American Water Works Association

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National Cost Implications of a Potential Perchlorate Regulation

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Contents

Appendices

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Executive Summary

In this study, a screening level cost assessment was conducted to evaluate the national cost implications of five potential regulatory levels for perchlorate in drinking water – 4, 6, 12, 18, and 24 μg/L. Initially, the Unregulated Contaminants Monitoring Rule (UCMR) database was reviewed to identify all source waters/entry points contaminated with perchlorate. Ninetieth percentile and median perchlorate concentrations were calculated for each contaminated source. Capital and operating costs to treat the contaminated sources were determined for each potential maximum contaminant level (MCL).

Results from the study reveal that perchlorate contamination is national in scope, with detectable perchlorate concentrations observed in source waters in 26 different states. However, only 4.1% of all source waters sampled under the UCMR exhibited detectable levels of perchlorate. Further, most perchlorate detections were at concentrations ranging from 4 to 12 μg/L, indicating that only a very few PWSs would be required to treat for perchlorate at higher regulatory levels. Although perchlorate contamination was detected in a number of different states, perchlorate occurrence is geographically focused in southern California, the southern states, and the northeast. Approximately one third of the PWSs affected are located in California.

Capital and operations and maintenance (O&M) costs to treat source waters contaminated with perchlorate were estimated based on the assumption that all contaminated sources would be treated (i.e., no blending or abandonment of sources) and that single pass ion exchange would be implemented for treatment at all sites. Full scale capital and O&M cost information was used to develop cost curves as a function of system size. All contaminated sources were then assigned capital and O&M costs based on the estimated design and average flow rates, respectively, for each site.

Figure ES-1 displays the total annualized national compliance costs associated with each potential regulatory level based on 20 years life of service at a 3% discount rate, using both the calculated median and the 90^{th} percentile perchlorate concentrations for each source. At the most stringent potential MCL evaluated (4 μg/L), the national compliance cost is estimated to be $140 million per year using the 90^{th} percentile and a 3% discount rate.

The national compliance cost to meet a 4 μg/L perchlorate MCL is smaller than estimated compliance costs for other drinking water regulations (e.g., $585 million/year for the Arsenic Rule at 10 μg/L; USEPA, 2001a). The relatively low national compliance costs reflect the small number of PWSs expected to be affected (3.4% at a perchlorate MCL of 4 μg/L and based on 90th percentile perchlorate concentrations). Additionally, treatment costs associated with single pass ion exchange systems are moderate due to the simplicity of operation and the recent development of highly-selective resins with high capacities for perchlorate removal. However, a small number of systems are carrying this cost burden and the cost impacts to an individual system installing perchlorate treatment would likely be significant. With O&M costs for perchlorate treatment comparable to the capital costs for construction and with these O&M costs continuing in perpetuity, ratepayers could face a significant increase.

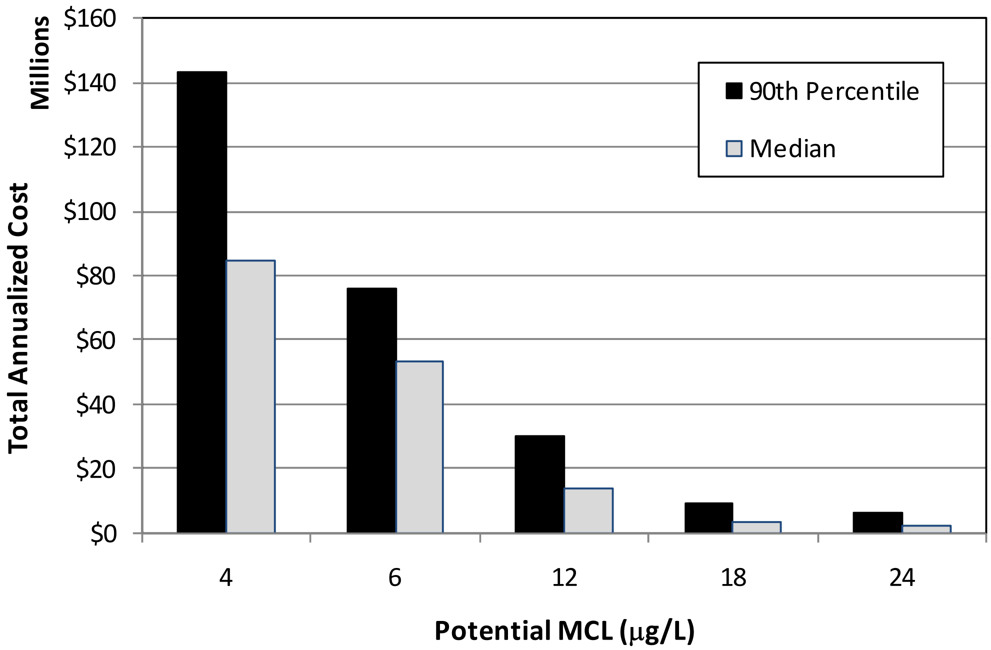

Figure ES-1. Total Estimated Annualized Costs Associated with Five Potential Perchlorate MCLs – based on installation of single pass ion exchange treatment systems (i.e., source abatement was not considered), 20 year life-of-service and 3% discount rate

1. Introduction and Background

Perchlorate is a persistent, inorganic anion known to disrupt thyroid function if ingested in significant quantity. Perchlorate salts have been used in a number of applications, including as an oxidizer in solid rocket fuel and as a component in fireworks and other explosives. Perchlorate has also been found as a contaminant in Chilean fertilizer and it has been used in some medical and analytical applications. The U.S. Environmental Protection Agency (USEPA) has identified over 100 potential perchlorate releases from governmental and non-governmental sites in 26 states, mostly associated with the use of perchlorate in solid rocket fuel (USEPA, 2003). Some non-anthropogenic sources of perchlorate in the environment have also recently been proposed (Rajagopalan et al., 2006; Rao et al., 2007).

Due to the known presence of perchlorate in the environment and public health concerns associated with consumption of water contaminated with perchlorate, USEPA added perchlorate to the first Contaminant Candidate List (CCL1) in 1998 (USEPA, 1998). Perchlorate was retained on the second CCL (CCL2) and on the recently published draft third CCL (CCL3; USEPA, 2005a, 2008a).

In 2005, the National Research Council (NRC) of the National Academy of Sciences (NAS) released their report on perchlorate in drinking water that recommended a Reference Dose (RfD) of 0.007 mg/kg/day (NRC, 2005). USEPA then incorporated this RfD into a Drinking Water Equivalent Level (DWEL) of 24 μg/L (USEPA, 2005b).

USEPA is required under the Safe Drinking Water Act (SDWA) to make regulatory determinations on a five-year cycle for contaminants included on the CCL. In May 2007, USEPA determined that insufficient information was available to make a decision of whether or not to regulate perchlorate, primarily due to the lack of complete information on perchlorate in food as opposed to water (USEPA, 2007). Since then, data from the Food and Drug Adminstration's (FDA's) Total Diet Study has been published (Murray et al, 2008). USEPA has also re-stated its intention to complete a regulatory determination for perchlorate by the end of 2008 (Grumbles, 2008). USEPA may be pressured by Congress via the Solis Bill (H.R. 1747) to establish a NPDWR for perchlorate if the currently proposed bill is enacted into law.

USEPA takes into account a number of factors when making a determination whether or not to regulate a drinking water contaminant, including the health impacts from exposure to the contaminant, the number of people impacted, the degree of contaminant occurrence, and whether or not a national drinking water regulation would provide an opportunity for significant risk reduction as required by the SDWA. The American

Water Works Association (AWWA) has recognized the lack of available information on projected national costs associated with treatment of perchlorate to various levels. Based on this recognized data gap, AWWA requested that Malcolm Pirnie conduct a study to estimate the national cost implications of setting a federal maximum contaminant level (MCL) for perchlorate at different levels between 4 and 24 μg/L.

This report presents the results from the study. The approach followed to identify contaminated sources and to assign costs to treat water from those sources is presented in Section 2. Results from the analysis of perchlorate occurrence and the cost evaluation are presented in Section 3. Section 4 provides a discussion of trends and implications of those costs. Potential limitations in the methods used to identify the treatment costs are also presented in Section 4.

2. Approach

Five potential perchlorate MCLs were evaluated – 4, 6, 12, 18, and 24 μg/L. The lower end of the range is based on the 4 μg/L detection limit for reporting (DLR) associated with EPA Method 314 at the time that UCMR samples were analyzed. Although many laboratories are now able to measure perchlorate to concentrations as low as 0.5 μg/L, the sensitivity of the analytical method at the time samples were collected for the UCMR only allowed detection to a concentration of 4 μg/L or greater. The upper end of the range is based on the 24.5 μg/L concentration associated with the previously discussed, EPA-adopted Reference Dose (RfD) of 0.007 milligram perchlorate per kilogram body weight (USEPA, 2005b).

Table 2-1 presents the general approach used to estimate national costs associated with treating source waters containing perchlorate at concentrations exceeding each proposed MCL. The approach was developed based on the guidelines described in Raucher et al (1995) for estimating the cost of compliance with drinking water standards. Various aspects of the economic analysis conducted for the Arsenic Rule (US EPA, 2000) and the Stage 2 Disinfectants and Disinfection By-Product Rule (DDBPR; US EPA 2005c) were also used as examples.

Table 2-1. Steps to Identify the Compliance Costs for a Given Regulatory Level

Step 1	Identify source waters and public water systems (PWSs) contaminated with perchlorate
Step 2	Determine perchlorate concentration and flow rate for each contaminated source
Step 3	Identify a likely treatment strategy for the contaminated sources
Step 4	Assign capital costs associated with treating each contaminated source
Step 5	Assign operations and maintenance (O&M) costs associated with treating each contaminated source
Step 6	Tally capital and O&M costs to treat each contaminated source with a perchlorate concentration exceeding a given value (e.g., 4, 6, 12, 18, or 24 μg/L)

2.1. Occurrence Data

As a first step, public water systems (PWSs) with detectable concentrations of perchlorate were identified using the Unregulated Contaminant Monitoring Rule (UCMR) database. A relatively complete set of occurrence data is available for perchlorate as a result of the UCMR data collection effort. However, the data set does have some limitations which are discussed in this report. Several states also have established independent water quality monitoring databases with perchlorate information (e.g., California, Texas, Massachusetts, Arizona; Brandhuber and Clark, 2005). The California Department of Public Health (CDPH) perchlorate occurrence data was used for groundtruthing.

Under the UCMR promulgated in 2001, all community water systems (CWSs) and non-transient, non-community water systems (NTNCWSs) serving water to more than 10,000 people (large systems) were required to sample all entry points to their distribution system for perchlorate. Four quarterly samples collected over one year were required for surface waters and two samples collected over the course of one year were required for groundwater sources. UCMR sampling of large systems was conducted between January 1, 2001 and December 31, 2003 (US EPA, 2001b).

A randomly selected sample of 800 CWSs and NTNCWSs serving less than 10,000 people (small systems) were also assessed for perchlorate contamination (US EPA, 2001c). The small systems were required to monitor all entry points to their distribution system once during one year between January 1, 2001 and December 31, 2003.

The UCMR database was queried for all entry points/source waters with a detectable perchlorate concentration. As mentioned, multiple samples were collected from each large system sample point during a 12-month period. To obtain a single perchlorate concentration associated with each sample point, non-detects were assigned zero values and the 90th percentile and median values were calculated for the given sample point. Both 90th percentile and median values were assessed to obtain a range of the expected extent of perchlorate contamination.[1]

Several additional data processing steps were required to enable assignment of perchlorate treatment costs for each contaminated source water. Specifically a design and average daily flow needed to be identified for each source water in order to estimate the capital and operations and maintenance (O&M) costs, respectively, to treat the water. Flow rates were first calculated for each PWS with a perchlorate detection using the following regression equations developed by US EPA (2005c).

[1] Both 90th percentile and median perchlorate concentrations were calculated for a given source water/point of entry. In the absence of information on the history of the sample points, it is difficult to ascertain whether the median or 90th percentile values is more representative. As an example, one contaminated sample point that was sampled two times over the course of one year had one detectable perchlorate concentration of 11.9 μg/L and one non-detect. The collection of two samples suggests the sample point correlates to a groundwater system. If a well was taken offline after the perchlorate “hit” was detected in the first sample, the subsequent sample may not be representative because water drawn from an inactive well may likely have different quality than water drawn from a well that is continuously pumping. On the other hand, the first sample could have exhibited measurable perchlorate concentrations due to analytical error. In the first case, the 90th percentile value may be more representative; in the latter case, the median value may be more accurate. Since it is impossible to discern which scenario is more likely without additional information for each of the 387 sample points, the occurrence and cost results are reported for both the median and 90th percentile values to provide a likely range of the expected number of contaminated PWSs and associated treatment costs.

Surface Waters: Design Flow (MGD) = $0.36971X^{0.97757}/1000$
Average Daily Flow (MGD) = $0.10540X^{1.02058}/1000$

Ground Waters: Design Flow (MGD) = $0.39639X^{0.97708}/1000$
Average Daily Flow (MGD) = $0.06428X^{1.07652}/1000$

where X is the population for the associated PWS.

Recent population data for each PWS was retrieved from US EPA's SDWIS database and cross-checked with the population size assignment for the PWS in the UCMR database. Design and average daily flow rates were then estimated for each contaminated source water by dividing the PWS flow rates by the total number of sources in the PWS under consideration. The number of sources for each PWS were tallied based on the total number of sampling points included for that system during the UCMR sampling effort.

2.2. Treatment Strategy

Several treatment technologies are available for perchlorate removal – regenerable ion exchange, single pass ion exchange, biological treatment through fixed or fluidized bed reactors, and reverse osmosis. Table 2-2 lists advantages and disadvantages associated with each treatment technology and Appendix B provides additional information on each of the technologies. Regenerable ion exchange and reverse osmosis are more costly than single pass ion exchange and generate a waste brine stream, creating disposal issues. The effectiveness of biological treatment has been demonstrated; however, due to potential public acceptance issues and additional post-treatment costs to meet SWTR requirements, no water utilities have adopted biological treatment for perchlorate removal in the U.S. to date.

Table 2-2. Disadvantages and Advantages of Available Perchlorate Treatment Technologies

Treatment Technology	Advantages	Disadvantages
Regenerable ion exchange	- Demonstrated technology - Also effective for nitrate removal	- Produces a perchlorate-laden waste brine - High salt costs
Single pass ion exchange	- Relatively low cost - Simple - Demonstrated technology	- Does not remove nitrate - Resin costs affected by petroleum market
Biological treatment	- CDPH approved technology - Negligible wastestream - Also effective for nitrate removal	- Post-treatment to meet SWTR may be required - Public acceptance issues
Reverse osmosis	- Also effective for nitrate removal	- High costs - Produces a perchlorate-laden waste brine

Based on the advantages and disadvantages mentioned above and also based on current trends in treatment selection in southern California, single pass ion exchange treatment was considered to be the reasonable treatment technology choice for the purpose of this national cost evaluation.

The costs associated with treating each contaminated source water were estimated by assuming that each source would be treated; blending and source abandonment were not considered as potential contamination abatement options. Capital and O&M costs were then assigned assuming that all contaminated sources would use single pass ion exchange systems for perchlorate removal.

2.3. Cost Data

The following paragraphs describe Steps 4 – 6 in Table 2-1: assignment of capital and O&M costs for each contaminated source and calculation of the total resulting treatment costs. Capital and O&M costs were assumed to be independent of the influent perchlorate concentration based on experience that system size and operation (and associated capital and O&M costs) are primarily dictated by plant capacity and concentrations of competing anions (e.g., nitrate). Additionally, the costs were calculated based on the assumption that the treatment goal would be non-detect since all but one queried utilities with single pass ion exchange systems for perchlorate removal treat to non-detect. This approach neglects the option of treating partial flow and blending to meet the MCL. A detailed list of assumptions made to designate capital and O&M treatment costs for each contaminated source water is provided in Appendix C.

2.3.1. Capital Costs

Capital costs to install single pass ion exchange systems were obtained from seven different water utilities in southern California. The ENR Cost Indices for Los Angeles were used to adjust capital costs to 2008 dollars for systems installed in previous years. Los Angeles Cost Indices were used since more of the impacted utilities are located in California than any other individual state and since the baseline cost data was obtained from California utilities that have already installed perchlorate treatment. Use of Los Angeles Cost Indices (and baseline cost data) is considered a conservative approach due to the generally higher construction costs in southern California relative to other parts of the nation.

Baseline capital costs for each of the participating utilities are depicted in Figure 2-1 and include the first fill of resin, ion exchange vessels, foundation and site work, installation of the vessels and resin, electrical, process controls, and engineering services. Cost data from a perchlorate cost study conducted by Kennedy/Jenks Consultants (2004) is also included in the graph.

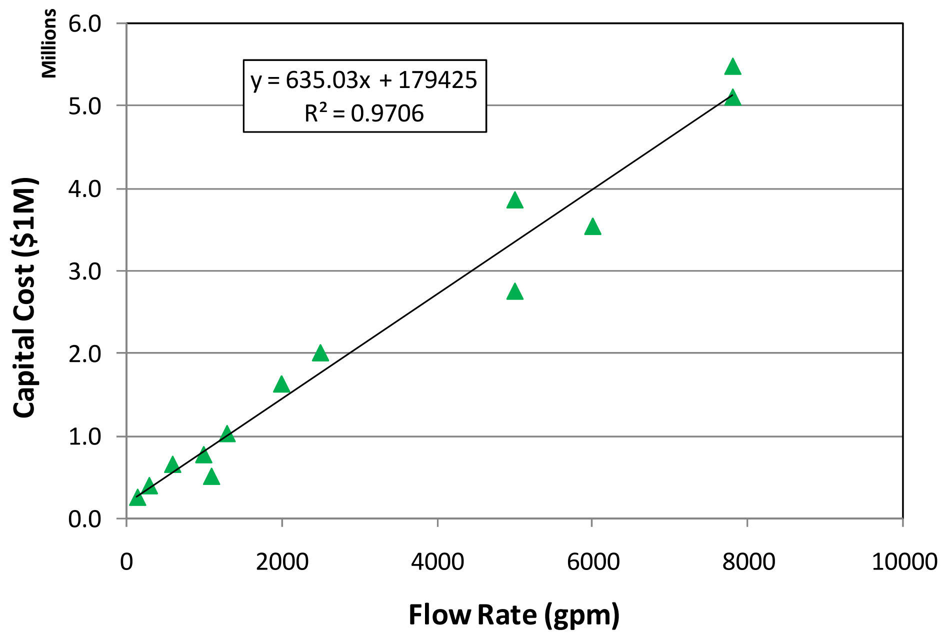

Figure 2-1. Baseline Capital Costs as a Function of System Flow Rate

As indicated by the R-squared value for the linear trendline depicted in the graph, the correlation between the full-scale baseline capital costs and system flow rate shows a very consistent trend. The linear regression equation was therefore used to assign baseline capital costs for all identified source waters/entry points from the UCMR database with a perchlorate detection. The minimum and maximum flow rates for the contaminated source waters identified in the UCMR database – 3 to 9,320 gpm – generally fall within the range of full-scale data obtained for this study.

