Review of CDPH's Economic Analysis Supporting the Draft California MCL for Hexavalent Chromium in Drinking Water

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The California Department of Public Health (CDPH) has issued a draft Maximum Contaminant Limit (MCL) of 10 µg/L for hexavalent chromium, Cr(VI), in drinking water. As part of its cost-benefit analysis in support of the MCL development, CDPH conducted an economic analysis to evaluate the impact of the draft MCL on California communities. Water Quality & Treatment Solutions, Inc. (WQTS) is providing technical support to the American Water Works Association (AWWA), Association of California Water Agencies (ACWA), and California Water Association (CWA) in preparing their comments to CDPH on the draft MCL. WQTS' effort includes an economic analysis conducted to address the following areas:

1. Analyze CDPH's approach to developing the unit treatment costs
2. Analyze CDPH's approach to developing the cost of compliance
3. Analyze CDPH's approach to determine the affordability of compliance with the draft MCL

This report includes the details of the economic analysis and its outcome. The discussion is presented within the context of the three focus areas listed above.

1.0 UNIT TREATMENT COSTS

In developing the draft MCL, CDPH relied exclusively on the unit cost estimates for a Weak Base Anion (WBA) resin treatment system developed by ARCADIS for the City of Glendale.[1] The selection of this technology is appropriate since it is the only technology that generates a low volume of waste backwash water with the least discharge limitations compared with other Cr(VI) treatment technologies. The following are specific comments on the WBA treatment cost approach and assumptions used by CDPH:

1. CDPH excluded the cost of the CO_2-stripping off-gas treatment system that was included in the ARCADIS cost estimates. This is a reasonable approach since Glendale's need for the off-gas treatment system was driven by the presence of volatile organic chemicals (VOCs) in the water, which would then be present in the off-gas from the CO_2-stripping process. However, it should be noted that for wells containing VOCs below their respective drinking water limits, off-gas treatment with Vapor-phase Granular Activated Carbon (VGAC) may still be required by the local Air Quality Management District (AQMD). If required, off-gas treatment with VGAC would result in additional treatment costs that are not included in CDPH's cost estimate.

2. CDPH did not include any land acquisition or building construction cost in the development of the treatment system cost. The assumption that every well in the State has sufficient available footprint to construct and operate a WBA treatment system grossly underestimates the overall capital cost of the treatment system. In addition, the assumption that all treatment systems can be installed outdoors is false for various reasons. Not only do weather conditions mandate that many plant components be installed indoors, but also it is important to cover treatment vessels and chemical tanks in urban areas where wells are located in residential neighborhoods. These two issues do not "average out" in that the need to acquire land and construct buildings will only add to the cost of treatment. This report includes an analysis of the impact of adding land acquisition cost to the capital cost of Cr(VI) compliance.

[1] Hexavalent Chromium Removal Research Project Report to the California Department of Public Health. Research Managed by the City of Glendale, California, Department of Water & Power. Report Prepared by Hazen and Sawyer, ARCADIS U.S./Malcolm Pirnie, 2013.

3. CDPH assumed a unit resin purchase cost of $400/ft^3$. While this is a reasonable cost estimate for large(r) treatment systems, the Glendale report shows that the unit costs provided by vendors for small treatment systems could be as high as $800/ft^3$. This means that the resin cost impact will be more severe on small and very small systems compared with that projected by CDPH.

4. CDPH assumed that all spent resin would be disposed of as TENORM waste. This assumption was based on the City of Glendale's finding that even when the resin was loaded with more than 0.05% uranium, material added to absorb the water from the spent resin removed from the vessel increase the total mass, and thus reduced the uranium concentration to less than 0.05% by weight. While this approach was suitable for the City of Glendale because of its relatively low uranium level of 2.5 µg/L, it may not be suitable for many water agencies with higher uranium levels in their groundwater. If the uranium level in the spent resin exceeds 0.05% by weight, it will be classified as Low-Level Radioactive Waste (LLRW), which limits its disposal options to only two locations in the entire United States, and at a higher cost than that assumed by CDPH.

2.0 COST OF COMPLIANCE

2.1 Baseline Comparison of Cost

In analyzing the statewide cost of the proposed MCL, WQTS re-constructed the spreadsheet used by CDPH. Comparisons between the values calculated by CDPH and those re-calculated by WQTS using CDPH's procedure and assumptions are presented in Figures 1 through 4 for Cr(VI) MCLs of 5, 10, 15, and 20 µg/L. Figure 1 shows a plot of the number of sources impacted. The differences between the number listed by CDPH and that re-calculated by WQTS are very small (3 or 4 sources), suggesting good agreement between the WQTS-generated spreadsheet and that generated and used by CDPH. The small difference could be due to discrepancies in assumptions about whether certain sources are to be included or excluded from the list.

Figures 2, 3, and 4 show the comparisons for the capital costs, annual O&M costs, and total annualized costs, respectively, at all four MCL values. The differences in costs between the CDPH values and the re-calculated values are slightly greater than the differences in number of impacted sources, but still a difference of less than 10 percent.

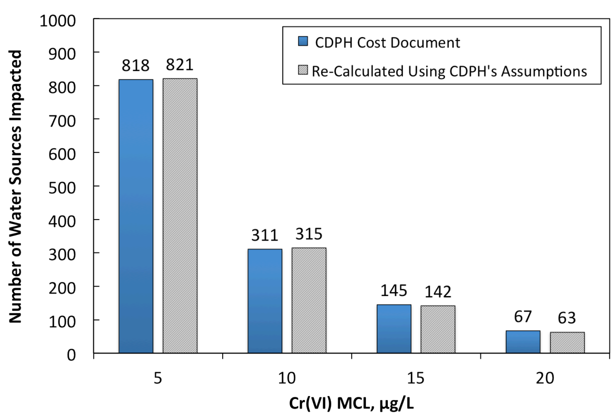

Figure 1 – Comparison between CDPH's Estimate of the Number of Impacted Sources and the Re-Calculated Value using CDPH's Assumptions

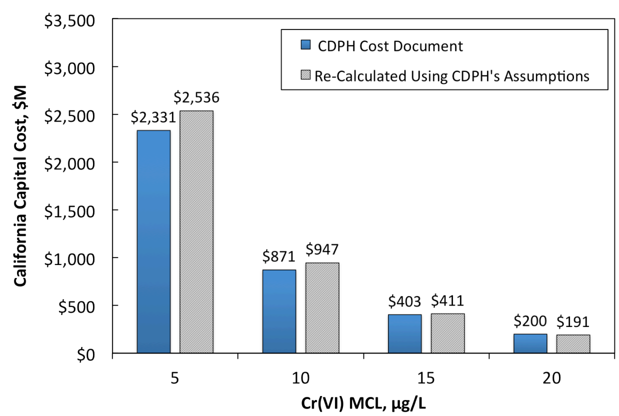

Figure 2 – Comparison between CDPH's Estimate of California Capital Cost and the Re-Calculated Value using CDPH's Assumptions

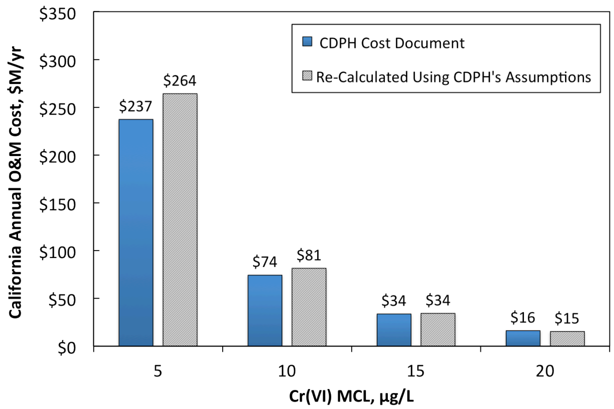

Figure 3 – Comparison between CDPH's Estimate of the Annual O&M Cost and the Re-Calculated Value using CDPH's Assumptions

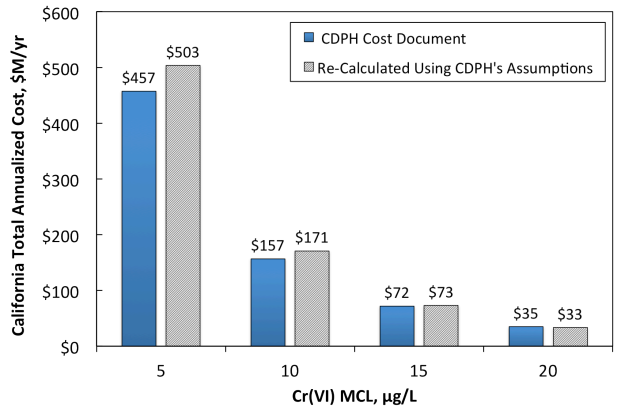

Figure 4 – Comparison between CDPH's Estimate of the Total Annualized Cost and the Re-Calculated Value using CDPH's Assumptions

2.2 Adjustments to CDPH Cost Assumptions & Approach

WQTS' analysis shows that the CDPH cost assumptions and costing approach did not account for a number of factors that have a dramatic impact on the cost of compliance, at both the state-wide level and at the individual community level. Four such factors are as follows:

1. Inclusion of Total Chromium Monitoring Data
2. Use of Correct Values for Water Usage Rate and Peaking Factor
3. Including Land Acquisition Cost and Treatment Building Cost
4. Treatment need for sources with Cr(VI) levels within 80% of the MCL

The next four subsections discuss the rationale for the need to account for these factors in the cost estimates. WQTS then identified the impact of including each factor on the overall compliance cost with Cr(VI) MCL scenarios of 5, 10, 15, and 20 µg/L.

