate of 50 % (gallons per day)	303	198
Water Production (Average MGD)	1.17	1.15
Caustic Dosage (mg/L)	117	129

6.2.3 Sand Use

The average sand use during the GWSDP was about 143 lb/day (~ 125 lb/MG of water treated). Approximately 170 mg/l as $CaCO_3$ of calcium hardness was removed to achieve treated water quality goal (i.e. about 0.15 lb sand/kg calcium hardness removed). Pellet sand usage for the proposed five plants was estimated based on the hardness removal required to meet the treated water hardness of 36 mg/l as $CaCO_3$ (Table 10).

6.2.4 CO_2 for pH Adjustment

Daily CO_2 consumption was about 350 lb per day for approximately 1.44 MGD treated. The same CO_2 use is assumed for O&M cost estimate for the proposed softening plants.

6.2.5 Labor

The labor requirements for various activities for the GWSDP as well those projected for the full-scale plants are summarized in Table 28. While the pellets were manually disposed during the GWSDP, they will be disposed by automatic disposal system in the full-scale plants. Hence, an average of approximately 1 hour per day of labor will be required for the full-scale plants.

Table 28: Labor Estimate for GWSDP and Full-Scale Plants

Routine Demonstration Activity	**Total Hours/Month for GWDSP**	**Total Hours/Month for Full Scale Plants**
Daily sampling and analysis for Calcium and Total Hardness	15	15
Discharge of pellets	30	0
On-site support during filling of caustic tanks by vendor	4	4
Maintenance of pH probes	4	4
On-site support during pellet disposal by vendor	2	2
Total	55	25

6.2.6 Pellet Disposal

For this study, it is assumed for these future plants, VWC will buy the bins and have A-1 Grit pay for their transport to Riverside, CA. Also, A-1 Grit will pay VWC $500 per treatment plant per month for the pellets generated regardless of plant size.

6.2.7 Pellet Dewatering and Backwash Discharge

Backwash discharge during the demonstration program was 0.18 % of the water production. Local irrigation or discharge to the storm drain system is the preferred alternative. The cost for backwash disposal is not included in the current O&M cost estimates.

6.2.8 Maintenance Cost

Typically over a 20 year period additional maintenance cost of the full-scale plants is assumed to be 2% of the equipment and installation cost. This is to cover painting, pump repairs, etc. However since these will be new plants, these type repairs will not be needed in the early days of operation. As a result, this cost has been eliminated, but will need to be added to the annual O&M budget at the 10 year age of each plant.

6.2.9 Well Production

Historic water production from VWC wells and the proposed capacity for the new wells were used to estimate annual water production for the full-scale plants. Annual production in AFY was provided by VWC and is based on amounts included in the 2009 Analysis of Groundwater Supplies and Groundwater Basin Yield Study. Table 29 summarizes the annual production for the full-scale plants which were also used to determine the annual O&M costs.

Table 29: Estimated Annual Water Production for Full-Scale Plants

Plant	**Wells**	**Design Capacity (gpm)**	**Water Production* (AFY)**
Live Oak	D, E15	2,450	1,680
Magic Mountain	206, 207	5,000	2,350
Belcaro	W11	1,000	800
Pan Handle	Q2, U6, U4, T7	4,650	3,450
Pardee Field	N, N7, N8	6,250	2,970
Commerce Center	E14, E16, E17	3,400	3,525
Castaic Junction	G1, G2, G3	3,600	3,525
Total		26,350	18,300

* Amounts based on the 2009 Analysis of Groundwater Supplies and Groundwater Basin Yield Study

6.2.10 Summary of O&M Constituents

Table 30 summarizes the requirement of various O&M constituents for the full-scale plants used in the cost estimation. Table 31 is a summary of the total O&M and the $/AF treated which ranges from a low of $120 to a high of $144. For the existing Copperhill facility, using the lower unit costs for caustic, sand, and CO_2, the estimated O&M cost is $111/AF as compared to the $164/AF during the demonstration phase. The total annual O&M cost for the GWSDP would be $106,000 for 950 AF of production.

Table 30: O&M Requirements for Full-Scale Plants

	Live Oak	Magic Mtn	Belcaro	Pan Handle	Pardee Field	Commerce Center	Castaic Junction
Production Rate (AFY)	1,680	2,350	800	3,450	2,970	3,525	3,525
Caustic Dose (ppm)	152	164	139	177	152	152	152
Sand Use (lb/day)	290	432	122	800	530	627	621
CO_2 Use (lb/day)	345	480	164	706	609	722	722
Labor (hours/day)	1	1	1	1	1	1	1

Table 31: Summary of Annual O&M Cost by Plant

Plant	Annual Production (AFY)	Annual O&M Cost ($)	O&M Cost ($/AF)
Live Oak	1,680	$212,000	$126
Magic Mountain	2,350	$317,000	$135
Belcaro	800	$96,000	$120
Pan Handle	3,450	$497,000	$144
Pardee Field	2,970	$373,000	$125
Commerce Center	3,525	$442,000	$125
Castaic Junction	3,525	$442,000	$125
Total	18,300	$2,379,000	**$130 (weighted average)**

6.3 Benefits of Full Scale Water Softening

Hardness removal has traditionally been related to aesthetics and the deterioration of fabrics related to the hardness interactions with soaps and detergents. The other impact of hardness is the effect of scale on pipes and water heaters.

Once the water softening technology has been deployed on a full scale basis, there will be three types of connections that will have additional savings in four different areas that are identified in Table 32. This section discusses each of the areas of savings identified in this table.

Table 32: Summary of Added Savings by Connection Category

SRWS Status	SRWS Savings	Soap and Detergents	Water Heater	Chloride Impact on WRP
No SRWS	No Added Savings	Savings	Savings	No Added Savings
Removed SRWS	Saving	Savings	Savings	Savings
Exchange Tank Remaining	Savings	No Added Savings	No Added Savings	No Added Savings

6.3.1 Self Regenerating Water Softener (SRWS) Savings

The basis of the water production for each treatment plant was the 2008 annual production records of the wells providing raw water. The treated production of each plant was then divided by the average monthly connection usage (15,396 gallons per month, [Exhibit 8, Water Quality Improvement Program, Attachment H to Application No. 06-07-002 filed July 3, 2006]) to estimate the number of connections that would be getting the soft water from these facilities. The estimated number of connections for each facility is presented in Table 33.

The basis of these savings were the data collected from the pre and post softening public outreach surveys conducted by O'Rorke. The information used from the September 2008 survey of 140 connections was the following:

- 48 percent of the connections do not have an SRWS
- 7 percent of the connections have exchange SRWS tanks
- 11 percent of the connections rent an SRWS
- 34 percent of the connections own an SRWS

The information used from the April-June 2009 survey of 118 connections was the following:

- 68 percent of the connection do not have an SRWS (never had or disconnected their SRWS)
- Through the outreach effort on this project, 92 percent of the connections would not have a SRWS hooked up
- The exchange tank softeners were not removed
- Monthly average charge for exchange tank softener is $50/month
- Monthly average cost for maintaining an owner SRWS is $11/month

Based on the information from these two surveys, the following assumptions were made.

- When a new centralized system is brought on-line, 20 percent of the connections (5,222 connections) would disconnect their SRWS. There would be a reduction of $11/month for each connection ($689,000, rounded).

- Through an outreach program, another 18 percent (4,700 connections) would remove their SRWS. There would be a reduction of $11/month for each connection ($620,000, rounded).

Table 33: Summary of SRWS Savings

	Plant Name								
	Copperhill	**Live Oak**	**Magic Mtn**	**Belcaro**	**Pan Handle**	**Pardee Field**	**Commerce Center**	**Castaic Junction**	**Total**
Prior to Centralize Softeners - Base Case Conditions									
Connections	747	2,331	3,264	934	3,671	5,563	4,663	4,937	26,110
Connections without SRWS (48%)	359	1,119	1,567	448	1,762	2,670	2,238	2,370	12,533
Connections with SRWS (52%)	389	1,212	1,697	486	1,909	2,893	2,425	2,567	13,577
Post Centralized Softeners - SRWS that are Removed from Service									
Connections with SRWS Removed (20%)	149	466	653	187	734	1,113	933	987	5,222
Savings for Initially Removed SRWSs/Year, $'s	$19,726	$61,545	$86,165	$24,658	$96,911	$146,867	$123,090	$130,331	$689,294
Outreach Removed SRWS Connections (18%)	134	420	587	168	661	1,001	839	889	4,700
Savings of Outreach Removed SRWS Connections (18%)	$17,754	$55,391	$77,549	$22,192	$87,220	$132,180	$110,781	$117,298	$620,364
Post Centralized Softeners - SRWS that Remain in Service									
Connections with Exchange Tanks SRWS (14 %)	105	326	457	131	514	779	653	691	3,655
Exchange Tank Connection Savings/Yr, $'s	$31,924	$99,602	$139,446	$39,905	$156,837	$237,682	$199,203	$210,921	$1,115,520
Total Savings	**$69,404**	**$216,537**	**$303,160**	**$86,755**	**$340,969**	**$516,729**	**$433,075**	**$458,550**	**$2,425,178**

- The connections with the exchange tank softeners (7 percent) would not disconnect these systems. There would be a cost saving of 50 percent or $25 per month due to the 50 percent reduction in total hardness. The survey indicated that there would be another 7 percent of the connections with a self regeneration SRWS that would not be removed. For this study it is assumed that these connections would convert their SRWS to an exchange tank and these connections would realize the same savings ($25 per month). The total for this category would be $1,115,000 (rounded).

The total annual savings generated by the SRWS upon the full scale implementation of this project would be $1,309,000 ($689,000 plus $620,000) from the removed SRWSs. For the remaining SRWSs, there would be an annual savings of $1,115,000 from the increased cycle time between change out of the exchange tanks. The total annual savings for this category is estimated to be $2,425,000 (rounded).

6.3.2 Hardness and Soaps and Detergents

6.3.2.1 Background

The amount of hardness minerals in water determines the amount of soap and detergent necessary for cleaning. Excessive minerals form a sticky curd or deposit a film, such as bathtub ring, when soap is added to water. Removing this requires greater amounts of soap, detergent, cleaning compound, shampoo, and time. The hardness precipitate lodges in fabric after washing and makes it stiff and rough. Remaining soil causes the graying of white fabric and the loss of brightness in colors.

Both bathing and grooming with soap in hard water leave a film of sticky soap curd on the skin. The film may prevent removal of soil and bacteria. Soap curd interferes with the return of the skin to its normal, slightly acid condition, and it may lead to irritation and infection. Soap curd on the hair makes it dull, lifeless, and difficult to manage.

Synthetic dishwater detergents are less effective in hard water because the active ingredient is partially inactivated by hardness, even though it stays dissolved. The alkaline builders, added to the detergent mixture to cut greases and oils, reacts with these greases and oils to form soap, which in turn produces soap curd in hard water. The deposits protect soil and bacteria and interfere with thorough cleaning.

6.3.2.2 Savings from Using Less Soaps and Detergents

The economic impact can be qualitatively described, but there is only literature from the 1930-1950's that document costs. There is no recent data that can document these savings.

From Table 29, the savings from using less soaps and detergents would arise from the connections without an SRWS and those connections that remove their SRWS. The total of these two groups for the full scale roll out would be 86 percent or 22,450 connections.

It is estimated that there would be an annual saving of $270,000 (rounded) per year assuming a savings of $1 per month per connections.

6.3.2.3 Hardness and Scaling Issues

Hard water also contributes to inefficient and costly water heater operation. Heated hard water forms a scale that is a major cause of water heater failure resulting in a shorter water heater lifespan. The typical lifespan of a water heater is 10-12 years. Better heaters have longer warranties, such as six to 10 years. Soften water generates less scale so one would expect a longer lifespan of the water heater using soft water.

Once hard water scale forms in a water heater, it is a poor conductor and heat is not transmitted to the water as rapidly as it is applied. The fuel wasted by poor heat transference increases hot water costs. A comparison of the energy efficiency of gas water heaters using hard and soft water supplies over a 14-day period indicated that the hard-water heaters used 29.57% more BTUs of energy (Isaacs and Stockton, 1984)

Talbert, et al, 1987 reported on pilot testing of water heaters using hard water. They observed a scale buildup of 130 pounds in one of the hard water heaters after 30 months of operation under accelerated test conditions (representing about 50 years of normal residential usage) caused the operating efficiency to decline about 12 percent more than a comparable water heater using soft water.

In this particular case, the scale buildup also caused the metal temperatures around the burner area to become so hot that distortion occurred and a leak developed from a crack through a weld joint leading to premature failure, i.e., a shorter lifespan.

In this same study they observed that scale buildup was minimized with softened water, but the magnesium anodes were consumed much more rapidly than in untreated hard water. This additional anode consumption will reduce its effectiveness in protecting the uncoated portions of steel tanks from corrosion. If the sacrificial anode is not routine maintained in very soft water, this will also lead to a shorter water heater lifespan. Furthermore, pipes clogged with scale reduce water flow and ultimately must be replaced.

6.3.2.4 Savings from Reduced Scale

The savings to the customers would come from a longer lifespan of the water heater and lower utility bill from more efficient heat transfer. The savings from generating less scale would arise from the connections without an SRWS and those connections that remove their SRWS. The total of these two groups for the full scale roll out would be 86 percent or 22,450 connections (See Table 29).

It is estimated that there would be a saving of $561,000/year assuming a savings of $25/year ($750/water heater, 10 years lifespan for hard water and 15 years lifespan for softer water, and the cost just prorated over the lifespan) from the longer lifespan of a water heater for 22,450 connections.

It is estimated that there would a saving of $1,131,000/year assuming a savings of $50.40/year in reduced utility bill attributed to heating the water (12 percent increase in efficiency for softer water; $35/month water heater utility bill for 22,450 connections that have an average of 3.9 people per connection (CDHS, 1993)).

The total annual savings generated by reducing the internal scaling upon the full scale implementation of this project would be $1,692,000.

6.3.2.5 One Time Savings from Reduced Chloride for Water Reclamation Plant

Information provided by the Los Angeles County Sanitation District (LACSD) [LACSD operates the local Santa Clarita Valley Sanitation District] for Measure S in the November 2008 election indicated that the Valencia and Saugus Water Reclamation Plants (WRPs) would save about $74 million in the construction of additional treatment and brine disposal to remove an equivalent chloride load from SRWSs in the Santa Clarita Valley. In addition, the Measure S literature indicated that LACSD had budgeted $1.6 million to remove the remaining 3,200 SRWSs or an average of $500/SRWS.

Information provided by LACSD, (personal communication 2009) indicates that for the Valencia and Saugus WRPs the per capita wastewater is 86 gallons per capita per day (gpcd). Based on an average of 3.9 occupants per account (CDHS aka CDPH, 1993), this calculates out to 7.5 MGD (22,455 accounts X 3.9 occupants/account X 86 gpcd) which is 43.6 percent of the average flow for the Valencia WRP or 25.6 percent of the combined Valencia and Saugus WRP flows. Proportioning the $74 million, the 35 percent is equivalent to $25.8 million savings that can be allocated to avoided costs for additional treatment and brine disposal. It is likely that these savings would be passed on to the entire service area as opposed to only the connections generating these savings. As a result of this assumption, the savings that is projected to flow to the 110,000 VWC customers is $11.4 million ([$25.8 million / 250,000 population served by Valencia and Saugus WRP] X 110,000, population served by VWC). These estimated savings would be avoided costs and be a one time savings.

It is difficult to allocate a savings to LACSD from SRWS removed from service solely due to the centralized softening ban pass by the November 2008 election (Measure S). Motivation for removal of SRWS in the demonstration area was probably a combination of the ban and improved water quality. Since the full scale roll out will start in a couple of years, it is assumed that there will be no savings accrued by LACSD from the rebate program.

6.3.3 Summary of Benefits of Soft Water

The some of the benefits of providing soft water can be translated to savings to the customers. The next two sections discuss the additional benefits and savings that can not be easily monetized. This is followed by a description of the non-monetized benefits.

6.3.3.1 Annual Monetized Customer Savings

Table 34 summarizes the annual savings to the VWC customers which is estimated to be $4,386,000 when all the facilities are in place.

Table 34: Summary of Annual Estimated Customer Savings from Full Scale Implementation of Softening Technology

Source of Savings	Connections	Annual Savings
SRWS Removed from Service	22,450	$1,309,000
Exchange Tanks with Reduced O&M	3,655	$1,115,000
Soaps and Detergents	22,450	$270,000
Water Heater	22,450	$1,692,000
	Total Annual Savings	**$4,386,000**

6.3.3.2 One Time Customer Savings

As described in Section 6.3.2.5, there would be a one time savings from the chloride reduction to the Valencia WRP for all the VWC customers getting pellet softened water. This one time savings is estimated to be $11.4 million for the treatment facilities of the Santa Clarita Valley Sanitation District that that are operated by LACSD.

6.3.3.3 Non-monetized Savings

There are two additional areas of savings that will accrue to VWC customers that is difficult to establish a reasonable cost because there is no literature. These are described below

4. Reducing the hardness of the water supply will also generate savings to customers from impact on scale on fixtures and piping. Examples are scale from the hard water causes gaskets to leak water from dishwashers and washing machines requiring more repairs; and scaling of piping, shut off valves, and kitchen and bathroom fixtures requiring more maintenance or shorter a lifespan and more costs associated with replacement.
5. More replacement of clothes or fabrics due to the inability to remove all the soil and dirt using harder waters causing the graying of white fabric and the loss of brightness in colors.
6. There are aesthetic benefits that are summarized in Section 5.

6.4 Cost Benefit Analysis

This section compares the capital and O&M costs against the savings or benefits. This analysis does not include the aesthetic benefits which does have some monetary value. Because of not including this element, this analysis is conservative from a benefits perspective, i.e., the benefits are under valued.

6.4.1 Summary of Annual Costs

Table 35 summarizes the annual costs estimated for the full system implementation. VWC can obtain a 20 year loan for the capital at a 7.37 percent interest rate. The capital recovery factor for this percent interest rate is 0.09712.

6.4.2 Summary of Annual Benefits

Table 35 also summarizes the annual benefits from the recurring as well as the one time savings. For the one time savings, LACSD generally funds construction projects by issuing bonds. For this study the total capital for the desalting facilities was amortized over 20 ears at an interest rate of 7 percent. The annual amortized capital cost equals the total capital times a capital recovery factor of 0.09439.

Table 35: Summary of Cost Benefits for the VWC System Wide Implementation of Pre-softened Water

Cost	**Total Capital ($ million)**	**Annual Amortized Capital ($K)**	**Annual O&M ($K)**	**Total ($K)**
Softening Plants (includes GWSDP)	$31.7	$3,079	$2,485	$5,564
Benefits				
Annual Benefit			$4,386	$4,386
Amortized One Time Savings	11.4	$1,076		$1,076
Total Benefit				$5,462

6.4.3 Cost Benefit Comparison

Using the annual cost and comparing it with the total for the annual benefit, the analysis indicates that for every dollar of costs there is an estimated $0.98 of benefit. It should be noted that the benefits in this study were recognized using conservative assumptions. The first is that only $1 per month per service connection was estimated as a savings for lower soap and shampoo usage. In addition, monetary estimate was developed some many of the aesthetic water quality impacts like less dry and smoother skin. The reduced O&M from the desalting technology that is being designed and constructed by LACSD was also not included in this analysis although there will be less chlorides, some 13 tons per year of chloride from only 419 service connections that will not get discharged to the collection system and therefore does not needed to be removed by their desalting technology.

Based on these factors, it is estimated that every cost dollar associated with this softening implementation plan will result in between $1.50 to $2 saved.

Section 7: Recommended Implementation Plan

Based on the findings of the outreach surveys and the estimated capital and O&M costs developed from the GWSDP, it is recommended that VWC implement the softening treatment component of their WQIP.

The same approach is recommended that was taken for the GWSDP that included a pilot scale study followed by a demonstration project, i.e., implement the project in manageable size increments instead of taking giant leaps. This allowed VWC to identify a variety of design and operational issues that can be leverage as the system wide implementation is rolled out.