Some water systems are expected to incur additional costs for installation of perchlorate treatment. For example, additional land may be required to accommodate the single pass ion exchange vessels, as demonstrated by a water utility in southern California that is currently procuring land to enable installation of their single pass ion exchange system. Several recent perchlorate treatment installations have included pre-filtration to protect the resin from clogging with suspended solids in the source water. Acid addition may also be added to protect against scaling. Additionally, walls or buildings may be required for aesthetic purposes at some facilities, building for process controls, etc. may be required for sites that currently do not have any treatment installed, and piping may be required for systems that are one mile or more from the well due to space limitations.

The following approach was used to assign these additional costs to a portion of the identified contaminated source waters:

1. Land and demolition costs were added to 35% of the contaminated sources. This percentage (35%) was selected based on trends observed in southern

California (e.g., one of three utilities in the San Gabriel Balley installing single pass ion exchange required additional land purchase).[2] A 7,800 gpm system and above is assumed to require three 0.2-acre parcels of land; a 2,500 to 5,000 gpm system is assumed to require two 0.2-acre parcels of land; and a 2,500 gpm system or smaller is assumed to require one 0.2-acre parcel of land. The median price for a 0.2-acre parcel of land is assumed to be $220,000 based on the National Association of Realtors median home prices in the U.S. between 2005 and 2008. Demolition costs are assumed to be $50,000 per lot.

2. Pre-treatment costs were added to 40% of the contaminated sources at 20% of the baseline capital costs.
3. Wall/building/piping costs were added to 50% of the contaminated sources at 15% of the baseline capital costs.

For each additional cost category, the Excel random number generator function was used to randomly assign the additional costs for land/demolition, pre-treatment, and wall/building/piping to the designated percentages of sources. Total capital costs for each contaminated source were then calculated by summing the baseline capital costs and any additional costs associated with land requirements, pre-treatment, etc.

Several PWSs in southern California have already installed (or are currently installing) single pass ion exchange systems to treat their contaminated source waters in compliance with the California Code of Regulations Title 22 perchlorate standard of 6 μg/L. Capital and O&M costs for these systems (approximately 6 out of 387 sources with perchlorate detections) were considered in estimating the national compliance costs.

2.3.2. Operations and Maintenance Costs

Operations and maintenance costs were obtained from five PWSs that currently operate (or previously operated) single pass ion exchange systems for perchlorate removal. Figure 2-2 shows the O&M costs (as cost per 1,000 gallons of water treated) for the full-scale single pass ion exchange systems by system flow rate. O&M costs that were estimated in a previous study (MP, 2008) for one 2,500 gpm single pass ion exchange treatment system and two 7,800 gpm systems are also included in the graph.

[2] As a comparison the Kennedy/Jenks study of perchlorate treatment costs for California assumed 25% of impacted sources would need to purchase land (Kennedy/Jenks, 2004). An economic analysis conducted for the arsenic rule (USEPA, 2000) did not include land costs; however, the report suggested adding 5% to the total capital costs to account for land purchases if a sensitivity analysis were conducted.

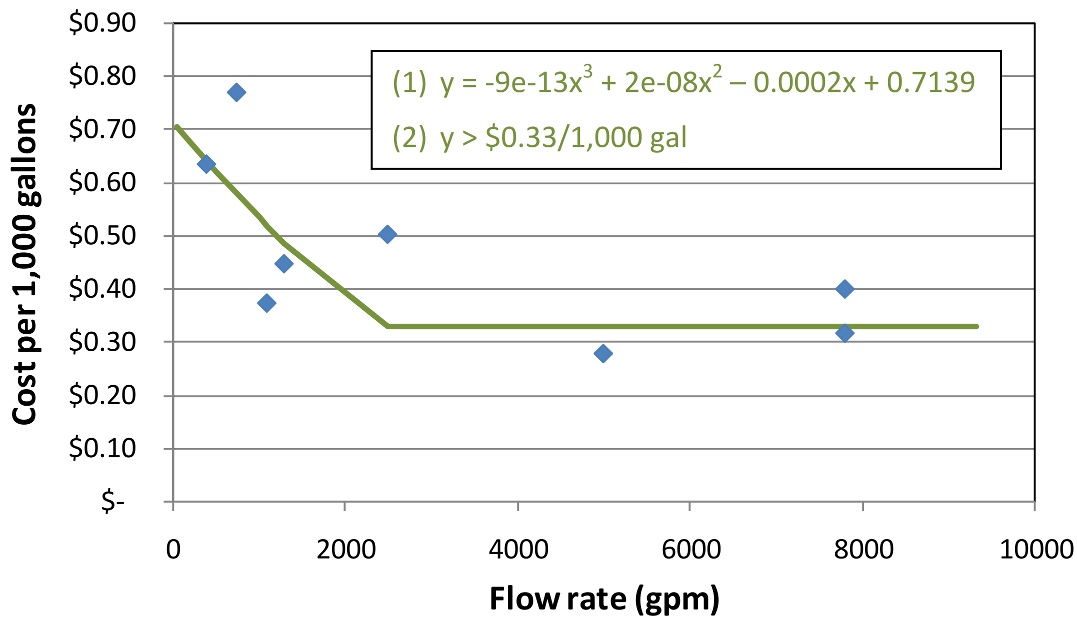

Figure 2-2. Operations and Maintenance Costs as a Function of System Flow Rate

A best fit polynomial was calculated using the Excel trendline function to correlate known operating costs to system flow rate. The polynomial equation was then used to estimate O&M costs for each contaminated source water/entry point identified in the UCMR database. Due to limitations in the data and the ability to fit a trendline enabling accurate estimates of O&M costs for all system flow rates under consideration, a lower bound cost of $0.33 per 1,000 gallons water treated was established. This assumption is reasonable given that economies of scale do not completely apply to larger flow rates as more vessels are simply added to increase the treatment capacity.

2.3.3. Total Costs

After assigning capital and O&M costs for each contaminated source water, the costs were tallied to identify total national costs for perchlorate treatment to meet a given MCL. The following steps were followed to tally the total costs.

1. Contaminated source waters for small PWSs (<10,000 people served) were separated from the data set. The capital and O&M costs estimated for these contaminated source waters needed to be scaled up since only 800 out of tens of thousands small PWSs nation-wide were sampled during the UCMR sampling effort. The use of a statistical sample set for small systems during UCMR sampling (USEPA, 2001d) enabled direct scaling based on the actual number of small PWSs.

2. Contaminated source waters requiring treatment were collated for each potential MCL and for each size category (i.e., large [≥10,000 people served] and small). For example, all contaminated sources for large PWSs with perchlorate concentrations of 6 μg/L or higher were tabulated to determine costs associated with a perchlorate MCL of 6 μg/L. Similar data assessments were conducted for the small PWS data set. The total capital and O&M costs associated with each perchlorate MCL and for each size category were then summed.

3. The nation-wide costs associated with treating small PWSs for each potential perchlorate MCL were estimated by multiplying the costs associated with treatment for the 800 PWS sample-set by a factor of 83.8 (i.e., 66,826 small CWS and NTNCWSs nation-wide [USEPA, 2008], divided by 797 small PWS respondents for the UCMR sampling effort).

4. The total nation-wide capital and O&M costs for each potential perchlorate MCL were then calculated by summing the costs for the large systems and the factored costs for the small systems. Amortized capital costs and net present value O&M costs were calculated assuming 20 years of operation and for both a 3% and 7% interest rate.

2.4. Ground Truthing

Ground truthing of several parameters was conducted for quality assurance/control. Specifically, the following parameters were checked for a subset of the contaminated water sources and PWSs to verify the data:

- number of sources for a given PWS,
- population size for a given PWS,
- estimated design and average flow rate for a given contaminated source water, and
- estimated perchlorate concentration for all contaminated sources with design flow rates greater than 10,000 gpm.

For most of the listed parameters, the values were checked for PWSs that the project team was familiar with through previous work. However in some cases, the PWSs were contacted directly to verify the estimated values. For example, estimated perchlorate concentrations for all contaminated sources with design flow rates greater than 10,000 gpm were verified by contacting the PWS to inquire about the validity of the UCMR data.

The national compliance costs were compared to costs of compliance in the State of California estimated in the Kennedy/Jenks study (2004) and the California Department of Public Health study (CDPH, 2007).

3. Results

3.1. Perchlorate Occurrence

The UCMR database was queried to identify all sample points with perchlorate detections to determine the distribution of PWSs that would be affected by a perchlorate MCL. Table 3-1 provides a breakdown of the UCMR data set, listing the number of samples collected, number of sample points, and number of systems with perchlorate detections. Perchlorate was detected in 647 out of 34,728 samples collected under the UCMR sampling effort. A total of 387 sample points (i.e., entry points/source waters) were identified in the UCMR database for which at least one sample exhibited a perchlorate concentration above the 4 μg/L DLR. Appendix A lists each source with a detectable perchlorate concentration. The calculated 90^{th} percentile and median perchlorate concentration for each source is also listed.

The 387 sample points with perchlorate detections correlate to a total of 160 PWSs contaminated with perchlorate since some PWSs had multiple entry points with detectable perchlorate concentrations. The number of PWSs with perchlorate detections number is expected to be significantly higher if all small PWSs are taken into account; the UCMR sampling effort only included 800 out of 66,826 CWSs and NTNCWSs serving less than 10,000 people nation-wide. The percentage of all sampled PWSs with a perchlorate detection (4.1%, Table 3-1) is consistent with trends observed in a previous study evaluating perchlorate occurrence using the UCMR data (Brandhuber and Clark, 2005) and indicates that only a small portion of PWSs would be affected by a perchlorate MCL.

Table 3-1. Summary of UCMR Data (Source: UCMR Database and Brandhuber, 2008)

Description	Total Number	Number with Detections	Percentage
Samples	34,728	647	1.9%
Sample Points	14,993	387	2.6%
Systems	3,870	160	4.1%

Table 3-2 lists the distribution of perchlorate detections by system size. Based on the data, a higher percentage of large PWSs (>10,000 people served) are contaminated with perchlorate compared to smaller PWSs (< 10,000 people served). Although a statistical approach was used to identify the set of small PWSs sampled under UCMR, it is possible that a more complete sampling effort would reveal slightly different trends in perchlorate

1.

occurrence in small PWSs. Therefore, when compared to the available data for small systems, large PWSs offer the best opportunity to estimate national economic impacts, since the data set for large PWSs is more complete.

Table 3-2. Distribution of PWSs with Perchlorate Detections by System Size (Source: UCMR Database and Brandhuber, 2008)

System Size	Total Number of PWSs	Number of Detections	Percentage
Very Large (> 100,001)	700	60	8.6%
Large (10,000 – 100,000)	2,373	92	3.9%
Medium (3,301 – 10,000)	344	2	0.6%
Small (501 – 3,300)	291	3	1.0%
Very Small (< 500)	162	3	1.9%

Figures 3-1 and 3-2 illustrate the geographic distribution of the 160 PWSs with perchlorate detections. As observed in previous assessments of the UCMR database (Brandhuber and Clark, 2005), twenty-six states were identified that had at least one PWS with a perchlorate detection. Perchlorate contamination was also found in Puerto Rico and the Mariana Islands (Saipan).

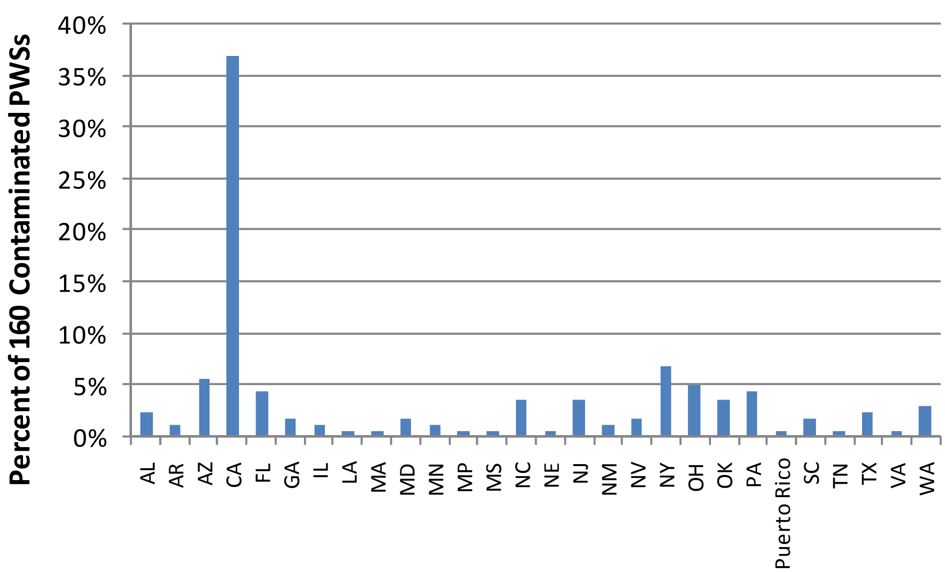

Figure 3-1. Percent of Contaminated PWSs (160 Total) in a Given State

Over a third of the 160 contaminated PWSs are located in California. These results are consistent with trends observed by Gullick et al. (2001) based on their survey of perchlorate occurrence in drinking water supplies of the American Water System. Kimbrough and Parekh (2007) also observed a higher percent (15%) of source waters throughout California with perchlorate detections, compared to the estimated 2.6% of source water/entry points sampled nationwide; however, the California data set analyzed in that study is biased towards source waters expected to be at high risk for perchlorate contamination. The majority of the remaining contaminated PWSs identified from the UCMR database are distributed across Nevada and Arizona, south central U.S. (e.g., Texas, Louisiana), the southeast (e.g., Florida, Georgia, and North Carolina) and the northeast (Figure 3-2).

Figure 3-2 illustrates that most perchlorate concentrations measured during UCMR sampling were relatively low; the majority of the 90^{th} percentile perchlorate concentrations fall within the range of 4 – 12 μg/L as shown by the prevalence of blue and green circles on the map. This trend is further represented by Figure 3-3, which shows the percent of PWSs that would be affected by a given perchlorate MCL for the calculated 90^{th} percentile and median perchlorate concentrations. At a potential MCL of 24 μg/L, only 0.3% of all PWSs would need to be treated for perchlorate removal as compared to 3.4% of all PWSs for a perchlorate MCL of 4 μg/L based on the 90^{th} percentile perchlorate concentrations.

Even at the most stringent MCL evaluated (i.e., 4 μg/L), the percent of PWSs expected to be affected is relatively low; only 2.2 to 3.4% are estimated to require perchlorate treatment based on the calculated median and 90^{th} percentile perchlorate concentrations, respectively. This estimate suggests that the costs for PWSs to comply with a potential perchlorate regulation may also be relatively low.

The calculated percentages of PWSs affected for a given perchlorate MCL shown in Figure 3-3 differ slightly from values reported in Brandhuber et al., (2008). The discrepancy is a result of slight differences in the approach used to analyze the UCMR data. Brandhuber et al. (2008) assigned non-detects a value of 2 μg/L, whereas non-detects were assigned a zero value in our study. Further, Brandhuber et al. (2008) averaged the perchlorate measurements at a given source; in contrast, the values shown in Figure 3-3 are based on either the median or 90^{th} percentile values. Despite these variations in data interpretation, the trends shown in Figure 3-3 and reported in Brandhuber et al. (2008) are consistent.

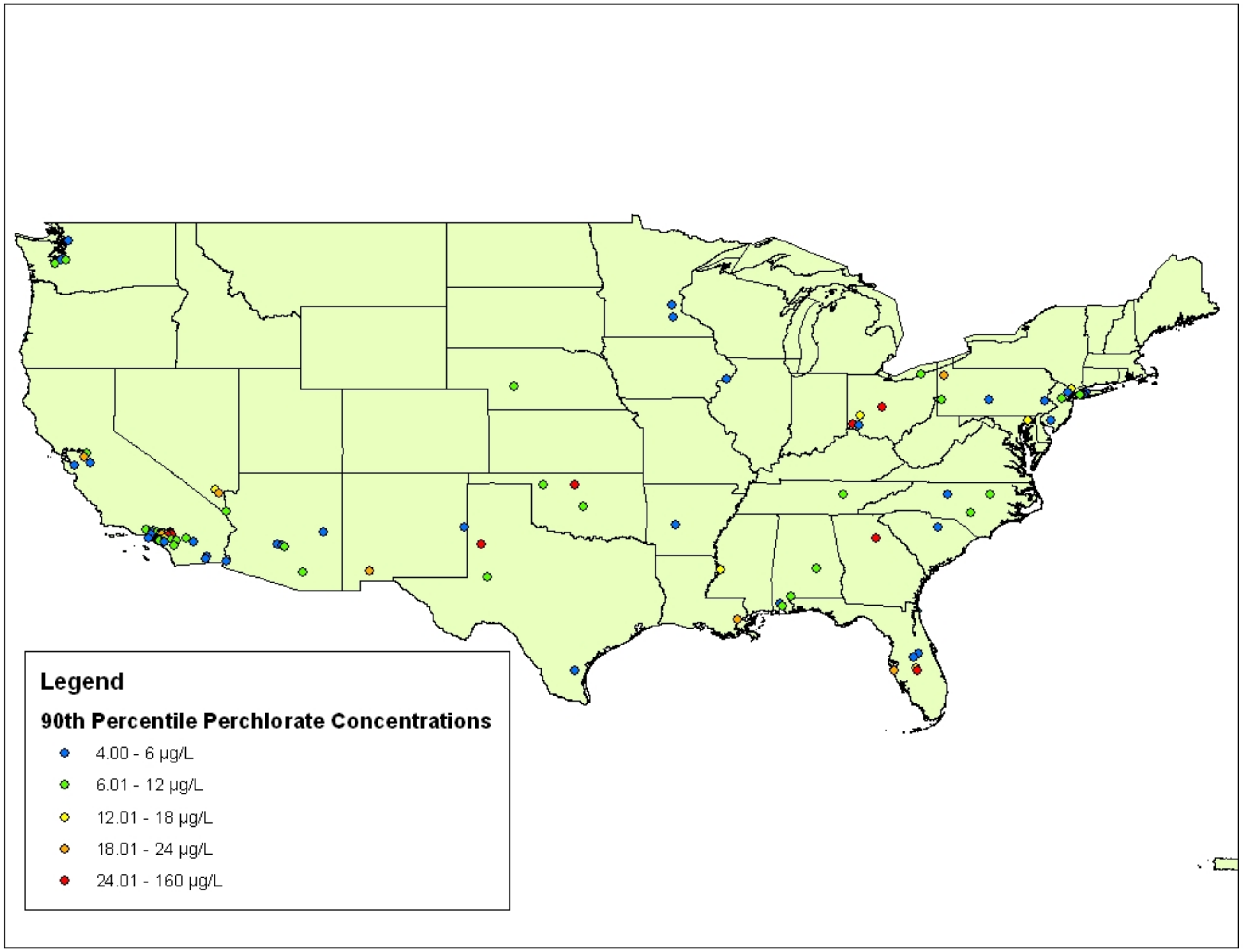

Figure 3-2. Geographic Distribution of PWSs with Perchlorate Contamination – 90th Percentile Concentrations

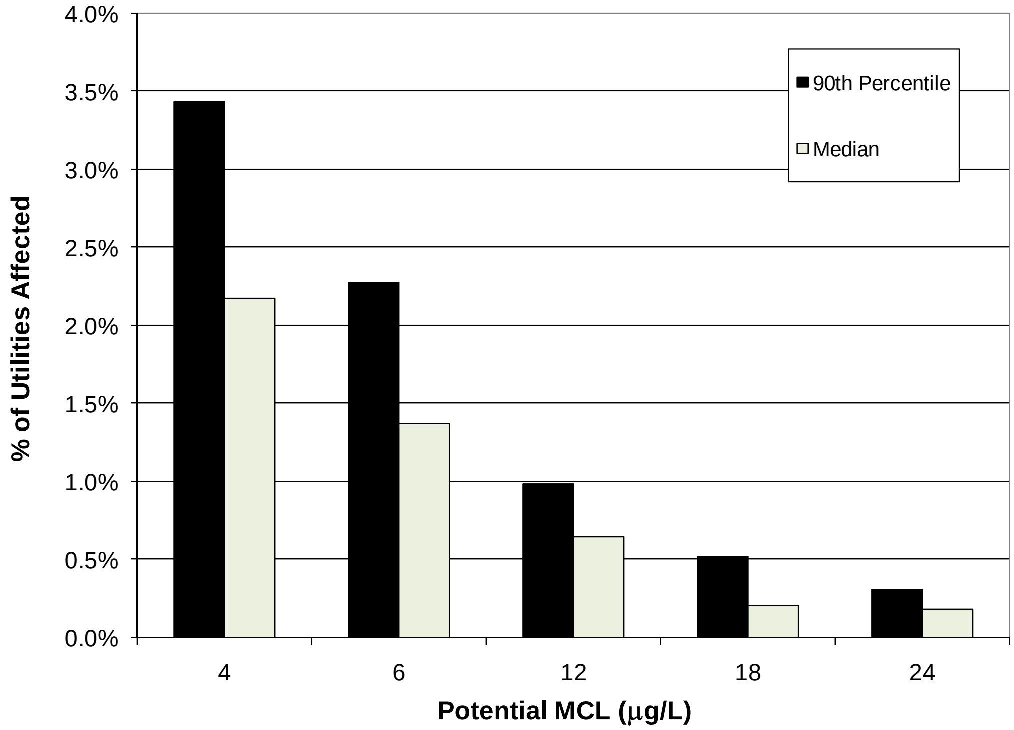

Figure 3-3. Percent of Utilities Affected by Various Potential MCLs - based on UCMR data and including all system sizes

3.2. Compliance Costs

3.2.1. Capital Costs

Total capital costs were estimated for each potential perchlorate MCL based on the calculated 90th percentile and median perchlorate concentrations in all contaminated sources (Figure 3-4). As expected, capital costs are higher if the 90th percentile perchlorate concentration is used. While a higher influent perchlorate concentration is not expected to affect capital costs to install a treatment system, a greater number of contaminated sources are estimated for a given perchlorate MCL if the 90th percentile value is considered.

