ASSESSMENT OF THE CURRENT CORROSION-CONTROL PRACTICES AT ZONE 7'S WATER TREATMENT PLANTS

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September 12, 2017

SECTION 1.0 – INTRODUCTION

The federal Lead and Copper Rule (LCR) was promulgated in 1992. Under the LCR, public water systems conduct routine tap monitoring for lead and copper and water quality parameters. The objective of the LCR is to determine if the water served to customers is optimized for corrosion control. There are different mechanisms described in the LCR to determine whether or not a given water supply would be considered optimized for corrosion control.

The purpose of this assessment is to evaluate the corrosivity of treated water produced by the water treatment plants owned and operated by the Zone 7 Water Agency (Zone 7) and to identify possible areas for improvement, if any. To conduct this assessment, lead and copper data, water quality data, and water production data were collected from Zone 7 and its four retail agencies. In general, data analyzed were from 2009 through 2016.

Over the past several years there has been a significant increase in interest in lead exposure through drinking water. This has occurred primarily following and in response to the circumstances that occurred in Flint, Michigan. An additional objective of this assessment was to review recent activities regarding the LCR and potential future changes and to highlight specific areas of concern for Zone 7, if any.

ORGANIZATION OF REPORT

The following is an outline of the sections of this report:

1. Lead and Copper Rule (Current Rule and Potential Future Revisions)
2. Background on Water Quality Parameters and Corrosion Control Indices
3. Description of the Zone 7 Water Agency System (and retail agencies)
4. Zone 7 Water Quality
5. Zone 7 Customer Reports
6. Zone 7 Lead and Copper Results
7. Retail Agencies
    a. City of Livermore
    b. California Water Service – Livermore
    c. City of Pleasanton
    d. Dublin San Ramon Services District
8. Summary, Conclusions and Recommendations

Appendix A: Mocho Wells Water Quality

Appendix B: Solubility Diagrams

Appendix C: Zone 7 Map with LCR Sample Locations for Direct Customers

SECTION 2.0 – LEAD & COPPER RULE

The Federal LCR became effective in 1991, with minor changes and clarifications published in January 2000 and another revision in 2007. California's rule is substantially the same as the Federal rule.

The LCR has four basic requirements:

1. Require water suppliers to optimize their treatment system to control corrosion in customer's plumbing;
2. Determine tap water levels of lead and copper for customers (targeting worst case homes);
3. Determine if source water is a source of lead; and,
4. If the lead action level is exceeded, educate customers about lead and suggest actions they can take to reduce their exposure to lead through public notices and public education programs.

The LCR established Action Levels (AL) for both lead and copper. The lead AL is 0.015 mg/L, while the copper AL is 1.3 mg/L. The lead AL is exceeded if the concentration of lead in more than 10% of all tap samples collected during a monitoring period (i.e., 90^{th} percentile level) exceeds 0.015 mg/L. Similarly, the copper AL is exceeded if the 90^{th} percentile copper concentration is higher than 1.3 mg/L. The Detection Limit for Purposes of Reporting (DLR) for lead is 0.005 mg/L, and the DLR for copper is 0.050 mg/L. California also has a secondary Maximum Contaminant Limit (MCL) for copper of 1.0 mg/L that applies to water supplied to a distribution system, not customer taps.

The LCR is one of the most complicated drinking water regulations. The following section presents an overview of the initial and follow up requirements under the LCR.

1. After promulgation of the LCR, water systems were to conduct two six-month rounds of customer tap sampling for lead and copper, as well as monitor for certain corrosion-related water quality parameters (WQPs).
2. The customer taps were to be selected such that those homes most likely to have high lead and/or copper concentrations were sampled (Tier 1 sites), and they had to be first-draw samples.
3. The number of homes sampled was based on population served by the water system.
4. Large water systems (serving populations greater than 50,000) had to conduct a corrosion-control study and submit a report to the Division of Drinking Water (DDW) detailing the optimal corrosion control treatment, based on the study's results.
5. The corrosion control study was not required if the system was deemed to have already optimized corrosion control treatment based on home tap results from the two six-month monitoring events.

6. The Division of Drinking Water was to then make a determination of the optimal corrosion control treatment based on the study and/or the tap-sampling results.
7. If a system was not deemed to be “optimized” for corrosion control based on home tap results, the system was required to propose and, if approved, install corrosion control treatment.
8. After installation of the corrosion control treatment, two additional six-month rounds of tap sampling and WQP monitoring were required.
9. The next step was for DDW was to review the installation and designate enforceable values and/or ranges (e.g., minimum pH values) for the optimal WQPs.
10. The system was to continue to operate in accordance with the designated optimal WQPs values. Compliance with the WQPs was to be determined every six months. Medium sized water systems (serving populations greater than 3,300 and less than 50,000) were required to monitor for WQP if they exceed an Action Level. DDW may require medium systems to then conduct a corrosion control study based on home tap and WQP monitoring results.
11. The LCR includes source water monitoring requirements for lead and copper.
12. All water systems would continue to conduct customer home tap monitoring.

Table 1 presents the number of home tap and WQP samples required based on population served (the table presents the “standard” and “reduced” number of locations).

Table 1: Number of Sites Required for Sampling

	Lead and Copper Tap Samples		Water Quality Parameters	
System size (Population served)	**Standard Monitoring**	**Reduced Monitoring**	**Standard Monitoring**	**Reduced Monitoring**
>100,000	100	50	25	10
10,001 – 100,000	60	30	10	7
3,301 – 10,000	40	20	3	3
501 – 3,300	20	10	2	2
101 – 500	10	5	1	1
≤100	5	5	1	1

There are few additional requirements under the LCR that are unique to California. For example, if lead is detected above the action level in more than 5% but less than 10% of the samples, then additional language is required in the Consumer Confidence Reports (Title 22, §64482). Title 22, Section 64679, Supplemental Monitoring, also states that “*A water system with a lead action level exceedance shall offer to sample the tap water of any customer who requests it. The system is not required to pay for collecting or analyzing the sample.*”

Federal Reduction of Lead in Drinking Water Act

On January 4, 2011 the "Reduction of Lead in Drinking Water Act" (PL 111-380) was signed into law amending section 1417 of the Safe Drinking Water Act. The amendment addressed the "use and introduction into commerce of lead pipes, plumbing fittings or fixtures, solder and flux." The "lead free" requirements went into effect in January 2014 (the definition of lead free in the federal amendments is consistent with the existing California definition, i.e., lead solders and flux shall contain no more than 0.2% lead and wetted surfaces of pipes, pipe fittings, plumbing fittings and fixtures shall contain no more than 0.25% lead).

National Drinking Water Advisory Council (NDWAC) LCR Working Group

The NDWAC LCR Working Group was formed in 2014. The goal of the LCR Working Group was to provide advice to EPA regarding potential revisions to the LCR. The NDWAC LCR working group was asked to address the five issues listed below:

- Sample site selection criteria,
- Lead sampling protocols,
- Public education for copper,
- Measures to ensure optimal corrosion control treatment, and
- Lead service line replacement.

In December 2015 the LCR Working submitted their final report to EPA. The NDWAC LCR Working Group made the following recommendations:

1. "Require proactive lead service line (LSL) replacement programs, which set replacement goals, effectively engage customers in implementing those goals, and provide improved access to information about LSLs, in place of current requirements in which LSLs must be replaced only after a lead action level (AL) exceedance;
2. Establish more robust public education requirements for lead and LSLs, by updating the Consumer Confidence Report (CCR), adding targeted outreach to consumers with lead service lines and other vulnerable populations (pregnant women and families with infants and young children), and increasing the information available to the public;
3. Strengthen corrosion control treatment, retaining the current rule requirements to re-assess corrosion control treatment if changes to source water or treatment are planned, adding a requirement to review updates to EPA guidance to determine if new scientific information warrants changes;
4. Modify monitoring requirements to provide for consumer requested tap samples for lead and to utilize results of tap samples for lead to inform consumer action to reduce the risks in their homes, to inform the appropriate public health agency when results are above a designated household action level, and to assess the effectiveness of corrosion control treatment and/or other reasons for elevated lead results;

5. Tailor WQPs to the specific corrosion control treatment plan for each system, and increase the frequency of WQP monitoring for process control;
6. Establish a health-based, household action level that triggers a report to the consumer and to the applicable health agency for follow up;
7. Separate the requirements for copper from those for lead and focus new requirements where water is corrosive to copper; and
8. Establish appropriate compliance and enforcement mechanisms."

Recent Activity Regarding Lead in Drinking Water

In April 2014 the City of Flint, Michigan changed the supply of drinking water. Prior to April 2014, the City purchased treated drinking water from the Detroit Water and Sewerage. In April 2014, Flint, Michigan stopped purchasing water from Detroit and switched to local treatment of the Flint River. Treated water purchased from Detroit Water and Sewerage was treated with a corrosion inhibitor. Soon after switching to the Flint River supply residents began complaining of color and odor issues. By February 2015 information indicated elevated levels of lead in the drinking water and reports of increased blood lead levels in children living in Flint. The situation in Flint, Michigan has become a national issue, and while a detailed discussion of the timeline of events is beyond the scope of this report, the high levels of lead in Flint triggered a number of responses by regulatory agencies that impact water systems across the country. The following presents a list and brief description of these items:

February 2016. EPA sent letters to all Governors and heads of primacy agencies requesting assistance to assure the "public that we are doing everything we can to work together to address risks from lead in drinking water." Requested actions included review of state protocols and procedures implementing the LCR, ensure water systems are following appropriate guidance for sample collection and conduct of corrosion control studies, increase transparency in the implementation of the LCR.

February 2016. EPA released the memorandum "Clarification of Recommended Tap Sampling Procedures for Purposes of the Lead and Copper Rule." This short document recommended that sampling instructions for customers not include (a) a "pre-stagnation flushing," (2) that faucet aerators not be removed and cleaned as part of the home tap sample collection, and (3) that wide-mouth bottles should be used for home tap sample collection to allow for higher flow rate. EPA included a one-page suggested format/content of the instructions provided to customers collecting first draw tap samples.

March 2016. California DDW provided a memorandum to all public water systems "Recommendations for Enhanced Public Access to Lead and Copper Rule Related Information." The purpose of this document was to encourage public water systems to "enhance their public outreach efforts on and the availability of LCR compliance-related information." DDW included a reminder that public water systems are required to provide results to all customers that participated in the home tap sampling.

September 2016. California Senate Bill 1398 is signed into law. This new law requires that by July 2018 public water systems are to prepare an inventory of known lead service lines in their distribution system. After preparing the inventory, public water systems are to prepare and submit to the State Water Resources Control Board (SWRCB) a timeline for removal of the lead service lines. If there are areas of the distribution system that may have lead service lines, but the information is not certain, for these situations by July 2020 public water systems are to (a) either confirm the presence or absence of lead service lines or (b) submit to the SWRCB a timeline for removal of service lines where it cannot be determined if the material is lead.

October 2016. EPA issued the memorandum "Implementation of the Lead and Copper Rule Provisions Related to Sample Site Selection and Triennial Monitoring." The intent of this document was to ensure that public water systems continue to update their materials evaluation of distribution system piping and ensure that a sufficient number of Tier 1 monitoring locations are included. This memorandum also clarified the needed steps for a system to return to reduced triennial monitoring after exceeding the Action Level for lead.

October 2016. EPA released the "Lead and Copper Rule Revisions White Paper." This White Paper provides background information on the LCR, highlighted the recommendations of the NDWAC LCR Working Group and identified key LCR issues being evaluated by EPA for potential future revisions. The issues being considered for revisions include the following: (1) lead service line replacement, (2) modifications to corrosion control treatment requirements, (3) development of a "Health Based Benchmark" (EPA is using this description for the NDWAC's recommended Household Action Level), (4) potential use of Point-of-Use (POU) filters in specific situations, (5) modifications of tap sample collection requirements, (6) increased transparency and information sharing with the public, (7) revised public education requirements, and (8) separating and modifying the requirements for copper from the requirements for lead.

January 2017. EPA published a *Federal Register* notice requesting nominations for peer reviewers on modeling efforts for blood lead levels in infants (part of the effort to develop the "Household Action Level" recommended by the NDWAC LCR Working Group). At the same time EPA released documentation on modeling approaches being considered by the Agency.

January 2017. California DDW issued permit amendments for public water systems regarding testing for lead in drinking water at schools. By July 1, 2017 public water systems are required to prepare and submit to DDW a list of all kindergarten through 12th grade schools served by the system. By November 1, 2019 if a kindergarten through 12th grade school makes a request to the public water system to test for lead, then the public water system must prepare a sampling plan for that school, collect up to five first draw samples for lead and provide the results to the school.

SECTION 3.0 – WATER QUALITY PARAMETERS & CORROSION INDICES

This section presents a brief description of water quality parameters (WQP) that are related to the corrosivity of water. In addition, descriptions are presented of corrosion indices included in this evaluation.

Water Quality Parameters

The following WQPs are related to the corrosivity of water and are included in this assessment:

Temperature: Warmer water temperatures could increase corrosion rates and also increase the tendency for $CaCO_3$ to precipitate.

pH: pH is the major factor that determines the solubility of most metals (Schock, AWWA Water Quality and Treatment, 1990). Higher pH may decrease corrosion rates and can help protect distribution system piping, whereas a lower pH may increase the corrosion rate of metals.

Alkalinity: The alkalinity of water is a measure of its ability to resist pH change. In natural waters, alkalinity is calculated as the sum of carbonate, bicarbonate and hydroxide equivalents and is reported as mg/L as $CaCO_3$. Waters with a higher alkalinity have a greater "buffering capacity" (i.e., a stronger capacity to resist changes in pH).

Chloride and sulfate: Chloride and sulfate ions could cause pitting of metallic pipe by reacting with metals in solution and causing them to stay soluble. This prevents the formation of protective metallic oxide films on the surface of the pipes. Research indicates that chloride is about three times as active as sulfate in causing this effect. The ratio of chloride to sulfate has been used as a potential indicator of the corrosivity of water.

Dissolved inorganic carbonate (DIC): DIC is an estimate of the amount of total carbonates in water measured as mg C/L. The level of DIC in the water can impact the stability of pH and relates to the buffering capacity of water.

Total Dissolved Solids (TDS)/Conductivity: The water's conductivity is important for corrosion activity in terms of completing the electrochemical circuit responsible for corrosion reactions. The type of ions that compose the TDS can be important factors affecting corrosion.

Corrosion Indices

This assessment of corrosivity of drinking water provided by Zone 7 and the retail agencies includes the calculation and evaluation of the following corrosion indices: the Aggressive Index (AI), the Langelier Saturation Index (LSI), the Calcium Carbonate Precipitation Potential (CCPP) and the chloride to sulfate mass ratio (CSMR). The following presents a brief description of the guidelines used to interpret the AI, LSI, CCPP, and CSMR results.

Aggressive Index (AI): The concept of AI was initially developed as a guide for determining whether asbestos/cement pipe was the appropriate material for a given solution. The AI is a simplified form of the Langelier Saturation Index and is calculated using the pH, total alkalinity, and calcium hardness of a water. The general guidelines for interpreting the calculated AI are as follows:

AI ≥ 12	Water is non-aggressive
AI = 10 – 11.9	Water is moderately aggressive
AI < 10	Water is aggressive

Langelier Saturation Index (LSI): the LSI is calculated based on the difference between the pH of the water and the "saturation pH" (pH_s). The LSI is used to predict the calcium carbonate stability of water, that is, whether the water will precipitate, dissolve, or be in equilibrium with calcium carbonate. The following general guidelines are used for interpreting LSI results:

LSI < 0	Water is under saturated with $CaCO_3$ and tends to dissolve $CaCO_3$
LSI = 0	Water is in equilibrium with $CaCO_3$, a layer of $CaCO_3$ is neither precipitated nor dissolved
LSI > 0	Water is supersaturated with $CaCO_3$ and tends to precipitate $CaCO_3$

Water with a positive LSI is expected to precipitate a film of $CaCO_3$ onto the surface of the pipes. This would protect the metal pipe surface from the corrosive nature of water. Alternatively, water with a negative LSI would not precipitate a film of $CaCO_3$, and therefore, does not protect the metal surface from the corrosive nature of water. Water with a negative LSI is not necessarily more corrosive than water with a positive LSI; rather it is that <u>water with a negative LSI is not as protective of the pipe surfaces as water with a positive LSI</u>. In general, a positive LSI is desirable, but it is reasonable to operate with an LSI in the range of –0.5 to +0.5. However, each water may require a different goal to match its corrosion control needs.

Calcium Carbonate Precipitation Potential (CCPP): the CCPP calculates the theoretical amount of $CaCO_3$ that will precipitate or dissolve from the solution as it comes to equilibrium under given water quality conditions. The following general guidelines are used for interpreting CCPP results:

CCPP < 0	Water tends to dissolve $CaCO_3$
CCPP = 0	Water is in equilibrium with $CaCO_3$, and a layer of $CaCO_3$ is neither precipitated nor dissolved
CCPP > 0	Water tends to precipitate $CaCO_3$

A typical goal is to maintain a CCPP between 4 and 10 mg/L as $CaCO_3$. A water with a CCPP in this range should experience the precipitation of a slight protective film of $CaCO_3$, but not too much precipitation to cause plugging of ports and orifices or hydraulic problems in the system.

Chloride to Sulfate Mass Ratio (CSMR): In Journal AWWA articles (Edwards & Triantafyllidou, 2007; Nguyen, et al., 2011), the authors reviewed the potential importance of the CSMR on galvanic corrosion and the leaching of lead from solder and plumbing fixtures, particularly brass fixtures. The authors reported that in a survey of 23 utilities, if the CSMR was less than 0.58, then the 90th percentile lead result was below the lead action level. This observation held true for 12 out of the 12 utilities where the ratio was less than 0.58. However, if the CSMR was greater than 0.58, the authors reported that only 4 out of 11 utilities had a 90th percentile lead result less than 15 μg/L. The authors concluded that water with a CSMR greater than 0.58 could be associated with increased leaching of lead from solder and brass fixtures. It is believed that sulfate in water can be beneficial by reducing galvanic currents and also through the formation of relatively insoluble $PbSO_4$ solids. Chloride is believed to enhance the dissolution of lead by increasing galvanic current and through the formation of soluble complexes such as $PbCl^+$.

WQTS Model Used in Calculation of Corrosion Indices. An internal WQTS, Inc. model 'Calcium Carbonate Precipitation Potential' was used to generate AI, LSI and CCPP values. The model was also used to generate DIC values, which were used for preparation of the lead solubility diagrams for the Del Valle WTP and the Patterson Pass WTP.

SECTION 4.0 – ZONE 7'S WATER SYSTEM

Zone 7 operates two surface water treatment plants: the Del Valle Water Treatment Plant (DVWTP) and the Patterson Pass Water Treatment Plant (PPWTP). DVWTP is a 40.9-MGD conventional filtration plant with SuperPulsators® followed by anthracite/sand media filters. Disinfection is achieved with chlorine followed by ammonia addition to form chloramine as water enters the distribution system. The PPWTP has two parallel trains: one is a 12 MGD conventional train that includes an upflow clarifier, followed by media filtration, chlorination, and ammonia addition. The second train is an 8 MGD train that includes an upflow clarifier, followed by membrane ultrafiltration (UF), chlorination, and ammonia addition. The UF train has been offline since June 2015 and staff indicated that it may not be restarted as Zone 7 will be expanding the capacity of the conventional train. Efforts are underway for ozone to be online as the primary disinfectant at the DVWTP by fall of 2019 and fall of 2021 at the PPWTP. Ozone will increase the concentration of dissolved oxygen (DO) in the finished water. While DO can be an important constituent impacting the corrosivity of drinking water, it is not expected to cause an increase in corrosivity of Zone 7's drinking water supplies.

Both plants treat water that originates mostly from the Sacramento-San Joaquin Delta and is transported to the plants via the South Bay Aqueduct (SBA). PPWTP draws water from Patterson Reservoir, which is an impoundment on the SBA, while DVWTP draws water directly from the SBA. The California Department of Water Resources frequently releases water from Lake Del Valle into the SBA at a location upstream of the DVWTP takeoff on the SBA. Therefore, influent water to DVWTP can either be 100% Delta water or a blend of Delta water and Lake Del Valle water. Lake Del Valle water represents a mix of SBA water pumped into the Lake during the rainy season, and local runoff.

Zone 7 owns and operates ten wells located in four different wellfields. The four wellfields: Hopyard, Mocho, Stoneridge and Chain of Lakes are located in the western portion of the service area. In addition, Zone 7 operates the Mocho Groundwater Demineralization Plant (MGDP). The combined capacity of the 10 wells is approximately 42.3 MGD (10.8 MGD of the total capacity of the wells is intended for use during emergency and drought conditions). Table 2 presents the rated capacities for each well.

Table 2: Zone 7 Wells and Rated Capacity

Facility	Rated Capacity (MGD)
Hopyard 6	7.1
Hopyard 9	5.5
Mocho 1	6.5
Mocho 2	3.2
Mocho 3	6.0
Mocho 4	5.3
Stoneridge	6.6
Chain of Lakes 1	3.6
Chain of Lakes 2	5.0
Chain of Lakes 3	2.2
Total	**42.3**

In addition to being a wholesaler, Zone 7 also serves approximately 43 direct customers via thirteen turnouts/service connections. Zone 7's direct customers are mostly a transient population with the exception of one single family home near the PPWTP. Zone 7 supplies drinking water to the following four retail agencies:

- City of Livermore
- California Water (Cal Water) Service Company – Livermore District
- Pleasanton
- Dublin San Ramon Services District (DSRSD)

Zone 7's retail customers provide drinking water to a total population of 238,000. Table 3 presents the population served by each retail agency.

Table 3: Population Served by Zone 7's Retail Agencies (2015)

Agency	Population Served
Cal Water Livermore	57,400
DSRSD	80,200
Livermore	28,200
Pleasanton	72,200
Total	**238,000**

Zone 7's transmission system is 41 miles in length with pipeline sizes ranging from 12 to 48 inches in diameter. The majority of the Zone 7 transmission pipelines were built in the 1960's and later. The oldest Zone 7 pipeline is the Hopyard Pipeline originally constructed in 1943 and reconstructed in 1951. Transmission piping is primarily steel (54%) and concrete cylinder (39%), with a small amount of PVC (6%) and ductile iron (1%). All pipelines are cement-mortar lined except the 12,320-foot PVC Sycamore Pipeline and the approximately 1,200-foot HDPE pipeline connecting Mocho Wells 1, 2 and 3 to the MGDP. Table 4 presents an inventory of Zone 7's transmission piping. Table 5 presents information on pipeline material for the connections to Zone 7's direct customers. It is noted that there are no known lead service lines in Zone 7's system.

Table 4: Zone 7 Transmission System Piping

Pipeline	Size (in)	Length Installed (ft)	% Pipe Length	Pipeline Material
Altamont	42	26,700	12	steel
Chain of Lakes	36	7,800	4	steel
Cross Valley	36	40,794	19	concrete cylinder
Del Valle	36	14,156	6	concrete cylinder
	48	4,787	2	concrete cylinder
Hopyard	18	2,240	1	concrete cylinder
	20	8,980	4	concrete cylinder
Livermore	24	10,450	5	steel
	24	9,580	4	concrete cylinder
	27	10,920	5	steel
Mocho	24	8,004	4	steel
Santa Rita	16	2,731	1	ductile iron
Santa Rita –	24	12,870	6	steel
Dougherty	24	640	0	concrete cylinder
	24	4,552	2	concrete cylinder
Sycamore	12	12,319	6	PVC
Vasco	18	6,550	3	steel
Vineyard	36	34,530	16	steel

Table 5: Zone 7 Direct Customer Connections Piping

Turnout	Customer	Pipeline Material
VAMC 2, VAMC 3	Veteran's Hospital	high density polyethylene (HDPE) ductile iron cement-lined ductile iron copper PVC
LARPD 1, 2 and 3	Parks – drinking fountains at Sycamore Park, irrigation, restrooms and kitchen at administrative building at Veterans Park	PVC copper
Boys Ranch/EBRPD	Camp Arroyo – Environmental Education Center and Summer Youth Camp	PVC and ductile iron copper
Wente	Restaurant	PVC copper
Residences	Private single-family residences	HDPE galvanized iron copper
Zone 7 Parkside Office and Landscaping	Former Zone 7 office	copper
LLNL	Lawrence Livermore National Laboratory (LLNL)	Asbestos Cement

Figure 1 presents the annual percent contribution for Zone 7 sources from 2009 through 2016. During this period, the DVWTP and PPWTP produced the majority of drinking water. During 2015 and 2016 over 90% of production was from the two surface water treatment plants.

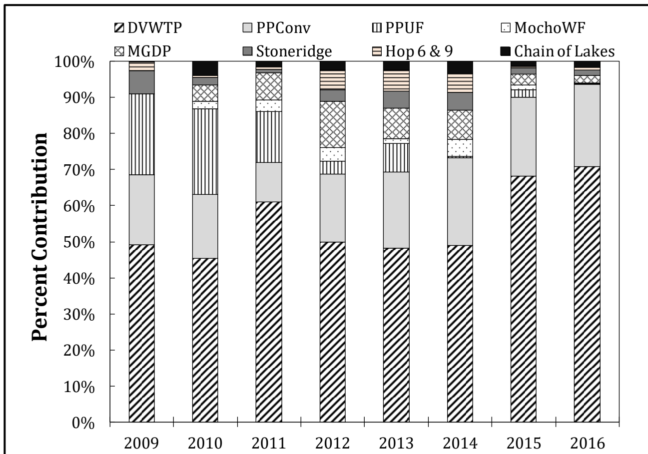


Figure 1: Annual Percent Contribution from Each Zone 7 Source (2009 – 2016)

SECTION 5.0 – ZONE 7 WATER QUALITY

In 1997 the SWRCB DDW approved pH adjustment for Zone 7's surface water as optimal corrosion control treatment. Zone 7 adjusts pH using caustic soda. Historically, Zone 7 has used two corrosion indices to assess corrosivity of the water. These two indices are the Aggressive Index (AI) and the Calcium Carbonate Precipitation Potential (CCPP). Zone 7 operators use the AI and CCPP to determine a target pH for each WTP effluent on a weekly basis. The operational goals are to maintain a "non-corrosive" condition (i.e., AI ≥ 12) and to maintain the pH within +/- 0.2 units of the weekly target pH. For this assessment, the AI, LSI and CCPP are the primary corrosion indices that were calculated and reviewed. In June 2016, Zone 7 staff increased the target AI for the DVWTP and PPWTP effluent from ≥12.0 to 12.2. The CCPP objective for the MGDP is 4 to 10 mg/L as $CaCO_3$.