2.2.1 Inclusion of Total Chromium Monitoring Data

In the cost development effort, CDPH limited its analysis to Cr(VI) monitoring data reported to the State by water systems. However, CDPH has a significant amount of Total Chromium (CrT) data reported to the State by water agencies. During a recent study conducted by WQTS for the Water Research Foundation (Project 4450), paired bi-weekly samples collected from eight California groundwater sources over a period of 6 months showed that virtually all the total chromium was present in the groundwater as Cr(VI). This observation is supported by the findings of Frey et al. (2004).[2] Based on this observation, it is appropriate to include those sources that had been monitored for CrT, but not monitored for Cr(VI) in the statewide cost of compliance calculation. The impact on this modification is significant. Using Cr(VI) monitoring data only, CDPH estimated that 3,045 water sources contain Cr(VI) at or above the Cr(VI) detection limit for the purpose of reporting (DLR) of 1 µg/L. Adding the CrT monitoring results increases this value to 5,281 sources; a 73% increase. It is noted that there are currently 11,984 water sources used by community and

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[2] Frey, M.M., Seidel, C.J., Edwards, M., Parks, J.L., McNeill, L., "*Occurrence Survey of Boron and Hexavalent Chromium*," American Water Works Association Research Foundation, Denver, CO, 2004

non-transient non-community water systems in California. Figure 5 shows the impact of including the available CrT data on the number of sources requiring treatment under the four MCL values evaluated in this report. For each MCL scenario, the number of sources requiring treatment is more than double the number assumed by CDPH in determining the overall state cost of compliance.

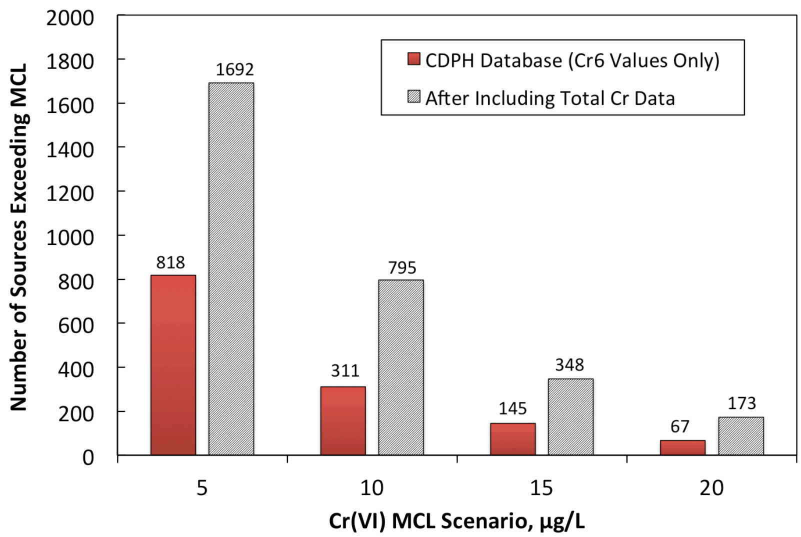

Figure 5 – Impact of Including CrT Monitoring Data into the Determination of the Cost of Compliance with Various Potential Cr(VI) MCLs

It is important to note that WQTS also removed a number of water systems and their sources from the analysis in order to avoid over-estimating the cost of compliance even though these sources contained Cr(VI) at or above the DLR of 1 µg/L. Specifically, WQTS removed all surface water sources and all systems that rely on a mix of surface water and groundwater sources, which amounted to 1,020 sources. The reason for excluding these sources is that CDPH calculates the number of people served by each water source by dividing the total population by the total number of sources used by the system. For 100% groundwater systems, this approach results in a system-wide average well production capacity. However, for systems using both surface water and groundwater, it is typical for the surface water source to be significantly greater in quantity produced than the groundwater source. If WQTS had not removed these 1,020 sources prior to applying CDPH's costing methodology, the resulting estimate would have been biased high. The current approach illustrates the impact of using the more complete dataset but it still does not capture a significant number of impacted sources that require Cr(VI) treatment. The following is a partial list of the systems excluded from the analysis due to the reason outlined above:

Alameda County Water District
Bella Vista Water District
City of Stockton
Contra Costa Water District
Elsinore Valley MWD
Kern County Water Agency
LA Dept. of Water & Power
San Jose Water Company
City of Upland
Zone 7 Water Agency
City of Anaheim
City of Garden Grove
Calleguas Municipal Water District
City of Roseville
City of Vacaville
Cal. Water Service Co., Bakersfield
Fern Valley Water District
City of Lodi
Marin Municipal Water District
Terra Bella Irrigation District
Ventura Water Department
City of Sacramento
City of Santa Ana
City of Orange
City of Fairfield
City of Santa Barbara
City of Vallejo
Desert Water Agency
Golden State Water Co. – Cordova
City of Lompoc
Palmdale Water District
City of Tracy
City of Watsonville
Eastern Municipal Water District
City of Fountain Valley
City of Fullerton

Some of the systems listed above have sources that contain significant levels of Cr(VI). For example, the City of Watsonville owns six wells with Cr(VI) levels above the proposed MCL of 10 μg/L. Nonetheless, in the interest of maximizing the accuracy of the cost estimating effort, these and other similar systems were excluded from the analysis. The numbers of impacted sources plotted in in Figure 5 do not include the 1,020 sources excluded.

In addition, the number of sources plotted in Figure 5 is limited to those sources that exceed the MCL values. However, these are less than the number of sources requiring treatment to meet the MCL values. As discussed later in this report, water systems with sources within 80% of an MCL will most likely implement treatment for that source to ensure that the Cr(VI) level is maintained at a safe level below the MCL. The total number of sources requiring treatment is presented later in this report.

2.2.2 Use of Correct Water Usage Rates and Peaking Factor

Cost calculations are dependent on the assumed size of the treatment system required at each source and the volume of water treated from that source. CDPH should have a complete record of the production capacity and annual usage rate for each water source. However, these values are not included in the electronic database used by CDPH in the cost analysis. In order to estimate the average production rate from each water source, CDPH utilized an average Water Usage Rate (WUR) for all systems, expressed in gallons/capita/day, and applied it to the estimated population served by each source. CDPH then applied an assumed Peaking Factor (PF) to estimate the maximum production rate from the average production rate. In mathematical terms, Equations 1 and 2 were used by CDPH to estimate the average and maximum production from each water source in a water system.

$$Average\ Treatment\ Size,\ gpm = \frac{\left[Population\ Served\right]}{1440 \times \left[Total\ Number\ of\ Sources\ Used\ by\ System\right]} \times WUR \qquad (1)$$

$$Max.\ Treatment\ Size,\ gpm = \left[Average\ Treatment\ Size\right] \times PF \qquad (2)$$

where WUR = Water Usage Rate, expressed in gal/capita/day (gpcd)
& PF = Peaking Factor = [Max-Day Demand]/[Ave-Day Demand]

As shown in Equation 1, the size of the treatment system, and thus its capital and O&M costs, are directly proportional to the assumed WUR and PF values used.

In its cost development, CDPH used a statewide WUR of 150 gpcd. This is the same value that CDPH used in the development of the arsenic MCL in 2008. This value underestimates the WUR in California. In a report by the California Department of Water Resources (DWR) submitted to the California legislature in 2012,[3] the water usage rates from 341 California cities and water agencies were presented. Using the values listed in the report, WQTS calculated the average of all values reported at 225 gpcd, which is 50% higher than the 150 gpcd value assumed by CDPH in the development of the Cr(VI) MCL.

[3] California Department of Water Resources, "*2010 Urban Water Management Plans*", A Report to the Legislature pursuant to section 10644(b) of the California Water Code, 2012.