Generally, capital costs for perchlorate treatment are estimated to be low when compared to other regulations, even at the most stringent regulatory level evaluated. As a comparison, estimated capital costs to treat for arsenic, another inorganic anion known to contaminate some source waters, were estimated to be $4.5 billion in 2001 (USEPA, 2001). The low estimated capital costs for perchlorate treatment reflect the small number of source waters expected to be affected nationwide (approximately 800) and the relatively low costs to install single pass ion exchange systems. However, a small number of systems are carrying this cost burden and the cost impacts to an individual system installing perchlorate treatment would likely be significant, particularly when O&M costs are also taken into account.

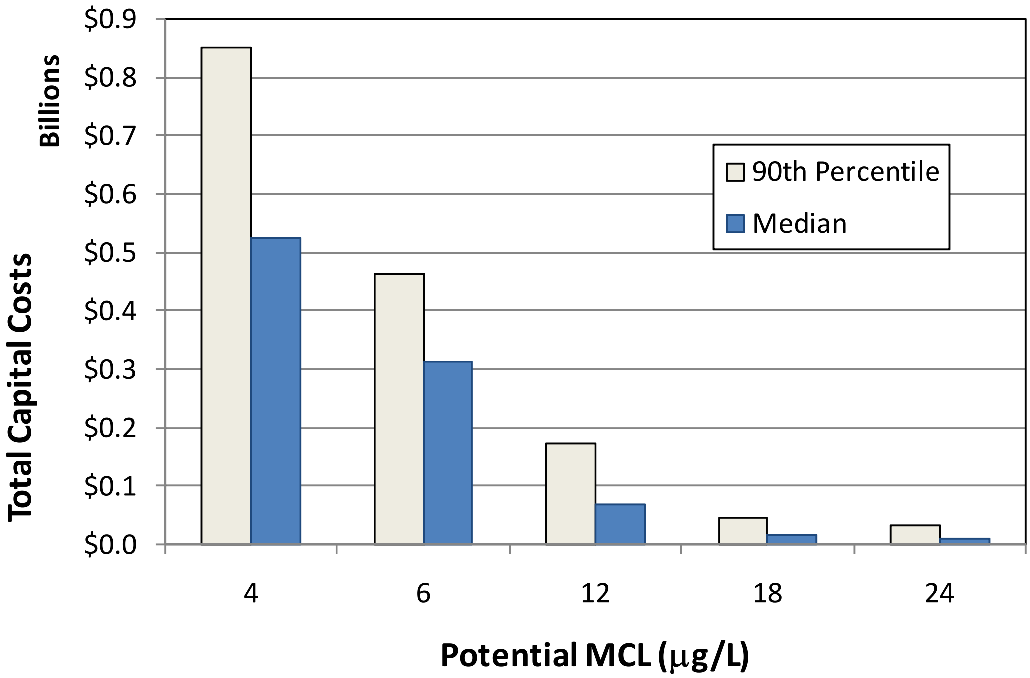

Figure 3-4. Total Estimated Capital Costs to Treat for Perchlorate at Various Potential MCLs – based on installation of single pass ion exchange treatment systems

Figure 3-5 shows the single pass ion exchange system installed at the California Domestic Water Company (Cal Domestic). Baseline capital costs to install this 5,000 gpm system include the ion exchange vessels, first fill of resin, foundation, piping and valves, telemetry, electrical, and engineering services, for a total of $2.8M in 2008 dollars. As the picture illustrates, the vessels can be installed uncovered in regions with moderate temperatures, cutting down costs.

Figure 3-5. Single Pass Ion Exchange System Installed at California Domestic Water Co.

3.2.2. O&M Costs

Annual operation and maintenance costs for a 5,000 gpm single pass ion exchange system are listed in Table 3-3. As indicated by the data, the major annual costs to operate the system are for power, labor, resin replacement, and contractor labor, with resin replacement costs being the most expensive line item.

Table 3-3. Annual O&M Costs for a 5,000 GPM Single Pass Ion Exchange System^

Description	Annual Cost	Percent of Total
Power	$114,000	20%
Labor	$79,000	14%
Resin Purchase and Disposal	$330,000	58%
Water Testing	$33,000	6%
Reports/Compliance	$7,000	1% or less
Permits/Renewals	$1,500	1% or less
Materials and Supplies (non-resin)	$6,000	1% or less
Automation/Telemetry	$700	1% or less
Repairs/Replacement	$6,800	1% or less
Contractor Labor	$78,000	14%
Engineering/Legal Costs	$1,200	1% or less
Insurance	$11,000	2%
Taxes	$11,000	2%

^ Costs averaged over 27 months of operation

Table 3-4 lists total O&M costs for the 5,000 gpm system discussed above (Cal Domestic, Figure 3-5) and the seven additional PWSs plotted in Figure 2-2. Several trends in the data warrant further discussion. The higher O&M costs per 1,000 gallons of water treated for the smaller systems (< 1,000 gpm) reflect economies of scale (e.g., a minimum level of staff hours are required despite system size). Additionally, several of the queried small water systems have entered into lease agreements with vendors of the single pass ion exchange systems. O&M costs for these systems tend to be higher due to the type of contract and service fees to the vendors for oversight and maintenance of the systems.

Table 3-4. Reported O&M Costs for Single Pass Ion Exchange Systems in Southern California^

PWS Name	Capacity (gpm)	Select Water Quality		Costs per 1,000 Gallons	
		Perchlorate (μg/L)	Nitrate (mg/L NO_3-N)	Resin Costs	Total O&M Costs
City of Morgan Hill	400	4 – 6	6.1	$ 0.37	$ 0.63
California Water Service Company – East Los Angeles System	750	N/a	N/a	N/a	$ 0.77
Valencia Water Company	1,100	N/a	N/a	$ 0.15*	$ 0.37
East Valley Water District	1,300	N/a	N/a	N/a	$ 0.44
La Puente Valley County Water District	2,500	40	5.6	$ 0.15	$ 0.50
California Domestic Water Company	5,000	9	6.9	$ 0.15	$ 0.28
San Gabriel Valley Water Company, B6 Plant	7,800	23	7.3	$ 0.16	$ 0.31
Valley County Water District	7,800	12	13.0	$ 0.22	$ 0.40

N/a – not available
^ Resin and total O&M costs listed for La Puente, San Gabriel B6, and Valley County are based on screening level cost estimates prepared in a previous study (MP, 2008).
* Resin costs were assumed based on average costs for similar systems.

The difference in estimated O&M costs for the two 7,800 gpm treatment systems ($0.31 and $0.40 per 1,000 gallons) reflects the differences in water quality between the two facilities. Nitrate concentrations in the source water for the Valley County Water District (Valley County) ranges between 11 and 13 mg/L NO_3–N (mg/L as nitrogen) compared with an average nitrate concentration of 7.3 mg/L NO_3–N for the San Gabriel Valley Water Company (San Gabriel) B6 plant. Despite higher selectivity of the perchlorate-selective resins for perchlorate removal, nitrate in the water can significantly reduce resin capacity due to orders of magnitude higher concentrations of nitrate than perchlorate (mg/L of nitrate as opposed to μg/L of perchlorate). The higher estimated operating cost ($0.40/1,000 gallons) at Valley County (compared to $0.31/1,000 gallons at San Gabriel's B6 plant) reflects the impact of nitrate co-occurrence on resin and total O&M costs. These factors known to influence O&M costs were inherently included in the nation-wide compliance cost estimates since the O&M cost curve (Figure 2-2) was developed using cost data for PWSs covering a range of different operations agreements (e.g., leasing versus operation by utility staff) and water quality.

Figure 3-6 shows the nationwide costs to operate single pass ion exchange treatment systems for perchlorate treatment for 20 years at a 3% discount rate. The costs shown are based on the 90th percentile perchlorate concentrations. Capital costs are also included in the graph as a reference point. As the data shows, O&M costs account for a larger portion of the total net present value (NPV) costs to treat for perchlorate than the capital costs. Similar to liquid-phase granular active carbon (GAC), the cost to operate single pass ion exchange is high relative to the capital costs since a significant component of the system must be replaced on a continual basis (i.e., the resin). O&M costs also continue in perpetuity.

Although the development of perchlorate-selective resins with high capacities for perchlorate removal (e.g., 175,000 to 280,000 bed volumes depending on water quality; MP, 2008) has made single pass ion exchange systems economically competitive with other available perchlorate treatment technologies, resin replacement costs are still a major component of the total costs to operate single pass ion exchange systems.

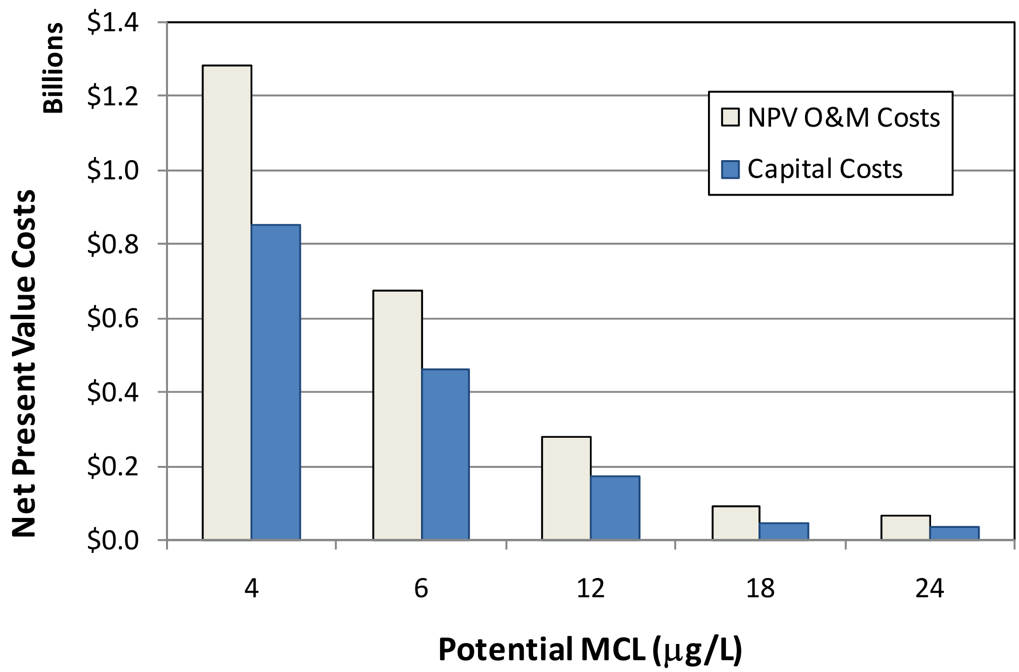

Figure 3-6. Total Estimated Net Present Value (NPV) O&M and Capital Costs to Treat for Perchlorate at Various Potential MCLs – based on 90th percentile perchlorate concentrations, installation of single pass ion exchange treatment systems, and 20 years of operation at a 3% discount rate

3.2.3. Total Costs

The total cost of compliance for an MCL of 4 μg/L is estimated to be $2.1 billion dollars ($0.85 billion in capital and $1.28 billion total NPV in operating costs) based on the 90th percentile perchlorate concentrations and operation of the systems for 20 years at a 3% discount rate (Table 3-5). In comparison, the estimated compliance cost for an MCL of 24 μg/L is much lower at approximately $0.1 billion or 4% of the cost at the most stringent MCL evaluated (4 μg/L). The significantly lower cost for the higher perchlorate concentration reflects the small number of PWSs that would be affected at that regulatory level (Figure 3-3).

Table 3-5. Estimated Cost to Treat All Sources Contaminated with Perchlorate Using Single Pass Ion Exchange*

Potential MCL (μg/L)	Capital Costs ($ Millions)	Annualized Capital costs ($ Millions/yr)	Annual O&M ($ Millions/yr)	Total O&M (NPV) ($ Millions)	Total Annualized Cost ($ Millions/yr)	Total NPV ($ Millions)
4	$ 851	$ 57	$ 86	$ 1,285	$ 143	$ 2,136
6	$ 464	$ 31	$ 45	$ 674	$ 76	$ 1,137
12	$ 174	$ 12	$ 19	$ 277	$ 30	$ 452
18	$ 47	$ 3	$ 6	$ 91	$ 9	$ 138
24	$ 34	$ 2	$ 4	$ 65	$ 7	$ 99

* Assuming a 3% interest rate, 20 years life of service, and perchlorate occurrence based on 90th percentile concentrations for a given source.

Capital and O&M costs to remove perchlorate from contaminated sources for large PWSs account for a greater percent of the nationwide compliance costs associated with each potential perchlorate MCL (Figure 3-7). The higher portion of costs for large PWS compliance is attributed to several factors: (1) the higher percentage of large PWSs with perchlorate contamination (Table 3-2); (2) the higher capital costs for a given system to meet the higher design flow; and, (3) higher operating costs associated with the greater quantity of water requiring treatment for a given system.

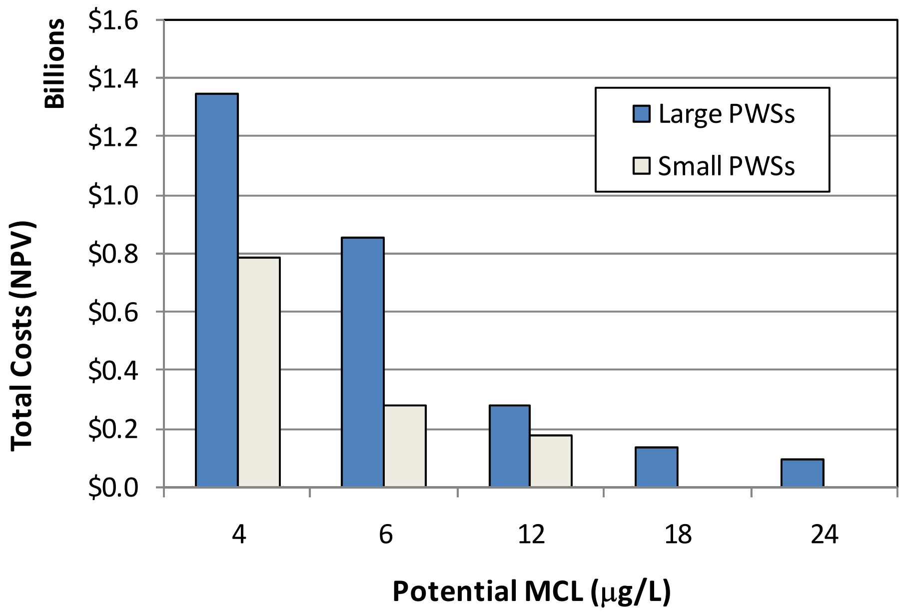

Figure 3-7. Total Estimated Compliance Costs for Large and Small PWSs – based on 90th percentile perchlorate concentrations, installation of single pass ion exchange treatment systems, and 20 years of operation at a 3% discount rate

Estimated compliance costs for small systems are negligible at the higher potential MCLs (18 and 24 μg/L). None of the 800 small PWSs sampled under UCMR exhibited 90th percentile or median perchlorate concentrations above 18 or 24 μg/L in any of their source waters. It is likely that several PWSs would be identified with perchlorate concentrations exceeding 18 μg/L in one of their source waters if all 66,826 small CWSs and NTNCWSs were sampled. However, based on the percent perchlorate occurrence in the small PWSs sampled under UCMR and the lower relative costs to treat the smaller systems, any additional costs attributed to small PWSs with perchlorate detections above 18 μg/L would not be expected to significantly affect the total nationwide costs of compliance.

Figure 3-8 illustrates total compliance costs (capital plus NPV O&M) under the range of parameters investigated – 90th percentile and median values for perchlorate concentrations at a given source, 3% and 7% discount rates. The compliance costs shown for a given perchlorate MCL cover the range of expected values depending on variations in perchlorate occurrence and fluctuations in interest rates over the next 20 years. Other factors discussed in Section 4 could also affect the compliance costs; however, based on the information available and to our best engineering knowledge, the calculated costs are expected to be accurate within an order of magnitude. A breakdown of the capital and O&M costs associated with each range of parameters is tabulated in Appendix D.