Water Quality

Zone 7 conducts routine monitoring for water quality parameters related to the corrosivity of water at the effluent of the surface water treatment plants and each of the wells. Water quality results for Zone 7's sources were collected from 2009 through 2016 for pH, alkalinity, calcium, TDS, temperature, hardness, sulfate and chloride. For this assessment, Zone 7 provided water quality data collected from the locations and at the frequencies described in Table 6.

Table 6: Zone 7 Water Quality Sample Locations, Constituents and Frequency

Location	Constituents	Frequency
DVWTP Effluent	pH, alkalinity, Ca, TDS, temp, hardness, Cl, SO_4	Monthly (some constituents weekly)
PPWTP Effluent	pH, alkalinity, Ca, TDS, temp, hardness, Cl, SO_4	Monthly (some constituents weekly)
Individual wells	pH, alkalinity, Ca, TDS, temp, hardness, Cl, SO_4	Varies (less frequently than surface WTPs)
MGDP	pH, alkalinity, Ca, TDS, temp, hardness, Cl, SO_4	Monthly (some constituents weekly)
POE*/Distribution Taps During LCR Monitoring Events	pH, alkalinity, Ca, TDS, temp	2 POE*/2-4 taps each monitoring event
Retail Agency Turnouts	pH, alkalinity, Ca, TDS, temp, hardness, Cl, SO_4	2-4 times/year

* POE = Point of Entry

Table 7 presents water quality results for the DVWTP and the PPWTP. The average effluent pH for both plants was 8.4. However, each treatment plant showed a significant amount of variability in pH during 2009 through 2016. The treated water for both WTPs has moderate levels of hardness, alkalinity and TDS.

Table 7: Water Quality Data for DVWTP and PPWTP (2009 – 2016)

Parameter		DVWTP	PPWTP
pH	Average	8.4	8.4
	Range	7.7 – 9	8 – 9
Alkalinity (mg/L $CaCO_3$)	Average	81	78
	Range	40 – 152	49 – 104
Calcium (mg/L)	Average	23	22
	Range	10 – 37	13 – 36
TDS (mg/L)	Average	311	345
	Range	123 – 600	191 – 520
Temperature (°C)	Average	17.9	19.2
	Range	9.3 – 24.9	8 – 27
Hardness (mg/L as $CaCO_3$)	Average	110	112
	Range	42 – 170	64 – 174
Sulfate (mg/L)	Average	33	37
	Range	9.2 – 75	13 – 79
Chloride (mg/L)	Average	103	125
	Range	29 – 223	61 – 196

Figures 2 and 3 present daily effluent pH for the DVWTP and the PPWP, respectively[1]. The pH generally ranged between 8.0 and 8.5, with occasional fluctuations as low as 7.3 and as high as 9.0.

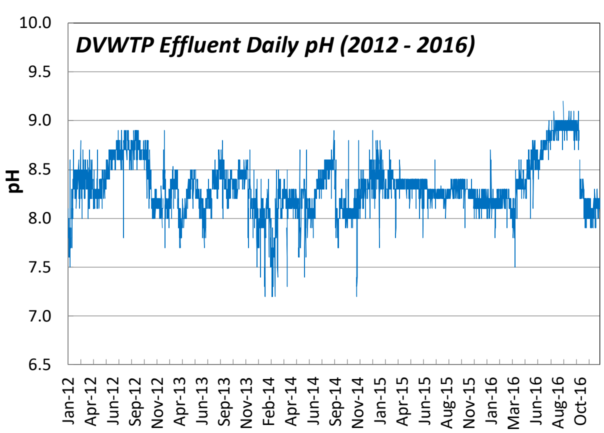


Figure 2: DVWTP Effluent Daily pH (2012 – 2016)

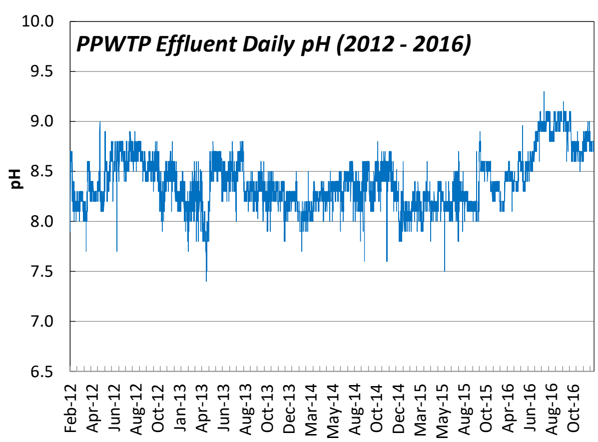


Figure 3: PPWTP Effluent Daily pH (2012 – 2016)

Table 8 presents water quality data for the three Chain of Lakes (COL) wells. The average pH for all three wells was approximately 7.4, the water produced by all three wells have elevated levels of alkalinity, hardness and TDS.

[1] In the data provided, there were a few unusually high and low individual pH values. When these data points clearly appeared to be outliers, they were not included in the presentation of the recorded pH data.

Table 8: Water Quality Data for Chain of Lakes (COL) Wells (2009 – 2016)

Parameter		COL 1	COL 2	COL 5
pH	Average	7.4	7.3	7.4
	Range	7 – 7.6	7 – 7.5	7.2 – 7.5
Alkalinity (mg/L $CaCO_3$)	Average	263	222	244
	Range	246 – 285	206 – 240	231 – 252
Calcium (mg/L)	Average	64	54	56
	Range	54 – 76	47 – 63	50 – 65
TDS (mg/L)	Average	479	408	428
	Range	443 – 532	364 – 444	399 – 455
Temperature (°C)	Average	17.5	18.2	19.2
	Range	16.6 – 18.3	16.7 – 19.7	18.6 – 20.4
Hardness (mg/L as $CaCO_3$)	Average	362	299	307
	Range	340 – 379	278 – 337	290 – 324
Sulfate (mg/L)	Average	45	39	41
	Range	38 – 53	31 – 45	38 – 45
Chloride (mg/L)	Average	76	61	56
	Range	69 – 86	49 – 74	46 – 70

Table 9 presents water quality data for the two Hopyard wells. The average pH for both wells was approximately 7.5. The wells have high alkalinity, hardness, and TDS.

Table 9: Water Quality Data for Hopyard Wells (2009 – 2016)

Parameter		Hopyard 6	Hopyard 9
pH	Average	7.5	7.4
	Range	7 – 7.9	7 – 7.8
Alkalinity (mg/L $CaCO_3$)	Average	345	283
	Range	329 – 361	275 – 290
Calcium (mg/L)	Average	84	74
	Range	81 – 93	71 – 81
TDS (mg/L)	Average	622	488
	Range	590 – 660	467 – 510
Temperature (°C)	Average	17.7	17.9
	Range	16.5 – 18.6	16.8 – 19.2
Hardness (mg/L as $CaCO_3$)	Average	402	353
	Range	382 – 418	340 – 364
Sulfate (mg/L)	Average	79	47
	Range	74 – 83	44 – 50
Chloride (mg/L)	Average	87	65
	Range	82 – 94	53 – 85

Appendix A presents water quality data for the Mocho wells. Table 10 presents water quality data for the MGDP. The average pH for the MGDP was 7.7, with a reported ranged of 7.1 to 9.1. The MGDP had moderate levels of alkalinity, hardness and TDS.

Table 10: Water Quality Data for MGDP (2009 – 2016)

Parameter	Average	Range
pH	7.7	7.1 – 9.1
Alkalinity, mg/L $CaCO_3$	171	82 – 331
Calcium, mg/L	43	13 – 85
TDS, mg/L	341	149 – 680
Temperature, °C	18.4	12.3 – 21.6
Hardness, mg/L as $CaCO_3$	215	86 – 413
Sulfate, mg/L	35	13 – 71
Chloride, mg/L	63	26 – 115

Table 11 presents water quality data for the Stoneridge well. The average pH was 7.6, with moderate levels of alkalinity, TDS, and hardness.

Table 11: Water Quality Data for Stoneridge Well (2009 – 2016)

Parameter	Average	Range
pH	7.6	7.1 – 8
Alkalinity, mg/L $CaCO_3$	248	217 – 304
Calcium, mg/L	53	42 – 75
TDS, mg/L	435	358 – 628
Temperature, °C	19.5	18.2 – 20.7
Hardness, mg/L as $CaCO_3$	288	234 – 395
Sulfate, mg/L	41	31 – 53
Chloride, mg/L	60	41 – 113

Corrosion Indices

Using the water quality data presented in Tables 7 through 11, corrosion indices were calculated for Zone 7's sources and are presented in Table 12. The average LSI for all sources was slightly positive (COL 2 LSI was slightly negative at -0.05, but is considered equivalent to 0). For all sources, the range of LSI values included slightly negative values to slightly positive values. The average CCPP value for COL 2 is negative, while the average CCPP of all of the other sources are positive. The range of calculated CCPP values for the DVWTP and the PPWTP varied from negative to positive with average CCPP values of 1.9 and 1.6, respectively. The average (and range) of calculated CSMR values was greater than 1.0 for all of Zone 7's sources. As described previously, a CSMR greater than 0.6 has been in theory associated with an increased leaching of lead from solder and brass fixtures. The average AI values for all sources were very near the threshold value of 12. The average AI values for DVWTP, PPWTP, COL 1, HOP 6, HOP 9, MGDP and Stoneridge wells were at or slightly greater than 12.0. The average AI for COL 2 and COL 5 were slightly less than 12. All of the sources ranged from an AI less than 12 to greater than 12. As stated previously, in June 2016 Zone 7 staff modified the DVWTP and PPWTP weekly AI target from 12.0 to 12.2.

Table 12: Zone 7 Corrosion Indices in All Sources (2009 – 2016)

	LSI		CCPP, mg/L $CaCO_3$		CSMR		AI	
Source	**Avg**	**Range**	**Avg**	**Range**	**Avg**	**Range**	**Avg**	**Range**
COL 1	0.10	−0.3 to 0.3	5.6	−29 to 20	1.7	1.5 to 1.8	12.0	11.6 to 12.2
COL 2	−0.05	−0.4 to 0.1	-4.2	−33 to 7	1.6	1.4 to 1.7	11.8	11.5 to 12.0
COL 5	0.05	−0.2 to 0.2	2.5	−13 to 13	1.4	1.1 to 1.6	11.9	11.7 to 12.1
DVWTP	0.19	−0.4 to 0.9	1.9	−4 to 12	3.4	1.1 to 7.7	12.1	11.4 to 12.8
HOP 6	0.40	−0.1 to 0.8	32.8	−10 to 48	1.1	1.0 to 1.1	12.3	11.9 to 12.7
HOP 9	0.24	−0.2 to 0.6	12.2	−22 to 34	1.4	1.2 to 1.8	12.1	11.7 to 12.5
MGDP	0.11	−0.9 to 1.1	3.1	−27 to 46	1.8	1.5 to 2.2	12.0	10.9 to 13.0
PPWTP	0.18	−0.3 to 0.6	1.6	−3 to 6	3.9	1.8 to 6.7	12.0	11.4 to 12.5
STONERIDGE	0.29	−0.2 to 0.5	13.3	−18 to 30	1.5	1.2 to 2.1	12.2	11.7 to 12.4

The following sections present figures generated to evaluate the changes in AI, LSI, CCPP and pH for Zone 7's sources over time. When reviewing these figures the important role of pH in the calculations becomes clear. In the figures presented below, for the surface water supplies and for several groundwater sources there were recorded pH values that were somewhat lower than most of the other recorded pH values. For example, in Figure 7 for the DVWTP, there were a few recorded pH values less than 8, while the majority of pH results fell within the range of 8.2 to 8.7. When the recorded pH is less than 8 there is a dip in the calculated AI, LSI and CCPP values in Figures 4, 5 and 6.

Similarly, for wells such as the Hopyard wells and the COL wells, there occasionally were recorded pH values around 7 (below the typically recorded values of 7.4 ± 0.2). The lower pH values lead to calculated AI, LSI and CCPP values that are somewhat lower than the majority of calculated values. From the information presented in Figure 1, it appears that Zone 7 significantly reduced groundwater production (likely due to drought conditions) during 2014 and 2015. While beyond the scope of this review, it is possible that wells being rested for extended periods to allow the groundwater basin to recover, and then being turned on for a short period to allow water quality testing, could have resulted in pH values that were outside of the expected range during typical operating conditions. It is also possible that field equipment and/or field techniques played a role in the lower pH values recorded.

DVWTP AI, LSI and CCPP Values. Figures 4, 5 and 6 present the calculated AI, LSI and CCPP values, respectively, for the DVWTP effluent. The water quality data used to calculate the AI, LSI and CCPP values were collected approximately monthly. The AI values ranged from 11.4 to 12.8. As previously indicated, in June 2016 Zone 7 increased the target AI for DVWTP from ≥12.0 to 12.2. The final two AI data points presented in Figure 4, July and October 2016, are 12.1 and 12.4, respectively. As shown in Figure 5, the LSI values for the DVWTP effluent fluctuated from positive (0.9) to slightly negative (-0.4) during the period 2009 through 2016. Likewise in Figure 6, the calculated CCPP values varied from negative (-4) to positive (12). Figure 7 presents the pH values that were used to calculate the AI, LSI and CCPP values for the DVWTP. The DVWTP pH values ranged from 7.7 to 9, with an average pH of 8.4.

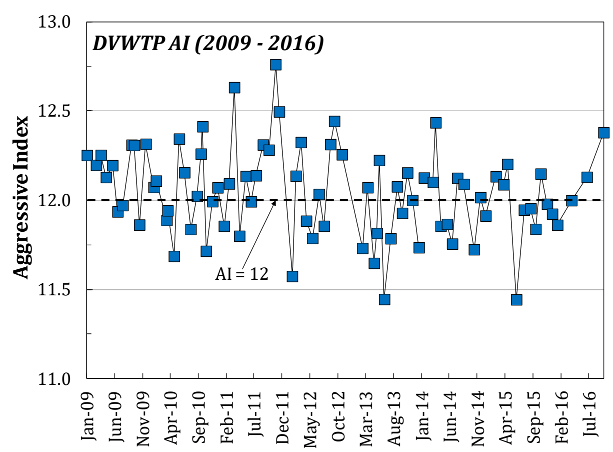


Figure 4: DVWTP Effluent AI Values

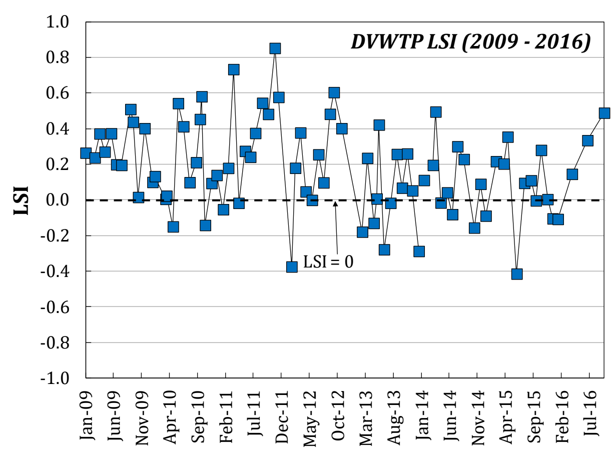


Figure 5: DVWTP Effluent LSI Values

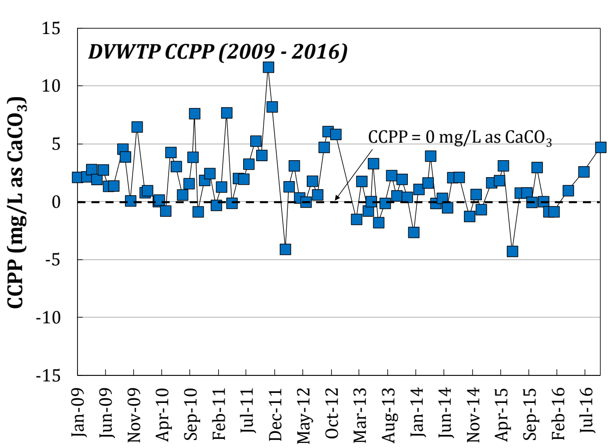


Figure 6: DVWTP Effluent CCPP Values

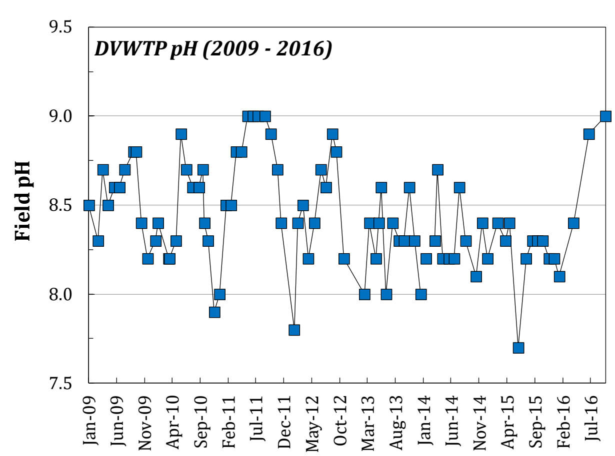


Figure 7: DVWTP Effluent pH Values

PPWTP AI, LSI and CCPP Values. Figures 8, 9 and 10, present the calculated AI, LSI and CCPP values, respectively, for the PPWTP. The water quality data used to calculate the AI, LSI and CCPP values were collected approximately monthly. In Figure 8 the AI values ranged from 11.4 to 12.5. As indicated previously, in June 2016 Zone 7 increased the target AI for PPWTP from ≥12.0 to 12.2. The last four AI data points in Figure 8, June through October 2016, ranged from 12.1 to 12.4. In Figure 9, the calculated LSI values fluctuated from slightly positive (0.6) to slightly negative (-0.3) during the period of 2012 through 2016. As indicated in Figure 10, the calculated CCPP values (in mg/L as $CaCO_3$) varied from negative (-3) to positive (6) during 2012 through 2016. Finally, Figure 11 presents the effluent pH values used to calculate the corrosion indices. The pH values for the PPWTP varied from 8 to 9.

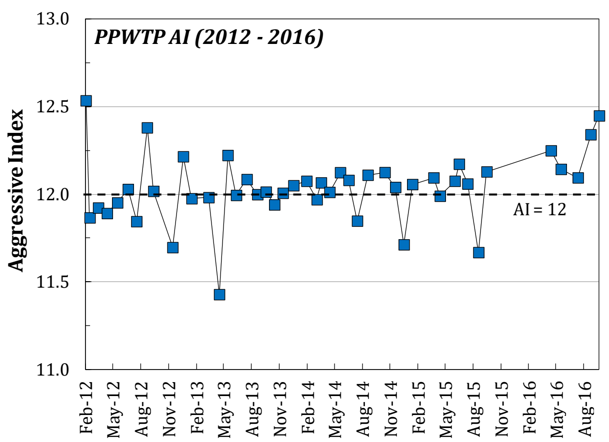


Figure 8: PPWTP Effluent AI Values

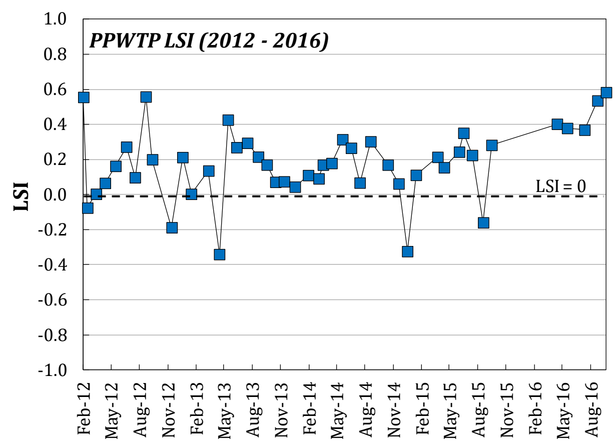


Figure 9: PPWTP Effluent LSI Values

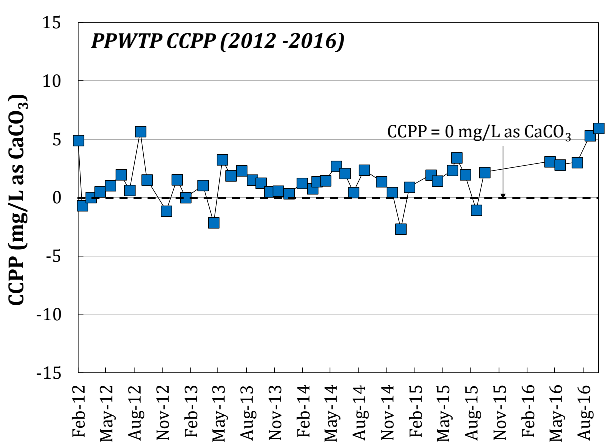


Figure 10: PPWTP Effluent CCPP Values

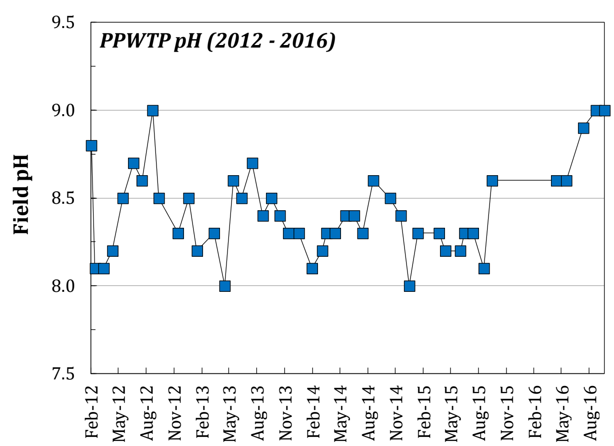


Figure 11: PPWTP Effluent pH Values

Using available water quality data, similar figures were generated for some of Zone 7's groundwater sources. Figures 12, 13 and 14 present the calculated AI, LSI and CCPP values, respectively, for the Hopyard 6 well. The AI values ranged from 11.9 to 12.7, but were primarily greater than 12.0. The LSI values ranged from -0.1 to 0.8, but all but one of the calculated LSI values were greater than zero. The CCPP values ranged from -10 to 48 mg/L as $CaCO_3$ (other than a single CCPP value less than zero, the results ranged from 7 to 48 mg/L as $CaCO_3$). Figure 15 presents the pH values used to calculate the AI, LSI and CCPP values for Hopyard 6 well. The pH values ranged from 7 to 7.9. The two lowest pH values of 7 and 7.1 were recorded in June and September of 2014 and led to the lowest calculated corrosion indices.

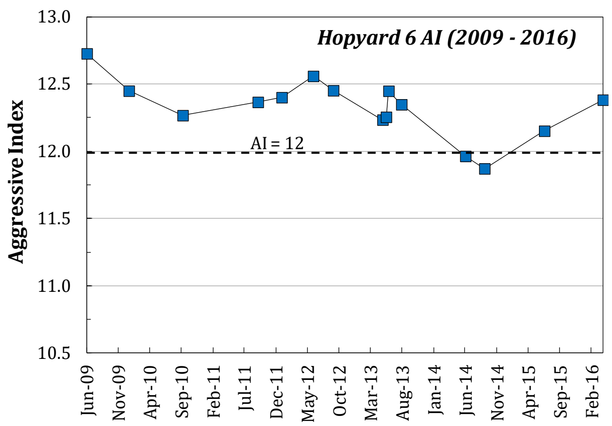


Figure 12: Hopyard 6 AI Values

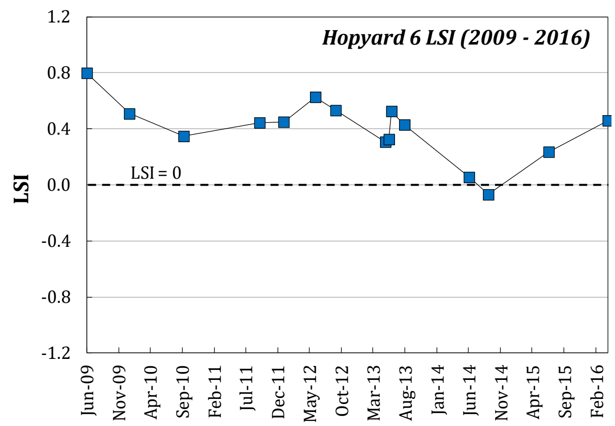


Figure 13: Hopyard 6 LSI Values

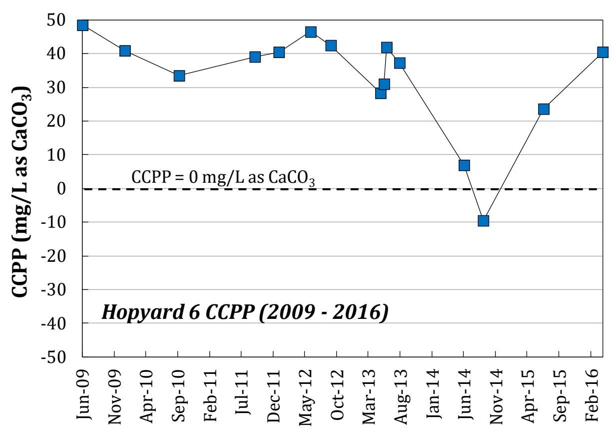


Figure 14: Hopyard 6 CCPP Values

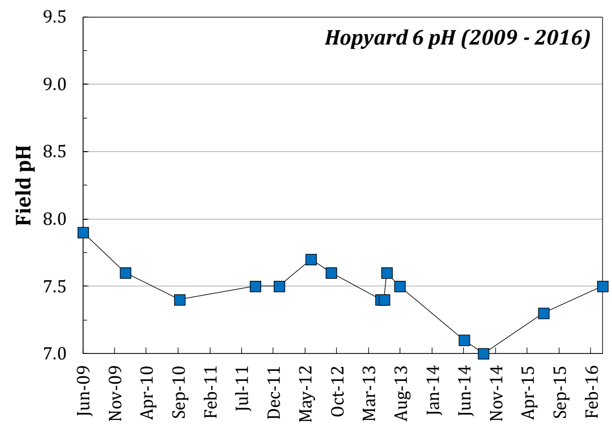


Figure 15: Hopyard 6 pH Values

Figures 16, 17 and 18 present the calculated AI, LSI and CCPP values for the COL 1 well. The calculated AI values ranged from 11.6 to 12.2. The calculated LSI values ranged from -0.3 to 0.3. The CCPP values ranged from -29 to 20 mg/L as $CaCO_3$. Figure 19 presents the pH values recorded during 2010 through 2016. The recorded pH values ranged from 7 to 7.6. The lowest pH value of 7 was recorded in June 2014 and is associated with the low calculated corrosion indices in Figures 16 through 18.