The use of an average WUR does not reflect the disparity of WUR values across California, which are significant; WUR values are typically higher in inland and more arid communities that rely mostly on groundwater for their water supply. As the proposed draft MCL notes, Cr(VI) is predominantly a groundwater constituent, as demonstrated by CDPH's analysis. Therefore, the WUR for communities impacted by the draft Cr(VI) MCL is most likely to be higher than the statewide average. This observation is supported by Figure 6, which was reproduced from the 2012 DWR report. The map shows that while coastal regions have an average WUR value ranging from 147 gpcd to 189 gpcd, the average WUR value for inland regions is as high as 379 gpcd.

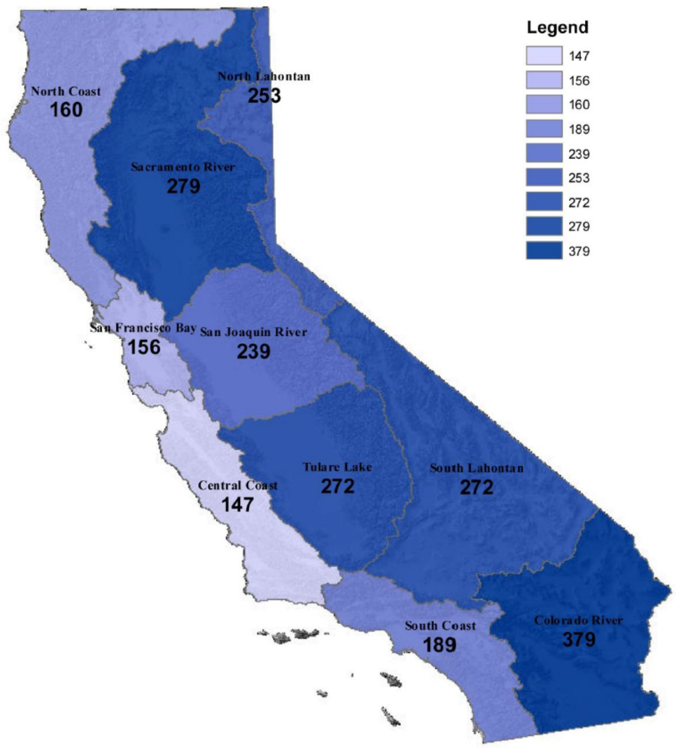

Figure 6 – Population-Weighted Water Usage Rate (WUR) by Hydrologic Regions (DWR, 2012)

With the availability of the actual WUR values for some of the systems impacted by the Cr(VI) MCL, WQTS re-calculated the average treatment size for each impacted source using the system-specific WUR values reported in the 2012 DWR report. For systems not listed in the 2012 DWR report, WQTS utilized the average WUR value of 225 gpcd in calculating their average treatment size in accordance with Equation 1.

The other important factor used by CDPH to estimate the size of the treatment system was the Peaking Factor (PF) as shown in Equation 2. Typically, the PF value for a water system is represented by the ratio of the system's maximum-day water demand to its average-day water demand. In its analysis, CDPH used a PF value of 1.5. While this is a reasonable value for an overall system, it is too low for individual wells, especially in systems that rely exclusively on groundwater. The following are three reasons for this statement:

First, a groundwater system cannot rely on having all its wells in production to meet its maximum-day demand. Indeed, CDPH requires that groundwater systems meet their maximum-day demand with their largest well offline. Unlike surface water plants, there is no redundancy built into a groundwater well. Any failure in the well pumping system would shut down the well production for extended periods of time. For this reason, a system has to plan on meeting its max-day demand with at least one of its wells off-line.

Second, many groundwater wells cannot be operated for extended periods of time due to limitations in the aquifer production. In many locations, wells have to be "rested" for parts of the year to give time for the aquifer to be replenished. This requirement further increases the true ratio between the production capacity of the well compared with its annual production rate.

Third, many California systems operate their wells under a strict Time-of-Use (TOU) schedule in coordination with the local power agency. A TOU schedule commonly limits the pumping schedule to off-peak hours, which are area-specific. For example, it is common for southern California water systems to have a TOU schedule that restricts energy use between 8 AM and 3 PM. This limitation further reduces the utilization rate of each well.

The combination of the above factors results in a PF value for groundwater sources that is significantly higher than 1.5. Indeed, CDPH acknowledged this observation during its review of the DBCP limit in 1999 in which CDPH utilized a PF value of 2.5. Since Cr(VI) at the draft MCL is predominantly a groundwater constituent, WQTS' analysis demonstrates that a PF value of 2.5 is more appropriate for Cr(VI) regulatory cost development.

The impact of using the system-specific WUR or an average of 250 gpcd instead of the 150 gpcd value used by CDPH, as well as using a more appropriate PF value of 2.5 instead of the 1.5 value used by CDPH, greatly increases the sizes and costs of the treatment systems required at all the impacted sources. The impact of these changes on the cost of compliance will be demonstrated later in this report.

2.2.3 Inclusion of Land Acquisition Cost and Building Construction Cost

In the regulatory cost development, CDPH did not account for the need to acquire additional land to accommodate the treatment system at an individual well, and did not include the cost of constructing a building to house the treatment system. Excluding these two requirements grossly underestimates the cost of compliance for groundwater systems.

It is very common for groundwater wells to be located in residential neighborhoods with little to no space for the construction of a treatment system as elaborate as those required for Cr(VI) removal from groundwater. Water agencies will need to acquire adjacent property and utilize it to construct a treatment system, or will have to construct a piping system that captures the well production and conveys it to a new site where the water can be treated before it is introduced into the distribution system. Both options require the acquisition of land not currently owned by the water system. For the purpose of this analysis, WQTS assigned a $200,000 land acquisition cost to a 2,000 gpm treatment system, and a $50,000 land acquisition cost to a 100 gpm treatment system. These two values were used to calculate a proportional land acquisition cost for treatment systems larger than 100 gpm. For treatment systems smaller than 100 gpm, a fixed land acquisition cost of $50,000 was assumed. These values are only placeholders since the need for, and cost of, land acquisition is highly site-dependent. It is noted that these cost additions do not take into account the potential need to convey the water away from the well for treatment. This may be required in many situations where wells are located within residential neighborhoods such that zoning constraints, ease of access, and/or environmental compliance requirements would disallow the construction of a treatment system at the well site.

CDPH also assumed that no treatment building is required at any impacted well sites. This assumption also underestimates the true cost of implementing Cr(VI) treatment. At a minimum, critical treatment components need to be protected from the elements, and secured inside a locked building. These include electrical components, instrumentation, chemical feed pumps, etc. In addition, air blowers used for stripping the CO_2 from the treated water cause significant noise pollution and must be housed inside closed buildings that are especially designed for noise-abatement. Furthermore, with groundwater wells scattered among residential properties, there will be strong community pressure to house the steel pressure vessels, chemical tanks, and pumps inside a building that somewhat blends with the neighborhood.

With all these requirements in mind, it is unreasonable to assume that no building will be required at any Cr(VI) treatment plants in California. Table 1 lists the treatment building sizes and costs assumed for treatment systems ranging in size from 10 gpm to 5,000 gpm. The building size values were based on a WQTS model used to size WBA treatment systems, and represent the minimum footprint required by the various plant components. In reality, additional footprint is typically required to provide sufficient room to move equipment in and out of the building for maintenance or replacement. Table 1 also calculates a placeholder building cost based on a constructed unit cost of $250/ft^2. For most urban areas, this value can be as high as $350/ft^2. However, a lower value is appropriate as an average statewide value considering that the building requirements will be less stringent in many rural areas where Cr(VI) treatment is implemented.

Table 1 – Assumed Building Size and Costs as a Function of Treatment Plant Size

Treatment Size, gpm	Bldg. Area, ft^2	Bldg. Cost (@ $250/ft^2)
10	500	$125,000
100	1,793	$448,250
500	2,791	$697,750
1,000	3,685	$921,250
2,000	5,531	$1,382,750
5,000	7,455	$1,863,750

2.2.4 Treatment for Sources within 80% of the MCL

In its cost analysis, CDPH assumed that only systems with a Cr(VI) concentration at or above 10.5 μg/L would be required to treat for Cr(VI) to meet an MCL of 10 μg/L. This is based on the assumption that any Cr(VI) value between 10 μg/L and 10.49 μg/L would be rounded down to 10 μg/L, and that any Cr(VI) level below 10 μg/L would not require treatment to meet an MCL of 10 μg/L. This approach has two main problems: First, the Cr(VI) concentrations used by CDPH were based on a very small number of samples with many relying on one or two monitoring results. Therefore, the uncertainty of the Cr(VI) concentration is quite high, which reduces the confidence in the accuracy of the average value used by CDPH. It would be more appropriate to add a factor of safety to this average to account for this uncertainty. Second, a water system with a source containing Cr(VI) at a level within close proximity of the MCL is most likely to implement treatment in order to avoid unexpected exceedances of the MCL due to variability in the Cr(VI) level in the source. A typical threshold of 80% of an MCL is commonly used for determining whether treatment is required to comply with that MCL. This approach has been used by the USEPA in the economic analyses for the final Stage 2 D/DBP Rule[4] and the Arsenic Rule.[5]

Using the same approach adopted by the USEPA in conducting economic analyses for regulatory compliance, WQTS adjusted the number of sources requiring treatment, and the corresponding cost impact, by assuming that any source with a projected Cr(VI) concentration within 80% of an MCL would receive treatment to reduce Cr(VI) to a level well below 80% of that MCL. The total number of sources requiring treatment at each of the four MCL values is presented in Figure 7 and compared with the values assumed by CDPH in its economic analysis. At the MCL of 10 μg/L, the number of sources requiring treatment is projected at 1,027 compared with 311 sources assumed by CDPH. Only at an MCL of 20 μg/L would the number of sources requiring treatment equal that assumed by CDPH for an MCL of 10 μg/L.