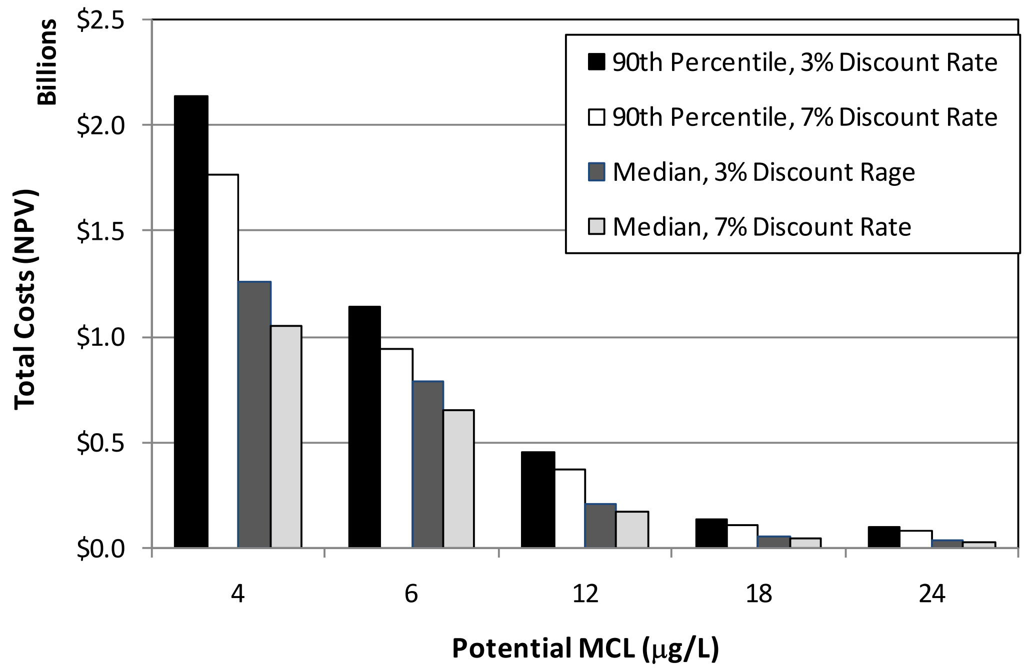

Figure 3-8. Total Estimated Compliance Costs for Various Parameters Investigated – based on installation of single pass ion exchange treatment systems operated for 20 years

4. Discussion

As with any attempt to assess the national costs associated with a potential drinking water regulation, the accuracy of the cost estimate is dependent on the information available to develop those costs (e.g., contaminant occurrence data, PWS size and type, capital and O&M costs for a given treatment process, etc.). Inevitably, assumptions must be made due to the magnitude of the studies (i.e., contaminated sources cannot be evaluated on a case-by-case basis) and the likely absence of data required for precise evaluation of costs. The following paragraphs discuss these limitations and the potential ramifications they have on the accuracy of the compliance costs cited in the previous Section.

4.1. Limitations in Data Sources

A number of limitations in the UCMR data were identified during the assessment of perchlorate occurrence:

- The UCMR sampling effort was collected when the analytical limit for perchlorate was 4 μg/L.[3] All samples with perchlorate concentrations below 4 μg/L are therefore reported as non-detect in the UCMR database. All non-detect samples were assigned zero values in order to analyze the data. Therefore, any samples with perchlorate concentrations less than 4 μg/L (but above 0 μg/L) are misrepresented due to the analytical limitations. However, the low concentrations should not have significantly affected the calculated 90th percentile and median values for a given source.

  If EPA sets the perchlorate MCL below 4 μg/L, this limitation in the UCMR data could significantly impact calculation of the national compliance costs. However, at the potential perchlorate regulatory levels evaluated for this study, the calculated compliance costs are not expected to be significantly affected by this limitation in the UCMR data.

- Only 800 small PWSs (CWSs and NTNCWSs serving less than 10,000 people) were sampled. The compliance costs were scaled up to account for the limited sample set. While USEPA and the State regulatory agencies carefully selected the 800 small PWSs to provide a representative distribution of samples, only approximate costs can be determined in the absence of a full data set. The 800 PWSs sampled account for less than 2% of the total number of CWSs and

[3] Recently, the sensitivity of analytical instruments and resulting perchlorate measurements using EPA Method 314 have improved. However, CDPH and EPA still recognize a 4 ug/L detection limit for reporting (DLR).

NTNCWSs throughout the United States. Nevertheless, the greater importance of large than small PWSs (Table 3-2) is promising from the standpoint of estimating realistic compliance costs since the data set for large PWSs is more complete.

- All systems using surface water for a portion of their water are classified as "surface water" systems in the UCMR database. The US EPA SDWIS database also characterizes systems under any influence of surface water as "surface water" systems. A number of the contaminated water sources identified from a review of the UCMR database are classified as surface water, but are actually groundwater. Since the design and average flow rates for each contaminated source water were calculated using the US EPA (2005) regression equations for surface and ground water systems, any discrepancies in the source water classification may have resulted in slight inaccuracies in the estimated flow rates. However, for this order of magnitude cost evaluation, the effect of this limitation is expected to be relatively small.

- Perchlorate was not detected during UCMR sampling for several PWSs known to be contaminated with perchlorate. For example, one well operated by the California Domestic Water Company is known to be contaminated with perchlorate. Since perchlorate treatment is already installed at this site and the costs to operate the perchlorate treatment system are covered primarily by the PRPs, the actual impact on nationwide costs to treat water from this well is negligible. However, the omission in the UCMR database suggests potential limitations in the database.

  A comparison of contaminated source waters in California identified through the UCMR sampling effort and statewide sampling further reveals potential omissions in the UCMR database. Approximately twice as many of the source waters detected during state-wide sampling in California do not appear in the list of contaminated sources from the UCMR database. Several factors may be attributed to the discrepancy between the state and nationwide datasets. First, some (or all) of the contaminated sources in the California data set that are not in the UCMR list may be small PWSs that were not included in the UCMR sampling effort. Second, the California data set includes some samples for which perchlorate concentrations below 4 μg/L were reported. These perchlorate detections would not have appeared in the UCMR database. Third, the California data set (1997 – 2003) includes samples collected prior to the UCMR sampling effort (2001 – 2003). Although unlikely, it is possible that source waters sampled prior to the UCMR sampling effort were remediated, reducing concentrations below 4 μg/L before samples were collected for analysis under UCMR. It is also possible that some wells were taken out of service.

Assuming the number of contaminated water sources detected during UCMR sampling is off by 50% (i.e., the discrepancy observed in the California data is consistent nationwide), then the estimated compliance costs (Table 3-3) should be increased by a factor of two. Although more accurate costs are desirable, this analysis of the UCMR data limitation still suggests that the costs are accurate within an order of magnitude.

4.2. Limitations in Assumptions and Approach

Limitations in the approach used and assumptions made to estimate the national compliance costs could also result in inaccuracies in the cited costs. The approach and assumptions were developed using best engineering judgment; however, two limitations in the scope warrant further discussion.

Monitoring Costs. Source water monitoring costs associated with a federal regulatory determination were not included in the cost evaluation. If USEPA establishes an MCL for perchlorate, the regulation will most certainly require that PWSs conduct an initial round of monitoring to determine if their source waters are contaminated. Subsequently, PWSs may be required to monitor on an annual or triennial basis. For example, the Arsenic Rule required that surface water systems monitor annually for arsenic contamination; ground water systems are required to collect triennial samples. CDPH estimated monitoring costs associated with their determination to regulate perchlorate at a 6 μg/L MCL (CDPH, 2007). The estimated annual monitoring costs were 2% of the total annualized treatment costs (capital and O&M). Assuming a similar proportioning of monitoring to treatment costs at a national level, the omission of monitoring costs in this study is not expected to significantly affect the accuracy of the calculated compliance costs.

Effect of Nitrate on Perchlorate Treatment Costs. The presence of nitrate is known to substantially impact resin capacity. The effect of higher source water nitrate concentrations and anion loading on O&M costs were inherently considered via the distribution of water qualities for the systems considered in the cost analysis. However, depending on the nationwide co-occurrence of nitrate with perchlorate, the operating costs for perchlorate treatment may be underestimated in this study. Kimbrough and Parekh (2007) observed a weak, but statistically significant, correlation between perchlorate and nitrate occurrence in California water sources. To more accurately account for the effect of nitrate co-occurrence on perchlorate treatment costs, it may be beneficial in subsequent studies to evaluate the distribution of nitrate contamination in the United States. The nationwide distribution of nitrate in surface and ground water could then be used to make reasonable assumptions on nitrate concentrations in source waters contaminated with perchlorate. The effect of nitrate on resin capacity and associated annual operating costs could then be incorporated in the compliance costs by assuming a distribution of resin costs (or total operating costs) based on the expected distribution of nitrate concentrations across nationwide PWSs.

4.3. Ground Truthing

Several parameters with significant importance in the determination of compliance costs were evaluated for accuracy via an assessment of those parameters for a subset of PWSs for which reasonable information was available. Specifically, values for the following parameters were checked for accuracy for a subset of the contaminated PWSs or contaminated source waters:

- number of sources for a given PWS,
- population size for a given PWS,
- estimated design and average flow rate for a given contaminated source water, and
- estimated perchlorate concentration for all contaminated sources with design flow rates greater than 10,000 gpm.

The estimated number of source waters for several of the PWSs with perchlorate detections were in the hundreds, whereas the nationwide median number of entry points per ground water system ranges from 1 to 9 depending on systems size (US EPA, 1999). The majority of surface water systems report only one or two entry points PWS. Based on the number of different sampling points incorporated in the UCMR database for the City of Tucson, that water utility has over 148 different water sources. Suffolk County Water Authority was estimated to have 502 different water sources/entry points and the Coachella Valley Water District was estimated to have 89 different water sources. Based on previous experience with these PWSs, all three serve groundwater from at least as many wells as indicated based on the review of the UCMR data. The number of source waters estimated to serve the remaining 157 affected PWSs were within range of expected values. Further, at lower estimated numbers of source waters for a given PWS, a slight discrepancy in the number of sources would not significantly impact the calculated flow rate for each contaminated source for that utility.

Population data for each PWS was obtained from the US EPA SDWIS database. All population data obtained from SDWIS was checked to ensure the numbers fell within the range of expected values based on the cited PWS size in the UCMR database (i.e., the population for a large PWS should fall between 10,001 and 100,000 people). No discrepancies were found.

The estimated design and average flow rates were evaluated for a subset of PWSs for which flow rate data was available. For example, source waters for the California Water (Cal Water) Service Company Dominguez System were estimated to have a design flow of approximately 1,900 gpm and an average flow of 980 gpm. Cal Water has thirteen active wells with design flows ranging from 800 to 2,600 gpm. Average flow rates for the wells are lower, ranging from 290 to 2,110 and encompass the estimated average flow rate calculated for this cost study. Therefore, the estimated flow rates calculated from the USEPA regression equations (2005) relatively accurately predicted known flow rates for source waters for the Cal Water Dominguez water system. Similar assessments were conducted for other systems with known flow rates.

The PWSs for all contaminated sources with design flow rates greater than 10,000 gpm were contacted to inquire about the validity of the estimated perchlorate concentration. Detailed evaluation of these PWSs was conducted since the costs associated with treating large contaminated sources could significantly skew the national cost estimate. Table 4-1 lists the PWSs for which one or more contaminated sources were identified with a design flow rate greater than 10,000 gpm. All listed PWSs are classified as very large utilities that serve more than 100,000 people.

Table 4-1. PWSs with Contaminated Source Water with Design Flow Rates > 10,000 GPM

PWS Name	State	Water Type	Perchlorate Concentration (μg/L)*		Design Flow (gpm)	Average Flow (gpm)
			90th Percentile	Median		
City of Henderson	NV	SW	9.7	7.1	246,000	10,420
Montgomery Water Works (2 sources)	AL	N/a	7.7	0 - 4.3 (source dependent)	240,840	16,640
Suburban Water System – San Jose	CA	GW	5.8	0	135,000	28,350
Metropolitan WD of Southern California	CA	SW	2.9 – 6.5 (source dependent)	0 – 5.6 (source dependent)	N/a	N/a
City of Highpoint	NC	SW	4.1	0	90,490	19,180
Manatee Co. Utilities Operations Dept.	FL	N/a	21	0	253,260	52,420
City of Midland	TX	GW	7.9	7.9	100,390	10,610

SW – surface water; GW – groundwater; N/a – not available

* Based on sampling data from the UCMR database with the exception of the values listed for the City of Henderson. City of Henderson perchlorate concentrations are based on the 2006 Consumer Confidence Report.

The City of Henderson (Nevada) has perchlorate concentrations ranging from non-detect to 9.7 μg/L, and averaging 7.1 μg/L (concentrations listed in the 2006 Consumer Confidence Report, CCR).[4] The PWS treats surface water from Lake Mead through its 15 MGD plant to meet SWTR requirements; however, the water is not currently treated for perchlorate removal. Capital and O&M costs to treat water at the City of Henderson

[4] Confirmed by personal communication with Tim Kelley, Operations Superintendent.

was included in the national cost estimates for potential perchlorate MCLs of 4 and 6 μg/L. Based on the perchlorate data, the utility would need to reduce perchlorate concentrations at those regulatory levels if perchlorate concentrations in their source water remain at current levels. The CCR data was used rather than UCMR measurements to assign perchlorate concentrations for this site. Specifically, a maximum concentration of 9.7 μg/L is used in place of the 90^{th} percentile value. The 7.1 μg/L average concentration is used in place of the median value. The more current perchlorate measurements are expected to be more representative to current levels in the City of Henderson source water intake than the measurements collected in the early 2000s for the UCMR sampling effort.

The authors were unable to reach Montgomery Water Works. Therefore, the two contaminated sources identified from the UCMR database for this PWS were included in the estimated national compliance costs.

Suburban Water System has a well that contains perchlorate at concentrations between 9 and 10 μg/L in their San Jose system.[5] They blend water from this well with other source water to achieve perchlorate concentrations below the California MCL of 6 μg/L. This system is not included in the cost assessment; it is assumed that Suburban will continue the blending scenario regardless of the establishment of a national perchlorate MCL.

Metropolitan Water District of Southern California was not included in the cost assessment. Recently measured perchlorate concentrations in Colorado River Water are below 2 μg/L due to the success of upstream remediation efforts. The City of Yuma was also excluded from the cost assessment since it is also served by Colorado River water.

The detectable perchlorate concentration (13.8 μg/L) measured in one of eight samples collected at an entry point for the City of High Point, North Carolina was confirmed by the contract laboratory as a false positive.[6] Bill Frazier, a lab supervisor at the City of High Point, North Carolina, indicated that subsequent source water sampling conducted by the U.S. Geological Survey and the City also confirms the absence of perchlorate in their source water. Therefore, the City of High Point was not included in the cost assessment.

During UCMR sampling, one sample collected for the Manatee County Utilities Operations Department had a detectable concentration of perchlorate. However, the other three quarterly samples were collected by a different lab and were non-detect. Mark Simpson at the Manatee County Public Works Department believes that the positive hit is attributable to analytical errors. For all other UCMR sampling for their

[5] Based on communication with Kobe Cohen, Water Quality Specialist for Suburban Water Systems – San Jose.
[6] Based on communication with Bill Frazier, lab supervisor at the City of High Point, on May 19, 2008.

system, perchlorate concentrations were non-detect. Additionally, all subsequent sampling also indicated an absence of perchlorate in the water. Therefore, Manatee County was not included in the cost assessment.

The City of Midland, TX had perchlorate contamination in a 5 MGD well field that was used to provide water during peak summer demands. The well field was abandoned five years ago after the perchlorate contamination was discovered. The well field is mostly dry; prior to five years ago, they would inject water from a more distant groundwater source into the 5 MGD well field during the winter. The stored water in the 5 MGD well field would then be withdrawn to meet peak summer demands for the City of Midland. This system was not included in the cost assessment.

4.3.1 Comparison to Other Cost Studies

The total annualized national compliance costs shown in Figure 4-1 were compared to costs developed in two previous studies – Kennedy/Jenks (2004) and CDPH (2007). The two previous studies estimated total perchlorate treatment costs for utilities in California to respond to a state regulation. Based on the trends shown in Figure 3-1, the estimated national compliance costs should be approximately three times the calculated California costs, assuming that all three studies produced fairly accurate cost information.

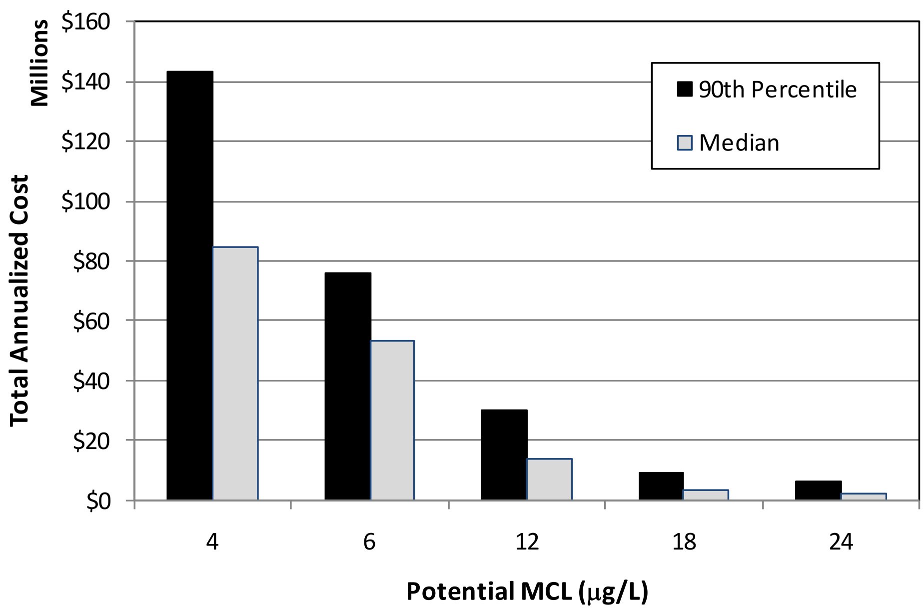

Figure 4-1. Total Estimated Annualized Costs Associated with Five Potential Perchlorate MCLs – based on installation of single pass ion exchange treatment systems (i.e., source abatement was not considered), 20 year life-of-service and 3% discount rate

Kennedy/Jenks (2004) estimated a total annual cost of $75 million (in 2004 dollars) to meet a 4 μg/L California MCL. The costs developed in this study indicate approximately twice that value for total national treatment costs, which is within an order of magnitude of expected results. For a 6 μg/L California MCL, Kennedy/Jenks (2004) and CDPH (2007) estimated $50 million and $24 million, respectively, in total annualized costs to treat perchlorate. The estimated national treatment costs (Figure 4-1) are approximately three times the CDPH calculated cost for California treatment, as expected. The resin replacement costs included in the Kennedy/Jenks (2004) study are higher than current market values, potentially accounting for the slightly higher estimates in the Kennedy/Jenks study as compared to the CDPH (2007) report and expected California costs based on the study presented herein.

