EPA Webinar on Lead and Copper Rule (LCR) Optimal Corrosion Control Treatment (OCCT) Evaluation

Technical Recommendations for Primacy Agencies and Public Water Systems

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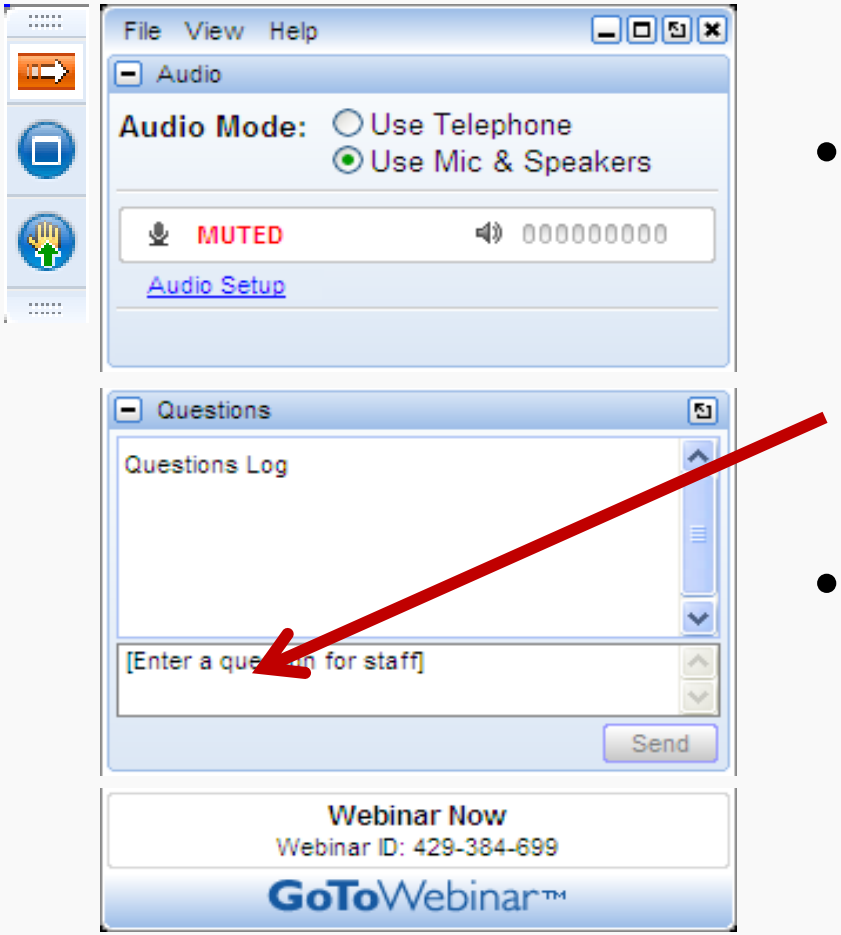

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Presenters

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Purpose of Today's Webinar

EPA recently released the following:

- *Optimal Corrosion Control Treatment Evaluation Technical Recommendations for Primacy Agencies and Public Water Systems (USEPA, 2016)*
- Excel-based templates

Purpose of this webinar is to show how the new document and templates can be used by primacy agencies and public water systems to more effectively implement OCCT.

To download the document and templates, go to https://www.epa.gov/dwreginfo/optimal-corrosion-control-treatment-evaluation-technical-recommendations

Agenda

- Audience and Purpose
- Document Organization
- Template Organization
- Review of Key Chapters
  - Ch 2: Background
  - Ch 3: Corrosion Control Treatment
  - Ch 4: Review of CCT Steps under the LCR
  - Ch 5: OCCT Start-up and Monitoring
  - Ch 6: Impacts of Source and Treatment Changes
- Summary
- Q&A Session

Major Acronyms

- AL - Action Level
- CCT - Corrosion Control Treatment
- DBP - Disinfection Byproduct
- DBPR - Disinfection Byproducts Rule
- DIC - Dissolved Inorganic Carbon
- DO – Dissolved Oxygen
- LCR - Lead and Copper Rule
- LSL - Lead Service Line
- mg/L – milligrams per liter
- NOM - Natural Organic Matter
- OCCT - Optimal Corrosion Control Treatment
- ORP - Oxidation-Reduction Potential
- OWQP - Optimal Water Quality Parameters
- TDS - Total Dissolved Solids
- WQP - Water Quality Parameter

Disclaimer

The technical recommendations in this document reflect the existing Lead and Copper Rule (LCR) as of the date of document publication. The Environmental Protection Agency (EPA) is in the process of reviewing CCT requirements as part of the Long-term Revisions to the Lead and Copper Rule (LCR LTR). These requirements may change based on any final rule revisions that are made. Readers can visit EPA's website for additional information and updates on the long-term revisions: http://water.epa.gov/lawsregs/rulesregs/sdwa/lcr/index.cfm.

Audience and Purpose of the Document and Templates

- Audience
  - Primacy agencies
  - Public water systems
  - Consultants and academics
- Purpose
  - Provide technical recommendations to help primacy agencies and systems comply with CCT requirements of the existing LCR
  - Provide background information on CCT techniques
  - Provide Excel-based templates that can be used to organize data and document decisions
  - Update previous guidance with new research findings

Document Organization: Chapters

OCCT Evaluation Technical Recommendations for Primacy Agencies and Public Water Systems