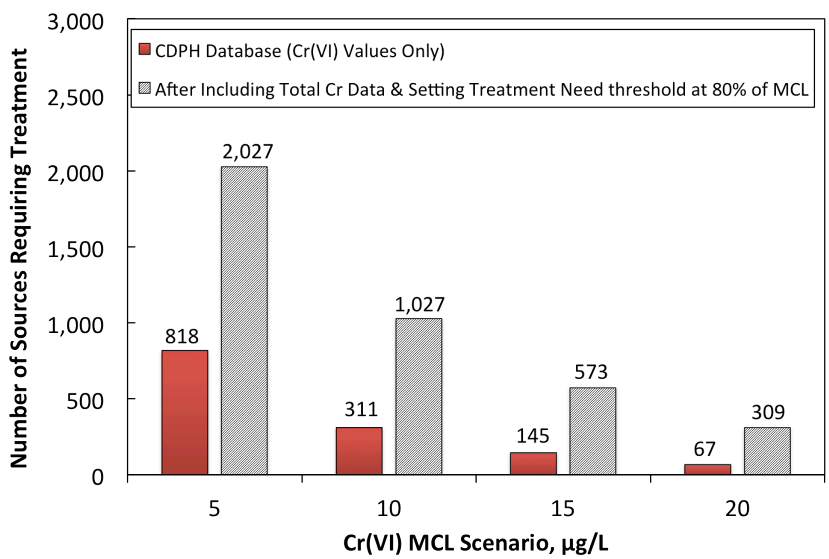

Figure 7 – Number of Water Sources Requiring Treatment in This Report Compared with that Assumed by CDPH in the Determination of the Cost of Compliance with Various Potential Cr(VI) MCLs

2.3 Comparison with CDPH Cost Estimates

WQTS re-calculated the cost of compliance for each water source based on the four cost adjustments discussed in section 2.2. The resulting statewide capital, annual O&M, and total annualized costs at four Cr(VI) MCL values are presented in Figures 8 through 10 and compared with the CDPH-calculated costs. At an MCL of 10 μg/L, CDPH estimated the statewide capital cost at $871M. After including water sources with CrT data, the cost increases to $1,505M; a 73% increase. Then, utilizing system-specific WUR values, and 225 gpcd for sources without available system-specific WUR values, along with increasing the PF value from 1.5 to 2.5, the capital cost of compliance with a Cr(VI) MCL of 10 μg/L increases to $2,484M (i.e., $2.48 billion). Then, adding the

[4] USEPA. *Economic Analysis for the Final Stage 2 Disinfectants and Disinfection By-Products Rule.* Office of Water (4606-M) EPA 815-R-05-010, December 2005. www.epa.gov/safewater.

[5] USEPA. *Arsenic in Drinking Water Rule Economic Analysis*. Office of Ground Water and Drinking Water, EPA815-R-00-026, December 2000.

land acquisition cost and the treatment building cost increases the capital cost to \$3.0 billion. Finally, recognizing that sources with Cr(VI) values within 80% of the MCL will implement treatment, the capital cost increases to \$4.1 billion. This value is almost five times higher than that estimated by CDPH. Even at an MCL of 15 µg/L, the actual capital cost is projected at \$2.0 billion, which is still more than double the capital cost calculated by CDPH for the 10 µg/L MCL. A summary of the cost comparison at all four MCL values is presented in Table 2.

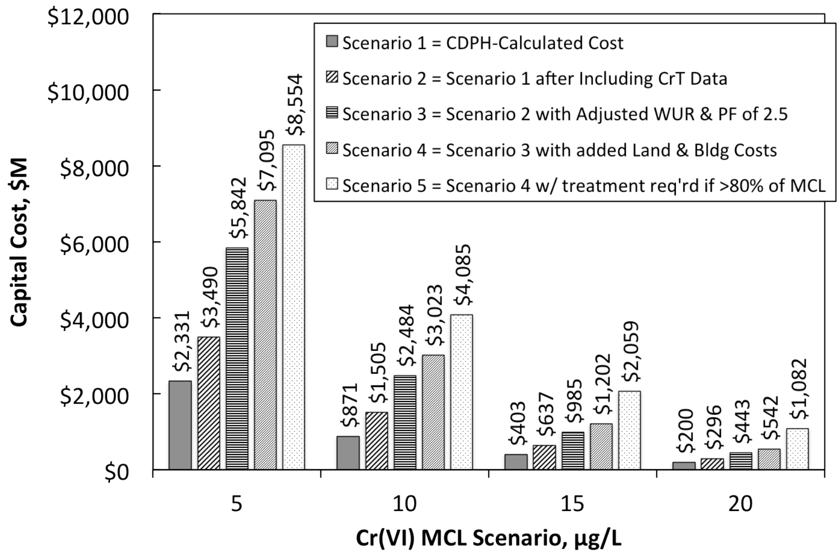

Figure 8 – Impact of Adding the Cost Adjustments on the Statewide Capital Cost of Compliance with Four Cr(VI) MCL Values

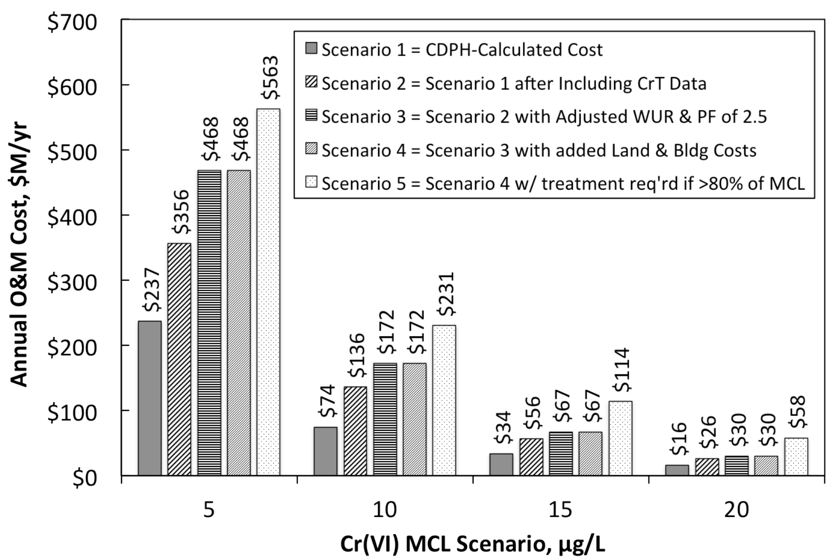

Figure 9 – Impact of Adding the Cost Adjustments on the Statewide Annual O&M Cost of Compliance with Four Cr(VI) MCL Values

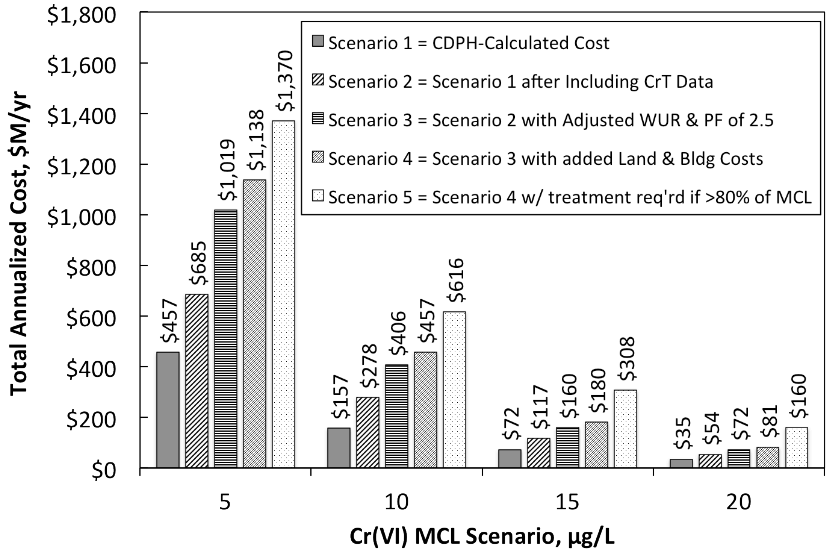

Figure 10 – Impact of Adding the Cost Adjustments on the Statewide Total Annualized Cost of Compliance with Four Cr(VI) MCL Values

