4. Conclusions and Recommendations

This chapter provides conclusions and recommendations based on the research summarized in Chapter 2 and the water quality data reviewed in Chapter 3. As noted in the relevant chapters, pipe loop data are through March 2006, and water quality data are through December 2005. Research conducted and data collected since that time could potentially change the conclusions presented in this chapter.

1) Orthophosphate has effectively reduced lead levels in D.C. drinking water.

There is a wealth of laboratory and field data that support the success of the orthophosphate treatment. Since the addition of orthophosphate, lead levels are generally near or below the AL after 8 hours of stagnation in both the DCWASA and WA pipe loops. Lead profiling results show significant reductions in dissolved and total lead following the orthophosphate treatment. Profiling results include some evidence that the orthophosphate scale is stabilizing over time as the treatment progresses. LCR compliance monitoring shows significant reductions in total lead levels at customers taps after only a few months of orthophosphate treatment. No other corrosion inhibitor (including zinc orthophosphate, blended polyphosphate, pH adjustment, or stannous chloride) outperformed orthophosphate in the DCWASA or WA pipe loop studies.

2) Circulation and flow through pipe loops are useful tools in selecting and optimizing corrosion control treatment.

The circulation loops constructed by DCWASA were invaluable in selecting the optimal corrosion control treatment for D.C. The overall lead concentration in the pipe loop studies correlated well with the peak lead concentration from the lead profiles of actual service lines and internal home plumbing. WA flow through pipe studies corroborated circulation loop findings, although beginning lead concentrations in the WA study were somewhat lower.

3) Partial Lead Service Line Replacement is an effective strategy to reduce lead in D.C. drinking water.

Field investigations by DCWASA have shown that the potential mechanical disruption of lead corrosion scales during partial LSL replacements is not a serious threat if care is taken during the cutting process and the line is vigorously flushed. Lead profiles conducted before and after partial replacements support DCWASA's field studies. Laboratory experiments have shown that when a new length of copper tubing is connected to a well-passivated LSL during partial LSL replacement, the area of galvanic influence is very small and decreases rapidly. Thus, any potential lead release caused by galvanic corrosion is minimal.

4) Operation of the orthophosphate treatment is progressing well, but needs improvement in some areas.

LCR compliance monitoring and lead profiling show slightly higher lead levels than are measured in either pipe loop study. This is expected given that water quality is more stable under controlled laboratory conditions than in the distribution system. However, improved lead control may still be achieved through more consistent water quality in the distribution system. A comparison of observed orthophosphate, pH, free ammonia, and nitrate/nitrite levels in the distribution system to WQP goals set by EPA show some deviation. pH in particular is critical to the success of orthophosphate treatment and should be closely tracked to ensure that it stays within acceptable treatment limits.

Further investigation into the following areas may be warranted to determine:

- The cause of intermittent low orthophosphate readings in June and October 2005;
- The cause of high free ammonia in September 2005; and
- The cause of consistently elevated free ammonia levels (average monthly free ammonia in the distribution system was higher than the WQP goal in all months evaluated except December 2005).

5) The potential drawbacks of a chlorine burn may outweigh the benefits.

The review of water quality data did not reveal significant nitrification problems in the D.C. system. In fact, there is limited evidence to suggest that occurrence of nitrification may have decreased since the orthophosphate application. Both DCWASA and WA pipe loop data show potential increases in lead leaching resulting in the change back to chloramines after a chlorine burn (DCWASA Pipe Loop 3 and WA Rack 3), although measured changes are very small and may not be meaningful. Given some LCR compliance samples still exceeded 15 ppb through the end of 2005, any decision to modify finished water quality should be approached with extreme caution. The potential benefits of a chlorine burn may not outweigh the risk of an AL exceedance.

While bacterial activity in the D.C. distribution system appears to be under control, nitrification is a potential problem as long as the D.C. system is using chloramines as a secondary disinfectant. Continued monitoring for nitrification parameters throughout the distribution system is recommended.

6) A further reduction in orthophosphate dose may not be advisable at this time.

Based on discussions with DCWASA and outside experts, WA reduced the target orthophosphate dose from 3.5 mg/L to 2.5 mg/L in February 2006. Technical experts agreed that 3.5 mg/L is much higher than typical maintenance doses for orthophosphate and that maintaining a dose at this concentration over the long term could potentially cause problems because of the formation of other solids.

This report does not include a comprehensive review of 2006 data to evaluate impacts of the change in orthophosphate dose on lead levels in the distribution system. DCWASA Pipe Loops 1 and 3 and WA Rack 7 all show a very slight increase in lead concentration at a reduced orthophosphate concentration of 2.5 mg/L. Furthermore, WA Rack 6 revealed a more substantive lead increase when orthophosphate dose was reduced to 1.0 mg/L.

It is difficult to predict how slight changes in lead release in the pipe loops will correlate to changes in lead release in the distribution system. However, based on the data reviewed in this document, this report recommends that WA and DCWASA maintain an orthophosphate target dose of 2.5 mg/L until evidence shows that the orthophosphate scale has stabilized in the distribution system.

7) Orthophosphate treatment has not resulted in a long-term increase in microbial activity, and may be responsible for a slight decrease.

As predicted by industry experts, D.C. experienced a spike in HPC levels and a total coliform violation soon after the orthophosphate application began system-wide. This spike was likely the result of biofilm sloughing as orthophosphate reacted with iron corrosion scale. Between September 2004 and December 2005, D.C. did not observe elevated HPC or total coliform levels. Data suggest that occurrence of coliforms, HPC levels, and incidence of high nitrite levels have all declined through 2005.

It should be noted that modifications to DCWASA's unidirectional flushing program in 2004 and 2005 may also have contributed to biofilm and nitrification control.

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