Table 35 summarizes the roll out scheduled for the additional seven plants. The phasing was developed with four objectives: 1) management of capital requirements; 2) ability to absorb the additional management, O&M and training required; and 3) development of experience for the range of plants sizes that would come on line in Phases 2 and 3; and 4) provide more customers with pre-softened water while slowly raising water rates. Phase 1 would be for a medium and large plant with existing wells so that there would an operating size covering the three typical sizes, i.e., small, medium, and large. Phase 2 would be for the three plants which already have existing wells. Phase 3 would be for treatment plants where there are no current existing wells.

Table 36: Recommended Roll Out Schedule

Phase	Treatment Plants	Rated Capacity (gpm)	Startup Date
1	Live Oak	2,450	2012
	Magic Mountain	5,000	2012
2	Belcaro	1,000	2014
	Pan Handle	4,650	2014
	Pardee Ball Field	6,250	2017
3	Commerce Center	3,400	2019
	Castaic Junction	3,600	2021

References

Alvord, Michael, 2009. Consumer Acceptability of Softened Groundwater Using Pellet Softening Technology, AWWA Annual Meeting, San Diego CA

California Department of Health Services, Office of Drinking Water, 1993. Drinking Water into the 21st Century", A report to the Legislature.

Decision 07-06-024, *Opinion On Application for General Rate Increase of Valencia Water Company*, California Public Utilities Commission, June 2007

Exhibit 8, Water Quality Improvement Program, Attachment H to Application No. 06-07-002 filed July 3, 2006.

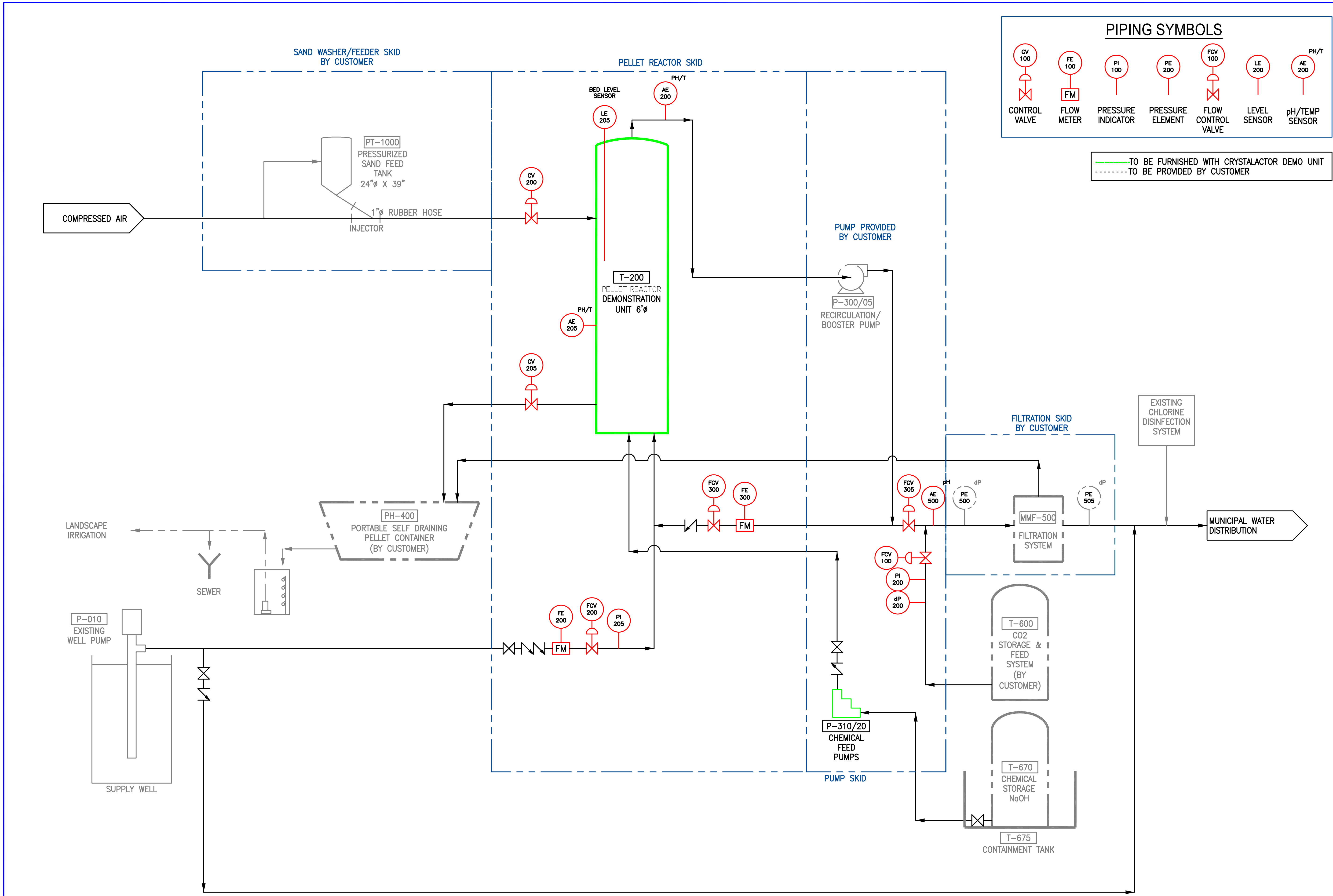
Hofman, J, Kramer, O., Peter van der Hoek, J., Nederlof, M, and Groenendik, http://www.kramersite.nl/onnokramer/publications/hofman_2006_centralsoftening_netherlands.pdf

Isaacs, W.P. and Stockton, G.R., 1984. *Softened water energy savings study controlled experimental testing program on household water heaters*, New Mexico University Engineering Experiment Station Report

LACSD, 2008. Basic Facts about Measure "S", http://www.lacsd.org/civica/filebank/blobdload.asp?BlobID=4168

Talbert, S. G., Stiegelmeyer, W. N., Stickford G. H., and Locklin, D. W., 1987. *Effect of Water Quality on Residential Water Heater Life-Cycle Efficiency*. Final Technical Report September 1985-December 1986.

Appendix A: GWSDP Drawings



DRAWING NO.

VALENCIA WATER COMPANY

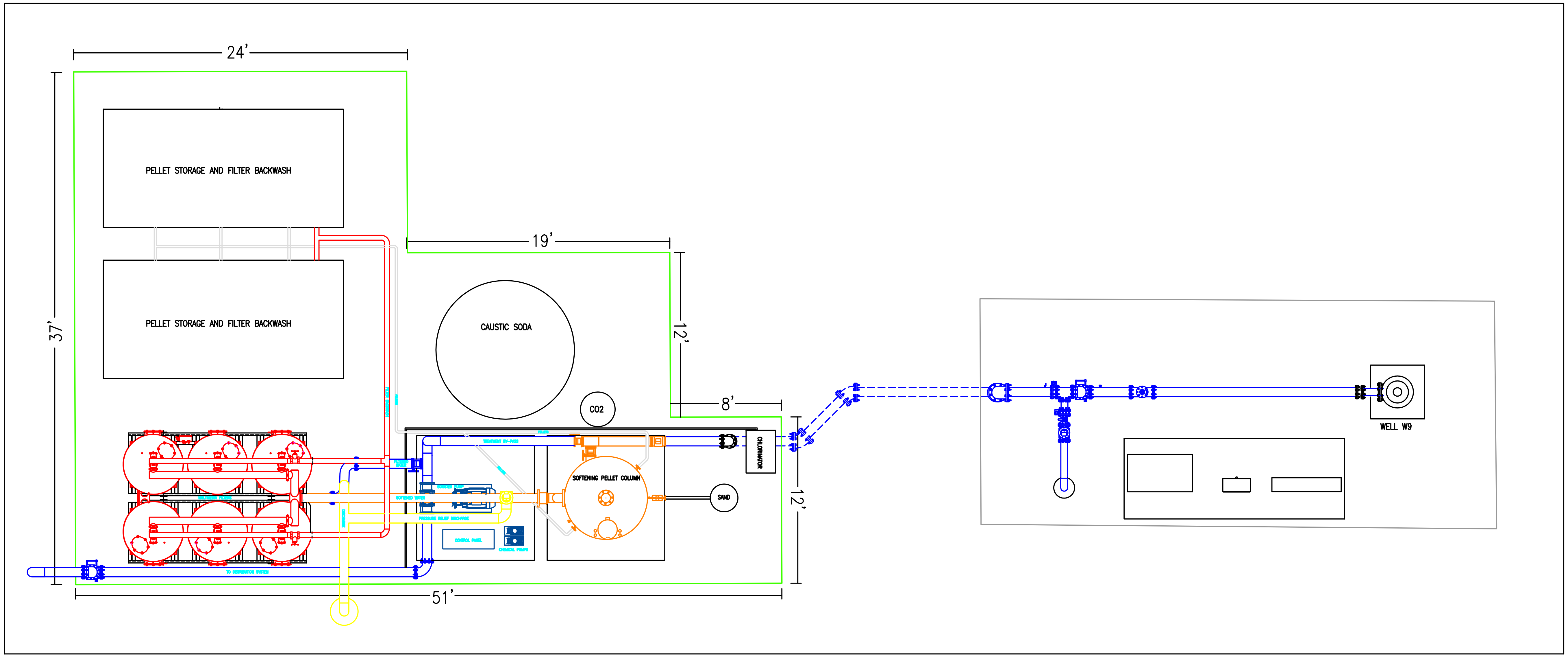
VALENCIA, CALIFORNIA
PELLET REACTOR WATER SOFTENING
PROCESS FLOW DIAGRAM

Procorp Enterprises LLC
3720 N. 124th St., Suite H
Wauwatosa, WI 53222
Phone: 414-258-8777
Fax: 414-258-8066

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING. 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

NO.	DATE	REVISION
B	7-17-07	GENERAL REVISIONS
A	3-8-07	PRELIMINARY RELEASE

PROJECT NUMBER:
SHEET No.: 1 OF 1
DRAWN BY: RGB
CHK'D BY:
PROJ. ENG:
APP'D BY:
ISSUE DATE: 7-17-07



DATE	REVISION	BY

DIGALERT
DIAL TOLL FREE
1-800-422-4133
AT LEAST TWO DAYS BEFORE YOU DIG
UNDERGROUND SERVICE ALERT OF SOUTHERN CALIFORNIA

DESIGNED BY

VICE PRESIDENT OF V.W.C.

PRESIDENT OF V.W.C.

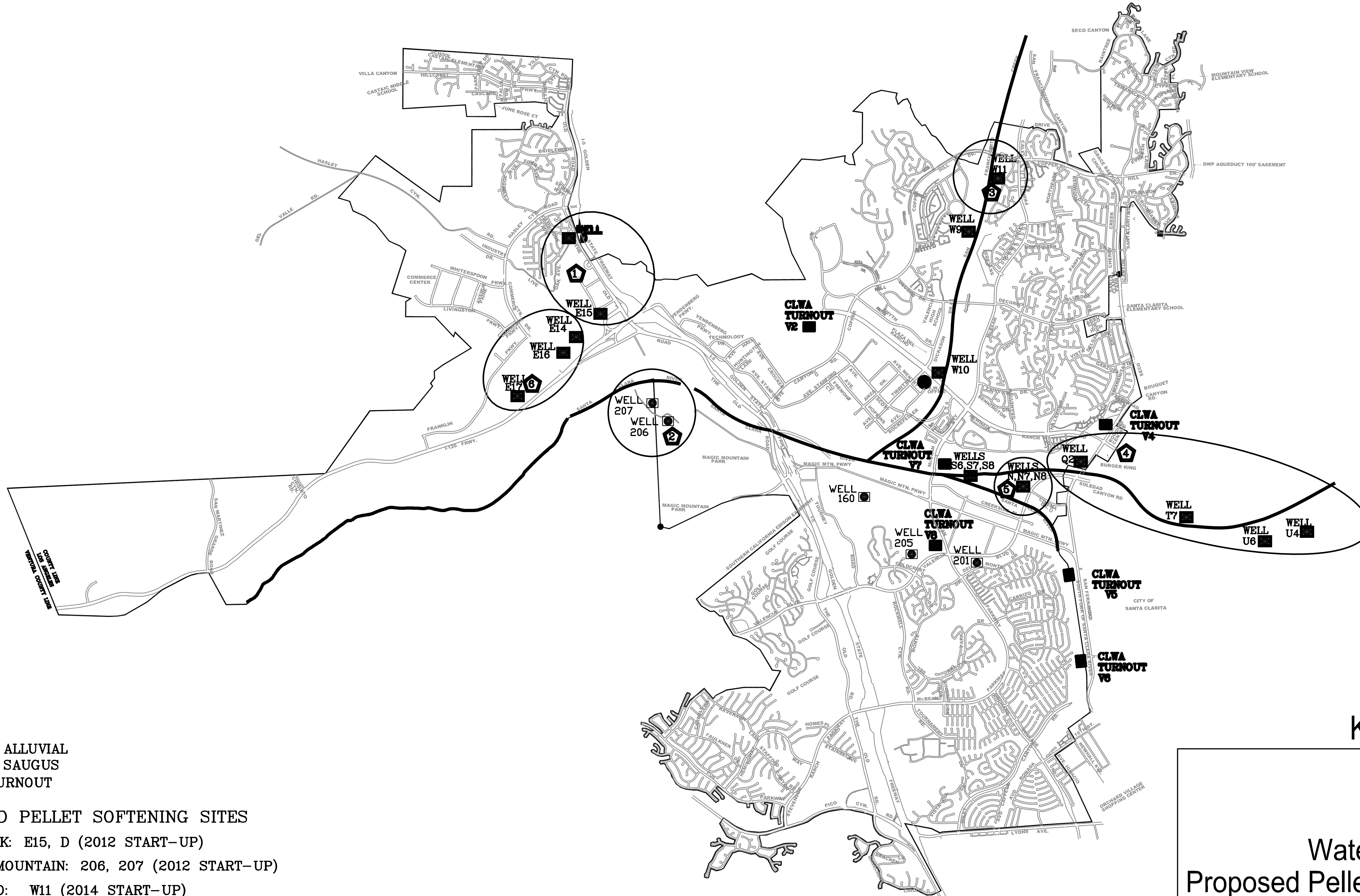
REGISTERED PROFESSIONAL ENGINEER
ROBERT J. DiPRIMIO
NO. 38055
EXPIRES 3/31/01
CIVIL
STATE OF CALIFORNIA

VALENCIA WATER COMPANY
24631 AVENUE ROCKEFELLER
POST OFFICE BOX 5904
VALENCIA, CALIF. 91355-5904
PH. (805) 294 - 1150
FAX. (805) 294 - 3806

WELL W9

GROUNDWATER SOFTENING DEMONSTRATION PROJECT

SCALE 1"=8'	WATER PRESSURE ZONE IIA-N
DATE 05/07/08	FILE NO. 6589
AS-BUILT	DWG. NO. W-5-833
CITY OF SANTA CLARITA	SHEET NO. 1 OF 1



SOURCE

- WELL – ALLUVIAL
- WELL – SAUGUS
- CLWA TURNOUT

PROPOSED PELLET SOFTENING SITES

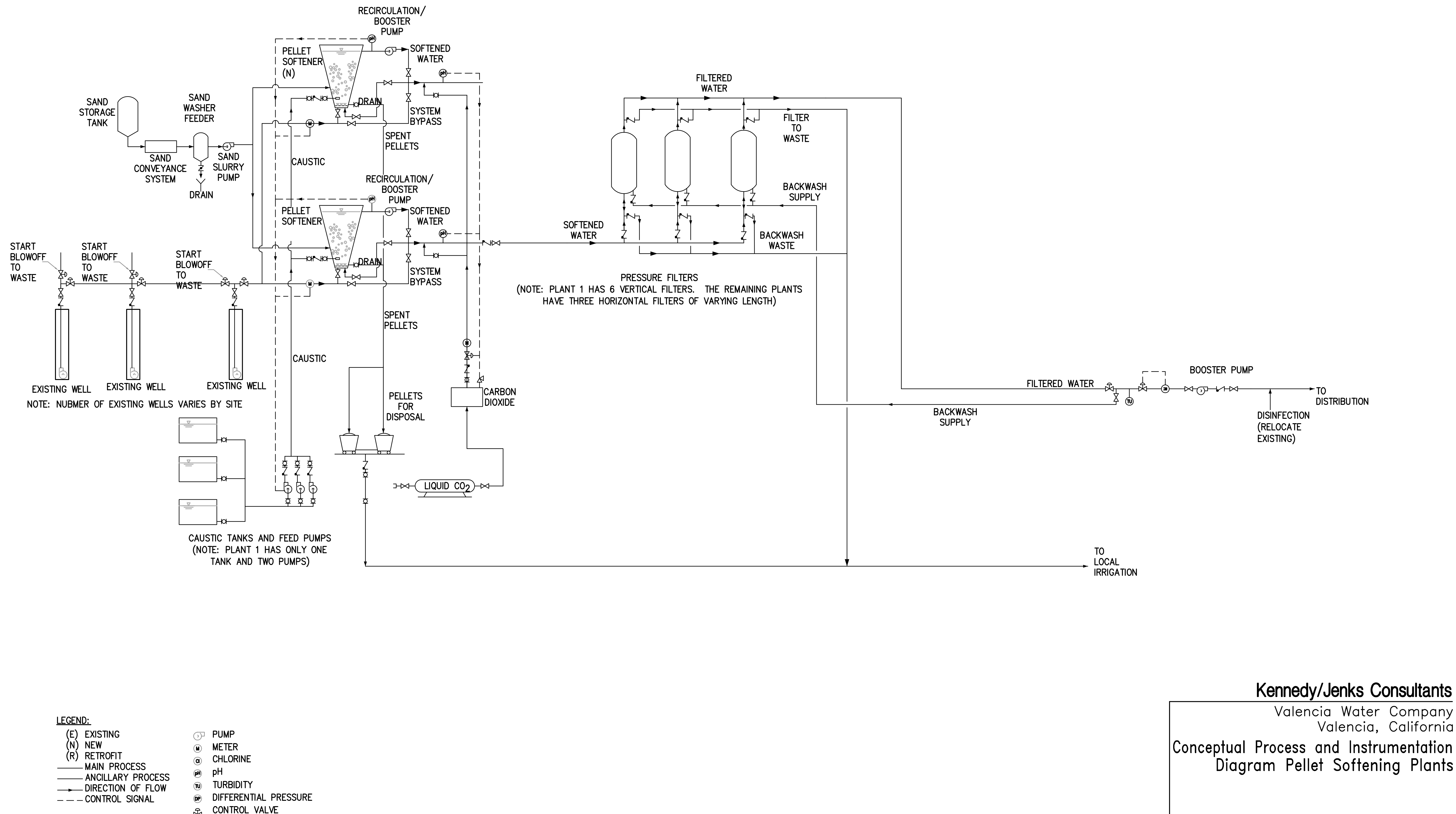
1. LIVE OAK: E15, D (2012 START-UP)
2. MAGIC MOUNTAIN: 206, 207 (2012 START-UP)
3. BELCARO: W11 (2014 START-UP)
4. PAN HANDLE: Q2, U4, U6, T7 (2014 START-UP)
5. PARDEE FIELD: N, N7, N8 (2017 START-UP)
6. COMMERCE CENTER: E14, E16, E17 (2019 START-UP)
7. CASTAIC JUNCTION: G1, G2, G3 (2021 START-UP) NOTE: G WELLS ARE FUTURE WELLS AND ARE NOT SHOWN ABOVE

Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Water Softening Plants - All Sites
Proposed Pellet Softening Plants and Wells