5. Conclusions

In this study, the extent of perchlorate occurrence in large and small PWSs throughout the United States was assessed via a review of the UCMR database and previously published reports (Brandhuber and Clark, 2005; Kimbrough and Parekh, 2007; Gullick et al., 2000). The perchlorate occurrence data was then used to estimate national costs to treat contaminated water sources to meet five potential regulatory levels. The following conclusions can be made from the evaluation:

- Only 4.1% of all PWSs sampled under the UCMR had detectable levels of perchlorate in one or more of their source waters/entry points. Further, measured perchlorate concentrations at most locations were relatively low (12 μg/L or less).
- Only 3.4% of PWSs would be affected by a perchlorate MCL of 4 μg/L; less than 1% of PWSs would be required to treat their water at an MCL of 24 μg/L.
- While perchlorate contamination has been detected in source waters in 26 different states, one third of the PWSs affected are located in California. Most of the affected PWSs in California are already required to treat to remove perchlorate to meet the 6 μg/L MCL for the State of California.
- Most PWSs required to treat for perchlorate are expected to install single pass ion exchange systems given the simplicity and relatively low costs and based on current trends in Southern California. The advent of perchlorate-selective resins has made single pass ion exchange an economically competitive treatment option for perchlorate removal.
- Compared to other regulatory determinations, cost implications of a perchlorate MCL are relatively low due to the limited occurrence in source waters throughout the U.S. At an MCL of 4 μg/L, total compliance costs are estimated to be $2.1 billion.[7] The estimated nationwide compliance cost drops to approximately $0.1 billion at an MCL of 24 μg/L due to the small number of PWSs contaminated with perchlorate at that level. However, a small number of systems are carrying this cost burden and the cost impacts to an individual system installing perchlorate treatment would likely be significant.
- Costs to treat large PWSs account for the majority of the estimated nationwide compliance costs due to the higher percentage of large PWSs with perchlorate contamination (Table 3-2) and the higher capital and O&M costs to treat the greater quantity of water requiring treatment for a large system.
- Capital costs for single pass ion exchange are relatively low due to the simplicity of the treatment system. Capital costs to install single pass ion exchange systems

[7] Capital plus total operating costs (NPV) based on 20 years life of service at a 3% discount rate.

for all PWSs with perchlorate concentrations exceeding 4 μg/L are estimated to be $0.8 billion. Costs to operate the treatment systems for 20 years account for a larger percent of the total costs at $1.2 billion (NPV). A significant portion of the O&M costs for single pass ion exchange systems is the cost to periodically replace the spent resin.

- The presence of nitrate is known to substantially affect resin capacity and thus O&M costs. The effect of nitrate co-occurrence on costs was implicitly included in the cost evaluation by basing the O&M cost equation on known full-scale operating costs for systems with a range of water quality characteristics (i.e., nitrate concentrations ranging from 5 to 13 mg/L as nitrogen. Nevertheless, it may be beneficial in subsequent studies to consider the distribution of nitrate co-occurrence in the United States and then make reasonable assumptions of treatment process selection for the impacted utilities and the associated treatment costs.

6. References

California Department of Public Health (CDPH, 2007) "Final Statement of Reasons Perchlorate Primary Maximum Contaminant Level (MCL)," R-16-04, July 25, 2007.

Brandhuber, P.; Clark, S. (2005) "Perchlorate Occurrence Mapping," Project report submitted to AWWA from HDR, Inc. January 2005.

Brandhuber, P. (2008) email attachments provided to Kevin Morley of AWWA from Phil Brandhuber of HDR, Inc. on March 11, 2008.

Brandhuber, P.; Clark, S.; Morley, K. (2008) "The Occurrence of Perchlorate in Public Drinking Water Systems," Submitted for publication in the *Jour. Am. Water Works Assoc.*

Grumbles, Benjamin H. (2008). Testimony before the Environment and Public Works Committee, United States Senate, May 6, 2008. http://www.epa.gov/ow/speeches/2008-05-06.pdf

Gullick, R.W.; LeChevallier, M.W.; Barhorst, T.S. (2001) "Occurrence of Perchlorate in Drinking Water Sources," *Jour. Am. Water Works. Assoc.*, 93:1:66.

Kennedy/Jenks Consultants (2004) "Cost of Compliance for Three Potential Perchlorate MCLs," Report prepared for Kahl/Pownall Advocates, June 2004.

Kimbrough, D.E.; Parekh, P. (2007) "Occurrence and Co-Occurrence of Perchlorate and Nitrate in California Drinking Water Sources," *Jour. Am. Water Works. Assoc.*, 99:9:127.

Malcolm Pirnie, Inc. (MP, 2006) "Perchlorate Removal Using Single-Pass Ion Exchange Resins at California Domestic Water Company," Final report submitted to Jim Byerrum at the California Domestic Water Company, August 22, 2006.

MP (2007) "Evaluation of Brine Treatment Technologies and Perchlorate Control Options without Brine Production," Final report submitted to the Main San Gabriel Basin Watermaster, March 2007.

MP (2008) "Single Pass Ion Exchange Resin Testing at the La Puente, San Gabriel B6, and Valley County Perchlorate Treatment Plants," Final report submitted to the Main San Gabriel Basin Watermaster, January 2008.

Murray. C.W., et al, 2008. US Food and Drug Administration's Total Diet Study: Dietary intake of perchlorate and iodine. *Journal of Exposure Science and Environmental Epidemiology*, 1-10.

National Resarch Council (2005). Health Implications of Perchlorate Ingestion. National Academies Press.

Raucher, R.S.; Castillo, E.T.; Dixon, A.; Breffle, W.; Waldman, D.; Drago, J.A. (1995) "Estimating the Cost of Compliance with Drinking Water Standards: A User's Guide," Denver, Colorado: AWWA Research Foundation and AWWA.

Rajagopalan et al. 2006. "Widespread Presence of Naturally Occurring Perchlorate in High Plains of Texas and New Mexico. *Envir. Sci. Technol.*, 40:10:3157.

Rao et al. 2007. "Widespread Natural Perchlorate in Unsaturated Zones of the Southwest United States," *Envir. Sci. Technol.*, 41:13:4522.

USEPA (1998). Announcement of the Drinking Water Contaminant Candidate List. Notice. *Fed. Reg.*, 63:40:10274.

USEPA (1999) "Geometries and Characteristics of Public Water Systems," prepared for Office of Ground Water and Drinking Water by Science Applications International Corporation. EPA Contract No. 69-C60059.

USEPA (2000) "Technologies and Costs for Removal of Arsenic from Drinking Water," Office of Water, EPA 815-R-00-028, December 2000.

USEPA, 2001a. Arsenic and Clarifications to Compliance and New Source Contaminants Monitoring. Final Rule. *Fed. Reg.*, 66:14:6978.

USEPA (2001b) "Unregulated Contaminant Monitoring Regulation: Monitoring for List 1 Contaminants by Large Public Water Systems," Office of Water, EPA 815-F-01-003, January 2001.

USEPA (2001c) "Unregulated Contaminant Monitoring Regulation: Monitoring for List 1 Contaminants by Selected Small Public Water Systems," Office of Water, EPA 815-F-01-004, January 2001.

USEPA (2001d) "Statistical Design and Sample Collection for the Unregulated Contaminant Monitoring Regulation (1999)," Office of Water, EPA 815-R-01-004, August 2001.

US EPA (2003) "Known Perchlorate Releases in the U.S. as of July 24, 2003," http://www.epa.gov/swerffrr/pdf/knwn_percholrate_releases_9_23_2004.pdf

USEPA, 2005a. Drinking Water Contaminant Candidate List 2. Final Notice. *Fed. Reg.*, 70:36:9071.

USEPA, 2005b. Integrated Risk Information System (IRIS). 2005. 1007 - Perchlorate (ClO_4^-) and Perchlorate Salts. http://www.epa.gov/iris/subst/1007.htm.

US EPA (2005c) "Economic Analysis for the Final Stage 2 Disinfectants and Disinfection By-Products Rule," Office of Water, EPA 815-R-05-010, December 2005.

U.S. EPA (2007) Draft Regulatory Determinations Support Document for Primary Contaminants on the Drinking Water Contaminant Candidate List, EPA 815-D-06-007.

USEPA (2008a). Drinking Water Contaminant Candidate List 3-Draft. Notice. *Fed. Reg.*, 73:35:9628.

US EPA (2008b) "Factoids: Drinking Water and Ground Water Statistics for 2007," Office of Water, EPA 816-K-07-004, March 2008.

Appendix A

Source Waters and PWSs with Perchlorate Detections

Utility name	Specific ID	90th percentile	Median	Size	State	System type	Gw_Sw	Sample Type	Owner	Sample Date
AMBLER BORO WATER DEPT	PA1460020-00103-00103E	6.0	0.0	Large	PA	CWS	gw	EP	Local_Govt	11/25/2003
AMBLER BORO WATER DEPT	PA1460020-00108-00108E	4.0	0.0	Large	PA	CWS	gw	EP	Local_Govt	11/26/2003
ATLANTIC BEACH WATER SYSTEM	FL2160200-09001-02A	180.0	100.0	Large	FL	CWS	gw	SR	Local_Govt	8/26/2002
ATMORE UTILITY BOARD	AL0000553-00016-0553006	8.9	8.7	Large	AL	CWS	gw	EP	Local_Govt	1/10/2002
AVON PARK, CITY OF	FL6280049-08002-WP #2	12.6	7.0	Large	FL	CWS	gw	EP	Local_Govt	12/19/2001
AVON PARK, CITY OF	FL6280049-08001-WP #1	14.4	8.0	Large	FL	CWS	gw	EP	Local_Govt	12/19/2001
AZUSA LIGHT AND WATER	CA1910007-00500-03K04	10.9	10.5	VL	CA	CWS	sw	EP	Local_Govt	12/26/2001
Bakersfield, City of	CA1510031-00026-29S/27E-26B01	1.5	0.0	VL	CA	CWS	gw	EP	Local_Govt	5/13/2001
BEREA CITY PWS	OH1800111-00002-EP001	3.4	0.0	Large	OH	CWS	sw	EP	Private	1/14/2002
BETHPAGE WD	NY2902817-34014-SRN8768	4.2	4.2	Large	NY	CWS	gw	EP	Local_Govt	6/26/2001
BETHPAGE WD	NY2902817-34015-SRN8767	4.4	4.4	Large	NY	CWS	gw	EP	Local_Govt	6/26/2001
BETHPAGE WD	NY2902817-34010-SRN3876	4.5	2.5	Large	NY	CWS	gw	EP	Local_Govt	11/15/2001
BIXBY PUBLIC WORKS AUTHORITY	OK1020406-10880-UCM0001	6.6	0.0	Large	OK	CWS	sw	EP	Local_Govt	12/11/2003
Brawley, City of	CA1310001-00950-00760	4.9	2.1	Large	CA	CWS	sw	EP	Local_Govt	3/4/2002
CALIF STATE POLYTECHNICAL UNIV - POMONA	CA1910022-00005-01S/09W-26C02	4.9	4.9	Large	CA	CWS	sw	SR	State_Govt	4/6/2004
CALIF STATE POLYTECHNICAL UNIV - POMONA	CA1910022-00002-01S/09W-27Q03	6.0	5.1	Large	CA	CWS	sw	SR	State_Govt	7/29/2003
California Water Service - Stockton	CA3910001-00013-02N/06E-36A01	3.4	0.0	VL	CA	CWS	sw	EP	Private	2/18/2004
CALIFORNIA WATER SERVICE CO. - DOMINGUEZ	CA1910033-00024-04S/13W-15F01	5.5	0.0	VL	CA	CWS	sw	EP	Private	4/10/2002
CALIFORNIA WATER SERVICE CO. - ELA	CA1910036-00004-02S/12W-07Q04	7.6	7.2	VL	CA	CWS	sw	EP	Private	7/17/2001
Carmichael Water District	CA3410004-00001-09N/06E-10M01	2.5	0.0	Large	CA	CWS	sw	SR	Local_Govt	7/23/2003
CASSATT WATER CO #1	SC2820005-00107T-0028108	4.5	4.5	Large	SC	CWS	sw	EP	Private	2/3/2003
CHAPARRAL CITY WATER CO	AZ0407017-01823-001	3.9	0.0	Large	AZ	CWS	sw	EP	Private	1/14/2003
CHAPARRAL CITY WATER CO	AZ0407017-01822-005	4.0	0.0	Large	AZ	CWS	sw	EP	Private	1/14/2003
CHAPEL HILL	MD0120002-00001-0100000	13.9	0.0	Large	MD	CWS	sw	EP	Local_Govt	12/11/2001
CITY OF ABERDEEN	MD0120001-00001-0100000	15.4	0.0	Large	MD	CWS	sw	EP	Local_Govt	12/11/2001
City of Anaheim	CA3010001-00033-04S/10W-20M01	2.9	0.0	VL	CA	CWS	sw	EP	Local_Govt	5/14/2001
City of Anaheim	CA3010001-00055-H30/001-TREAT	4.5	4.3	VL	CA	CWS	sw	EP	Local_Govt	2/4/2002
City of Anaheim	CA3010001-00032-04S/11W-14K01	5.2	5.0	VL	CA	CWS	sw	EP	Local_Govt	6/23/2003
CITY OF CHINO	CA3610012-00016-R4	3.6	2.0	VL	CA	CWS	sw	EP	Local_Govt	9/14/2004
CITY OF CHINO	CA3610012-00005-02S/08W-11M01	5.8	0.0	VL	CA	CWS	sw	EP	Local_Govt	9/14/2004
CITY OF CHINO	CA3610012-00015-R3	6.1	3.4	VL	CA	CWS	sw	EP	Local_Govt	9/14/2004
CITY OF CHINO	CA3610012-00004-01S/08W-35J01	8.7	7.8	VL	CA	CWS	sw	SR	Local_Govt	7/8/2003
CITY OF CHINO	CA3610012-00013-01S/08W-26H02	11.7	10.3	VL	CA	CWS	sw	SR	Local_Govt	7/8/2003
CITY OF CHINO	CA3610012-00011-01S/08W-35C07	16.0	13.5	VL	CA	CWS	sw	SR	Local_Govt	7/8/2003
CITY OF CHINO	CA3610012-00008-01S/08W-35J03	17.4	14.0	VL	CA	CWS	sw	SR	Local_Govt	7/8/2003
CITY OF CHINO	CA3610012-00009-01S/08W-35C05	20.1	17.5	VL	CA	CWS	sw	SR	Local_Govt	7/8/2003
City of Chino Hills	CA3610036-00010-02S/08W-15C02	3.5	0.0	VL	CA	CWS	sw	EP	Local_Govt	2/10/2003
CITY OF COLTON	CA3610014-00010-01S/04W-18G01	4.5	0.0	Large	CA	CWS	gw	SR	Local_Govt	5/3/2004
CITY OF COLTON	CA3610014-00012-01S/04W-18F01	6.2	0.0	Large	CA	CWS	gw	SR	Local_Govt	5/3/2004
City of Garden Grove	CA3010062-00019-04S/10W-30E02	4.4	4.2	VL	CA	CWS	sw	EP	Local_Govt	6/24/2003
CITY OF HAGERSTOWN	MD0210010-00001-0100000	2.4	0.0	VL	MD	CWS	sw	EP	Local_Govt	8/21/2002
CITY OF KINGSVILLE	TX1370001-04006-04006	3.2	0.0	Large	TX	CWS	sw	EP	Local_Govt	12/4/2003
CITY OF KINGSVILLE	TX1370001-04005-04005	4.1	2.3	Large	TX	CWS	sw	EP	Local_Govt	12/4/2003
CITY OF LEVELLAND	TX1100002-04003-04003	28.8	16.0	Large	TX	CWS	sw	EP	Local_Govt	10/9/2002
CITY OF LOMA LINDA	CA3610013-00009-01S/04W-24C01	4.5	2.5	Large	CA	CWS	gw	SR	Local_Govt	7/22/2003
CITY OF MIDLAND	TX1650001-04002-04002	7.9	7.9	VL	TX	CWS	sw	EP	Local_Govt	2/13/2002
City of Santa Ana	CA3010038-00019-05S/10W-01E02	4.0	2.2	VL	CA	CWS	sw	SR	Local_Govt	6/25/2003
City of South Pasadena	CA1910154-00950-G19/154-NTBLRV\	4.1	2.3	Large	CA	CWS	sw	EP	Local_Govt	11/15/2001
City of Stockton	CA3910012-00085-3910012-084	1.6	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/18/2005
City of Stockton	CA3910012-00038-02N/06E-10J03	3.0	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/17/2005
City of Stockton	CA3910012-00039-02N/06E-15A01	3.0	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/17/2005