Table 2 – Comparison between CDPH-Calculated Statewide Cost of Compliance and that Projected by WQTS Based on the Cost Adjustments Discussed in this Report

	Capital Cost, $M		Annual O&M Cost, $M		Total Annualized Cost, $M	
MCL, μg/L	CDPH Estimates	WQTS Estimates after Adjustments	CDPH Estimates	WQTS Estimates after Adjustments	CDPH Estimates	WQTS Estimates after Adjustments
5	$2,331	$8,554	$237	$563	$457	$1,370
10	$871	$4,085	$74	$231	$157	$616
15	$403	$2,059	$34	$114	$72	$308
20	$200	$1,082	$16	$58	$35	$160

3.0 CASE STUDIES

The impact of a Cr(VI) MCL on individual communities is lost in the overall analysis and discussion of statewide costs. In this section, four water systems were selected from the overall database, and the impact of four Cr(VI) MCLs on them is highlighted. The four systems range in size from 50 people to more than 200,000 people. For each system, the projected actual costs were estimated based on the cost-adjustment factors discussed earlier, and then compared with the baseline cost estimate developed by CDPH for that system.

Case Study #1 – Coachella Valley Water District

The Coachella Valley Water District serves drinking water to a population of approximately 219,000 people through 105,515 connections. The District's water supply is exclusively groundwater extracted from a total of 101 wells scattered across the District's service area. The Cr(VI) levels in the District's groundwater wells ranges from 2 to 21 µg/L. Because of various factors, such as the arid climate in the Coachella Valley, the District has one of the highest WUR values in the state (591 gpcd).

Figures 11 through 14 show the comparison between the projected actual costs and the CDPH-calculated costs for the District. Figure 11 focuses on the capital cost, while Figure 12 presents the annual O&M costs. Figure 13 shows the total annualized cost, while Figure 14 presents the projected cost per household per year (i.e., cost per connection).

CDPH projects the capital cost for the District at $68M for a Cr(VI) MCL of 10 µg/L based on the need to treat water from 26 wells. However, when factoring in the adjustment factors, the actual number of wells requiring treatment for an MCL of 10 µg/L is as high as 55 at an actual capital cost of $534M. This is almost an eight-fold higher capital cost estimate. The cost per household is calculated by CDPH at $111/yr for an MCL of 10 µg/L, but is projected at $744/yr after including the cost adjustments. This is a very large increase in the estimate of household cost, and represents a 135% increase over the current cost of water for the average household in the District's service area, which is approximately $46/month ($552/year).

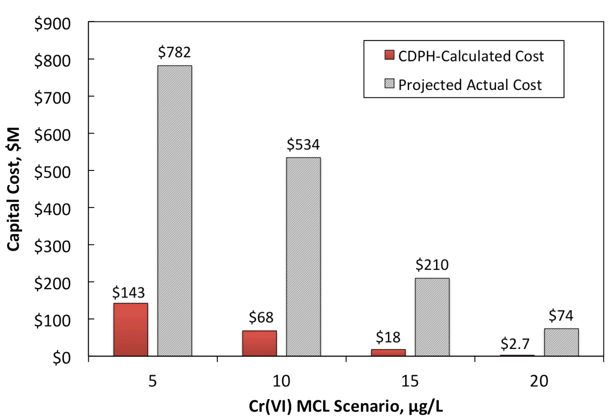

Figure 11 – Projected Actual vs CDPH-Estimated Capital Cost of Compliance for the Coachella Valley Water District

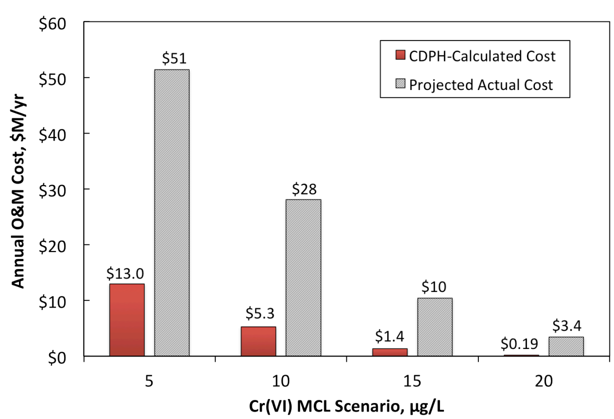

Figure 12 – Projected Actual vs CDPH-Estimated Annual O&M Cost of Compliance for the Coachella Valley Water District

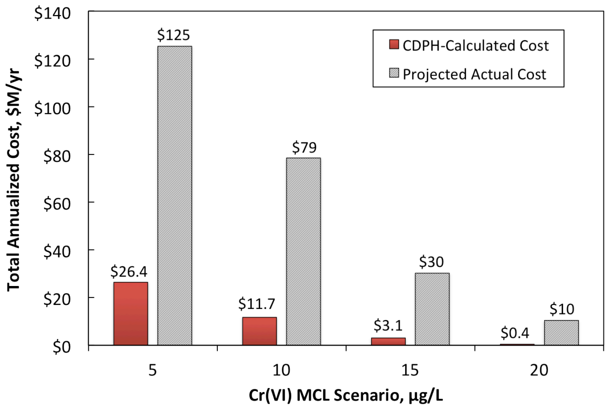

Figure 13 – Projected Actual vs. CDPH-Estimated Total Annualized Cost of Compliance for the Coachella Valley Water District

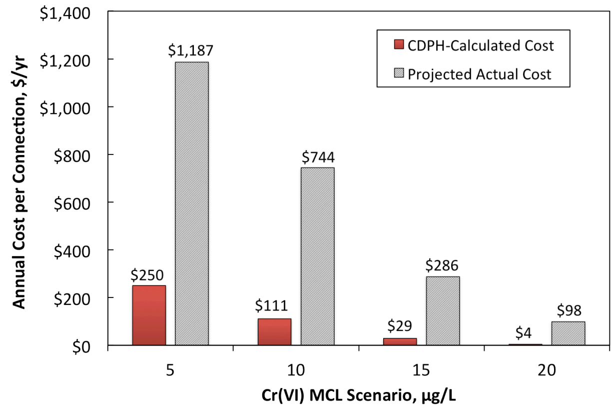

Figure 14 – Projected Actual vs. CDPH-Estimated Annual Cost of Compliance per Connection at the Coachella Valley Water District

Case Study #2 – City of Woodland

The City of Woodland serves drinking water to a population of approximately 56,500 people through 14,355 connections. The District's water supply is exclusively groundwater extracted from a total of 23 wells containing Cr(VI) levels ranging from 6 to 30 µg/L with an average of 18 µg/L. The City's WUR is 289 gpcd.

Figures 15 through 18 show the comparison between the projected actual costs and the CDPH-calculated costs for the City. CDPH projects the capital cost for the City at $46M at a Cr(VI) MCL of 10 µg/L. However, the actual cost is projected at $127M after accounting for the cost adjustment factors discussed earlier. Even at an MCL of 15 µg/L, the capital cost is projected at $120M, which is well above the $46M projected by CDPH at an MCL of 10 µg/L. At the MCL of 10 µg/L, the cost per household is calculated by CDPH at $555/yr, but is projected at $1,288/yr after including the cost adjustments. This is more than a two-fold increase in household cost over that projected by CDPH.