September 2009
K/J 0889019.00

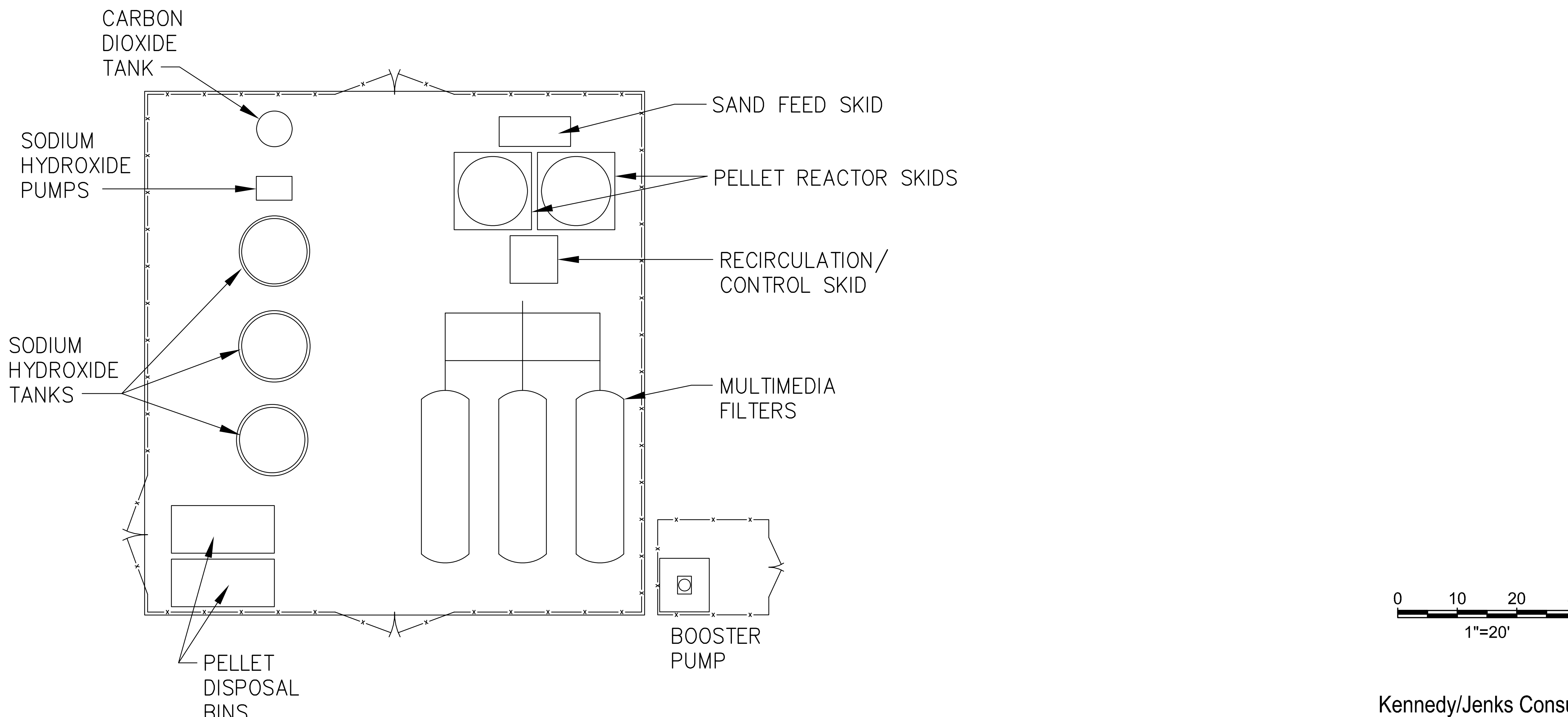


Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Conceptual Process and Instrumentation Diagram Pellet Softening Plants

September 2009
K/J 0889019



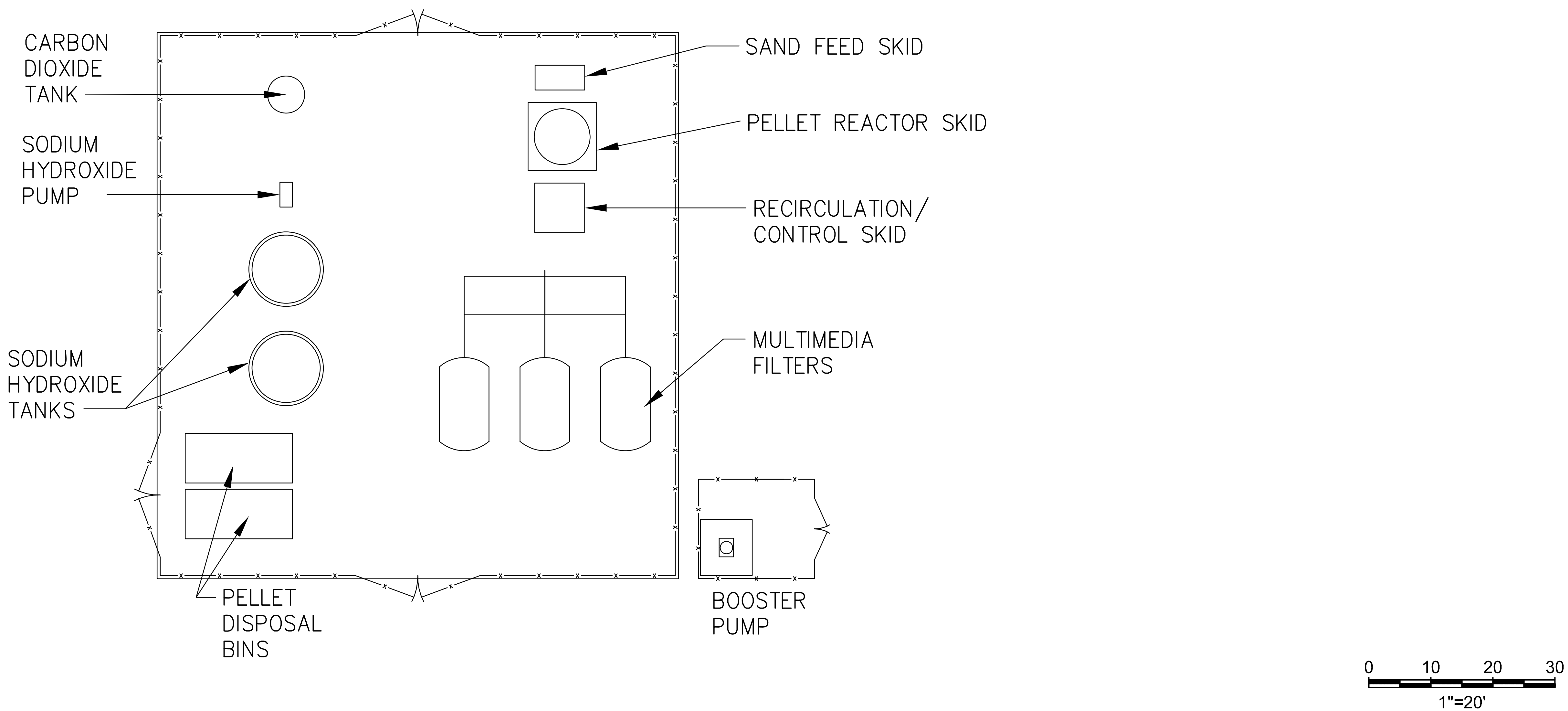
Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Water Softening Plants
Magic Mountain Plant Layout (2012)
Capacity - 5,000 gpm

September 2009
K/J 0889019.00

P:\IRV\2008\0889019_VWC_Demonstration\Draft_Report\Figures\0889019-Fig 7-4.dwg, 8/6/2009



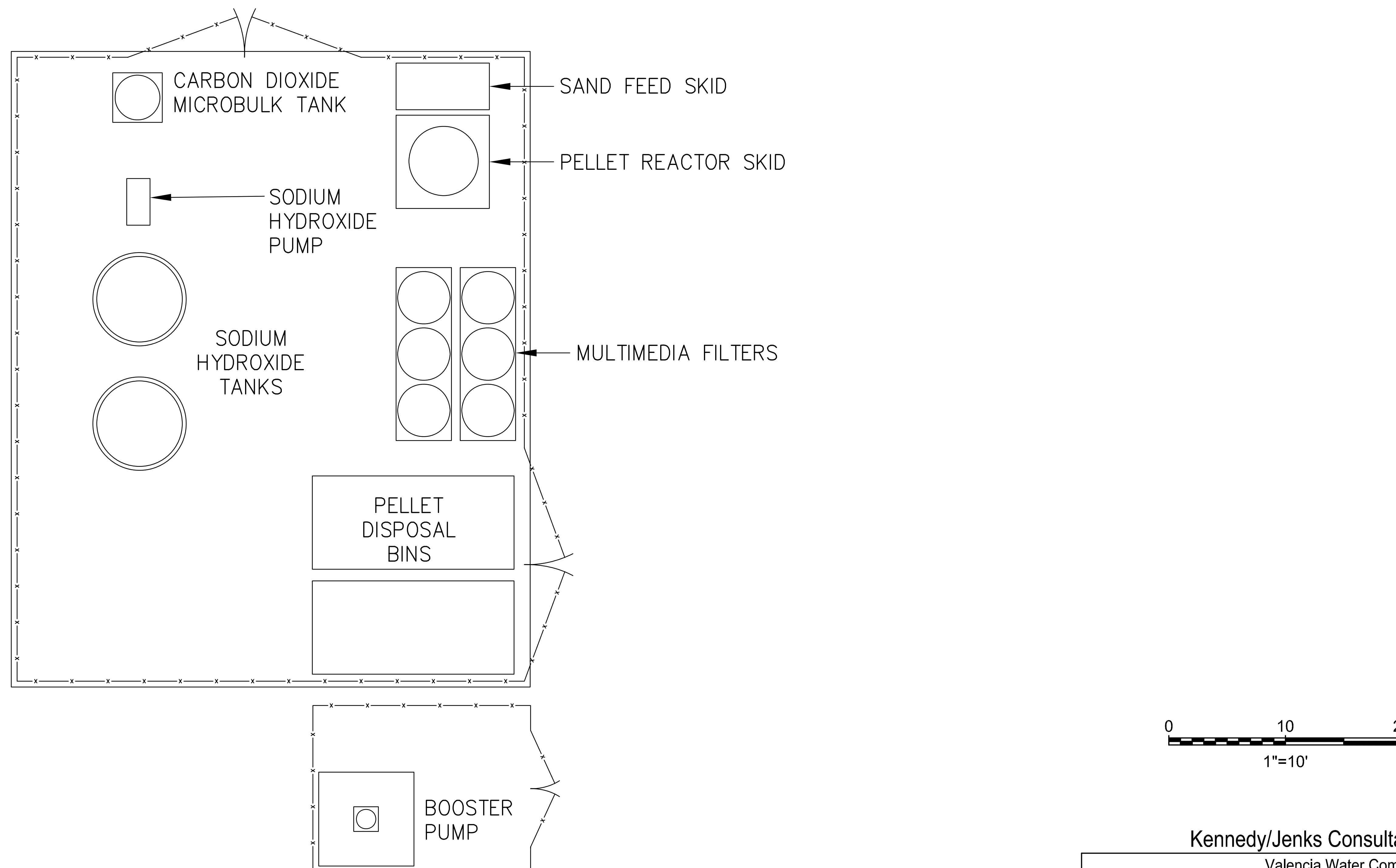
Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Water Softening Plants
Live Oak Plant Layout (2012)
Capacity - 2,450 gpm

September 2009
K/J 0889019.00

P:\IRV\2008\0889019_VWC_Demonstration\Draft_Report\Figures\0889019-Fig 7-3.dwg, 8/6/2009



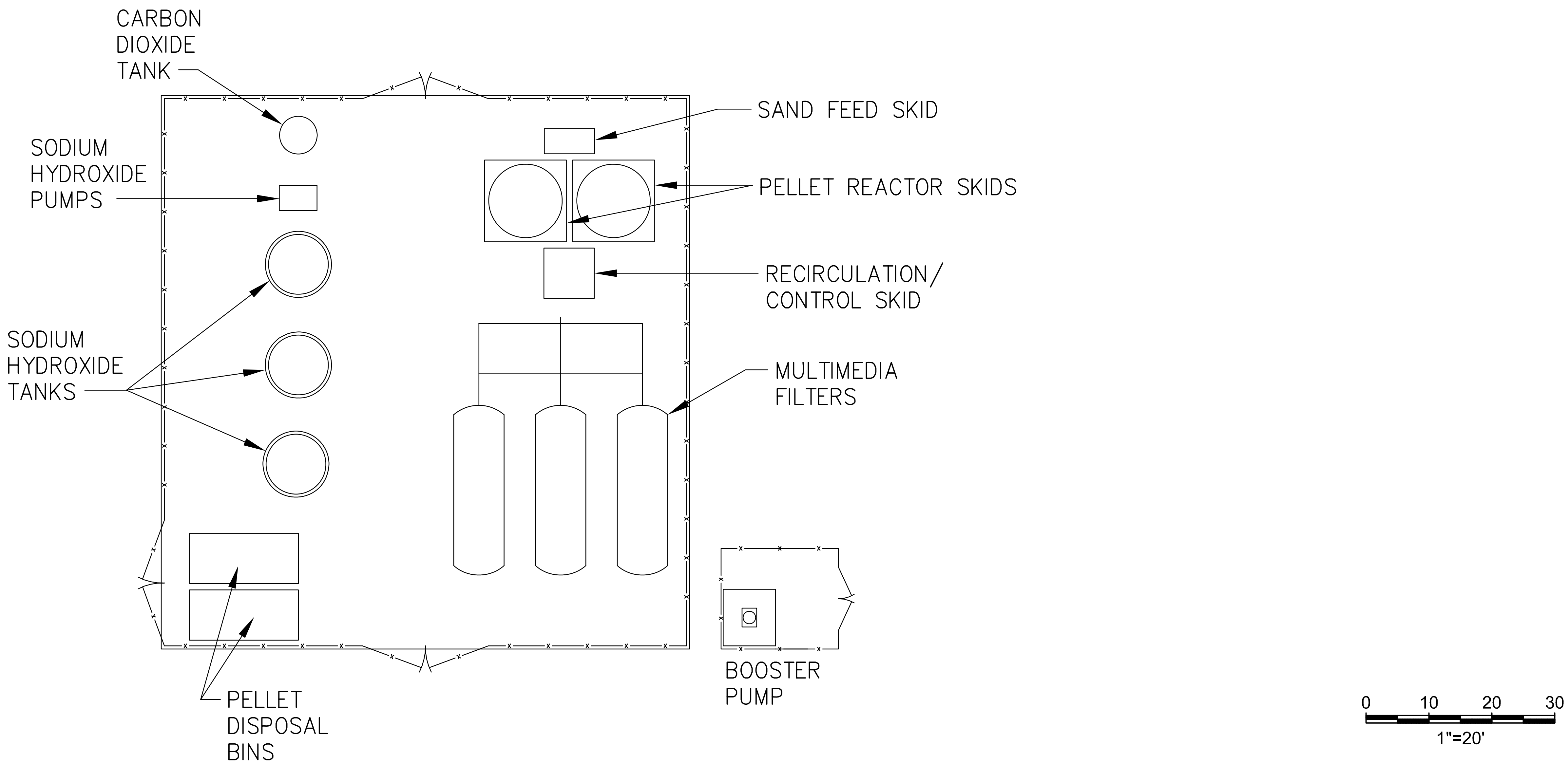
Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Water Softening Plants
Belcaro Plant Layout (2014)
Capacity - 1,000 gpm

September 2009
K/J 0889019.00

P:\IRV\2008\0889019_VWC_Demonstration\Draft_Report\Figures\0889019-Fig 7-2.dwg, 8/6/2009

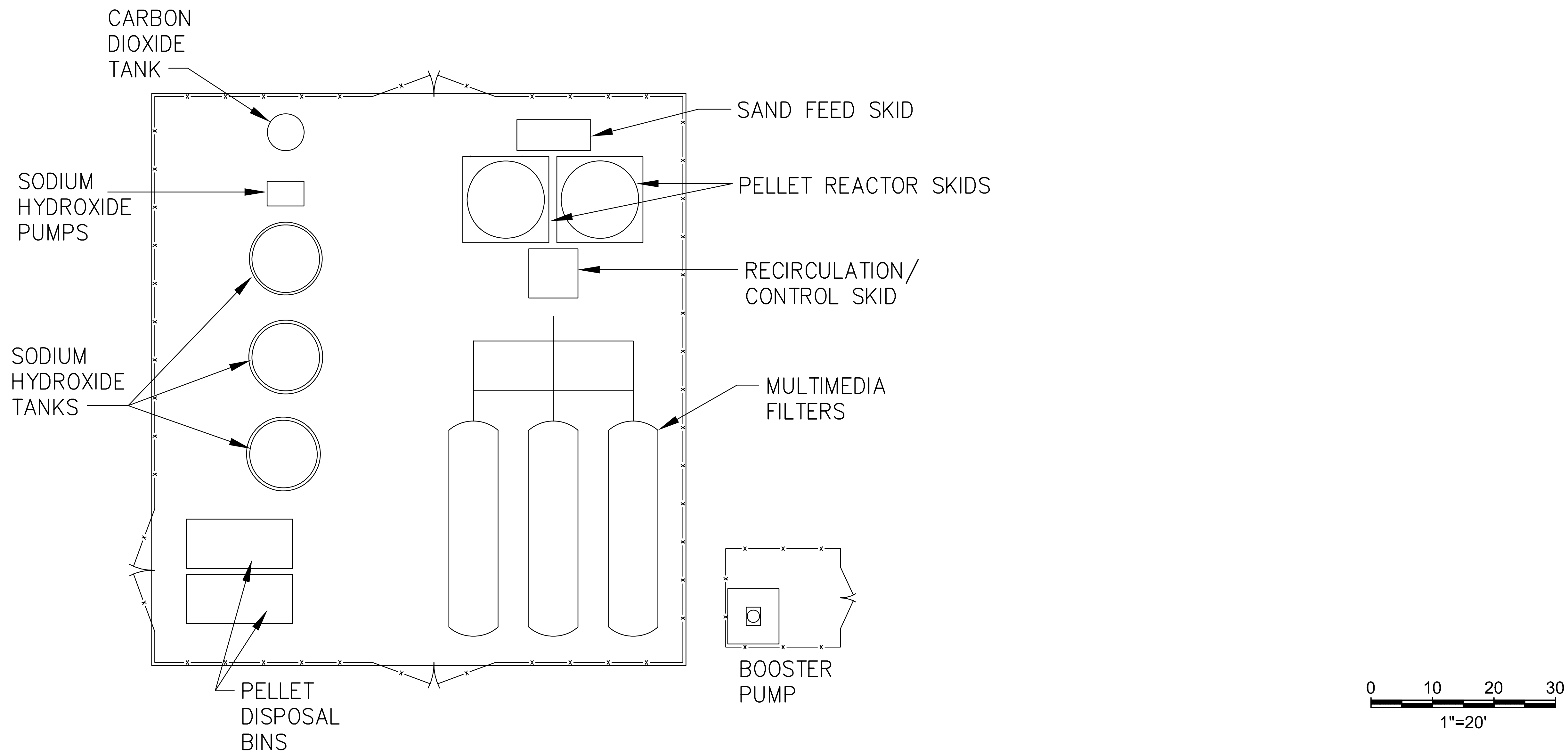


Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Water Softening Plants
Pan Handle Plant Layout (2014)
Capacity - 4,650 gpm