Utility name	Specific ID	90th percentile	Median	Size	State	System type	Gw_Sw	Sample Type	Owner	Sample Date
City of Stockton	CA3910012-00027-02N/06E-16B01	2.8	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/24/2005
City of Stockton	CA3910012-00083-J39/012-SSS3	2.8	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/4/2005
City of Stockton	CA3910012-00030-02N/06E-20M02	3.6	0.0	VL	CA	CWS	sw	SR	Local_Govt	12/12/2001
City of Stockton	CA3910012-00029-02N/06E-09J01	4.0	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/11/2005
City of Stockton	CA3910012-00043-02N/06E-11H03	4.9	0.0	VL	CA	CWS	sw	SR	Local_Govt	11/17/2004
City of Stockton	CA3910012-00004-01N/07E-31F01	6.0	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/4/2005
City of Stockton	CA3910012-00005-01N/07E-31C01	6.0	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/4/2005
City of Stockton	CA3910012-00040-02N/06E-15B01	6.6	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/17/2005
City of Stockton	CA3910012-00033-02N/06E-15F01	8.0	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/18/2005
City of Stockton	CA3910012-00003-01N/07E-29A02	9.5	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/3/2005
City of Tustin	CA3010046-00002-05S/09W-09J02	3.8	0.0	VL	CA	CWS	sw	SR	Local_Govt	6/17/2003
City of Tustin	CA3010046-00022-3010046-022	6.3	5.4	VL	CA	CWS	sw	SR	Local_Govt	7/16/2003
City of Tustin	CA3010046-00009-05S/09W-10L01	8.8	8.1	VL	CA	CWS	sw	SR	Local_Govt	5/7/2003
CLIFFDALE WEST	NC0326332-00070-E22	3.6	2.0	Large	NC	CWS	gw	EP	Private	6/26/2002
CLIFFDALE WEST	NC0326332-00104-E35	5.3	4.5	Large	NC	CWS	gw	EP	Private	6/26/2002
CLIFFDALE WEST	NC0326332-00035-E09	5.5	5.0	Large	NC	CWS	gw	EP	Private	6/17/2002
CLIFFDALE WEST	NC0326332-00069-E21	6.2	6.0	Large	NC	CWS	gw	EP	Private	6/26/2002
CLIFFDALE WEST	NC0326332-00076-E28	7.2	6.7	Large	NC	CWS	gw	EP	Private	6/12/2002
CLIFFDALE WEST	NC0326332-00077-E29	7.9	7.3	Large	NC	CWS	gw	EP	Private	6/12/2002
CLIFFDALE WEST	NC0326332-00074-E26	8.4	7.4	Large	NC	CWS	gw	EP	Private	6/12/2002
CLINTON WATER DEPT	MA2064000-00011-24948	4.2	0.0	Large	MA	CWS	sw	EP	Local_Govt	10/22/2002
Coachella VWD: Cove Community	CA3310001-00147-06S/07E-16D02	5.3	3.0	VL	CA	CWS	gw	EP	Local_Govt	10/23/2001
COLUMBIA WATER CO	PA7360123-00101-00101E	8.5	0.0	Large	PA	CWS	sw	EP	Private	10/5/2001
COMMONWEALTH UTILITIES CORP. (SAIPAN)	MP0000001-90009-01055	7.7	6.3	Large	MP	CWS	sw	EP	State_Govt	10/9/2001
COMMONWEALTH UTILITIES CORP. (SAIPAN)	MP0000001-90049-01116	13.8	13.0	Large	MP	CWS	sw	EP	State_Govt	10/21/2001
Corona, City of	CA3310037-00019-N33/037-TREAT	1.9	0.0	VL	CA	CWS	sw	EP	Local_Govt	12/15/2003
Corona, City of	CA3310037-00025-03S/07W-25L02	3.7	0.0	VL	CA	CWS	sw	SR	Local_Govt	12/12/2002
Corona, City of	CA3310037-00009-03S/07W-25M02	4.2	4.2	VL	CA	CWS	sw	SR	Local_Govt	1/29/2002
Corona, City of	CA3310037-00043-3310037-043	4.2	2.0	VL	CA	CWS	sw	EP	Local_Govt	9/11/2003
Corona, City of	CA3310037-00008-03S/07W-25J01	5.1	4.4	VL	CA	CWS	sw	SR	Local_Govt	12/12/2002
Corona, City of	CA3310037-00033-3310037-033	5.3	4.7	VL	CA	CWS	sw	EP	Local_Govt	12/11/2003
Corona, City of	CA3310037-00021-03S/07W-25L01	5.3	4.8	VL	CA	CWS	sw	SR	Local_Govt	12/12/2002
Corona, City of	CA3310037-00030-3310037-030	6.8	6.5	VL	CA	CWS	sw	EP	Local_Govt	12/11/2003
Corona, City of	CA3310037-00031-3310037-031	6.9	6.4	VL	CA	CWS	sw	EP	Local_Govt	12/11/2003
Corona, City of	CA3310037-00012-03S/07W-27F01	7.1	6.7	VL	CA	CWS	sw	EP	Local_Govt	12/12/2002
Corona, City of	CA3310037-00032-3310037-032	7.5	6.0	VL	CA	CWS	sw	SR	Local_Govt	12/11/2003
Corona, City of	CA3310037-00015-03S/07W-26G01	8.7	5.9	VL	CA	CWS	sw	EP	Local_Govt	12/12/2002
Corona, City of	CA3310037-00027-03S/07W-25E02	9.1	7.9	VL	CA	CWS	sw	SR	Local_Govt	12/12/2002
Corona, City of	CA3310037-00024-03S/07W-26J03	10.3	7.7	VL	CA	CWS	sw	SR	Local_Govt	12/12/2002
Corona, City of	CA3310037-00011-03S/07W-27G01	10.4	7.8	VL	CA	CWS	sw	EP	Local_Govt	12/12/2002
Corona, City of	CA3310037-00014-03S/07W-35C01	10.5	8.4	VL	CA	CWS	sw	EP	Local_Govt	12/12/2002
Corona, City of	CA3310037-00007-03S/06W-31D01	11.0	11.0	VL	CA	CWS	sw	SR	Local_Govt	1/29/2002
Corona, City of	CA3310037-00006-03S/06W-31D02	12.0	12.0	VL	CA	CWS	sw	SR	Local_Govt	1/29/2002
Corona, City of	CA3310037-00013-03S/06W-31K01	12.9	12.5	VL	CA	CWS	sw	EP	Local_Govt	7/8/2003
CREEK CO RWD # 1	OK1020419-10204-1020419	11.9	0.0	Large	OK	CWS	sw	EP	Local_Govt	7/22/2003
CROSS COUNTY RURAL WATER SYS	AR0000459-00001-0459001	5.4	5.0	Large	AR	CWS	gw	EP	Public/Private	1/13/2003
CROSSVILLE WATER DEPT	TN0000150-00002T-000082B	6.3	0.0	Large	TN	CWS	sw	EP	Local_Govt	4/22/2002
Cucamonga Valley Water District	CA3610018-00031-01N/07W-33E01	2.4	0.0	VL	CA	CWS	sw	SR	Local_Govt	3/25/2002
Cucamonga Valley Water District	CA3610018-00007-01S/07W-04B03	2.5	0.0	VL	CA	CWS	sw	SR	Local_Govt	3/28/2002
Cucamonga Valley Water District	CA3610018-00039-036/018-004	3.2	0.0	VL	CA	CWS	sw	SR	Local_Govt	3/25/2002
Cucamonga Valley Water District	CA3610018-00038-036/018-001	3.7	0.0	VL	CA	CWS	sw	SR	Local_Govt	3/25/2002

Utility name	Specific ID	90th percentile	Median	Size	State	System type	Gw_Sw	Sample Type	Owner	Sample Date
Cucamonga Valley Water District	CA3610018-00037-036/018-005	5.8	5.2	VL	CA	CWS	sw	SR	Local_Govt	3/25/2002
Cucamonga Valley Water District	CA3610018-00041-3610018-041	5.9	4.2	VL	CA	CWS	sw	SR	Local_Govt	3/25/2002
Cucamonga Valley Water District	CA3610018-00027-01N/07W-27P02	6.8	4.0	VL	CA	CWS	sw	SR	Local_Govt	3/25/2002
Cucamonga Valley Water District	CA3610018-00030-01N/07W-33L01	7.0	6.0	VL	CA	CWS	sw	SR	Local_Govt	3/28/2002
Cucamonga Valley Water District	CA3610018-00002-01S/07W-14E01	8.3	6.1	VL	CA	CWS	sw	SR	Local_Govt	3/25/2002
CWSC Los Altos Suburban	CA4310001-00020-07S/02W-01E02	0.0	0.0	VL	CA	CWS	sw	EP	Private	2/18/2004
CWSC Salinas	CA2710010-00046-14S/03E-22E51	3.1	0.0	VL	CA	CWS	gw	EP	Private	2/25/2003
CWSC Salinas	CA2710010-00029-15S/03E-02G01	8.9	0.0	VL	CA	CWS	gw	EP	Private	6/25/2002
DAPHNE (UTILITIES BOARD OF THE CITY OF)	AL0000029-00007T-0029005	6.5	3.6	Large	AL	CWS	gw	EP	Local_Govt	12/11/2002
DARLINGTON COUNTY W&SA	SC1620001-00402-0016004	6.7	3.7	Large	SC	CWS	gw	EP	Local_Govt	11/27/2001
DEFIANCE WATER TREATMENT PLANT	OH2000111-00002-EP001	4.0	0.0	Large	OH	CWS	sw	EP	Private	1/8/2002
DEMING MUNICIPAL WATER SYSTEM	NM3528616-00003-003	19.2	16.0	Large	NM	CWS	gw	SR	Local_Govt	5/2/2003
Desert Water Agency	CA3310005-00029-03S/04E-35R01	2.9	0.0	VL	CA	CWS	sw	EP	Local_Govt	11/21/2003
Desert Water Agency	CA3310005-00019-03S/04E-30C01	3.0	0.0	VL	CA	CWS	sw	EP	Local_Govt	11/25/2003
Desert Water Agency	CA3310005-00032-03S/04E-34H01	4.3	2.0	VL	CA	CWS	sw	EP	Local_Govt	11/24/2003
Desert Water Agency	CA3310005-00024-04S/04E-02B01	5.3	2.1	VL	CA	CWS	sw	EP	Local_Govt	11/21/2003
Desert Water Agency	CA3310005-00039-03S/04E-34H02	5.5	4.1	VL	CA	CWS	sw	EP	Local_Govt	11/25/2003
Desert Water Agency	CA3310005-00013-03S/04E-36M01	5.8	5.6	VL	CA	CWS	sw	EP	Local_Govt	12/12/2001
Desert Water Agency	CA3310005-00023-03S/04E-34R01	6.4	5.8	VL	CA	CWS	sw	EP	Local_Govt	11/25/2003
EAST VALLEY WD	CA3610064-00017-01S/04W-02Q09	2.9	0.0	VL	CA	CWS	sw	EP	Local_Govt	11/6/2002
EAST VALLEY WD	CA3610064-00021-01N/04W-25C02	4.2	2.0	VL	CA	CWS	sw	EP	Local_Govt	11/15/2002
EAST VALLEY WD	CA3610064-00020-01N/04W-26A03	5.6	2.3	VL	CA	CWS	sw	EP	Local_Govt	11/6/2002
EAST VALLEY WD	CA3610064-00023-01S/04W-12B06	7.3	5.9	VL	CA	CWS	sw	EP	Local_Govt	11/15/2002
EAST VALLEY WD	CA3610064-00022-01N/04W-25A01	7.8	5.9	VL	CA	CWS	sw	EP	Local_Govt	11/6/2002
EAST VALLEY WD	CA3610064-00026-01N/03W-30N01	10.6	9.2	VL	CA	CWS	sw	EP	Local_Govt	7/25/2001
EAST VALLEY WD	CA3610064-00028-01N/04W-25C04	11.5	9.8	VL	CA	CWS	sw	EP	Local_Govt	11/27/2002
EAST VALLEY WD	CA3610064-00018-01S/04W-02Q08	15.1	12.5	VL	CA	CWS	sw	EP	Local_Govt	11/6/2002
Eastern Municipal WD	CA3310009-00047-3310009-047	4.7	2.6	VL	CA	CWS	sw	SR	Local_Govt	2/27/2002
Eastern Municipal WD	CA3310009-00042-03S/03W-06D04	6.8	3.8	VL	CA	CWS	sw	SR	Local_Govt	2/27/2002
ENID	OK2002412-11032-UCM0001	27.0	15.0	Large	OK	CWS	gw	EP	Local_Govt	1/14/2003
ENID #2	OK2002445-11038-UCM0002	9.3	5.2	Large	OK	CWS	gw	EP	Local_Govt	1/14/2003
ERIE CITY WATER AUTHORITY	PA6250028-00102-00102E	2.7	0.0	VL	PA	CWS	sw	EP	Local_Govt	11/18/2002
Escondido, City of	CA3710006-00019-N37/006-SDCWA	2.9	0.0	VL	CA	CWS	sw	SR	Local_Govt	11/13/2001
Escondido, City of	CA3710006-00018-N37/006-PLNTEFF	3.0	0.0	VL	CA	CWS	sw	EP	Local_Govt	11/13/2001
FAIRFIELD CITY PWS	OH0900715-00008-EP001	25.0	16.5	Large	OH	CWS	gw	EP	Private	11/12/2002
FAR WEST WATER CO	AZ0414004-00407-POE007	2.0	0.0	Large	AZ	CWS	sw	EP	Private	1/28/2003
FAYETTE COUNTY	GA1130001-03775-305	4.7	2.6	VL	GA	CWS	sw	EP	Local_Govt	5/20/2003
FIRGROVE MUTUAL INC	WA5325200-00014-SO14	3.6	2.0	Large	WA	CWS	sw	EP	Local_Govt	7/25/2002
FIRGROVE MUTUAL INC	WA5325200-00013-WELLHEAD	5.0	5.0	Large	WA	CWS	sw	EP	Local_Govt	3/7/2002
FIRGROVE MUTUAL INC	WA5325200-00003-WELLHEAD	4.8	0.0	Large	WA	CWS	sw	EP	Local_Govt	7/25/2002
FIRGROVE MUTUAL INC	WA5325200-00017-SO17	6.0	6.0	Large	WA	CWS	sw	EP	Local_Govt	3/7/2002
GARDEN CITY (V)	NY2902824-34060-SRN8339	3.8	2.1	Large	NY	CWS	gw	SR	Local_Govt	2/1/2002
GLEN COVE CITY	NY2902826-34074-SRN09334	3.6	2.0	Large	NY	CWS	gw	SR	Public/Private	6/12/2003
GLENDALE, CITY OF	AZ0407093-01834-002	3.2	0.0	VL	AZ	CWS	sw	EP	Local_Govt	8/15/2001
GLENDALE, CITY OF	AZ0407093-00155-040	4.6	4.6	VL	AZ	CWS	sw	EP	Local_Govt	3/27/2002
GLENDALE, CITY OF	AZ0407093-00158-043	4.4	2.5	VL	AZ	CWS	sw	EP	Local_Govt	3/13/2002
GLENDALE, CITY OF	AZ0407093-01833-001	5.4	2.0	VL	AZ	CWS	sw	EP	Local_Govt	8/15/2001
GOLDEN STATE WATER CO - BARSTOW	CA3610043-00025-10N/01W-31Q02	3.8	0.0	Large	CA	CWS	gw	SR	Private	10/22/2004
Golden State WC - West Orange	CA3010022-00024-04S/11W-25Q01	3.6	2.0	VL	CA	CWS	sw	EP	Private	6/9/2003
Golden State WC - West Orange	CA3010022-00025-04S/11W-24M02	3.9	2.2	VL	CA	CWS	sw	EP	Private	5/19/2003
Golden State WC - West Orange	CA3010022-00020-04S/11W-26R01	5.7	5.5	VL	CA	CWS	sw	EP	Private	6/25/2003

Utility name	Specific ID	90th percentile	Median	Size	State	System type	Gw_Sw	Sample Type	Owner	Sample Date
Golden State WC - West Orange	CA3010022-00022-04S/11W-23L03	6.1	5.5	VL	CA	CWS	sw	EP	Private	3/25/2003
Great Oaks WC, Inc.	CA4310022-00007-08S/01E-12D10	3.5	0.0	VL	CA	CWS	gw	EP	Private	8/20/2002
GREENLAWN WD	NY5103271-40759-SRS21134	5.5	5.1	Large	NY	CWS	gw	EP	Local_Govt	1/7/2002
HAMMONTON WATER DEPT	NJ0113001-00003-NJ0113001-01	3.6	2.0	Large	NJ	CWS	gw	EP	Local_Govt	9/5/2003
HECLA WATER ASSOCIATION-PLANT PWS	OH4401612-00006-EP001	29.1	16.2	Large	OH	CWS	gw	EP	Private	7/10/2002
Hemet, City of	CA3310016-00004-05S/01W-22D03	3.8	0.0	Large	CA	CWS	gw	SR	Local_Govt	7/21/2004
Hemet, City of	CA3310016-00012-05S/01W-11A01	6.0	5.9	Large	CA	CWS	gw	SR	Local_Govt	8/25/2004
Hemet, City of	CA3310016-00003-05S/01W-22D02	7.1	6.6	Large	CA	CWS	gw	SR	Local_Govt	3/17/2004
HENDERSON CITY OF	NV0000076-00206-EP04	20.0	11.3	VL	NV	CWS	sw	EP	Local_Govt	8/27/2003
HICKSVILLE WD	NY2902829-34106-SRN08778	4.1	2.3	Large	NY	CWS	gw	EP	Public/Private	12/11/2001
HICKSVILLE WD	NY2902829-34093-SRN03878	5.5	5.5	Large	NY	CWS	gw	EP	Public/Private	6/27/2001
HICKSVILLE WD	NY2902829-25282-EPN7561/9212	5.6	5.6	Large	NY	CWS	gw	EP	Public/Private	1/21/2003
HICKSVILLE WD	NY2902829-34099-SRN07561	5.7	3.2	Large	NY	CWS	gw	EP	Public/Private	12/5/2001
HICKSVILLE WD	NY2902829-22570-EPN03878	6.4	6.4	Large	NY	CWS	gw	EP	Public/Private	6/25/2002
HICKSVILLE WD	NY2902829-22571-EPN06190	7.7	7.7	Large	NY	CWS	gw	EP	Public/Private	6/25/2002
HIGH POINT, CITY OF	NC0241020-00005-001	4.1	0.0	VL	NC	CWS	sw	EP	Local_Govt	10/29/2002
HILLDALE WATER DISTRICT	MS0750005-00004T-7500502	17.6	9.8	M	MS	CWS	gw	EP	Public/Private	12/5/2002
HOKE CO REGIONAL WATER SYSTEM	NC0347025-00023-EP2	3.7	2.0	Large	NC	CWS	gw	EP	Local_Govt	12/22/2003
HOKE CO REGIONAL WATER SYSTEM	NC0347025-00048-EP8	9.4	5.2	Large	NC	CWS	gw	EP	Local_Govt	12/22/2003
HOT SPRINGS WATERWORKS	AR0000209-00001-0209001	3.2	0.0	VL	AR	CWS	sw	EP	Local_Govt	2/20/2002
HOT SPRINGS WATERWORKS	AR0000209-00002-0209002	5.8	0.0	VL	AR	CWS	sw	EP	Local_Govt	2/20/2002
HOUSTON COUNTY-FEAGIN MILL	GA1530021-03905-308	4.7	2.6	Large	GA	CWS	gw	EP	Local_Govt	5/29/2002
HUNTINGDON BORO WATER DEPT	PA4310012-00101-00101E	4.7	0.0	Large	PA	CWS	sw	EP	Local_Govt	10/16/2001
IMPERIAL VALLEY COLLEGE	CA1300549-00001T-1300549UCMR*0	5.7	2.2	M	CA	NTNCWS	sw	EP	State_Govt	5/14/2002
Irvine Ranch Water District	CA3010092-00015-05S/09W-30G02	5.4	3.0	VL	CA	CWS	sw	SR	Local_Govt	2/12/2003
JOLIET	IL1970450-33066-TAP 14	3.6	2.0	VL	IL	CWS	gw	EP	Local_Govt	12/1/2003
Jurupa Community SD	CA3310021-00003-02S/06W-05A01	3.7	0.0	Large	CA	CWS	gw	SR	Local_Govt	5/21/2003
KINSTON, CITY OF	NC0454010-00048-016	3.8	2.1	Large	NC	CWS	gw	EP	Local_Govt	10/14/2002
LA VERNE, CITY WD	CA1910062-00010-01S/08W-05E01	10.0	10.0	Large	CA	CWS	sw	EP	Local_Govt	1/6/2004
LA VERNE, CITY WD	CA1910062-00032-01S/08W-06H06	9.9	5.5	Large	CA	CWS	sw	EP	Local_Govt	9/10/2003
LA VERNE, CITY WD	CA1910062-00012-01S/08W-07F06	15.0	15.0	Large	CA	CWS	sw	EP	Local_Govt	1/6/2004
LA VERNE, CITY WD	CA1910062-00016-01S/08W-07F02	16.0	16.0	Large	CA	CWS	sw	EP	Local_Govt	1/6/2004
LA VERNE, CITY WD	CA1910062-00018-01S/09W-12H01	20.0	20.0	Large	CA	CWS	sw	EP	Local_Govt	1/6/2004
LACEY WATER DEPARTMENT	WA5343500-00010-WA5343500-S10	6.3	3.5	Large	WA	CWS	sw	EP	Local_Govt	1/14/2003
LACEY WATER DEPARTMENT	WA5343500-00023-WA5343500-S23	8.1	4.5	Large	WA	CWS	sw	EP	Local_Govt	1/13/2003
LAKESIDE	AZ0415010-00831-001	6.0	5.9	S	AZ	CWS	sw	EP	Private	2/16/2001
LAKEWOOD WATER DISTRICT	WA5345550-00003-SO3	3.6	2.0	VL	WA	CWS	gw	EP	Local_Govt	10/10/2002
LAKEWOOD WATER DISTRICT	WA5345550-00016T-S16	4.5	2.5	VL	WA	CWS	gw	EP	Local_Govt	10/10/2002
LAKEWOOD WATER DISTRICT	WA5345550-00021-SO21	4.5	2.5	VL	WA	CWS	gw	EP	Local_Govt	10/10/2002
LAKEWOOD WATER DISTRICT	WA5345550-00007-SO7	5.4	3.0	VL	WA	CWS	gw	EP	Local_Govt	10/10/2002
LAKEWOOD WATER DISTRICT	WA5345550-00019T-S19	5.4	3.0	VL	WA	CWS	gw	EP	Local_Govt	10/10/2002
LINCOLN AVENUE WATER CO.	CA1910063-00003-01N/12W-05Q02	4.8	4.5	Large	CA	CWS	sw	SR	Private	12/10/2001
LINCOLN AVENUE WATER CO.	CA1910063-17-1910063-026	14.5	12.5	Large	CA	CWS	sw	EP	Private	8/3/2004
LOVELAND CITY PWS	OH1300812-00003-EP001	6.0	0.0	Large	OH	CWS	gw	EP	Private	8/20/2001
MANATEE COUNTY UTILITIES OPERATIONS DEPT	FL6411132-08001-POE1	21.0	0.0	VL	FL	CWS	sw	EP	Local_Govt	10/31/2001
MEADVILLE AREA WATER AUTHORITY	PA6200036-00100-00101E	19.6	0.0	Large	PA	CWS	gw	EP	Local_Govt	7/1/2003
MESA, CITY OF	AZ0407095-01872-001	6.4	4.8	VL	AZ	CWS	sw	UK	Local_Govt	3/20/2002
METROPOLITAN WATER DIST. OF SO. CAL.	CA1910087-00003T-G19/087-SYSTMI	2.9	0.0	VL	CA	CWS	sw	EP	State_Govt	5/6/2002
METROPOLITAN WATER DIST. OF SO. CAL.	CA1910087-00023-G19/087-SYSTMSI	3.2	0.0	VL	CA	CWS	sw	EP	State_Govt	5/6/2002
METROPOLITAN WATER DIST. OF SO. CAL.	CA1910087-00012-G19/087-LKESKNF	4.9	2.2	VL	CA	CWS	sw	SR	State_Govt	5/6/2002
METROPOLITAN WATER DIST. OF SO. CAL.	CA1910087-00008-G19/087-LMHDKE	5.6	4.9	VL	CA	CWS	sw	SR	State_Govt	5/6/2002