OCCT Evaluation Templates

Chapter 1: Introduction

Chapter 2: Background Information

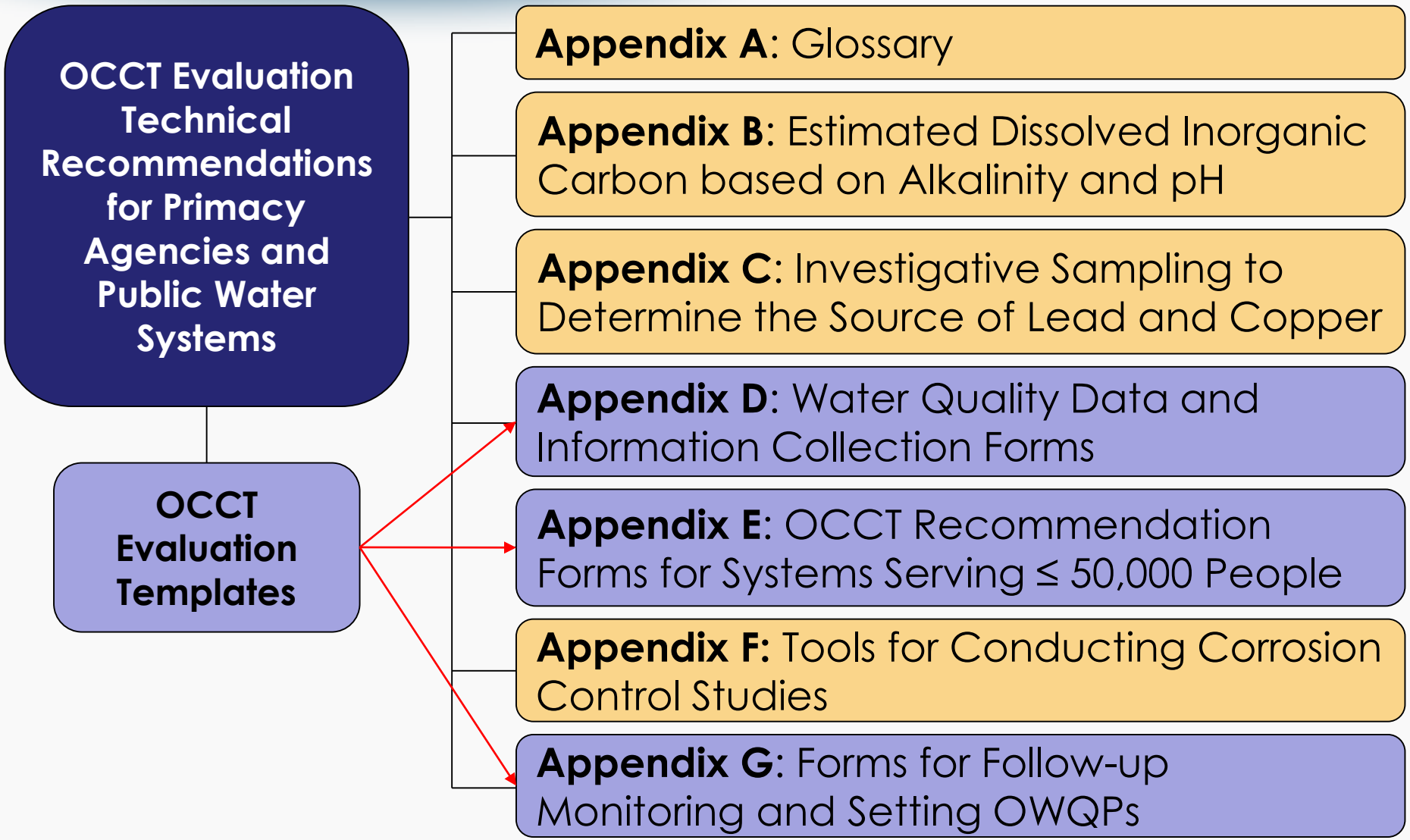
Chapter 3: CCT for Lead and Copper

Chapter 4: Review of CCT Steps under the LCR

Chapter 5: OCCT Start-Up and Monitoring

Chapter 6: Impacts of Source Water and Treatment Changes on Lead and Copper in Drinking Water

Document Organization: Appendices



OCCT Evaluation Templates

- Customizable, Excel-based forms that can be completed electronically.
- 2 templates:
  - For systems serving ≤ 50,000
  - For systems serving > 50,000
- The numbering in templates corresponds to exhibits in the document.
- Tabs are color code according to who should fill them out:
  - Blue for primacy agencies
  - Green for systems

Introduction Worksheet

This template supplements the EPA document, ***Optimal Corrosion Control Treatment Evaluation Technical Recommendations for Primacy Agencies and Public Water Systems*** (the OCCT Manual). It contains blank forms and decision trees that can be used by primacy agencies to document the required corrosion control steps taken by Public Water Systems (PWSs) under the Lead and Copper Rule (LCR). It also contains blank forms that can be used by PWSs to submit data and recommendations. Unless otherwise indicated by rule citations, this template provides technical recommendations that can assist systems in complying with corrosion control treatment (CCT) steps and assist primacy agencies with evaluation of technical information from systems. Refer to the OCCT Manual for CCT requirements of the LCR. Acronyms, definitions, and additional guidance are also provided in the manual.

The table numbering in this template corresponds to exhibits in the OCCT Manual. The first character is the chapter number or appendix letter, and the second character is the exhibit number. The PWS information form is not included in the OCCT Manual, and thus, has no exhibit number.

This template applies to ***systems serving 50,000 or fewer people*** (includes community and non-transients).

The following worksheets are included in this template. Note that worksheets highlighted blue are for Primacy Agencies, and those highlighted green are for PWSs.

Introduction Worksheet (Cont.)

PWS and ALE Information is a form to be used by **Primacy Agencies** to document the condition under which the PWS is required to take corrosion control treatment (CCT) steps under the LCR.
4.1 Deadlines is a schedule to be completed by **Primacy Agencies** to develop a timetable for PWSs to complete corrosion control steps. This worksheet corresponds to Exhibit 4.1 of the OCCT Manual.
D.1 - D.7 PWS Data are forms to be completed by **Public Water Systems** to support their optimal corrosion control treatment (OCCT) recommendation. Exhibits D.1 through D.3 (water quality data for source water, entry point, and distribution system, respectively) contain recommended minimum data, which can be modified by Primacy Agencies. This worksheet corresponds to Appendix D of the OCCT Manual.
E.1 - E.3 PWS OCCT Rec are forms to be completed by **Public Water Systems** to make their OCCT determination and submit their recommendation to their Primacy Agency. This worksheet corresponds to Appendix E of the OCCT Manual.
4.2 CCT Study Checklist is a form to be completed by **Primacy Agencies** to determine whether or not to require a CCT study. This worksheet corresponds to Exhibit 4.2 of the OCCT Manual.
4.4 Study Type Checklist is a form to be completed by **Primacy Agencies** to determine whether or not to require systems to perform a desktop or demonstration study. This worksheet corresponds to Exhibit 4.4 of the OCCT Manual.
G.1 - G.3 Follow-up Mon are forms to be completed by **Public Water Systems** to document the results of follow-up monitoring. The worksheet corresponds to Exhibits G.1 through G.3 of the OCCT Manual.
G.4 - G.7 Setting OWQPs are technical recommendations for **Primacy Agencies** for developing optimal water quality parameters (OWQPs). The worksheet corresponds to Exhibits G.4 through G.7 of the OCCT Manual.