September 2009
K/J 0889019.00

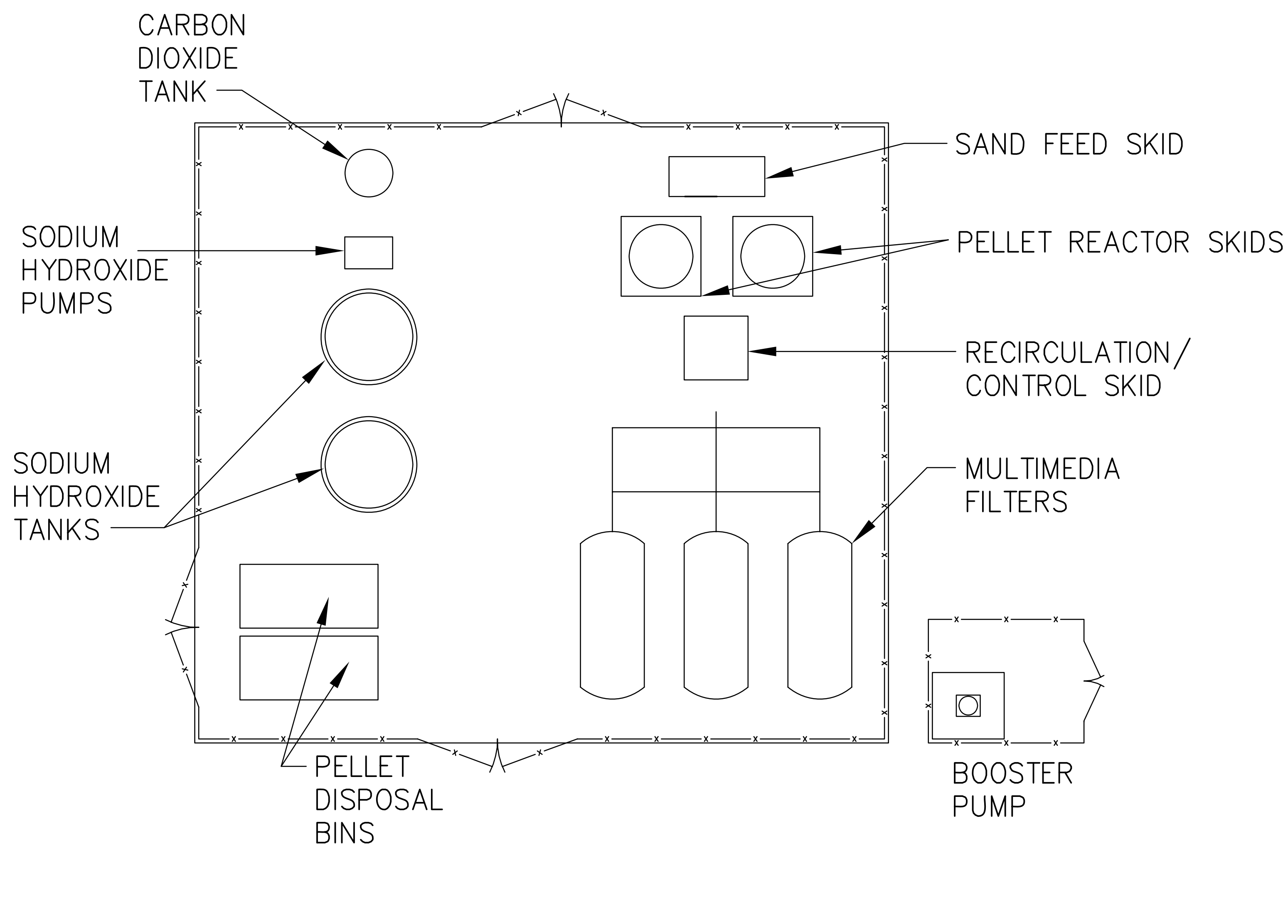


Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Water Softening Plants
Pardee Field Plant Layout (2017)
Capacity - 6,250 gpm

September 2009
K/J 0889019.00

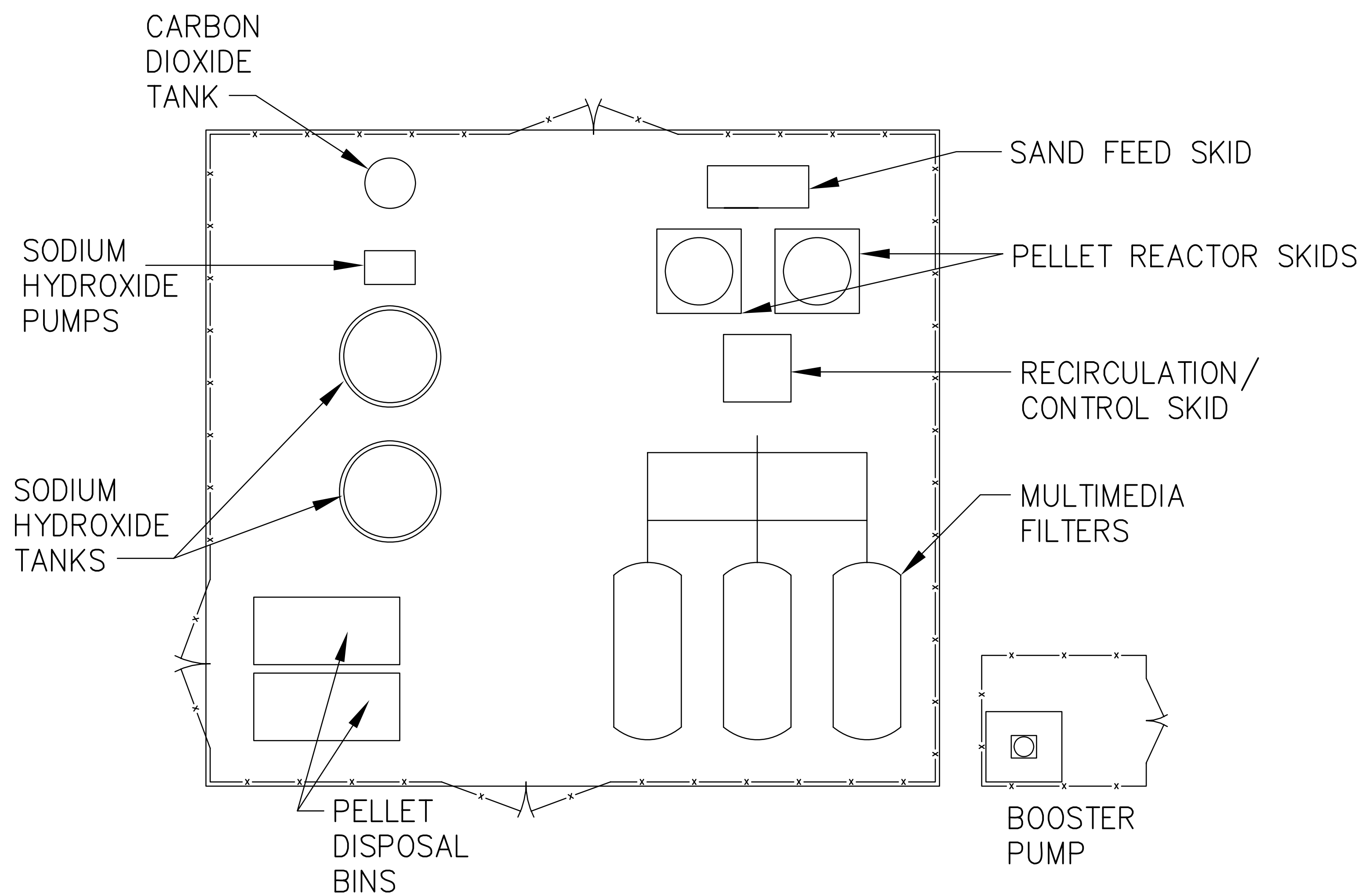


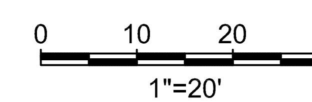
Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Water Softening Plants
Commerce Center Plant Layout (2019)
Capacity - 3,400 gpm

September 2009
K/J 0889019.00





Kennedy/Jenks Consultants

Valencia Water Company
Valencia, California

Water Softening Plants
Castaic Junction Plant Layout (2021)
Capacity - 3,600 gpm

September 2009
K/J 0889019.00

Appendix B: Outreach Reports

B.1 Meyer Marketing Intelligence, Inc.

CUSTOMER SURVEY OF

DECORO HIGHLANDS AREA

November 2006

Meyer Marketing Intelligence, Inc.
P.O. Box 221904 Newhall, CA 91322-1904
dmeyer@meyermktg.com 661.254.6141

Executive Summary

Valencia Water Company is currently in the processing of developing the usage of and technology to provide customers with softer water.

A five-minute telephone study was conducted among Valencia Water Company's customers residing in the Decoro Highlands area in the northwestern part of Santa Clarita.

- Interviews were conducted in September – October 2006.
- A total of 162 interviews were completed out of 419 customers and resulted in an error rate of ±6.0% at a 95% confidence interval.
- One of the project's objectives was to ascertain the number of customers in that region with either a monthly water softening service or a self-regenerating/automatic water softener.
- The other objective was to determine customers' willingness to either discontinue their monthly service or disconnect their self-regenerating system during a test period in which Valencia Water Company would provide softer water.

More than one-half or **57% of Decoro Highlands customers has some type of water softening system** – either a monthly service with tanks exchanged out or an automatic/self-regenerating water softener.

Slightly more than one-fourth or **28% currently use a monthly service** that provides them with a tank for softer water.

- When asked why they had signed up for a service, 74% of them had heard the water was very hard while 48% had noticed spots on their dishes, and 37% were having lines appear in their washing machines, dishwashers, and toilets.
- Two-fifths or *41% would definitely discontinue* their monthly service during a test period.
- An additional *15% or 7 customers would not discontinue* their service primarily because they were either happy with their current set-up or would rather have someone else test the technology first.
- The remaining *43% were uncertain about discontinuing* their service, and most of these customers either needed more details or information or needed to talk it over with their spouse.

Two-fifths or **40%** of the remaining customers without a monthly service or 28% of all customers surveyed **use a self-regenerating water softening system** in their homes.

- Over one-half or 52% indicated they installed such a system because they had heard the water was hard while 35% had noticed spots on their dishes, glasses, or shower doors and 22% saw lines in their washing machines, dishwashers, and toilets.
- Close to one-half or *46% would definitely disconnect* their self-regenerating system during a test period.
- An additional *22% would not disconnect* their system either because they were happy with their current system or they would be wasting the money they had already paid for their system.
- The remaining *33% were uncertain* about disconnecting their system primarily because they needed additional details or information or needed to discuss it with their spouse.

In total, *52% of customers are currently noticing spots* on their dishes, glasses or shower doors; therefore, suggesting that the water in the Decoro Highlands area is hard.

- Close to three-fifths or 57% have a monthly service or a self-regenerating water softening system ***and*** 38% of them are currently noticing spots.
- Of the remaining 43% of customers without any type of softening system, 71% of them are noticing water spots due to the hardness of the water.

In sum, the *potential exists for 82% of Decoro Highlands customers to discontinue their monthly service or disconnect their self-regenerating softener during a test period*.

- More than two-fifths or 44% are willing to discontinue/disconnect their system and only 18% are unwilling to do the same.
- The remaining 38% are uncertain and many of them need additional information or need to discuss it with their spouse.

Close to three-fourths or 72% of customers would be willing to participate in future telephone surveys and only 27% would definitely be willing to participate in focus group research in the future.

Slightly more than two-fifths or 43% provided the interviewers with their e-mail address for future communications.

Lastly, customers were asked if there were any **additional comments** they wanted to share with Valencia Water Company.

- The overwhelming majority, 81%, had no additional comments to share.

- Another 9% of the customers made some comment regarding the hardness of the water with a few others commented on the taste.

Based on the results of the research conducted the following **conclusions** can be drawn:

- Customers appear to be receptive to receiving softer water from Valencia Water Company.

- Customers in the Decoro Highlands are currently noticing spots on their dishes, glasses, or shower doors indicating the water is hard in the area.

- Even customers with a water softening system are still noticing water spots on their dishes, glasses, or shower doors.

- However, before agreeing to discontinue a monthly service or disconnect a self-regenerating system they need more information including cost implications, chemicals used, and how to handle their existing system either through a monthly service or an automatic water softener.

Research Overview & Methodology

Valencia Water Company (VWC) has been developing and refining the usage of specific technology to provide its customers with softer water. Currently, the company plans on conducting a test that would affect its customers residing in the Decoro Highlands area in the northwester section of Santa Clarita. However, in order to ascertain the number of customers in this area with either water softening services or self-regenerating (automatic) water softener, VWC conducted telephone research among those customers.

A marketing research consultant, Meyer Marketing Intelligence (MMI), developed a questionnaire to be administered over the telephone. (Note: a copy of the questionnaire is presented in Appendix A on page 20.) The interviews were approximately 5 minutes in length and the customers were told the research was being conducted on behalf of VWC in order to gauge customers' reactions towards the project as well as determine the usage of water softening systems either via a monthly service or self-regenerating systems.

The majority of the interviews were conducted in September 2006; however, there were a few that occurred in the second-half of October 2006. Out of a total of 419 Decoro Highlands customers in the database with telephone numbers, 162 interviews were completed.

Although this was shy of the 201 desired interviews in order to maintain an error rate of ±5.0%, the error rate reached with the 162 completes was ±6.0% at a 95% confidence level. The results are still usable, just the survey if repeated over time may yield results within six percentage points in either direction of the current results.

Usage of Monthly Service

All customers were asked whether they have a monthly service that provides them with a tank in order for them to have softer water in their home.

- More than one-fourth or 28% have such a monthly service.

MONTHLY WATER SOFTENING SERVICE

	Total
Base: All customers	**162**
Yes	28.40%
No	71.60%

Reasons for Monthly Service

Multiple reasons were cited by customers for signing up for a monthly service. In fact, on average Decoro Highlands customers gave 2 reasons each.

- Close to three-fourths, or 74%, indicated they had heard the water was very hard, while another 48% had noticed spots on their dishes, glasses, and shower doors.

- Still another 37% were seeing lines in their various household appliance including washing machines, dishwashers, and toilets.

REASONS FOR SIGNING UP FOR MONTHLY SERVICE

	Total
Base: Customers with monthly service	**46**
Heard water was very hard	73.91%
Noticed spots on dishes, glasses, shower doors	47.83%
Lines in washing machines, dishwasher, toilets	36.96%
Friend/relative/coworker recommended	17.39%
Real estate agent recommended	2.17%
Plumber recommended it	0.00%
Other	26.09%

A total of 13 customers had indicated "Other". These reasons included:

- Already in the house / previously had softener – 7 responses
    - ***"It was included in the purchase price of home."***
    - ***"When we bought the house, the water softener machine was already there."***
    - ***"Already hooked up when I moved in.***"
    - ***"It was here when I moved in.***"
    - ***"I had it in my old house as well.***"
    - ***"Had it when I purchased home.***"
    - ***"I've always had a softener since I lived in San Diego."***
- Other comments included:
    - ***"We're renting this house and they had to add salt to the water."***
    - ***"The Builder recommended it."***
    - ***"It was to help the environment."***
    - ***"The itchiness of the water, you could feel the hardness on your skin."***
    - ***"It's much better for your clothes if you wash with soft water."***
    - ***"The water tasted funny. You couldn't get any bubbles in the bath."***

Monthly Service: Likelihood to Discontinue

Decoro Highlands residents with a monthly service or exchange tank providing them with softer water were asked if they would discontinue their service during a test period in which Valencia Water Company would provide them with soft water.

- Two-fifths or 41% would discontinue their monthly service during a test period, and only 15% indicated they would not discontinue the service.
- However, the segment to also focus on is those who are uncertain which account for 43% of the customers.

DISCONTINUE MONTHLY SERVICE DURING TEST

	Total
Base: Customer with monthly service	**46**
Yes	41.30%
No	15.22%
Don't Know	13.04%
Maybe	30.43%

Reasons "Would Not" Discontinue Monthly Service

Only 7 customers with a monthly service would not discontinue their monthly service during a test period.

- Some were either moving, satisfied with their current vendor, or wanted to keep both.
  - ***"I'm more than satisfied with my current vendor."***
  - ***"I'm satisfied with the company I have."***
  - ***"I'm going to stay with Culligan."***
  - ***"We are moving to Georgia."***
  - ***"I want to keep both during the test period."***
- Two Decoro Highlands customers would much rather wait until someone else tests the program out to make sure the water is truly softer.
  - ***"I'd rather wait for someone else to test it."***
  - ***"I'm just not willing to take that chance. Somebody else could take that chance. Soft water is really important to me for washing hair, doing dishes. I've been in place where they don't have soft water. There are spots on you're dishes. You're hair isn't as soft, all of the mineral deposits, etc. I'm just not willing to take a chance."***

Reasons Uncertain About Discontinuing Monthly Service

A total of 20 customers with a monthly service indicated either "Don't Know" or "Maybe" to discontinuing their service during a test period.

- The majority of those customers cited the need for more details or information as the reason for their uncertainty. In fact, a summary of those reasons are as follows:
  - ***"I need more details." – 4 customers***
  - ***"It depends on how much of a hassle it will be." – 2 customers***
  - ***"It would depend on the circumstances. I would need to know more." – 2 customers***
  - ***"Need more details, but I would be interested."***
  - ***"Need more details on how much hassle it would be and also could be a consideration."***
  - ***"We don't necessarily want to have to switch back and forth if its is going to be a hassle."***
- Still others would need to talk to their spouse.
  - ***"I'd have to talk to my husband about it and we'd have to discuss it. It would depend on if he wanted to do it."***
  - ***"I'd have to ask my husband."***
  - ***"I have to ask them to ask my husband."***
- Other reasons are specific to the service and/or equipment.
  - ***"If the water softener would allow it. I was just going to shut it off for six months and the water softener company insisted on taking the tanks out."***
  - ***"Once you turn them off, they won't let you get them back again. There's a new law that prevents you from doing that. We can bypass the water softener with a switch, so I don't know how that would work."***
  - ***"I'm not sure what the situation is with the equipment. I believe it's still rented."***

- Still, other reasons included:
    - ***"We just add salt. It's not a monthly service."***
    - ***"Because I like what I have now."***
    - ***"I don't have a problem with my service now."***

Usage of Automatic Water Softener

Decoro Highlands customers without a monthly service for softer water were asked if they either lease or own an automatic water softener or self-regenerating system for their home.

- Two-fifths or 40% of customers without a monthly service own an automatic water softener.
- Interestingly, the same percentage 28% of the entire sample interviewed either use a monthly service or use an automatic water softener.

CUSTOMER WITH AUTOMATIC WATER SOFTENER

	Total
Base: Customer without monthly service	**116**
Yes	39.66%
No	60.34%

Reasons for Automatic Water Softener

Multiple reasons were cited by Decoro Highlands customers for owning or leasing a self-regenerating water softener system.

- More than one-half, 52%, installed a self-regenerating system since they had heard the water was very hard.
- An additional 35% had noticed spots on their dishes, glasses or shower doors and 22% had seen lines in their washing machines, dishwashers or toilets.

REASONS FOR INSTALLING AUTOMATIC WATER SOFTENER

	Total
Base: Customers with automatic softener	**46**
Heard water was very hard	52.17%
Noticed spots on dishes, glasses, shower doors	34.78%
Lines in washing machines, dishwasher, toilets	21.74%
Friend/relative/coworker recommended	8.70%
Real estate agent recommended	2.17%
Plumber recommended it	0.00%
Other	39.13%

A total of 17 customers had mentioned some “Other” reason. These reasons included:

- Already in the house / previously had softener – 11 responses
  - ***“It was here when I purchased the home.” (2 respondents)***
  - ***“It was already installed when we bought the home.”***
  - ***“When we bought the house the water softener was already installed.”***
  - ***“It came with the house.”***
  - ***“I had it with me from Ohio and I brought it with me.”***
  - ***“It was there when we purchased home.”***
  - ***“It was there when I purchased home.”***
  - ***“I am renting the house. I don’t know.”***
  - ***“It was in my house when I moved in.”***
  - ***“When we bought the house, it was here.”***
  - ***“It was there when the home was purchased.”***

- Other comments included:
  - ***"The builder recommended it."***
  - ***"My husband has skin problems and needs soft water."***
  - ***"We have a lot of skin problems in our family."***
  - ***"We've had it in other areas that we've lived and I've just gotten used to softer water."***
  - ***"I had used a water softener before."***

Self-Regenerating System: Likelihood to Disconnect

Customers with an automatic or self-regenerating softening system were asked if they would disconnect the softener during a test period whereby Valencia Water Company would provide softer water.

- Close to one-half or 46% would disconnect their system during a test period.
- One-fifth or 22% would not disconnect their softener; however, 33% were uncertain and indicated "Don't Know" or "Maybe".

DISCONNECT SELF-REGENERATING SYSTEM DURING TEST

	Total
Base: Customers with self-regenerating system	**46**
Yes	45.65%
No	21.74%
Don't Know	6.52%
Maybe	26.09%

Reasons "Would Not" Disconnect Self-Regenerating System

A total of 10 customers indicated reasons why they "Would Not" disconnect their self-regenerating system during a test period.

- Some of the reasons related to the cost associated with their automatic water softeners.