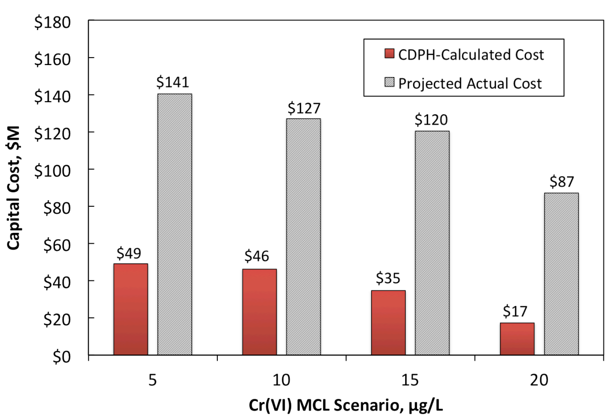

Figure 15 – Projected Actual vs. CDPH-Estimated Capital Cost of Compliance for the City of Woodland

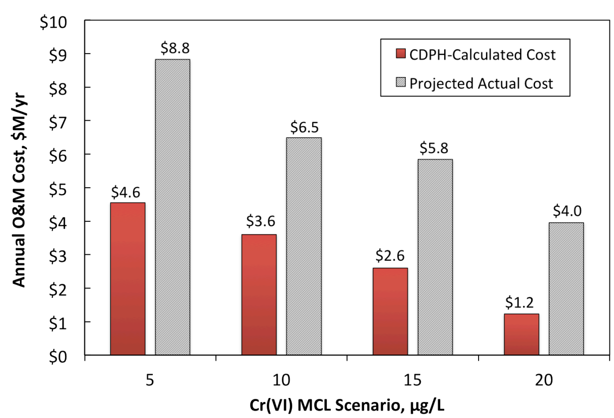

Figure 16 – Projected Actual vs. CDPH-Estimated Annual O&M Cost of Compliance for the City of Woodland

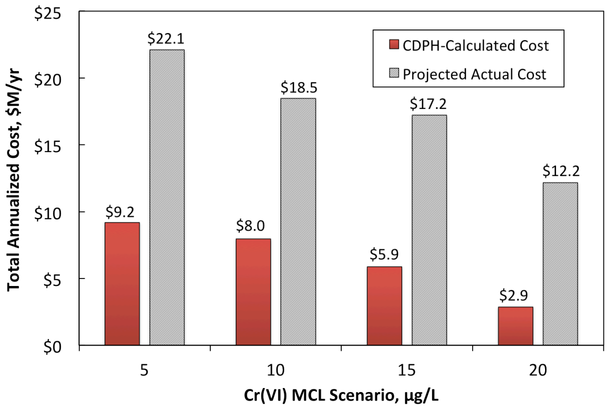

Figure 17 – Projected Actual vs. CDPH-Estimated Total Annualized Cost of Compliance for the City of Woodland

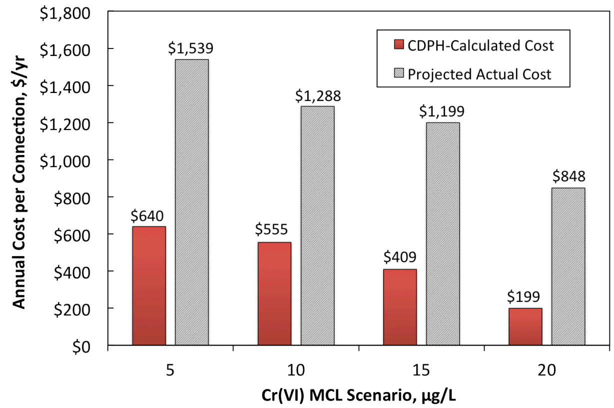

Figure 18 – Projected Actual vs. CDPH-Estimated Annual Cost of Compliance per Connection at the City of Woodland

Case Study #3 – Oak Trail Mutual Water Company

The Oak Trail Mutual Water Company serves drinking water to 105 people through 31 connections. The system's water supply is exclusively groundwater extracted from 2 wells. The water from one well contains 17 µg/L Cr(VI), while the water from the other well contains 19 µg/L Cr(VI). In the absence of system-specific WUR value, the adjusted value was set at 225 gpcd for this analysis.

Figures 19 through 22 show the comparison between the projected actual costs and the CDPH-calculated costs for this water system. CDPH projects the capital cost for the system at $1.8M for a Cr(VI) MCL of 10 µg/L. However, the actual cost is projected at $2.38M after accounting for the cost adjustment factors discussed earlier. Even at an MCL of 15 µg/L, the capital costs remain unchanged because the system's two wells contain Cr(VI) between 15 and 20 µg/L. At an MCL of 20 µg/L, CDPH determined that no treatment is required. However, since the two Cr(VI) levels are 17 µg/L and 19 µg/L, both of which are greater than 16 µg/L (i.e., 80% of the MCL of 20 µg/L), then both wells require treatment. Most important, Figure 22 shows that treating for Cr(VI) will result in an increase in the household cost of water by more than $14,000/yr at all four MCL values evaluated.

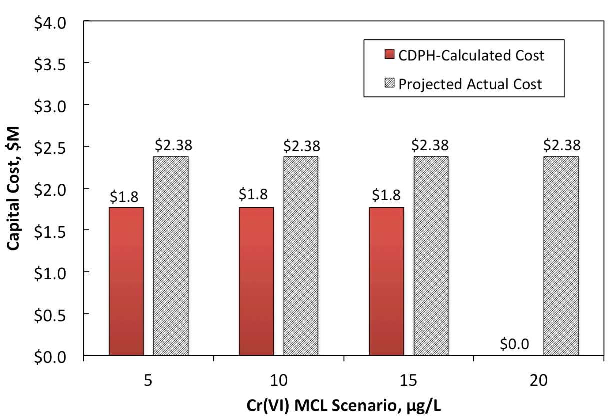

Figure 19 – Projected Actual vs. CDPH-Estimated Capital Cost of Compliance for the Oak Trail Ranch MWC

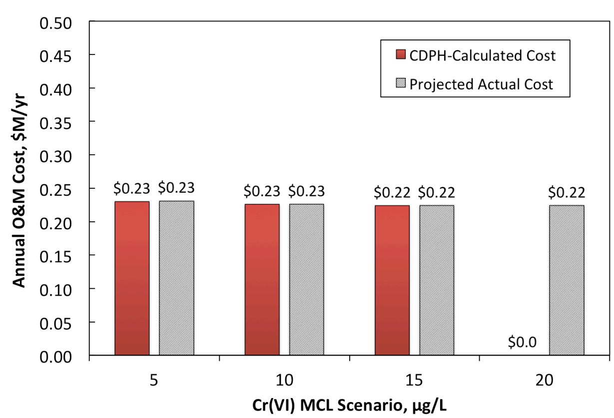

Figure 20 – Projected Actual vs. CDPH-Estimated Annual O&M Cost of Compliance for the Oak Trail Ranch MWC

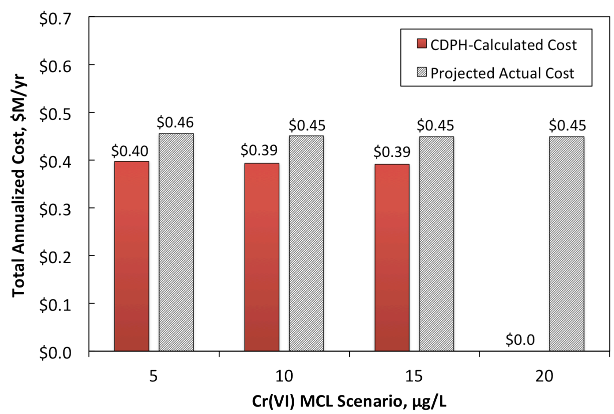

Figure 20 – Projected Actual vs. CDPH-Estimated Total Annualized Cost of Compliance for the Oak Trail Ranch MWC

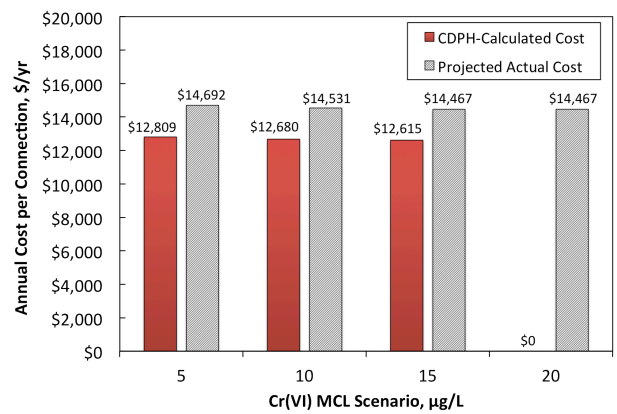

Figure 22 – Projected Actual vs. CDPH-Estimated Annual Cost of Compliance per Connection at the Oak Trail Ranch MWC

Case Study #4 – Tierra Buena Mobile Home Park #1

The Tierra Buena Mobile Home Park #1 has 50 residents with 17 water connections. The Park relies on one well for its water supply. The well contains 12 µg/L of Cr(VI). In the absence of system-specific WUR value, the adjusted value was set at 225 gpcd in this analysis.

Figures 23 through 26 show the comparison between the projected actual costs and the CDPH-calculated costs for this system. CDPH projects the WBA treatment system's capital cost at $890,000 for a Cr(VI) MCL of 10 µg/L. Using the cost adjustment factors discussed in this document, the actual cost is projected at $1.18M. Only if the MCL is set at 15 µg/L or higher will the system avoid the need to add Cr(VI) treatment. More important, Figure 26 shows that treating for Cr(VI) will result in an increase in the household cost of water by approximately $11,561/yr by CDPH's estimate, or $13,182/yr by WQTS' estimate.

