

# Monterey Peninsula Water Supply Project Integration Study Phase 1

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#### 4.2.3 Zinc Orthophosphate Addition Throughout System

The infrastructure being built to support the changes to the water sources entering the distribution system may also alter the distribution of existing water sources in the near term. A review of the pipeline materials in the system reveals substantial amounts of galvanized iron, cast iron and unlined steel pipe. Changes in water sources in systems with materials of this kind are commonly associated with red water and customer complaints. It is thought that these colored water events result more from destabilizing the corrosion scales which have already developed on these pipe surfaces over their years of service than they do from changes in the underlying corrosion rate.

Two fundamental approaches have been successfully used to stabilize the corrosion scale on these surfaces in water systems throughout the world: the management of the mineral chemistry of the water (pH, alkalinity, hardness, calcium carbonate saturation, etc.) and the addition of an orthophosphate corrosion inhibitor. Although the Langelier Saturation Index (LSI) has long been used as a control parameter for a good mineral management strategy, the use of the LSI alone is not a guarantee of success. Where the mineral management strategy is concerned, the best strategy for maintaining the stability of a corrosion scale is generally not to change water quality conditions, and, if conditions must change, to seek modest calcium carbonate saturation and alkalinity (discussed on Section 4.2.7 below).

A mineral management strategy alone is unlikely to be sufficient for control of water quality-related customer complaints for two reasons. First, at the present time, the largest portion of the system, the portion served by the BIRP plant, has been operated with the use of zinc orthophosphate. The stability of the scale in those portions of the system requires the continued presence of that corrosion inhibitor. Second, future

sources and their distribution within different regions of the system are not yet certain. The new water supplies will largely be made up of desalinated and remineralized water and these waters will be softer and lower in alkalinity than the present supplies. Although arrangements are being made to ensure that adequate water will be available throughout the system in the future, it is not yet possible to know exactly which portions of the system will receive water of exactly which quality throughout the year. What is clear, however, is that some portions of the system will receive water of significantly different mineral quality in the future.

**As a result, it is recommended that CalAm plan on using the same zinc orthophosphate inhibitor to control corrosion and corrosion scale stability throughout its system and throughout the year. Portions of the system currently have well-developed scales in equilibrium with present mineral quality, not in equilibrium with zinc orthophosphate. In these locations, the transition to a stable phosphate-controlled scale may take some time. Thus, it is also recommended that CalAm move toward the addition of zinc orthophosphate throughout the existing distribution system as soon as possible. This will help condition the system for the addition of the new sources and maintain the stability of the existing scale upon introduction of the new sources.**

Phosphates of various kinds (orthophosphates, glassy phosphates and bimetallic phosphates) have been utilized in corrosion control since the middle of the 20<sup>th</sup> century (Rice and Hatch 1939, Illig 1957). In 1970, Bruce Murray in Long Beach, CA developed and patented the zinc/orthophosphate combination that is widely used by water utilities today (Murray 1970). Murray's formulation included sulfamic acid, a component that was later found unnecessary. Since that time, work done in Germany, the U.K. and the United States has shown that orthophosphate, alone, is often effective in controlling the corrosion of cast iron, galvanized iron, copper and lead surfaces. Work done by Reiber suggests that orthophosphate operates as both an anodic and cathodic inhibitor, forming a protective coating on metal surfaces that dissipates rapidly when orthophosphate is no longer present in the solution (Reiber 1989). Work done by the EPA and, more recently, at Virginia Tech (Buelow, Miltette et al. 1980, Parks, Kashyap et al. 2012), suggests that the zinc in the formulation may protect cement-based surfaces.

Zinc orthophosphate is added in some locations in the Monterey distribution system, including at BIRP and the Luzern and Ord Grove Treatment Plants, but nowhere else in the system (to our knowledge). This means that the ASR wells and remaining wells in the SGB do not presently have zinc orthophosphate added to their extracted water. Zinc orthophosphate is also widely used by American Water systems throughout the country, not only for controlling red water, but also for controlling the corrosion of lead and copper<sup>3</sup>.

**Trussell Technologies has already drafted a brief memo recommending the addition of zinc orthophosphate to a treatment plant being implemented by the Monterey Water Management District for the Phase II and future ASR wells (wells 3 – 6; refer to Section 6.5: Appendix E). Most, if not all, of the GWR water will also be extracted via the ASR**

<sup>3</sup> Personal communication with Dr. Mark LeChevallier

wells so adding orthophosphate at the ASR wells covers the GWR water as well. In addition to the ASR wells, it will be important to add zinc orthophosphate consistently to all of the water sources throughout the distribution system. Since zinc orthophosphate is already added at BIRP, the largest remaining source of water to the distribution system in the future that has not addressed corrosion inhibitor addition is the MPWSP desal water (refer to Figure 11).

Adding zinc orthophosphate to the desal water in the future will be less straightforward than the addition to other water sources. A small fraction of the desal water (approximately 11%) is expected to be injected into the SGB via the ASR wells and the effect of zinc orthophosphate on the wells and the aquifer is currently unclear. Zinc orthophosphate should not be added to water to be injected in the ASR wells because the orthophosphate will react with the calcium in the hard groundwater to form calcium phosphate. Since such a large portion of the desal water is directly distributed to the system, it is important that zinc orthophosphate be added to this water. It may be necessary to conduct a study to determine where in the distribution system zinc orthophosphate should be added, most importantly with respect to the desal water. Determining the dynamics of zinc orthophosphate in the ASR wells and the SGB would also help to determine likely locations for zinc orthophosphate addition.

The timing and dosing of the zinc orthophosphate are important considerations. It is necessary to begin adding zinc orthophosphate to the system as soon as possible. Conditioning the system with zinc orthophosphate before the addition of the new sources will increase the stability of the existing scale. It will also ease the transition to the new sources, which will contain zinc orthophosphate, help keep the exposure to zinc orthophosphate consistent in time and assist in maintaining similar scale throughout the system.