Chapter 2: Background Information

2.1 Regulatory Actions to Control Lead and Copper in Drinking Water

2.2 Sources of Lead and Copper

2.3 Water Quality Factors Affecting the Release of Lead and Copper

2.4 Physical and Hydraulic Factors Affecting the Release of Lead and Copper

2.1 Regulatory Actions Related to Lead and Copper

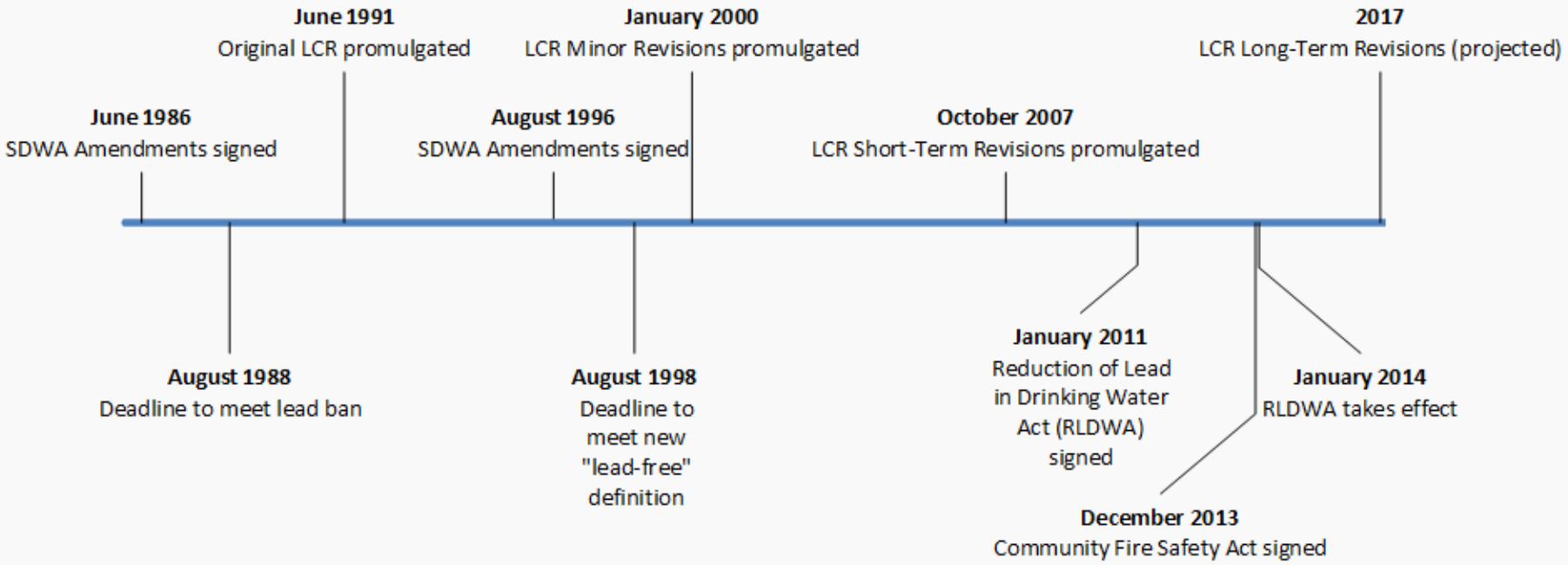


Exhibit 2.1: Timeline of Regulatory Actions Related to the Lead and Copper Rule

http://water.epa.gov/lawsregs/rulesregs/sdwa/lcr/index.cfm.

2.2 Sources of Lead and Copper

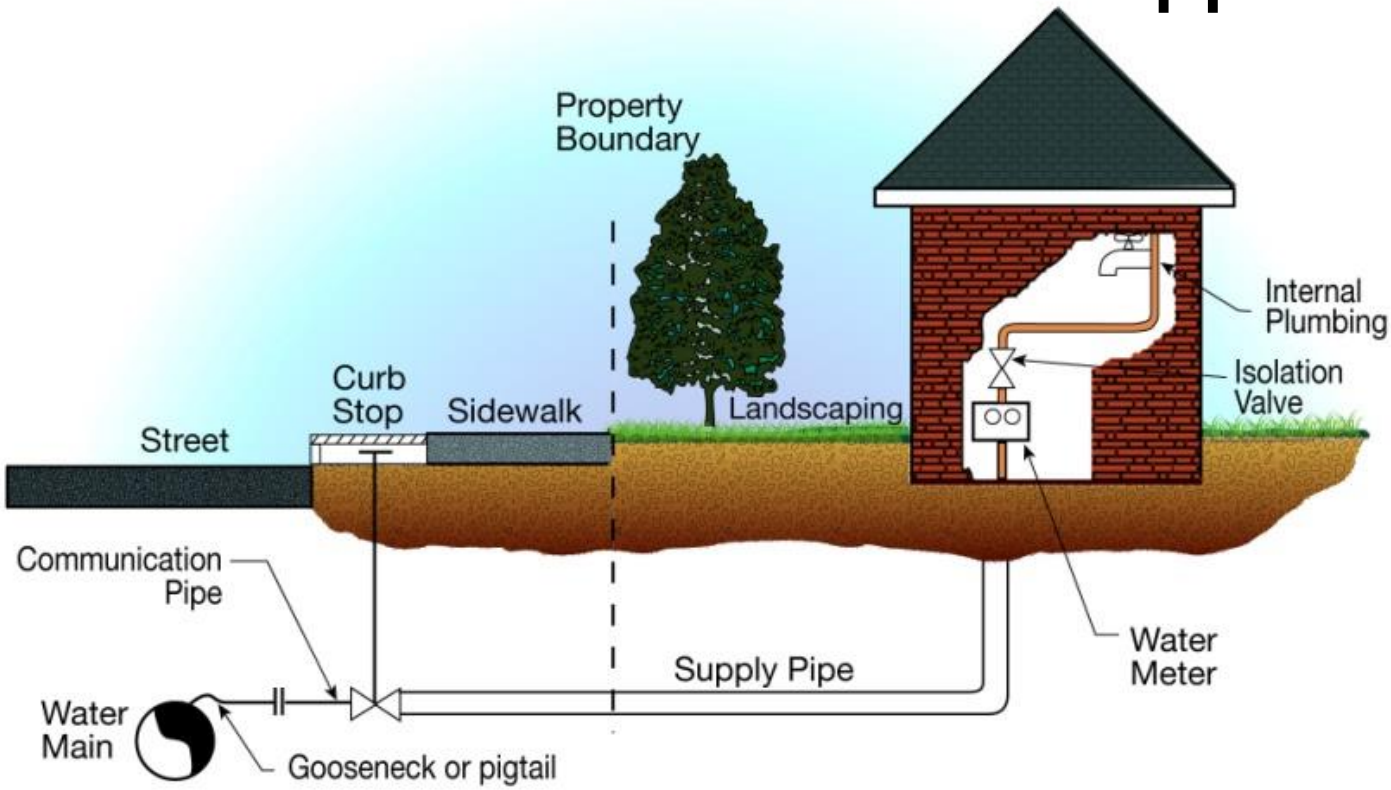


Exhibit 2.2: Typical Water Service Connection that May Provide Sources of Lead (Sandvig et al., 2008)

2.3 Water Quality Factors Affecting Release of Lead and Copper

- Alkalinity, pH, and Dissolved Inorganic Carbon
- Corrosion inhibitors
- Hardness (calcium and magnesium)
- Buffer intensity
- Dissolved Oxygen
- Oxidation Reduction Potential
- Ammonia, chloride, and sulfate
- Natural Organic Matter
- Iron, aluminum, and magnesium

2.4 Physical and Hydraulic Factors Affecting Release of Lead and Copper

- Physical Disturbances
- Hydraulic Factors
- Water Use
- Water Temperature

Chapter 3: Corrosion Control Treatment for Lead and Copper

- Technical Information on:
  - Corrosion control treatment techniques (3.1)
  - Recommendations for selecting treatment alternatives (3.2)
  - Recommendations for setting target dose and water quality (3.3)

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Which CCT Techniques are Included?

1. pH/alkalinity/DIC adjustment
2. Phosphate-based corrosion inhibitors
3. Silicate-based corrosion inhibitors

3.1.1 pH/Alkalinity/DIC Adjustment

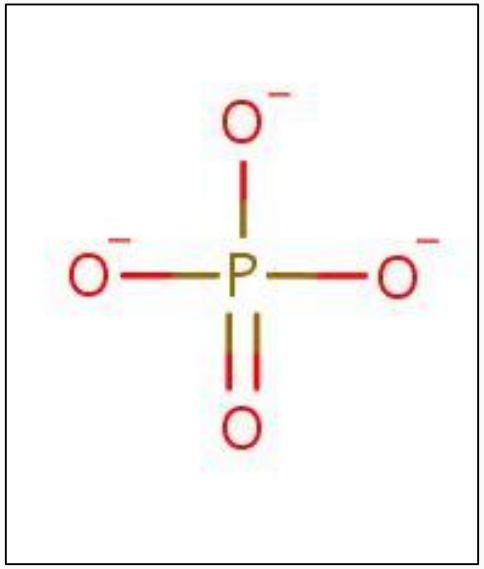
- Summary of chemical processes in Exhibit 3.1
- Information on limestone contactors and aeration