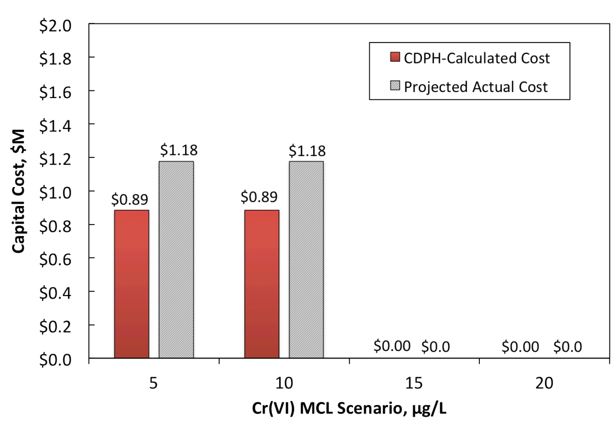

Figure 23 – Projected Actual vs. CDPH-Estimated Capital Cost of Compliance for the Tierra Buena Mobile Home Park #1

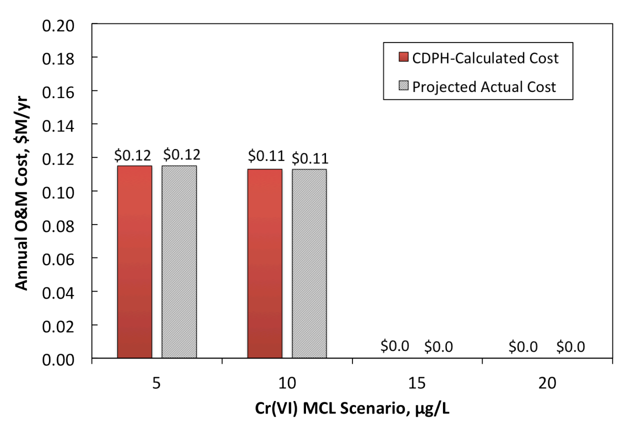

Figure 24 – Projected Actual vs. CDPH-Estimated Annual O&M Cost of Compliance for the Tierra Buena Mobile Home Park #1

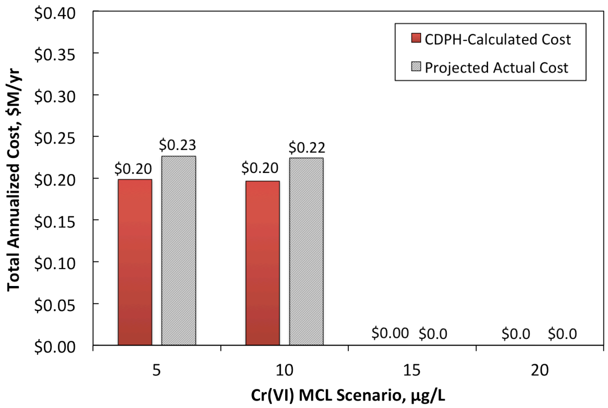

Figure 25 – Projected Actual vs. CDPH-Estimated Total Annualized Cost of Compliance for the Tierra Buena Mobile Home Park #1

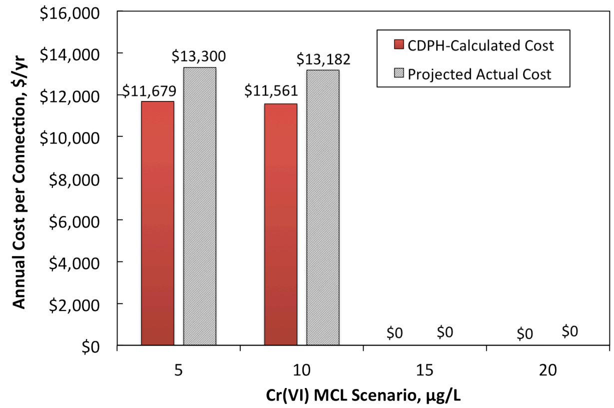

Figure 26 – Projected Actual vs. CDPH-Estimated Annual Cost of Compliance per Connection at the Tierra Buena Mobile Home Park #1

4.0 AFFORDABILITY

When setting a drinking water MCL, CDPH considers the PHG, any federal MCL, and technological and economic feasibility of compliance with the proposed standard. For the purposes of determining economic feasibility, CDPH considers the costs of compliance to public water systems, their customers, and other affected parties with the proposed primary drinking water standard, including the cost per customer and aggregate cost of compliance, using best available technology.

In its analysis, CDPH calculated the annual cost of compliance for an individual family (i.e., service connection) at different MCL scenarios. At a Cr(VI) MCL of 10 µg/L, CDPH estimated this value at $5,627/yr for small systems serving less than 200 connections. However, CDPH did not address the question of whether this value is affordable. In the Final Statement of Reasons for the arsenic MCL developed in 2008, CDPH indicates that for systems serving less than 200 service connections, the average per service connection (i.e. per household) cost ranges from $1,870 to $1,950 a year (for MCLs ranging from 2 to 10 µg/L). Responding to these high annual costs for small systems, CDPH states, "*For any family, this is a significant budget impact; for a family on a fixed income, this is probably not manageable. At an MCL of 0.010 mg/L, there are 136 [small] systems (4,580 service connections) that would be impacted to this extent*[6]*, for which funding approaches to achieve compliance would have to be developed. If the MCL were to be adopted at a more stringent level, the number of impacted systems, burdened families, and stress on loan programs would increase significantly.*"

CDPH goes on to state: "*The National Drinking Water Advisory Council (NDWAC) developed affordability criteria for MCL compliance (Recommendations of NDWAC to the U.S. EPA on its National Small Systems Affordability Criteria, July 2003. …California has not developed its own general affordability criteria, but was active in the NDWAC that drafted the cited recommendations and believes that they provide an excellent basis for evaluating a water system's ability to pay for treatment. The NDWAC's criteria for affordability is that the estimated annualized treatment cost per*

[6] On page 8 of the Arsenic MCL Revision Regulations, Final Statement of Reasons, the document incorrectly states that there are 276 small systems (4,580 services connections) that would be impacted at an MCL of 0.010 mg/L. According to the DPH document there are a total of 276 of all sizes (Table 3) that would be impacted at an MCL of 0.010 mg/L. According to the DPH information, there were 136 small systems (with 4,580 service connections, Table 4)) impacted at the MCL of 0.010 mg/L. For all other sizes there were 140 systems (with 1,085,272 service connections).

household (i.e. service connection) for treatment to comply with an MCL should not exceed 1% of the median household income (MHI) in the community within which the customers served by the water system reside." With reference to the arsenic MCL, CDPH also stated that "*...even at the federal (arsenic) MCL of 0.010 mg/L the average per service connection MCL compliance cost of $1,870/year for the smallest water systems exceeds by more than several magnitudes 1% of either the disadvantaged community or statewide MHI. Since the MHIs provided are average, it is important to note that there will likely be communities with MHIs below the average that will be required to install treatment to comply with the arsenic MCL, shouldering an even greater burden related to affordability.*"

4.1 Statewide Affordability

Table 3 presents a comparison between the annual household costs for small systems for meeting the arsenic MCL of 10 μg/L and that for meeting the proposed Cr(VI) MCL of 10 μg/L. These values are those developed by CDPH for both rules, and do not reflect any of the cost adjustments discussed in this report. The table also presents information on the percent of Median Household Income (MHI) for the various MCL costs. For the arsenic MCL, CDPH determined that the cost impacts for small systems were not sustainable, nor sufficiently justified the benefits. However, DPH was required to adopt an arsenic MCL that is no less stringent than the federal MCL, and thus settled on 10 μg/L.

Based on the values listed in Table 3, the annual household costs for small systems for the proposed Cr(VI) MCL dwarf the costs of compliance with the arsenic MCL. The household costs estimated by CDPH, which he analysis in this report shows to be grossly underestimated, already exceed readily available benchmarks of affordability. Finalizing a Cr(VI) MCL at a level where household costs exceed these benchmarks sets the stage for protracted compliance challenges with systems in violation and severe stress on the State's revolving loan fund program.

Table 3 – Comparison of Household Costs of the Cr(VI) MCL to that of the Arsenic MCL for Small Systems as Calculated by CDPH for both Rules

Cr(VI) MCL Evaluated, μg/L	Annual Cost per SWS Connection	Percent of MHI*
1	$7,159	12.2%
5	$6,679	11.4%
10	$5,627	9.6%
15	$5,866	10.0%
20	$5,472	9.3%
25	$4,237	7.2%
30	$4,143	7.0%

As MCL Evaluated, μg/L	Annual Cost per SWS Connection	Percent of MHI*
2	$1,960	3.7%
4	$1,850	3.7%
6	$1,880	3.6%
8	$1,950	3.7%
10	$1,870	3.6%

* The California MHI for the Arsenic MCL was set at $52,400, while that for the Cr(VI) MCL was set at $58,553.

