

**REPORT OF THIRD PARTY REVIEW OF  
EVENTS AND RESPONSES OF THE  
DEPARTMENT OF WATER MANAGEMENT  
CITY OF DURHAM, NORTH CAROLINA  
TO THE IDENTIFICATION OF A CHILD WITH ELEVATED BLOOD LEAD LEVEL  
IN THE HOME OF A CUSTOMER**

**Prepared by  
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## ACRONYMS

CFR	Code of Federal Regulations
DCHD	Durham County Health Department
DDWM	Durham Department of Water Management
EBLL	Elevated Blood Lead Level
LCR	Lead and Copper Rule
MCLG	Maximum Contaminant Level Goal
N&O	News and Observer
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
OCCT	Optimal Corrosion Control Treatment
PWS	Public Water Supply
PWSS	Public Water Supply Section of NCDENR
RRO-PWSS	Raleigh Regional Office of the Public Water Supply Section
SPHL	State Public Health Laboratory
USEPA	United States Environmental Protection Agency
WRRI	Water Resources Research Institute
WQP	Water Quality Parameters
WSTB	Water Science and Technology Board



## **Purpose of Report**

This document is a third-party review of the performance of the City of Durham's Department of Water Management (DDWM) after learning that a child living in an apartment served by the public water supply owned and operated by the city had been diagnosed with elevated levels of lead in its blood. Durham's response is reviewed with respect to two matters. The first matter is Durham's responses to the general concern about public health implications of the single lead poisoning case and subsequent findings of high lead levels in the drinking water in several homes served by the city. The second matter is a narrow issue of whether Durham will be required to revise its public education program and return to the standard monitoring program instead of the reduced monitoring status that it has held for over a decade.

The drinking water regulation relevant to this review is the Lead and Copper Rule (LCR) established by the United States Environmental Protection Agency (USEPA) and the North Carolina Department of Environment and Natural Resources' (NCDENR) "Rules Governing Public Water Systems". The federal rule, codified in Title 40 of the Code of Federal Regulations, Section 141, was issued in 1991 and has been subject to several minor revisions. USEPA delegated its primary enforcement authority to the Public Water Supply Section (PWSS) of NCDENR. That delegation occurred after NCDENR adopted the Lead and Copper Rule by reference in the North Carolina Administrative Code (NCAC) as part of NCAC Title 15A Subchapter 18C Section .1500.

It should be noted from the outset that the City of Durham's public water supply did not violate a drinking water standard for lead. USEPA set the Maximum Contaminant Level Goal (MCLG) for lead to be zero. The MCLG is a non-enforceable health-based goal which Durham has achieved. Lead has never been found at detectable levels in the source water, in water leaving Durham's water treatment plants, or in Durham's distribution system. Lead problems that exist in some Durham homes are most likely associated with lead in plumbing fixtures or lead-based solder used to join pipes in customer plumbing systems. USEPA regulates lead in public water systems with an enforceable Treatment Technique, which in fact is a series of actions to: (1) install and optimize a corrosion control treatment (CCT) to minimize the corrosive effect of a publicly supplied water on customer plumbing systems; (2) eliminate lead in source water if it exists; (3) replace any known lead pipes; and (4) educate the public on how to minimize exposure to lead in drinking water.

The City is required to monitor several water quality parameters for purposes of maintaining corrosion control, and the City is required to conduct periodic monitoring of lead and copper at customer taps. The number and frequency of samples in the monitoring program is dependent on the past history of the system.

Actions (2) and (3) in the above list are not applicable to Durham. Durham does not have lead in its source water, and there are no known lead pipes or lead connections to the distribution system. Durham has an established CCT, and there is no allegation and no evidence that Durham has operated outside state-specified limits on water quality parameters that are used to optimize corrosion control. The issue under consideration is related to the monitoring for lead and copper at customer taps. If more than 10 percent of samples from customer taps exceed the federal action level during a sampling period, the City would be required to take certain actions. These actions include: (1) revise and expand its public education program to conform to the precise language in USEPA's regulations; (2) increase the frequency of monitoring for corrosion control and lead and copper; (3) make any additional adjustments to water treatment processes to minimize effects of the water on customer plumbing systems. None of these actions would require significant capital expenditures.

### **Why a Third-Party Review**

For decades the City of Durham has enjoyed an excellent reputation in the field of water resource management. It has enjoyed a favorable geographical location at the upper end of the Neuse River Basin with no municipal or industrial waste dischargers upstream of its public water supplies. Durham's Department of Water Management (DDWM) is fortunate to have been led by a series of excellent water administrators who have worked closely with NCDENR and its predecessor agencies to provide an ample supply of water and protect the health of its consumers. DDWM and the City were puzzled and dismayed when its performance and integrity were questioned during and after DDWM responded to information that a child in an apartment that it served was found to have EBLL.

A detailed timeline for events under review in this document is attached as Appendix A. An abbreviated version is used here to set the background for this report.

In March 2004, health care personnel in Greenville, NC detected an elevated blood lead level in a baby boy. This finding prompted the Raleigh News and Observer (N&O) to initiate in

late summer 2005 an investigation of the state's regulation of drinking water. PWSS, Division of Environmental Health, NCDENR administers that program. The N&O Editorial was very critical of the program, but pointed out that deficiencies were due in large part to an insufficient number of personnel.

As the N&O's investigation was in progress, it was publicly disclosed by the Durham County Health Department (DCHD) in May 2006 that a child served by the Durham public water supply had been diagnosed with elevated blood lead level (EBLL). The diagnosis was apparently made sometime in March 2006; DCHD apparently began sampling the water on April 3. A sample taken from the kitchen faucet in the apartment where the child lived was found to have a very high concentration of lead. After eliminating other possible sources, DCHD concluded that the tap water was the most likely source of the EBLL.

Representatives of DCHD and the State Childhood Lead Prevention program met with DDWM staff on May 16 to inform DDWM of the incident. That was at least six weeks after DCHD began its investigation. They began immediately to run diagnostic tests. Six samples were taken from fire hydrants on Penrith Drive on May 19. Those samples showed no lead concentration above the action level (N&O, May 20, 2006; DDWM, 2007a). The finding of elevated lead levels at the tap but not in the DDWM distribution system was consistent with USEPA's finding at the national level that the primary pathway by which lead and copper enter drinking water is from corrosion of household plumbing (USEPA, 2004).

DDWM began its own sampling of customer taps in June and offered to conduct tests on tap water for any customer who requested it. From mid-June to mid-July DDWM sampled some of the same sites previously sampled by DCHD. In those re-samples, only three sites were found that exceeded the action level (DDWM, 2007a).

In June, the Regional Engineer from the Raleigh Regional Office of PWSS (RRO-PWSS) conducted an audit of Durham's sampling plan for compliance with the LCR monitoring requirements. That audit included a review of sites that are included in the sampling pool. At the conclusion of the audit, Durham and the Regional Engineer agreed that it would be appropriate under the circumstances to move the LCR monitoring to September 2006 instead of 2007. In a letter to DDWM on June 29, the Regional Engineer stated that the sampling period would be September 2006 and analysis of results would be based on those samples (Douglas, 2006).

Both the News and Observer and the Durham Herald-Sun followed the sampling program very closely with frequent news articles and editorial opinions (Herald-Sun, June 14, June 26, July 22, and August 8; N&O, June 14, July 21, and July 22)

In early December 2006, a newspaper reporter contacted a USEPA official raising questions about Durham's LCR monitoring (Hrebeniuk, 2006a). The reporter implied that DDWM was taking samples and not reporting them to PWSS. The USEPA official reported the conversation to PWSS, and PWSS sought advice from USEPA as to how to handle the samples taken by Durham and how to decide whether DDWM would remain eligible for the reduced monitoring status that it had been granted in the 1990's. That consultation between PWSS and USEPA continued into early 2007.

In January 2007, USEPA and PWSS made an interpretation on two aspects of the LCR (Thomas, 2007). The first was that the official LCR monitoring period extended from June 1 to September 30, 2006. The second was that all samples taken during that time period that met the same criteria as those submitted for September must be included in the prescribed set of criteria used to determine whether or not the City avoids the additional actions described earlier.

DDWM and Durham's City Manager had reason to dispute those interpretations, but in an apparent effort to avoid lengthy judicial processes to resolve the issue, the City has agreed to accept the more frequent monitoring status and take all related actions specified in the LCR. Some of those actions were initiated in June 2006. In particular, the City, with agreement by the State, will take the following actions regardless of the outcome of the 2006 process (Baker, 2007):

- Test at least 100 homes every six months;
- Continue to monitor water quality at entry points to the distribution system;
- Step up the public education efforts regarding lead; and
- Initiate a corrosion control study to identify additional treatment to control leaching from household plumbing as much as possible.

Nevertheless, the City Manager has sought this review to obtain independent judgments about the performance of DDWM in this process and whether the City would have qualified for continued reduced frequency monitoring. News coverage of these events has done the public considerable service in raising concerns about lead in drinking water. However, several articles have suggested improper behavior on the part of DDWM personnel. DDWM disagrees with these implications.

## Review Process

Mr. Patrick Baker, City Manager of Durham, contacted the Water Resources Research Institute (WRRI) of the University of North Carolina to inquire if WRRI would be willing to conduct a third-party review of the issues. WRRI agreed to do so with the understanding that any judgments reached about DDWM's performance would have to come from experts on the subject matter that have no relationship with Durham and the state regulatory agency. The City accepted those terms. Dr. Steve Parker, Director, Water Science and Technology Board (WSTB) of the National Research Council (the operating organization of the National Academy of Sciences), was asked for recommendations for peer reviewers. WSTB routinely selects experts to perform peer reviews of USEPA drinking water programs. Dr. Parker recommended Dr. Robert Clark, former Director of USEPA's Water Supply and Water Resources Division, and Mr. Gary Burlingame, a member of the American Water Works Association (AWWA), the Water Environment Federation, and the AWWA Research Foundation. He holds a masters degree in Environmental Sciences from Drexel University, and he is employed as Administrative Scientist for the Philadelphia Water Department. Dr. Clark received his Ph.D. in Environmental Engineering from the University of Cincinnati. He is now an independent consultant. Mr. Burlingame holds a masters degree in Environmental Science from Drexel University. It would have been desirable to have a state drinking water administrator to participate. Two were contacted directly, and recommendations were sought from the Director of the Association of State Drinking Water Administrators (ASDWA). ASDWA would not make a recommendation, and the two direct contacts were not fruitful. Dr. Clark recommended Mr. Jeff Swertfeger, Supervising Chemist of the Greater Cincinnati Water Works. Mr. Swertfeger holds a masters degree in Environmental Science from the University of Cincinnati. He served as an invited expert in USEPA's Lead and Copper Rule Simultaneous Compliance Meetings. Mr. Burlingame and Mr. Swertfeger jointly authored a refereed paper in the Journal of the American Water Works Association in 1997 entitled: "Toward a Lead-Free Public Water Supply: The Course is Set but the Pace Must Quicken".

Mr. Burlingame and Mr. Swertfeger acted as individuals in the review process. Their views do not necessarily reflect those of their employers.

The scope of the review was negotiated between Durham and WRRI. It included:

- A review of federal and state regulations and guidelines relevant to monitoring and reporting under the Lead and Copper rule;

- A review of correspondence between PWSS and Durham and between NCDENR and USEPA regarding relevant issues;
- Review of Durham's 2006 LCR compliance sampling plan, its implementation, results, reporting, and notification of customers.
- Review of all other sampling, including special study samples and customer requested samples, by Durham relevant to the lead and copper rule, including results, reporting requirements, and notification of customers; and
- Review DDWM's Public Education Efforts

Reviewers were given notebooks of background material compiled by WRRI from information supplied by the City of Durham and PWSS. Dr. Clark and Dr. David Moreau, Director of WRRI, held onsite interviews with DDWM staff and the City Manager. Dr. Moreau interviewed Ms. Jessica Miles, Chief of PWSS. She and her staff were fully cooperative in this review.

### **Organization of the Report**

This report is divided into three parts. Part I is a review of the events, applicable regulations, and correspondence among local, state, and federal agencies. Part II is an edited compilation of comments by the external experts who have reviewed material assembled by the Water Resources Research Institute from PWSS and DDWM. A large portion of this section is verbatim. Some of the material was edited to eliminate duplicative statements and to help the flow of comments. Part III is a summary of the findings. There are three appendices:

- A. A detailed timeline of events relevant to this review;
- B. Complete versions of comments by reviewers; and
- C. Resumes of the external reviewers.

## **PART I. REVIEW OF APPLICABLE RULES, EVENTS, AND CORRESPONDENCE**

### **Lead and Copper in Drinking Water**

Lead and copper in drinking water are known to have adverse health effects. Exposure to lead has been shown to "... cause damage to brain, red blood cells, and kidneys, especially for young children and pregnant women." Infants may experience delays in physical or mental development, and children could show slight deficits in attention span and learning abilities. NCDENR's Children's Environmental Health Branch classifies a child as having lead poisoning if the child has at least 10 micrograms per deciliter of blood for two consecutive tests with a six-month period (CEHB, 2006). Short-term exposure to high levels of copper in adults can cause gastrointestinal distress, and long-term exposure can cause damage to the liver or kidneys. Since there appears to be no safe threshold for lead, USEPA set a non-enforceable MCLG of zero for lead in drinking water. The MCLG for copper is 1.3 mg/l.

Because USEPA found that the primary pathways by which lead and copper enter drinking water are from corrosion of plumbing materials (USEPA, 2004), it regulates lead and copper by what is called a Treatment Technique as specified in the Lead and Copper Rule (LCR). That rule was adopted by the USEPA pursuant to authority under the Safe Drinking Water Act. The rule establishes different requirements for systems of various sizes. This discussion addresses only those requirements for large systems such as Durham that serves over 100,000 persons.

### **Lead and Copper Rule**

#### **General Requirements**

General requirements of the LCR are given in Section 141.80 in Title 40 for the Code of Federal Regulations and adopted by reference in the North Carolina regulations. All large systems must install and operate an optimal corrosion control treatment (OCCT). Additional actions may be required by results of a periodic mandatory sampling program. The criteria that necessitate the additional actions are:

- more than 10 percent of samples have lead concentrations that exceed the Action Level (AL) for lead, 0.015 mg/L, or
- more than 10 percent of samples have copper concentrations that exceed the Action Level (AL) for copper, 1.3 mg/L.

If results of monitoring during any sampling period trip the need for additional action, then:

- if lead is found in the source water, the system must implement all applicable state treatment requirements for lead removal;
- if lead lines are known to exist, the system must embark on a lead line replacement program; and
- the system must implement a specified public education program.

In Durham's case, lead has never been found in the source water. There are no known lead lines to be replaced. Lead gooseneck connectors to the distribution system are occasionally uncovered during maintenance or replacement activities, but DDWM has a long-standing policy of replacing them when they are found.

### **Monitoring Requirements**

The LCR also requires two types of monitoring, one to monitor water quality parameters (WQP) relevant to the operation of the OCCT and the other for lead and copper at customer taps. For Durham, the water quality parameters subject to OCCT monitoring are alkalinity, pH, calcium, and zinc orthophosphate (a corrosion inhibitor). The LCR requires that WQP's be monitored at least biweekly sampling at all points where water enters the distribution system. It requires monitoring of WQP's at customer taps. The number and frequency of samples for WQP can be reduced if the system satisfies criteria shown in Figure 1 by operating within state-specified limits for OCCT. Durham qualified for the reduced sampling of taps for WQP's several years ago, and its performance with respect to those parameters has never been questioned.

Requirements for lead and copper monitoring are shown graphically in Figure 2. Initial sampling required at least 100 samples every six months. If a system meets the criteria for two successive six-month periods, it could reduce sampling to once a year. If it satisfied the criteria for two successive years, it could reduce the number of samples from 100 to 50 and the frequency to once every three years. If samples during any three-year monitoring trigger the need for the additional actions described above, then monitoring must go back to the starting points in Figures 1 and 2.

Therefore, if Durham's monitoring program in 2006 is judged to have triggered the need for additional actions, those additional actions would be to:

- implement the complete public education program specified in the LCR; and

- return to starting point for monitoring lead and copper (see discussion on monitoring requirements that follow).