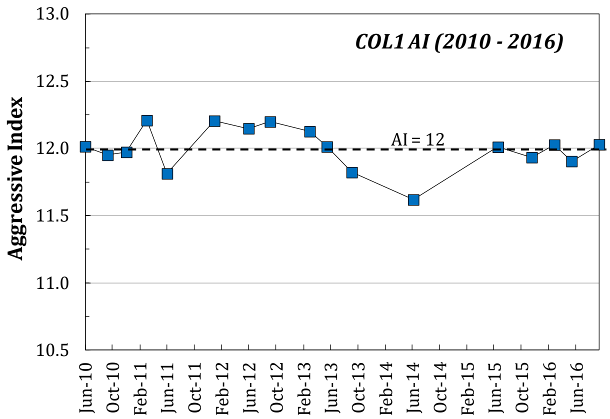


Figure 16: COL 1 AI Values

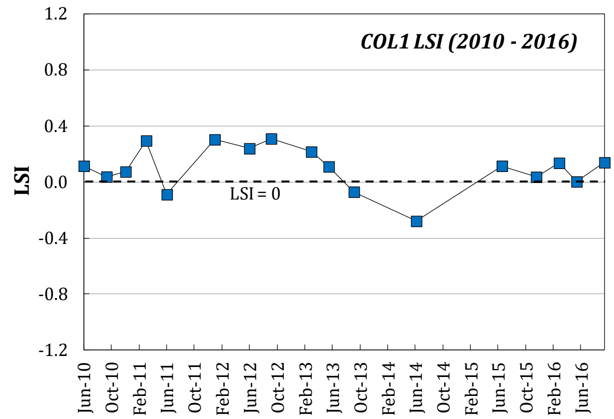


Figure 17: COL 1 LSI Values

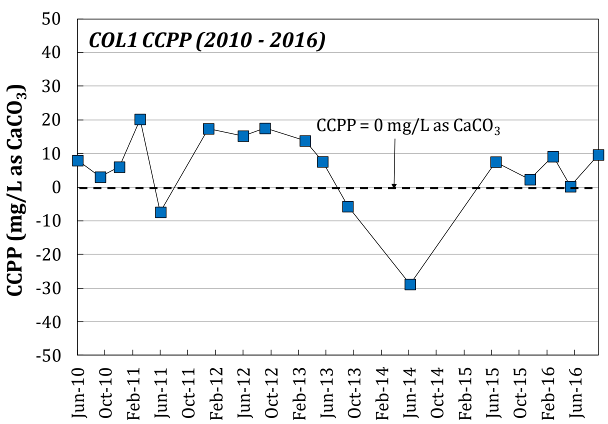


Figure 18: COL 1 CCPP Values

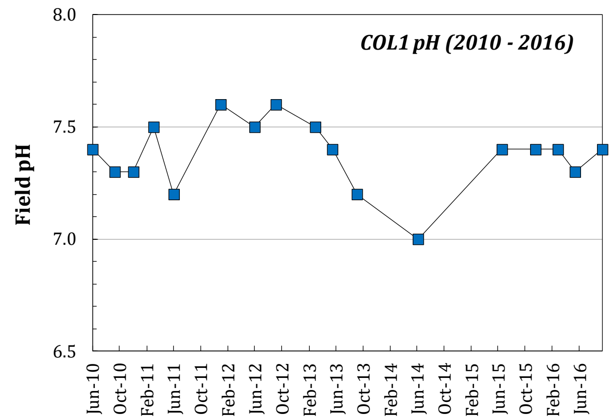


Figure 19: COL 1 pH Values

Figures 20, 21 and 22 present the calculated AI, LSI and CCPP values, respectively, for the COL 2 well. The calculated AI values ranged from 11.5 to 12.0. The calculated LSI values ranged from -0.4 to 0.1. The CCPP values ranged from -33 to 7 mg/L as $CaCO_3$. Figure 23 presents the pH values recorded during 2010 through 2016. pH ranged from 7 to 7.5. The lowest pH value of 7 was recorded in June 2014 and is associated with the low calculated corrosion indices in Figures 20 through 22.

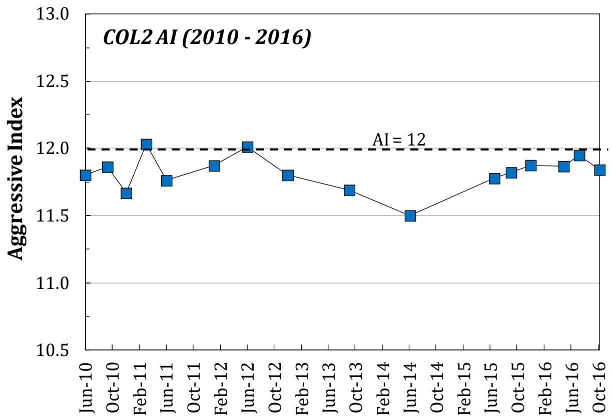


Figure 20: COL 2 AI Values

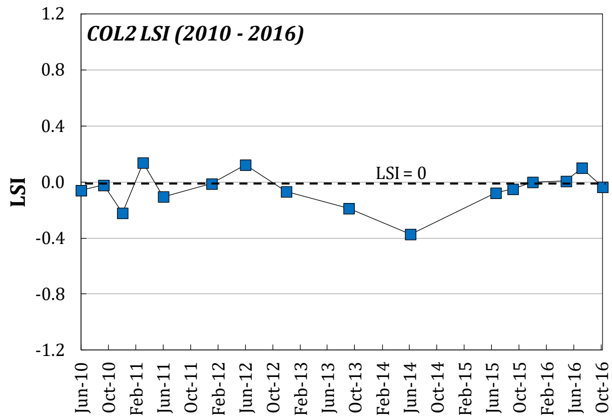


Figure 21: COL 2 LSI Values

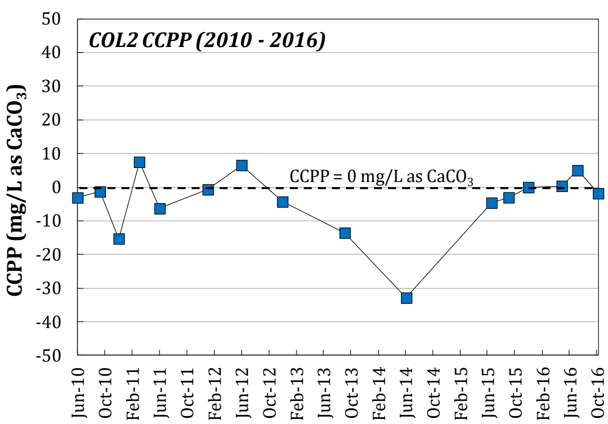


Figure 22: COL 2 CCPP Values

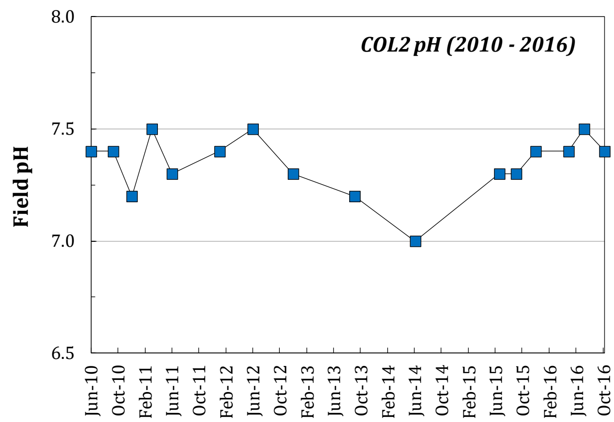


Figure 23: COL 2 pH Values

Figures 24, 25 and 26 present the calculated AI, LSI and CCPP values, respectively, for the COL 5 well. The calculated AI values ranged from 11.7 to 12.1. The calculated LSI values ranged from -0.2 to 0.2. The CCPP values ranged from -13 to 13 mg/L as $CaCO_3$. Figure 27 presents the pH values recorded during 2010 through 2016. The recorded pH values ranged from 7.2 to 7.5. The lowest pH values of 7.2 were recorded in October and again in November 2014 and are associated with the low calculated corrosion indices in Figures 24 through 26.

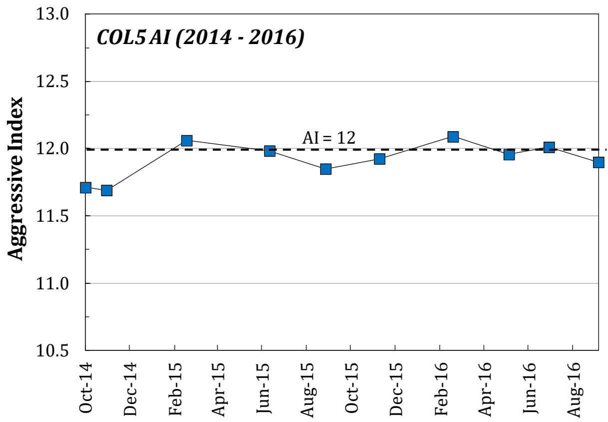


Figure 24: COL 5 AI Values

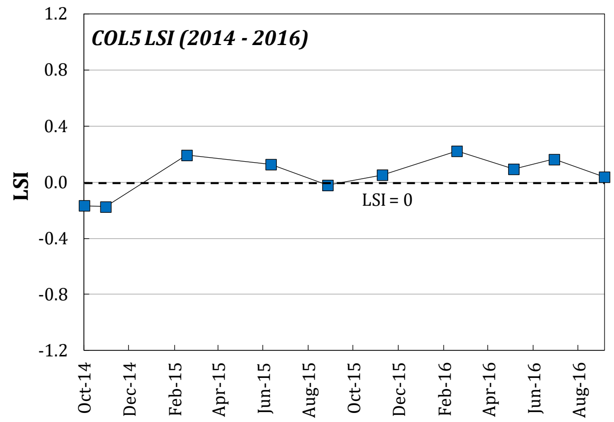


Figure 25: COL 5 LSI Values

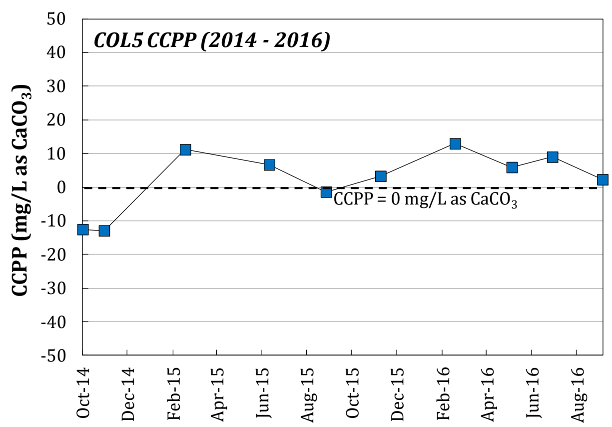


Figure 26: COL 5 CCPP Values

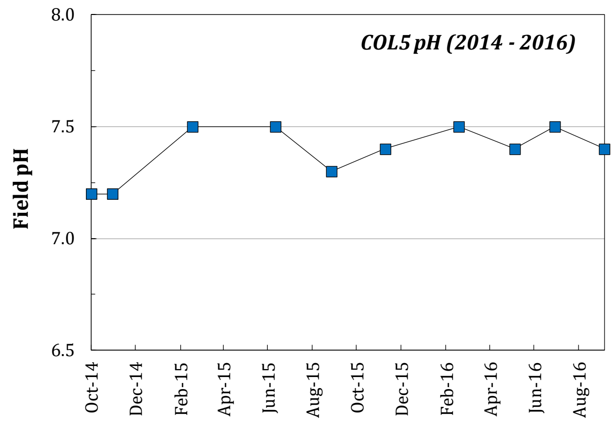


Figure 27: COL 5 pH Values

Figures 28, 29 and 30 present the calculated AI, LSI and CCPP values for the MGDP. The AI values ranged from 10.9 to 13.0. The calculated LSI values ranged from -0.9 to 1.1. The calculated CCPP values ranged from -27 to 46 mg/L as $CaCO_3$. Figure 31 presents the recorded pH values for the MGDP. The pH ranged from 7.1 to 9.1. During California's 2012-2015 drought Zone 7 limited the operation of the MGDP due to declining groundwater levels.

Figures 32, 33 and 34 present the calculated AI, LSI and CCPP values, respectively, for the Stoneridge well. The calculated AI values ranged from 11.7 to 12.4. The calculated LSI values ranged from -0.2 to 0.5. The calculated CCPP values ranged from -18 to 30 mg/L as $CaCO_3$. The recorded pH values ranged from 7.1 to 7.8 and are presented in Figure 35. The lowest pH value of 7.1 was recorded in June 2014 and is associated with the drop in all three corrosion indices.

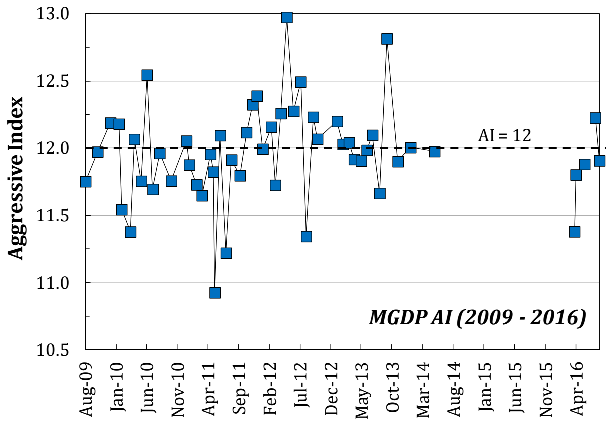


Figure 28: MGDP AI Values

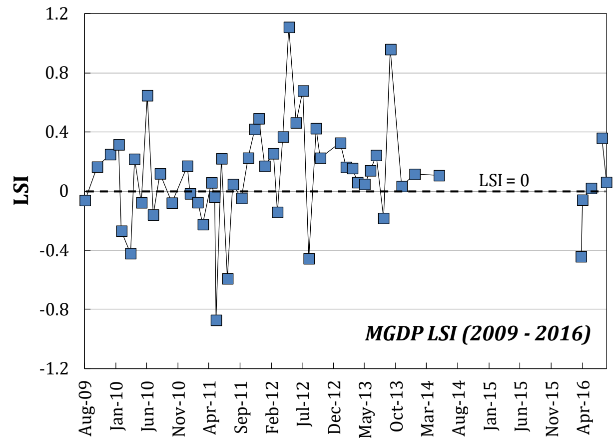


Figure 29: MGDP LSI Values

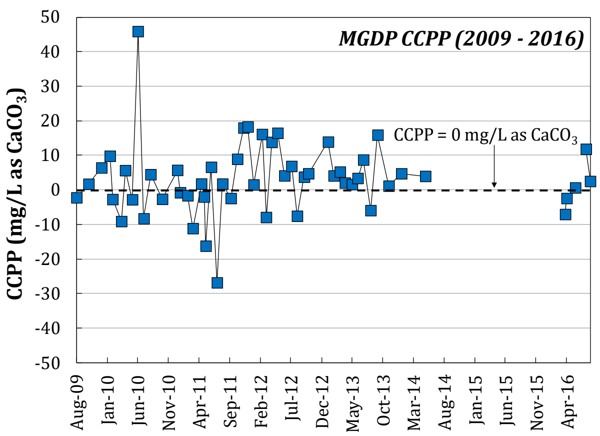


Figure 30: MGDP CCPP Values

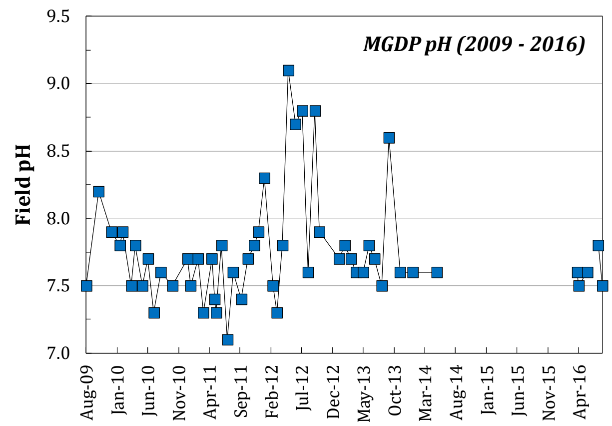


Figure 31: MGDP pH Values

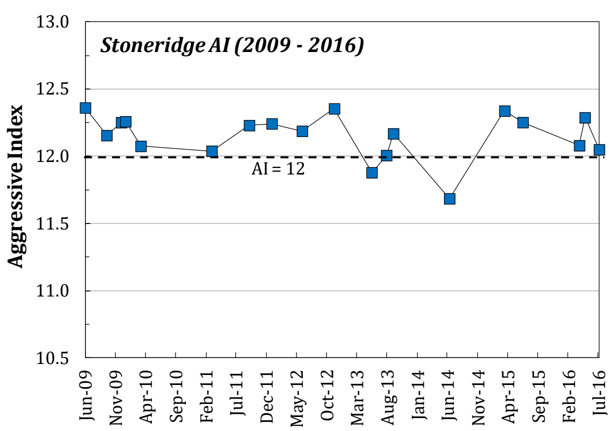


Figure 32: Stoneridge AI Values

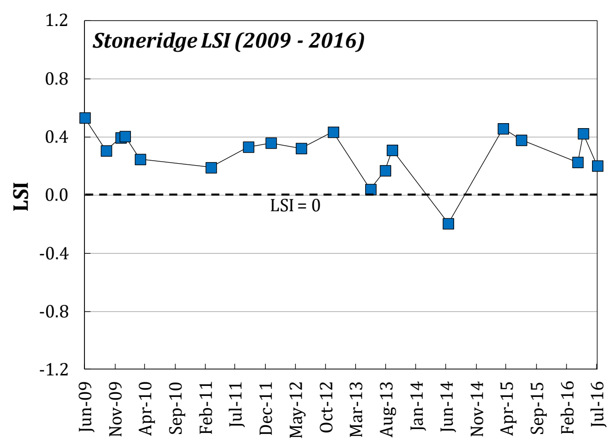


Figure 33: Stoneridge LSI Values

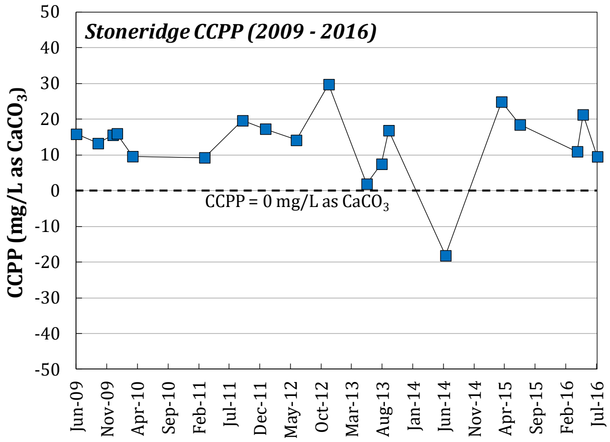


Figure 34: Stoneridge CCPP Values

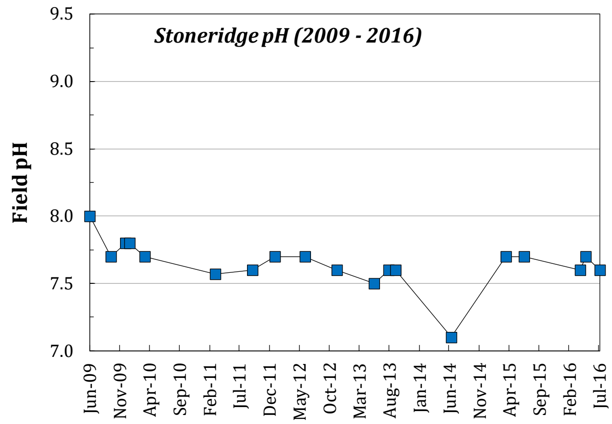


Figure 35: Stoneridge pH Values

Lead and Copper Solubility Diagrams for DVWTP and PPWTP. The solubility of metals is dependent upon the form of the metal in solution. The impact on corrosion due to changes in pH is related to the formation of less soluble metal species (typically, hydroxyl-carbonate compounds). Lead and copper solubility diagrams were prepared for the DVWTP and the PPWTP For this analysis the minimum, maximum and average pH conditions were evaluated using the calculated average DIC concentrations. The solubility diagrams are presented in Appendix B.

Costumer Reports

During the period 2009 – 2015 Zone 7 staff indicated that there were no customer reports that could be related to corrosion issues such as colored water or pipe failures.

SECTION 6.0 – ZONE 7 LEAD AND COPPER RESULTS

Zone 7 provided lead and copper results from four different rounds of tap monitoring in the distribution system: (1) two rounds of monitoring in 2009, (2) one round of monitoring in 2012 and (3) one round of monitoring in 2015. Zone 7 is considered a small system for purposes of LCR monitoring requirements. Under the LCR, utilities determine the 90th percentile of the tap results and compare this value against an Action Level. The Action Level for lead is 15 µg/L (0.015 mg/L) and for copper the Action Level is 1,300 µg/L (1.3 mg/L). In addition to the 90th percentile, for this corrosion assessment the 50th percentile tap results were determined and included in the review of results to better observe any trends. Table 13 is taken from Zone 7's LCR Monitoring Plan and presents the approach used to determine 90th percentiles depending upon the number of samples as described in a DDW Guidance Document.

Table 13: Procedure to Determine 90th Percentile[2]

Number of Tap Samples	How to Determine 90th Percentile
5 to 7	Average of the two highest sample results
8 to 12	The second highest sample result
13 to 17	Average of the second and third highest sample results
18 to 22	The third highest sample result

Zone 7 Lead Results

Table 14 presents the 90th and 50th percentile results for Zone 7's four tap monitoring events (and the total number of samples collected during each monitoring event). While all of the 90th percentile values were below the Action Level, the 90th percentile value (as well as the 50th percentile value) increased during the 2015 monitoring event when compared to previous years. The California Detection Level for Purposes of Reporting (DLR) for lead is 5 µg/L. The 90th percentile results for both monitoring rounds during 2009 as well as the 2012 samples were less than the DLR and would be reported as ND.

Table 14: Zone 7 90th and 50th Percentile Lead Results (µg/L)

Percentile	2009 (June)	2009 (December)	2012 (June)	2015 (June)
90th	4	4	4	13
50th	0	1.2	1.2	5
Total Tap Samples =	**17**	**24**	**13**	**15**

Table 15 presents the distribution of the lead results into four concentration categories. During the first six-month monitoring conducted in 2009 and during the 2015 tap monitoring event, the

[2] SWRCB, DDW, July 2014. *Lead and Copper Rule Sampling Guidance for Systems Serving Less than 50,000 people.*

results at one sample tap exceeded the lead Action Level. During the second round of monitoring in 2009 and the 2012 monitoring, there were no results above the Action Level. During the 2015 monitoring, there was an increase in the number of taps that had lead concentrations above the DLR (but still below the Action Level) when compared to previous monitoring events.

Table 15: Distribution of Zone 7 Lead Results

	Number of Taps Sampled			
Lead Concentration	**2009 (June)**	**2009 (December)**	**2012 (June)**	**2015 (June)**
≤5 μg/L	15	22	12	8
>5 μg/L and ≤10 μg/L	1	2	1	3
>10 μg/L and ≤15 μg/L	0	0	0	3
>15 μg/L	1	0	0	1
Total Taps Sampled =	**17**	**24**	**13**	**15**

The 90th and 50th lead percentiles for each monitoring period are presented in Figure 36. The distribution of lead results shown in Table 15 were converted to percentages and presented in Figure 37. The distribution of results was much different in 2015 when compared to the previous three rounds of monitoring.