Chemical	Use	Composition	Alkalinity Change	DIC Change	Notes
Baking Soda, $NaHCO_3$, (sodium bicarbonate)	Increases alkalinity with moderate increase in pH.	95% purity. Dry storage with solution feed.	0.60 mg/L as $CaCO_3$ alkalinity per mg/L as $NaHCO_3$	0.14 mg/L as C per mg/L as $NaHCO_3$	Good alkalinity adjustment chemical but expensive.
Carbon Dioxide, CO_2	Lowers pH. Converts hydroxide to bicarbonate and carbonate species.	Pressurized gas storage. Fed either through eduction or directly.	None	0.27 mg/L as C per mg/L as CO_2	Can be used to enhance NaOH or lime feed systems.
Caustic Soda, NaOH (sodium hydroxide) Or KOH (potassium hydroxide)[1]	Raises pH. Converts excess carbon dioxide to carbonate alkalinity species.	93% purity liquid bulk, but generally shipped and stored, at < 50% purity to prevent freezing. KOH has a higher freezing point and may be stored at higher concentrations.	1.55 mg/L as $CaCO_3$ alkalinity per mg/L as NaOH	None	pH control is difficult when applied to poorly buffered water. Is a hazardous chemical, requires safe handling and containment areas
Hydrated Lime, $Ca(OH)_2$ (calcium hydroxide)[2]	Raises pH. Increases alkalinity and calcium content (i.e., hardness).	95 to 98% purity as $Ca(OH)_2$. 74% active ingredient as CaO. Dry storage with slurry feed.	1.21 mg/L as $CaCO_3$ alkalinity per mg/L as $Ca(OH)_2$	None	pH control is difficult when applied to poorly buffered water. Slurry feed can cause excess turbidity. O&M is intensive.
Soda Ash, Na_2CO_3 (sodium carbonate) Or Potash, KCO_3 (potassium carbonate)	Increases alkalinity with moderate increase in pH.	95% purity. Dry storage with solution feed.	0.90 mg/L as $CaCO_3$ alkalinity per mg/L as Na_2HCO_3	0.11 mg/L as C per mg/L as Na_2CO_3	More pH increase caused compared with $NaHCO_3$, but less costly. Has increased buffer capacity over hydroxides.
Sodium Silicates Na_2SiO_3	Moderate increases in alkalinity and pH	Available in liquid form mainly in 1:3.2 or 1:2 ratios of $Na_2O:SiO_2$	Depends on formulation	None	More expensive than other options but easier to handle than lime and other solid feed options. Has additional benefits in sequestering or passivating metals.

Exhibit 3.1 Typical Chemical Processes for pH/Alkalinity Adjustment

3.1.2 Phosphate-Based Corrosion Inhibitors

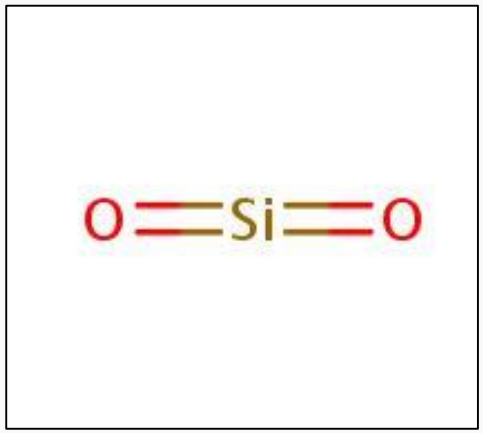
- Orthophosphate (PO_4)
  - Available forms
  - New research on zinc orthophosphate
- Blended phosphates
  - Mix of orthophosphate and polyphosphate
  - Orthophosphate fraction ranges from 0.05 – 0.7
  - Effectiveness cannot always be based strictly on orthophosphate concentration in the blend



Chemical Structure of Orthophosphate
Source: ChemIDplus, 2016

3.1.3 Silicate-Based Corrosion Inhibitors

- Mix of soda ash and silicon dioxide
- Shown in a few cases to reduce lead and copper
- Limited use in full scale plants
- Mechanism is unclear because silicates also raise the pH of the water.



Chemical Structure of Silicon Dioxide
Source: ChemIDplus, 2016

3.2 Technical Recommendations for Selecting Treatment Alternatives

- STEP 1: Review Water Quality Data and Other Information
- STEP 2: Evaluate Potential for Scaling
- STEP 3: Select One or More Treatment Options
- STEP 4: Identify Possible Limitations for Treatment Options
- STEP 5: Evaluate Feasibility and Costs of Options that Meet the OCCT Definition

3.2.1 Review Water Quality Data and Other Information (STEP 1): Collect and Organize Data

- Forms in Appendix D and templates can be used to organize data for review and submittal to the primacy agency

Exhibit D.1 Water Quality Data - Raw Water [1]													
Source Name (if more than one source, copy this section and complete for each source)													
Source ID													
Source Type													
Parameter	Required Monitoring			Recommended Monitoring			System Data						
	No. of Samples	Frequency	Duration of Sampling	No. of Samples	Frequency	Duration of Sampling	No. of Sites	No. of Samples	Date Range When Samples Were Collected		Minimum Value	Maximum Value	Average Value
									Start (dd/mm/yyyy)	End (dd/mm/yyyy)			
Lead (mg/L)				2	2x/year	1 year							
Copper (mg/L)				2	2x/year	1 year							
pH				6	every other month	1 year							
Alkalinity (mg/L as $CaCO_3$)				4	quarterly	1 year							
Hardness (mg/L as $CaCO_3$)				4	quarterly	1 year							
Temperature (°C)				6	every other month	1 year							
Calcium (mg/L as Ca)				4	quarterly	1 year							
Total Dissolved Solids (mg/L) [2]				4	quarterly	1 year							
Conductivity (as µmho/cm @ 25 °C) [2]				6	every other month	1 year							
Total Chlorine (mg/L as Cl_2)				NA	NA	NA							

Excerpt from Exhibit D.1: Water Quality Data – Raw Water

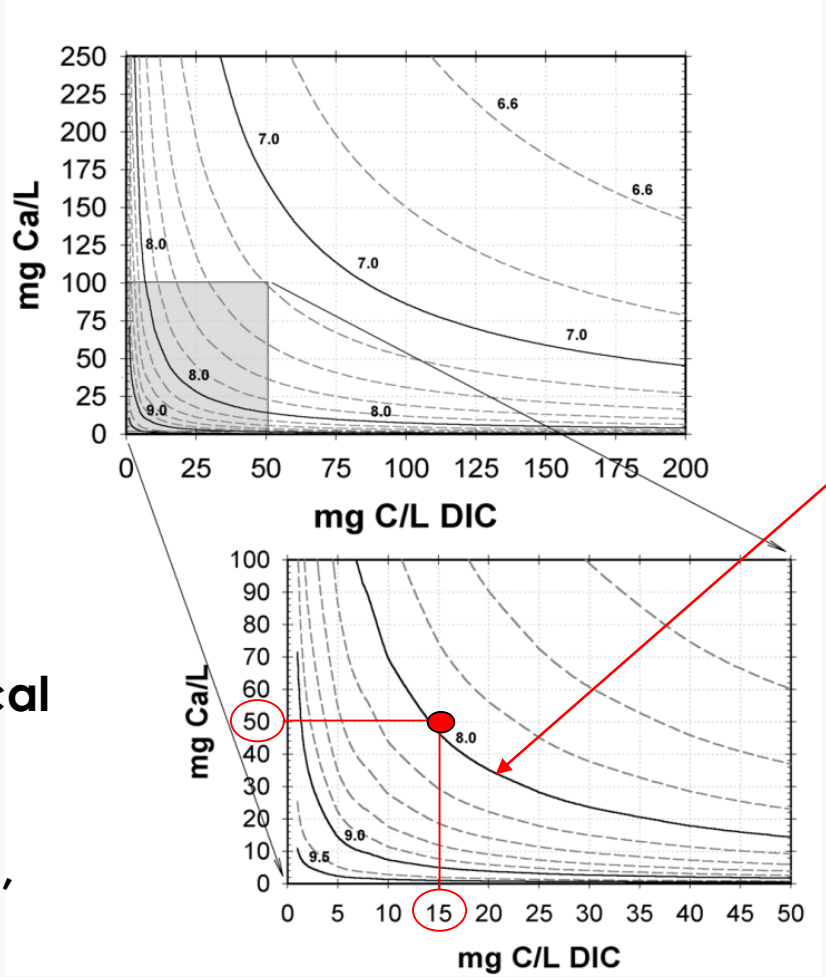
3.2.1 Review Water Quality Data and Other Information (STEP 1): Review Lead and Copper Tap Data