One other aspect of the monitoring requirements is relevant to this discussion. The LCR specifies the types of homes from which samples are taken, and it describes methods by which samples are to be taken. Homes to be targeted for sampling are those thought to be at high risk for lead and copper contamination. North Carolina requires that the targeted homes be single-family structures built in years 1983-1985 unless multi-family structures make up more than 20 percent of service connections (NCDENR, 2006). These homes are referred to as Tier 1 sites.

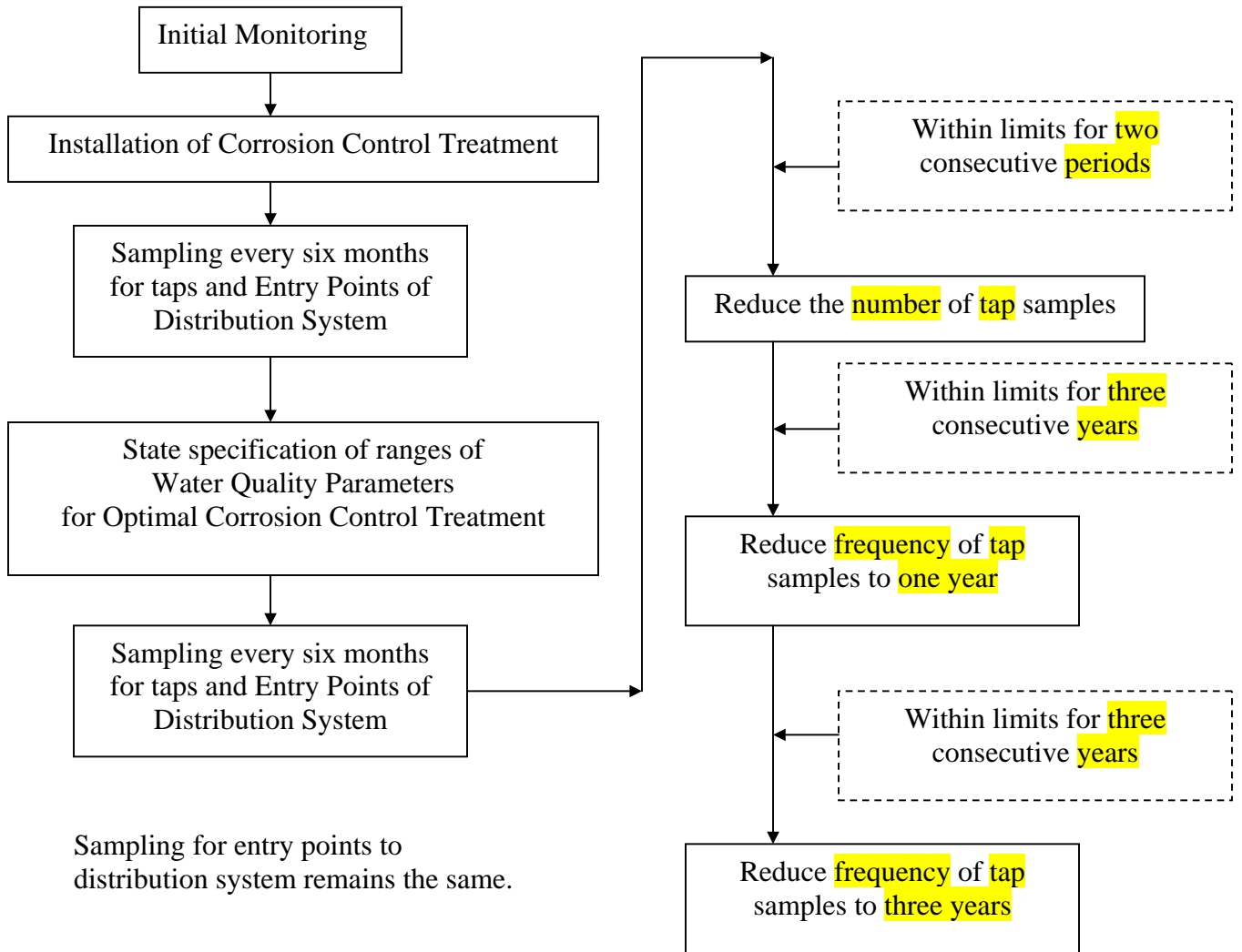


Figure 1. Monitoring for Water Quality Parameters

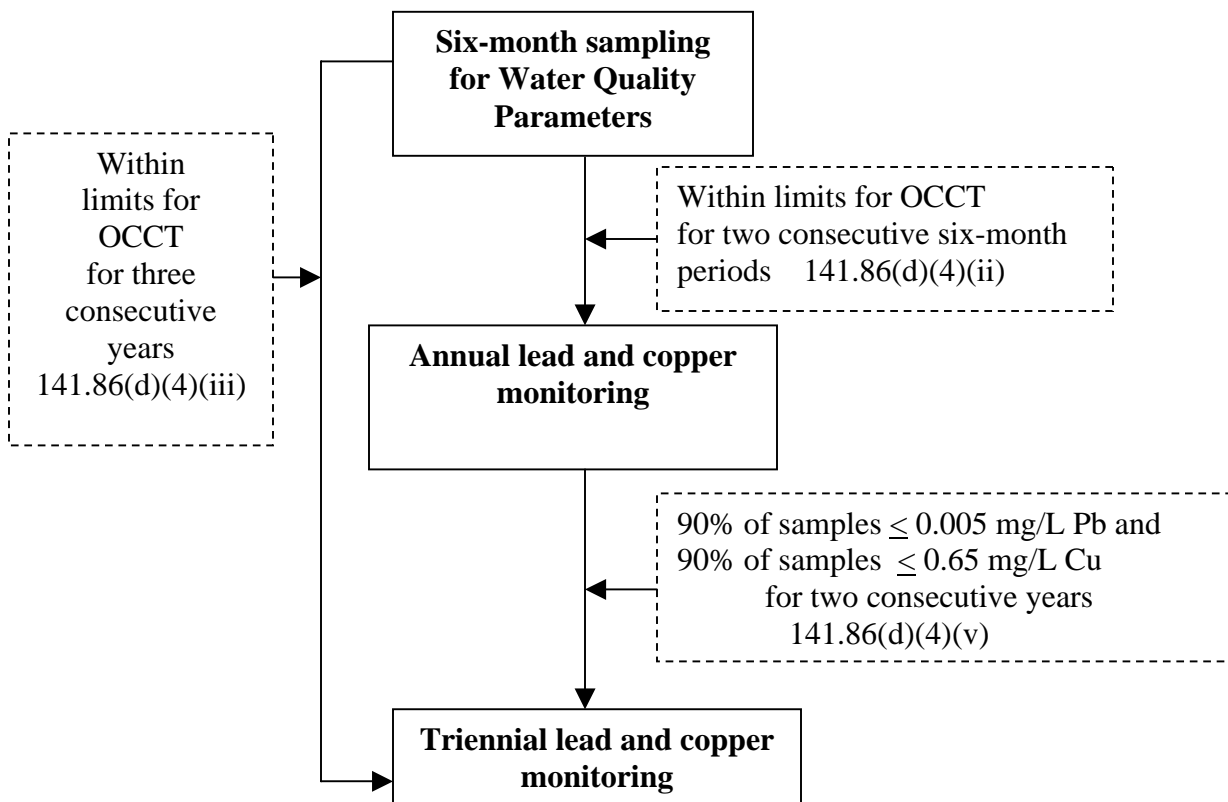


Figure 2. Monitoring for Lead and Copper at Customer Taps

Durham's history of monitoring under the lead and copper rule is illustrated in Figure 3. The six-month samples were taken in March-February and October of 1992. That was followed by three consecutive annual monitoring periods. After the 1995 period, Durham was granted reduced monitoring status, giving the system a three-year frequency. Samples were then taken in 1998, 2001, and 2004. They were scheduled for another round of sampling in 2007. All of the LCR samples in 1993, 1994, 1995, 1998, 2001, and 2004 were taken in the month of September.

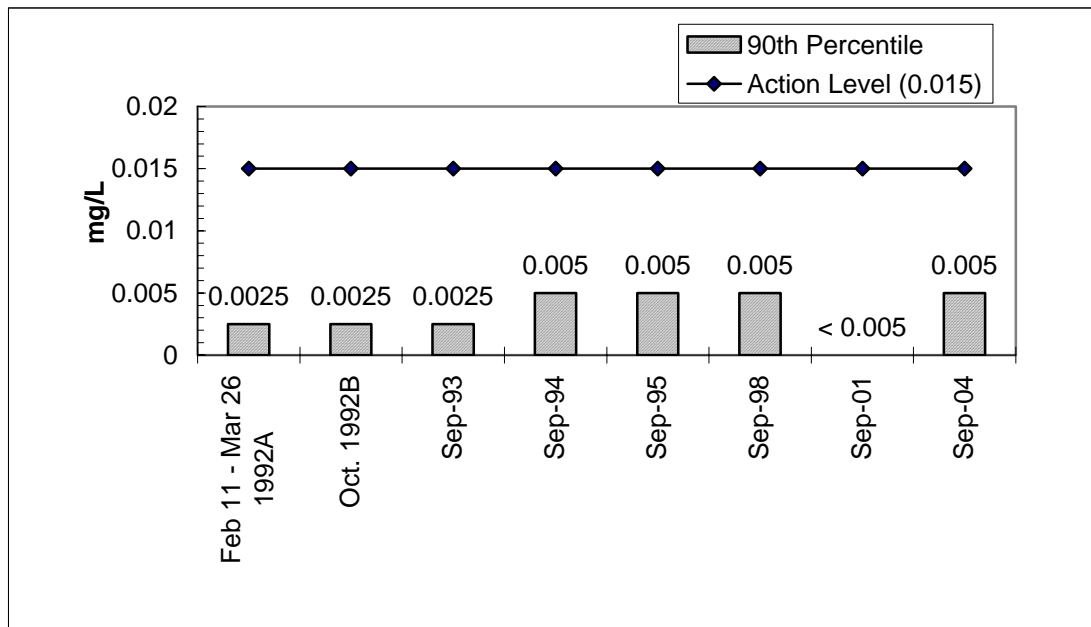


Figure 3. Durham's History of Monitoring under the Lead and Copper Rule

Timing of monitoring for lead and copper in tap water under a reduced sampling status is governed by the Code of Federal Regulations, Title 40 (40 CFR), Chapter I, Part 141, Subpart I, Section 141.86 (d)(iv). That section states in part:

(d) Timing of monitoring ---

(iv) A water system that reduces the number and frequency of sampling shall collect these samples from representative sites included in the pool of targeted sampling sites identified in paragraph (a) of this section. Systems sampling annually or less frequently shall conduct the lead and copper tap sampling during the months of June, July, August, or September unless the State has approved a different sampling period in accordance with paragraph (d)(4)(iv)(A) of this section.

(A) The State, at its discretion, may approve a different period for conducting the lead and copper tap sampling for systems collecting a reduced number of samples. Such a period shall be no longer than four consecutive months and must represent a time of normal operation where the highest levels of lead are most likely to occur.

North Carolina adopted that identical language as part of its "Rules Governing Public Water Systems" in NCAC Title 15A Subchapter 18C Section .1500.

There is an important qualifier in 40 CFR Part 142, Subpart B that governs state primacy. It states in Section 142.16(d) that an application for approval of a state program must contain, in addition to general primacy requirements, a description of how the state will accomplish the designation of an alternative period for sample collection for systems subject to reduced monitoring for lead and copper under Section 141.86(d)(4)(iv)(A). In its Primacy Revision Application for the Lead and Copper Rule Minor Revisions in 2002, PWSS stated that it does not plan to designate alternative monitoring periods for systems subject to reduced monitoring for lead and copper (Miles, 2002). The application was approved in 2004 (Palmer, 2004).

It is important to note that the language in the rule says "...tap sampling during the months of June, July, August, or September...". Section 141.86 makes reference to the sampling period five times. The one applicable to Durham is cited above. The next four use the term "June through September", but none of those references are applicable to Durham. One reference is to non-transient non-community supplies, two references are to systems that have received state approval to alter the monitoring period, and the other is to small systems with waivers.

USEPA has been interpreting the rule to say "June through September", but that is not what the rule says when referring to large community systems. USEPA's *Lead and Copper Monitoring and Reporting Guidance for Public Water Systems* (USEPA, 2002) makes several references to "June through September", but never with specific reference to the regulation. When it comes to certification of samples, the language follows the strict language of the regulation, namely: "Each first-draw sample collected during an annual or triennial monitoring period has been collected in the months of June, July, August, or September or in the alternate period specified by the State." There is some uncertainty regarding which samples within a monitoring period are to be included in the 90<sup>th</sup> percentile calculation. A revision to the LCR in 2000 gave states the authority to specify which sampling locations a system must use if it is collecting lead and copper tap samples at the reduced number of sites [Section 141.86(c)]. North Carolina has not generally required prior approval, but following an audit in June 2006, it gave prior approval to Durham's sampling pool. Then, in Section 141.86 (e) headed *Additional monitoring by systems*, the rule states: "The results of any monitoring conducted in addition to the minimum requirements of this section shall be considered by the system and the State in making any determinations (i.e., calculating the 90th percentile lead or copper level) under this subpart." USEPA attempted to clarify what it meant by

the additional samples in guidance from Mr. Ben Grumbles, USEPA Headquarters in 2004. That letter is discussed later in this report.

### Lead Sampling in Durham in April–September 2006

Following identification of the child with elevated blood lead levels, at least four sets of tap samples were taken in Durham and tested for lead between April 1 and early October 2006. That time frame covers initial samples for the lead poisoning case and the conclusion of the LCR-authorized monitoring period. They are referred to in this report as:

- 1) Durham County Health Department samples;
  - 2) Special investigational samples by DDWM;
  - 3) Customer-requested samples processed by DDWM; and
  - 4) September LCR samples processed by DDWR.
- 5) Timing of those samples is shown in Figure 4.

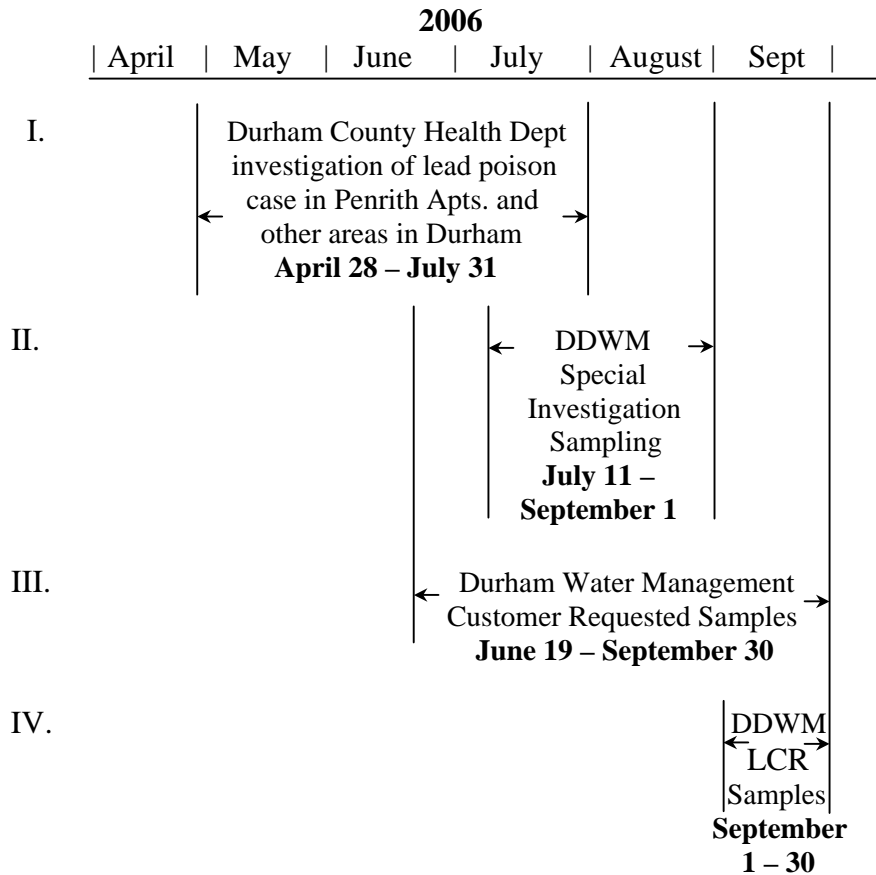


Figure 4. Timing of Various Sampling Programs for Lead in Durham, April 1–September 30

When DCHD was informed of elevated lead levels in the child living in Penrith Apartments, they began taking samples at that tap as early as April 3, 2006. The initial sample showed a very high lead concentration, over 0.8 mg/L. Unfortunately, there appears to be no written report of this investigation other than the records of the water samples (Meyer, 2007). DCHD took another sample on April 28 at the same location. Lead in that sample was less than a tenth of what was found April 3, but the concentration was still above the federal action level. In May and June DCHD took a number of other samples in the Penrith Apartment area and in other areas of Durham. Data reported on the SPHL website show that 35-40 samples were above the federal action level. Approximately 50 percent of those samples were part of multiple samples taken at five housing units. Ninety percent of the samples were taken from housing units located on or in the near vicinity of Penrith Drive.