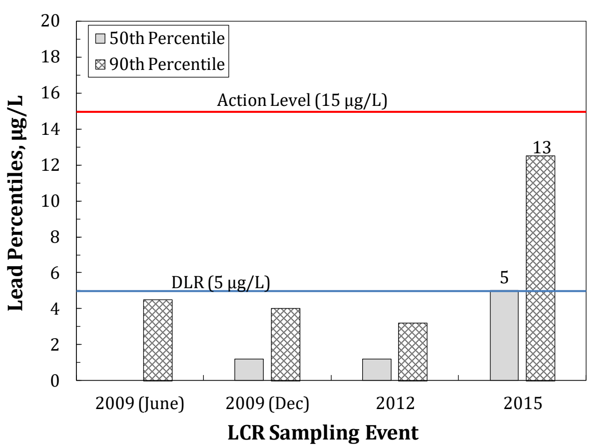


Figure 36: Zone 7 90th and 50th Percentile Lead Results (2009 – 2015)

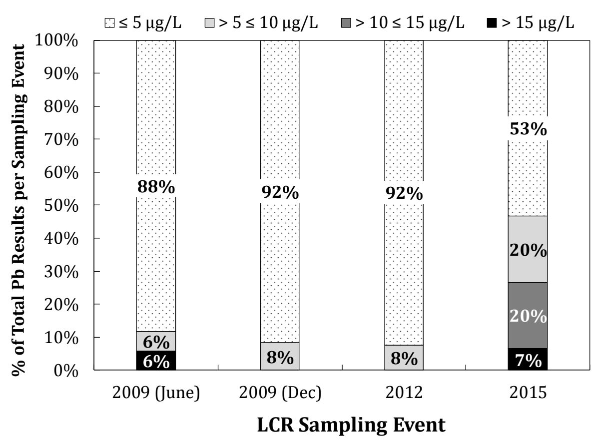


Figure 37: Zone 7 Distribution of Lead Results (2009 – 2015)

In addition to routine water quality monitoring conducted by Zone 7, during each lead and copper tap monitoring event, Zone 7 collected POE and distribution system samples that were analyzed for water quality parameters (i.e., pH, alkalinity, calcium, TDS and temperature). These results were used to calculate average pH, AI, LSI and CCPP values during each tap monitoring event and are presented in the following section.

Zone 7 Lead Results and Corrosion Indices. Figures 38 through 41 present the 90th and 50th percentile lead values together with the average pH, AI, LSI and CCPP values, respectively. Figures

38, 39 and 40 indicate little association between average pH, AI and LSI and the 90th percentile tap results for lead. In Figure 41, the highest 90th percentile result (June 2015) occurred when the average CCPP value was the lowest of the four monitoring events, however, the average CCPP value was positive during the June 2015 monitoring event. Figures 38 through 41 provide little insight as to the increase in lead levels during the June 2015 monitoring event.

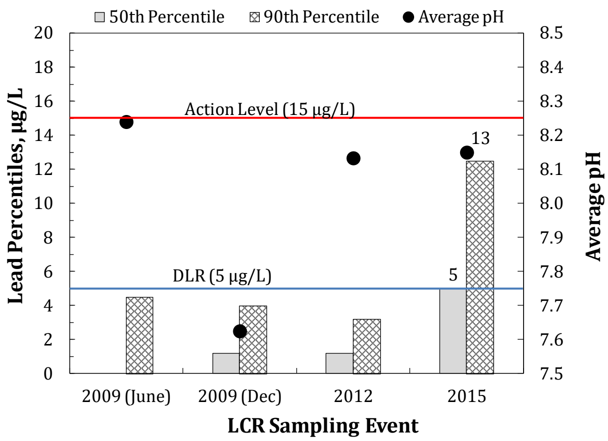


Figure 38: Lead Results and Average pH

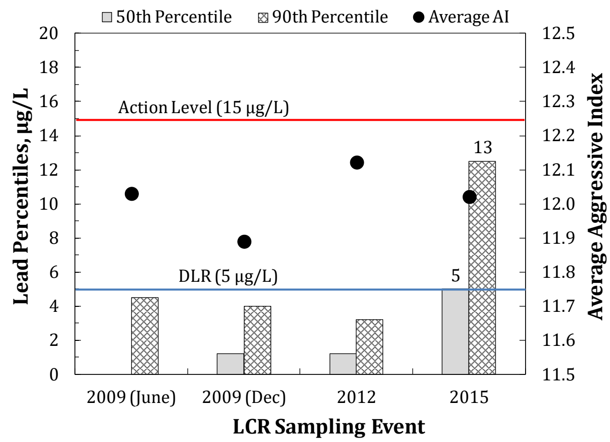


Figure 39: Zone 7 Lead Results and Average AI Level

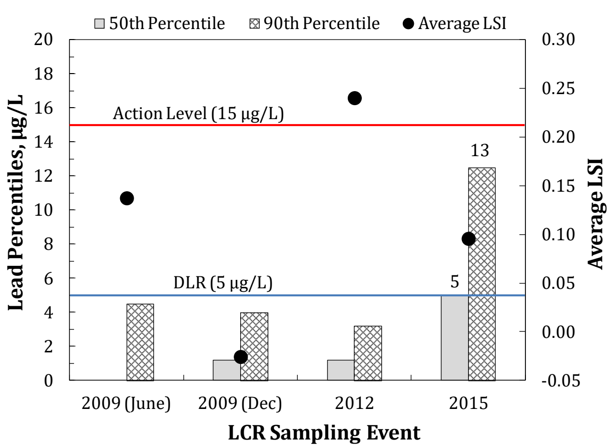


Figure 40: Zone 7 Lead Results and Average LSI Value

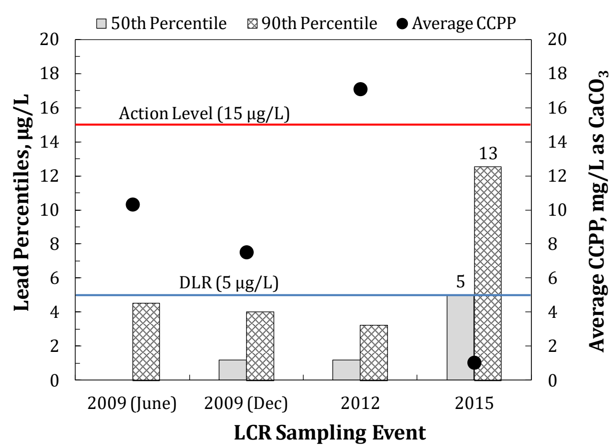


Figure 41: Zone 7 Lead Results and Average CCPP

Additional Evaluation of Zone 7's 2015 Lead Results. Appendix C contains a map showing the location of the Zone 7 sources and the LCR sample locations. As indicated in Table 15 and Figure 37, during the 2015 tap monitoring there was a general increase in the lead results. While the 90th percentile lead value for the entire sample pool was below the Action Level, there were several sample locations where increased concentrations of lead were detected when compared to the previous three rounds of tap monitoring.

Figure 42 presents the lead results for sample locations that were sampled multiple times during the four rounds of tap monitoring reviewed in this assessment. Two of the sample locations (Mr. Rodger's Residence and Mrs. Greer's residence) met the LCR Tier 1 sample location criteria. The remainder of the sample sites presented in Figure 42 are classified as Tier 2 sample locations. There was little change in the lead results during all four monitoring events for the two Tier 1 sample locations (the results at both of the Tier 1 sample locations were consistently below the DLR). For the Tier 2 sample sites, some of the locations did not experience a change in the lead concentration, while other locations did experience an increase during the June 2015 monitoring event.

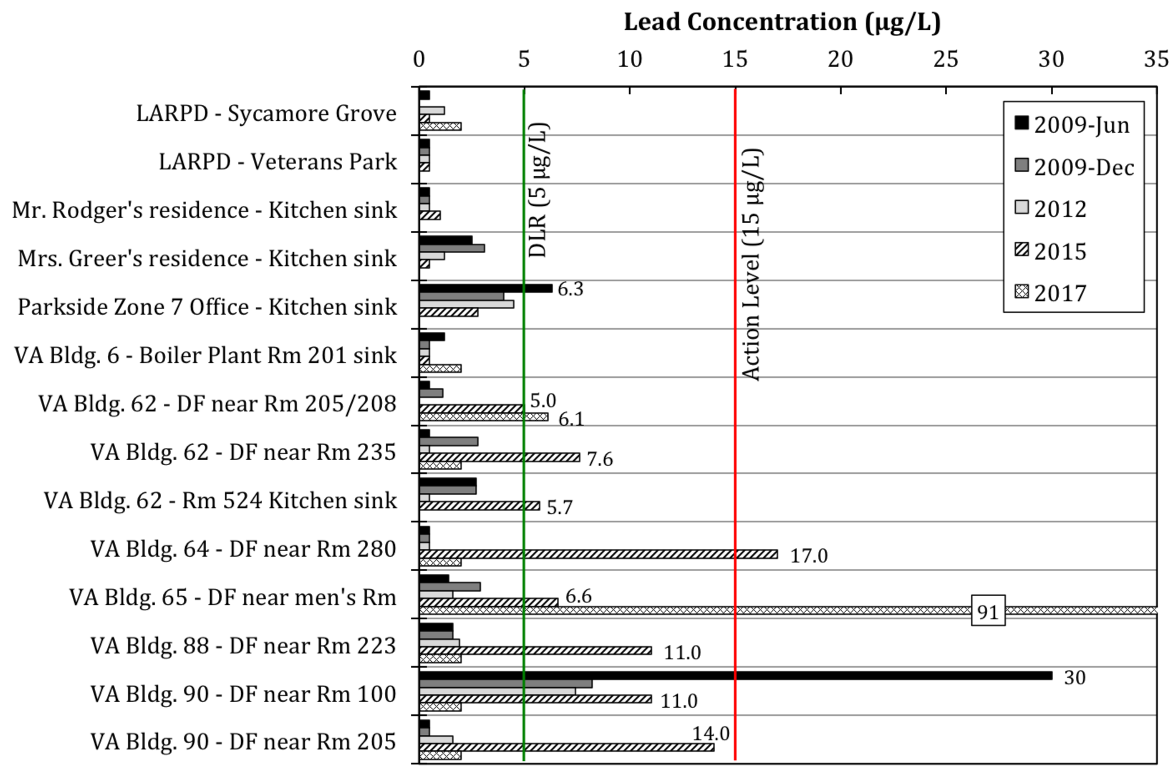


Figure 42: Sample Locations Sampled Multiple Times (2009 – 2017)[3]

Upon closer review of the results, only sample locations in the "VA Building" experienced an increase in lead concentration during the June 2015 monitoring. Not all of the "VA Building" sample locations, however, experienced an increase. For example, sample location "VA Building 62 – Boiler Plant Room 201 Sink" did not experience an increase, and the "VA Building 90 – DF near Rm 100" sample location had much higher lead levels in the June 2009 sampling. Table 16 presents the seven (7) VA Building sample locations that experienced an increase in lead concentration during the 2015 monitoring event.

[3] In May 2017 Zone 7 conducted additional supplementary monitoring in the VA Hospital Buildings. This morning was not part of the Zone 7 routine LCR compliance monitoring program. See additional discussion of the lead and copper results later in this report.

Table 16: Sample Locations Showing an Increase in Lead During the June 2015 Monitoring Event[4]

Location	2009 (June)	2009 (December)	2012 (June)	2015 (June)	2017 (May)
VA Bldg. 62 - DF near Rm 205/208	ND	1.1	--	5	6.1
VA Bldg. 62 - DF near Rm 235	ND	2.8	ND	7.6	ND
VA Bldg. 62 - Rm 524 Kitchen sink	2.7	2.7	ND	5.7	--
VA Bldg. 64 - DF near Rm 280	ND	ND	ND	17	ND
VA Bldg. 65 - DF near Men's Rm	ND	ND	ND	6.6	91*
VA Bldg. 88 - DF near Rm 223	1.6	1.6	1.9	11	ND
VA Bldg. 90 - DF near Rm 205	ND	ND	1.6	14	ND

* Drinking water fountain has been tagged "not for drinking." The filter will be replaced and the fountain will be retested before being returned to service.

Figures 43 through 46 present the percent contribution of drinking water from each of Zone 7's sources during the month of each of the four monitoring events. During the June 2015 monitoring event, the percent contribution from each source was similar to the percent contribution during the June 2009 and June 2012 monitoring events. The percent contribution from each source during December 2009 was much different, however, with one of the surface water treatment plants off-line during the month.

From the map of the Zone 7 distribution system presented in Appendix C, it appears that the DVWTP serves the VA Buildings. During June 2015 monitoring event, the DVWTP was the primary contributor of Zone 7 drinking water (Figure 46). During the June 2015 tap monitoring event, the LSI and CCPP values for DVWTP were both negative (the LSI was −0.4 and the CCPP was −4.3). The AI value during June 2015 was 11.4. The AI, LSI and CCPP values during the June 2015 were the lowest values recorded for the DVWTP during 2009 through 2016. During both the June and December 2009 monitoring events, the LSI and CCPP values for the DVWTP effluent were positive. The AI values during June and December 2009 were 12.2 and 12.3, respectively. During the June 2012 monitoring event, the LSI and CCPP values were both approximately zero and the AI was approximately 11.8.

[4] In May 2017, Zone 7 staff conducted supplemental testing at six of the seven locations presented in Table 16 (the "VA Bldg 62 – Rm 524 Kitchen Sink" was not tested). The 2017 results are presented in Table 16.

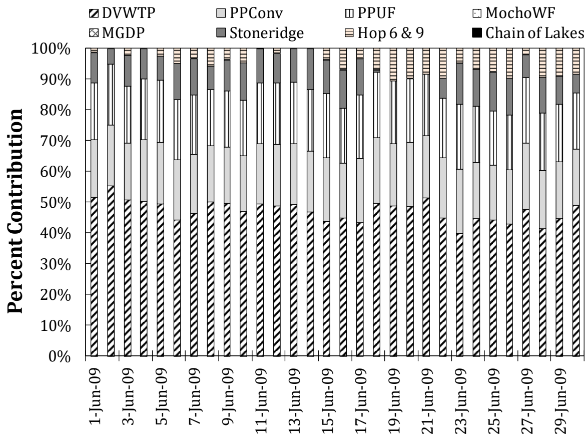


Figure 43: Daily Percent Contribution from Each Zone 7 Source (June 2009)

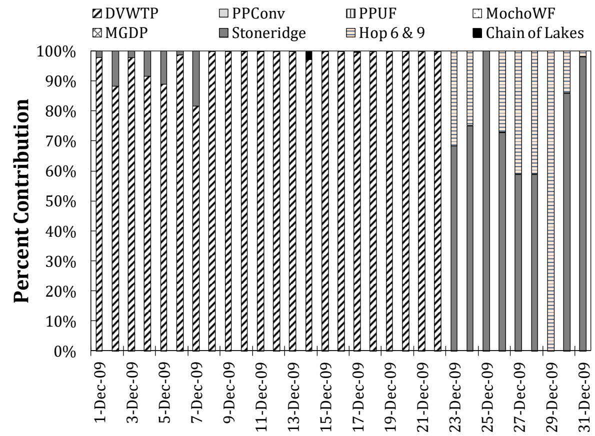


Figure 44: Daily Percent Contribution from Each Zone 7 Source (December 2009)

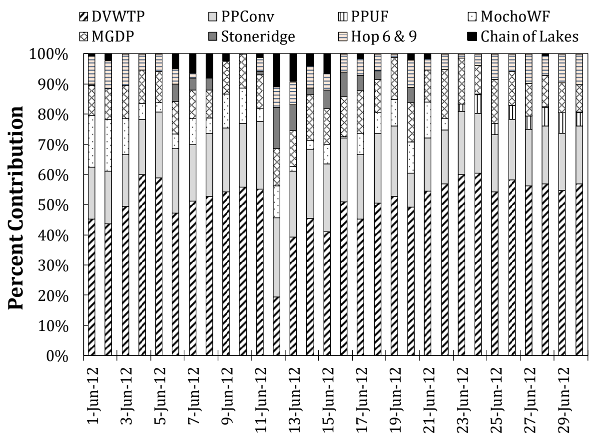


Figure 45: Daily Percent Contribution from Each Zone 7 Source (June 2012)

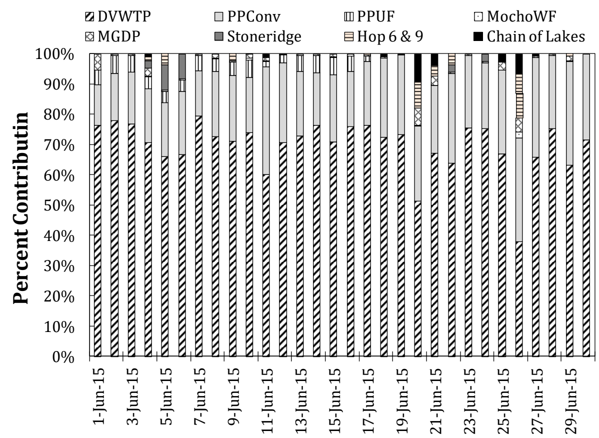


Figure 46: Daily Percent Contribution from Each Zone 7 Source (June 2015)

VA Hospital Staff Conducted Monitoring in 2016. VA Building staff conducted lead and copper monitoring in July, August, and September 2016. VA Building staff replaced two drinking water fountains where elevated levels of lead were detected. Water filters were replaced at a number of locations.

May 2017 Zone 7 Supplemental Monitoring in VA Buildings. After Zone 7 received the results from the VA's 2016 monitoring, Zone 7 staff conducted supplemental lead and copper monitoring at eight locations within the VA Buildings in May 2017. Six of the lead results were ND, one sample had a lead level of 6.1 µg/L, and one drinking water fountain sample contained 91 µg/L lead and as much as 10,000 µg/L copper. The drinking water fountain with the elevated lead and copper results has been tagged by the VA staff as "not for drinking", and it is our understanding that it will not be placed back in service until the filter has been replaced and the fountain retested. Zone 7 also collected a sample prior to the water entering the VA Hospital Buildings. There was no measurable lead or copper in the water and water quality conditions were normal. The May 2017 results at six of the locations are included in Figure 42 and presented in Table 16. During review of the May 2017 lead and copper results for the VA Buildings, additional historical lead and copper results were provided by Zone 7. While not included in this analysis, several locations had elevated lead results, which had led in the past to the installation of point-of-use filters to address the lead levels. When these historical results are viewed in conjunction with the June 2015 results and the May 2017 results, they raise concerns about potential lead and copper exposure within the various VA Buildings. It is our understanding that, over the years, Zone 7 staff has continued to work with VA Building staff to address potential internal sources of lead and copper in these buildings.

Future of the VA Buildings. In 2004, the federal government announced plans to close the VA Buildings in Livermore. In October 2014, the Livermore City Council passed a resolution to support the repurposing of the VA Buildings as a shelter for homeless veterans, which would require Congressional approval. With the new Administration in DC, there were 2017 newspaper reports of local authorities approaching the Secretary of Interior to keep the facility open. As of the preparation of this assessment, the ultimate fate of the VA Buildings remains unclear.

Historical Lead 90th Percentiles. In addition to the LCR tap monitoring data provided by Zone 7, the State Water Resources Control Board (SWRCB) Division of Drinking Water's (DDW) Safe Drinking Water Information System (SDWIS) online water quality database was accessed for historical 90th percentile lead values. Figure 47 presents the 90th percentile lead values for Zone 7's LCR monitoring events conducted from 2006 through 2016. As indicated in Figure 47, prior to 2009, the 90th percentile values for lead during 2006, 2007 and 2008 (two rounds) were above the lead AL[5]. The highest 90th percentile result for lead was 57 µg/L (0.057 mg/L) reported in 2006. Beginning with LCR monitoring conducted in 2009 all of the 90th percentile results have been below the lead AL.

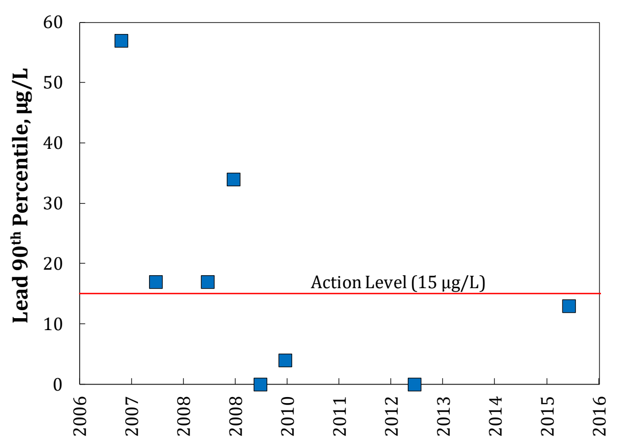


Figure 47: Zone 7 90th Percentile Lead Values from SDWIS (2006 – 2015)

Zone 7 Copper Results

The copper Action Level is 1,300 µg/L (1.3 mg/L). In addition to presenting 90th percentile values, the 50th percentile value was determined to better observe any trends. Table 17 presents the 90th and 50th percentile copper values for Zone 7's four tap monitoring events (the DLR for copper is 50 µg/L). Similar to what was observed for the lead results, the 2015 tap results indicate an increase in copper concentration for both the 90th and 50th percentiles when compared to previous results. However, the 90th percentile copper result during the June 2015 monitoring event was well below the Action Level.

[5] According to Zone 7 staff, the 90th percentile values above the AL were due to results from the VA Hospital Buildings, which was addressed at the time with the installation of point-of-use filters in 2009.

Table 17: Zone 7 90th and 50th Percentile Copper Results (µg/L)

Percentile	2009 (June)	2009 (December)	2012 (June)	2015 (June)
90th	220	270	160	630
50th	43	100	48	160
Total Taps Sampled =	**17**	**24**	**13**	**15**

Table 18 presents the number of tap samples collected by Zone 7 during each tap monitoring event and the distribution of the copper results into three concentration categories. There were no results above the copper Action Level and the majority of results were less than one-half of the Action Level. The 90th and 50th percentile copper values for each monitoring period are presented in Figure 48. The Table 18 distribution of copper results were converted to percentages and presented in Figure 49.

Table 18: Number of Sample Taps with Copper Results in Different Concentration Categories

Copper Concentration	2009 (June)	2009 (December)	2012 (June)	2015 (June)
≤650 µg/L	16	23	13	13
>650 µg/L and ≤1,300 µg/L	1	1	0	2
>1,300 µg/L	0	0	0	0
Total Taps Sampled =	**17**	**24**	**13**	**15**

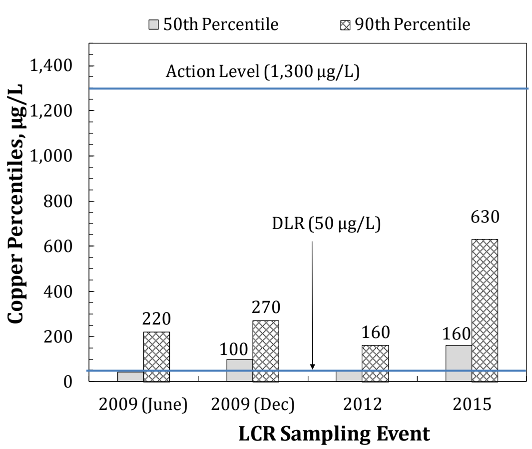


Figure 48: Zone 7 90th and 50th Percentile Copper Results (2009 – 2015)

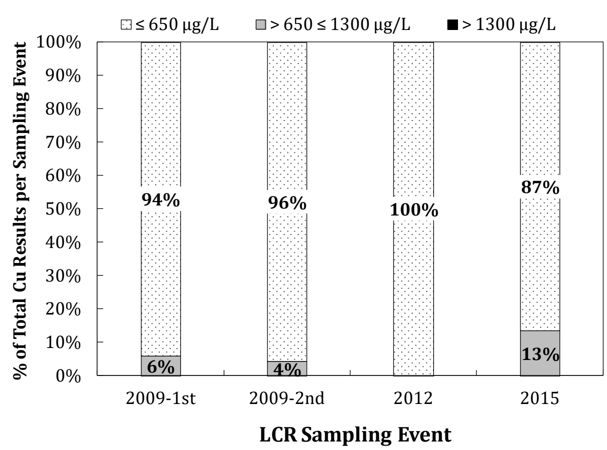


Figure 49: Zone 7 Distribution of Copper Results (2009 – 2015)

Zone 7 Copper Results and Corrosion Indices. Figures 50 through 53 present the 90th and 50th percentile copper values together with the average pH, AI, LSI and CCPP values during each tap monitoring event. As was the case for the lead tap results, there appears to be little to no association between pH, AI, LSI and the 90th and 50th percentile copper results. In Figure 53, the lowest average CCPP value occurred during the period with the highest 90th and 50th percentile copper values (however, the average CCPP was positive during the 2015 monitoring event).