- Review ***all*** lead and copper tap data
  - Collected by the system
  - Part of special studies
- Review locations and dates where sample results > Action Level (15 ppb for lead, 1.3 ppm for copper)
  - Any spatial or temporal patterns?
  - Any sites that have been > AL before?
  - Talk to residents about sample collection, water usage, construction
  - Consider additional sampling

3.2.1 Review Water Quality Data and Other Information (STEP 1): Review Water Quality and System Data

- Use the information in Chapter 2 to help identify water quality and physical factors that may be contributing to lead and/or copper release.
- If cause is unclear, consider additional studies
  - Investigative sampling (Appendix C)
  - Direct examination of pipe scales

3.2.2 Evaluate Potential for Scaling (STEP 2)



The pH level is the curve closest to the intersection of DIC and calcium. Therefore, the saturation pH is 8.0.

Exhibit 3.2: Theoretical Saturation pH for Calcium Carbonate Precipitation (USEPA, 2003)

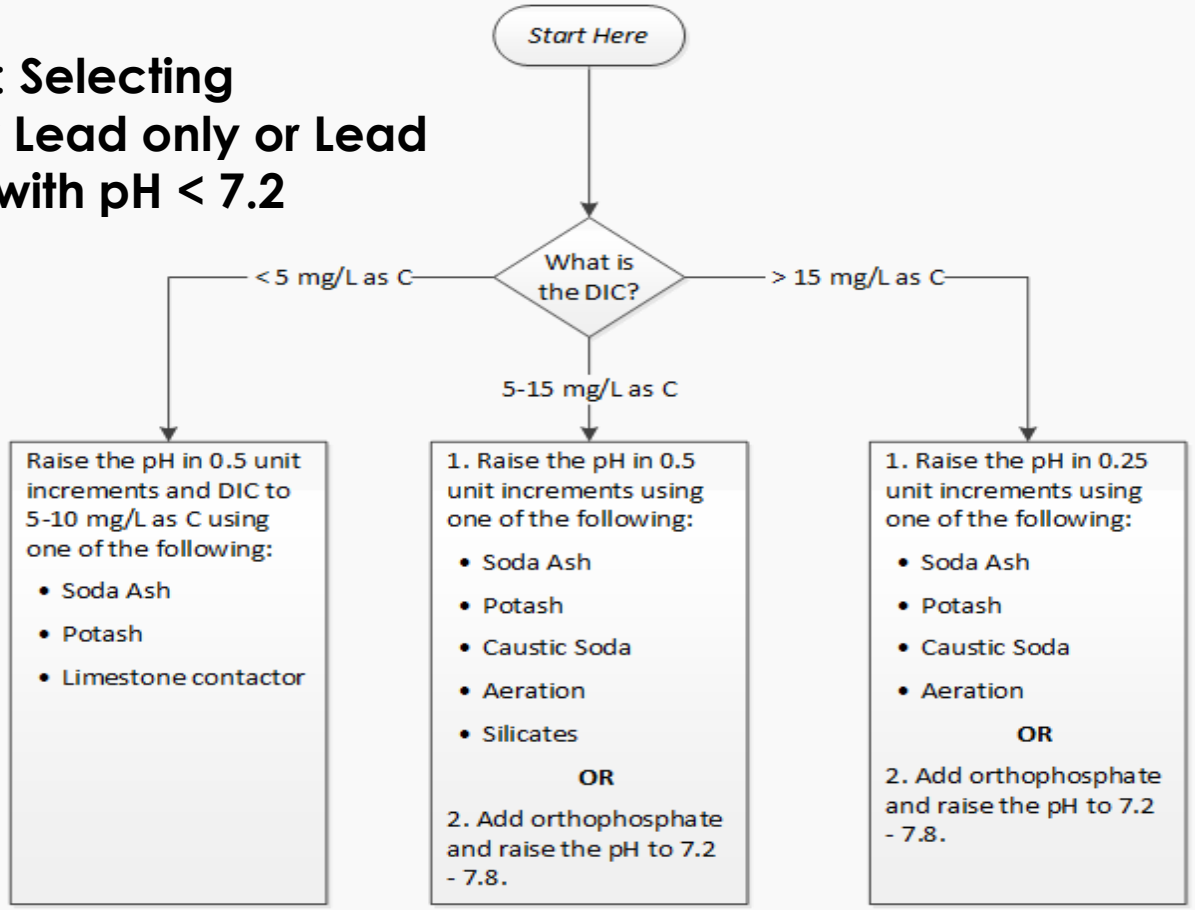
3.2.3 Select One or More Treatment Options (STEP 3)

Is iron or manganese present in finished water?	What is the contaminant to be addressed?	What is the finished water pH?	Use This Flowchart
No	Lead only, or Both Lead and Copper	< 7.2	**1a**
		7.2 - 7.8	**1b**
		>7.8 - 9.5	**1c**
		>9.5	**1d**
	Copper only	< 7.2	**2a**
		7.2 - 7.8	**2b**
		>7.8	**2c**
Yes[1]	Lead and/or Copper	< 7.2	**3a**
		≥ 7.2	**3b**

Exhibit 3.3: Identifying the Appropriate Flowchart for Preliminary CCT Selection

3.2.3 Select One or More Treatment Options (STEP 3) (cont.)

Flowchart 1a: Selecting Treatment for Lead only or Lead and Copper with pH < 7.2



3.2.4 Identify Possible Limitations for Treatment Options (STEP 4)

- pH/alkalinity/DIC adjustment
  - Optimal pH for other processes
  - Calcium carbonate precipitation
  - Oxidation of iron and manganese
- Phosphate-based corrosion inhibitors
  - Reactions with aluminum
  - Impacts on wastewater

3.2.5 Evaluate Feasibility and Costs of Options that Meet the OCCT Definition (STEP 5)

- Consider operability, reliability, system configuration, and other site-specific factors when evaluating CCT alternatives
- In cases where more than one option can meet OCCT, consider costs:
  - Capital equipment
  - Operations and Maintenance

3.3.1 pH/Alkalinity/DIC Adjustment

- To control for ***lead only*** or ***lead and copper***
  - Target pH
    - **8.8 to 10**
    - Systems with LSLs should consider pH > 9
    - pH 8.2 - 8.5 has poor buffer intensity and should be avoided
  - Target DIC
    - Minimum is needed for buffer intensity
    - Too much can re-solubilize lead
- To control for ***copper only***
  - Control can be achieved at pH as low as **7.8**
  - For pH 7.0 to 7.8, alkalinity is the limiting factor

3.3.2 Phosphate-Based Inhibitors

- Target dose
  - Typically between **0.33 – 1.0 mg/L as P** (1.0 – 3.0 mg/L as PO_4)
  - High doses (1.0 mg/L as P or higher) may be needed in some cases
    - LSLs
    - Copper corrosion problems
    - Aluminum carryover
- Target pH
  - Optimal range is **7.2 – 7.8**, but can work at higher pH levels (as high as 9)
  - Avoid operating at pH between 8 and 8.5
  - If controlling copper only, pH is less important
- Orthophosphate is generally more effective at low DIC (< 10 mg/L as C)
- Make sure target dose is measured in ***premise plumbing***
- Some systems use a higher passivation dose followed by a lower maintenance dose

3.3.3 Silicate-Based Inhibitors

- Effectiveness depends on silicate level, pH, and DIC of the water.
- High doses (>20 mg/L) are often needed to control for lead and copper
- Can raise the pH of the water and sequester iron if present
- Limited full-scale experience

Chapter 4: Review of CCT Steps under LCR

- Organized into 2 main sections:

  4.1: For systems serving ≤ **50,000 people** that **exceed the lead and/or copper AL**.