After DDWM was informed of the Penrith case on May 16, they took six samples from fire hydrants on Penrith Drive on May 19. Those samples were negative for lead (N&O, May 20, 2006; DDWM, 2007a). The finding of elevated lead levels at the tap but not in the DDWM distribution system was consistent with USEPA's finding at the national level that the primary pathway by which lead and copper enter drinking water is from corrosion of plumbing materials that connect the customer to the distribution system (USEPA, 2004). That is, lead contamination of residential water typically occurs in household piping systems that belong to the customer.

DDWM began its own tap sampling program in June and offered to run tests on tap water for any customer who requested them. From mid-June to mid-July DDWM sampled some of the same sites previously sampled by DCHD. In those samples, DDWM found only three sites that exceeded the action level (DDWM, 2007a). At least a part of the difference could be attributed to differences in how sampling protocols dealt with aerators attached to faucets. DCHD's protocol specified that if an aerator was attached it was not removed before sampling. DDWM's long-standing protocol, used by a number of other cities in North Carolina, was to remove aerators before sampling. Aerators can trap materials that flake from interior walls of pipes. The difference in protocols became an issue after Durham had completed its sampling at the end of September. When USEPA issued new guidance on October 20 stating a preference for the DCHD-type protocol, it acknowledged that its rule did not specify which protocol was to be used.

DDWM's file on customer-requested samples shows 666 results with reported first draw lead concentrations over the period April 28 to September 30, 2006. Among them were 23

duplicate samples. Seventy-five results were at or above the AL. For those 75 with first-draw concentrations above the AL, five had concentrations above the AL on the second draw.

To try to determine what changes might be occurring at customers' taps, DDWM made pair wise comparisons of results in 2001 and 2004. Nine sites showed slight increases in lead in 2004 relative to 2001. DDWM then tracked those nine sites while making adjustments to the treatment process. The 21 samples taken at those were termed "Special Investigational Studies".

Durham reported its September LCR samples on October 23, 2006. That report included 69 samples with four at or above the AL. The 90<sup>th</sup> percentile value based on that data was 0.009 mg/l.

### **The Durham Response to Elevated Blood Lead Cases**

#### **Sample Results May–August**

As a regulated PWS subject to the LCR and an active member of the American Water Works Association, DDWM was well aware of potential problems with lead contamination. According to DDWM, after the March 2004 incident involving a child in Greenville, NC, DDWM staff worked with the City of Durham webmaster to provide information on drinking water on the City's website. DDWM staff was also contacted by Greenville Utilities to assist with development of public notification tools. In July 2005, Concerned Partners Against Lead (CPAL) and the Durham Affordable Housing Coalition contacted DDWM staff to discuss lead in drinking water issues. A series of meetings were held with these groups, including Durham County Health Department staff and personnel from the Childhood Lead program (State). A request was made for assistance and cooperation from the Durham Department of Water Management to be part of a four city testing program. Durham responded by providing copies of literature and sample customer letters and chain-of-custody forms for the group to use. Staff reviewed the proposed list of sites to be sampled to ensure they were City water customers.

It is unclear as to how and when DCHD became aware of the EBLL case at the Penrith Apartments (Meyer, 2007). The State Lab data show that DCHD began taking samples at that location on April 3, 2006. Representatives of DCHD, DDWM, and the State Childhood Lead Prevention program held a meeting on May 16 to review the situation and develop an action plan. DDWM staff reported that it was at that meeting that they were first informed about the situation.

On May 19, the News and Observer reported DCHD's findings about the lead poisoning case. DDWM response was reported the next day to the effect that elevated lead levels in Durham were not a utility wide problem.

On June 1, DDWM began its own sampling program, and offered testing to any water customer. According to DDWM, their staff worked closely with Durham One Call (DOC) to develop protocols for submittal of service requests for lead testing. They also worked with the City's webmaster to keep information on the situation highly visible and up-to-date.

According to the email record, RRO-PWSS was informed on or before June 9 regarding the sampling program at the Penrith Apartments (Whisnant, June 13, 2006). It was also reported that the RRO-PWSS did not consider those results to be part of the monitoring program required under the LCR.

As results of the sampling programs by DCHD and DDWM became available, news coverage was intense. For examples, the Herald-Sun reported on June 13, that DCHD found elevated lead levels in 12 of 51 units sampled in the Penrith Apartment area. The story also reported that 11 of the 19 homes sampled within a half-mile of Penrith in a follow-up study had elevated levels. The next day the Herald-Sun reported that DDWM would conduct its own tests on the 11 homes. On June 26, the paper reported that out of 31 samples taken for a special state study five had lead levels above the federal action limit. The News and Observer and the Herald-Sun carried stories on July 21 and 22, respectively, that DDWM had found high levels in 18 of the 89 results it had taken. On August 8, the Herald-Sun cited statistics of customer-requested samples released by DDWM that showed 11 or 12 of the 34 homes tested that were built between 1982 and 1985 had results above the AL. On October 23, as DDMW was reporting its September LCR results to PWSS, the Herald-Sun ran a story that six percent of the homes tested were above the AL.

### **Public Education**

DDWM has documented a number of actions taken by the utility to educate customers about the hazards of lead in drinking water and ways to reduce exposure. Among those actions were:

- An extensive write-up in the annual water quality report distributed to all Durham postal customers on June 6, 2006;

- Maintenance of an up-to-date Website throughout the summer featuring a faucet icon with lead information highly visible on the City Home Page;
- Twenty thousand (20,000) “Get the Lead Out” magnets were received on July 17, 2006, and distributed with the help of DCHD, the Partnership Effort for the Advancement of Children’s Health, and Community Partners Against Lead (CPAL);
- Taped a “City Life” Episode on August 9, 2006, featuring Durham’s Water Supply and Treatment Superintendent and Regulatory Compliance Superintendent. Episodes run for a month after taping was completed.
- Bus signs with “Get the Lead Out” in English and Spanish were received on September 6 and posted in all DATA buses by the end of the following week.
- Lead information was included in the June/July and August/September water bill inserts; and
- DDWM staff attended meetings of the following groups and made presentations on the lead issue to a number of civic, religious, and neighborhood groups.

In addition to their reporting on results of sampling and investigations, both major newspapers that serve the region carried educational articles about lead and ways to reduce exposure.

### **Process Changes**

In response to concerns about lead levels, Durham reviewed its corrosion control program at the two water treatment plants. DDWM reported the following changes:

- June 21, 2006 – Final pH for both treatment plants was decreased to a target range of 8.0 to 8.3 standard units from 8.2 to 8.5 standard units.
- July 6, 2006 – W.G. Brown Plant coagulant switched back to Aluminum Sulfate from Ferric Chloride. This change was made following consultation with Dr. Marc Edwards of Virginia Tech. Dr. Edward’s review of treatment plant finished water quality data revealed a chloride to sulfate ratio greater than 0.6 after the coagulant change to Ferric at the Brown Plant.
- July 21, 2006 – Finished water Zinc Orthophosphate residual increased to 0.60 ppm from the initial range of 0.30-0.35 ppm. The dose of 0.3-0.35 ppm had been held in this standard operating range for several years based upon the data collected through the New Facility Sampling Program and historic distribution system lead and copper results.
- July 21, 2006 – Final pH for treatment plants was decreased again to target of 7.8 standard units based on the additional literature studies and results from the first round of special study results.

- August 1, 2006 – Finished water Zinc Orthophosphate residual was increased to target of 0.8 – 1.0 ppm to continue to enhance corrosion control following results from additional samples collected from special sample locations.
- January 4, 2007 – Finished water Zinc Orthophosphate residual targeted to maintain a residual of 1.0 ppm based upon results from all samples collected in September 2006.

DDWM concluded that results of testing with these changes appear to show that corrosion control had been optimized (DDWM, 2007b).

### **Monitoring Under the Lead and Copper Rule**

In June 2006, the Regional Engineer for PWSS conducted an audit of Durham’s sampling program for compliance with the LCR. At the conclusion of the audit, the Regional Engineer had a conversation with DDWM on June 28, regarding what next steps should be taken. As stated in a letter sent to the Director of DDWM on June 29, there was an agreement to move up the LCR monitoring from its 2007 time to September 2006.

That letter covers two crucial points affecting LCR monitoring, namely the time frame for sampling and the pool of sites from which samples would be drawn. The time frame was clearly established. The letter states that the City of Durham agreed to move the LCR monitoring from 2007 to 2006. Samples will be collected during the month of September, and prior to that date, a revised sampling site plan will be submitted to PWSS for review. It also states “If the 90<sup>th</sup> percentile is not exceeded, Durham’s next lead and copper monitoring period will be 2009.”

Selection of the pool of sites from which samples were to be taken was also approved in that letter. It stated in part that the Regional Engineer had worked with Durham personnel to assemble information on “...past and current monitoring site selections”. He further stated that the sites were constructed, renovated, or permitted in 1983, 1984, and 1985 and that they met the USEPA Tier 1 criteria. He and the City agreed to add 10 sites in the Penrith area (Douglas, 2006).

According to 40 CFR 141.86(c), “States may specify sampling locations when a system is conducting reduced monitoring”. PWSS does not require prior approval of sampling locations for all public water supplies, but it instituted the auditing process in 2006. On March 24, 2006, PWSS requested all PWS’s to review their lead and copper monitoring locations. Suppliers were required to submit their plans to PWSS by June 1, 2006, include descriptions of the sites and a justification for assigning each site to a particular tier level. Because the response was slow, a reminder was

sent on June 28. Systems that failed to submit their reports by earlier deadline were given until July 14, to do so. Durham's plan was submitted to PWSS on June 29, 2006 (Lawrence, 2006), the same day the Regional Engineer had given it his stamp of approval.

It was with these understandings about the monitoring period and the sampling pool that Durham initiated the September LCR monitoring. There was little reason to question these conditions. All previous sampling for Durham's LCR monitoring had also been conducted in September, and the sampling pool had only minor changes from the 2004 pool.

Durham submitted results of its September LCR monitoring to PWSS on October 23. Results of 69 samples were reported with four of them above the AL. The 90<sup>th</sup> percentile value was reported to be 0.009 mg/l, well below the AL.

On October 25, 2006, the Section Chief of PWSS, Ms. Miles, asked the Team Leader of the Compliance Services Branch, Mr. Hrebenuk to verify that he either agreed or disagreed with Durham's assessment, noting that it was important that PWSS be certain before going on record regarding their 2006 compliance (Miles, 2006). There is no record in correspondence provided for this review of any further action by PWSS until December 7.

On that date, Mr. Chris Thomas, USEPA Region IV, in Atlanta sent an email to PWSS regarding a conversation with a newspaper reporter alleging that Durham had not properly disclosed results from its LCR monitoring program. In at least a partial response to the Thomas email, Miles requested and got a briefing from Hrebenuk about the Durham data, noting that she was aware that Durham had other data. Hrebenuk reported on a conversation with Durham personnel about an interview with newspaper reporters who were insinuating that Durham was deliberately withholding of information.

Those media inquiries apparently sparked a couple on inquiries from PWSS to USEPA requesting guidance on how to handle the Durham data. On December 27, 2006, Hrebenuk raised four questions to Mr. Tom Degaetano (Hrebenuk, 2006b). Three of the questions were:

1. If a system takes samples from its approved sampling pool during the approved sampling period in addition to those taken for compliance sampling, do they have to be included in the calculation of the 90<sup>th</sup> percentile value?
2. How do you treat multiple samples from the same location?
3. Does a system have to include a customer-requested sample at a site that qualifies as Tier 1 but is not in the sampling pool?

A follow-up question was posed to USEPA on January 3, 2007. The questions appear to ask how to handle “non-compliance” samples taken by DCHD with assistance from the city. Some of the samples were first draw; some were not. Another question has to do with multiple samples taken from sampling pool sites within the monitoring period, some of which were taken for compliance purposes, others for a special investigation to evaluate effects of changes in the treatment process (Hrebeniuk, 2007a).

Thomas responded on January 10, 2007. The questioned posed by Hrebeniuk were generic without any details of what had transpired in Durham, particularly the approvals the Regional Engineer had given to Durham. Thomas gave a generic response, citing a November 23, 2004 memo from Mr. Benjamin Grumbles of USEPA Headquarters stating that all sample results from a system’s sampling pool during the monitoring period must be included in calculating the 90<sup>th</sup> percentile value for compliance. Thomas also stated that there could be no substitution or averaging at sites where multiple samples were taken. Thomas further stated that any samples taken as part of a “Special Investigation” that were not part of the system’s regular compliance sampling pool and meet the site selection criteria should be used as part of the 90<sup>th</sup> percentile calculation.

The most relevant parts of the Grumbles’ letter are discussed below. Under the section marked “1) What samples are used to calculate the 90<sup>th</sup> percentile?”, it states:

EPA regulations require water systems to develop a targeted sampling pool focused on sites with the greatest risk of lead leaching. All compliance samples used to determine the 90<sup>th</sup> percentile must come from that sampling pool. All sample results from a system’s sampling pool during the monitoring period must be included in the 90<sup>th</sup> percentile calculation even if this includes more samples than the required minimum number for compliance. [40 CFR 141.86(e)].

An explanatory example is used to clarify that comment. If a system that is required to submit at least 100 samples sends out 150 sample kits and gets 140 back from customers, then it must include all 140 results in its calculation of the 90<sup>th</sup> percentile value. That example applies only to those samples required under LCR monitoring.

The section headed by “2) What should utilities do with samples results from customer-requested sampling programs?”, the letter states:

Customer-requested samples that are not part of the system’s regular compliance pool may or may not meet the sample selection criteria. ... Therefore, samples

collected under these programs should not be used to calculate the 90<sup>th</sup> percentile, except in cases where the system is reasonably able to determine that the site selection criteria for compliance sampling are satisfied.

That portion of the letter of clarification appears to have contradictory language. In the first paragraph cited above it says all compliance samples must come from the compliance pool. In the second cited paragraph it appears to allow the use of customer-requested samples outside the sampling pool.

There doesn't appear to be any ambiguity about a later sentence in the letter. It states "...even though these customer-requested samples are not used for the 90<sup>th</sup> percentile calculation, the sample results must still be provided to the state. [40 CFR 141.90(g)]".

Although PWSS did not necessarily agree with USEPA's interpretation of the rule as it applied to Durham (Miles, 2007), PWSS sent an email to Durham on January 10 stating that (Hrebeniuk, 2007b):

EPA has indicated that any sampling performed meeting compliance sampling criteria at Tier level 1 locations during the monitoring period shall be designated as compliance samples regardless of the sampling locations' prior inclusion in the water system's sampling pool and that the results be used in the calculation of the system's 90th percentile value.

PWSS stated that written confirmation from USEPA was expected soon. Durham was then requested to submit lead and copper sampling "...that was performed during the time frame of June 1, 2006 through September 30, 2006 in order for action level compliance determination to be completed."

That exchange raised the question of: What was the sampling period? On January 11, 2007, the Assistant City Manager of Durham, Mr. Voorhees, sent an email and letter to PWSS asserting that a plain reading of the RRO-PWSS letter of June 29, 2006 was the basis on which Durham relied conducting its testing in September. Voorhees stated that Durham believed that PWSS had full authority to set September 2006 as the monitoring period under the LCR.