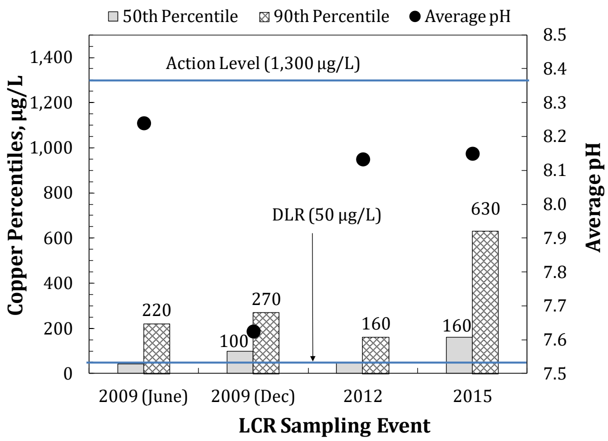


Figure 50: Zone 7 Copper Results and Average pH

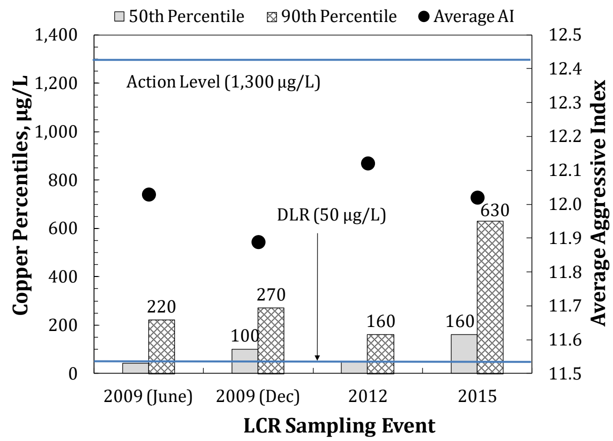


Figure 51: Zone 7 Copper Results and Average AI

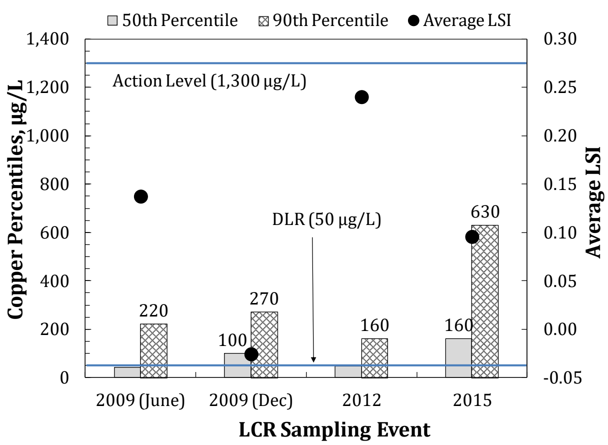


Figure 52: Zone 7 Copper Results and Average LSI

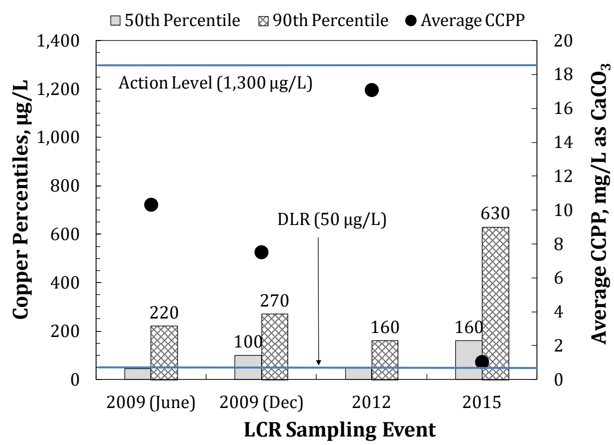


Figure 53: Zone 7 Copper Results and Average CCPP

Additional Evaluation of Zone 7's 2015 Copper Results. The June 2015 copper results were evaluated in greater detail to assess whether there was a trend of increasing copper results in the VA Building, similar to what occurred for lead. Figure 54 presents the copper results for the sample locations that were sampled multiple times during the four rounds of tap monitoring reviewed in this assessment.

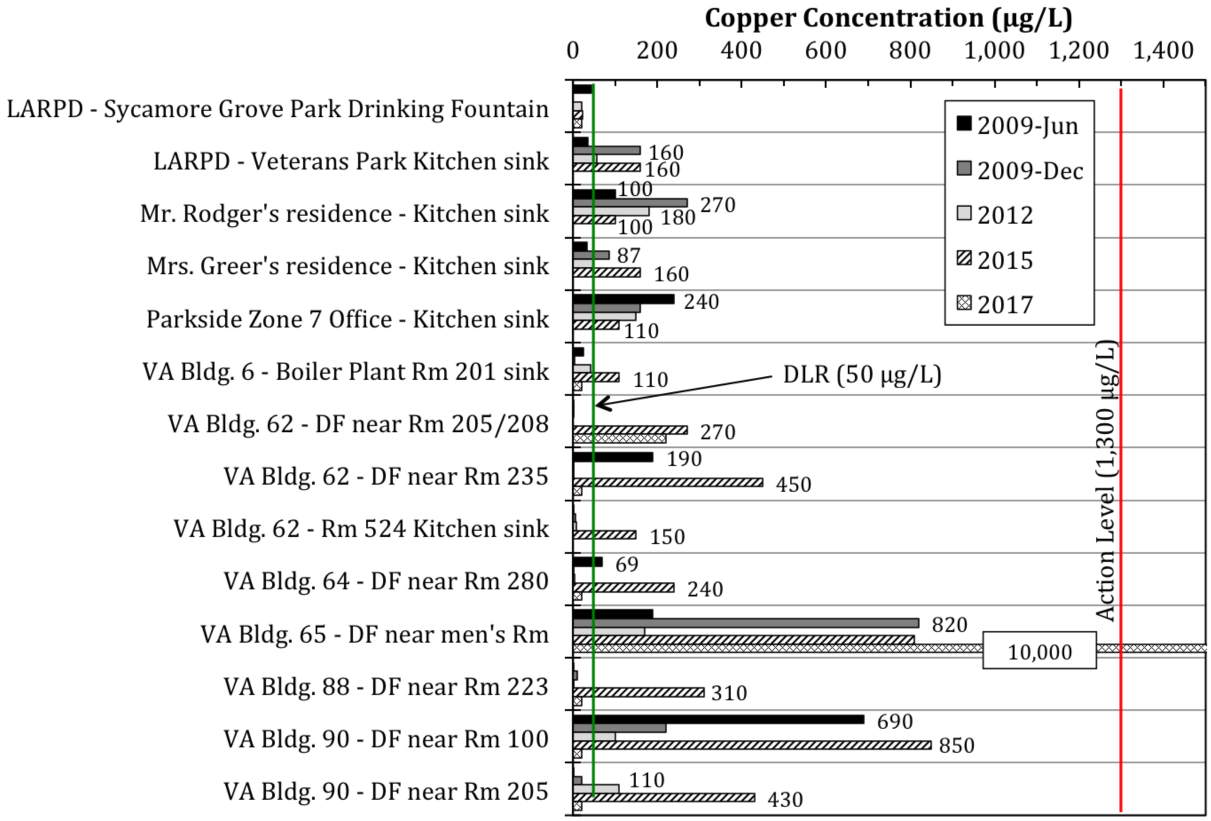


Figure 54: Copper Levels at Multiple Locations Sampled Multiple Times (2009 – 2017)[6]

Table 19 presents the copper results for the seven (7) VA Building sample locations that experienced an increase in lead concentration during the 2015 monitoring event. As indicated in Table 19, each of the six sample locations also experienced an increase in copper levels.

May 2017 Copper Results for VA Sample Locations. In May 2017, Zone 7 staff tested the VA Building Sample locations listed in Table 19 (with the exception of the "VA Bldg 62 – Rm 524 Kitchen sink" location). The copper results were quite low, with the exception that one location had a copper result of 10,000 µg/L (that drinking water fountain also had elevated levels of lead and has been tagged "not for drinking." The filter will be replaced and the fountain will be retested before it is put back into service.)

[6] In May 2017 Zone 7 conducted supplemental monitoring at locations within the VA Hospital. These results are not part of Zone 7's regular LCR Compliance Monitoring program.

Table 19: Sample Locations Showing an Increase in Copper During the June 2015 Monitoring Event

Location	2009 (June)	2009 (Dec)	2012 (June)	2015 (June)	2017 (May)*
VA Bldg. 62 – DF near Rm 205/208	ND	ND	--	270	220
VA Bldg. 62 – DF near Rm 235	190	2.4	2.3	450	ND
VA Bldg. 62 – Rm 524 Kitchen sink	ND	5.7	7.2	150	--
VA Bldg. 64 – DF near Rm 280	69	2.3	4.2	240	ND
VA Bldg. 65 – DR near Men's Rm	190	820	170	810	10,000**
VA Bldg. 88 – DF near Rm 223	ND	11	2.5	310	ND
VA Bldg. 90 – DF near Rm 205	ND	20	110	430	ND

* In May 2017, Zone 7 conducted supplemental monitoring at locations within the VA Hospital. These results are not part of Zone 7's regular LCR compliance monitoring.

** Drinking water fountain currently tagged "not for drinking." The filter will be replaced and the fountain retested before being put into service.

Historical Copper 90th Percentiles. The DDW SDWIS online water quality database was accessed for historical 90th percentile copper values for Zone 7. Figure 55 presents the 90th percentile copper values for tap monitoring events conducted from 2006 through 2015. As indicated in Figure 55, all of the 90th percentile values for copper from 2006 through 2015 were below the copper Action Level. The maximum 90th percentile value was 950 µg/L during the 2006 monitoring event.

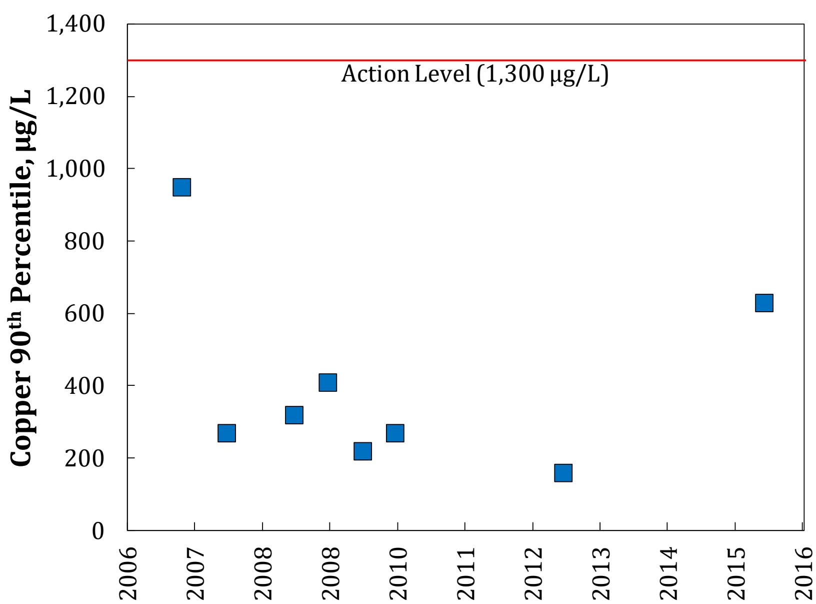


Figure 55: Zone 7 90th Percentile Copper Values from SDWIS (2006 – 2015)

Section 7.0 – Retail Agencies' Lead and Copper Results

This section presents information on water quality and LCR tap monitoring results for Zone 7's four retail agencies including:

- City of Livermore
- California Water (Cal Water) Service Company – Livermore
- City of Pleasanton
- Dublin San Ramon Services District (DSRSD)

The City of Livermore and DSRSD purchase 100% of their drinking water supply from Zone 7. Cal Water Livermore and the City of Pleasanton utilize local groundwater supplies in addition to water purchased from Zone 7.

Zone 7 conducts routine water quality monitoring at turnouts for each retail agency (the frequency of data collection varied at the turnouts, but in general each turnout was sampled 2 to 4 times per year). The water quality results for each individual retail agency turnout are presented and used to calculate corrosion indices for the water supplied to the retail agency. For Cal Water Livermore and the City of Pleasanton, water quality and production data for their local sources are included in the assessment. Each retail agency provided the most recent three rounds of LCR home tap monitoring results.

CITY OF LIVERMORE

The City of Livermore serves a population of approximately 28,200. The City purchases 100% of its drinking water supply from Zone 7. While the majority of the water purchased by Livermore is treated surface water, a portion of the water is estimated to be from Zone 7's groundwater supplies. Livermore's 2016 Consumer Confidence Report reported that 8.5% of the water purchased from Zone 7 during 2015 was groundwater. Zone 7 conducts water quality monitoring at two turnouts (LIV 6 and LIV 9) for the City of Livermore. The City of Livermore provided LCR home tap lead and copper results for monitoring events conducted during 2010, 2013 and 2016.

Based on information provided by the City of Livermore, it appears that the City's distribution system piping consists of approximately 174 miles and the piping material is primarily of PVC (57%) and asbestos cement pipe (36%). There are small amounts of cast iron pipe, steel/cement lined pipe and reinforced concrete.

City of Livermore Water Quality & Corrosion Indices

Table 20 presents water quality results for the two Zone 7 turnouts for the City of Livermore. Using the available water quality data, Table 21 presents the average and range of calculated corrosion indices for Livermore's two Zone 7 connections. The average LSI and CCPP values were slightly positive from 2012 through 2016, and both indices ranged from slightly negative to slightly positive. The average and range of CSMR values were all greater than 0.6.

Table 20: Water Quality Results at Livermore's Two Zone 7 Turnouts (2012 – 2016)

Parameter		LIV 6	LIV 9
pH	Average	8.2	8.2
	Range	8 - 8.5	8 - 8.6
Alkalinity (mg/L as $CaCO_3$)	Average	80	85
	Range	72 - 94	66 – 120
Ca (mg/L)	Average	22	23
	Range	17 - 28	18 – 30
TDS (mg/L)	Average	354	345
	Range	289 - 405	272 – 402
Temperature (°C)	Average	19.6	19.1
	Range	14.9 - 24.4	14.4 – 24
Hardness (mg/L $CaCO_3$)	Average	128	135
	Range	96 - 309	98 – 324
Sulfate (mg/L)	Average	34	35
	Range	21 - 56	24 – 56
Chloride (mg/L)	Average	125	120
	Range	89 - 167	80 - 182

Table 21: Corrosion Indices for Livermore's Two Zone 7 Turnouts (2012 – 2016)

Corrosion Index		LIV 6	LIV 9
LSI	Average	0.01	0.02
	Range	-0.2 to 0.2	-0.3 to 0.4
CCPP (mg/L as $CaCO_3$)	Average	0.11	0.35
	Range	-1.7 to 1.9	-1.7 to 3
DIC (mg C/L)	Average	20	21
	Range	18 to 23	16 to 29
CSMR	Average	4.3	3.8
	Range	2.1 to 7	2 to 7.3

City of Livermore's Lead Results

Table 22 presents the number of samples collected and the 90th and 50th percentile lead values for the City of Livermore's home tap LCR monitoring conducted in 2010, 2013 and 2016. All of the 90th percentile results were less than the DLR and would be reported as ND.

Table 22: City of Livermore 90th and 50th Percentile Lead Results (µg/L)

Percentile	2010	2013	2016
90th	2.7	1.1	ND
50th	0.8	0.3	ND
Total Homes Sampled =	**31**	**30**	**31**

Table 23 presents the distribution of Livermore's lead results into three concentration categories. There were no homes with lead results above the Action Level and the vast majority of results were below the DLR.

Table 23: City of Livermore Distribution Home Tap Lead Results

Lead Concentration	2010	2013	2016
≤5 µg/L	30	29	31
>5 µg/L and ≤15 µg/L	1	1	0
>15 µg/L	0	0	0
Total Homes Sampled =	**31**	**30**	**31**

Figure 56 presents the 90th and 50th percentile values for Livermore's LCR monitoring events. The distribution of lead results in Table 23 were converted to percentages and presented in Figure 57.

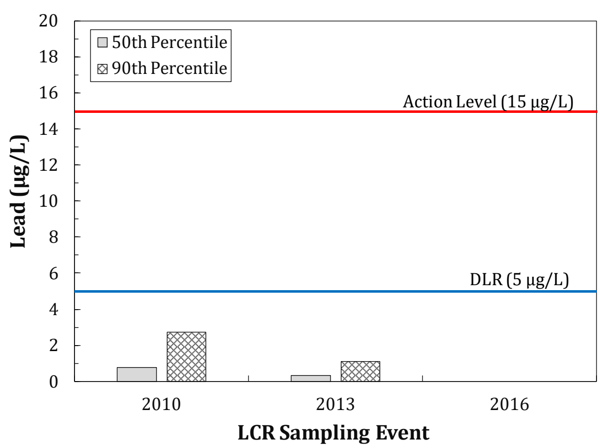


Figure 56: City of Livermore 90th and 50th Percentile Lead Values (2010 – 2016)

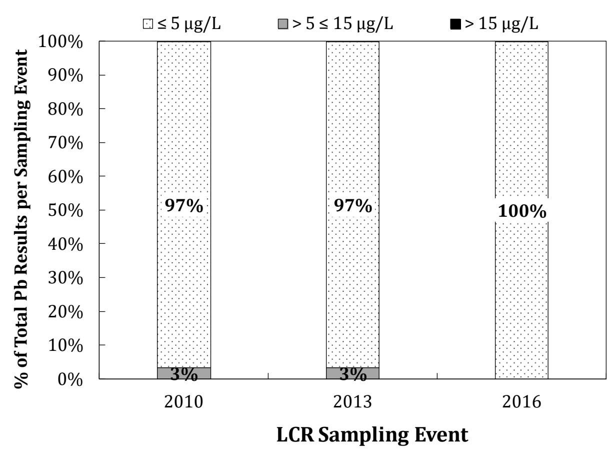


Figure 57: City of Livermore Distribution of Lead Results (2010 – 2016)

Historical Lead 90th Percentiles. The DDW SDWIS online water quality database was accessed for historical 90th percentile lead values for the City of Livermore. Figure 58 presents the 90th percentile lead values for LCR monitoring events conducted from 1992 through 2016. During the initial LCR monitoring event conducted in 1992, the 90th percentile result was just below the lead Action Level (the initial 90th percentile value was 14 µg/L). However, after the initial round all of the 90th percentile values have been well below the Action Level and in fact, from 1998 to the present all of the 90th percentile results have been below the DLR for lead.

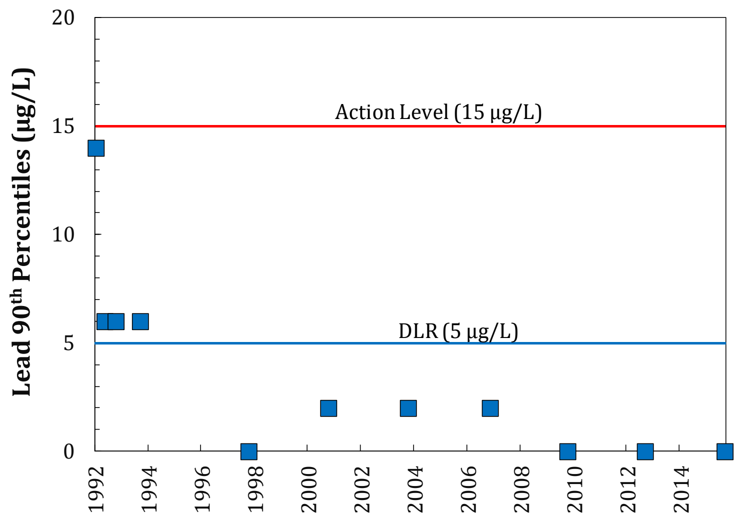


Figure 58: City of Livermore 90th Percentile Lead Values from SDWIS (1992 – 2016)

City of Livermore's Copper Results

Table 24 presents the 90th and 50th percentile copper values for the City of Livermore's home tap LCR monitoring events during 2010, 2013 and 2016. All of the 90th percentile values were well below the copper Action Level.

Table 24: City of Livermore 90th and 50th Percentile Copper Results (µg/L)

Percentile	2010	2013	2016
90th	84	85	ND
50th	ND	ND	ND
Total Homes Sampled =	**31**	**30**	**31**

Table 25 presents the distribution of copper results for the City of Livermore's home tap LCR monitoring events into three concentration categories. As indicated in Table 25, there were no results above the Action Level, and the results for all homes during all three monitoring events were below one-half of the Action Level.

Table 25: City of Livermore Distribution of Home Tap Copper Results

Copper Concentration	2010	2013	2016
≤650 µg/L	31	30	31
>650 µg/L and ≤1300 µg/L	0	0	0
>1300 µg/L	0	0	0
Total Homes Sampled =	**31**	**30**	**31**

Livermore's 90th and 50th percentile copper values are presented in Figure 59 (all 50th percentile values were ND). The distribution of the home tap copper results were converted to percentages and presented in Figure 60.

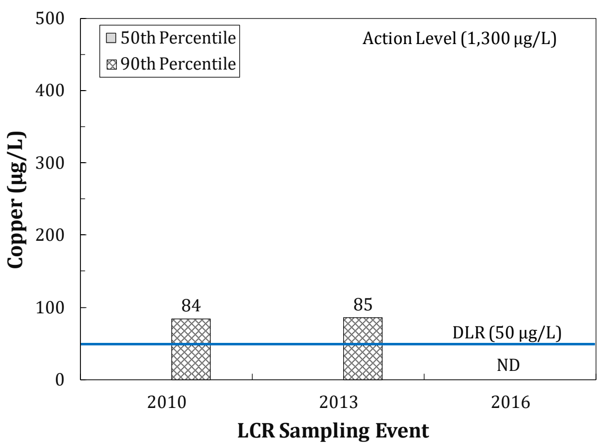


Figure 59: City of Livermore 90th and 50th Percentile Copper Values (2010 – 2016)

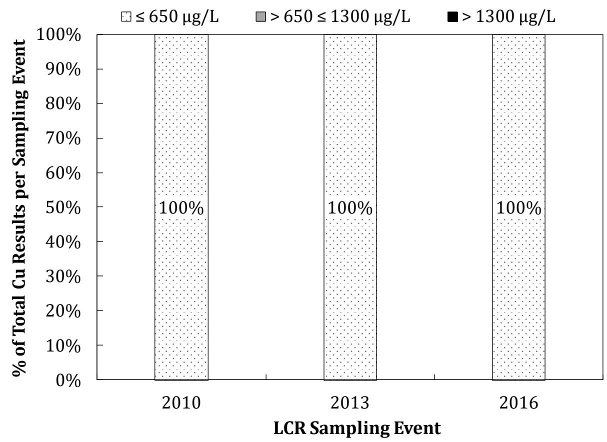


Figure 60: City of Livermore Distribution of Copper Results (2010 – 2016)

Historical Copper 90th Percentiles. The DDW SDWIS database was queried for historical 90th percentile copper values for the City of Livermore. Figure 61 presents the 90th percentile copper from 1992 through 2016. All of the 90th percentile copper values have been quite low.

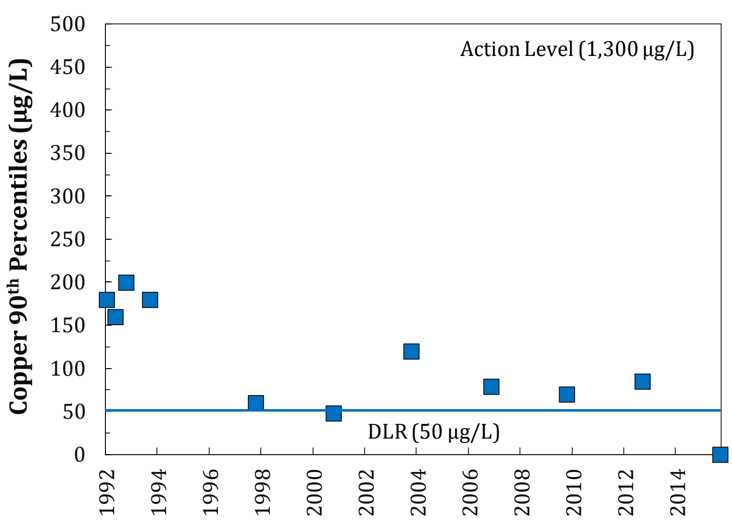


Figure 61: City of Livermore 90th Percentile Copper Values from SDWIS (1992 – 2016)

Summary: During the three most recent LCR home tap monitoring events the lead and copper results for the City of Livermore were quite low. No individual homes had a result above either the lead or copper Action Level, and 90th percentile values were quite low for both lead and copper. The range of LSI and CCPP values at the Zone 7 turnouts ranged from slightly negative to slightly positive, and the average values were slightly positive for both indices. The CSMR values were consistently greater than the threshold of 0.6, however, there appears to be little association between a CSMR greater than 0.6 and the City of Livermore's home tap monitoring results.

The City of Livermore is currently monitoring on a reduced schedule (every three years) and a reduced number of samples (30). From the information provided and reviewed for this assessment, there is no indication of a need to change the current monitoring program.

Cal Water - Livermore

Cal Water – Livermore serves a population of approximately 57,400. In addition to purchasing water from Zone 7, Cal Water – Livermore owns and operates 11 wells and leases an additional well from a private entity (the leased well is referred to as "Station 15"). For the period of this assessment, Cal Water - Livermore provided home tap lead and copper results for LCR monitoring events conducted in 2010, 2013 and 2015.

There are approximately 83 miles of piping in the Cal Water distribution system. Based on information provided by Cal Water – Livermore, it appears that the distribution system piping material is primarily asbestos cement (61%), PVC (18%) and ductile iron (14%). There are small amounts of cast iron and steel piping in the distribution system.

Figure 62 presents the annual production for Cal Water Livermore's purchased Zone 7 supply and its local supplies for 2012 through 2016. During 2012 through 2016 Cal Water Livermore purchased from 63% to 78% of its supply from Zone 7.

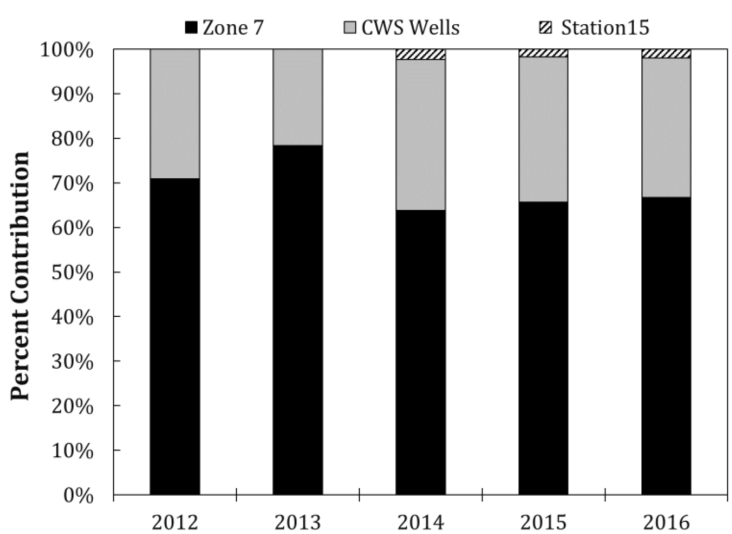


Figure 62: Annual Percent Contribution from Cal Water Livermore Supplies (2012 – 2016)

Cal Water Livermore provided annual water quality data for their wells. Tables 26 and 27 present a summary of the annual water quality data and calculated corrosion indices for all of Cal Water's wells. The results presented in Tables 24 and 25 are based on an annual pH results during 2010 through 2017, while for all of the other constituents, 2 to 3 samples were collected during 2010 through 2017.