Utility name	Specific ID	90th percentile	Median	Size	State	System type	Gw_Sw	Sample Type	Owner	Sample Date
METROPOLITAN WATER DIST. OF SO. CAL.	CA1910087-00015-G19/087-SANJNTT	6.3	2.7	VL	CA	CWS	sw	SR	State_Govt	5/6/2002
METROPOLITAN WATER DIST. OF SO. CAL.	CA1910087-00007-G19/087-LHNWHIN	6.5	5.6	VL	CA	CWS	sw	SR	State_Govt	5/7/2002
MIDDLESEX WATER COMPANY	NJ1225001-00025-NJ1225001-05	4.7	2.6	VL	NJ	CWS	sw	EP	Private	11/27/2001
MIDDLESEX WATER COMPANY	NJ1225001-00027-NJ1225001-06	6.9	6.0	VL	NJ	CWS	sw	EP	Private	11/27/2001
MOBILE COUNTY WATER & FIRE PRO AUTHORITY	AL0001002-00003T-1002003	5.0	2.8	Large	AL	CWS	gw	EP	Local_Govt	12/6/2002
MOHAVE GENERATING STATION	NV0001048-00238-EP02	6.7	5.9	VS	NV	NTNCWS	sw	EP	Private	12/4/2002
MONTCLAIR WATER BUREAU	NJ0713001-00003-NJ0713001-01	4.8	2.7	Large	NJ	CWS	sw	EP	Local_Govt	5/19/2003
MONTE VISTA CWD	CA3610029-00027-01S/08W-13C01 S	3.4	0.0	Large	CA	CWS	sw	SR	Local_Govt	7/19/2004
MONTE VISTA CWD	CA3610029-00005-01S/08W-15H01	3.5	0.0	Large	CA	CWS	sw	SR	Local_Govt	7/19/2004
MONTGOMERY WATER WORKS	AL0001070-00051-1070003	7.7	4.3	VL	AL	CWS	sw	EP	Local_Govt	2/28/2001
MONTGOMERY WATER WORKS	AL0001070-00001T-1070001	7.7	0.0	VL	AL	CWS	sw	EP	Local_Govt	2/28/2001
MOORE	OK2001412-12300-UCM0016	8.6	8.6	Large	OK	CWS	gw	EP	Local_Govt	1/20/2003
MOORE	OK2001412-12292-UCM0019	8.7	4.9	Large	OK	CWS	gw	EP	Local_Govt	7/21/2003
MOORE	OK2001412-12305-UCM0028	9.7	9.7	Large	OK	CWS	gw	EP	Local_Govt	1/20/2003
MOORE	OK2001412-20619-UCM0039	10.4	0.0	Large	OK	CWS	gw	EP	Local_Govt	7/22/2003
MUHLENBERG TWP MUNI AUTH	PA3060038-00105-00105E	3.6	2.0	Large	PA	CWS	gw	EP	Local_Govt	6/21/2002
New Brighton	MN1620009-00017-E03	4.1	2.3	Large	MN	CWS	gw	EP	Local_Govt	9/21/2001
NEW HANOVER CO WATER SYSTEM	NC0465232-00026-007	5.9	5.9	Large	NC	CWS	gw	EP	Local_Govt	11/25/2002
NEW HANOVER CO WATER SYSTEM	NC0465232-00058-011	6.4	3.5	Large	NC	CWS	gw	EP	Local_Govt	11/21/2002
NEW MEXICO AMERICAN WATER CO (CLOVIS)	NM3527305-00036-SP273050361	5.7	5.5	Large	NM	CWS	gw	EP	Private	11/18/2002
NJ AMERICAN WATER COMPANY - LAKEWOOD	NJ1514001-00013-NJ1514001-06	4.2	0.0	VL	NJ	CWS	sw	EP	Private	12/11/2002
NORTH PLATTE, CITY OF	NE3111106-03581-EP1	7.0	6.1	Large	NE	CWS	gw	EP	Local_Govt	6/30/2003
Northfield	MN1660010-00006-E02	5.4	3.0	Large	MN	CWS	gw	EP	Local_Govt	10/25/2001
OCONEE CO.-WATKINSVILLE	GA2190000-15152-323	38.0	38.0	Large	GA	CWS	sw	EP	Local_Govt	7/23/2001
ONTARIO, CITY OF	CA3610034-00032-036/034-001	3.6	0.0	Large	CA	CWS	sw	SR	Local_Govt	8/24/2004
ONTARIO, CITY OF	CA3610034-00016-01S/07W-23D01	5.0	5.0	Large	CA	CWS	sw	SR	Local_Govt	12/27/2001
ONTARIO, CITY OF	CA3610034-00008-01S/07W-18G01	6.9	5.2	Large	CA	CWS	sw	SR	Local_Govt	8/17/2004
ONTARIO, CITY OF	CA3610034-00012-01S/08W-25Q02	8.3	7.3	Large	CA	CWS	sw	SR	Local_Govt	5/28/2004
ONTARIO, CITY OF	CA3610034-00003-01S/07W-21D01	10.6	9.1	Large	CA	CWS	sw	SR	Local_Govt	6/7/2004
ONTARIO, CITY OF	CA3610034-00015-01S/07W-22B01	12.0	12.0	Large	CA	CWS	sw	SR	Local_Govt	12/27/2001
PAINESVILLE CITY PWS	OH4301611-00002-EP001	6.5	0.0	Large	OH	CWS	sw	EP	Private	12/11/2001
PALM BEACH COUNTY SYSTEM 10	FL4501242-08001-2002/12152	15.3	8.5	Large	FL	CWS	gw	EP	Private	12/17/2003
PARK RIDGE WATER DEPT	NJ0247001-00036-NJ0247001-16	12.2	9.1	Large	NJ	CWS	gw	EP	Local_Govt	7/17/2003
PASADENA-CITY, WATER DEPT.	CA1910124-00007-01N/12W-23G01	4.5	2.5	VL	CA	CWS	sw	SR	Local_Govt	5/9/2001
PASADENA-CITY, WATER DEPT.	CA1910124-00010-01N/12W-21K01	4.5	2.5	VL	CA	CWS	sw	SR	Local_Govt	5/9/2001
PASADENA-CITY, WATER DEPT.	CA1910124-00014-01N/12W-23L01	4.9	4.5	VL	CA	CWS	sw	SR	Local_Govt	5/9/2001
PASADENA-CITY, WATER DEPT.	CA1910124-00022-01N/12W-08D08	6.8	6.0	VL	CA	CWS	sw	SR	Local_Govt	5/9/2001
PASADENA-CITY, WATER DEPT.	CA1910124-00019-01N/12W-05N01	6.9	6.5	VL	CA	CWS	sw	SR	Local_Govt	5/9/2001
PASADENA-CITY, WATER DEPT.	CA1910124-00020-01N/12W-21K02	7.0	7.0	VL	CA	CWS	sw	SR	Local_Govt	5/9/2001
PASADENA-CITY, WATER DEPT.	CA1910124-00028-01N/12W-20B03	7.9	7.5	VL	CA	CWS	sw	SR	Local_Govt	5/9/2001
PASADENA-CITY, WATER DEPT.	CA1910124-00018-01N/12W-20A01	12.0	12.0	VL	CA	CWS	sw	SR	Local_Govt	5/9/2001
PASADENA-CITY, WATER DEPT.	CA1910124-00006-01N/12W-20B01	12.8	12.0	VL	CA	CWS	sw	SR	Local_Govt	5/9/2001
PASADENA-CITY, WATER DEPT.	CA1910124-00021-01N/12W-05N02	34.3	31.5	VL	CA	CWS	sw	SR	Local_Govt	5/9/2001
PATTERSON, CITY OF	CA5010017-00006-SP002	4.3	4.1	Large	CA	CWS	gw	SR	Local_Govt	5/4/2004
PERDUE FARMS INC	VA3001700-20368-EP001	3.9	2.2	S	VA	NTNCWS	gw	EP	Private	7/30/2001
PHOENIX, CITY OF	AZ0407025-01811-405	3.6	0.0	VL	AZ	CWS	sw	UK	Local_Govt	1/14/2002
PHOENIX, CITY OF	AZ0407025-01812-406	3.6	0.0	VL	AZ	CWS	sw	UK	Local_Govt	1/14/2002
PLAINVIEW WD	NY2902845-34291-SRN06580	4.7	4.7	Large	NY	CWS	gw	SR	Public/Private	5/29/2001
PLAINVIEW WD	NY2902845-34290-SRN07526	6.3	6.3	Large	NY	CWS	gw	SR	Public/Private	7/9/2002
PLAINVIEW WD	NY2902845-34292-EPN06077	7.5	7.5	Large	NY	CWS	gw	EP	Public/Private	11/5/2001
PLAINVIEW WD	NY2902845-34294-EPN07421	7.5	7.5	Large	NY	CWS	gw	EP	Public/Private	11/5/2001

Utility name	Specific ID	90th percentile	Median	Size	State	System type	Gw_Sw	Sample Type	Owner	Sample Date
PLAINVIEW WD	NY2902845-34294-SRN07421	14.8	14.8	Large	NY	CWS	gw	EP	Public/Private	7/9/2002
PLAINVIEW WD	NY2902845-34292-SRN06077	17.5	17.5	Large	NY	CWS	gw	EP	Public/Private	7/9/2002
POMONA - CITY, WATER DEPT.	CA1910126-00013-01S/08W-09D01	3.4	0.0	VL	CA	CWS	sw	SR	Local_Govt	6/20/2001
POMONA - CITY, WATER DEPT.	CA1910126-00025-01S/08W-33E01	4.5	4.4	VL	CA	CWS	sw	SR	Local_Govt	5/23/2001
POMONA - CITY, WATER DEPT.	CA1910126-00002-01S/08W-28F01	5.7	5.2	VL	CA	CWS	sw	SR	Local_Govt	6/13/2001
POMONA - CITY, WATER DEPT.	CA1910126-00030-01S/08W-21R01	6.2	6.2	VL	CA	CWS	sw	SR	Local_Govt	6/14/2001
POMONA - CITY, WATER DEPT.	CA1910126-00049-1910126-049	6.3	5.7	VL	CA	CWS	sw	SR	Local_Govt	5/24/2001
POMONA - CITY, WATER DEPT.	CA1910126-00021-01S/08W-31J01	6.7	6.6	VL	CA	CWS	sw	SR	Local_Govt	6/28/2001
POMONA - CITY, WATER DEPT.	CA1910126-00051-1910126-051	6.7	5.8	VL	CA	CWS	sw	SR	Local_Govt	6/20/2001
POMONA - CITY, WATER DEPT.	CA1910126-00010-01S/08W-28G02	7.0	6.9	VL	CA	CWS	sw	SR	Local_Govt	6/13/2001
POMONA - CITY, WATER DEPT.	CA1910126-00023-01S/08W-33D01	8.3	8.3	VL	CA	CWS	sw	SR	Local_Govt	5/23/2001
POMONA - CITY, WATER DEPT.	CA1910126-00026-01S/08W-33C01	8.5	7.1	VL	CA	CWS	sw	SR	Local_Govt	1/8/2003
POMONA - CITY, WATER DEPT.	CA1910126-00003-01S/08W-18J02	10.0	10.0	VL	CA	CWS	sw	SR	Local_Govt	6/13/2001
POMONA - CITY, WATER DEPT.	CA1910126-00050-1910126-050	11.0	11.0	VL	CA	CWS	sw	SR	Local_Govt	1/7/2003
POMONA - CITY, WATER DEPT.	CA1910126-00007-01S/08W-17K02	12.0	12.0	VL	CA	CWS	sw	SR	Local_Govt	1/7/2003
PUYALLUP, CITY OF	WA5370050-00001-SO-1	4.0	4.0	Large	WA	CWS	sw	EP	Local_Govt	6/25/2002
PUYALLUP, CITY OF	WA5370050-00005-SO-5	4.5	2.5	Large	WA	CWS	sw	EP	Local_Govt	1/30/2002
PUYALLUP, CITY OF	WA5370050-00008-SO-8	7.2	4.0	Large	WA	CWS	sw	EP	Local_Govt	1/30/2002
QUAKERTOWN BORO	PA1090082-00101-00101E	3.8	0.0	Large	PA	CWS	gw	EP	Local_Govt	1/23/2002
QUAKERTOWN BORO	PA1090082-00102-00102E	4.4	4.4	Large	PA	CWS	gw	EP	Local_Govt	7/17/2001
Rancho California Water District	CA3310038-00085-8S/1W-05M00	6.4	6.4	VL	CA	CWS	sw	SR	Local_Govt	6/18/2002
RAVENNA CITY PWS	OH6703211-00002-EP001	3.7	0.0	Large	OH	CWS	sw	EP	Private	1/16/2002
REDLANDS CITY MUD-WATER DIV	CA3610037-00049-01S/03W-26C01	2.8	0.0	VL	CA	CWS	sw	SR	Local_Govt	5/6/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00016-01S/03W-32J02	3.7	0.0	VL	CA	CWS	sw	EP	Local_Govt	9/24/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00102-3610037-102GA	4.9	4.9	VL	CA	CWS	sw	EP	Local_Govt	7/11/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00031-01S/03W-23A05	5.3	0.0	VL	CA	CWS	sw	EP	Local_Govt	11/25/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00054-3610037-054	5.3	0.0	VL	CA	CWS	sw	SR	Local_Govt	12/9/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00041-01S/03W-35H03	5.5	5.0	VL	CA	CWS	sw	SR	Local_Govt	11/5/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00039-01S/03W-35G09	5.8	5.8	VL	CA	CWS	sw	EP	Local_Govt	5/15/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00004-02S/02W-03L01	7.1	6.9	VL	CA	CWS	sw	EP	Local_Govt	5/19/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00038-01S/03W-35G07	7.3	6.8	VL	CA	CWS	sw	SR	Local_Govt	4/15/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00037-01S/03W-35G08	7.4	6.7	VL	CA	CWS	sw	EP	Local_Govt	5/21/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00052-01S/02W-34N02	10.0	9.0	VL	CA	CWS	sw	EP	Local_Govt	10/28/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00051-01S/03W-28H01	11.0	10.8	VL	CA	CWS	sw	SR	Local_Govt	10/16/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00028-01S/03W-28K01	16.2	15.0	VL	CA	CWS	sw	SR	Local_Govt	2/11/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00045-01S/03W-21H01	17.7	17.0	VL	CA	CWS	sw	SR	Local_Govt	6/11/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00047-01S/03W-22A02	17.7	17.0	VL	CA	CWS	sw	SR	Local_Govt	7/2/2003
REDLANDS CITY MUD-WATER DIV	CA3610037-00044-01S/03W-21H07	66.6	62.0	VL	CA	CWS	sw	EP	Local_Govt	9/22/2003
RIALTO-CITY	CA3610038-00017-01S/05W-02E02	4.5	0.0	Large	CA	CWS	sw	SR	Local_Govt	7/20/2004
RIALTO-CITY	CA3610038-00015-01S/05W-10H01	9.5	8.3	Large	CA	CWS	sw	SR	Local_Govt	7/11/2002
RIALTO-CITY	CA3610038-00010-036/038-005	21.0	21.0	Large	CA	CWS	sw	SR	Local_Govt	2/21/2002
RIALTO-CITY	CA3610038-00014-01N/05W-34B01	33.0	33.0	Large	CA	CWS	sw	SR	Local_Govt	7/26/2004
Riverside Highland Water Co	CA3610057-00010-02S/04W-06R01	4.2	0.0	Large	CA	CWS	gw	SR	Private	12/14/2001
Riverside, City of	CA3310031-00041-02S/05W-12C03	3.1	0.0	VL	CA	CWS	sw	SR	Local_Govt	6/14/2001
Riverside, City of	CA3310031-00015-02S/04W-07L01	4.8	4.8	VL	CA	CWS	sw	SR	Local_Govt	6/14/2001
Riverside, City of	CA3310031-00120-01S/04W-02Q11	5.4	4.8	VL	CA	CWS	sw	SR	Local_Govt	11/21/2001
Riverside, City of	CA3310031-00080-01S/04W-23C03	5.1	0.0	VL	CA	CWS	sw	SR	Local_Govt	6/14/2001
Riverside, City of	CA3310031-00100-01S/04W-22H04	5.8	3.2	VL	CA	CWS	sw	SR	Local_Govt	6/12/2001
Riverside, City of	CA3310031-00083-01S/04W-02L01	6.7	6.7	VL	CA	CWS	sw	SR	Local_Govt	6/19/2001
Riverside, City of	CA3310031-00034-01S/04W-13F02	8.0	8.0	VL	CA	CWS	sw	SR	Local_Govt	6/19/2001
Riverside, City of	CA3310031-00051-01S/04W-27A11	8.0	8.0	VL	CA	CWS	sw	SR	Local_Govt	6/19/2001