In that letter Voorhees argued that it was "...in the best interest of the City, NCDENR, and the public ... not (to) spend a lot of time and effort arguing about how the rule is supposed to work." He offered a compromise. It consisted of two parts. First, PWSS would support the

position that September was the sampling period, and, second, Durham would voluntarily proceed with more frequent monitoring and other provisions of the LCR.

On January 17, Miles responded by email to Voorhees with a defense of PWSS's actions, asserting that if Durham had a problem, it was with USEPA who had made the determination as to what samples should be included. She did say that PWSS would hold off making a final determination on the 90<sup>th</sup> percentile calculation until USEPA has made a final decision regarding any protest by the City of Durham regarding what samples should be and should not be included in the calculation. That statement was conditioned on Durham's compliance with five requirements under Section 141.80 of the Lead and Copper Rule.

Ms. Miles took exception to the characterization that NC approved a different monitoring period than was provided for in the regulation. She stated that the letter (presumably the June 29 letter from Douglas) did not contain any language describing approval of an alternative monitoring period. She further stated that North Carolina does not have the authority to approval an alternative sampling period.

In that email, Ms. Miles also acknowledged that neither the state nor the city was concerned about the technicalities of lead and copper sampling. They were much more concerned about the overall lead problem and effects of changes to the treatment process. She acknowledged that sampling was biased by the focus on sites known to have higher lead levels.

On January 25, 2007, PWSS issued a notice of violation to the City of Durham for failure to submit the "additional" lead and copper samples within ten days of the end of September as required by 15A NCAC 18C.1507 [40 CFR 141.90(g)]. Additional samples in this context refer to those taken in the June–August time period

On January 29, 2007, Durham submitted to PWSS an electronic file labeled "final PB and CU submittal to state 012907.xls" to comply with PWSS's directive of January 10. That spreadsheet included a list of 166 samples covering the period June 17, 2006 through the month of September. It included the Special Investigational samples and customer-requested samples that were judged to have satisfied the Tier 1 criteria. An analysis of those samples shows the following:

- 81 of the 166 samples were taken from sites not in the targeted sampling pool that had been audited by the Regional Engineer and submitted to PWSS for approval;
- 85 of those samples were taken in June, July and August with 24 of them (28 percent) at or above the AL;

- 81 sites were sampled in September.
  - 4 (4%) exceeded the AL;
  - 23 of the September sites had been sampled previously during the June-August period; and
  - 2 of the September sites had duplicate samples during that month.

PWSS has yet to make a final determination as to which samples will be included in the 90<sup>th</sup> percentile calculation.

## **PART II. COMMENTS OF EXTERNAL REVIEWERS**

External reviewers were asked to evaluate four matters, namely:

- The overall performance of DDWM in response to the revelation of a elevated blood lead level in a child living in an apartment served by Durham’s public water supply?
- Durham’s compliance with provisions of the lead and copper rule? In particular, reviewers were asked to comment on the special investigational samples, customer-requested samples, the September LCR samples, and related reporting requirements.
- Customer notification procedures; and
- Public notification techniques.

### **Overall Performance**

(1) Mr. Swertfeger commented that of all of the drinking water regulations that have been promulgated by the USEPA, the Lead and Copper Rule is one of the most confusing. Unlike other rules, there is no contaminant level that is monitored in a defined location. Rather the rule is a series of actions that a utility must undertake and requires participation by the general public to assist in these actions. Compliance with this rule is judged not by the safety of the water, but on whether these actions are completed as prescribed within certain timeframes. As a result, there has been much confusion in the rules implementation on the part of utilities, states, the USEPA regions, and the USEPA. Adding to the confusion, since the original rule was promulgated, there have also been several “updates” to the rule originally published in the Federal Register, several clarifying memos put out by USEPA’s Office of Water, and many modifications and interpretations that have been made by each of the primacy agencies.

(2) Mr. Burlingame commented that it is unfortunate that Durham, in a costly, time-consuming, and conscientious response to real and perceived lead issues, may have tried to do too much in a one-year period. DDWM moved its reduced LCR monitoring period from 2007 to 2006, pulled its LCR compliance into the confusion of a problematic regulation and a volatile public health issue that the media exacerbated. The State agreed with Durham that this action was intended to confirm optimization of the corrosion control treatment, which DDWM was changing. These actions were taken concurrently with the Health Department’s investigation of a lead poisoning case and customer-requested sampling offered by the City. Durham was trying to

achieve too much in a one-year period, and the attempt seemed to backfire on them. A broader concern is that the handling of the Durham case by the state and USEPA may create disincentives for public utilities to promote customer-requested testing, conducting follow-up sampling, and conducting investigations.

(3) Dr. Clark, after spending a number of years researching lead in drinking water, found it disappointing to learn that these types of problems still exist, but he was pleased at the attention given to the issue once the lead poisoning case was discovered. Ultimately, the various agencies involved have “done the right thing”, although the initial reactions were excessively bureaucratic and defensive. Despite what may appear to be defensive postures and finger pointing, the city, county, state and federal agencies eventually responded in a manner that seems to have addressed the problem. Even though it was a little messy, involvement of the press and various environmental and public interest groups helped the government entities find resolution. Although the reactions and interactions among and between the agencies and organizations involved in this situation seems a little chaotic, the ultimate goal of public health protection has been achieved.

**Which samples should have been included in the determination of the 90<sup>th</sup> percentile value?**

(1) Mr. Swertfeger noted that the purpose of the monitoring program under the Rule is to ensure that long-term optimal corrosion control is being maintained by the system after it is established. To accomplish this goal, monitoring should be performed after the system has established its optimal corrosion control. In Durham, sampling earlier in the summer would not achieve this goal as the system was undergoing transition with the pH and the phosphate dose being adjusted to the optimal level. A completely different sampling plan was needed in order to track the effectiveness of the treatment changes over the short-term. Such a plan was implemented in the special study sampling in which the Durham Department of Water Management (DWM) tracked eight locations, which had historically higher lead levels.

From the Lead and Copper Rule section 141.86(d)(4), systems such as Durham, which are on a reduced monitoring schedule, are required to collect samples June through September for compliance determination. Durham believed that the state did change the sampling period to only September of 2006. If the state did agree to limit the compliance monitoring to just September, then it would not have had the authority to do so.

The Durham Department of Water (DWM) had good reason to believe that compliance monitoring was limited to September and consistently acted in good faith based on that belief. However, given what is written in the Rule and the lack of state authority to change it, the actual compliance period was June through September.

It should also be noted that the DDWM, and the state were not the only ones to be confused about the actual compliance period. The USEPA found the definition of a compliance period to be confusing enough that on July 18, 2006, they proposed a clarification to the rule, which specifically addressed the definition of a compliance period.

The best way to track changes would be to monitor the same set of locations each monitoring period and see how they change. By using the same set of locations, the only variable would be any changing water chemistry that could affect corrosion. In Section 141.86(b)(4), the USEPA tries to maintain the same sampling pool by requiring systems to return to the same locations as it did in previous samplings or provide justification why it could not return to the same location. In order to prevent systems from only “cherry picking” locations that are low in lead and to prevent systems from trying to throw out high values, the USEPA also requires systems to report any other lead sample that meets the sample location criteria and the sample collection and analysis criteria.

In contrast, the state of North Carolina requires that systems get pre-approval for their sample pool in order to use the results for calculation of the 90<sup>th</sup> percentile (or so it appeared to this reviewer). This seems to be in conflict with requirements of the federal regulation, which requires all proper samples to be included. North Carolina is not alone with its interpretation of the sample results, which prompted Benjamin Grumbles of the USEPA Office of Water to write a clarifying memo in November 2004 to the regions instructing the regions to count all qualifying samples in the calculation. It is important to note that this memo was written to the USEPA Regions and may or may not have been received by the State or DDWM. It would appear, based on correspondence between PWSS and USEPA Region 4 on December 27 and January 3, that the state was not familiar with how to use these data either.

(2) Mr. Burlingame cited the fact that Durham was only able to obtain 69 samples from its pool of 142 sites (original 132 planned sample sites plus 10 more the State asked to add from the region of concern) as evidence that the move to conduct LCR sampling in 2006 was not a successful move. In past years, Durham had obtained 95 or more samples. The 90<sup>th</sup> percentile

value is a variable statistic that is affected by too few samples because the distribution of lead sampling data is highly skewed.

Starting in June 2006, Durham began making changes in response to Dr. Edward's report. Between June and August, pH was decreased, the Brown plant reverted back to aluminum sulfate, and the corrosion inhibitor (zinc orthophosphate) was increased quite significantly. Durham's treatment or OCCT was in a process of change in June, July and August (during most of the reduced monitoring sampling period). The USEPA practice is to notify the State within 60 days after making any changes. LCR sampling should be conducted *after* changes in treatment that could affect OCCT, and these changes by Durham were designed to improve OCCT. Again, choosing to move up the reduced monitoring to 2006 was not the best decision. The question seems to be, within 2006, which months should be included in the reporting of lead sampling data under LCR compliance? Even though the State approved the moving of reduced LCR sampling from 2007 to 2006 for the purposes of verifying OCCT, Durham was changing its OCCT (pH and phosphate) into August. Durham's 21 samples from its special study suggest that OCCT was indeed improved as was expected. Thus, sampling results to confirm OCCT should not include data from samples in June, July and August.

Other issues and objectives complicated the additional lead data collected from Tier 1 homes during the June–September time period. Durham's resubmission of LCR data in January 2007 contains lead samples that are questionable for use in compliance calculation of the 90<sup>th</sup> percentile, although not questionable for reporting separately to the State. The State's requirements use statements such as, "Each first-draw tap sample for lead and copper..." which suggest that the intent for sampling and analysis is to conduct lead *and* copper on the same samples, on every sample that falls within the LCR. In fact, the State requires a waiver for utilities to not analyze for copper (a utility cannot choose to exclude copper from testing), and lead and copper results must be invalidated *by the State* (lead and copper results must be submitted for each sample). This seems to follow USEPA requirements. The data that Durham sent to the USEPA in January 2007, included 166 lead results but only 97 of them had copper results. Sixty-nine samples had not copper analysis. These samples should likely not have been included: the LCR is a lead *and* copper rule, requiring lead and copper analyses on all samples properly collected unless invalidated or given a waiver by the State. Thus, lead but no copper, or the reverse, copper but no lead results fall outside of the LCR compliance data set. In addition, the 21 samples of the special study by

Durham to determine if its changes in treatment were affecting lead levels at the taps of eight homes, show an unusual distribution compared to all other lead data distributions, did not have copper analyses conducted, and were taken during the changes being made to OCCT rather than before or after such changes. All of this supports the opinion that these 21 samples, while being reported to the State for evaluation of the system's lead corrosion status, should not be used in the determination of the 90<sup>th</sup> percentile compliance statistic.

Mr. Burlingame concluded that it seems reasonable that the 69 samples originally submitted should be used for 2006 compliance. Samples from June- August should not be used as these were collected during changes in OCCT. Samples that did not have both lead and copper analyzed in the same sample should not be included, as that is a basic requirement of LCR compliance samples unless the State waives reporting or invalidates the data.

(3) Dr. Clark's opinion is that the City of Durham received mixed messages regarding their sampling program. When Durham began their expanded monitoring program in the Penrith Apartment area they were operating under the assumption that they were engaging in a treatment optimization study. The study was designed to evaluate treatment changes that had been made to minimize the formation of disinfection by-products, while simultaneously controlling corrosion in consumers' plumbing. Therefore, the samples collected in the June–August timeframe should not be included as part of the utilities' compliance monitoring program. This opinion is supported by various E-mails and correspondence between the Regional Engineer for the PWSS and various members of the DDWM (for example, the letter from Michael Douglas to Terry Rolan on June 29, 2006).

Subsequently, the USEPA Regional Office (Mr. Thomas) identified a memo from Mr. Grumbles of USEPA providing guidance as to which samples should be included in compliance calculations. Using this memo the State PWSS issued a determination that the "optimization" samples should be included in the compliance calculations, as well ultimately resulting in Durham being in violation of the LCR.

Dr. Clark's interpretation of the "Grumbles" memo is that it deals only with "compliance" calculations, and does not address the issue of "optimization" studies. Therefore, the "optimization" samples should not have been included in the compliance calculations. However, as a matter of prudence it is Dr. Clark's advice to the Durham Water Management Department that they operate on the more frequent sampling protocol, using the expanded sampling pool.

(4) In summary, all of the reviewers agreed that Durham acted in good faith when it limited the samples used for the 90<sup>th</sup> percentile calculation to those collected in September. All three noted that the PWSS had concurred in the decision to do the lead and copper sampling in September. Two reviewers concluded that only the September samples should have been included in the 90<sup>th</sup> percentile calculation. Both of them cited as reasons for their judgment the fact that PWSS stated in writing that Durham's sampling period would be September and the need to separate sampling during changes to treatment processes from the mandatory lead and copper monitoring. One reviewer concluded that all Tier 1 samples taken in the period June through September should be included in the 90<sup>th</sup> percentile calculation. The basis of that judgment was USEPA's interpretation of the rule that the sampling period was June-September and, unless PWSS had authority to change that period, all samples had to be included in the calculation. That judgment was made despite his acknowledgement that: (1) Durham had good reason to believe that September was the appropriate period; (2) confusion about the sampling period was so widespread that USEPA proposed a change in the rule in July 2006; (3) evidence that PWSS lacked familiarity with use of the data; and (4) inclusion of the larger set of samples interferes with the intended purpose of monitoring.

**Did the City of Durham do what was expected of them?**

(1) Mr. Swertfeger stated that the City of Durham and DDWM in particular did an exemplary job as guardians of public health. The city took quick action in response to lead problems to protect public health. They continued to act professionally, and their actions with regard to the regulations show an understanding to try to fulfill the intent of the regulations. Unfortunately, by abiding by the spirit of the rules they did not comply with the letter of the law. They did not submit all sample data to the state in the time frame required and they did not include all of the data in making their initial determination of the 90<sup>th</sup> percentile. However, there is no evidence that anyone in the city intentionally hid any data or purposefully deceived anyone with regard to lead compliance.

(2) Mr. Burlingame commented at some length about confusion in the rule, citing a report of the General Accounting Office (GAO, 2006) and the fact that PWSS had to request guidance from the USEPA in order to give directions to Durham. GAO stated "EPA and state officials attribute

the problem with lead rule data to the complicated nature of the rule, the incompatibility of EPA and state information management systems, and resource constraints”. He stated the following:

no glaring, intentional, or obvious noncompliance concerns with how Durham approached their LCR monitoring and reporting in 2006. Considering the complexity of the LCR and similar issues with it across the country, we can argue back and forth over the details of compliance with no benefit to public health.

(3) Dr. Clark’s observation is that the record shows the City of Durham was complying with the Lead and Copper Rule under the guidance provided them by the State PWSS. After the high blood lead levels were reported the City took a set of reasonable steps to deal with the problem. They reviewed the samples that were collected, started their own monitoring program, and began investigating the effect of treatment changes intended to bring down the level of lead at the targeted sample locations. He concluded that Durham did what was expected of them.

He added that he would have been more comfortable if the utility had been more “proactive”, and embarked on an expanded sampling program once they began to make changes in their treatment process. The issue of chloramines and increased lead leaching has been reported widely in the literature.

### **Durham’s Public Education Program**

(1) Mr. Swertfeger reviewed Durham’s public education program and concluded it is a good beginning and is especially noteworthy as they were implemented well before the City was aware that they would exceed the action level for lead. The level of effort provided thus far by the City on the lead issue has been more that what would be expected of a similar sized city facing the same issues. Besides the mainstream press articles about the lead situation, the city used a good variety of methods to convey the message of how lead exposure could be minimized. Of the materials that were provided, the message appeared consistent, direct, and clear.

Unfortunately, the City and in particular DDWM has lost some credibility judging by some of the press coverage over the past six months. This would be an excellent opportunity for the City to partner with local and state health agencies that may be seen as more of an authority on health related issues. The PWSS could also be of assistance in this effort by either confirming the messages put out by the City or by providing their own messages in parallel with the City’s plan.

This would especially be important in helping to re-establish the credibility of the City with the public.