Table 26: Cal Water Livermore Wells 5-01 to 12-01
Water Quality and Corrosion Indices (2010-2017)

Parameter		Well 5-01*	Well 8-01	Well 9-01	Well 10-01	Well 12-01**
pH	Average	7.5	7.4	7.5	7.4	7.5
	Range	7.3 – 7.9	6.8 – 7.7	6.7 – 8.4	6.7 – 7.9	7.0 – 7.9
Alk. (mg/L $CaCO_3$)	Average	310	275	290	280	305
	Range	NA	260 – 290	280 – 300	270 – 290	300 – 310
Calcium (mg/L)	Average	52	47	55	55	64
	Range	51 – 52	43 – 51	52 – 58	52 – 58	63 – 65
TDS (mg/L)	Average	435	485	550	540	570
	Range	420 – 450	470 – 500	530 – 570	500 – 570	560 – 580
Conductivity (μS)	Average	790	830	925	943	1010
	Range	780 – 800	810 – 850	920 – 930	910 – 990	920 – 1010
Temperature (°C)	Average	19	20	20	18	22
	Range	19 – 19	19 – 22	15 – 23	13 – 24	19 – 22
Chloride (mg/L)	Average	54	72	73	100	96
	Range	50 – 57	70 – 73	70 – 76	83 – 120	92 – 99
Sulfate (mg/L)	Average	52	51	50	55	55
	Range	51 – 52	50 – 51	47 – 52	51 – 58	54 – 55
LSI	Average	0.2	0.0	0.3	0.2	0.3
	Range	NA	–0.05 to 0.02	0.2 – 0.4	0.16 – 0.19	NA
CCPP (mg/L $CaCO_3$)	Average	14	–1.1	17	11	19
	Range	NA	–3.6 to 1.5	13 – 22	10 – 11	NA
DIC (mg C/L)	Average	80	72	74	71	77
	Range	NA	68 – 77	70 – 77	69 – 72	NA
CSMR	Average	1.0	1.4	1.5	1.8	1.8
	Range	1.0 – 1.1	1.4 – 1.43	NA	1.5 – 2.4	1.7 – 1.8

* Listed as active, standby well in DDW SDWIS database.

** Listed as inactive well in SDWIS database, was tested in 2011, 2012, 2014, & 2015.

Table 27: Cal Water Livermore Wells 14-01 to 31-01
Water Quality and Corrosion Indices (2010-2017)*

Parameter		Well 14-01	Well 15-01	Well 20-01	Well 24-01	Well 31-01
pH	Average	7.4	7.4	7.3	7.6	7.5
	Range	6.8 – 8.4	6.5 – 7.9	7.0 – 7.9	7.0 – 8.0	6.6 – 7.9
Alkalinity	Average	260	270	185	140	285
(mg/L $CaCO_3$)	Range	250 – 270	NA	160 – 210	130 – 150	260 – 310
Calcium (mg/L)	Average	45	45	35	49	48
	Range	42 – 48	43 – 47	29 – 40	18 – 110	45 – 51
TDS (mg/L)	Average	435	430	375	257	495
	Range	410 – 460	420 – 440	360 – 390	240 – 270	470 – 520
Conductivity (µS)	Average	770	770	645	437	890
	Range	740 – 800	NA	590 – 700	430 – 450	NA
Temperature (°C)	Average	19	22	19	21	21
	Range	18 – 30	20 – 30	18 – 20	19 – 24	13 – 24
Chloride (mg/L)	Average	67	59	65	36	84
	Range	66 – 68	58 – 60	NA	35 – 38	79 – 88
Sulfate (mg/L)	Average	47	47	32	16	41
	Range	NA	44 – 49	25 – 38	NA	37 – 45
LSI	Average	0.0	0.2	−0.4	−0.4	0.2
	Range	−0.01 to 0.0	0.19 to 0.3	−0.5 to −0.4	−0.5 to −0.4	0.07 to 0.29
CCPP	Average	−0.4	12	−19	−9.8	9.8
(mg/L $CaCO_3$)	Range	−0.6 to −0.2	11 to 14	−21 to −17	−11 to −8.9	5.1 to 14
DIC (mg C/L)	Average	68	68	50	37	73
	Range	65 – 71	68 – 69	43 – 58	36 – 38	65 – 81
CSMR	Average	1.4	1.3	2.2	2.3	2.0
	Range	1.4 – 1.45	1.2 – 1.4	1.7 – 2.6	2.2 – 2.4	2.0 – 2.1

* Well 19-01 had a single set of results in 2010, and is not included in this table. Well 19-01 is listed as active in SDWIS database.

The average pH for the wells was approximately 7.5. The wells have high levels of alkalinity and TDS and average LSI and CCPP values ranged from negative to positive. The CSMR for all of the wells was greater than the threshold of 0.6. However, it should be noted that limited data was available for most constituents.

Zone 7 conducts water quality monitoring at two turnouts for Cal Water Livermore (CWS 1 and CWS 6). Table 28 presents water quality results for the two Zone 7 turnouts for Cal Water Livermore. The results presented in Table 28 indicate an average pH of 8.2, along with moderate levels hardness, TDS and alkalinity.

Table 28: Water Quality Data at Cal Water Livermore's Two Zone 7 Turnouts (2012 – 2016)

Parameter		CWS 1	CWS 6
pH	Average	8.2	8.2
	Range	7.9 – 8.5	8 – 8.8
Alkalinity (mg/L as $CaCO_3$)	Average	80	90
	Range	67 – 92	65 – 149
Ca (mg/L)	Average	21	24
	Range	18 – 28	18 – 38
TDS (mg/L)	Average	356	343
	Range	294 – 407	271 – 415
Temperature (°C)	Average	18.4	18.3
	Range	14 – 23	15 – 22
Hardness (mg/L $CaCO_3$)	Average	128	138
	Range	93 – 321	96 – 322
Sulfate (mg/L)	Average	34	37
	Range	22 – 59	23 – 59
Chloride (mg/L)	Average	123	115
	Range	83 – 167	72 – 189

Table 29 presents the calculated corrosion indices for the two Cal Water Livermore connections with Zone 7. The average LSI values were 0 and 0.1 for data collected from 2012 through 2016. The average CCPP values were slightly negative for CWS 1 and slightly positive for CWS 6. For both turnouts, the calculated LSI and CCPP values ranged from negative to positive during 2012 through 2016. The range and average CSMR values for both turnouts were greater than 0.6, the threshold for a water to be considered corrosive to lead in solder and brass fixtures.

Table 29: Calculated Corrosion Indices for Cal Water Livermore Water at the Two Zone 7 Turnouts (2012 – 2016)

Corrosion Index		CWS 1	CWS 6
LSI	Average	0.0	0.1
	Range	−0.2 to 0.2	−0.4 to 0.6
CCPP (mg/L as $CaCO_3$)	Average	−0.4	1.3
	Range	−2 to 1.6	−2.6 to 7.3
DIC (mg C/L)	Average	19	22
	Range	16 to 22	16 to 36
CSMR	Average	4.2	3.5
	Range	1.8 to 6.9	1.8 to 7.6

Cal Water Lead Results. Table 30 presents the 90th and 50th percentile lead values for Cal Water Livermore's LCR monitoring events conducted in 2010, 2013 and 2015. All of the 90th percentile values were ND for lead. Table 31 presents the distribution of the home tap lead values for Cal Water Livermore. During the 2010 monitoring event, one home had a result above the lead Action Level. There were no homes above the Action Level during 2013 and 2015, and the majority of results were less than the DLR during all three monitoring events.

Table 30: Cal Water Livermore 90th and 50th Percentile Lead Results

Percentile	2010	2013	2015
90th	ND	ND	ND
50th	ND	ND	ND
Total Homes Sampled =	**30**	**31**	**31**

Table 31: Cal Water Livermore – Distribution of Home Tap Lead Results

Lead Concentration	2010	2013	2015
≤5 µg/L	28	30	29
>5 µg/L and ≤15 µg/L	1	1	2
>15 µg/L	1	0	0
Total Homes Sampled =	**30**	**31**	**31**

Figure 63 presents the 90th and 50th percentile results for Cal Water – Livermore (all values are ND). The distribution of lead results presented in Table 31 were converted to percentages and presented in Figure 64.

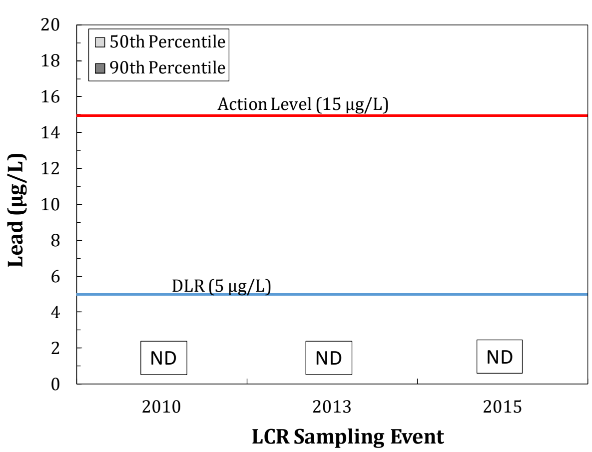


Figure 63: Cal Water Livermore 90th and 50th Percentile Lead Values (2010 – 2015)

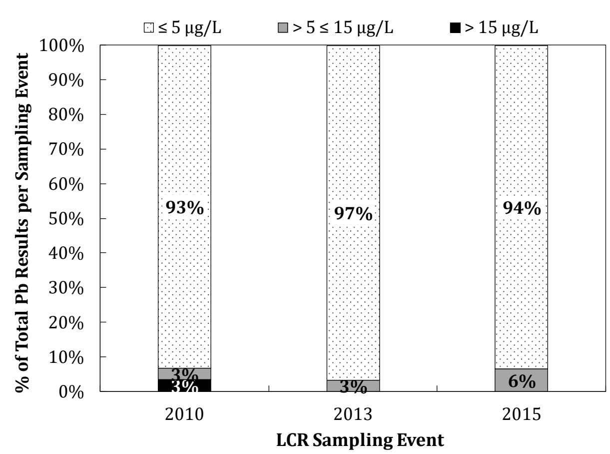


Figure 64: Cal Water Livermore Distribution of Lead Results (2010 – 2015)

Historical Lead 90th Percentiles. The DDW SDWIS database was queried for historical 90th percentile lead values. Figure 65 presents the 90th percentile lead values from 1992 through 2015. All of the 90th percentile lead values have been below the Action Level. From 2001 to the most recent monitoring event, all of the 90th percentile lead values have been below the DLR.

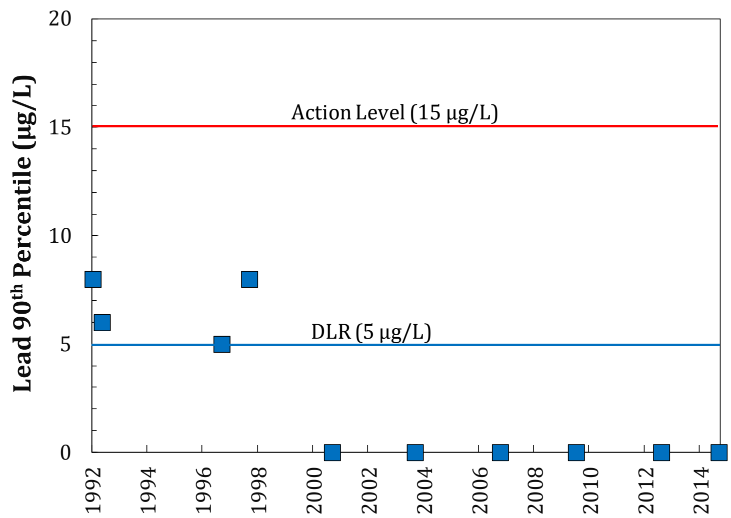


Figure 65: Cal Water Livermore 90th Percentile Lead Values from SDWIS (1992 – 2015)

Cal Water-Livermore's Copper Results. Table 32 presents the 90th and 50th percentile copper values for Cal Water Livermore for LCR home tap monitoring events in 2010, 2013 and 2015. All of the 90th percentile values were well below the copper Action Level. While there does appear to be a slight trend of increasing values from 2010 to 2015 for both the 90th and 50th percentile values, the results are quite low and well below the copper Action Level.

Table 32: Cal Water Livermore 90th and 50th Percentile Copper Results (µg/L)

Percentile	2010	2013	2015
90th	190	205	336
50th	57	88	120
Total Homes Sampled =	**30**	**31**	**31**

Table 33 presents the distribution of copper results for the Cal Water Livermore's home tap LCR monitoring events into three concentration categories. There were no homes with copper results above the Action Level. During all three monitoring events, the majority of homes had results less than one-half the copper Action Level.

Table 33: Cal Water Livermore – Distribution of Home Tap Copper Results

Copper Concentration	2010	2013	2015
≤650 µg/L	29	30	31
>650 µg/L and ≤1300 µg/L	1	1	0
>1300 µg/L	0	0	0
Total Homes Sampled =	**30**	**31**	**31**

Cal Water Livermore's 90th and 50th percentile copper values are presented in Figure 66. The distribution of the home tap copper results were converted to percentages and presented in Figure 67.

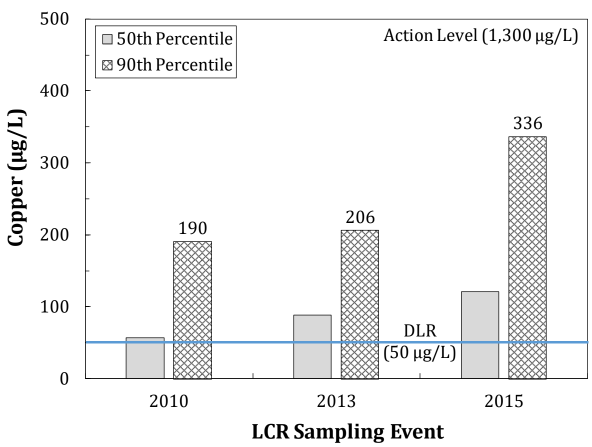


Figure 66: Cal Water Livermore 90th and 50th Percentile Copper Values (2010 – 2015)

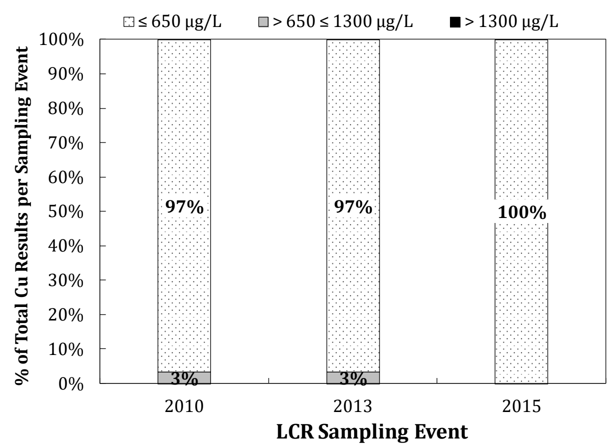


Figure 67: Cal Water Livermore Distribution of Copper Results (2010 – 2015)

Historical Copper 90th Percentiles. The DDW SDWIS database was queried for Cal Water Livermore's historical 90th percentile copper values. Figure 68 presents the 90th percentile copper from 1992 through 2015. During the initial LCR tap monitoring conducted in 1992 the copper 90th percentile was slightly elevated, but below the Action Level, at 960 µg/L. Since that initial round, all subsequent 90th percentile values have been quite low.

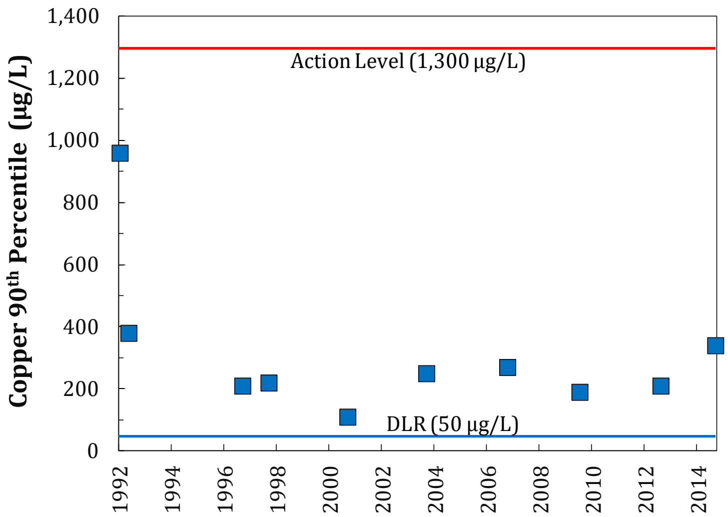


Figure 68: Cal Water Livermore 90th Percentile Copper Values from SDWIS (1992 – 2015)

Summary. During the period of this assessment, Cal Water Livermore purchased approximately 63% to 78% of its drinking water supply annually from Zone 7. The remaining supply is produced from wells owned and operated by Cal Water (and a well leased from a private entity). Cal Water Livermore is currently conducting LCR monitoring on a reduced frequency (every three years, although there was only a two year gap between 2013 and the 2015 monitoring event) and at a reduced number of tap locations (30). The water quality at the Zone 7 connections and for the wells indicates varying water quality (from slightly negative to slightly positive LSI values and a range of negative to positive CCPP values). However, the 90th percentile results reviewed in this report were quite good. During LCR home tap monitoring conducted in 2010, 2013 and 2015 all lead and copper results were quite low and are consistent with historical results. Historical 90th percentile values for lead and copper in the DDW SDWIS database are consistently below their respective Action Levels. Cal Water Livermore is considered a large system under LCR and should also be conducting water quality parameter monitoring at a reduced number of taps during each LCR monitoring event. No tap water quality monitoring results were provided for this review.

City of Pleasanton

The City of Pleasanton serves a population of approximately 72,200. Pleasanton owns and operates three wells (Wells 5, 6 and 8). Based on information provided by the City of Pleasanton, it appears that the City's distribution system piping material consists of asbestos cement, PVC, steel, and ductile iron. For this assessment Pleasanton provided monthly production totals for the groundwater supply and treated water purchased from Zone 7 from 2011 through 2016. Figure 69 presents the annual percent of the total supply from Zone 7 and the City's three wells. During the period of 2011 through 2016, Pleasanton purchased approximately 67% to 80% of its total drinking water supply annually from Zone 7.

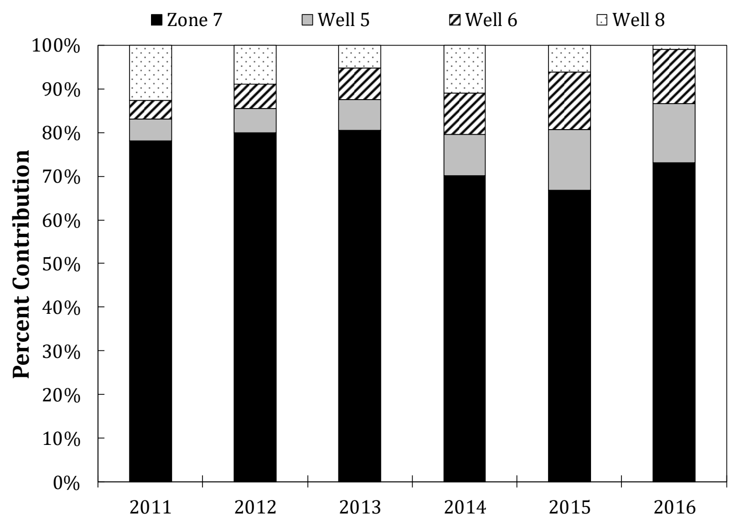


Figure 69: Percent Contribution from City of Pleasanton Supplies (2011 – 2016)

Zone 7 tests water quality at three Pleasanton turnouts (P3, P4 and P5). Table 34 presents water quality data for the City of Pleasanton turnouts from 2012 through 2016.

Table 34: Water Quality Data for Pleasanton's Three Zone 7 Turnouts (2012 – 2016)

Parameter		P3	P4	P5
pH	Average	7.8	7.8	8.2
	Range	7.4 – 8.1	7.3 – 8.4	7.4 – 8.5
Alkalinity (mg/L as $CaCO_3$)	Average	162	197	88
	Range	66 – 268	88 – 345	63 – 151
Calcium (mg/L)	Average	38	52	31
	Range	19 – 53	25 – 92	17 – 97
TDS (mg/L)	Average	400	455	345
	Range	354 – 488	342 – 646	278 – 422
Temperature (°C)	Average	19.4	18.0	18.9
	Range	17.3 – 21.2	16 – 21	16 – 22
Hardness (mg/L)	Average	226	263	177
	Range	112 – 322	128 – 401	101 – 480
Sulfate (mg/L)	Average	39	53	37
	Range	25 – 48	35 – 81	23 – 63
Chloride (mg/L)	Average	99	99	116
	Range	50 – 184	83 – 119	73 – 195

The average pH ranged from 7.8 to 8.2, while individual pH results ranged from 7.3 to 8.5. All three turnouts indicated moderate alkalinity, hardness and TDS. Turnout P5 is supplied by DVWTP. The higher alkalinity, hardness and TDS values recorded for turnouts P3 and P4 are due to the influence of groundwater.

Table 35 presents the calculated corrosion indices for the three Pleasanton connections. The average LSI at the three connections ranged from slightly negative to slightly positive. The average CCPP at the three connections were positive (but the range of CCPP values was from negative to positive). The CSMR at all three connections were greater than 0.6.

Table 35: Corrosion Indices at City of Pleasanton's Three Zone 7 Turnouts (2012 – 2016)

Corrosion Index		P 3	P 4	P 5
LSI	Average	–0.05	0.22	0.10
	Range	–0.2 to 0.2	–0.1 to 0.7	–0.2 to 0.4
CCPP (mg/L as $CaCO_3$)	Average	0.9	10.5	1.3
	Range	–7 to 12	–3 to 42	–2.2 to 7.4
DIC (mg/L)	Average	37	47	22
	Range	16 to 68	21 to 92	15 to 36
CSMR	Average	2.9	2.0	3.5
	Range	1.3 to 7.4	1.1 to 2.8	1.7 to 7.5

The City of Pleasanton provided three years of water quality results for the three wells and for a number of sample locations within the distribution system. Table 36 presents the average and range for pH, alkalinity, calcium, conductivity, and temperature. The average pH values for the distribution system locations ranged from 7.9 to 8.3. The average pH for the wells ranged from 7.4 to 7.5.

Table 36: Pleasanton Water Quality for Wells and Distribution System (2014 – 2016)

Location		pH	Alkalinity mg/L $CaCO_3$	Calcium mg/L	Conductivity µS	Temperature °C
S-10	Average	7.9	172	71	785	20
	Range	7.2–8.7	60–344	22–197	404–1038	16–23
S-11	Average	8.0	182	57	815	20
	Range	7.5–8.8	68–348	21–107	401–1188	14–23
S-13	Average	7.9	204	73	830	19
	Range	7.3–8.8	60–340	18–162	403–1112	11–24
S-15	Average	7.8	200	63	803	20
	Range	7.3–8.2	72–400	27–139	509–1023	16–23
S-16	Average	7.9	188	62	805	20
	Range	7.5–8.5	72–400	26–112	473–1064	16–23
S-17	Average	8.0	192	60	805	20
	Range	7.6–8.6	65–360	18–133	407–1067	16–23
S-19	Average	7.8	169	60	798	20
	Range	7.4–8.1	72–380	28–135	475–1036	16–24
S-38	Average	8.0	169	59	765	21
	Range	7.4–8.9	64–360	18–139	402–1035	16–25
S-39	Average	7.8	160	58	809	20
	Range	7.3–8.4	72–308	27–106	521–1023	16–23
S-40	Average	8.2	126	48	737	21
	Range	7.8–8.7	80–240	18–98	428–1028	16–27
S-45	Average	7.8	182	59	780	20
	Range	7.3–8.8	70–320	22–130	404–1035	14–24
S-46	Average	8.1	152	52	750	21
	Range	7.4–8.9	68–320	16–154	405–1007	15–25
S-47	Average	8.3	150	42	710	20
	Range	7.8–8.8	60–306	20–115	426–1024	15–25
Well #5	Average	7.4	324	113	1124	19
	Range	7.2–7.9	156–444	55–178	1017–1276	15–22
Well #6	Average	7.4	302	106	1035	19
	Range	7.2–7.9	227–360	58–168	959–1101	14–21
Well #8	Average	7.5	262	89	833	20
	Range	7.3–7.9	163–360	51–168	716–945	18–23

The water quality results in Table 36 were used to calculate corrosion indices for the three wells and the distribution system locations. The results are presented in Table 37. The average LSI values were positive for all sample locations, however individual locations had values that varied from slightly negative to slightly positive. All results for the wells indicated slightly positive LSI values. There were similar results for CCPP values. The average CCPP values for the wells and all distribution system locations were positive. However, nine of the thirteen distribution system sample locations ranged from negative CCPP values to positive CCPP values.