- ***"We're doing just fine with what we have and we paid for this system. It doesn't make sense for us to go in another direction right now."***
- ***"If I disconnect my unit, the money I spend on it would be wasted."***

- Others were satisfied with their current system.
  - ***"I am satisfied with my current water softening system and don't want to rock the boat."***
  - ***"We are happy with our water softener."***
  - ***"I am satisfied with what I have."***
  - ***"I am happy with my present system."***

- Still, some customers either did not want to disconnect their system or had some other reason.
  - ***"Why would I get someone else's?"***
  - ***"I don't want to take a chance on anything else."***
  - ***"It doesn't belong to me."***
  - ***"I don't want to disconnect what we have now."***

Reasons Uncertain About Disconnecting Self-Regenerating System

A total of 15 customers with a self-regenerating water softener indicated either "Don't Know" or "Maybe" to disconnecting their system during a test period.

- Three of them stated "Don't Know" although it appears that two of them might be willing to do so depending on receiving additional information.
  - ***"It really would have to depend. I would need more details."***
  - ***"I don't know because I'm going to be out of the country for the next month. I'll be gone until the 8th or 9th of October."***
  - ***"I can't shut off my machine."***

- The remaining 12 customers indicated "Maybe". Many of them stated the following:
  - ***"It depends on the circumstance." / "Need more details." – 6 customers***

- Still others needed to speak with their spouse or other issues were involved.
  - ***"I have to talk to my husband about it."***
  - ***"I need to ask my wife, but I am willing."***
  - ***"My husband would make the decision, but it sounds interesting."***
  - ***"We may be moving and we may try it at the new house."***
  - ***"If I disconnect it will I have to pay Culligan to come back and reconnect the machine that I own outright?"***
  - ***"Will I be able to reconnect it?"***

Current Condition: Water Spots

All customers, regardless of their usage of a monthly service or a self-regenerating system for softer water were asked if they were currently noticing water spots on their dishes, glasses, or shower doors, an indication of the presence of hard water.

- More than one-half or 52% were noticing water spots; therefore, suggesting that the water in the Decoro Highlands is hard and is not leaving glass items spot-free.
- It will be demonstrated later in this report that 56% of all customers surveyed had either a monthly service or a self-regenerating system. Consequently, this suggests that even customers with water softening systems are still noticing water spots on their glasses, dishes, or shower doors.

EXISTENCE OF WATER SPOTS

	Total
Base: All customers	**162**
Yes	52.47%
No	46.30%
Don't Know	1.23%

Currently Noticing Spots & Existence of Water Softening System

In fact, some of the Decoro Highlands customers with some type of water softening system are still noticing spots on their glasses, dishes, or shower doors.

- A total of 38% of customers with either a monthly service or an automatic or self-regenerating softening system are still noticing water spots on their glasses, dishes or shower doors.
- Additionally, 71% of all Decoro Highlands customers without any type of water softening system are noticing water spots.

EXISTENCE OF WATER SPOTS AND SOFTENING SYSTEM

	Total	Has Monthly Service	Has Automatic Water Softener	Net: Has Some Type of Softener	Has Neither
Base: All customers	**162**	**46**	**46**	**92**	**70**
Currently have spots					
Yes	52.47%	36.96%	39.13%	38.04%	71.43%
No	46.30%	63.04%	60.87%	61.96%	25.71%
Don't Know	1.23%	0.00%	0.00%	0.00%	7.14%

Summary of Willing to Discontinue/Disconnect Water Softeners

Overall 43% of customers with some type of water softener are willing to discontinue their monthly service or disconnect their automatic water softener during a test period and only 18% are unwilling to do so.

- The potential exists to convert the remaining 38% who are uncertain and many of whom need additional information or need to discuss it with their spouse in order to make a decision.
- Valencia Water Company could potentially convert those “uncertain” which could result in 82% being willing to discontinue their monthly service or disconnecting their self-regenerating system during a test period.

SUMMARY OF WILLINGNESS TO DISCONTINUE/DISCONNECT SOFTENER

	Total
Base: Customers with water softening system	**92**
Yes	43.48%
No	18.48%
Don't Know	9.78%
Maybe	28.26%
Net: Uncertain	38.04%
Net: Potential for Valencia Water Company	**81.52%**

Participation in Future Research

Decoro Highlands residents were asked if they would be willing to participate in future *telephone surveys* by Valencia Water Company.

- The majority, 72%, indicated they would be willing to be respondents in future telephone surveys.
- Another 23% indicated they would not be willing to do so and the 5% were uncertain and perhaps might in the future.

WILLING TO PARTICIPATE IN FUTURE RESEARCH: TELEPHONE SURVEYS

	Total
Base: All customers	**162**
Yes	71.60%
No	22.84%
Don't Know	1.85%
Maybe	3.70%

All customers were also asked if they would be willing to participate in future *focus group discussions* on behalf of Valencia Water Company in order for the company to provide them and other customers with better service and quality water.

- Not surprisingly, only 27% would be willing to be participants in focus group research. This research methodology requires the participant to be an active responded for a longer period of time.

- Nonetheless, focus group research with this group of customers – Decoro Highlands residents – would still be viable since the 27% translates into 44 customers willing to participate in this form of research in the future.
- Still, there is another 25% who was uncertain and might be willing to take part in focus group research in the future.

**WILLING TO PARTICIPATE IN FUTURE RESEARCH:
FOCUS GROUPS**

	Total
Base: All customers	**162**
Yes	27.16%
No	48.15%
Don't Know	3.70%
Maybe	20.99%

Communication Via E-mail

All customers were asked if they would be willing to provide Valencia Water Company with an e-mail address for future contacts.

- Two-fifths or 43% indicated they would share their e-mail address while another 38% were not willing to have additional contacts be electronic.
- The remaining 19% either did not want or refused to answer the question.

	Total
Base: All customers	**162**
Yes	43.21%
No	37.65%
No Answer/Refused	19.14%

Additional Comments

Upon conclusion of the survey, customers were asked if there was anything else they would like to share with Valencia Water Company.

- The vast majority, 132 or 81% of the customers had nothing additional to add or to share with Valencia Water Company.

- An additional 14 or 9% of the customers had a comment related to the hardness of their water.

  - ***"The water is unreasonably hard in this area." – 2 customers***

  - ***"Even on my car I have bad hard water deposits."***

  - ***"I am interested in know if you could get a water softener from Valencia."***

  - ***I am very interested in finding out if there is an alternative to cleaning up my water spots."***

  - ***I don't know how safe the water is. We've spent thousands of dollars on landscaping and I have huge water deposits on the rocks outside, because the water is so hard."***

  - ***"I have a problem with my plants dying and aquarium fish dying. I think it is some chlorine variant. My water is so hard I am looking into purchasing a reverse osmosis system."***

  - ***"I hope that the company is going to provide for the homes water that is softer and better for the homes. It is costs a little more, why not?"***

  - ***"I just wish the water would be a little softer. I know that they don't want us to use salt to make the water softer, but it's the best. The quality of the water softeners, the water is so soft. It's spotless."***

  - ***"If you go with soft water it will be a savings for us."***

  - ***"I'm just looking forward to having softer water."***

  - ***"My good Dansk wedding dishes are ruined. Glasses, dishes, everything. You run the dishwasher and you have to rinse the dishes again."***

  - ***"When the sprinklers hit cars, the water is impossible to get off the car. I have had to throw out glass and dishes. You cannot get the film out and now our dishwasher is not working because of the white film."***

   - ***"Without the cost coming back to us, could you soften the water? Hard water has destroyed my dishwasher, shower doors. I have hard water deposits."***

- Another 8 customers or 5% had some other type of comment including:

   - ***"We will be moving." – 2 customers***

   - ***"I think the Sanitation District should upgrade their system so they can handle chlorides. They should not be threatening the homeowners with an extra $400-500 for upgrading their systems. Do it like the Las Virgenes District and charge customers for their purchase of reclaimed water."***

   - ***"I think Valencia should promote water conservation more than they do."***

   - ***"Lots of people say we cannot drink the water here because it is harsh and has chemicals in it or isn't filtered right. I don't know if this is true, but just to be on the safe side, I don't drink it."***

   - ***"Price is fair."***

   - ***"We're concerned with the environment. If there's some kind of incentive, we'd be happy to get rid of the tank. It's not cost beneficial right now. If the pipes get all crusted, it's not worth it."***

   - ***"Why do my towels turn brown?"***

- Four customers had comments specific to the quality of water including:

   - ***"The water does not taste good." – 2 customers***

   - ***"Great water, but I wouldn't drink it."***

   - ***"The smell in the water, when you open the faucet at night, it has some strong smells. It's kind of difficult."***

- Of the remaining 3 comments, two were related to the proposed test specifically.

   - ***"I will try anything new if it improves the water."***

   - ***"It is a good idea to get a program from Valencia to soften the water."***

   - ***"I feel slimy when I am in the shower with soft water. I can't tell if all the soap is off."***

Appendix A
Telephone Survey Questionnaire

INTRODUCTION: Hello, may I please speak with __________________?

My name is _____________ and I'm with MMI, an marketing research company. Valencia Water Company, your water provider, asked us to call customers in your neighborhood regarding water quality.

IF PERSON IS NOT AVAILABLE THEN ASK: May I please speak with who ever helps make decisions regarding household purchases.

WITH CORRECT PERSON, REPEAT INTRO IF NECESSARY
This will take approximately 5 minutes. May we proceed?

IF NO, is there a more convenient time for you and we will call back?
Record: ____

Valencia Water Company is always striving for ways to improve the quality of your water. Currently, Valencia is planning a water softening demonstration project for your specific neighborhood – Decoro Highlands – to determine if this is a viable water quality treatment option for the company to pursue on a permanent basis.

Q1. Do you currently have a monthly service that provides you with a tank in order for you to have softer water in your home?

1 Yes (1) **GO TO Q2. THEN Q5.**
2 No (2) **SKIP TO Q3.**

Q2. Why did you sign up for a monthly service?

Was it because (READ LIST)
[CHECK ALL THAT APPLY]

1 A plumber recommended it
2 A friend/relative/coworker recommended it
3 A real estate agent recommended it
4 You noticed spots on dishes, glasses, or shower doors
5 Lines remained in washing machine, dishwasher, or toilets
6 You heard the water was very hard
7 Were there any other reasons for installing a water softener?
Other: ____

Q3. Do you currently own or lease an Automatic Water Softener or self-regenerating system in your home in which salt is added periodically?

1 Yes **GO TO Q4.**
2 No **SKIP TO Q5.**

Q4. Why did you install a water softener?

Was it because (READ LIST)
[CHECK ALL THAT APPLY]

1 A plumber recommended it
2 A friend/relative/coworker recommended it
3 A real estate agent recommended it
4 You noticed spots on dishes, glasses, or shower doors
5 Lines remained in washing machine, dishwasher, or toilets
6 You heard the water was very hard
7 Were there any other reasons for installing a water softener?
Other: ____

Q5. Are you currently noticing water spots on your dishes, glasses, or shower doors?

1 Yes
2 No
3 Don't Know / Refused **[DO NOT READ]**

Q6. **ASK IF "YES" ON Q1, OTHERWISE SKIP TO DIRECTIONAL ABOVE Q8**
If Valencia Water Company was able to provide you with soft water during a test period, would you be willing to discontinue your monthly service during a test period?

1 Yes **GO TO Q10.**
2 No **GO TO Q7. THEN Q10.**

3 Don't Know **[DO NOT READ]** **GO TO Q7. THEN Q10.**
4 Maybe **[DO NOT READ]** **GO TO Q7. THEN Q10.**

Q7. Why do you say that?
____
____

Q8**. ASK IF "YES" ON Q3, OTHERWISE SKIP TO Q10**
If Valencia Water Company was able to provide you with soft water during a test period, would you be willing to disconnect your self-regenerating system at no cost to you during a test period?

1 Yes **SKIP TO Q10.**
2 No **GO TO Q9.**

3 Don't Know **[DO NOT READ]** **GO TO Q9.**
4 Maybe **[DO NOT READ]** **GO TO Q9.**

Q9. Why do you say that?
____
____
____

Q10. As Valencia Water Company develops new technology or additional services would you be willing to participate in future telephone surveys in order for Valencia Water Company to provide its customers with better service and quality water?

1 Yes
2 No
3 Don't Know **[DO NOT READ]**
4 Maybe **[DO NOT READ]**

Q11. Would you be willing to participate in future focus groups in order for Valencia Water Company to provide its customers with better service and quality water?

1 Yes
2 No
3 Don't Know **[DO NOT READ]**
4 Maybe **[DO NOT READ]**

Q12. **SKIP IF "NO" TO BOTH Q10. AND Q11.** May I confirm your name?

____

Q13. Would you be willing to provide Valencia Water with an e-mail address for future contacts?

1 Yes ___________________________________
2 No

Q14. Is there anything else you would like to share with Valencia Water Company?

RECORD GENDER

CLOSING: On behalf of Valencia Water Company, I would like to thank you very much for your time and your comments.

B.2 O'RORKE, Inc., Public Outreach

B.2.1 O'Rorke, Inc., VALENCIA WATER COMPANY PHONE SURVEY

August 29, 2006 - Final

INTRODUCTION: Hello, may I please speak with _________________?

My name is _____________ and I'm with NRS research company. Valencia Water Company, your water provider, asked us to call customers in your neighborhood regarding water quality.

IF PERSON IS NOT AVAILABLE THEN ASK: May I please speak with who ever helps make decisions regarding household purchases.

WITH CORRECT PERSON, REPEAT INTRO IF NECESSARY

This will take approximately 5 minutes. May we proceed?

IF NO, is there a more convenient time for you and we will call back?
Record: ____

Valencia Water Company is always striving for ways to improve the quality of your water. Currently, Valencia is planning a water softening demonstration project for your specific neighborhood – Decoro Highlands – to determine if this is a viable water quality treatment option for the company to pursue on a permanent basis.

Q1a. How satisfied are you with the overall service from Valencia Water Company? Would you say you are: **[READ LIST]**

1 Extremely Satisfied (1) **SKIP TO Q2.**
2 Somewhat Satisfied (2) **SKIP TO Q2.**
3 Neither Satisfied nor Dissatisfied (3) **SKIP TO Q2.**
4 Somewhat Dissatisfied (4) **GO TO Q1B.**
5 Extremely Dissatisfied (5) **GO TO Q1B.**
6 Don't know/Refused (DO NOT READ) **SKIP TO Q2.**

Q1b. Why are you dissatisfied with the service?

____

____

Q2. Do you currently have a monthly service that provides you with a tank in order for you to have softer water in your home?

1 Yes (1) **GO TO Q3. THEN Q6.**
2 No (2) **SKIP TO Q4.**

Q3. Why did you sign up for a monthly service?

Was it because (READ LIST)
[CHECK ALL THAT APPLY]

1 A plumber recommended it
2 A friend/relative/coworker recommended it
3 A real estate agent recommended it
4 You noticed spots on dishes, glasses, or shower doors
5 Lines remained in washing machine, dishwasher, or toilets
6 You heard the water was very hard
7 Were there any other reasons for installing a water softener?

____

Q4. Do you currently own or lease an Automatic Water Softener or self-regenerating system in your home in which salt is added periodically?

1 Yes **GO TO Q5.**
2 No **SKIP TO Q6.**

Q5. Why did you install a water softener?

Was it because (READ LIST)
[CHECK ALL THAT APPLY]

1 A plumber recommended it
2 A friend/relative/coworker recommended it
3 A real estate agent recommended it
4 You noticed spots on dishes, glasses, or shower doors
5 Lines remained in washing machine, dishwasher, or toilets
6 You heard the water was very hard
7 Were there any other reasons for installing a water softener?

____

Q6. Are you currently noticing water spots on your dishes, glasses, or shower doors?

1 Yes
2 No
3 Don't Know / Refused **[DO NOT READ]**

Q7. **ASK IF "YES" ON Q2, OTHERWISE SKIP TO DIRECTIONAL ABOVE Q9**
If Valencia Water Company was able to provide you with soft water during a test period, would you be willing to discontinue your monthly service during a test period?

1 Yes **GO TO Q11.**
2 No **GO TO Q8. THEN Q11.**

3 Don't Know **[DO NOT READ]** **GO TO Q8. THEN Q11.**
4 Maybe **[DO NOT READ]** **GO TO Q8. THEN Q11.**

Q8. Why do you say that?

____

____

Q9**. ASK IF "YES" ON Q4, OTHERWISE SKIP TO Q11**
If Valencia Water Company was able to provide you with soft water during a test period, would you be willing to disconnect your self-regenerating system at no cost to you during a test period?

1 Yes **SKIP TO Q11.**
2 No **GO TO Q10.**

3 Don't Know **[DO NOT READ] GO TO Q10.**
4 Maybe **[DO NOT READ] GO TO Q10.**

Q10. Why do you say that?

____

____

____

Q11. As Valencia Water Company develops new technology or additional services would you be willing to participate in future telephone surveys in order for Valencia Water Company to provide its customers with better service and quality water?

1 Yes
2 No
3 Don't Know **[DO NOT READ]**
4 Maybe **[DO NOT READ]**

Q12. Would you be willing to participate in future focus groups in order for Valencia Water Company to provide its customers with better service and quality water?

1 Yes
2 No
3 Don't Know **[DO NOT READ]**
4 Maybe **[DO NOT READ]**

Q13. **SKIP IF "NO" TO BOTH Q11. AND Q12.** May I confirm your name?

____

Q14. Would you be willing to provide Valencia Water with an e-mail address for future contacts?

1 Yes ____________________________________
2 No

Q15. Is there anything else you would like to share with Valencia Water Company?

____

RECORD GENDER

CLOSING: On behalf of Valencia Water Company, I would like to thank you very much for your time and your comments.

B.2.2 O'Rorke Door Hanger

Valencia Water Company
Groundwater Softening Demonstration Project
Copperhill Report
November 25, 2008

Methodology
Following the launch of Valencia Water Company's Groundwater Softening Demonstration Project, staff from the Valencia Water Company (Valencia), Los Angeles County Sanitation District (Sanitation District) and O'Rorke completed two rounds of door-to-door outreach September 19-20 in the Copperhill community. The goal was to inform residents about the project and to conduct surveys on hard water issues as well as to reach each of the 432 homes at least once each day.

Despite many residents' hesitation to open their door to potential solicitors, the community's overall response to the outreach was very positive. The majority of residents seemed to be aware of the negative environmental impact tied to automatic water softeners, and pleased to hear about the demonstration project.

A total of 134 surveys were conducted in person, with six additional surveys submitted online at www.valenciawater.com. Residents that submitted the survey during the door-to-door outreach received a Baskin Robbins coupon while those that submit the survey online will receive a Starbucks gift card. On the second day, a door hanger was left at those homes where no one answered the door.

Survey Summary
Copperhill residents were generally pleased to learn about Valencia's Groundwater Softening Demonstration Project (GWSDP), as they are greatly concerned with the hard water they receive in their homes. Please note that in cases where residents did not know the answer, the question was left blank.

In cases where residents had open garages but did not answer the door, staff noted whether the home had a visible water softener. The outreach staff observed that 95 homes have a water softener, and 15 of those have a portable exchange tank. Of those residents that submitted a survey, 73 residents (or 52 percent) have a water softener in their home. Not including portable exchange tanks, a total of 62 residents (or 44 percent) have an automatic water softener (AWS), with 48 of those residents (or 67 percent) owning their AWS and 15 residents (or 21 percent) renting their AWS. A total of 10 residents rent an exchange tank unit. Most named spots on dishes and glasses and the general hardness of the water as the major reasons they use a water softener. Nearly 30 percent of residents with a water softener moved into a home with it already installed.

Of those with a water softener in home, 90 percent are willing to disconnect their unit during the test period, but many are hesitant to permanently disconnect until Valencia confirms whether they will continue to provide pre-softened water after the demonstration project period. Of those with an automatic water softener, 90 percent w willing to disconnect during the test period.

When asked what would encourage residents to permanently disconnect their softener, most cited rebate programs, saving money, and Valencia offering pre-softened water as the top motivators.

Many residents were already excited about the project after reading the Copperhill HOA newsletter, while others hadn't heard of it but still were open to the idea. The primary concerns were cost and whether the project will really provide water similar to what they receive from their water softener. Residents were willing to set their water softener to bypass, but not necessarily remove their units.

Regarding the perception of hard water, 83 percent of residents consider their water to be hard. Most residents use their water softener because they noticed spots on their dishes and shower doors, and continue to see lines around their toilet, dishwasher and washing machine. If residents did not use a water softener, they anticipate they would experience calcium build-up, dry itchy skin and poor taste. While residents are excited to receive pre-softened water, many are skeptical about how soft the water really is.