Section 141.85 of the LCR has some very prescriptive actions and some exact language that must be used in the public education program for utilities that exceed the action level. Durham's language has to make some changes to meet the strict requirements of the rule, but the current program could easily be modified to fit the requirements of the rule.

(2) Mr. Burlingame noted that Durham used a variety of tools to reach the public and customers of Durham about the issue of lead in tap water. It seems clear that Durham used appropriate letters explaining lead results and potential health issues for customers receiving results of lead testing. He expressed concern about the offsetting effects of media coverage that failed to explain the role of action levels and the 90<sup>th</sup> percentile values in managing lead and copper.

Although it was not required in 2006, there was no analysis in the materials provided for review that compared Durham's public education program with what is required under the LCR. There was no analysis in the review materials of local sources of lead. That information could be used to better inform the public about the risk and actions they can take to avoid or mitigate that risk.

Mr. Burlingame concludes by noting that it would benefit the public to have the local and state health agencies explain the issue of lead and how certain or uncertain they can be about the link to drinking water. Those agencies could help explain what a water utility is required to do to reduce lead in drinking water. Under the larger umbrella of risk communication, a coordinated effort, beyond Durham's authority, seems to be lacking to the detriment of the public's trust.

(3) Dr. Clark stated that DDWM has done a very good job in conducting a public education program regarding lead concerns in the service area. The list of public education activities is extensive. The utility also used the press to convey the status of their monitoring and remediation program. The Director of DDWM even contributed an impressive newspaper editorial on the issue.

(4) In summary, Durham is given high marks for its public education program. One reviewer made the assumption that, based on the data submitted in January 2007, Durham had been notified that the 90<sup>th</sup> percentile value had been exceeded. He argued that, as a consequence, the public education program did not fully meet requirements of the LCR because it did not contain the

precise language in the rule. However, at the time this report is being written, PWSS has not made a decision on which samples will be included, and hence, the City was not required to follow the language of the rule in its notices. If PWSS does rule that additional action is required, public notices will need to conform to language in the rule. Two reviewers commented that the City, County Health, and the State share a responsibility to better inform the public as to what is required of the City.

### **Notification Procedures**

(1) Mr. Swertfeger had several constructive comments on the language used in form letters sent to customers. The language is very direct and understandable for the two “Blank Letters to Customer” letters, but he made comments about the use of terms “exceeds the EPA and State of North Carolina guidelines” and the need to simplify some of the language. Given uncertainties about what is or is not a safe level for lead, he added a caution for the City to err on the safe side and to not underplay the significance of finding low levels of lead even if those levels are below the action level. He also recommended that for any sample that has a detection of lead to include the USEPA brochure titled “Lead in Your Drinking Water” which is available free of charge from the USEPA (EPA publication 810-F-93-001).

He gave DDWM high marks for making many of the notifications via direct phone call to customers, but the record on notification is not complete. Personal contact is very important in conveying to customers the urgency of potential risks. In the spreadsheet of customer-requested samples, the date of phone call notification of the results is noted. This type of spreadsheet could yield valuable information to the utility to track its own responsiveness to the customers. Unfortunately, this file is incomplete with many of the dates not filled in for the notification date so the timeliness of notifications is uncertain. It is recommended that a separate column be added to record dates of phone calls.

(2) Mr. Burlingame pointed out that PWSS’s notice of violation for failure to report additional samples in a timely manner stated “No public notice is required for reporting violations.” However, this eventually could require a notice in the 2008 Consumer Confidence Report.

(3) Dr. Clark observed that the utility seems to have conducted a very effective notification program, including the use of the City’s website. His admonition is to make sure the utility is in contact with organizations that may not be connected to traditional media outlets, including day

care centers, schools and nursing homes that house vulnerable populations. An effective relationship with the county health department would be helpful here.

(4) In summary, one reviewer made several constructive comments about language used in the notifications procedures. He lauded Durham for using phone calls to make contact with customers where lead was found above the action level. He also noted that improvements in tracking notices were needed. One reviewer again pointed to the need for a more effective relationship with the county health department.

### **PART III. SUMMARY OF OBSERVATIONS AND FINDINGS**

Reviews of events, rules and comments by external experts lead to several observations and conclusions. They are discussed in the following paragraphs.

- Durham did not violate any drinking water standard. There is no evidence that detectable levels of lead were found in Durham's source water or in the output of its water treatment plant.
- There is ample evidence that some number of homes in Durham are experiencing elevated lead levels in their tap water. It is reasonable to conclude that the elevated levels are resulting from corrosion of customer's plumbing systems.
- No scientifically defensible survey has been published to estimate the extent of the problem. Monitoring under the Lead and Copper Rule does not necessarily satisfy criteria necessary to draw valid inferences about all homes in Durham or even the subset of them that are suspected to be at higher risk. Caution should be exercised about drawing general conclusions from existing data about the level of risk that does exist in Durham.
- The Lead and Copper Rule is a very complex set of regulations that has required numerous clarifications and several rule changes since it was promulgated in 1991, including a rule change proposed while Durham was conducting studies in 2006. It is obvious from the record that the city, the state regulatory agency, USEPA, and the press did not have a complete and unambiguous understanding of the rule.
- Regardless of complexities in how the LCR is implemented, the primary regulatory consequences of exceeding the 90<sup>th</sup> percentile for lead in tap samples for Durham are:
  - Implementation of the USEPA prescribed public education program;
  - Return to the standard monitoring program until it is again granted reduced monitoring status; and
  - Re-optimization of corrosion control treatment.
- The process of interactions among county, city, state, and federal agencies, neighborhood and health advocacy groups, and the press may have been chaotic, but it did heighten public awareness of the hazard of lead in tap water and advised users of ways to minimize potential exposure to it.
- External reviewers were generally complimentary of the City's response to revelation of elevated blood lead level in a child living in Penrith Apartments and samples showing lead above the action level in several homes.
- There appears to be a general consensus that the City tried to do too much in one year by seeking to optimize its corrosion control treatment, offer testing to all customers, move the reduced monitoring period from 2007 to 2006, and accomplish the monitoring within a short period of time. Monitoring for lead to isolate its source during June-August, the special investigational sampling to track effects of process changes, and sampling for lead and copper in September all occurred within the four-month window that USEPA has interpreted (contrary to advice given by PWSS to Durham) to be the sampling period for

- lead and copper compliance sampling. The City would have been better advised to refuse to do the compliance sampling in September.
- The City acted in good faith when it agreed to a monitoring period limited to September 2006. A letter from the state regulatory agency gave explicit approval to the September as the sampling period for calculation of the 90<sup>th</sup> percentile value. All lead and copper sampling required under the LCR in 1995, 1998, 2001, and 2004 had been conducted in September and had been accepted by the state regulatory agency. The LCR states that sampling will be done in “June, July, August or September”, not “June through September” as USEPA stated interpreted the rule.
  - If USEPA’s interpretation that the PWSS could not use September as the sampling period, then PWSS erroneously advised Durham to use the September time frame. It not only erred in 2006, it has erred for more than a decade.
  - Durham acted in good faith when it limited lead and copper sampling to sites included in the sampling plan submitted to PWSS on June 29. Except for the Penrith area sites, the 2006 sites were the same as the 2004 sites with minor additions and deletions. A PWSS audit of the sampling plan had just been completed prior to the monitoring period.
  - Consistent with what the LCR allows, PWSS approved the LCR sampling pool pursuant to its new auditing policy. There may have been some confusion or incomplete information in communications between PWSS and USEPA that failed to make that point clear. When PWSS posed questions to USEPA regarding Durham’s situation, the questions did not make specific reference to the factual situation in Durham. In particular, USEPA was not informed at that time that PWSS had approved the Durham sampling pool following an audit in June 2006. USEPA responded based on their general policy that all Tier 1, first-draw samples from June 1 to September 30, should be used in the calculation of the 90<sup>th</sup> percentile value. Forty-nine percent of the samples in the final submission of LCR samples are not from the approved pool.
  - A sufficient number of significant issues have been raised about the 2006 LCR monitoring program to put the entire process in question. Those issues include:
    - Samples taken in June and July were taken while adjustments were being made to treatment processes;
    - PWSS agreed that the City would conduct LCR sampling in September;
    - Most of the June-August samples are lead-only with no copper measurements; and
    - Durham took samples from a pool of sites that had just been audited by PWSS;
  - If it is determined that the LCR monitoring was a valid process, then the City violated a reporting deadline by failing to submit all sample data to PWSS by October 10, 2006. For that, it was issued a notice of violation.
  - There is no evidence that there was any intentional withholding of data. Quite the contrary, PWSS was aware that the special investigational data existed, and it was aware that some customer-requested sample data existed. Newspaper articles had previously reported some of the findings. Durham had an extensive public educational program to inform people that the service was available.

- Durham's public education program initiated after the Penrith case was applauded by all of the reviewers. One reviewer critiqued the program based on the assumption that the 90th percentile Action Level had been exceeded. He pointed out differences under what is required under the LCR and Durham's program in 2006. If additional action is necessary, the program will have to comply with the precise language in the LCR.
- Notification of customers as to the results of samples taken from their homes needs improvement. An enhanced tracking system, simplified language, and more conservative statements of potential risks are among the recommendations cited by reviewers.
- External reviewers were in agreement that to increase its credibility with its consumers the City should move to the standard frequency status for monitoring under the Lead and Copper Rule regardless of the outcome of a pending ruling by PWSS (an action that Durham has already taken).
- The City, PWSS, and USEPA share a responsibility to better inform the public on what is expected of the City under the Lead and Copper Rule.

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**Appendix A**  
**Timelines of Events**

**Appendix A.1**  
**Timeline for LCR Events in Durham**  
**Compiled by External Reviewers, WRI and City of Durham**

- **September 3, 1996** - Letter from George Carter of Durham to John McFadyen requesting reduced monitoring status for Durham.
- **Activities in 2004**
  - In March 2004 lead was detected in a baby's blood in Greenville, NC according to an article in the News & Observer (N&O). Durham staff worked with the City webmaster to provide information in drinking water on City's website. Staff also released information regarding successful LCR testing in September of 2004. The N&O reported this occurrence on March 28, 2006.
- **Activities in 2005**
  - Durham water staff was consulted by Greenville as they developed public notification tools and received advanced copies of brochure.
  - July, 2005, City staff were contacted by CPAL (Concerned Partners Against Lead) and the Durham Affordable Housing Coalition to discuss lead in drinking water issues.
  - A series of meetings were held with these groups, including Durham County Health Department staff and personnel from the Childhood Lead program (State). A request was made for assistance and cooperation from the Durham Department of Water Management and was part of a four city testing program.
  - September, 2005-Durham provided copies of literature and sample customer letters and chain-of-custody forms for the group to use. Staff reviewed the proposed list of sites to be sampled to ensure they were City water customers.
  - Late September and early October (2005) was the scheduled time period for sampling but due to a backlog in the state lab, the state deferred the sampling until the spring of 2006.
  - Late summer of 2005-N&O initiated an investigation into the State's regulation of drinking water.
- **Activities in 2006**
  - March 24, 2006-The North Carolina Public Water Supply Section (PWSS) mailed a letter to all public water supplies asking them to review their sampling programs to comply with the LCR. These revised plans were due to PWSS by July 14, 2006.
  - Late March, 2006-A lead poisoning case is discovered by the Durham County Health Department (DCHD) in a child who lived in an apartment in the Penrith area.
  - April 3, 2006-DCHD begins taking samples at Penrith Apartments in Durham and collected 210 samples at 183 sites from April 3-August 3, 2006. County staff relayed only the information they were allowed to release based on HIPPA regulations: an asymptomatic child tested as a part of a routine check was determined to have elevated blood lead levels (BLL) - in excess 10 micrograms per deciliter which is considered to be a critical threshold. The tap water tested at the

child's former residence had very high lead levels (837 ppb) leading county officials to attribute the cause of the elevated BLL to the tap water. County staff commented that when they arrived to test collect water samples at the apartment, it was obvious to them that the family had moved all but a very few possessions to their new residence in another county. They suggested that the water may have been standing unused in the pipes at least two weeks.

- April 20, 2006-N&O publishes an editorial stating that widespread confusion and an appalling lack of consistency in water testing across the state had been documented.
- May 3, 2006-Boris Hrebeniuk of PWSS sends e-mail to Michael Douglas of PWSS summarizing Durham's Pb and Cu sampling program from 1994-2004.
- May 4, 2006-Boris H sends e-mail to Jessica Miles relating to samples at apartment complex on Penrith Drive. This is the residence of the child diagnosed with an elevated blood Pb level.
- May 10, 2006-Boris H. sends e-mail to Jessica Miles, Chief of PWSS, giving address for sample results.
- May 16, 2006- Representatives from the County Health Department, Durham City Water Management Department, State Childhood Lead Poisoning Prevention group and the apartment complex management met to review information and develop an action plan. The apartment complex staff developed and distributed a public health notice to their residents. Additional testing was performed by the County and City at the complex and in homes surrounding the area. Many of the samples collected were above the action level. The apartment management also contracted with Va. Tech professor Marc Edwards to collect and review data. City staff provided lead education materials to County staff. County staff, working with apartment staff, promoted free blood lead testing for area children under the age of six.
- May 19, 2006-N&O reported that Durham County Health Department had identified a child with lead poisoning. The poisoning was traced to the Penrith Townhomes apartment which is served by the City of Durham's Department of Water Management (DDWM).
- May 20, 2006-City of Durham issued news release indicating that the elevated lead levels in Durham were not a utility wide problem, appeared to be isolated to the area.
- June 1, 2006-Durham water utility begins its own sampling program. City offered testing to any water customer regardless of the age of their home. Department staff worked closely with Durham One Call (DOC) to develop protocols for submittal of service requests for lead testing and also with the City's webmaster to keep information highly visible and up-to-date and develop an on-line lead test request form. Durham's files show that 704 customer samples were requested from April 28, 2006 through September 30, 2007. Among those samples 697 had first-draw lead concentrations. 86 of them had lead levels above the action limit. It should be noted that those samples included 21 samples labeled "special investigational samples". Another six were hydrant tests, and another six were master meter tests at the Penrith Apartments. There were 39 samples that had the same address as another sample in the list.

Of the 166 samples in Final Submission on January 29, 2007, 94 that are also in Customer Requested file. Those 94 samples were taken at 80 sites (11 sites had at least two samples). The action level for Pb was exceeded in 22 of the 94 samples at 17 sites. The timing of the 94 samples are: about 8 percent in June, about 32 percent in July, 43 percent in August, and 11 percent in September. There are 21 Special Investigational Samples in the 97 samples that appear in both the Final and LCR, and 10 of those exceed the action level.

- Also in June-the deferred special State study started. City staff reviewed the updated site list to ensure that sites were served by City's system; Durham County Health Department staff assisted in the distribution and collection of sample kits. Results were referenced in the 8/10/06 State Department of Public Health advisory.
- June 1, 2006-Sometime on or before this date DDMW requested an extension of time to submit its updated lead and copper sampling sites as requested by PWSS in its March 24, 2006 directive. An extension was granted until July 1, 2006.
- June 1, 2006-Boris H. sends e-mail to Renee Lawrence (Durham) granting time extension.
- June 13, 2006-Bobby Whisnant (Durham) sent an e-mail to Michael Adcock (Durham) regarding the sampling at the Penrith Apartments. According to e-mail Michael Douglas in a conversation indicated PWSS was not interested in the sampling because samples were not for compliance.
- June 13, 2006-Michael Douglas sent e-mail to Bobby Whisnant, which transmitted an e-mail from Boris H to Jessica Miles (June 9) acknowledging the results from the Penrith sampling effort.
- June 14, 2006-Boris H. sends e-mail to Laura Leonard (DENR) indicating that between 1992-2004 Durham had not exceeded either the lead or copper action level on a system wide basis.
- June 21, 2006- Final pH for both treatment plants decreased to a target range of 8.0 to 8.3 from 8.2 to 8.5 based on review of technical publications.
- June 28, 2006- Michael Douglas of PWSS met with members of the DDMW staff to discuss the DDMW program for lead and copper. He had completed an audit of the City's Lead and Copper program, approving the existing, compliance sampling pool.
- June 28, 2006-Letter from Linda Raynor of PWSS indicating the copy of the mandate Lead and Copper Sampling Site Plan is Past Due (from state web page).
- During this time, Dr. Edwards of Va. Tech shared research with City staff regarding his theory that the chloride/sulfate ratio in water chemistry was critical to minimizing the corrosivity of drinking water. Dr. Edwards had proposed this concept to staff of Greenville Utilities as well. Based on Dr. Edwards's research, Durham decided to cease using ferric chloride (July 6, 2006) as a coagulant and change back to using aluminum sulfate. The change to ferric chloride had been made - at the Brown Water Plant only - in February of 2003, in an effort to reduce DBP formation in the distribution system. To monitor the effects of the change back to alum and other anticipated process changes, the Department also began an investigational sampling of selected sites in July. Staff chose homes with a noted increase in lead levels between the 2001 and 2004 compliance samplings. Independent literature review by staff revealed other factors that were considered

for potential treatment adjustments that might beneficially impact the levels of lead leaching from customer plumbing. Accordingly, additional process changes were made during the months of July and August, which included decreasing the pH and increasing the zinc orthophosphate dosage. Results of this special study testing showed decreased lead levels in all but one of the nine homes, with levels decreasing by the time of compliance monitoring in September.