Table 37: Calculated LSI and CCPP Values for Pleasanton's Wells and Distribution System (2014 – 2016)

Location	LSI		CCPP, mg/L as $CaCO_3$	
	Average	Range	Average	Range
S-10	0.3	–0.19 to 0.86	11.5	–2.7 to 39.7
S-11	0.4	–0.07 to 0.79	16.8	–0.5 to 53.9
S-13	0.4	–0.2 to 1.09	19.8	–1.9 to 66.6
S-15	0.3	–0.09 to 0.83	16.2	–4 to 69.5
S-16	0.3	0.05 to 0.68	15.8	0.5 to 69.8
S-17	0.5	–0.03 to 0.87	19.7	–0.2 to 77.7
S-19	0.3	–0.07 to 0.70	12.3	–0.7 to 48.8
S-38	0.3	–0.27 to 0.70	15.6	–1.9 to 65.6
S-39	0.2	–0.15 to 0.54	9.3	–2.1 to 30.8
S-40	0.4	0.09 to 0.78	7.8	0.8 to 23.1
S-45	0.3	–0.46 to 0.71	11.1	–4.1 to 44.6
S-46	0.4	0.09 to 0.66	13.4	0.6 to 62.3
S-47	0.5	0.09 to 0.93	11.5	0.6 to 32.9
Well #5	0.4	0.08 to 0.94	35.6	6.3 to 81.8
Well #6	0.4	0.1 to 0.86	34.8	7.4 to 56.4
Well #8	0.3	0.02 to 0.79	24.4	0.7 to 77.9

In addition, the City of Pleasanton provided water quality data for six (6) entry points to the distribution system (T1 through T5 and T7). Water quality results for the six sample locations are presented in Table 38.

Table 38: Pleasanton Water Quality Data for Entry Points (2014 – 2016)

Location		pH	Alkalinity mg/L $CaCO_3$	Calcium mg/L	Conductivity µS	Temperature °C
T-1	Average	8.4	147	42	729	19
	Range	7.5–9.1	60–392	18–99	399–1018	11–23
T-2	Average	8.5	170	53	712	20
	Range	7.5–10	52–408	19–125	397–1066	14–24
T-3	Average	8.3	175	48	790	19
	Range	7.5–8.9	60–384	22–96	401–1195	13–24
T-4	Average	8.2	204	55	828	19
	Range	7.6–8.8	60–380	24–88	405–1063	15–23
T-5	Average	8.5	114	41	707	20
	Range	8.1–9.1	68–200	24–89	405–1023	14–24
T-7	Average	8.5	115	42	709	20
	Range	7.8–9.1	60–200	24–109	406–1020	11–25

The water quality results in Table 38 were used to calculate corrosion indices for the six entry points to the distribution system. The results are presented in Table 39. The average LSI values were positive for all entry points and the range of LSI values was positive at all locations. The range and average CCPP values for all of the entry point locations were positive.

Table 39: LSI and CCPP Values for Pleasanton's Entry Points (2014 – 2016)

	Langelier Index		CCPP, mg/L as $CaCO_3$	
Location	Average	Range	Average	Range
T-1	0.5	0.04 to 0.9	12.6	0.4 to 46.8
T-2	0.7	0.03 to 1.9	23.1	0.3 to 67.7
T-3	0.6	0.29 to 0.9	15.9	2.9 to 47.6
T-4	0.6	0.36 to 1.1	20.3	3.9 to 51.4
T-5	0.6	0.09 to 1.1	8.2	1.1 to 16.5
T-7	0.6	0.24 to 1.0	8.5	3.6 to 14.1

City of Pleasanton's Lead Tap Results. The City of Pleasanton provided LCR home tap lead and copper results for monitoring events conducted during 2010, 2013 and 2016. Table 40 presents the 90th and 50th percentile lead values for the City of Pleasanton. The 90th percentile in 2010 was slightly above the DLR for lead while the 90th percentile in 2013 and 2016 were below the DLR.

Table 40: City of Pleasanton 90th and 50th Percentile Lead Results (µg/L)

Percentile	2010	2013	2016
90th	5.6	ND	4.2
50th	2.5	ND	ND
Total Home Sampled =	**42**	**40**	**62**

Table 41 presents the distribution of the home tap lead values for the City of Pleasanton. During the 2010 monitoring event there were two home tap sample locations where the result exceeded the Action Level. There were no homes with results above the Action Level in 2013 and 2016. During all three monitoring events, the majority of homes had a result below the lead DLR.

Table 41: City of Pleasanton – Distribution of Home Lead Results

Lead Concentration	2010	2013	2016
≤5 µg/L	36	37	58
>5 µg/L and ≤15 µg/L	4	3	4
>15 µg/L	2	0	0
Total Homes Tested =	**42**	**40**	**62**

Figure 70 presents the 90th and 50th percentile results for the City of Pleasanton. The distribution of lead results presented in Table 41 were converted to percentages and presented in Figure 71.

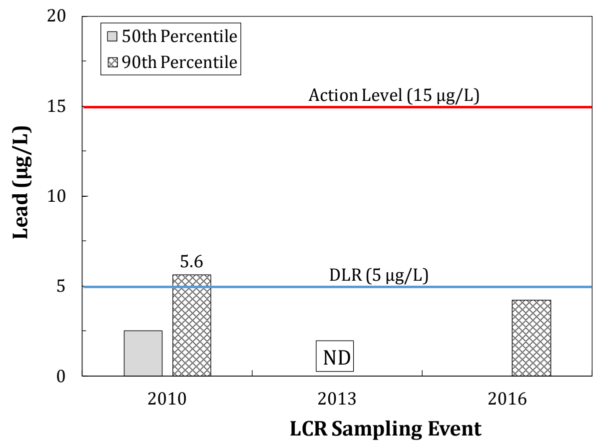


Figure 70: City of Pleasanton 90th and 50th Percentile Lead Values (2010 – 2016)

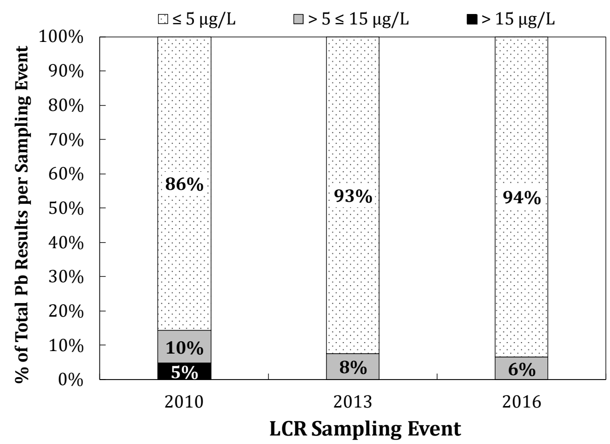


Figure 71: City of Pleasanton Distribution of Lead Results (2010 – 2016)

Historical Lead 90th Percentiles. The City of Pleasanton provided historical 90th percentile lead values. Figure 72 presents the 90th percentile lead values from 1992 through 2016. During the initial round of LCR monitoring in 1992, the 90th percentile result was 16 µg/L and exceeded the Action Level. All other 90th percentile values were below the Action Level (in 1998 the 90th percentile result was 10 µg/L, all other 90th percentiles have been less than the DLR or slightly above the DLR).

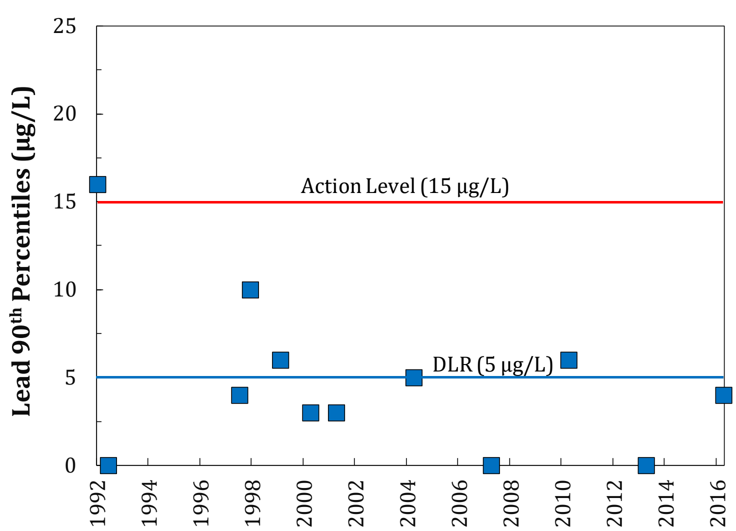


Figure 72: Pleasanton Lead 90th Percentile Values (1992 – 2016)

City of Pleasanton's Copper Results. Table 42 presents the 90th and 50th percentile copper values for Pleasanton. All of the 90th percentile values were below the Action Level. The 90th percentile values recorded during 2013 and 2016 were well below the 90th percentile value for 2010.

Table 42: City of Pleasanton's 90th and 50th Percentile Copper Results (µg/L)

Percentile	2010	2013	2016
90th	710	360	410
50th	260	150	66
Total Homes Tested =	**42**	**40**	**62**

Table 43 presents the distribution of copper results for the City of Pleasanton's home tap LCR monitoring events into three concentration categories. During the 2010 LCR monitoring event, two homes had a copper result above the Action Level. During 2013 and 2016 there were no homes with a copper result above the Action Level. For all three monitoring events, the majority of homes had results less than one-half of the Action Level.

Table 43: City of Pleasanton – Distribution of Home Tap Copper Results

Copper Concentration	2010	2013	2016
≤650 µg/L	37	39	60
>650 µg/L and ≤1300 µg/L	3	1	2
>1300 µg/L	2	0	0
Total Homes Sampled =	**42**	**40**	**62**

City of Pleasanton's 90th and 50th percentile copper values are presented in Figure 73. The distribution of the home tap copper results were converted to percentages and presented in Figure 74.

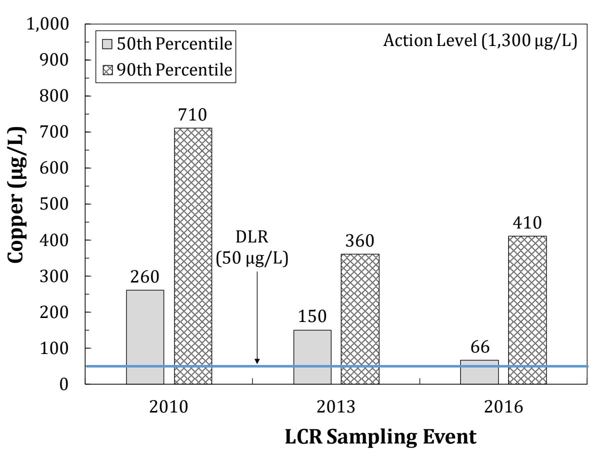


Figure 73: Pleasanton 90th and 50th Percentile Copper Values (2010 – 2016)

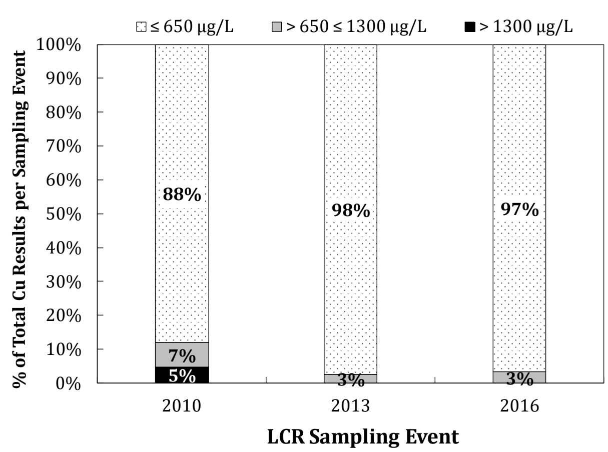


Figure 74: Pleasanton Distribution of Copper Results (2010 – 2016)

Historical Copper 90th Percentiles. The City of Pleasanton provided historical 90th percentile copper values. Figure 75 presents the 90th percentile copper from 1992 through 2016. During the initial two rounds of LCR monitoring in 1992, the 90th percentile result was 1,700 µg/L during both rounds and exceeded the Action Level. Since the initial rounds of monitoring, all of the 90th percentile copper values were below the Action Level.

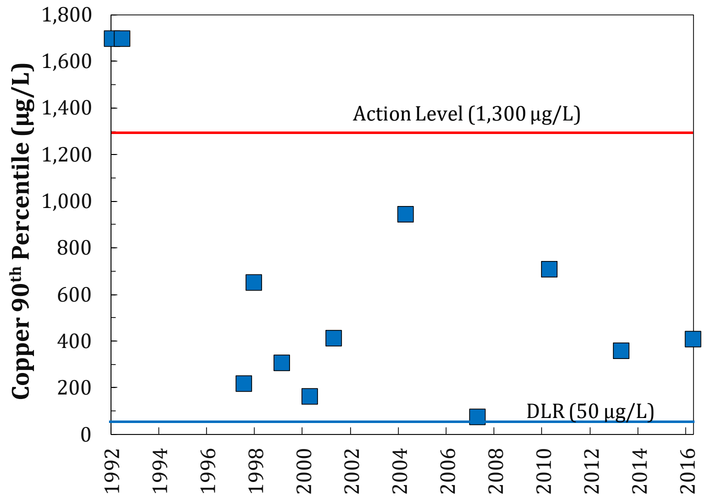


Figure 75: City of Pleasanton 90th Percentile Copper Values (1992 – 2016)

Summary. During the period of this assessment, the City of Pleasanton purchased approximately 67% to 80% of its drinking water supply annually from Zone 7. The remaining supply is produced from wells owned and operated by the City of Pleasanton. The City of Pleasanton is currently conducting LCR monitoring on a reduced frequency. The water quality at the Zone 7 connections and for the wells indicates varying water quality (from slightly negative to slightly positive LSI values and a range of negative to positive CCPP values). The 90th percentile results reviewed in this report were quite good. During LCR home tap monitoring conducted in 2010, 2013 and 2016 all lead and copper results were quite low and are consistent with historical results. During initial LCR tap monitoring events in 1992, 90th percentile results exceeded both the lead and copper Action Level. After the 1992 results, historical 90th percentile values for lead and copper in the DDW SDWIS database are consistently below their respective Action Levels. The City of Pleasanton is considered a large system under LCR and conducts water quality parameter monitoring. That water quality data was provided and included in this assessment.

Dublin San Ramon Services District (DSRSD)

DSRSD serves a population of approximately 80,200. DSRSD purchases 100% of its supply from Zone 7. The DWRSD distribution system consists of over 300 miles of piping. Based on information provided by DSRSD, it appears that the distribution system piping material consists primary of PVC (75%), with smaller amounts of asbestos cement pipe (16%), cast iron (5%), ductile iron (4%) and steel (1%). Zone 7 conducts routine water quality monitoring at three DSRSD turnouts (DSRSD 1, DSRSD 2 and DSRSD 5). Table 44 presents water quality data collected by Zone 7 at the three DSRSD turnouts from 2012 through 2016.

Table 44: Water Quality Data for DSRSD's Three Zone 7 Turnouts (2012 – 2016)

Parameter		DSRSD 1	DSRSD 2*	DSRSD 5
pH	Average	7.9	7.4	7.9
	Range	7.5 - 8.4	7.4	7.4 - 8.3
Alkalinity (mg/L as $CaCO_3$)	Average	140.0	386	144
	Range	76 - 223	386	70 - 266
Ca (mg/L)	Average	39	110	40
	Range	24 - 57	110	18 – 59
TDS (mg/L)	Average	384	851	398
	Range	274 - 498	851	292 - 493
Temperature (°C)	Average	18.6	20.7	18.9
	Range	16.7 - 21	20.7	17.1 - 21.3
Hardness (mg/L as $CaCO_3$)	Average	214	446	247
	Range	108 - 370	358 - 534	102 - 341
Sulfate (mg/L)	Average	45	119	40
	Range	27 - 58	119	25 – 48
Chloride (mg/L)	Average	97	172	107
	Range	45 - 130	172	70 - 182

*With the exception of hardness, one set of water quality data provided for this sample location.

Using the water quality data presented in Table 44 above, Table 45 presents the calculated corrosion indices for Zone 7's three DSRSD connections. As indicated in Table 45, the average LSI values were zero or slightly positive at all three connections. The average CCPP values were all positive (the water quality data for the DSRSD 2 connection indicated a much higher average CCPP value than the other two connections). The range of LSI and CCPP values included slightly negative values at two of the three turnouts. The average and range of CSMR values at all three turnouts were greater than the theoretical threshold of 0.6.

Table 45: Corrosion Indices for DSRSD Three Zone 7 Turnouts (2012 – 2016)

Corrosion Index		DSRSD 1	DSRSD 2*	DSRSD 5
LSI	Average	0.2	0.5	0.0
	Range	0 to 0.4	0.5	-0.1 to 0.2
CCPP (mg/L as $CaCO_3$)	Average	3.0	56	3.3
	Range	-0.2 to 6.9	56	-0.9 to 13.8
DIC (mg C/L)	Average	32	100	30.7
	Range	18 to 44	100	17 to 68
CSMR	Average	2.3	1.4	3.1
	Range	1.3 to 4.4	1.4	1.5 to 7.3

*One set of water quality data available for this turnout.

DSRSD's Lead Results. DSRSD provided LCR tap results for monitoring events conducted in 2010, 2013 and 2016. Table 46 presents the 90th and 50th percentile lead values for the DSRSD home tap monitoring events conducted in 2010, 2013 and 2016. As indicated in Table 46, the results for all three monitoring events have been quite good. In 2010 and 2016 the 90th percentile lead values were below the lead DLR. In 2013, the 90th percentile was slightly above the lead DLR.

Table 46: DSRSD 90th and 50th Percentile Lead Results (µg/L)

Percentile	2010	2013	2016
90th	3	6	3
50th	ND	ND	1.2
Total Homes Sampled =	**62**	**66**	**30**

Table 47 presents the distribution of the DSRSD's home tap lead results. During each of the three home tap monitoring events there was one home with a result above the lead Action Level (different homes during each monitoring event). The majority of homes had lead results less than the DLR during each monitoring event.

Table 47: DSRSD – Distribution of Home Lead Results

Lead Concentration	2010	2013	2016
≤5 µg/L	58	58	27
>5 µg/L and ≤15 µg/L	3	7	2
>15 µg/L	1	1	1
Total Homes Sampled =	**62**	**66**	**30**

Figure 76 presents the 90th and 50th percentile results for DSRSD. The distribution of lead results presented in Table 47 were converted to percentages and presented in Figure 77.

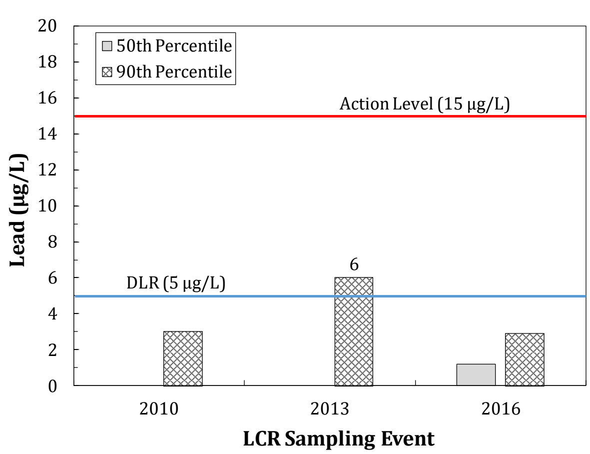


Figure 76: DSRSD 90th and 50th Percentile Lead Values (2010 – 2016)

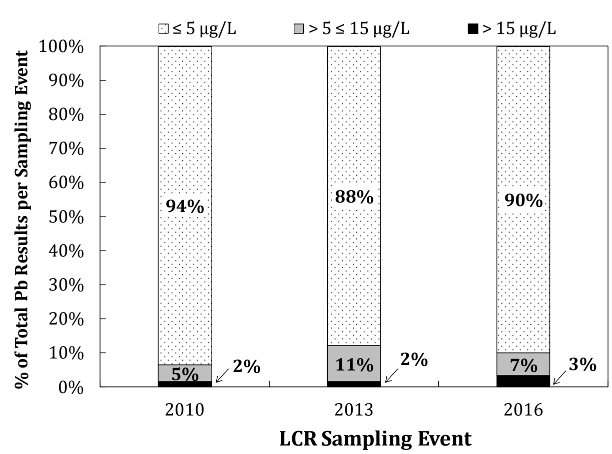


Figure 77: DSRSD Distribution of Lead Results (2010 – 2016)

Historical Lead 90th Percentiles. The DDW SDWIS database was queried for DSRSD's historical 90th percentile lead values. Figure 78 presents the 90th percentile lead values from 1992 through 2013 (the 2016 LCR monitoring results and the 90th percentile value of 3 µg/L has not yet been entered into SDWIS). In August 2000, the 90th percentile value was 22 µg/L and in 2001 the 90th percentile lead value was 73 µg/L. Since the 2001 monitoring event, all of the 90th percentile lead values were at or below the Action Level.

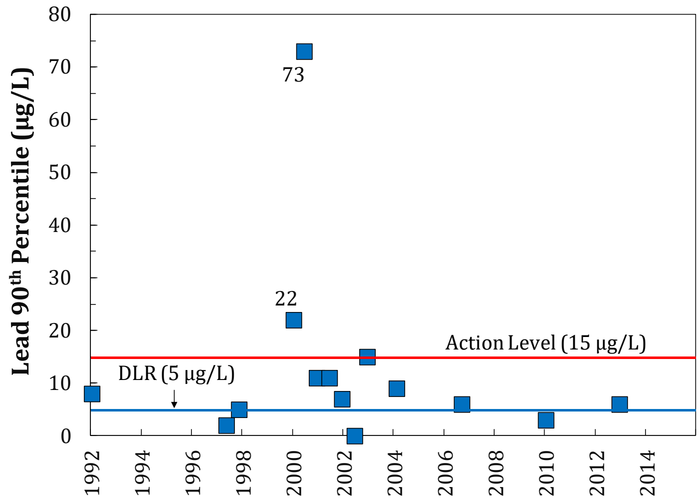


Figure 78: DSRSD 90th Percentile Lead Values from SDWIS (1992 – 2013)

DSRSD's Copper Results. Table 48 presents the 90th and 50th percentile copper values for DSRSD for the home tap monitoring events conducted in 2010, 2013 and 2016. The 90th percentile results were well below the copper Action Level during all three monitoring events.

Table 48: DSRSD 90th and 50th Percentile Copper Results (µg/L)

Percentile	2010	2013	2016
90th	416	650	368
50th	172	228	106
Total Homes Sampled =	**62**	**66**	**30**

Table 49 presents the distribution of copper results for the DSRSD's home tap LCR monitoring events into three concentration categories. During the three tap monitoring events, no homes had a copper result above the Action Level.

Table 49: DSRSD – Distribution of Home Tap Copper Results

Copper Concentration	2010	2013	2016
≤650 µg/L	61	59	29
>650 µg/L and ≤1300 µg/L	1	7	1
>1300 µg/L	0	0	0
Total Homes Tested =	**62**	**66**	**30**

DSRSD's 90th and 50th percentile copper values are presented in Figure 79. The distribution of the home tap copper results were converted to percentages and presented in Figure 80.

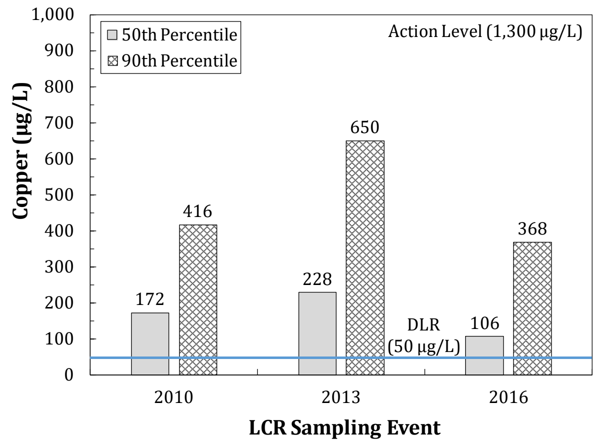


Figure 79: DSRSD 90th and 50th Percentile Copper Values (2010 – 2016)

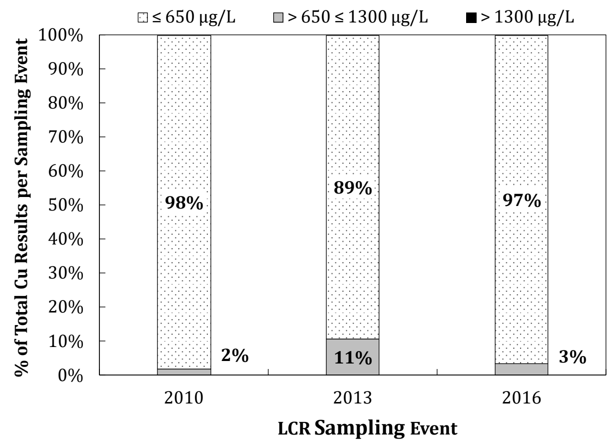


Figure 80: DSRSD Distribution of Copper Results (2010 – 2016)

Historical Copper 90th Percentiles. The DDW SDWIS database was queried for historical 90th percentile copper values. Figure 81 presents the 90th percentile copper values from 1992 through 2013. During the initial LCR home tap monitoring (August 1992) the 90th percentile copper value was 1,500 µg/L. Since that initial monitoring event, all of the 90th percentile copper values were below the Action Level.