Utility name	Specific ID	90th percentile	Median	Size	State	System type	Gw_Sw	Sample Type	Owner	Sample Date
Riverside, City of	CA3310031-00053-01S/04W-27A10	8.4	8.4	VL	CA	CWS	sw	SR	Local_Govt	6/19/2001
Riverside, City of	CA3310031-00028-01S/04W-23H01	8.9	7.6	VL	CA	CWS	sw	SR	Local_Govt	2/27/2001
Riverside, City of	CA3310031-00052-01S/04W-27A09	9.3	9.3	VL	CA	CWS	sw	SR	Local_Govt	6/14/2001
Riverside, City of	CA3310031-00027-01S/04W-23A02	11.0	10.5	VL	CA	CWS	sw	SR	Local_Govt	11/8/2001
Riverside, City of	CA3310031-00030-01S/04W-23K02	11.0	11.0	VL	CA	CWS	sw	SR	Local_Govt	6/29/2001
Riverside, City of	CA3310031-00035-01S/04W-13G02	11.0	11.0	VL	CA	CWS	sw	SR	Local_Govt	6/28/2001
Riverside, City of	CA3310031-00029-01S/04W-23K01	12.0	12.0	VL	CA	CWS	sw	SR	Local_Govt	6/29/2001
Riverside, City of	CA3310031-00078-01S/04W-23C02	12.0	12.0	VL	CA	CWS	sw	SR	Local_Govt	6/28/2001
Riverside, City of	CA3310031-00085-01S/04W-02A03	12.0	12.0	VL	CA	CWS	sw	SR	Local_Govt	11/15/2001
Riverside, City of	CA3310031-00043-01S/04W-02Q03	13.8	13.0	VL	CA	CWS	sw	SR	Local_Govt	11/15/2001
Riverside, City of	CA3310031-00038-01S/04W-23G03	15.0	15.0	VL	CA	CWS	sw	SR	Local_Govt	11/8/2001
Riverside, City of	CA3310031-00111-01S/04W-13N07	18.2	12.0	VL	CA	CWS	sw	SR	Local_Govt	2/27/2001
Riverside, City of	CA3310031-00031-01S/04W-13N01	37.4	29.0	VL	CA	CWS	sw	SR	Local_Govt	11/8/2001
Riverside, City of	CA3310031-00036-01S/04W-23A05	41.7	36.0	VL	CA	CWS	sw	SR	Local_Govt	2/27/2001
Riverside, City of	CA3310031-00032-01S/04W-13N02	42.0	42.0	VL	CA	CWS	sw	SR	Local_Govt	11/8/2001
ROCK ISLAND	IL1610650-17079-TAP_01	5.8	0.0	Large	IL	CWS	sw	EP	Local_Govt	9/9/2003
Rubidoux Community SD	CA3310044-00006-02S/05W-11C03	9.5	8.9	Large	CA	CWS	gw	SR	Local_Govt	10/1/2003
Rubidoux Community SD	CA3310044-00002-02S/05W-16H02	9.9	9.0	Large	CA	CWS	gw	SR	Local_Govt	10/1/2003
Rubidoux Community SD	CA3310044-00004-02S/05W-11C02	10.1	9.1	Large	CA	CWS	gw	SR	Local_Govt	10/1/2003
SAN BERNARDINO CITY	CA3610039-00047-01N/04W-35C03	6.3	4.1	VL	CA	CWS	gw	SR	Local_Govt	7/25/2001
SAN FERNANDO-CITY, WATER DEPT.	CA1910143-00002-03N/15W-34B02	8.0	4.5	Large	CA	CWS	sw	SR	Local_Govt	11/5/2002
SAN GABRIEL COUNTY WD	CA1910144-00016-00016	3.8	2.1	Large	CA	CWS	sw	EP	Local_Govt	6/12/2002
SAN GABRIEL VALLEY WC - FONTANA	CA3610041-00026-01S/05W-06D02	3.2	0.0	VL	CA	CWS	sw	EP	Private	6/14/2001
SAN GABRIEL VALLEY WC - FONTANA	CA3610041-00010-01S/05W-07R01	7.0	3.9	VL	CA	CWS	sw	EP	Private	11/29/2001
SAN GABRIEL VALLEY WC - FONTANA	CA3610041-00042-3610041-042	8.5	8.3	VL	CA	CWS	sw	SR	Private	11/29/2001
SAN GABRIEL VALLEY WC - FONTANA	CA3610041-00033-01S/06W-23D02	9.3	8.8	VL	CA	CWS	sw	SR	Private	11/29/2001
SAN GABRIEL VALLEY WC - FONTANA	CA3610041-00029-01S/05W-06J01	13.6	11.8	VL	CA	CWS	sw	SR	Private	11/30/2001
SAN GABRIEL VALLEY WC - FONTANA	CA3610041-00036-3610041-036	14.9	14.5	VL	CA	CWS	sw	SR	Private	11/29/2001
SANTA CLARITA WATER DIVISION	CA1910017-00020-04N/16W-23F01	3.8	2.1	VL	CA	CWS	sw	SR	Private	10/31/2002
SCOTTSDALE, CITY OF	AZ0407098-00191-014	4.1	4.1	VL	AZ	CWS	sw	EP	Local_Govt	1/9/2002
SCOTTSDALE, CITY OF	AZ0407098-01836-001	5.8	0.0	VL	AZ	CWS	sw	EP	Local_Govt	5/5/2004
SEBRING WATER & SEWER SYSTEM	FL6280250-08001-001	34.2	19.0	Large	FL	CWS	gw	EP	Local_Govt	12/20/2001
SEBRING WATER & SEWER SYSTEM	FL6280250-08002-002	41.4	23.0	Large	FL	CWS	gw	EP	Local_Govt	12/20/2001
SEBRING WATER & SEWER SYSTEM	FL6280250-08004-004	63.0	35.0	Large	FL	CWS	gw	EP	Local_Govt	12/20/2001
SOUTH HUNTINGTON WD	NY5103263-40730-SRS12079	3.8	0.0	VL	NY	CWS	gw	EP	Local_Govt	6/26/2002
SOUTH HUNTINGTON WD	NY5103263-40721-SRS77126	3.8	0.0	VL	NY	CWS	gw	EP	Local_Govt	11/29/2001
SOUTHERN NEVADA WATER SYSTEM	NV0000289-00225-EP03	12.0	6.6	VL	NV	NTNCWS	sw	EP	Local_Govt	8/27/2003
SOUTHERN NEVADA WATER SYSTEM	NV0000289-00224-EP02	15.3	10.5	VL	NV	NTNCWS	sw	EP	Local_Govt	8/27/2003
SOUTHWOOD WATER SYSTEM	WA5382844-00007T-07T	4.0	4.0	Large	WA	CWS	gw	EP	Private	10/13/2004
ST CHARLES WATER DIST NO 1	LA1089001-00001T-3CAA-6	21.6	12.0	Large	LA	CWS	sw	EP	Local_Govt	2/20/2001
SUBURBAN WATER SYSTEMS-SAN JOSE	CA1910205-00034-01S/10W-31G09	5.8	0.0	VL	CA	CWS	sw	SR	Private	10/21/2002
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-68741-SRS22048	3.9	0.0	VL	NY	CWS	gw	EP	Local_Govt	6/16/2001
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-82078-SRS118363	4.1	2.3	VL	NY	CWS	gw	EP	Local_Govt	2/5/2002
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-41094-EPS68230TR	4.6	4.6	VL	NY	CWS	gw	EP	Local_Govt	11/27/2001
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-68636-SRS57354	4.3	0.0	VL	NY	CWS	gw	EP	Local_Govt	10/24/2001
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-41094-SRS68230	6.1	6.1	VL	NY	CWS	gw	EP	Local_Govt	6/15/2001
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-41077-SRS53593	6.6	5.7	VL	NY	CWS	gw	EP	Local_Govt	7/18/2001
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-41078-EPS23184	6.7	6.7	VL	NY	CWS	gw	EP	Local_Govt	7/18/2001
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-82733-SRS115702	7.4	6.9	VL	NY	CWS	gw	EP	Local_Govt	5/22/2001
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-41078-EPSSP12	5.3	3.0	VL	NY	CWS	gw	EP	Local_Govt	7/18/2002
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-41078-SRS23184	8.6	8.6	VL	NY	CWS	gw	SR	Local_Govt	7/18/2001

Utility name	Specific ID	90th percentile	Median	Size	State	System type	Gw_Sw	Sample Type	Owner	Sample Date
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-41220-EPSSS13	10.2	8.8	VL	NY	CWS	gw	EP	Local_Govt	4/4/2001
SUFFOLK COUNTY WATER AUTHORITY	NY5110526-41220-SRS35939	12.1	12.0	VL	NY	CWS	gw	EP	Local_Govt	10/5/2001
TALATHA W/D (0220005)	SC0220005-00101T-0302153	3.9	2.2	S	SC	CWS	gw	EP	Local_Govt	7/7/2003
THREE WORLDS CAMP RESORT	FL6531812-08001-901	4.2	2.4	VS	FL	CWS	gw	EP	Private	8/20/2002
TOHO WATER AUTHORITY EASTERN	FL3490751-08004-FP-01	4.2	2.3	VL	FL	CWS	gw	EP	Private	6/14/2001
TOWN OF HEMPSTEAD WD	NY2900000-33979-SRN08957	3.8	2.1	VL	NY	CWS	gw	SR	Local_Govt	6/9/2003
TOWN OF HEMPSTEAD WD	NY2900000-33969-SRN08956	8.2	5.3	VL	NY	CWS	gw	SR	Local_Govt	6/9/2003
Trabuco Canyon Water District	CA3010094-00001-06S/07W-11P01	4.0	0.0	Large	CA	CWS	sw	SR	Local_Govt	6/29/2004
Tracy, City of	CA3910011-00008-J39/011-TREAT	18.9	10.5	Large	CA	CWS	sw	EP	Private	11/18/2002
TUCSON, CITY OF	AZ0410112-00351-128	3.8	0.0	VL	AZ	CWS	gw	EP	Local_Govt	7/30/2001
TUCSON, CITY OF	AZ0410112-00165-153	10.7	6.0	VL	AZ	CWS	gw	EP	Local_Govt	1/4/2001
US ARMY FORT IRWIN	CA3610705-00014-036/705-004	8.7	4.9	Large	CA	CWS	gw	EP	Fed_Govt	8/17/2004
UTUADO URBANO	PR0002702-00004-2702004	294.0	0.0	Large	PR	CWS	sw	EP	Local_Govt	2/27/2002
VERNON-CITY, WATER DEPT.	CA1910167-00012-02S/13W-15E02	5.3	4.9	Large	CA	CWS	sw	SR	Local_Govt	12/18/2002
VICK`S MHP	NC0464126-00001-901	6.2	6.0	VS	NC	CWS	gw	EP	Private	6/20/2001
VINELAND WATER & SEWER UTILITY	NJ0614003-00012-NJ0614003-06	6.0	6.0	Large	NJ	CWS	gw	EP	Local_Govt	12/3/2003
WA OF WESTERN NASSAU	NY2902830-34122-SRN07650	4.2	2.4	VL	NY	CWS	gw	EP	Public/Private	12/6/2001
WA OF WESTERN NASSAU	NY2902830-34132-SRN09151	5.0	2.8	VL	NY	CWS	gw	EP	Public/Private	12/13/2001
WEST CEDAR CREEK MUD	TX1070190-04001-04001	5.6	0.0	Large	TX	CWS	sw	EP	Local_Govt	5/6/2003
WEST VALLEY WATER DISTRICT	CA3610004-00031-3610004-031	5.3	4.8	Large	CA	CWS	sw	EP	Local_Govt	9/9/2004
WEST VALLEY WATER DISTRICT	CA3610004-00034-01S/05W-24M02	6.3	6.3	Large	CA	CWS	sw	SR	Local_Govt	7/18/2003
WEST VALLEY WATER DISTRICT	CA3610004-00028-036/004-004	7.2	6.6	Large	CA	CWS	sw	EP	Local_Govt	7/18/2003
WESTBURY WD	NY2902856-34351-SRN08497	6.7	6.7	Large	NY	CWS	gw	EP	Public/Private	6/27/2001
WESTBURY WD	NY2902856-68557-EPN07353	11.0	11.0	Large	NY	CWS	gw	EP	Public/Private	11/6/2001
WESTBURY WD	NY2902856-68556-SRN7353	14.0	14.0	Large	NY	CWS	gw	EP	Public/Private	6/27/2001
WOODWARD	OK2007701-18386-EP001	10.8	6.0	Large	OK	CWS	gw	EP	Local_Govt	1/22/2003
WOODWARD	OK2007701-18387-EP002	11.7	6.5	Large	OK	CWS	gw	EP	Local_Govt	1/22/2003
WRIGHT-PATTERSON AFB AREA B PWS	OH2903312-00014-EP2	15.5	8.6	Large	OH	CWS	gw	EP	Fed_Govt	2/6/2002
YUMA, CITY OF	AZ0414024-01813-001	5.7	4.5	VL	AZ	CWS	sw	UK	Local_Govt	6/3/2002
YUMA, CITY OF	AZ0414024-01816-002	5.9	4.4	VL	AZ	CWS	sw	UK	Local_Govt	9/4/2001

Several treatment technologies are available for perchlorate removal – regenerable ion exchange, single pass ion exchange, biological treatment through fixed or fluidized bed reactors, and reverse osmosis. Table B-1 lists advantages and disadvantages associated with each treatment technology.

Table B-1. Disadvantages and Advantages of Available Perchlorate Treatment Technologies

Treatment Technology	Advantages	Disadvantages
Regenerable ion exchange	- Demonstrated technology - Also effective for nitrate removal	- Produces a perchlorate-laden waste brine - High salt costs
Single pass ion exchange	- Relatively low cost - Simple - Demonstrated technology	- Does not remove nitrate - Resin costs affected by petroleum market
Biological treatment	- CDPH approved technology - Negligible wastestream - Also effective for nitrate removal	- Post-treatment to meet SWTR may be required - Public acceptance issues
Reverse osmosis	- Also effective for nitrate removal	- High costs - Produces a perchlorate-laden waste brine

When perchlorate contamination was initially discovered in southern California, several utilities installed regenerable ion exchange systems for perchlorate removal. While the ability of these systems to remove perchlorate from contaminated water has been demonstrated at full-scale for over five years, discharge of the perchlorate-laden waste brine generated by the systems can be problematic. Additionally, O&M costs for these systems are high since perchlorate is tightly bound to the ion exchange resin, resulting in the need for large quantities of salt to regenerate the resin. As a result, three utilities in the San Gabriel Valley are currently switching from regenerable ion exchange to single pass ion exchange systems. The invention of highly-selective ion exchange resins for perchlorate removal in single pass ion exchange systems has also influenced the switch.

All other utilities in southern California known to already have implemented perchlorate treatment or to be in the process of installing perchlorate treatment have selected single pass ion exchange systems. Single pass ion exchange, regenerable ion exchange, and biological fluidized or fixed bed reactors have all been approved for use in to remove perchlorate from drinking water in the State of California. CDPH cited biological fluidized bed reactors and ion exchange as the BATs for perchlorate removal (CDPH, 2007). However, the compliance costs estimated for the 2007 regulatory determination to establish a 6 μg/L perchlorate MCL were developed based on installation of single pass ion exchange systems to treat contaminated sources, since “it is currently the treatment being selected to address most drinking water contamination problems (CDPH, 2007).”

Appendix C. Assumptions for Capital and O&M Cost Assignments

- Treatment systems will be installed for all contaminated source waters. For the purpose of this cost assessment, it was assumed that no sources would be abandoned, nor would blending be an option.
- Single pass ion exchange will be installed to treat all contaminated water sources.
- Perchlorate regulations would affect CWSs and NTNCWSs, but not TNCWSs.
- Any potential differences in costs between public and private water systems were neglected.
- Any potential differences in costs between surface and ground water systems were neglected.
- Capital and O&M costs were assumed to be independent of the influent perchlorate concentration based on experience that system size (and associated capital costs) is dictated by plant capacity and anion loading (e.g., nitrate concentration). This approach neglects the option of treating partial flow and blending to meet the MCL; all California utilities evaluated tend to treat to ND.
- A 20 year life of service at a 3 and a 7% discount rate was assumed to develop annualized capital costs and total operating costs over the 20 year period.

Appendix D

Tabulated Capital, O&M, and Total Costs to Treat for Perchlorate for Two Interest Rates and Two Approaches to Designate Perchlorate Concentrations

Table D.1. Estimated Cost to Treat All Sources Contaminated with Perchlorate Using Single Pass Ion Exchange – 90th Percentile Perchlorate Concentration and 3% Discount Rate

Potential MCL	Capital Costs	Annualized Capital	Annual O&M	NPV O&M	Annualized Cost	Total NPV
4	$ 850,740,737	$ 56,859,850	$ 86,356,266	$ 1,284,763,170	$ 143,216,116	$ 2,135,503,907
6	$ 463,641,689	$ 30,840,714	$ 45,277,676	$ 673,617,484	$ 76,118,390	$ 1,137,259,174
12	$ 174,168,163	$ 11,508,241	$ 18,650,707	$ 277,475,429	$ 30,158,949	$ 451,643,592
18	$ 46,857,498	$ 2,901,417	$ 6,113,860	$ 90,958,799	$ 9,015,277	$ 137,816,298
24	$ 33,915,337	$ 2,271,063	$ 4,365,052	$ 64,940,946	$ 6,636,115	$ 98,856,283

Table D.2. Estimated Cost to Treat All Sources Contaminated with Perchlorate Using Single Pass Ion Exchange – Median Perchlorate Concentration and 3% Discount Rate

Potential MCL	Capital Costs	Annualized Capital	Annual O&M	NPV O&M	Annualized Cost	Total NPV
4	$ 526,026,515	$ 35,357,244	$ 49,444,178	$ 735,604,516	$ 84,801,423	$ 1,261,631,032
6	$ 314,178,138	$ 21,117,706	$ 31,937,670	$ 475,151,887	$ 53,055,376	$ 789,330,025
12	$ 68,745,992	$ 4,620,811	$ 9,528,431	$ 141,758,994	$ 14,149,242	$ 210,504,986
18	$ 15,991,822	$ 1,074,902	$ 2,402,711	$ 35,746,267	$ 3,477,612	$ 51,738,088
24	$ 11,030,586	$ 741,429	$ 1,683,699	$ 25,049,196	$ 2,425,128	$ 36,079,782

Table D.3. Estimated Cost to Treat All Sources Contaminated with Perchlorate Using Single Pass Ion Exchange – 90th Percentile Perchlorate Concentration and 7% Discount Rate

Potential MCL	Capital Costs	Annualized Capital	Annual O&M	NPV O&M	Annualized Cost	Total NPV
4	$ 850,740,737	$ 80,303,907	$ 86,356,266	$ 914,859,507	$ 166,660,173	$ 1,765,600,245
6	$ 463,641,689	$ 43,764,496	$ 45,277,676	$ 479,672,343	$ 89,042,171	$ 943,314,032
12	$ 174,168,163	$ 16,440,242	$ 18,650,707	$ 197,585,859	$ 35,090,950	$ 371,754,022
18	$ 46,857,498	$ 4,423,016	$ 6,113,860	$ 64,770,321	$ 10,536,876	$ 111,627,819
24	$ 33,915,337	$ 3,201,368	$ 4,365,052	$ 46,243,419	$ 7,566,419	$ 80,158,756

Table D.4. Estimated Cost to Treat All Sources Contaminated with Perchlorate Using Single Pass Ion Exchange – Median Perchlorate Concentration and 7% Discount Rate

Potential MCL	Capital Costs	Annualized Capital	Annual O&M	NPV O&M	Annualized Cost	Total NPV
4	$ 526,026,515	$ 49,653,182	$ 49,444,178	$ 523,812,327	$ 99,097,360	$ 1,049,838,842
6	$ 314,178,138	$ 29,656,194	$ 31,937,670	$ 338,348,134	$ 61,593,864	$ 652,526,272
12	$ 68,745,992	$ 6,489,135	$ 9,528,431	$ 100,944,335	$ 16,017,566	$ 169,690,327
18	$ 15,991,822	$ 1,509,515	$ 2,402,711	$ 25,454,351	$ 3,912,225	$ 41,446,172
24	$ 11,030,586	$ 1,041,209	$ 1,683,699	$ 17,837,136	$ 2,724,909	$ 28,867,722