- June 29, 2006-Letter in which Mr. Douglas of PWSS and Ms. Westbrook of DDMW appear to have agreed to move compliance monitoring for LCR to 2006 (would have been in 2007). Discussion in the letter including making the month of September as period of compliance sampling (contested by PWSS) Ms. Westbrook indicated she expected to include 10 sites in the Penrith Apartment Area. The documentation letter acknowledged that the City's 90th percentile had not been exceeded for either lead or copper during the sampling periods of 1992, 1993, 1994, 1995, 1998, 2001 or 2004. The Department offered to conduct its triennial LCR compliance sampling one year early-in September 2006 rather than 2007. The City also indicated that they "expect the 2006 compliance monitoring to include approximately ten sampling sites from the Penrith area. Samples will be collected during the month of September." This letter also stated that if the 90<sup>th</sup> percentile of the September 2006 sampling was below the action level, Durham's next required sampling would be due in 2009. Mr. Douglas directed Durham to submit a revised lead and copper sampling site plan to PWSS for review. At this point there is no confirmation that PWSS has formally approved the sampling plan.
- June 29, 2006-Renee Lawrence sent e-mail to Michael Douglas and Jessica Miles informing them of release of Marc Edwards report.
- June 29, 2006-DENR PWSS received a letter from Renee Lawrence concerning the Lead and Copper Rule Sample Locations. Durham sent this in response to the letter from PWSS dated March 24, 2006. Durham included location code and sample count spreadsheet as a reference sheet for the individual data sheets. The Durham City/County Tax Record data sheets were also included showing the year the sampling sites were built for each of the Tier 1 locations.
- June 30, 2006-The City submitted 132 sites to the State-those that had historically been in the City's testing pool—with the information the State had requested in its updated Statewide protocol, and the State approved the City's 132 sites (as per letter to Jessica Miles from Ted Voorhees, City of Durham Deputy City Manager, dated January 11, 2007).
- July 6, 2006-W.G Brown Plant coagulant switched back to Aluminum Sulfate from Ferric Chloride (based on review by Marc Edwards).
- July 21, 2006-Finished water Zinc Orthophosphate residual increased to 0.60 ppm from the initial range of 0.30-0.35 ppm.
- July 21, 2006-Final pH for treatment plants decreased again to target of 7.8 based on additional studies.
- July 21, 2006-The City of Durham and the County Health Department hosted a joint news conference to address concerns related to the Penrith case. Statements were made by representatives of the NC Department of Public Health, the Durham County Health Department and the City Department of Water Management.

- July 26, 2006-Renee Lawrence (Durham) sent e-mail to Michael Douglas indicating some confusion exists over Durham lead testing conduction by City or County.
- August 1, 2006-Finished water Zinc Orthophosphate residual increased to target of 0.8-1.0 ppm.
- August 10, 2006-The Director of the State Department of Public Health issued a health alert encouraging people living in homes built prior to 1986, with copper piping and lead based solder, to flush their taps if water had been standing in excess of six hours. The alert further encouraged families with children under six, and pregnant or breastfeeding mothers living in these homes to have their tap water tested if they were concerned about the risk of exposure to lead in drinking water. The alert was for homes built in this time frame state-wide. As a part of the August 10<sup>th</sup> alert, the state released the results of the study conducted in June and July collaboratively between the DPH/Childhood Lead group and the Durham County Health Department. Overall results indicated that fewer than 8 % of samples had lead at or above the action level.
- August 14, 2006-Boris H. sent e-mail to Jessica Miles with State lab results. Starts with samples taken on July 13, 2006.
- August 21, 2006-Renee Lawrence sends out letter to residents selected for inclusion in lead and copper survey.
- Throughout the summer and fall of 2006, the level of public education efforts in regard to lead was increased, including distribution of "Get the lead out" magnets, providing information on how to reduce the risk of exposure to lead; bus signs were posted in all buses (in English and Spanish), fact sheets, an increased web presence, televised. programming, participation in multiple public events and presentations to civic and community groups. In late August and early September, letters were mailed to the existing compliance pool customers, requesting participation in the sampling. Later, additional customers from the SW Durham/Penrith area were contacted by telephone to request participation. By the end of September, a total of 69 samples had been collected from homes among the existing compliance customer pool and the newly identified "Penrith" data pool. Results of the sampling indicated that the 90<sup>th</sup> percentile was 0.009 mg/L, below the USEPA action level of 0.015 mg/L.
- September 28, 2006-Renee Lawrence sends out results from Lead and Copper survey to participants in the study.
- Several customers failed to collect samples before the September 30<sup>th</sup> cut-off date.
- October 5, 2006-Renee Lawrence sent e-mail to Jimmy Coor indicating that Durham was having trouble getting participation from Penrith and noted samples were being turned in collected first week of October.
- October 10, 2006 – Renee Lawrence sent out second batch of letters with results to compliance pool.
- October 20, 2006-Durham received notification (through N&O reporter) that USEPA had issued a new guidance memo regarding facet aerators. The City's protocol had required that customers remove faucet aerators prior to collecting lead and copper samples. This was based on long standing practices, updated and documented in an EP A guidance document issued in 2004. Upon receiving notification of the new guidance, staff immediately revised the sample collection protocol which requires that aerators be left in place while sampling for lead and

- copper. Staff surveyed other NC water providers and found that approximately 50% of those surveyed had followed the same practices as Durham. All have revised their protocols to incorporate the October 2006 USEPA guidance.
- October 23, 2006-DDWM submitted results of 69 LCR compliance samples taken from Sept 1-Sept 30, 2006 to PWSS. These samples showed Durham in compliance. There was a question about chain of custody of one sample. Department staff had sought guidance from the LCR Rule Manager regarding inclusion of early October samples from both site pools referenced above. Staff missed the 10<sup>th</sup> of the month submission data waiting for a formal response from PWSS staff. Five sites were omitted from the compliance calculation because they were collected during the first 7 days of October. Public education efforts, such as meetings with neighborhood and civic groups, and sampling for customers continue upon request. Customer requested samples significantly decreased after October, 2006.
  - October 25, 2006-Jessica Miles of PWSS asked Boris Hrebeniuk via e-mail of PWSS to agree or disagree with Durham report.
  - October 30, 2006-Boris H sent e-mail to Linda Raynor PWSS concerning Durham news release. Included e-mail from Vicki Westbrook to Jessica Miles of October 23 including a letter from Renee Lawrence to Jessica Miles indicating that the September 2006 monitoring program shows that the City's corrosion control program is effective.
  - November 14, 2006-Renee Lawrence sent e-mail to Jimmy Coor about need for clarification on Pb and Cu sampling items.
  - November 15, 2006-Renee Lawrence sends out corrected Lead and Copper Analytical sheets to Jim Coor PWSS Lead and Copper Manager.
  - December 5, 2006-In a phone conversation with DENR/PWSS staff, Department was informed that all results from *customer requested analyses* should be reported to State. Based on that information, Durham staff processed data for 800+ samples into the appropriate format and submitted reports to the state. This submittal included results from the City's state-certified laboratory and a reference laboratory that was contracted to perform some of the analyses.
  - December 7, 2006-Chris Thomas of USEPA sent an e-mail to Jessica Miles regarding a conversation with a newspaper reporter alleging that Durham did not properly disclose results to PWSS.
  - December 7, 2006-E-mail from Boris H. to Jessica Miles regarding interview with reporter. Reporter believe that Durham had taken samples that were not reported to state. Also included e-mail from Chris Thomas to Jessica Miles raising questions (based on conversation with reporter) about Durham's sampling program.
  - December 8, 2006-Customer-requested sample results were submitted (marked "special non-compliance").
  - December 15, 2006-Boris H. sends e-mail to Renee Lawrence and Vicki Westbrook to request information on ten new compliance sites.
  - December 22, 2006-Staff had learned that the reference laboratory that conducted the special studies tests had not submitted the results to the state. After conferring with the reference lab, the samples were submitted to the state (marked, "special non-compliance").

- December 27, 2006-Boris H. of PWSS in an e-mail to USEPA raised four questions about compliance sampling.
- **Activities in 2007**
  - January 3, 2007-Boris H. posed follow-up questions to USEPA about special samples taken by DCHD with assistance by the city.
  - January 4, 2007-Finished water Zinc Orthophosphate residual targeted to maintain a residual of 1.0 ppm based on results from sample collected in September 2006. Durham feels that corrosion control process has been optimized.
  - January 5, 2007- Letter from Durham addresses questions raised by PWSS about 10 additional sites in the Penrith area.
  - January 5, 2007- City management and Department staff met with State officials to discuss the state's and City's position on the lead results and related issues and review data to include in re-submittal of compliance calculations. At this meeting, the City offered to further increase public notification efforts and take other efforts such as a corrosion control study, as if the City had exceeded the action level. City Manager Patrick Baker also stated that City staff would provide a formal request to USEPA, through the State, detailing the City's understanding of the results that should be included in the 90<sup>th</sup> percentile calculation and why the City excluded the results of the special study. After this meeting, several City staff met and determined that submitting a hastily developed document would not be prudent and therefore requested that the state allow more time to develop the document and also requested that the state set up a conference call with EP A officials at either Region 4 or Headquarters or both.
  - January 8, 2007-Renee Lawrence sends e-mail to Jessica Miles explaining the City's Lead and Copper rule compliance procedures.
  - Not sure of date-City staff provided additional information to PWSS staff which was forwarded to USEPA for additional comment/guidance. State personnel indicated that USEPA was not willing to participate in a conference call with City representatives. Based on initial guidance given by PWSS staff, Durham staff began compiling data" and providing tax documentation of customer request sites.
  - January 10, 2007-Chris Thomas of USEPA sent an e-mail to Jessica Miles of PWSS responding to questions from Boris H from PWSS. Recommended that Durham include samples that were taken as part of a special investigation should be part of the compliance calculation.
  - January 10, 2007- Boris H. sent an e-mail to Vicki Westbrook and Renee Lawrence of Durham asking Durham to submit lead and copper sampling that that was completed from June 1-September 30.
  - January 10, 2007- Boris H sent an e-mail to Renee Lawrence, Vicki Westbrook and Terry Rolan of Durham providing USEPA's responses to questions raised as to which samples should be included in compliance pool.
  - January 11, 2007- Ted Voorhees sent e-mail to Jessica Miles justifying that only the September compliance data should be used in calculating compliance for the city of Durham. Included was the June 28, 2006 letter of concurrence from Michael Douglas Regional Engineer, PWSS.

- January 17, 2007- Jessica Miles sent e-mail to Ted Vorhees, Durham Assistant City Manager. PWSS would hold off on making a final determination on the 90<sup>th</sup> percentile calculation pending any protest by the City of Durham. Ms. Miles took exception to the characterization that PWSS approved a different monitoring period than was provided for in the regulation.
- January 24, 2006-City staff forwarded additional documentation to PWSS staff and requested additional guidance on results to use in the compliance determination. Staff noted that upon receipt of the final guidance, a full day would be needed to compile the complete report with full documentation.
- January 24, 2007-Boris H. sent e-mail to Jessica Miles, and other PWSS staff forwarding comments from Vicki Westbrook (Durham) on USEPA position.
- January 24, 2007-Boris H. sent e-mail to Jessica Miles and other PWSS staff forwarding additional attachment.
- January 25, 2007- Linda Raynor of PWSS issued a notice of a monitoring violation to the City of Durham citing a monitoring period from June-September 2006.
- January 29, 2007-Boris H sends e-mail to Vicki Westbrook and Renee Lawrence indicating that all of the samples collected during the “special” study should be included in the compliance calculation and citing the Grumbles memo. Vicki Westbrook indicated Durham will recalculate the 90<sup>th</sup> percentile. At 1:55 PM Durham staff received the final guidance from PWSS staff while in a meeting. Follow-up phone calls with state staff ensued and although the compiled report was not complete, State staff insisted that Durham forward a spreadsheet with the recalculated results.
- January 29, 2007- Durham submitted an electronic file containing 166 samples covering the period from June 17, 2006 through the month of September. This was done electronically at 5:15 PM with the complete package hand delivered the next day. The re-interpretation of the LCR required that that the City include all customer-requested samples that met the criteria for compliance sampling that were collected between June 1 and September 30, 2006 in Durham’s compliance report. This also included the results of those multiple samples taken as part of the special investigational study. Compliance criteria dictate that the home must be built in 1983, 1984 or 1985 and be a single family home. Historically, Durham’s compliance testing has been conducted during the month of September. The final determination, using the 69 September sites, the customer-requested results from June through September and the special study results (21 tests from 8 sites) indicated that the 90<sup>th</sup> percentile was at 0.028 mg/L, in exceedance of the action level at 0.015 mg/L. It is important to note that without the inclusion of the special study results, the September only samples (customer-request and previous compliance pool) yield a 90<sup>th</sup> percentile calculation of 0.007 mg/L, well below the action level. This result demonstrates that Durham’s proactive adjustments made during the summer of 2006 have effectively optimized the corrosion control program.
- January 30, 2007-Renee Lawrence send letter to Jessica Miles with resubmitted results form the September sampling program.
- January 31, 2007-Boris H. sent e-mail to Vicki Westbrook requesting additional information on compliance samples.

- February 2, 2007-Vicki Westbrook sends memorandum to Boris H with supporting documentation for Durham Lead and Copper re-submittal.
- February 2, 2007- Boris H sends e-mail to Vicki Lawrence regarding the compliance samples.
- February 5, 2007-Boris H. sends memorandum to Vicki Westbrook with requesting supporting documentation for Durham Lead and Copper re-submittal.
- February 9, 2007 – Renee Lawrence received phone call and fax from USEPA Region 4 staff requesting submittal of certification letter for Durham information forwarded to Region 4 by DENR PWSS. Discussion-City staff will forward complete packet to USEPA, independent of state, with certification letter.
- February 12, 2007 – Boris H. emails City staff (Renee Lawrence, Vicki Westbrook) with additional supporting documentation for January 29<sup>th</sup> submittal.
- February 16, 2007 – Renee provided status update to USEPA Region 4 staff.
- March 9, 2007 – Renee and Vicki deliver complete updated submittal to Boris H. and Linda Raynor. Discussed possibility of including both sets of results from July special study split sampling in 90<sup>th</sup> percentile calculation. Durham staff disagree that these should be included.
- March 12, 2007 – At 4:45 pm, results faxed to PWSS, with cover letter disagreeing with inclusion.

**Appendix A.2**  
**Chronology of Durham Lead Exceedance**  
**(as of February 23, 2007)**  
**Compiled by NC Public Water Supply Section**

The NC Public Water Supply Section (PWSS) first learned of a problem with lead at the Penrith Apartments on May 2, 2006 when Jessica Miles received a phone call from Dr. Ken Rudo, NC DHHS Public Health epidemiologist, regarding the circumstances of a child who lived at the complex diagnosed with blood lead poisoning. The drinking water was suspected to be the source of the lead in the apartment.