Most did not notice the change in the current hardness of their water since they were unaware they were receiving pre-softened water, and will now pay attention to see if there are any differences in their water quality. Some residents without water softeners in their homes noticed they no longer had rings in their bath tubs. In addition, a few respondents noticed that their hair is better and believed it was tied to the pre-softened water.

As a whole, Copperhill residents seemed to be well informed on the subject of hard water. Many were willing to discuss the project, and are willing to participate in future outreach efforts.

Findings

A total of 140 surveys were conducted, with 73 homes having a water softener in their home. Sixty-three of these homes have an AWS and 10 homes have a portable exchange tank system. Of those homes with an AWS, 48 residents confirmed that they own their unit, while 15 rent. Of those homes with a water softener, 86 percent claim cost savings would motivate the permanent disconnection of their water softener. When asked whether residents would be willing to sign a pledge to discontinue use of their water softener, 60 percent said yes, 30 percent said no, and 10 percent were undecided. Of AWS users, 37 (or 59 percent) are willing to sign a pledge to discontinue use

More than two-thirds of residents would be willing to pay for pre-softened water as part of their water bill. Residents offered $10-15 as a reasonable increase. A few residents were willing to pay as much as $30 per month for pre-softened water.

Recommendations

Future door-to-door outreach should be conducted after 4 p.m. on Fridays for the best success in reaching residents. Valencia Water employees in uniform enabled us to engage people longer since they had questions about things like online billing, price increases etc. With this in mind, it is suggested that Valencia representatives wear company attire during any upcoming outreach programs.

The following questions were most often skipped by residents due to the fact that they did not know an answer, or were unsure of the correct answer.

- What can Valencia Water Company do to help you disconnect your in-home water softener?
    - Many residents skipped this question because they already know how to disconnect.

- Would you be willing to sign a pledge to discontinue use of your water softener during the demonstration period?
    - Some residents commented they did not feel comfortable signing anything. Others had to check with a spouse before deciding, while many wanted to try the water before committing to any type of pledge.

- Is salt or potassium chloride added to your water softener on a regular basis?
    - Some people who indicated they have a water softener skipped this question because they did not know the answer as they were not the primary person handling the water softener maintenance.

The following details the response to key survey questions.

Do you own or rent your unit?	**Response**
Own	**48**
Rent	**25***

*Of the total rental units, 10 rent a portable exchange tank system

Why do you use your water softener?	**Response**
Already installed when they moved in	**17**
Plumber recommended it	**2**
Friend/relative/coworker recommended it	**4**
Real estate agent recommended it	**3**
Noticed spots on dishes, glasses or shower doors	**44**
Lines remained in washing machine, dishwasher or toilets	**19**
Heard the water was very hard	**23**

What are some of the problems you would anticipate if you did not have a softener?	**Response**
Calcium build up	**55**

Dry, itchy skin	**41**
Poor taste	**30**
Poor color	**14**
Poor smell	**16**
Not healthy	**16**
Less detergent foam/hard to wash off soap/wash hair	**30**
All of the above	**30**

Would you be willing to pay for pre-softened water as part of your monthly bill?	**Response**
Yes	**83**
Yes, but only if it is less than $10 more per month	**6**
Yes, but only if it is less than $15 per month	**4**
Yes, but only if less than $30 per month	**2**
No	**24**
Maybe	**12**

Would cost savings and rebates affect your decision to permanently unplug your water softener?	**Response**
Yes	**63**
No	**10**

Would you be willing to sign a pledge to discontinue use of your water softener during the demonstration project?	**Response**
Yes	**44**
No	**22**
Maybe	**7**

Would you be willing to participate in focus groups or future surveys during the softening demonstration project?	Response
Yes	**91**
No	**38**
Maybe	**3**

Common Concerns
Copperhill residents voiced a few common concerns about the groundwater softening demonstration project.

- What happens if I get rid of my water softener and then Valencia Water Company chooses not to continue with the pre-softened water after the trial period?

- What are the statistics regarding how hard/soft my water was before this trial period as compared to now?

- Can VWC provide statistics comparing the quality of my water with my water softener to the pre-softened water provided by Valencia Water Company?

- Is there a way to avoid the fees I committed to paying for my water softener if I choose to temporarily disconnect for the trial period?

Next Steps

- A follow-up postcard will be mailed to all residents, encouraging them to go online to submit a follow-up survey about their water. Two weeks after the postcards arrive in homes O'Rorke will start making follow up calls and conduct the follow-up survey over the phone.

- A follow up survey will be developed to determine how Copperhill residents like the pellet softened water, as well as how many automatic water softeners have been removed since the project launch.

- We will work with the home owners association to arrange mini-focus groups in a casual block party type setting to discuss the community's opinions on the progress of the groundwater softening project.

- Valencia Water Company will provide the residents of Copperhill with a detailed report explaining the results of the Groundwater Softening Demonstration Project. The report will also explain the differences between pre-softened groundwater using pellet softening technology and the process of automatic water softening.

- The Sanitation Districts will continue to monitor incoming rebate applications and inquiries coming from the Copperhill neighborhood.

- A total of 36 homes removed their water softener prior to the door-to-door outreach. Six of those units were rentals through Culligan or Rayne.

- Between September 19 and November 4, a total of 11 applications were received from Copperhill homes. Of those applications, seven completed the survey in person or online. Also, of the 11 applications received, seven were received in the week following the door-to-door outreach.

Valencia Water Company
Groundwater Softening Demonstration Project
Follow-up Survey Report

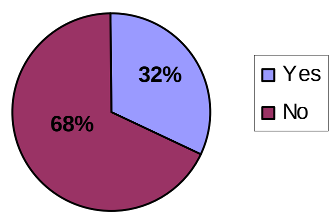
Methodology

O'Rorke conducted two rounds of follow up surveys to obtain resident feedback on the pre-softened water provided by Valencia Water Company as part of the Groundwater Softening Demonstration Project (Demonstration Project). A total of 118 follow up surveys were completed, representing 27 percent of the Copperhill community, which meets the sample required by the California Public Utilities Commission. Twenty-one of the surveys were completed via phone throughout the month of April and the remaining 97 were completed during the door-to-door outreach on May 31 and June 2. The following report represents the combined results.

Survey Summary

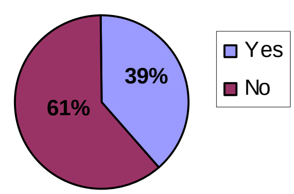
A total of 118 surveys were completed over the phone or in person. Of those surveyed, 80 residents (68 percent) do not currently have an automatic water softener (AWS) or have unplugged their AWS since the project launch.

Do you currently use a w ater softener or exchange tank in your home?



Thirty-eight residents (32 percent) currently use a water softener and of those, six residents reported use of an exchange tank and three use a carbon based system. The remaining 29 use an AWS. Seventy-eight percent of those residents currently using a water softener said they would disconnect right away to try the pre-softened water. Two residents were provided a rebate application during door-to-door outreach. Three residents said they would not disconnect as they use an AWS due to health concerns, including eczema.

Did the launch of the Groundw ater Softening Demonstration Project influence your decision to disconnect?



Thirty-nine percent of respondents cited the launch of the Demonstration Project as the primary reason they disconnected their AWS, while 61 percent named other reasons, including the rebate program and the ordinance banning softeners.

Most residents had strong opinions about how they like about their water, and provided feedback ranging from "it could be better" to "don't get rid of it!"

One resident shared how much her family liked the new water and explained how they used to buy bottled water for drinking but now exclusively drink tap water. She was very enthusiastic about the project and said that she hopes Valencia continues providing the pre-softened water.

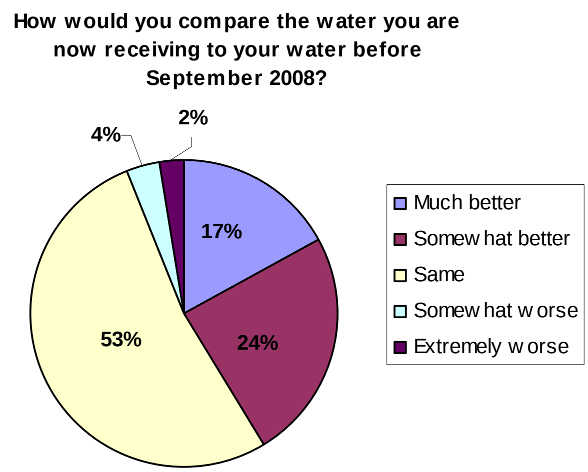
A resident who previously used an AWS said that while he thought the AWS worked better, the pre-softened water is better than not having a softener at all and added it would be "horrible to not have anything."

Another mentioned she didn't like salt-softened water as it had a slimy feeling and likes the pre-softened water she is receiving now better than the water previously softened by her AWS.

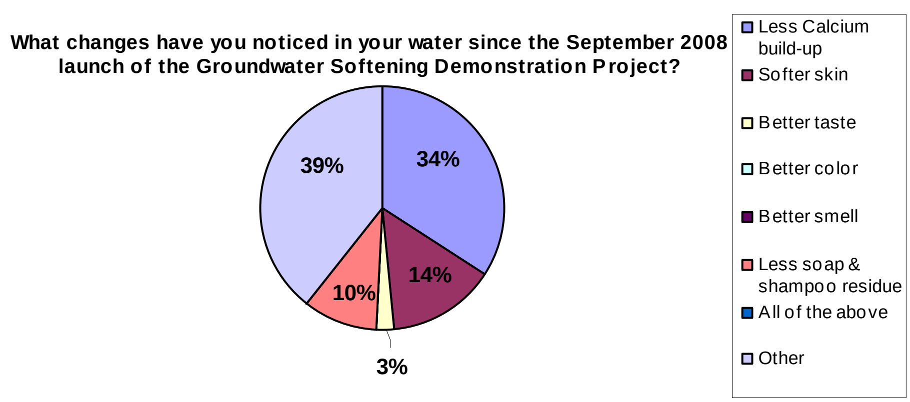
Findings

When asked how the water compares to the water they received prior to the launch of the Demonstration Project 20 percent of respondents said they have no opinion, some because they were new to the area (67 percent) and did not have anything to compare to the pre-softened water. Those residents' results are not included in the final percentages. Additionally, three of the fourteen new residents currently use a pre-installed water softener and could not fully comment on the pre-softened water.

Of the respondents who provided an opinion on the pre-softened water, 41 percent said the water is much better or somewhat better than water received prior to September 2008. Fifty-two percent of respondents think the water is the same—however, 16 percent of those residents are previous AWS users and another 16 percent currently use an exchange tank or a salt-free unit. Six percent of respondents said the water is somewhat worse or extremely worse compared to the water they previously received from their AWS.

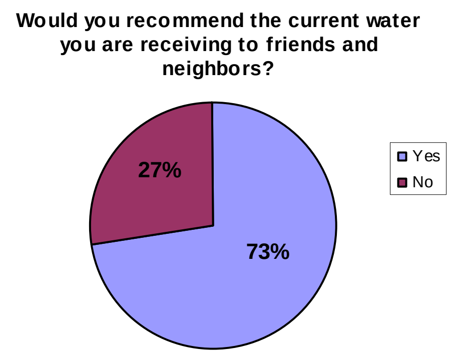


The changes most commonly reported by residents since the start of the Demonstration Project are fewer spots and calcium buildup on pipes and appliances (34 percent) and softer skin (14 percent).



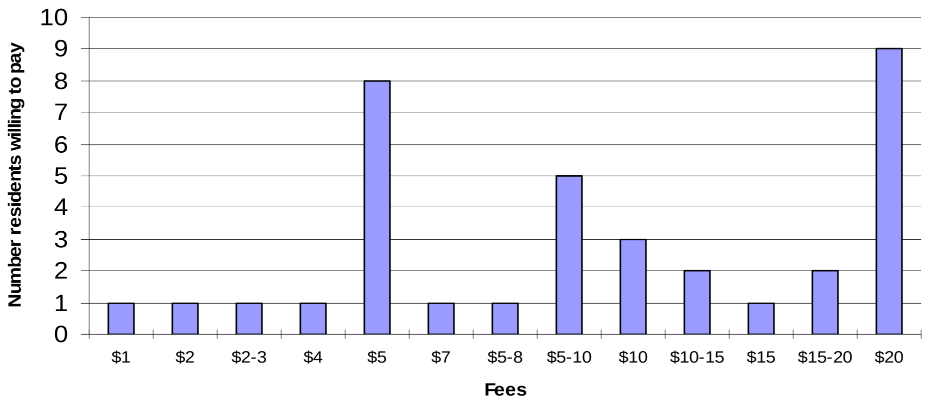
Respondents noted the following changes in their water since the launch of the Demonstration Project:

- One resident said she noticed less calcium build-up in her dishwasher, softer skin and a better taste in the water.
- Another mentioned that although his water is not as soft as with his AWS, it is much better than the original tap water. He has noticed less calcium build-up and less soap and shampoo residue since the launch of the project.
- Another resident commented that his pre-softened water is better than the hard tap water and produces less calcium build-up.
- One resident noted her laundry was better and cleaner since the project began is September.
- Another resident noted there is more calcium in the water compared to the water received through her AWS, but less than with original tap water. She also commented that the water is also not as slippery as it was with an AWS.
- One resident commented there is less calcium build-up, and it's better than the original tap water and it tastes better than water softened by an AWS.



Seventy-three percent of respondents said they would recommend pre-softened water to friends and neighbors. Of those, 17 percent are new residents to Copperhill. One resident commented, "I don't know why anyone wouldn't be happy with the water," and added that she likes the pre-softened water better than the water she previously received from an AWS.

Sixty-two percent of respondents are willing to pay for pre-softened water as part of their monthly bill. Residents considered the wide range of $2-30 as a reasonable increase, with the average response being $10. Some opposed to paying a fee did not want to pay a fee unless it the water improved while others (eight percent) simply were not concerned with the hardness or softness of their water.



There is a notable increase in awareness between the project launch survey and follow up survey. For example, with the launch survey 71 percent of residents reported they still used a water softener or exchange tank whereas with the follow up survey, only 32 percent reported continued use of a water softener or exchange tank, showing that residents are well educated about the need to disconnect and try the pre-softened water. The importance of education is well represented by the 13 residents who completed both the initial project launch survey and this survey. These residents were engaged at the time of the project launch and as a result were able to provide more thorough responses to the follow up survey and are perhaps the best representation of water acceptability as they were able to judge water from inception.

An analysis of the responses from residents that completed both surveys shows a generally high level of satisfaction with the project. Sixty-nine percent of those respondents still used a water softener at the time of the launch survey and all have disconnected since then. Nearly half of the respondents (46 percent) disconnected their water softener due to the launch of the Demonstration Project. Forty-five percent of the respondents described the pre-softened water as being much better or somewhat better than the water their home used prior to the Demonstration Project. Fifty-five percent of respondents considered the water to be the same. Of this group, no residents described the water as being worse than before the Demonstration Project. Ninety percent of the respondents would recommend the pre-softened water to their friends and neighbors. Willingness to pay fees for pre-softened water remains constant, with 73 percent saying they would pay at the time of the project launch and 75 percent stating they would pay for satisfactory pre-softened water on the follow up survey.

Conclusion

Overall, residents are satisfied with the pre-softened water with 73 percent stating they would recommend the water to their friends and 94 percent rating the water as the same or better than their previous tap water. While many wish for “perfect” water or water identical to their AWS, the general consensus is that the community welcomes the pre-softened water, especially since they cannot use an AWS after June 30. Some residents noted paying a small monthly fee for pre-softened water is less expensive than purchasing a new salt-free alternative unit. The pre-softened water appears to solve residents’ top problems reasons for using an AWS—calcium build up and dry skin.

Upcoming Coffees

Forty-six respondents confirmed their interest in participating in future follow up about the Demonstration Project. We plan to host the coffee discussions on a weeknight in the second half of June. A resident informed us that many residents are likely to be unavailable on Wednesday nights as most youth groups meetings take place on Wednesday nights. We expect to have a strong turn out for the evening gathering as most residents expressed that evenings work best with their schedule.

Next steps

- Plan coffee gathering
- Discussion guide for coffees
- Project update in Copperhill newsletter
- Final report

B.2.5 O'RORKE, Inc, Final Report

Valencia Water Company
Groundwater Softening Demonstration Project
Final Report

Methodology

O'Rorke conducted two rounds of follow up surveys to obtain resident feedback on the pre-softened water provided by Valencia Water Company (Valencia) as part of the Groundwater Softening Demonstration Project (Demonstration Project). Fifty-seven percent of all Copperhill homes were surveyed at least once during the Demonstration Project. A total of 140 surveys (32 percent) were completed at the project launch in fall 2008. During the first round of follow up outreach in spring 2009, a total of 118 surveys (27 percent) were completed. Twenty-one of the surveys were completed via phone throughout the month of April and the remaining 97 were completed during the door-to-door outreach on May-June. The combined results are provided below. A second follow up survey was presented in September-October 2009 to residents who completed the project launch survey in September 2008 and the first follow up survey in spring 2009 and indicated their willingness to participate in future surveys. Findings of this survey are on page five.

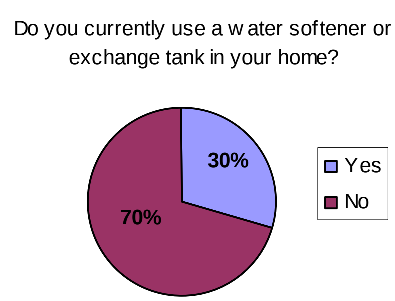
Launch Survey Summary (Fall 2008)

At the time of the project launch survey, 73 homes used a water softener in their home. Of those homes with a water softener, 86 percent claimed cost savings would motivate the permanent disconnection of their water softener. When asked whether residents would be willing to sign a pledge to discontinue use of their water softener, 60 percent said yes, 30 percent said no, and 10 percent were undecided.

Most respondents did not notice the change in the current hardness of their water as they were unaware they were receiving pre-softened water prior to the launch survey. Some residents without water softeners in their homes noticed a reduction in bathtub rings an improvement to their hair and believed it was tied to the pre-softened water.

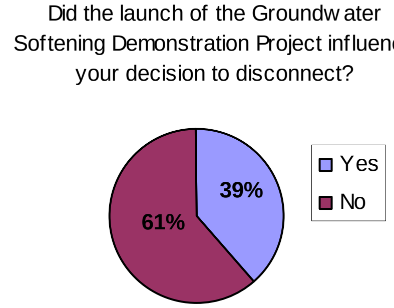
More than two-thirds of residents stated their willingness to pay for pre-softened water as part of their water bill. Residents offered $10-15 as a reasonable increase. A few residents were willing to pay as much as $30 per month for pre-softened water. Overall, residents were excited and curious about the new pre-softened water.

Phase One Follow Up Survey Summary (Spring 2009)



Results from our first follow up survey showed many residents had removed their AWS since the project launch and were generally pleased with the Demonstration Project. Of those surveyed, 80 residents (70 percent) do not currently have an AWS or have unplugged their AWS since the project launch. Thirty-five residents (30 percent) currently still use a water softener and of those, six residents reported use of an exchange tank. The remaining 29 use an AWS. Of those using their AWS, 70 percent said they would disconnect immediately to try the pre-softened water. Despite awareness of the AWS ban, three residents said they would not disconnect due to the perceived AWS benefits to their health concerns, including eczema. These residents were encouraged to explore alternatives.

Thirty-nine percent of respondents who disconnected since the launch cited the Demonstration Project as the primary reason they disconnected their AWS, while 61 percent named other reasons, including the rebate program and the AWS ordinance ban.



Most residents had strong opinions about what they like and dislike about the water they receive, and provided feedback ranging from "it could be better" to "don't get rid of it!"

Overall, residents had a favorable opinion of the pre-softened water and were eager to share their experiences. For example, one resident commented on how much her family liked the new water and explained they used to buy bottled water for drinking but now exclusively drink tap water. She was enthusiastic about the project and said that she hopes Valencia continues providing the pre-softened water.