4.2 Community-Specific Affordability

For the four case studies presented in Section 3 of this report, the household cost impact was compared with the area-specific MHI value at four MCL levels: 5 µg/L, 10 µg/L, 15 µg/L, and 20 µg/L. The area-specific MHI values are the average values for the postal zip-code in which the system is located, and are based on the period of 2006 through 2010.[7] The household costs as a percent of local MHI are presented in Figures 27 through 30 for the four case studies discussed herein. The cost as percent of MHI increases with decreasing system size. However, using the adjusted cost values, the cost per household is well above the threshold of 1% for all four systems evaluated. The profiles in Figures 27 and 28 show that the actual household costs for the Coachella Valley water District and the City of Woodland are far above those projected by CDPH.

For a medium-sized system, such as that of the City of Woodland, the household cost of compliance with a Cr(VI) MCL of 10 µg/L represents 2% of MHI compared with the CDPH-calculated value of 0.9%. Even for an MCL of 15 µg/L, WQTS projects the household cost to be 1.8% of MHI. For the two small systems evaluated (Figures 29 and 30), the household cost for implementing any Cr(VI) treatment amounts to 16% and 21% of the system-specific MHI's, respectively. Even CDPH's calculated values are approximately 14% and 18% for the two systems. Under no foreseeable circumstance will either of these two systems be able to afford the implementation of Cr(VI) treatment. In addition, it is noted that the annual O&M costs are approximately half the total annualized cost (see Figures 20 and 21 for the Oak Trail MWC, and Figures 24 and 25 for the Tierra Buena Mobile Home Park). Therefore, even if the State funds the capital cost of treatment, the annual O&M costs will still amount to about 8% of MHI for the Oak Trail WMC and 10% of MHI for the Tierra Buena Mobile Home Park. These continue to be well outside the reach of either community.

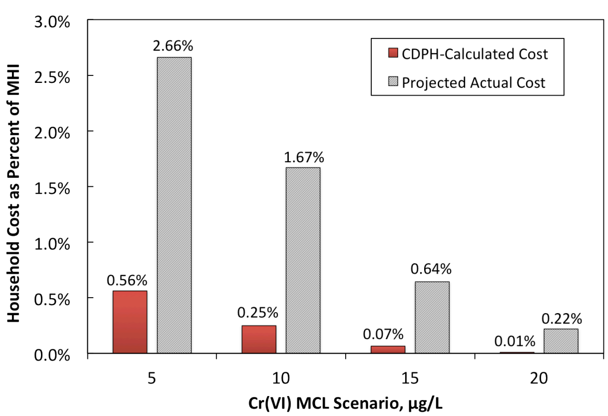

Figure 27 – Household Cost Impact as a Percent of Local MHI at the Coachella Valley Water District (2010 MHI = $44,572)

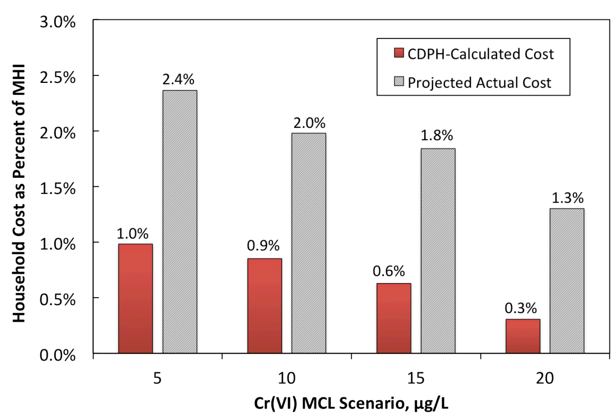

Figure 28 – Household Cost Impact as a Percent of Local MHI at the City of Woodland (2010 MHI = $65,104)

[7] http://www.psc.isr.umich.edu/dis/census/Features/tract2zip/index.html

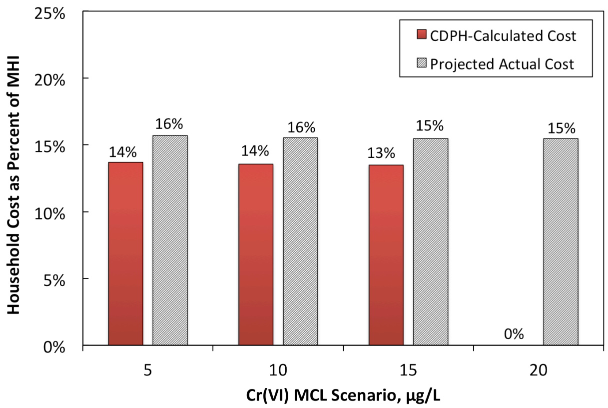

Figure 29 – Household Cost Impact as a Percent of Local MHI at the Oak Trail Mutual Water Co. (2010 MHI = $93,544)

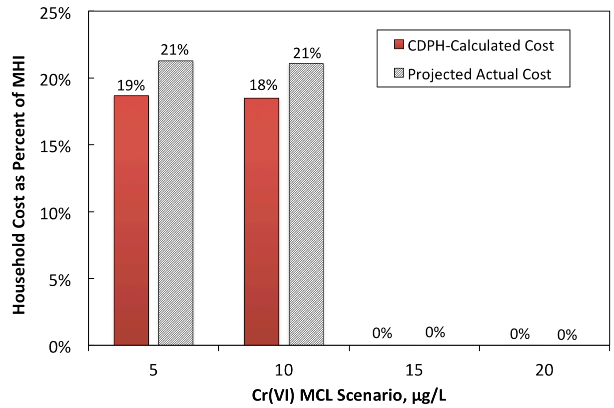

Figure 30 – Household Cost Impact as a Percent of Local MHI at the Tierra Buena Mobile Home Park (2010 MHI = $62,526)

5.0 SUMMARY

The economic analysis conducted by CDPH in the development of the draft Cr(VI) MCL made a number of assumptions that resulted in a gross under-estimation of the cost impact of the MCL on the State as a whole, and on individual California communities. The following is a summary list of these assumptions and how they were corrected in the economic analysis presented in this report:

1. CDPH used only the Cr(VI) monitoring results from a limited number of sources to represent the entire State. With the addition of total Chromium monitoring results to the database, the number of impacted systems increases dramatically.

2. CDPH assumed a low water usage rate of only 150 gpcd to estimate the size of the treatment system needed at each impacted source. Using information published by the California Department of Water Resources in 2012, WQTS determined that the average water usage rate in the State is more likely to be 225 gpcd, a 50% increase over that used by CDPH. WQTS also used system specific water usage rates, when available, instead of the State-average value. The use of these modified water usage rates results in the need for larger treatment systems compared to those projected by CDPH.

3. In estimating the sizes of the treatment systems required, CDPH also used a peaking factor of 1.5 for all water sources. WQTS' analysis shows that a peaking factor of 2.5 is more appropriate. The higher peaking factor results in the need for larger treatment systems that those projected by CDPH.

4. CDPH assumed that all treatment systems can be accommodated at the existing well sites, and no additional land is required. WQTS' analysis provided an allowance for land acquisition based on the anticipated size of the treatment system.

5. CDPH assumed that no building is required to house any of the treatment system components. Due to a number of factors, WQTS believes that a treatment building is necessary to provide cover to many of the treatment system components, and to allow the treatment system to blend into the surrounding neighborhoods. In its economic analysis, WQTS provided an allowance for the construction of a building to house the treatment system.

6. CDPH assumed that sources with estimated average Cr(VI) levels at or below 10.49 μg/L do not need to install treatment to meet with the 10 μg/L MCL since the 10.49 μg/L is rounded-down to 10 μg/L. In accordance with USEPA's guidelines, and with proper allowance for potential fluctuations on the Cr(VI) levels, WQTS' economic analysis assumes that any source containing Cr(VI) within 80% of the MCL will require treatment to remove Cr(VI) to a safe level below 80% of the MCL.

With all the above adjustments, WQTS' economic analysis shows that the cost of compliance with the draft Cr(VI) MCL is projected to be far higher than that estimated by CDPH. For example, at an MCL of 10 μg/L, CDPH's analysis suggests that the statewide capital cost is $871 million. Based on the cost adjustments listed above, WQTS's analysis shows that the statewide capital cost can be as high as $4.1 billion. That is more than four (4) times higher than that projected by CDPH.

This report also includes case studies of four water systems serving between 50 and more than 200,000 people. The economic analysis shows that the projected costs for the large and medium-sized systems are far higher than those projected by CDPH. More important, the analysis shows that the household cost for complying with the draft MCL of 10 μg/L exceeds the affordability threshold of 1% of median house income (MHI) for all four systems evaluated. This is especially true for the small systems evaluated where the cost of treatment represents as much as 21% of the system's MHI. It is doubtful that these systems, and many others like them in California, will be able to afford implementing and/or operating Cr(VI) treatment systems.