PWSS monitored the results of tap water sampling being conducted by the Durham County Health Department at the apartment complex and in the surrounding area by downloading the test results from the State Lab web site and compiling the results into a spreadsheet. The spreadsheet was then disseminated to PWSS staff at the central office and at the Raleigh Regional Office (RRO). The spreadsheet was updated periodically and disseminated again after each update.

On May 18, PWSS received a copy of the investigation performed by the Durham County Health Department determining the tap water to be the source of lead in the apartment. The report was forwarded to us by Ed Norman of the Children's Environmental Health Branch of NC DEH. The report was disseminated to PWSS staff at the central office and at the RRO.

During this same time period, PWSS sent letters to all community and NTNC water systems statewide requiring them to send in updated LCR site sampling plans with updated Tier level justifications in order to ensure that LCR sampling was being performed at the proper locations required by the LCR.

On June 16, 2006 NC DHHS issued a lead advisory regarding the drinking water in Durham.

On June 28, 2006 RRO staff met with City of Durham water system representatives to discuss the lead situation. During the meeting, the City agreed to perform LCR compliance sampling in 2006, one year earlier than required, in order to demonstrate their contention that the lead problem appeared to be isolated to a specific area in their distribution system instead of a system-wide problem. The City planned on performing its compliance sampling during the month of September.

On June 30, 2006 PWSS received a copy of the investigation performed by Dr. Marc Edwards of Virginia Tech at the Penrith Apartments site. Dr. Edwards was hired by the owners of the apartments to perform the investigation. The report was disseminated to central office and RRO staff.

On July 6, 2006, according to the treatment plant superintendent, the City of Durham changed coagulant chemicals at the Brown plant. The use of ferric chloride was discontinued and the use of alum as a coagulant was reinstated. (The treatment plant superintendent has informed PWSS that ferric chloride was used as a coagulant at the Brown Plant from January, 2003 until July 6, 2006. Alum has been in use as a coagulant at the Williams plant throughout this period.)

On August 10, 2006 NC DHHS issued the findings of its study of tap water sampling for lead in Durham. Included with the findings were recommendations on reducing lead exposure from drinking water.

Prior to the opening of school, the Durham school system conducted lead testing at a number of its school buildings. Water fountains were taken out of service at eight schools.

On October 23, 2006 the City of Durham issued a news release stating that the results of LCR compliance sampling of 69 locations during September 2006 showed the water system to be in compliance with the LCR action levels.

On October 27, 2006 USEPA released guidance regarding non-removal of faucet aerators during LCR tap sampling.

On December 7, 2006 PWSS received an email from USEPA regarding questions of additional LCR sampling that the City of Durham performed during the 2006 LCR reduced monitoring period that had not been reported to PWSS. From the end of November until early December 2006, PWSS had several telephone conversations with City of Durham representatives during which PWSS informed them that the results of non-compliance samples must also be reported to the State. The City agreed to forward the results of the additional sampling to PWSS. The results of the additional sampling were delivered to PWSS on December 8, 2006.

On December 22, 2006 PWSS coordinated with the Certification Office of the State Laboratory in sending a memo to all certified laboratories reminding them of the requirement to report the results of all LCR sampling completed, including non-compliance sampling.

On December 27, 2006 PWSS sent an email to EPA Region 4 requesting clarification of certain points raised in interpretation of the November 23, 2004 memorandum from Mr. Grumbles regarding LCR sampling and compliance.

On January 3, 2007 PWSS sent an email to EPA Region 4 with additional questions on points raised in the memo from Mr. Grumbles.

On January 4, 2007 PWSS staff met with representatives of the City of Durham to discuss the LCR sampling results and LCR reporting requirements.

On January 8, 2007 DEH and PWSS staff participated in a conference call with EPA regarding the questions raised in PWSS emails of December 27, 2006 and January 3, 2007.

On January 10, 2007 EPA Region 4 responded to PWSS questions regarding LCR sampling and reporting requirements raised in the memo from Mr. Grumbles. The response was forwarded to City of Durham staff on the same day. Additionally, PWSS sent an email to City of Durham requesting answers to questions regarding the conduct of additional LCR sampling the City conducted. A telephone conversation was also held with City of Durham staff informing them that

they could also choose to review other locations sampled to see which met Tier 1 criteria and could also be included in their 90<sup>th</sup> percentile compliance calculations.

On January 11, 2007 PWSS received an email from the City of Durham requesting information on procedures to be used to appeal the interpretation of LCR sampling and reporting requirements received from EPA Region 4.

On January 17, 2007 PWSS responded by email to the City of Durham's questions regarding an appeal. PWSS agreed to hold off on calculating 90<sup>th</sup> percentile compliance while the system appeals to EPA as long as the City of Durham completes the actions required by the LCR for a system that has experienced an exceedance of the lead action level. The date of this email is being used as the action level exceedance date from which any follow-up LCR compliance requirements will be determined.

On January 24, 2007 PWSS received a request from the Water Resources Research Institute (WRI) at NC State University for copies of all the sampling data submitted by the City of Durham regarding the 2006 LCR sampling. WRI was hired by the City of Durham to perform an independent review of the City's lead and copper sampling during 2006.

On January 24, 2007 PWSS received a response from the City of Durham to the email questions sent on January 10, 2007 regarding the procedures used in conducting the LCR sampling in 2006. In the response, Durham informed PWSS that some compliance samples were "split" after collection by the homeowner so that two labs could independently analyze the samples for verification purposes and didn't believe the split samples should be used in the compliance calculation. The City also informed PWSS that other locations sampled during 2006 were being examined for Tier 1 qualification and that those results and site justifications would be forwarded to PWSS.

On January 25, 2007 PWSS issued Durham a Notice of Violation for failure to report the results of the additional sampling in the timeframe required by the LCR.

On January 26, 2007 PWSS staff participated in a conference call with EPA Region 4 staff and the Superintendent of Durham Public Schools. The guidance contained in EPA's 3Ts Toolkit was explained to him, as well as, suggestions on future sampling procedures. The Durham situation was also discussed after the superintendent left the conversation. Region 4 staff asked PWSS to provide them with copies of all the LCR sampling data that Durham had submitted to PWSS.

On January 29, 2007 PWSS staff responded by email to the City of Durham informing them that although some LCR samples were "split", the samples were split by the water system after the sample was properly collected by the homeowner and that the results of the "split" samples needed to be included in the compliance calculations.

On January 29, 2007 the City of Durham sent PWSS an email with the results of LCR sampling from 2006 showing a total of 163 Tier 1 locations having been sampled for lead.

On January 30, 2007 the City of Durham held a press briefing to recant earlier statements regarding their lead sampling results and indicating that the recalculated results showed an exceedance of the lead action level.

On January 31, 2007 PWSS staff sent an email to the City of Durham requesting clarification of Tier level justifications that Durham used in its compliance calculations.

On February 1, 2007 WRRRI requested copies of the data that the City of Durham submitted to PWSS on January 29.

On February 12, 2007 PWSS sent an email to the City of Durham outlining discrepancies found in a comparison of the spreadsheet and the paper copies of the sampling results that were submitted by the City. PWSS told the City that the discrepancies must be resolved prior to performing the 90<sup>th</sup> percentile compliance calculation.

On February 14, 2007 PWSS participated in a conference call with EPA Region 4 staff to discuss the status of the Durham situation. PWSS staff reiterated that PWSS had previously informed the City of Durham by email that the City was required to perform the actions required by the LCR for a lead exceedance. PWSS also informed Region 4 staff that the compliance determination was awaiting the receipt of data from the City.

On February 15, 2007 PWSS staff sent an email to EPA Region 4 containing additional sampling location data that was requested in the previous day's conference call.

Since February 12, 2007 PWSS staff has made several phone calls to the City of Durham to obtain the "verified" sampling information. To date, the "verified" data has not been received from the City. The most recent phone call took place on February 22, 2007.

### **PWSS Thoughts:**

The City of Durham has been fully cooperative in providing information requested by PWSS staff. However, since a lot of bad press has been published recently, obtaining the requested information seems to be taking longer.

A literal interpretation of the memo from Mr. Grumbles may not be the best approach to take in this case. The City was making changes to treatment and following up on the effects of the treatment changes by repeatedly sampling for lead at locations with historically high results. A literal interpretation of the memo from Mr. Grumbles seems to penalize the system for being proactive by taking measures to correct a situation that could jeopardize public health. The literal interpretation may also cause systems to forego additional sampling from locations beyond the minimum required by the LCR.

**Appendix B**  
**External Reviewer Comments**

**Appendix B.1**  
**External Review by Mr. Gary A. Burlingame**

**External Review for the City of Durham: Lead and Copper Rule, 2006**

Contract held by Water Resources Research Institute of the University of North Carolina

**This external review provided on February 21, 2007 by:**

**Gary A. Burlingame**

Philadelphia, PA

GBurlingame@verizon.net

BS, MS in Environmental Science

Administrative Scientist for the Philadelphia Water Department

28 years of experience in drinking water quality and research

Member: American Water Works Association, International Water Association, Water Environment Federation, American Water Works Association Research Foundation

*Disclaimer: The opinions stated herein are those solely of Gary A. Burlingame, the author, and do not represent the opinions of the Philadelphia Water Department, the City of Philadelphia, or the State of Pennsylvania.*

**Abbreviations used:**

**EPA:** US Environmental Protection Agency

**LCR :** US EPA Lead and Copper Rule

**State:** North Carolina Department of Environment and Natural Resources, and its Public Water Supply Section.

**Health:** Durham County Environmental Health and DC Division of Public Health

**Durham:** City of Durham and its Department of Water Management

**AL:** LCR's lead action level of 0.015 mg/L

**90<sup>th</sup>%:** The 90<sup>th</sup> percentile statistic used in the LCR for determining compliance and upon which the AL is based.

**OCCT:** Optimized corrosion control treatment (as required by the LCR under its Treatment Technique Requirements).

**WQP:** Water quality parameters as required for determining OCCT.

**General Comments:**

Over the years I have spoken to various federal, state, health and water utility staff (outside North Carolina) as well as news media and customers, about lead in water, and I have found the LCR to be a complicated and troublesome rule. Note that the LCR is currently under revision by the EPA and the water industry has commented on possible revisions the EPA is considering. The EPA had sent out clarifications about certain elements of the LCR to help states better apply those elements in uniform ways. Thus, when the news media and other groups, unaccustomed to the technical details of drinking water regulations, challenge a water utility's compliance or a state's

enforcement, more confusion erupts. And the unfortunate consequence is that the public (the utility's customers) is left wondering about the safety of their tap water without the availability of balanced information with which to make informed decisions. In conclusion, we need to be honest about the LCR- its complicated design, varied application, and need for revision.

My overarching observation in Durham's case is how unfortunate it is that Durham- in its costly, and time-consuming conscientious response to real and perceived lead issues- moved its reduced LCR monitoring period from 2007 to 2006, and pulled its LCR compliance into the confusion of a problematic regulation and a volatile public health issue, which the media exacerbated. Durham rescheduled its reduced LCR monitoring from 2007 to 2006, and the State agreed that this was to confirm OCCT, at the same time that Health was conducting sampling and Durham was offering customer-requested sampling, and Durham was changing its OCCT (pH, phosphate). Durham was trying to achieve, in one year, too many objectives and the attempt seemed to backfire on them.

A broader concern I have with the implications of how the State and EPA handle Durham's case is that, in its wake, water utilities may be given disincentives toward conducting customer-requested testing, toward conducting follow-up sampling, and toward conducting investigations. I believe the State and EPA do not intend for this to happen, yet they need to carefully consider the possible implications.

In the time I had to review the records associated with Durham's LCR compliance, using the information provided to me within its limitations, I have arrived at the following observations below according to the questions I was asked to address.

### **Issues that were Requested to be Addressed:**

#### **1. What do you determine should be the period for compliance sampling from this record and your knowledge of the Lead and Copper Rule?**

In general, the LCR lays out the reduced LCR monitoring period as June-September. Durham's historical LCR data (according to State records) show that it conducted LCR monitoring in September during 1993, 1995, 1998 and 2001 while in 1994 the monitoring extended from July through September and in 2004 from August through September. I cannot find an adequate argument for stating that *only* samples collected during September should be counted towards the 90<sup>th</sup>% calculation for the 2006 monitoring period. However, this relates to samples that qualify as meeting the LCR monitoring criteria for Durham and the intent of the LCR.

The fact that Durham was only able to obtain 69 samples from its pool of 142 sites (original 132 planned sample sites plus 10 more the State asked to add from the region of concern), in comparison to past years when 95 or more samples were obtained, suggests that the move to conduct sampling in 2006 was not a successful move. The 90<sup>th</sup>% is a variable statistic that is affected by too few samples because the distribution of lead sampling data is highly skewed.

Starting in June, 2006, Durham began making changes in response to Dr. Edward's report. Between June and August, pH was decreased, the Brown plant reverted back to aluminum sulfate, and the corrosion inhibitor (zinc orthophosphate) was increased quite significantly. Durham's treatment or OCCT was in a process of change in June, July and August (during most of the reduced monitoring sampling period). However, it's unclear as to what the State requires of systems that change treatment. I could only assume that the State follows the EPA practice, to notify the State within 60 days after making any changes. LCR sampling should be conducted *after* changes in treatment that could affect OCCT, and these changes by Durham were designed to improve OCCT. Again, choosing to move up the reduced monitoring to 2006 was not the best decision. The question seems to be, within 2006, which months should be included in the reporting of lead sampling data under LCR compliance? Even though the State approved the moving of reduced LCR sampling from 2007 to 2006 for the purposes of verifying OCCT, Durham was changing its OCCT (pH and phosphate) into August. Durham's 21 samples from its special study suggest that OCCT was indeed improved as was expected. Thus, sampling results to confirm OCCT should not include data from samples in June, July and August.

**2. Which samples should have been included in the determination of the 90<sup>th</sup> percentile value for determining whether the City of Durham would continue to operate under the reduced sampling protocol or be required to operate under the more frequent protocol?**

I make the assumption that all sampling and analyses were performed in a way that met certification requirements and that all sites submitted for LCR compliance met sample site requirements of the LCR.

In 2005, in Greenville, North Carolina, children were found to have elevated blood lead levels. This followed on the heels of national media attention about lead in the tap water in Washington, D.C. This prompted the State to have concern over lead exposure, and to develop a plan for testing various cities in North Carolina. The news media seemed to expect such testing to begin in the Fall of 2005. Lead in water sampling, however, was delayed until 2006. In March, 2006, a child with an elevated blood lead level was found in Durham and Health suggested that the tap water was the source. The water of the then-vacant apartment was tested and was found to be elevated in lead (above the AL although the AL should not be used in this way) as well as in some other homes in the area. In June, the planned sampling of water by Health was finally initiated.

Durham offered, in response, to test tap water as requested by their customers, which started in June and continued into October for 1328 samples. After 800 tests were done it was found that less than 8% were greater than the AL. If this is accurate, there were no early signs of problems in OCCT. Durham put out a considerable effort, over a short period of time, to address public health concerns- going far beyond the LCR's requirements.

We must keep in mind that a responsible water utility will act on the information that is made available, such as information, however scanty, that lead in some homes' tap waters could be elevated. Action requires investigation using water quality analyses and lead testing. A water utility should satisfy the concerns of its customers, and supply information and even sample the

water in their homes if warranted. Finally, research is sometimes conducted to provide better information with which to make changes or improvements- research that includes lead and copper sampling. In these cases, the sampling is not designed to meet the LCR requirements. Unfortunately, the delineation between sampling for lead under the LCR's Treatment Technique Requirement and sampling for lead to investigate public health concerns has become blurred, resulting in disagreements over the responsible management of the data. EPA's memo (November 2004, Memorandum, US EPA, from Benjamin H. Grumbles, Acting Assistant Administrator to Regional Administrators: Lead and Copper Rule – Clarification of Requirements for Collecting Samples and Calculating Compliance) seems to strongly encourage that when utilities collect customer-requested samples during the period of reduced sampling (the same year of sampling, from June through September, at comparable sites as used in the utilities plans such as Tier 1 sites) then such samples match all criteria of the LCR compliance samples and should be included in the LCR data reporting. EPA has attempted to reduce the confusion. North Carolina's application of the above states (Rules Governing Public Water Systems, North Carolina Administrative Code, Title 15A, Department of Environment and Natural Resources, Subchapter 18C, Water Supplies, Sections .0100 through .2100, Updated September 2004, § 141.86 Monitoring requirements for lead and copper in tap water, (e) *Additional monitoring by systems*): "The results of any monitoring conducted in addition to the minimum requirements of this section shall be considered by the system and the State in making any determinations (i.e., calculating the 90<sup>th</sup> percentile lead or copper level) under this subpart."