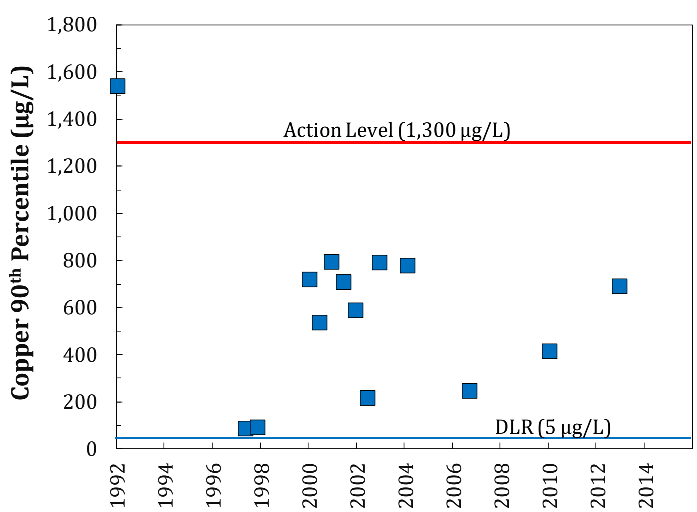


Figure 81: DSRSD 90th Percentile Copper Values from SDWIS (1992 – 2013)

Summary. DSRSD purchases 100% of its drinking water supply from Zone 7. The 90th percentile results reviewed in this report were quite low. Historical data from SDWIS indicated that there were exceedances of the lead and copper Action Levels, however the results have been well below the respective Action Levels for over 15 years (over 20 years for copper).

SECTION 8.0 – SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Zone 7 operates two large surface water treatment plants, DVWTP and PPWTP (during most of the period of this assessment the PPWTP operated with both a conventional train and a UF train, however the UF train has been off line since June 2015). Zone 7 adjusts the effluent pH with sodium hydroxide for each surface water treatment plant to meet a weekly target. In 1997 the State Water Resources Control Board California Division of Drinking Water approved pH adjustment of Zone 7's surface water as optimal corrosion control treatment. Zone 7's target for Aggressive Index (AI) was ≥12.0 during the period of time when most of the data evaluated for this assessment was generated. In June 2016, Zone 7 increased the target AI value to 12.2 for the effluent of both surface water treatment plants.

Zone 7 owns and operates ten groundwater wells. These wells are used to meet peak demands as needed. Some of the Mocho wells are treated to remove high levels of minerals and blended with untreated groundwater prior to serving the system. The pH of the blended water is adjusted with addition of sodium hydroxide prior to serving the system.

Zone 7 serves approximately 43 direct customers via thirteen turnouts/service connections. Zone 7's direct customers are mostly a transient population with the exception of one single family home near the PPWTP. Zone 7 supplies drinking water to the following four agencies that serve a combined population of approximately 238,000:

- City of Livermore
- Cal Water Livermore
- City of Pleasanton
- Dublin San Ramon Services District (DSRSD)

The City of Livermore and DSRSD purchase 100% of their supplies from Zone 7. Cal Water Livermore and the City of Pleasanton own and operate local groundwater supplies. For this assessment, lead and copper tap monitoring results, water quality data, and production data were collected from Zone 7 and the four retail agencies. Corrosion indices were calculated for Zone 7 and for each agency using available data. The focus of the assessment was on the period of 2009 through 2016.

SUMMARY AND CONCLUSIONS

The following are highlights of the analysis presented in this report, and WQTS' conclusions:

1. The Lead and Copper Rule (LCR) is based on a comparison of the 90^{th} percentile of home tap results against an Action Level. The 90^{th} percentile tap results from the most recent four Zone 7 monitoring events were below the respective Action Levels for lead and copper.
2. The 90^{th} percentile lead and copper results for all four of Zone 7's retail agencies were well below the respective Action Levels, and there were no data indicating a trend towards increasing concentrations.

3. There are no known lead service lines for Zone 7's direct customers.
4. Some of the samples collected under the LCR monitoring program are from the local Veterans Administration (VA) buildings. During the June 2015 LCR monitoring event there was a noticeable increase in lead levels at some of the VA building sites. Some of these levels were well above the action level of 15 µg/L. It is our understanding that Zone 7 staff has already been in contact with the VA Building staff, and have discussed the elevated lead and copper levels at some of the sampling sites. Since no other site in the LCR monitoring program has shown elevated lead (or copper), all indicates are that these elevated levels are likely due to internal plumbing problems. It is our understanding that the VA Building staff is aware of internal plumbing issues, and has conducted additional follow up monitoring in July, August, and September of 2016. VA Building staff replaced two drinking water fountains where elevated levels of lead were detected. Water filters were replaced at a number of locations. In May 2017, Zone 7 staff collected supplemental lead and copper samples at 8 sample locations, and lead and copper results at seven of the eight locations were low or non-detect. The lead and copper levels at one drinking water fountain were well above the lead and copper Action Levels. That fountain has been tagged "not for drinking water" and the filter will be replaced and the fountain retested prior to being used for drinking water.
5. AI values ranged from slightly less than 12.0 to greater than 12.0 for both surface water treatment plants during the period of this assessment. In June 2016 the AI goal for the treated water from the two surface water treatment plants was increased from ≥12.0 to 12.2.
6. Langelier Saturation Index (LSI) and Calcium Carbonate Precipitation Potential (CCPP) values for Zone 7's surface water treatment plants fluctuated between negative and positive values during the period of this assessment.
7. The calcium to sulfate mass ratio (CSMR) for all sources (Zone 7 and the retail agencies) was greater than the theoretical threshold of 0.6. For the data reviewed in this assessment, however, there appears to be no relationship between the CSMR threshold of 0.6 and lead results.
8. Projects are underway for ozone to be online as the primary disinfectant at the Del Val Water Treatment Plant (DVWTP) by fall of 2019 and fall of 2021 at the Patterson Pass Water Treatment Plant (PPWTP). Ozone will increase the concentration of dissolved oxygen (DO) in the finished water. While DO can be an important constituent impacting the corrosivity of drinking water, it is not expected to cause an increase in corrosivity of Zone 7's drinking water supplies.

RECOMMENDATIONS

The following are WQTS' recommendations for Zone 7's consideration:

1. Based on our analysis of the water quality data received, WQTS recommends that Zone 7 continue its current approach of pH adjustment with sodium hydroxide at the surface water treatment plants as its primary corrosion control measure. No other mitigation measures are warranted at this time.
2. However, WQTS is concerned about the elevated lead levels at some of the potable water taps in the VA Hospital buildings, especially since samples have been collected from only a fraction of the taps used for drinking or cooking. While Zone 7 staff has been working with the staff of the VA Hospital to address the elevated lead and copper issues within the hospital buildings, WQTS offers the following additional recommended actions for consideration by the VA staff:
    a. The VA should consider retaining the services of a professional qualified entity to develop and implement a lead and copper monitoring and mitigation program, and conduct a thorough assessment of the plumbing system in its buildings.
    b. The VA should consider making sure that all taps used for human consumption are monitored for lead and copper, and that taps with elevated levels are tagged and removed from service.
    c. The VA should consider carefully examining its plumbing system and identify the cause of the increase in lead and copper levels at some of its taps.
    d. The VA should consider implementing a program for continued monitoring of the performance of its point-of-use devices and ensure that they are properly maintained and replaced when necessary.

Appendix A

Mocho Wells Water Quality

Table A1 presents water quality data for the four Mocho wells. The average pH for the four wells ranged from 7.4 to 7.6 (the pH of individual wells ranged from 7 to 7.9). The wells have high TDS, hardness and alkalinity. Table A2 presents the calculated corrosion indices for the individual Mocho wells.

Table A1: Water Quality Data for Mocho Wells (2009 – 2016)

Parameter		Mocho 1	Mocho 2	Mocho 3	Mocho 4
pH	Average	7.4	7.3	7.4	7.4
	Range	7 - 7.7	7.1 - 7.6	7.1 - 7.6	7 – 7.6
Alkalinity (mg/L $CaCO_3$)	Average	326	312	400	375
	Range	283 - 354	268 – 368	342 - 455	332 - 456
Calcium, mg/L	Average	76	92	99	102
	Range	66 - 88	66 – 115	81 - 117	86 - 129
TDS, mg/L	Average	654	627	868	776
	Range	602 - 753	520 – 730	726 - 1146	662 - 1010
Temperature, °C	Average	17.6	17.4	18.7	20.6
	Range	16.8 - 18.6	15.7 - 18.5	17.7 - 20.1	19.6 - 21.7
Hardness (mg/L as $CaCO_3$)	Average	419	433	526	494
	Range	374 - 466	376 – 512	415 - 632	416 - 653
Sulfate, mg/L	Average	66	68	111	98
	Range	58 - 75	56 – 86	87 - 150	85 - 137
Chloride, mg/L	Average	120	114	164	136
	Range	95 - 143	86 – 144	145 - 193	110 - 196

Table A2: Zone 7 Corrosion Indices Mocho Wells (2009 – 2016)

	LSI		CCPP		DIC		CSMR	
	Avg	Range	Avg	Range	Avg	Range	Avg	Range
MOCHO 1	0.28	−0.2 to 0.5	22	−25 to 38	85	72 to 95	1.8	1.6 to 2.4
MOCHO 2	0.26	0.0 to 0.5	24	−2 to 49	83	70 to 100	1.7	1.5 to 2.0
MOCHO 3	0.47	0.1 to 0.7	51	11 to 78	104	89 to 118	1.5	1.3 to 1.7
MOCHO 4	0.49	0.1 to 0.7	50	8 to 75	98	84 to 121	1.4	1.3 to 1.7

Appendix B

Solubility Diagrams for

DVWTP and PPWTP

The following is a description of how the solubility diagrams can be interpreted. Figure B1 is a contour diagram presenting the theoretical relationship between pH, inorganic carbonate (DIC), and the solubility of lead for the DVWTP. The number associated with each contour line represents the $\log_{10}$ of the theoretical lead concentration in mg/L. For example, the contour line on Figure B1 identified with the -0.8 value, represents a theoretical lead solubility of $10^{-0.8}$ or 0.156 mg/L. On Figure B1, the "Min" point is located at the average DIC concentration of 19 mg C/L and the minimum recorded pH of 7.7. At the "Min" point on the contour diagram, the theoretical lead concentration would be calculated as follows:

$10^{-0.63}$ = 0.234 mg/L

The "Avg" location on Figure B1 is located at the average pH of 8.4 for the DVWTP. At the "Avg" point, the theoretical lead solubility would be calculated as follows:

$10^{-0.74}$ = 0.189 mg/L

Moving from the "Min" location to the "Avg" location on Figure B1 (and reducing the theoretical lead solubility from 0.234 mg/L to 0.189 mg/L) represents a 19 percent decrease in the solubility of lead[7]. Doing the same analysis for the "Max" pH of 9.0, the theoretical lead solubility would be calculated as follows:

$10^{-0.87}$ = 0.135 mg/L

A change in pH from 7.7 to 9 would represent a theoretical 42% reduction in the solubility of lead. Figures B1 through B4 presents lead and copper solubility diagrams for the DVWTP and PPWTP, respectively.

[7] Lead solubility is a complex phenomenon, and can vary based on site-specific conditions. The lead solubility diagrams presented in Appendix B is applicable for the specific water quality conditions presented with the figure and are used here for illustrative purposes only.

Del Valle Water Treatment Plant

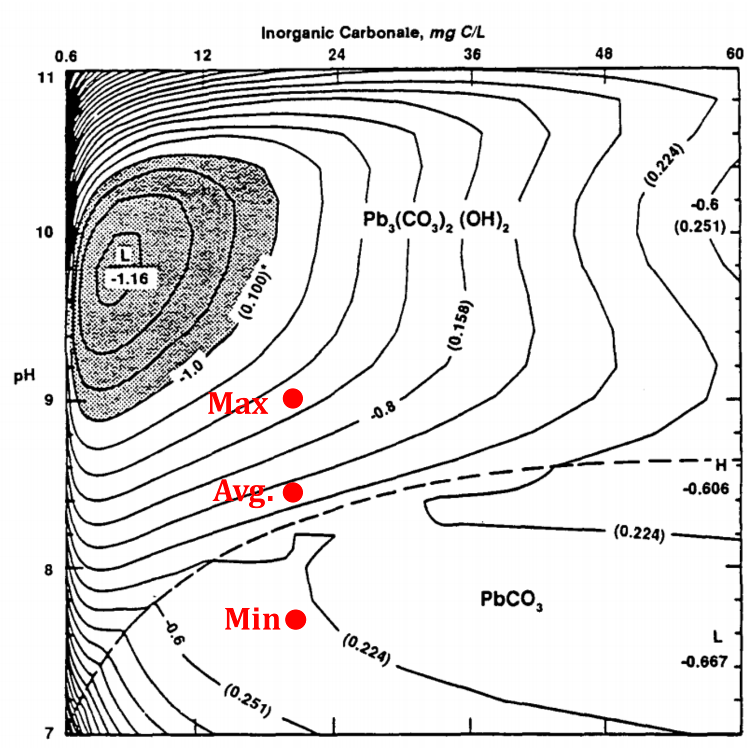


Figure B1 – Contour Diagram of Lead Solubility
Ionic Strength: 0.01 M; Temperature: 25 °C

Min Point – Del Valle WTP minimum water pH=7.7 and average DIC = 19 mg C/L
Theoretical lead solubility is approximately $10^{-0.63}$ = 0.234 mg/L
At the given average pH and DIC, lead solubility is controlled by $PbCO_3$ (cerussite)

Average Point – Del Valle WTP average water pH=8.4 and average DIC = 19 mg C/L
Theoretical Lead solubility is approximately $10^{-0.74}$ = 0.189 mg/L
At the given average pH and DIC, lead solubility is controlled by $Pb_3(CO_3)_2(OH)_2$ (hydrocerussite), which is a more stable precipitate than $PbCO_3$

Max Point – Del Valle WTP maximum water pH=9.0 and average DIC = 19 mg C/L
Theoretical lead solubility is approximately $10^{-0.87}$ = 0.135 mg/L
At the given average pH and DIC, lead solubility is controlled by $Pb_3(CO_3)_2(OH)_2$ (hydrocerussite), which is a more stable precipitate than $PbCO_3$

Del Valle Water Treatment Plant

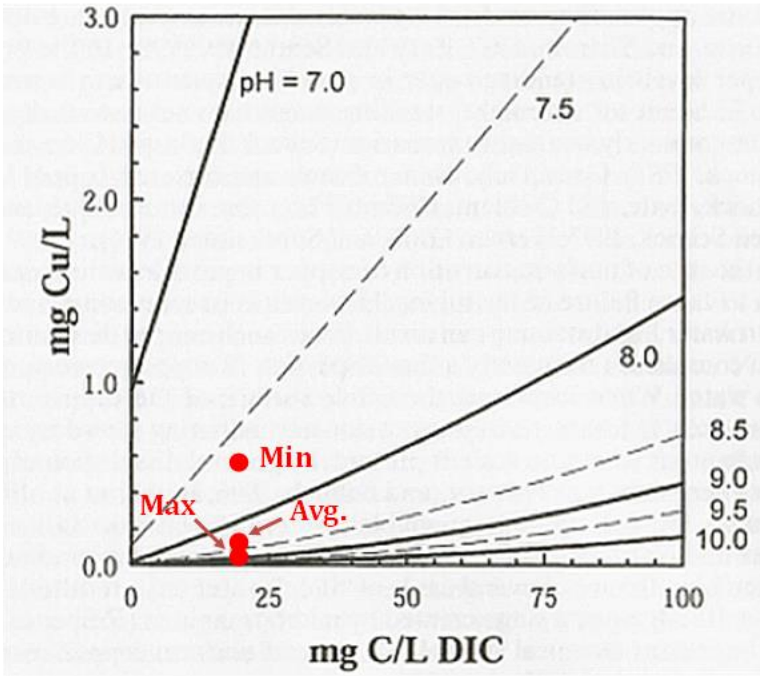


Figure B2 – Copper Solubility assuming equilibrium with cupric hydroxide ($Cu(OH)_{2(s)}$) of high surface area. Computed for 25 °C, Ionic strength = 0.02.

Min Point – Del Valle WTP minimum water pH=7.7 and average DIC = 19 mg C/L
Theoretical copper solubility is approximately 0.60 mg/L.

Average Point – Del Valle WTP average water pH=8.4 and average DIC = 19 mg C/L
Theoretical copper solubility is approximately 0.18 mg/L.

Max Point – Del Valle WTP maximum water pH=9.0 and average DIC = 19 mg C/L
Theoretical copper solubility is approximately <0.1 mg/L.

Patterson Pass Water Treatment Plant

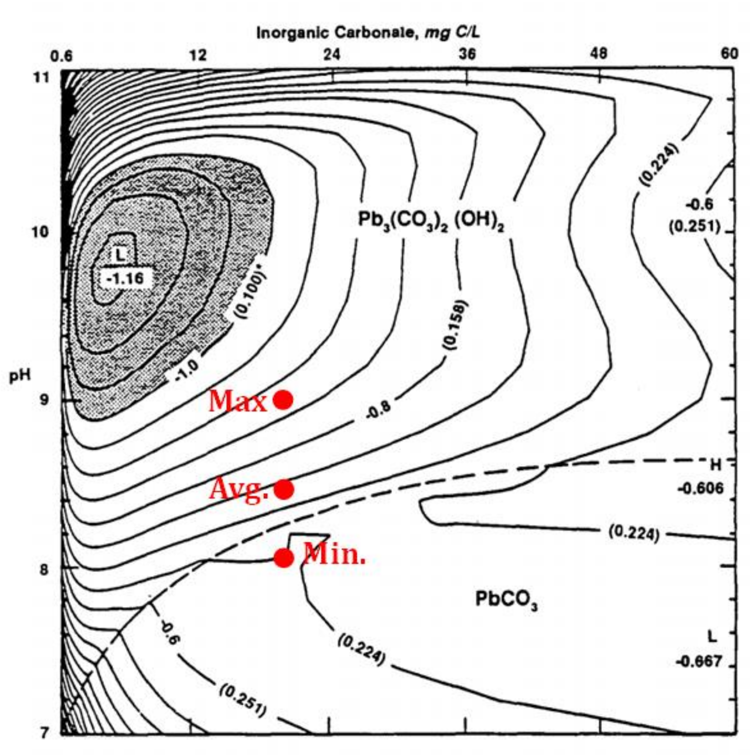


Figure B3 – Contour Diagram of Lead Solubility
Ionic Strength: 0.01 M; Temperature: 25 °C

Min Point – Patterson Pass WTP minimum water pH=8.0 and average DIC = 19 mg C/L
Theoretical lead solubility is approximately $10^{-0.65}$ = 0.224 mg/L
At the given average pH and DIC, lead solubility is controlled by $PbCO_3$ (cerussite)

Average Point – Patterson Pass WTP average water pH=8.4 and average DIC = 19 mg C/L Theoretical lead solubility is approximately $10^{-0.74}$ = 0.189 mg/L
At the given average pH and DIC, lead solubility is controlled by $Pb_3(CO_3)_2(OH)_2$ (hydrocerussite), which is a more stable precipitate than $PbCO_3$

Max Point – Patterson Pass WTP maximum water pH=9.0 and average DIC = 19 mg C/L
Theoretical lead solubility is approximately $10^{-0.87}$ = 0.135 mg/L
At the given average pH and DIC, lead solubility is controlled by $Pb_3(CO_3)_2(OH)_2$ (hydrocerussite), which is a more stable precipitate than $PbCO_3$

Patterson Pass Water Treatment Plant

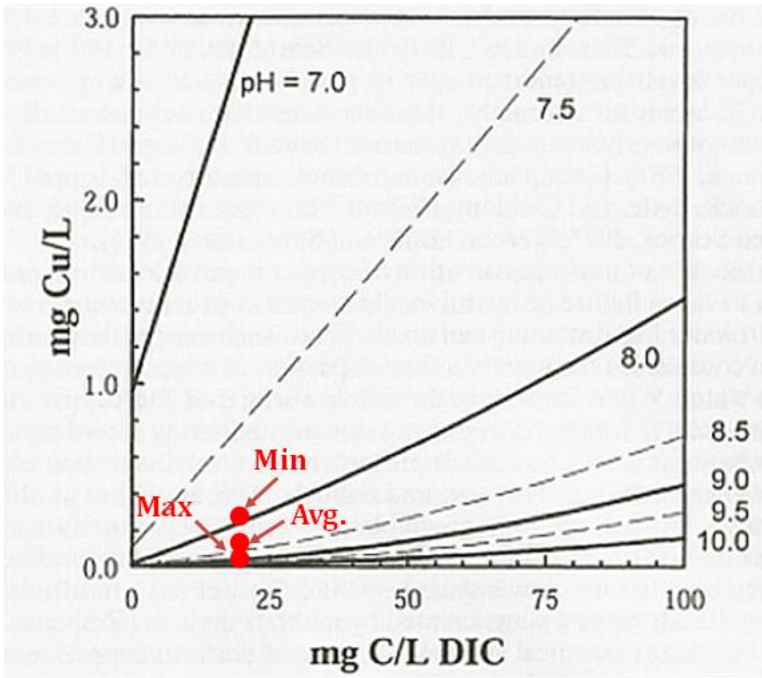


Figure B4 – Copper Solubility assuming equilibrium with cupric hydroxide ($Cu(OH)_{2(s)}$) of high surface area. Computed for 25 °C, Ionic strength = 0.02.

Min Point – Patterson Pass WTP minimum water pH=8.0 and average DIC = 19 mg C/L
Theoretical copper solubility is approximately 0.30 mg/L.

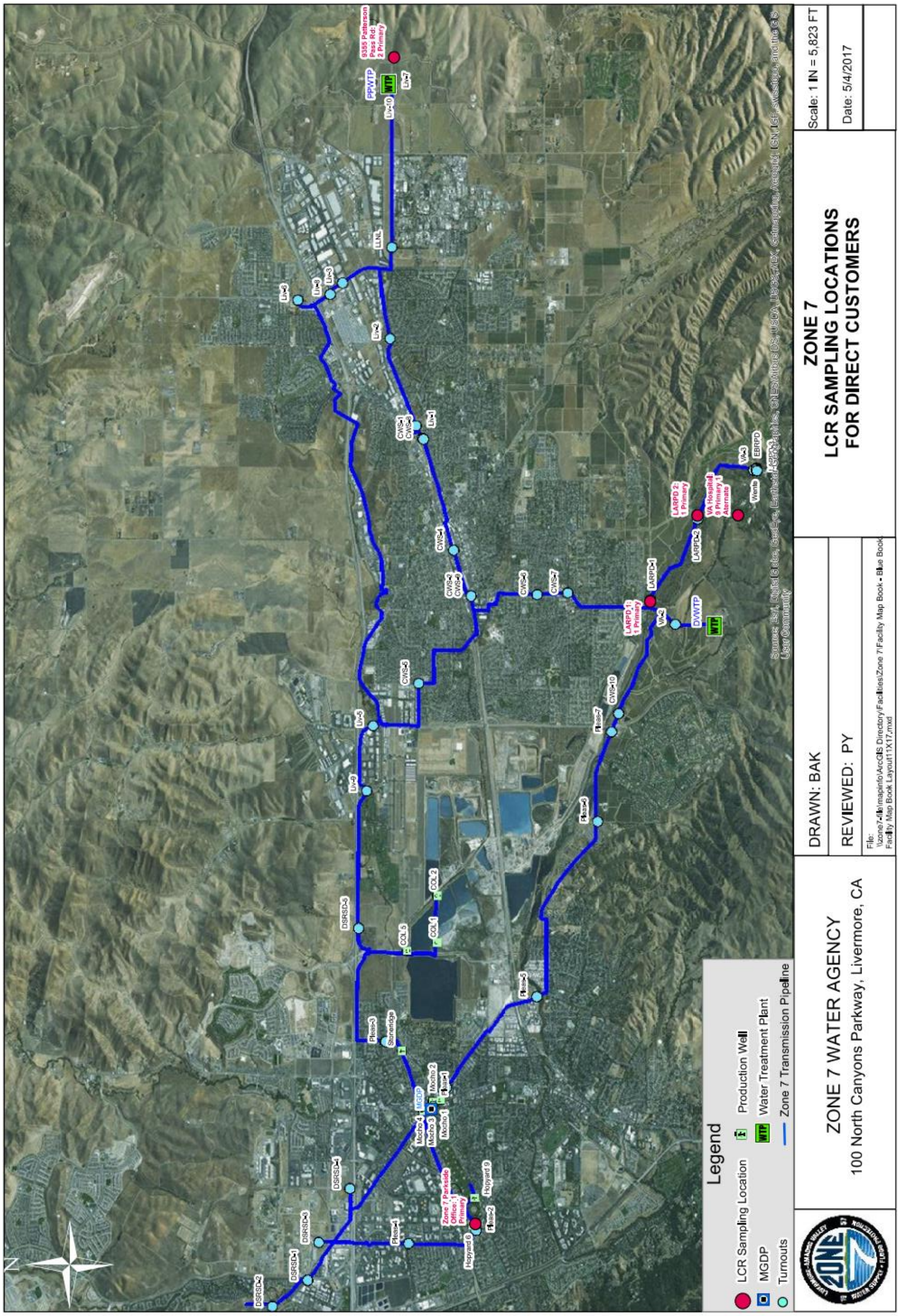
Average Point – Patterson Pass WTP average water pH=8.4 and average DIC = 19 mg C/L
Theoretical copper solubility is approximately 0.18 mg/L.

Max Point – Patterson Pass WTP maximum water pH=9.0 and average DIC = 19 mg C/L
Theoretical copper solubility is approximately <0.1 mg/L.

Appendix C

Zone 7 Map with Sources

and 2015 Sample Locations


Legend
LCR Sampling Location
MGDP
Turnouts
Production Well
Water Treatment Plant
Zone 7 Transmission Pipeline
ZONE 7 WATER AGENCY
100 North Canyons Parkway, Livermore, CA
DRAWN: BAK
REVIEWED: PY
ZONE 7
LCR SAMPLING LOCATIONS
FOR DIRECT CUSTOMERS
Scale: 1 IN = 5,823 FT
Date: 5/4/2017
PPWTP
DVWTP
9355 Patterson Pass Rd: 2 Primary
Zone 7 Parkside Office: 1 Primary
LARPD 1: 1 Primary
LARPD 2: 1 Primary
VA Hospital: 9 Primary 1 Alternate