  4.2: For systems ***newly*** serving **> 50,000 people**

- Section 4.2 can also be used when an existing system **serving > 50,000 people** with CCT has a subsequent **AL exceedance**
- Includes requirements and technical recommendations
- Includes CCT steps up to primacy agency designation of OCCT
  - OCCT Installation, follow-up monitoring, setting OWQPs, and long-term monitoring is in Chapter 5

4.1: Systems Serving ≤ 50,000 People

Requirement[1]	Timetable for Completing Corrosion Control Treatment Steps[1]	Compliance Date (to be completed by the Primacy Agency)	Corresponding Section of The OCCT Manual
STEP 1: System exceeds the lead or copper action level (AL).			
STEP 2: System recommends optimal corrosion control treatment (OCCT).	Within 6 months[2]	-	Section 4.1.1
STEP 3: Primacy Agency decides whether system must perform a corrosion control study. If system must conduct a corrosion control study, go to Step 5. If not, go to Step 4.	Within 12 months[2]	-	Section 4.1.2
STEP 4: The Primacy Agency designates OCCT for systems that were not required to conduct a study. Go to Step 7.	• Within18 months[2] for systems serving 3,301-50,000 people • Within 24 months[2] for systems serving ≤ 3,300 people	-	Section 4.1.3
STEP 5: System completes corrosion control study.[3]	Within 18 months after Primacy Agency requires that such a study be conducted	-	Section 4.1.4
STEP 6: Primacy Agency designates OCCT.[3]	Within 6 months after completion of Step 5	-	Section 4.1.5

Exhibit 4.1 Review of CCT Requirements and Deadlines for Systems Serving ≤ 50,000 (Steps 1 – 6)

4.1: Systems Serving ≤ 50,000 People

Requirement[1]	Timetable for Completing Corrosion Control Treatment Steps[1]	Compliance Date (to be completed by the Primacy Agency)	Corresponding Section of The OCCT Manual
STEP 7: System installs OCCT.	Within 24 months after the Primacy Agency designates such treatment	-	Section 5.1
STEP 8: System conducts follow-up sampling for 2 consecutive 6-month periods.	Within 36 months after the Primacy Agency designates OCCT	-	Section 5.2
STEP 9: Primacy Agency designates optimal water quality parameters (OWQP).[4]	Within 6 months after completion of Step 8	-	Section 5.3
STEP 10: System conducts continued WQP and lead and copper tap sampling.	The schedule for required monitoring is based on whether the system exceeds an AL and/or complies with OWQP ranges or minimum		Section 5.4

Notes:
[1]Systems serving 50,000 or fewer people can discontinue these steps whenever their 90th percentile levels are at or below both action levels for two consecutive six-month monitoring periods. However, if these systems then exceed the lead or copper action level, they must recommence completion of the applicable CCT steps.
[2]The required timetable (i.e., number of months) for completing Steps 2, 3, and 4 represent the number of months after the end of the monitoring period during which the lead and/or copper action level was exceeded in Step 1.
[3]These steps only apply to systems that were required to conduct a corrosion control study.
[4]The primacy agency is not required to designate OWQPs for systems serving 50,000 or fewer people that no longer exceed either action level after installing treatment. However, some primacy agencies have opted to do so.

Exhibit 4.1 Review of CCT Requirements and Deadlines for Systems Serving ≤ 50,000 (Steps 7 – 10)

4.1.1 System Makes OCCT Recommendation (STEP 2)

- System must make OCCT recommendation ***within 6 months*** of the end of the monitoring period during which the AL was exceeded.
- Can use technical recommendations from Chapter 3 to identify OCCT
  - 5-step process (with flowcharts)
- Can use templates to organize data and make recommendation:
  - Forms in Appendices D and E
  - Available electronically in the template.

4.1.1 System Makes OCCT Recommendation (STEP 2) (Cont.)

CCT Options	Put an X next to all that apply	Identify possible treatment chemicals or processes for the options identified (chemical formula or common name)
Raise pH		
Raise DIC (alkalinity)		
Add orthophosphate[1]		
Add silicate		
Add blended phosphate[1]		

[1] For orthophosphate and blended phosphate, provide in mg/L as P. For blended phosphate, include the percent of the blend that is orthophosphate.

Exhibit E.1: Identification of Potential Corrosion Control Treatment Options

4.1.2 Primacy Agency Determines Whether a Study Is Required (STEP 3)

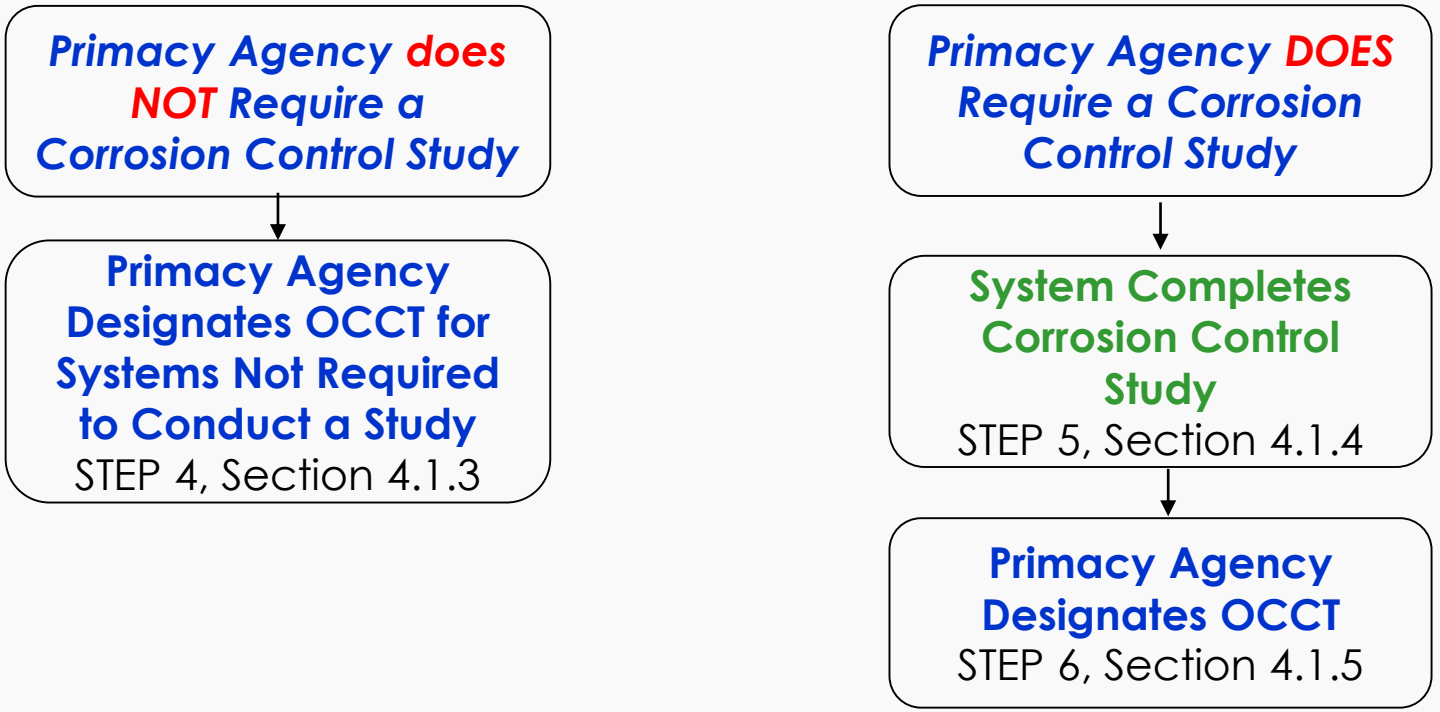
- Review data for completeness
- Can use checklist in Exhibit 4.2 to decide if study is needed
  - If > 2 questions answered "yes", recommend study
  - EPA recommends that primacy agencies require a CCT study for systems with LSLs
  - Can document review and decision using template sheet "4.2 CCT Study Checklist"