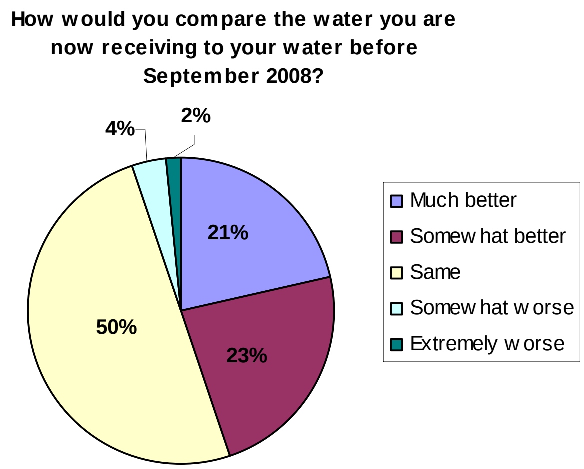
A resident who previously used an AWS said that while he thought the AWS worked better, the pre-softened water is better than not having a softener at all and added "it would be horrible to not have anything."

Another mentioned she didn't like slimy, salt-softened water and likes the pre-softened water she is receiving now better than the water previously softened by her AWS.

Phase One Findings (Spring 2009)

Of the respondents who do not currently use a water softener and have lived in Copperhill prior to the project launch, 95 percent consider the current pre-softened water to be the same or better than the water they received before the Demonstration Project.

A total of 44 percent of respondents agree the water is much better (21 percent) or somewhat better (23 percent) than water received prior to September 2008 and 50 percent of respondents think the water is the same. Of those respondents who consider the water to be the same, 18 percent are previous water softener users who consider the pre-softened water to be the same as the water they received from their water softener. The remaining 82 percent of respondents represents a mix of previous softener users and residents who never used a softener. This group considers the water to be the same, citing various reasons for this belief, a common comment being that they would only notice a negative change to their water and in this case do not have any changes to report.

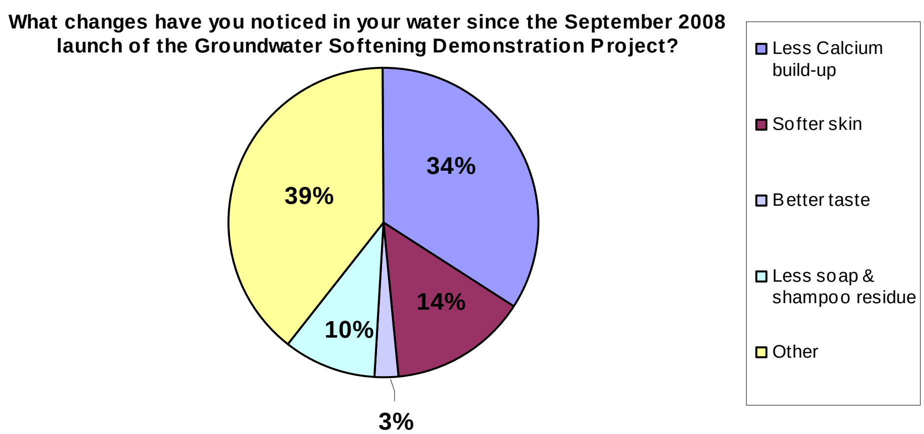


Twenty percent of respondents said they have no opinion on water changes, some because they were new to the area (67 percent of the "no opinion" responses) and did not have anything to compare to the pre-softened water. Those residents' results are not included in the final percentages. Additionally, three of the 14 new residents currently use a pre-installed water softener and could not fully comment on the pre-softened water.

A small six percent of respondents said the water is somewhat worse (four percent) or extremely worse (two percent) compared to the water they previously received from their AWS, with one resident citing more buildup in his refrigerator and shower door. Despite their negative comparison, each of these residents is willing to pay for pre-softened water as part of their monthly bill if the quality is satisfactory to them.

Results show that some residents are more sensitive to changes in the aesthetic quality of the water than others, as six percent residents say they have more buildup than before, which is counter to results from the other 44 percent of the community which has experienced a decrease in calcium buildup and soap residue. Negative responses may be attributed to a reluctance to disconnect AWSs to comply with the 2009 ordinance banning the use of salt-based water softeners.

Changes most commonly reported since the Demonstration Project was launched are fewer spots and calcium buildup on pipes and appliances (34 percent) and softer skin (14 percent).

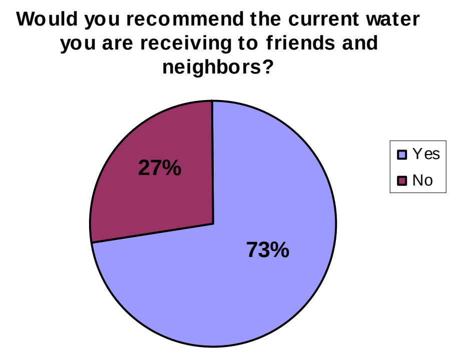


Respondents noted the following changes in their water:

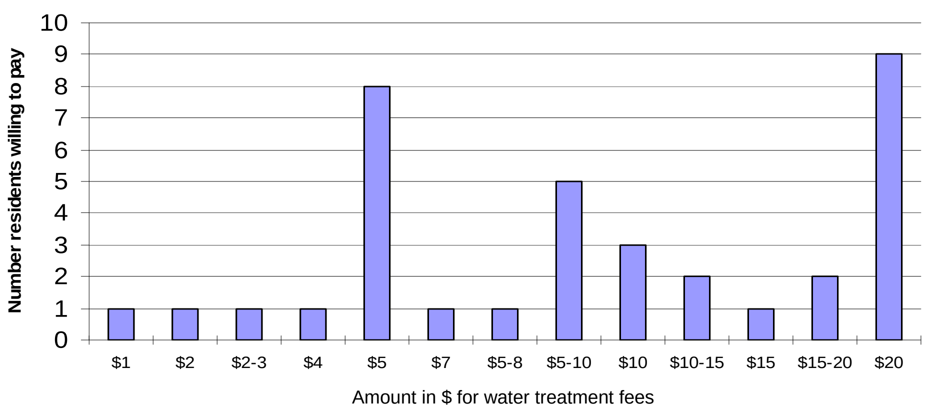
- One resident said she noticed less calcium build-up in her dishwasher, softer skin and a better taste in the water.
- Another mentioned that although his water is not as soft as with an AWS, it is much better than the original tap water. He has noticed less calcium build-up and less soap and shampoo residue since the launch of the project.
- Resident commented that the pre-softened water he receives is better than normal hard tap water and produces less calcium build-up.
- One resident noted her laundry was cleaner since the project launched.
- Another resident noted there is more calcium in the water compared to the water received through her AWS, but less than with original tap water. She also commented that the water is also not as slippery as it was with an AWS.

- One commented there is less calcium build-up, and it's better than the original tap water and it tastes better than water softened by an AWS.

Seventy-three percent of respondents said they would recommend pre-softened water to friends and neighbors. Of those, 17 percent are new residents to Copperhill. One resident commented, "I don't know why anyone wouldn't be happy with the water," and added that she likes the pre-softened water better than the water she previously received from an AWS.



Sixty-two percent of respondents are willing to pay for pre-softened water as part of their monthly bill. Residents considered the wide range of $2-30 as a reasonable increase, with the average response being $10. Some residents noted paying a small monthly fee for pre-softened water is less expensive than purchasing a new salt-free alternative unit. Those opposed to paying a fee (38 percent) did not want to pay a fee unless it the water improved while others (six percent) simply were not concerned with the hardness or softness of their water.



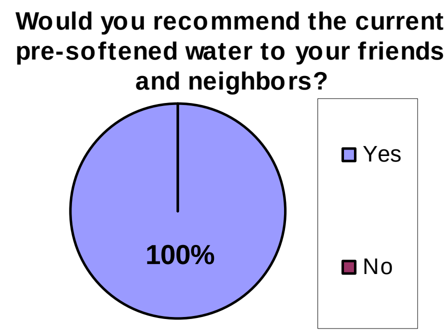
Trends: Launch Survey vs. Phase One Survey

There is a notable increase in awareness between the project launch survey and follow up survey. For example, during the launch survey 71 percent of residents reported they still used a water softener or exchange tank whereas with the follow up survey, only 32 percent reported continued use of a water softener or exchange tank, showing that residents are well educated about the need to disconnect and try the pre-softened water. The importance of education is well represented by the 13 residents who completed both the initial project launch survey and this survey. These residents were engaged at the time of the project launch and as a result were able to provide more thorough responses to the follow up survey and are perhaps the best representation of water acceptability as they were able to judge water from inception.

An analysis of the responses from residents that completed both surveys shows a high level of satisfaction with the project. Sixty-nine percent of respondents still used a water softener at the time of the launch survey but have disconnected since then. Nearly half of the respondents (46 percent) disconnected their water softener due to the launch of the Demonstration Project. Forty-five percent of the respondents described the pre-softened water as being much better or somewhat better than the water their home used prior to the Demonstration Project. Fifty-five percent of respondents considered the water to be the same. Of this group, no residents described the water as being worse than before the Demonstration Project. Ninety percent of the respondents would recommend the pre-softened water to their friends and neighbors. Willingness to pay fees for pre-softened water remains constant, with 73 percent saying they would pay at the time of the project launch and 75 percent stating they would pay for satisfactory pre-softened water on the follow up survey.

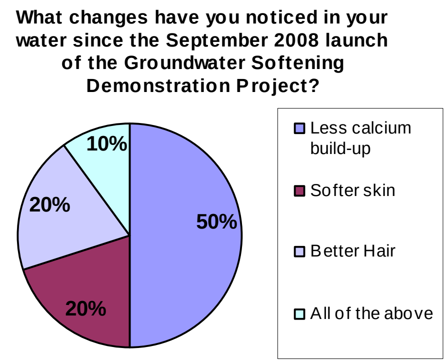
Phase Two Final Resident Survey Findings (Fall 2009)

In September-October 2009, O'Rorke conducted a third survey via phone to eight residents who completed both the project launch survey in September 2008 and spring 2009 follow up survey and opted in for future contact. This group includes a mix of residents who previously used water softening units and some who never used a softener. We chose to contact this group once more as they are the most informed residents and have had an awareness of the Demonstration Project since the initial launch. These residents offer an educated overview of the Demonstration Project as they have witnessed the project's progression throughout the past year. Results show absolute support for the Demonstration Project, with all residents agreeing the current pre-softened water is much better or somewhat better than the regular tap water they received prior to the launch of the Demonstration Project. One resident who removed an AWS several years ago for environmental reasons, praised the Demonstration Project and added that the pre-softened water is "even better" than the water she received when she used an AWS.

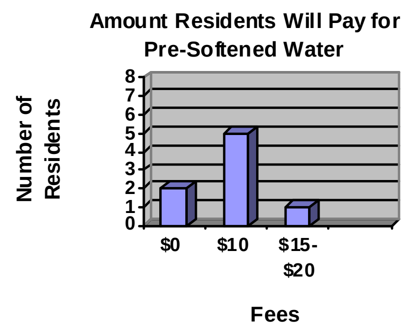


One hundred percent of these residents stated they would recommend the current pre-softened water to their friends and neighbors. Of the residents that previously used a water softener, 40 percent consider the water to be the same (20 percent) or better (20 percent) as the water received from their water softener. While 60 percent rate the pre-softened water as somewhat worse than the water provided by their softener, these residents emphasized that the current pre-softened water is far better than normal tap water even considering the fact that the pre-softened water has different softness levels than their former water softeners. It is also important to note that each type of water softener provides a different level of softness. As with the phase one follow up survey, residents cited minor aesthetic differences between water softener water and pre-softened water such as the feeling of the water. One resident informed us that since the launch of the Demonstration Project when her guests ask for a bottle of water she tells them about the pre-softened water and offers them tap water instead.

Residents cited less calcium build up (63 percent), softer skin (25 percent) and better hair (25 percent) as the major improvements they have noticed since the launch of the Demonstration Project. One resident added "I'm still just so happy that every time I open my dishwasher I don't see *any* calcium build up on my dishes anymore." Twenty-five percent of respondents did not notice any changes, as they used a water softener up until the launch of the project and did not see any difference between the water provided by the softener and the pre-softened water.



A strong 75 percent of residents stated they are willing to pay for pre-softened water as part of their monthly bill. Of those residents, 83 percent are willing to pay up to $10 per month and 17 percent is willing to pay up to $20 per month. Twenty-five percent of residents surveyed were unsure about the amount they would be willing to pay, as the current economic climate makes them hesitant to increase household spending.



Conclusion

The phase one and phase two survey participants are a fair representation of the Copperhill community and show a high satisfaction level with the Demonstration Project. We consider their informed opinions regarding the Demonstration Project to be an adequate reflection of the entire community. Every resident surveyed believes the pre-softened water provided as part of the Demonstration Project is an improvement with one resident stating, "this is *definitely* better than the alternative of having regular tap water."

Overall, residents are satisfied with the pre-softened water with the majority stating they would recommend the water to their friends and rating the water as the same or better than their previous tap water. As a whole, the community welcomes the pre-softened water, especially since they can no longer use salt-based softeners due to the ordinance banning their use. Residents expressed a clear satisfaction with the pre-softened water, which solves residents' top reasons for using an AWS—calcium build up and dry skin. Additionally, residents are willing to absorb the costs of the pre-softened water, providing the softness and quality are consistent with the water received during the summer of 2009.

"this is *definitely* better than the alternative of having regular tap water."

Appendix C: Detailed Capital Cost Estimates for Each Plant for System Implementation

ENGINEER'S ESTIMATE OF PROBABLE COST **KENNEDY/JENKS CONSULTANTS**

Project: Valencia Water Company - Full-Scale Planning Costs

Prepared By: K. Tirado
Date Prepared: 9/24/2009
K/J Proj. No. 0883024

Building, Area: Live Oak - 2,450 gpm -(Wells D, E15) - Start Up 2012

Current at ENR ____________
Escalated to ENR ____________

Estimate Type: [x] **Conceptual** [ ] **Construction**
[ ] **Preliminary (w/o plans)** [ ] **Change Order**
[ ] **Design Development @** _________ **% Complete**

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source
Plant 1												
Process Equipment												
	P1 - 1	Pellet Reactor	1	ea.	800,000	800,000	100,000	100,000			900,000	Pro-Corp e-mail quote 9/23/09
	P1 - 2	Sand Wash/Feed Skid	1	ea.	40,000	40,000					40,000	Pro-Corp e-mail quote 9/23/09. Installation included in pellet softening line item.
	P1 - 3	Multimedia Filters	1	ea.	600,000	600,000	180,000	180,000			780,000	Loprest Water Treatment Co. quote 9/24/09
	P1 - 4	Caustic storage tanks	2	ea.	17,473	34,946	5,242	10,484			45,430	Core-Rosion quote 9/25/09. Polyprocessing double wall tank - 5400 gal
	P1 - 5	Caustic solution metering pumps	1	ea.	3,000	3,000	900	900			3,900	Cortech Engineering simplex pump, with controls, and VFD's.
	P1 - 6	CO_2 storage & feed sytem	1	ea.			5,000	5,000			5,000	Rental tank, some required contractor work for equipment set-up and piping.
	P1 - 7	Well pump modifications	2	ea.			25,000	50,000			50,000	
	P1 - 9	Distribution booster pumps	1	ea.	42,000	42,000	12,600	12,600			54,600	Vendor quote: Cortech Pumps
Site/Concrete Work												
	P1 - 11	Distribution booster pumps slab on grade	27	SF	4.04	109	0.96	26			135	Means Fac. 2009: 03-30-53.40.4900
	P1 - 12	Distribution booster pumps excavation	2	CY			5.30	11			11	Means 31-23-16.13-0500
	P1 - 17	Gravel Base Cover (6")	2,000	SY	9.50	19,000	1.00	2,000			21,000	Means Fac. 2009: 32-11-23.23.0100
	P1 - 18	Plant Pad - Slab on Grade	61	CY	175.00	10,630	225.00	13,667			24,296	Means Fac. 2009: 03-30-53.40.4900 adjusted
	P1 - 20	Security fencing	200	LF	53.00	10,600	1.99	398			10,998	Means Fac. 2009: 32-31-13.53.0100
	P1 - 21	Fence gates	3	ea.	1,700	5,100	1,195	3,585			8,685	Means Fac. 2009: 32-31-13.20.5090
	P1 - 15	Pellet Disposal Tanks	2	ea.	5,500	11,000	1,100	2,200			13,200	Quote from Con-Fab for 16'x4' rounded bottom roll-off. Does not include drain.
		Subtotal				**1,576,385**		**380,870**			**1,957,255**	
		Equipment Subtotal				1,519,946		358,984			1,878,930	
		Electrical & Instrumentation	@	15%		227,992		53,848			281,839	
		Subtotal				**1,804,377**		**434,718**		**0**	**2,239,094**	
		Mobilization	@	2%		31,528		7,617			39,145	
		Taxes	@	9.75%		153,698					153,698	
		Subtotals				**1,989,602**		**442,335**		**0**	**2,431,937**	
		Contractor OH&P	@	15%		298,440		66,350			364,791	
		Subtotals				**2,288,042**		**508,685**		**0**	**2,796,727**	
		Estimate Contingency	@	10%							279,673	
		Estimated Bid Cost									**3,076,500**	
		Indirect Capital Cost Estimated by VWC									250,000	
		Total Estimate									**3,327,000**	

ENGINEER'S ESTIMATE OF PROBABLE COST | **KENNEDY/JENKS CONSULTANTS**

Project: Valencia Water Company - Full-Scale Planning Costs

Building, Area: Magic Mountain -5,000 gpm (Wells 206, 207) - Start Up 2012

Prepared By: K. Tirado
Date Prepared: 9/24/2009
K/J Proj. No. 0883024

Current at ENR ______
Escalated to ENR ______

Estimate Type: [x] **Conceptual** [ ] **Construction**
[ ] **Preliminary (w/o plans)** [ ] **Change Order**
[ ] **Design Development @** ________ **% Complete**

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source
Plant 3												
Process Equipment												
	P4-1	Pellet Reactor and Sand Feed/Wash System	1	ea.	1,300,000	1,300,000	200,000	200,000			1,500,000	Pro-Corp e-mail quote 9/23/09
	P4-2	Sand Wash/Feed System	1	ea.	40,000	40,000					40,000	Pro-Corp e-mail quote 9/25/09. Installation included in pellet softening line item.
	P4-3	Multimedia Filters	1	ea.	760,000	760,000	228,000	228,000			988,000	Loprest Water Treatment Co. quote 9/24/09
	P4-4	Caustic storage tanks	3	ea.	26,103	78,309	7,830.90	23,493			101,802	Core-Rosion quote 9/25/09. Polyprocessing double wall tank - 6500 gal
	P4-5	Caustic solution metering pumps	3	ea.	8,000	24,000	2,400.00	7,200			31,200	Cortech Engineering simplex pump, with controls, and VFD's.
	P4-6	CO_2 storage & feed sytem	1	ea.			15,000	15,000			15,000	Tank is rented. Airgas provided an estimated installation cost for this size tank.
	P4-7	Well pump modifications	2	ea.			25,000	50,000			50,000	
	P4-8	Distribution booster pumps	1	ea.	158,000	158,000	47,400	47,400			205,400	Vendor quote: Cortech Pumps
Site/Concrete Work												
	P4-9	Distribution booster pumps slab on grade	63	SF	4.04	253	0.96	60			313	Means Fac. 2009: 03-30-53.40.4900
	P4-10	Distribution booster pumps excavation	3.7	CY			5.30	20			20	Means 31-23-16.13-0500
	P4-11	Gravel Base Cover (6")	3,000	SY	9.50	28,500	1.00	3,000			31,500	Means Fac. 2009: 32-11-23.23.0100
	P4-12	Plant Slab - Slab on Grade	185	SF	175	32,321	225	41,556			73,877	Means Fac. 2009: 03-30-53.40.4900 adjusted
	P4-13	Security fencing	346	LF	53.00	18,338	1.99	689			19,027	Means Fac. 2009: 32-31-13.53.0100
	P4-14	Fence gates	3	ea.	1,700	5,100	1,195	3,585			8,685	Means Fac. 2009: 32-31-13.20.5090
	P1 - 15	Pellet Disposal Tanks	2	ea.	5,500	11,000	1,100	2,200			13,200	Quote from Con-Fab for 16'x4' rounded bottom roll-off. Does not include drain.
		Subtotal				**2,455,820**		**622,201**			**3,078,022**	
		Equipment Subtotal				2,360,309		571,093			2,931,402	
		Electrical & Instrumentation	@	15%		354,046		85,664			439,710	
		Subtotal				**2,809,867**		**707,865**			**3,517,732**	
		Mobilization	@	2%		49,116		12,444			61,560	
		Taxes	@	9.75%		239,442					239,442	
		Subtotals				**3,098,426**		**720,309**			**3,818,735**	
		Contractor OH&P	@	20%		619,685		144,062			763,747	
		Subtotals				**3,718,111**		**864,371**			**4,582,482**	
		Estimate Contingency	@	10%							458,248	
		Estimated Bid Cost									**5,040,800**	
		Indirect Capital Cost Estimated by VWC									250,000	
		Total Estimate									**5,291,000**	