4.1.2 Primacy Agency Determines Whether a Study is Required (STEP 3) (Cont.)

Category	Question	Response (YES or NO)
Presence of LSLs	Does the system have lead service lines?[1]	
pH stability	Is the range of pH values measured at the entry point > 1.0 pH units. (Range = max entry point pH – min entry point pH)?	
	Is the range of pH values measured in the distribution system > 1.0 pH units. (Range = max pH – min pH)?	
Iron Deposition Potential	Is average entry point iron > 0.3 mg/L?	
	Is average distribution system iron > 0.3 mg/L?	
Manganese Deposition Potential	Is average entry point manganese > 0.05 mg/L?	
	Is average distribution system manganese > 0.05 mg/L?	
Calcium Carbonate Deposition Potential	Is average hardness > 150 mg/L as $CaCO_3$? *Entry point of distribution system values may be used.*	
Chloride/Sulfate Mass Ratio Issues	Is the chloride/sulfate mass ratio (CSMR) for either entry point or distribution system data > 0.6? *Use average chloride level divided by the average sulfate level.*	
Source Water Changes in the Future	Did the system indicate that there may be source water changes in the future?	
Treatment Process Changes	Did the system indicate that there may be treatment process changes in the future including changes in coagulant?	

Exhibit 4.2: Recommended Checklist to Support Determination of the Need for a CCT Study

4.1: Systems Serving ≤ 50,000 People



4.1.3 Primacy Agency Designates OCCT (STEP 4)

- When the primacy agency ***does not*** require system to do a study, they can either
  - Approve the OCCT recommended by the system, or
  - Designate alternative CCT
- Information in Chapters 2 and 3 of the document can be used as a reference.

Chapter 2: Background Information

Chapter 3: CCT for Lead and Copper

4.1.4 System Conducts CCT Study (STEP 5)

- For when the primacy agency ***requires a study***
- CCT requirements of the LCR summarized in Exhibit 4.3
- Technical recommendations also provided in this section:
  - What type of study to require
    - Desktop vs. demonstration
    - Checklist to support primacy agency determination (Exhibit 4.4, also in template)
  - Use of CCT study tools
    - Description of study tools in Appendix F
  - CCT study reporting
    - Possible outlines for desktop and demonstration study report

4.1.5 Primacy Agency Designates OCCT (STEP 6)

- Technical recommendations for primacy agency review of CCT study
  - Exhibit 4.7 for desktop study
  - Exhibit 4.8 for demonstration study
- Information in Chapters 2 and 3 of the document can be used as a reference.

Chapter 2: Background Information

Chapter 3: CCT for Lead and Copper

4.1.5 Primacy Agency Designates OCCT (STEP 6) (Cont.)

1) Make sure all components of a desktop study are included in the report

   If they are not, coordinate with system to complete study and check against recommended outline of required components for desktop studies.

   If they are, continue.

2) Evaluate raw, entry point, and distribution system water quality information

   Evaluate key water quality parameters (pH, alkalinity, conductivity, hardness, other anions and cations) and their impact on lead and/or copper release to water (entry point and distribution system) and treatability (raw water).

   Evaluate differences in entry point versus distribution system data for key water quality parameters, particularly variations in pH and DIC.

3) Review regulatory tap monitoring data for lead and copper and other supplemental lead and copper data (e.g., from special studies by universities).

   Assess 90th percentile lead and copper levels and that sites selected for regulatory monitoring meet the criteria in the LCR.

   Assess available supplemental lead and copper data, if available.

4) Review materials and customer complaint history

   Determine primary sources of lead and copper in drinking water (lead pipe, lead solder, brass, copper pipe).

   [continued]

Exhibit 4.7: Recommendations for Primacy Agency Review of Desktop Study (Partial)

4.2 CCT Steps for Systems Serving > 50,000 People

- Fewer steps because ***all*** systems must do a corrosion control study
- Schedule for systems ***newly*** serving 50,000 people:
  - Because the regulatory deadlines have passed for these systems, they must follow schedule for systems serving 3,300 – 50,000 people
- Can be used by systems serving > 50,000 with CCT that have an ALE
  - LCR does not contain deadlines for these systems; will likely be set by the primacy agency

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4.2 Systems Serving > 50,000 People

Requirement[1]	Timetable for Completing Corrosion Control Treatment Steps	Compliance Date (to be completed by the Primacy Agency)	Corresponding Section of The OCCT Manual
STEP 1: System completes Corrosion Control Study.	Within 18 months after the end of the monitoring period which triggered a study[2]		Section 4.2.1
STEP 2: Primacy Agency designates OCCT.	Within 6 months after study is completed		Section 4.2.2
STEP 3: System installs OCCT.[3]	Within 24 months after Primacy Agency's decision regarding type of treatment to be installed		Section 5.1
STEP 4: System conducts follow-up monitoring for 2 consecutive 6-month periods.	Within 36 months after Primacy Agency designates OCCT		Section 5.2
STEP 5: Primacy Agency designates OWQPs.	Within 6 months of Step 4		Section 5.3
STEP 6: System conducts continued WQP and lead and copper tap monitoring.	The schedule for required monitoring is based on whether the system exceeds an AL and/or complies with OWQP ranges or minimums		Section 5.4

Notes:
[1]This schedule applies to systems newly serving > 50,000 people that are installing CCT. Because the regulatory deadlines for systems serving more than 50,000 people have passed, systems newly serving 50,000 people must follow the schedule for systems serving 3,301-50,000 people
[2]In other words, at the end of the monitoring period when the system became a system serving > 50,000 people.
[3]For systems with existing CCT, this step would involve adjusting CCT.