ENGINEER'S ESTIMATE OF PROBABLE COST | **KENNEDY/JENKS CONSULTANTS**

Project: **Valencia Water Company - Full-Scale Planning Costs**

Building, Area: Belcaro (Well W11) - 1,000 GPM -Start Up 2014

Prepared By: K. Tirado
Date Prepared: 9/24/2009
K/J Proj. No. **0883024**

Current at ENR ____________
Escalated to ENR ____________

Estimate Type: [x] **Conceptual** [ ] **Construction**
[ ] **Preliminary (w/o plans)** [ ] **Change Order**
[ ] **Design Development @** _________ **% Complete**

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source
Plant 1												
Process Equipment												
	P1 - 1	Pellet Reactor and Sand Feed/Wash System	1	ea.	560,000	560,000	100,000	100,000			660,000	Pro-Corp e-mail quote 9/23/09
	P1 - 2	Sand Feed & Wash Skid	1	ea.	40,000	40,000					40,000	Pro-Corp e-mail quote 9/23/09. Installation included in pellet softening line item.
	P1 - 3	Multimedia Filters	1	ea.	110,000		33,000	33,000			33,000	Pro-Corp e-mail quote 7/26/09. Includes 6, 54" diameter Yardney filters.
	P1 - 4	Caustic storage tanks	2	ea.	10,843	21,686	3,252.90	6,506			28,192	Core-Rosion quote 9/25/09. Polyprocessing double wall tank - 2500 gal
	P1 - 5	Caustic solution metering pumps	1	ea.	3,000	3,000	900.00	900			3,900	Cortech Engineering simplex pump, with controls, and VFD's.
	P1 - 6	CO_2 storage & feed sytem	1	ea.			5,000	5,000			5,000	Rental tank, some required contractor work for equipment set-up and piping.
	P1 - 7	Well pump modifications	1	ea.			25,000	25,000			25,000	
	P1 - 8	Distribution booster pumps	1	ea.	42,000.00	42,000	12,600	12,600			54,600	Vendor quote: Cortech Pumps
Site/Concrete Work												
	P1 - 9	Distribution booster pumps slab on grade	54	SF	4.04	218	0.96	52			270	Means Fac. 2009: 03-30-53.40.4900
	P1 - 10	Distribution booster pumps excavation	2	CY			5.30	11			11	Means 31-23-16.13-0500
	P1 - 11	Gravel Base Cover (6")	285	SY	9.50	2,708	1.00	285			2,993	Means Fac. 2009: 32-11-23.23.0100
	P1 - 12	Plant Pad - Slab on Grade	61	CY	175.00	10,630	225.00	13,667			24,296	Means Fac. 2009: 03-30-53.40.4900 adjusted
	P1 - 13	Security fencing	250	LF	53.00	13,250	1.99	498			13,748	Means Fac. 2009: 32-31-13.53.0100
	P1 - 14	Fence gates	3	ea.	1,700.00	5,100	1,195.00	3,585			8,685	Means Fac. 2009: 32-31-13.20.5090
	P1 - 15	Pellet Disposal Tanks	2	ea.	5,500	11,000	1,100	2,200			13,200	Quote from Con-Fab for 16'x4' rounded bottom roll-off. Does not include drain.
		Subtotal				**709,591**		**203,302**			**912,894**	
		Equipment Subtotal				666,686		183,006			849,692	
		Electrical & Instrumentation	@	15%		100,003		27,451			127,454	
		Subtotal				**809,594**		**230,753**			**1,040,347**	
		Mobilization	@	2%		14,192		4,066			18,258	
		Taxes	@	9.75%		69,185					69,185	
		Subtotals				**892,971**		**234,819**			**1,127,790**	
		Contractor OH&P	@	15%		133,946		35,223			169,169	
		Subtotals				**1,026,917**		**270,042**			**1,296,959**	
		Estimate Contingency	@	10%							129,696	
		Estimated Bid Cost									**1,426,700**	
		Indirect Capital Cost Estimated by VWC									100,000	
		Total Estimate									**1,527,000**	

ENGINEER'S ESTIMATE OF PROBABLE COST **KENNEDY/JENKS CONSULTANTS**

Project: Valencia Water Company - Full-Scale Planning Costs

Prepared By: K. Tirado
Date Prepared: 9/24/2009
K/J Proj. No. 0883024

Building, Area: Pan Handle - 4,650 gpm (Wells Q2, T7, U4, U6) - Start Up 2014

Current at ENR ____________
Escalated to ENR ____________

Estimate Type: [x] **Conceptual** [ ] **Construction**
[ ] **Preliminary (w/o plans)** [ ] **Change Order**
[ ] **Design Development @** _________ **% Complete**

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source
Plant 2												
Process Equipment												
	P3-1	Pellet Reactor and Sand Feed/Wash System	1	ea.	1,300,000	1,300,000	200,000	200,000			1,500,000	Pro-Corp e-mail quote 9/23/09
	P3-2	Sand Wash/Feed System	1	ea.	40,000	40,000					40,000	Pro-Corp e-mail quote 9/25/09. Installation included in pellet softening line item.
	P3-3	Multimedia Filters	1	ea.	730,000	730,000	219,000	219,000			949,000	Lopres Water Treatment Co. quote 9/24/09
	P3-4	Caustic storage tanks	3	ea.	20,878	62,634	6,263	18,790			81,424	Core-Rosion quote 9/25/09. Polyprocessing double wall tank - 6500 gal
	P3-5	Caustic solution metering pumps	2	ea.	3,000	6,000	900	1,800			7,800	Cortech Engineering simplex pump, with controls, and VFD's.
	P3-6	CO_2 storage & feed sytem	1	ea.			15,000	15,000			15,000	Tank is rented. Airgas provided an estimated installation cost for this size tank.
	P3-7	Well pump modifications	4	ea.			25,000	100,000			100,000	
	P3-8	Distribution booster pumps	1	ea.	150,000	150,000	45,000	45,000			195,000	
Site/Concrete Work												
	P3-9	Distribution booster pumps slab on grade	63	SF	4.04	253	0.96	60			313	Means Fac. 2009: 03-30-53.40.4900
	P3-10	Distribution booster pumps excavation	3.3	CY			5.30	17			17	Means 31-23-16.13-0500
	P3-11	Gravel Base Cover (6")	3,000	SY	9.50	28,500	1.00	3,000			31,500	Means Fac. 2009: 32-11-23.23.0100
	P3-12	Plant Slab - Slab on Grade	185	CY	175.00	32,321	225.00	41,556			73,877	Means Fac. 2009: 03-30-53.40.4900 adjusted
	P3-13	Security fencing	346	LF	53.00	18,338	1.99	689			19,027	Means Fac. 2009: 32-31-13.53.0100
	P3-14	Fence gates	3	ea.	1,700	5,100	1,195	3,585			8,685	Means Fac. 2009: 32-31-13.20.5090
	P1 - 15	Pellet Disposal Tanks	2	ea.	5,500	11,000	1,100	2,200			13,200	Quote from Con-Fab for 16'x4' rounded bottom roll-off. Does not include drain.
		Subtotal				**2,384,145**		**650,697**			**3,034,842**	
		Equipment Subtotal				2,288,634		599,590			2,888,224	
		Electrical & Instrumentation	@	15%		343,295		89,939			433,234	
		Subtotal				**2,727,441**		**740,635**			**3,468,076**	
		Mobilization	@	2%		47,683		13,014			60,697	
		Taxes	@	9.75%		232,454					232,454	
		Subtotals				**3,007,578**		**753,649**			**3,761,227**	
		Contractor OH&P	@	15%		451,137		113,047			564,184	
		Subtotals				**3,458,714**		**866,696**			**4,325,411**	
		Estimate Contingency	@	10%							432,541	
		Estimated Bid Cost									**4,758,000**	
		Indirect Capital Cost Estimated by VWC									250,000	
		Total Estimate									**5,008,000**	

ENGINEER'S ESTIMATE OF PROBABLE COST **KENNEDY/JENKS CONSULTANTS**

Project: Valencia Water Company - Full-Scale Planning Costs

Building, Area: Pardee Field - 6,250 gpm (Wells N, N7, N8) - Start Up 2017

Prepared By: K. Tirado
Date Prepared: 9/24/2009
K/J Proj. No. 0883024

Current at ENR ____________
Escalated to ENR ____________

Estimate Type: [x] Conceptual [ ] Construction
[ ] Preliminary (w/o plans) [ ] Change Order
[ ] Design Development @ _________ % Complete

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source
Plant 4												
Process Equipment												
	P4-1	Pellet Reactor and Sand Feed/Wash System	1	ea.	1,400,000	1,400,000	200,000	200,000			1,600,000	Pro-Corp e-mail quote 9/23/09
	P4-2	Sand Wash/Feed System	1	ea.	40,000	40,000					40,000	Pro-Corp e-mail quote 9/25/09. Installation included in pellet softening line item.
	P4-3	Multimedia Filters	1	ea.	900,000	900,000	270,000	270,000			1,170,000	Loprest Water Treatment Co. quote 9/24/09
	P4-4	Caustic storage tanks	3	ea.	26,103	78,309	7,831	23,493			101,802	Core-Rosion quote 9/25/09. Polyprocessing double wall tank - 6500 gal
	P4-5	Caustic solution metering pumps	3	ea.	8,000.00	24,000	2,400	7,200			31,200	Cortech Engineering simplex pump, with controls, and VFD's.
	P4-6	CO_2 storage & feed sytem	1	ea.			15,000	15,000			15,000	Tank is rented. Airgas provided an estimated installation cost for this size tank.
	P4-7	Well pump modifications	3	ea.			25,000	75,000			75,000	
	P4-9	Distribution booster pumps	1	ea.	178,000	178,000	53,400	53,400			231,400	Vendor quote: Cortech Pumps
Site/Concrete Work												
	P4-11	Distribution booster pumps slab on grade	63	SF	4.04	253	0.96	60			313	Means Fac. 2009: 03-30-53.40.4900
	P4-12	Distribution booster pumps excavation	5	CY			5.30	27			27	Means 31-23-16.13-0500
	P4-17	Gravel Base Cover (6")	3,000	SY	9.50	28,500	1.00	3,000			31,500	Means Fac. 2009: 32-11-23.23.0100
	P4-18	Plant Pad - Slab on Grade	189	CY	175.00	33,056	225.00	42,500			75,556	Means Fac. 2009: 03-30-53.40.4900
	P4-20	Security fencing	350	LF	53.00	18,550	1.99	697			19,247	Means Fac. 2009: 32-31-13.53.0100
	P4-21	Fence gates	3	ea.	1,700	5,100	1,195	3,585			8,685	Means Fac. 2009: 32-31-13.20.5090
	P1 - 15	Pellet Disposal Tanks	2	ea.	5,500	11,000	1,100	2,200			13,200	Quote from Con-Fab for 16'x4' rounded bottom roll-off. Does not include drain.
		Subtotal				**2,716,767**		**696,161**			**3,412,928**	
		Equipment Subtotal				2,620,309		644,093			3,264,402	
		Electrical & Instrumentation	@	15%		393,046		96,614			489,660	
		Subtotal				**3,109,813**		**792,775**			**3,902,588**	
		Mobilization	@	2%		54,335		13,923			68,259	
		Taxes	@	9.75%		264,885					264,885	
		Subtotals				**3,429,034**		**806,698**			**4,235,731**	
		Contractor OH&P	@	20%		685,807		161,340			847,146	
		Subtotals				**4,114,840**		**968,037**			**5,082,878**	
		Estimate Contingency	@	10%							508,288	
		Estimated Bid Cost									**5,591,200**	
		Indirect Capital Cost Estimated by VWC									250,000	
		Total Estimate									**5,842,000**	

ENGINEER'S ESTIMATE OF PROBABLE COST **KENNEDY/JENKS CONSULTANTS**

Project: Valencia Water Company - Full-Scale Planning Costs

Prepared By: K. Tirado
Date Prepared: 9/24/2009
K/J Proj. No. 0883024

Building, Area: Castaic Commerce Center - 3,400 gpm (Wells E14, E16, E17) - Start Up 2019

Current at ENR ____________
Escalated to ENR ____________

Estimate Type: [x] **Conceptual** [ ] **Construction**
[ ] **Preliminary (w/o plans)** [ ] **Change Order**
[ ] **Design Development @** _________ **% Complete**

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source
Plant 5												
Process Equipment												
	P6-1	Pellet Reactor and Sand Feed/Wash System	1	ea.	1,200,000	1,200,000	200,000	200,000			1,400,000	Pro-Corp e-mail quote 9/23/09
	P6-2	Sand Wash/Feed System	1	ea.	40,000	40,000					40,000	Pro-Corp e-mail quote 9/25/09. Installation included in pellet softening line item.
	P6-3	Multimedia Filters	1	ea.	690,000	690,000	207,000	207,000			897,000	Loprest Water Treatment Co. quote 9/24/09
	P4-4	Caustic storage tanks	3	ea.	26,103	78,309	7,831	23,493			101,802	Core-Rosion quote 9/25/09. Polyprocessing double wall tank - 6500 gal
	P6-5	Caustic solution metering pumps	3	ea.	8,000.00	24,000	2,400	7,200			31,200	Cortech Engineering simplex pump, with controls, and VFD's.
	P6-6	CO_2 storage & feed sytem	1	ea.			15,000	15,000			15,000	Tank is rented. Airgas provided an estimated installation cost for this size tank.
	P6-7	Well pump modifications	3	ea.			25,000	75,000			75,000	
	P6-8	Distribution booster pumps	1	ea.	153,000	153,000	45,900	45,900			198,900	Vendor quote: Cortech Pumps
Site/Concrete Work												
	P6-9	Distribution booster pumps slab on grade	66	SF	4.04	265	0.96	63			328	Means Fac. 2009: 03-30-53.40.4900
	P6-10	Distribution booster pumps excavation	1.8	CY			5.30	10			10	Means 31-23-16.13-0500
	P6-11	Gravel Base Cover (6")	4,000	SY	9.50	38,000	1.00	4,000			42,000	Means Fac. 2009: 32-11-23.23.0100
	P6-12	Plant Pad - Slab on Grade	185	CY	175	32,375	225	41,625			74,000	Means Fac. 2009: 03-30-53.40.4900 adjusted
	P6-13	Security fencing	346	LF	53.00	18,338	1.99	689			19,027	Means Fac. 2009: 32-31-13.53.0100
	P6-14	Fence gates	3	ea.	1,700	5,100	1,195	3,585			8,685	Means Fac. 2009: 32-31-13.20.5090
	P1 - 15	Pellet Disposal Tanks	2	ea.	5,500	11,000	1,100	2,200			13,200	Quote from Con-Fab for 16'x4' rounded bottom roll-off. Does not include drain.
		Subtotal				**2,290,387**		**625,764**			**2,916,150**	
		Equipment Subtotal				2,185,309		573,593			2,758,902	
		Electrical & Instrumentation	@	15%		327,796		86,039			413,835	
		Subtotal				**2,618,183**		**711,803**			**3,329,986**	
		Mobilization	@	2%		45,808		12,515			58,323	
		Taxes	@	9.75%		223,313					223,313	
		Subtotals				**2,887,303**		**724,318**			**3,611,621**	
		Contractor OH&P	@	20%		577,461		144,864			722,324	
		Subtotals				**3,464,764**		**869,181**			**4,333,945**	
		Estimate Contingency	@	10%							433,395	
		Estimated Bid Cost									**4,767,400**	
		Indirect Capital Cost Estimated by VWC									250,000	
		Total Estimate									**5,018,000**	

ENGINEER'S ESTIMATE OF PROBABLE COST **KENNEDY/JENKS CONSULTANTS**

Project: **Valencia Water Company - Full-Scale Planning Costs**

Building, Area: Castaic Junction - 3,600 gpm - (Wells G1, G2, G3) - Start Up 2021

Prepared By: K. Tirado
Date Prepared: 9/24/2009
K/J Proj. No. **0883024**
Current at ENR ____________
Escalated to ENR ____________

Estimate Type: [x] **Conceptual** [ ] **Construction**
[ ] **Preliminary (w/o plans)** [ ] **Change Order**
[ ] **Design Development @** ________ **% Complete**

Spec. No.	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total	Source
Plant 5												
Process Equipment												
	P7-1	Pellet Reactor and Sand Feed/Wash System	1	ea.	1,200,000	1,200,000	200,000	200,000			1,400,000	Pro-Corp e-mail quote 9/23/09
	P7-2	Sand Wash/Feed System	1	ea.	40,000	40,000					40,000	Pro-Corp e-mail quote 9/25/09. Installation included in pellet softening line item.
	P7-3	Multimedia Filters	1	ea.	690,000	690,000	207,000	207,000			897,000	Loprest Water Treatment Co. quote 9/24/09
	P4-4	Caustic storage tanks	3	ea.	26,103	78,309	7,831	23,493			101,802	Core-Rosion quote 9/25/09. Polyprocessing double wall tank - 6500 gal
	P7-5	Caustic solution metering pumps	3	ea.	8,000	24,000	2,400	7,200			31,200	Cortech Engineering simplex pump, with controls, and VFD's.
	P7-6	CO_2 storage & feed sytem	1	ea.			15,000	15,000			15,000	Tank is rented. Airgas provided an estimated installation cost for this size tank.
	P7-7	Well pump modifications	3	ea.			25,000	75,000			75,000	
	P7-8	Distribution booster pumps	1	ea.	153,000	153,000	45,900	45,900			198,900	Vendor quote: Cortech Pumps
Site/Concrete Work												
	P7-9	Distribution booster pumps slab on grade	66	SF	4.04	265	0.96	63			328	Means Fac. 2009: 03-30-53.40.4900
	P7-10	Distribution booster pumps excavation	1.8	CY			5.30	10			10	Means 31-23-16.13-0500
	P7-11	Gravel or Asphalt access road	4,000	SY	9.50	38,000	1.00	4,000			42,000	Means Fac. 2009: 32-11-23.23.0100
	P7-12	Plant Pad - Slab on Grade	185	CY	175.00	32,375	225	41,625			74,000	Means Fac. 2009: 03-30-53.40.4900 adjusted
	P7-13	Security fencing	346	LF	53.00	18,338	1.99	689			19,027	Means Fac. 2009: 32-31-13.53.0100
	P7-14	Fence gates	3	ea.	1,700	5,100	1,195	3,585			8,685	Means Fac. 2009: 32-31-13.20.5090
	P1 - 15	Pellet Disposal Tanks	2	ea.	5,500	11,000	1,100	2,200			13,200	Quote from Con-Fab for 16'x4' rounded bottom roll-off. Does not include drain.
		Subtotal				**2,290,387**		**625,764**		**0**	**2,916,150**	
		Equipment Subtotal				2,185,309		573,593			2,758,902	
		Electrical & Instrumentation	@	15%		327,796		86,039			413,835	
		Subtotal				**2,618,183**		**711,803**		**0**	**3,329,986**	
		Mobilization	@	2%		45,808		12,515			58,323	
		Taxes	@	9.75%		223,313					223,313	
		Subtotals				**2,887,303**		**724,318**		**0**	**3,611,621**	
		Contractor OH&P	@	20%		577,461		144,864			722,324	
		Subtotals				**3,464,764**		**869,181**		**0**	**4,333,945**	
		Estimate Contingency	@	10%							433,395	
		Estimated Bid Cost									**4,767,400**	
		Indirect Capital Cost Estimated by VWC									250,000	
		Total Estimate									**5,018,000**	