Exhibit 4.9 Review of CCT Requirements and Deadlines for Systems Serving > 50,000

4.2.1 System Conducts a Corrosion Control Study (STEP 1)

- Systems must complete corrosion control study ***within 18 months*** of the end of the monitoring period that triggered the study:
  - When the system became a system serving > 50,000
- Minimum Requirements for CCT Study in Exhibit 4.3
- Use forms in Appendix D or template to organize data and information
- Study tools described in Appendix F
  - EPA recommends ***demonstration study*** for these systems
- Exhibit 4.6 provides possible outline for demonstration study report.

4.2.2 Primacy Agency Reviews the Study and Designates OCCT (STEP 2)

- Use the checklist in Exhibit 4.8 to review demonstration study
- Information in Chapters 2 and 3 of the document can be used as a reference.

Chapter 2: Background Information

Chapter 3: CCT for Lead and Copper

Chapter 5: Requirements and Technical Recommendations for OCCT Start-Up and Monitoring

- 5.1 CCT Start-up
- 5.2 Follow-up Monitoring During the First Year of Operation
- 5.3 Evaluating OCCT and Setting OWQPs
- 5.4 Required and Recommended Long-Term Corrosion Control Monitoring

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5.1 CCT Start-up

- Changes in finished water quality (pH, DIC, addition of orthophosphate) can have temporary adverse impacts
  - Red water from sloughing of corrosion scale
  - Microbial changes
- Recommendations to minimize impacts
  - Gradually increase the pH over time
  - Consider adding phosphate-based corrosion inhibitors in increments
    - See Section 3.3.2 for recommendations on initial passivation dose vs. maintenance dose for orthophosphate

5.2 Follow-up Monitoring during First Year of Operation

- The LCR requires systems to conduct two types of follow-up monitoring:
  1. Lead and copper tap monitoring; and
  2. WQP monitoring at entry points and taps.
- Must occur during the two consecutive, 6-month periods directly following installation of OCCT
- Section 5.2 contains follow-up monitoring requirements of the LCR and additional technical recommendations.
- Systems can use the forms in ***Appendix G*** and in the ***OCCT evaluation templates*** to document results.

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5.2.1 Follow-up Lead and Copper Tap Monitoring

Population Served	Required Number of Sites
≤100	5
101 – 500	10
501 – 3,300	20
3,301 – 10,000	40
10,001 – 100,000	60
>100,000	100

Exhibit 5.1: Required Number of Sites for Follow-up Lead and Copper Tap Monitoring

- Number of sites is the same as the required number for routine monitoring
- EPA recommends systems with LSLs conduct special samples (optional)

5.2.2 Follow-up WQP Monitoring

Type	Parameters	Required [1]		Recommended	
		Number of Sites	Frequency of Sampling	Number of Sites	Frequency of Sampling
Entry point	pH, alkalinity dosage rate and concentration,[2] inhibitor dosage rate and orthophosphate or silicate concentration (whichever is used)[3]	At each entry point[4]	At least once every two weeks	No Change	No Change
Tap (Distribution system samples)[5]	pH, alkalinity, orthophosphate or silica[3], calcium[6]	Number of sites based on system size, See Exhibit 5.3	At least twice every six months (4 sample periods)	At ***more taps than required.*** See Exhibit 5.3.	All parameters: ***Monthly***

Exhibit 5.2: Follow-up WQP Monitoring Requirements and Recommendations

5.2.2 Follow-up WQP Monitoring (Cont.)

Population Served	Required Number of Sites[1]	Recommended Number Sites
≤100	1	2
101 – 500	1	5
501 - 3,300	2	10
3,301 - 10,000	3	15
10,001 - 50,000	10	20
50,001 - 75,000	10	25
75,001 - 100,000	10	30
100,001 - 500,000	25	40
500,001 - 1,000,000	25	50
>1,000,000	25	>50

Exhibit 5.3: Required and Recommended Number of Sites for Follow-up WQP Tap Monitoring

5.3 Evaluating OCCT and Setting OWQPs

- Requirements for designating Optimal Water Quality Parameters (minimums or ranges).
- Primacy agencies can designate values for additional WQPs that reflect optimal corrosion control for the system.
- Technical recommendations for evaluating follow-up monitoring data and setting OWQPs are in ***Appendix G*** and the ***templates.***

5.4 Required and Recommended Long-Term Corrosion Control Monitoring

- Required WQP monitoring
  - At taps and entry points
  - For pH, alkalinity, orthophosphate when used, and silicate when used
  - Minimum number of locations and frequency specified in the LCR
- Technical recommendations for additional monitoring
  - Monitoring for additional WQPs
    - ORP
    - Aluminum
    - Chloride and sulfate
    - Iron and manganese
  - Customer complaint tracking
  - Monitoring associated with lead source replacement programs

Chapter 6: Impacts of Source Water and Treatment Changes on Lead and Copper in Drinking Water

- 6.1 Review of LCR Requirements
- 6.2 Impacts of Source Water Changes
- 6.3 Impacts of Treatment Changes

6.1 Review of LCR Requirements

- Requirements in Code of Federal Regulations
- Clarifications based on November 3, 2015 memorandum from Director of EPA OGWDW
- Examples of source and treatment changes
- Recommendations for evaluating potential impacts and conducting ongoing monitoring

6.2 Impacts of Source Water Changes

- Examples of source water changes
- Direct impacts on CCT:
  - Changes to pH/alkalinity/DIC
  - Changes in corrosion inhibitor type or dose
- Other impacts on CCT effectiveness:
  - NOM
  - Metals
  - Chloride
  - Sulfate
  - ORP
  - Buffer intensity
- Examples from the literature

6.3 Impacts of Treatment Changes

- Corrosion Control Treatment
- Disinfection
- Coagulation
- Softening
- Filtration

6.3.2 Disinfection

Important Information about Pb(IV)

Do my lead service lines have Pb(IV) scales?

Pb(IV) (also known as Lead IV or Pb^{++}) can occur on any lead surface. It forms under highly oxidative conditions. If you have lead service lines with a moderate pH (7 – 8), a consistent free chlorine residual throughout the system (typically 1 – 2 mg/L or higher), no corrosion inhibitor, and no lead problems, you might have predominantly Pb(IV) scales. To help determine if your systems is a candidate for Pb(IV) scales, you can measure ORP of the water – Eh values of 0.7 volts or higher are indicative of Pb(IV) scales. You can also evaluate the scale on exhumed lead service lines to find out for sure.

Can I promote formation of Pb(IV) scales to reduce lead levels?

Although some utilities are targeting the development of a Pb(IV) scale in their systems to control lead release (Brown et al., 2013), questions remain as to how systems and primacy agencies can ensure that disinfectant residuals required for the formation and maintenance of Pb(IV) scales are maintained within lead service lines throughout the distribution system and to the customer's taps. This may be a particular challenge with homes that go unoccupied for an extended period of time. Therefore, EPA has not included formation of a Pb(IV) scale as a corrosion control treatment technique in this document at this time.

What happens if I have Pb(IV) scales and I change treatment?

Changing disinfectant from free chlorine to chloramine for disinfection may destabilize Pb(IV) scales. Systems can use other corrosion control treatments such as pH/alkalinity/DIC adjustment or phosphate-based corrosion inhibitors, but lead levels may increase as the scale is converting from Pb(IV) to Pb(II) based scale.

Summary

- The OCCT Evaluation Document
  - Explains CCT requirements of the LCR
  - Provides additional technical recommendations to help primacy agencies and systems comply with the requirements
  - Reflects improved understanding of corrosion and corrosion control treatment techniques
- Excel-based OCCT Evaluation Templates
  - Can be used by systems to organize data and prepare submittals
  - Can be used by primacy agencies to review submittals and document decisions

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