There are various regulatory statements that lay out the thinking behind the selection of sample results to include in a 90<sup>th</sup>% compliance report. It is easy to find statements that direct a utility to have a pre-designed sampling plan that must be State-approved: "Another uncertainty is whether systems that are on reduced monitoring- and have been allowed to reduce the number of samples they collect- are taking samples from locations that represent the highest risk sites based on previous testing. According to the lead rule, these water systems must take their samples from sites included in the pool of high risk sampling sites identified initially" (p 26; GAO Report to Congressional Requesters: EPA Should Strengthen Ongoing Efforts to Ensure that Consumers are Protected from Lead Contamination, January 2006). North Carolina stated the following (Rules Governing Public Water Systems, North Carolina Administrative Code, Title 15A, Department of Environment and Natural Resources, Subchapter 18C, Water Supplies, Sections .0100 through .2100, Updated September 2004, § 141.86 Monitoring requirements for lead and copper in tap water, ( a ) ( 1 )): "All sites from which first draw samples are collected shall be selected from this pool of targeted sampling sites." All of this agrees with the EPA's recent clarifications (1- What samples are used to calculate the 90<sup>th</sup> percentile? November 2004, Memorandum, US EPA, from Benjamin H. Grumbles, Acting Assistant Administrator to Regional Administrators: Lead and Copper Rule – Clarification of Requirements for Collecting Samples and Calculating Compliance): "EPA regulations require water systems to develop a targeted sampling pool, focused on those sites with the greatest risk of lead leaching. All compliance samples used to determine the 90<sup>th</sup> percentile must come from that sampling pool. All sample results from a system's sampling pool during the monitoring period must be included in the 90<sup>th</sup> percentile calculations, even if this includes more samples than the required minimum number needed for compliance." And again, from the EPA, comes the statement (2- What should utilities do with sample results from customer-requested sampling programs? November 2004, Memorandum, US EPA, from Benjamin H. Grumbles, Acting Assistant Administrator to Regional Administrators:

Lead and Copper Rule – Clarification of Requirements for Collecting Samples and Calculating Compliance): “Maintaining a consistent set of compliance sample sites provides the system with a baseline against which to measure the 90<sup>th</sup> percentile over time.” This final statement, it seems, is in agreement with Durham’s intent for LCR compliance monitoring over the years.

In addition, there is guidance on what utilities should do with lead sampling results that are not part of planned LCR compliance. These are still to be reported to the states, but separately. Consider the EPA’s statement (2- What should utilities do with sample results from customer-requested sampling programs? November 2004, Memorandum, US EPA, from Benjamin H. Grumbles, Acting Assistant Administrator to Regional Administrators: Lead and Copper Rule – Clarification of Requirements for Collecting Samples and Calculating Compliance): “However, even though these customer-requested samples are not used for the 90<sup>th</sup> percentile calculation, the sample results must still be provided to the state. If a significant number of customer-requested samples are above the lead action level, the state should re-evaluate the corrosion control used by the system and the composition of the compliance sampling pool.” This was reinforced in the same document (3- What should states do with samples taken outside of the sampling compliance period? November 2004, Memorandum, US EPA, from Benjamin H. Grumbles, Acting Assistant Administrator to Regional Administrators: Lead and Copper Rule – Clarification of Requirements for Collecting Samples and Calculating Compliance): “Although samples collected outside the sampling compliance period should not be used in the compliance calculation, they must still be provided to the states, as is the case with customer-requested samples.” EPA’s memorandum (November 2004, Memorandum, US EPA, from Benjamin H. Grumbles, Acting Assistant Administrator to Regional Administrators: Lead and Copper Rule – Clarification of Requirements for Collecting Samples and Calculating Compliance) has even been interpreted by EPA staff to read, “Customer samples are not included in 90<sup>th</sup> percentile calculation, but reported to State.” (Lead and Copper Rule Update presentation at the AWWA Annual Conference, June 11, 2006, by Jeffery Kempic, OGWDW, EPA).

I understand the EPA’s desire to include all relevant lead and copper data in LCR reporting when it meets all appropriate criteria to do so. However, Durham’s case of additional lead data that were collected during the June through September period of 2006, and that meet the LCR criteria (such as being from Tier 1 homes) is complicated by other issues and objectives.

A March 24, 2006 letter from the State (Lead and Copper Rule Changes/Clarifications), asked for an updated sampling plan from utilities by June 1, 2006. My understanding is that Durham submitted the LCR monitoring plan (required by the State under its primacy responsibility) including 132 sites on June 30, 2006. The State was aware that this was later than requested and had given an extension. I am not aware that the State responded with written notice that the plan was officially approved and maybe Durham should have pursued the State more actively. Since the State had apparently approved Durham’s plan to move up its reduced monitoring from 2007 to 2006, it knew that monitoring was to begin as early as June. In addition, the State asked Durham to add 10 more sites to its list of 132 sites to represent the area including the townhouses of elevated lead. This suggests that the State accepted Durham’s plans as long as 10 more sites were added.

Durham’s resubmission of LCR data in January, 2007, contains additional lead data that are questionable for use in compliance calculation of the 90<sup>th</sup>%, although not questionable for

reporting separately to the State. The State's requirements use statements such as, "Each first-draw tap sample for lead and copper..." which suggest that the intent for sampling and analysis is to conduct lead *and* copper on the same samples, on every sample that falls within the LCR. In fact, the State requires a waiver for utilities to not analyze for copper (a utility cannot choose to exclude copper from testing), and lead and copper results must be invalidated *by the State* (lead and copper results must be submitted for each sample). This seems to follow EPA requirements. The resubmission data that Durham sent to the EPA in January, 2007, included 166 lead results but only 97 copper results- 69 samples that were analyzed for lead did not have copper data although all copper-analyzed samples had lead data. These samples should likely not have been included: the LCR is a lead *and* copper rule, requiring lead and copper analyses on all samples properly collected unless invalidated or given a waiver by the State. Thus, lead but no copper, or the reverse, copper but no lead results fall outside of the LCR compliance data set. In addition, the 21 samples of the special study by Durham to determine if its changes in treatment were affecting lead levels at the taps of 8 homes, show an unusual distribution compared to all other lead data distributions (Table 1), did not have copper analyses conducted, and were taken during the changes being made to OCCT rather than before or after such changes. All of this supports the opinion that these 21 samples, while being reported to the State for evaluation of the system's lead corrosion status, should not be used in the determination of the 90<sup>th</sup> % compliance statistic.

In conclusion, it seems reasonable that the 69 samples originally submitted should be used for 2006 compliance. Samples from June- August should not be used as these were collected during changes in OCCT. Samples that did not have both lead and copper analyzed in the same sample should not be included, as that is a basic requirement of LCR compliance samples unless the State waives reporting or invalidates the data.

Additional monitoring results for lead and copper that were collected but not included in the LCR compliance data were to be reported to the State by October 10, 2006 along with the LCR compliance data. The media's allegation that lead data can be hidden from the public, the State and the EPA, is not supported if Durham follows the requirements to report all data as appropriate whether through the LCR or separately.

### **3. Did the City of Durham do what was expected of them? Did they comply with the Lead and Copper Rule and guidance provided?**

In March, 2005, EPA announced a Drinking Water Lead Reduction Plan to improve and clarify such areas of the rule as: monitoring requirements; treatment requirements; and customer awareness requirements. The GAO made this statement: "EPA and state officials attribute the problem with lead rule data to the complicated nature of the rule, the incompatibility of EPA and state information management systems, and resource constraints" (p 23; GAO Report to Congressional Requesters: EPA Should Strengthen Ongoing Efforts to Ensure that Consumers are Protected from Lead Contamination, January 2006). A survey, prior to 2004, of states showed the variability in application of LCR details from state to state, but also that there are states that are not up-to-date on the LCR (Post-Optimization Lead and Copper Control Monitoring Strategies. 2004. G.J. Kirmeyer, B.M. Murphy, A. Sandvig, G. Korshin, B. Shaha, M. Fabbicino and G.

Burlingame. AwwaRF, Denver, CO.). The fact that the State of NC had to request guidance from the EPA in order to give directions to Durham further confirms the confusion and variability in application of the LCR. The LCR has been a difficult rule.

On April 20, 2006, *The News & Observer* reported that in NC there was “widespread confusion” and a “lack of consistency”. Apparently, in confirmation of this, the State responded by adding 20 new positions and the State required utilities under its responsibility to resubmit LCR monitoring plans for review and renewed approval. The GAO noticed problems: “Through June 2005, however, EPA’s database did not contain any milestone information on more than 70 percent of the nation’s community water systems....EPA has been slow to take action on these data problems” (p 5; GAO Report to Congressional Requesters: EPA Should Strengthen Ongoing Efforts to Ensure that Consumers are Protected from Lead Contamination, January 2006). In Appendix II, Detailed Analysis of Corrective Action Milestone Data Reported to EPA by State, through June 2005, North Carolina was found to have 100 percent of systems *without* milestones for large, medium and small systems although 16.4 percent of systems had monitoring and reporting violations, and 6.6 percent had treatment technique violations. Again, the LCR has been a difficult rule.

Even in the calculation of the AL compliance statistic, the 90<sup>th</sup>%, there has been confusion (Rules Governing Public Water Systems, North Carolina Administrative Code, Title 15A, Department of Environment and Natural Resources, Subchapter 18C, Water Supplies, Sections .0100 through .2100, Updated September 2004, §141.80 General Requirements, (c) (3)): “The 90<sup>th</sup> percentile lead and copper levels shall be computed as follows: (ii) The number of samples taken during the monitoring period shall be multiplied by 0.9.” A March 24, 2006 State letter to utilities (Lead and Copper Rule Changes/Clarifications) explains how the EPA calculates the 90<sup>th</sup> % and this was different than the State – the EPA uses interpolation. This shows the confusion and variability in the application of details in the LCR.

I found no glaring, intentional, or obvious noncompliance concerns with how Durham approached their LCR monitoring and reporting in 2006. Considering the complexity of the LCR and similar issues with it across the country, we can argue back and forth over the details of compliance with no benefit to public health.

- 4. Did the City of Durham act within the rules in making changes to its water treatment processes, and did the City have a reasonable basis for making those changes? Please comment on the process changes associated with the special studies sampling. You are not being asked to comment on the effectiveness of those changes.**

The LCR uses a Treatment Technique Requirement for enforcement and for reducing the public’s exposure to lead in tap water: “In the case of lead, EPA established a treatment technique-including corrosion control treatment- because the agency believed that the variability of lead levels measured at the tap, even after treatment, makes it technologically infeasible to establish an enforceable standard.” (p 7; GAO Report to Congressional Requesters: EPA Should Strengthen Ongoing Efforts to Ensure that Consumers are Protected from Lead Contamination, January 2006).

OCCT, its determination by the 90<sup>th</sup>% statistic, and its maintenance by WQP monitoring is a clear basis for lead corrosion control provided by the LCR.

Durham switched from free chlorine to chloramine for its distribution system residual in 2002. The Brown plant changed coagulant treatment from aluminum sulfate to ferric chloride in 2003. Apparently these changes were made to better control disinfection by-products and improve future compliance with other federal regulations. The EPA and the water industry have recognized the problem of simultaneous compliance and unintended consequences- the problem that arises when changes made to comply with a new regulation affect compliance with an existing regulation: “According to EPA, state, and industry officials, one of the biggest challenges in implementing the lead rule is achieving “simultaneous compliance” with other rules, including, in particular, rules related to total coliform bacteria, surface water treatment, and disinfection by-products” (p 31; GAO Report to Congressional Requesters: EPA Should Strengthen Ongoing Efforts to Ensure that Consumers are Protected from Lead Contamination, January 2006). Other water utilities have faced this problem with controlling lead corrosion: “Some of the participants in EPA’s May 2004 workshop on simultaneous compliance cited a need for additional regulations or guidance to help ensure that the effectiveness of corrosion control is maintained when water systems make changes to other treatment processes” (p 32; GAO Report to Congressional Requesters: EPA Should Strengthen Ongoing Efforts to Ensure that Consumers are Protected from Lead Contamination, January 2006).

The management firm responsible for the homes with elevated lead levels brought in expert Dr. Marc Edwards. Apparently, upon reviewing water treatment records for Durham, he had concerns that the switch to ferric chloride (for DBP control and for compliance with regulations on disinfection by-products) had altered the water’s characteristics for that treatment plant’s water for lead corrosion, and his report was made available in late June, 2006 (though I have not reviewed this report). Durham is in the process, as are many other utilities, of trying to address such problems with multiple regulatory compliance. However, it is not a certain consequence that lead corrosion increases when a water utility switches to chloramine or to ferric chloride: utilities can make such switches and stay within compliance with the LCR. Today’s understanding of lead chemistry and corrosion control require that careful case-by-case assessments be conducted because many factors are at play (see AwwaRF’s February 2007 report, Distribution System Corrosion and the Lead and Copper Rule: An Overview of AwwaRF Research). Starting in June, 2006, Durham began making changes in response to Dr. Edward’s report. Between June and August, pH was decreased, the Brown plant reverted back to aluminum sulfate, and the corrosion inhibitor (zinc orthophosphate) was increased quite significantly. The pH and orthophosphate changes are common strategies used by water utilities to better control lead corrosion, and are part of OCCT for Durham.

The application of OCCT determinations and of monitoring following treatment changes varies from state to state, with some relying on WQP monitoring while others require LCR monitoring every 6 months (Post-Optimization Lead and Copper Control Monitoring Strategies. 2004. G.J. Kirmeyer, B.M. Murphy, A. Sandvig, G. Korshin, B. Shaha, M. Fabbicino and G. Burlingame. AwwaRF, Denver, CO.). The EPA requires utilities to notify the states in writing no later than 60 days after a treatment change is made (and this is one issue being looked at for the LCR revisions),

and utilities are encouraged to notify their states in advance in order to determine the need for follow up monitoring. The June 29, 2006 letter from the State to Durham stated the reason for moving up the reduced monitoring from 2007 to 2006 “as a mean to validate its corrosion control program.” Corrosion control treatment changes (changes in pH and phosphate) were not completed until sometime in August, 2006.

##### **5. Did the City of Durham conduct the proper monitoring of the distribution system during the time frame in question?**

In June, 1995, phosphorous-based corrosion inhibitor use was approved by the State for Durham with limits of 0.1-1.0 mg/L. Changes in orthophosphate, thus, cause changes in OCCT. Durham appears to have stayed within these limits with its changes in 2006. In February, 2002, it appears that the State set WQP limits for calcium (1-25 mg/L), pH (7.0-8.6) and alkalinity (10-50 mg/L). Changes by Durham for pH seem to have stayed within these limitations, and changes in pH could translate to a change in OCCT. However, there appear to be significant variations in such parameters as pH and phosphate. Maybe this could be better studied and understood throughout the distribution system? See AwwaRF’s February 2007 report, Distribution System Corrosion and the Lead and Copper Rule: An Overview of AwwaRF Research, for more information on how such changes can affect lead occurrence.

Durham apparently obtained State approval for achieving optimized corrosion control treatment by letter on August 2, 1993, after two 6-month rounds of lead and copper monitoring. In 1996, after LCR monitoring, Durham requested the ability to go to reduced, triennial monitoring for lead and copper (and was approved by the State).

Apparently, in December, 1985 the State ban on leaded solder took effect. EPA’s Tier 1 homes use a start date of January 1983. Thus, Tier 1 homes were selected as homes with new copper plumbing during the years of 1983, 1984 and 1985. However, the GAO recognizes that today, 2007, these requirements are outdated: “Specifically, enough time has elapsed so that lead solder in plumbing installed from 1983 to 1986 is no longer “fresh” (lead solder was banned in 1986). Experts believe that, by now, solder from that period has been coated by a naturally occurring film that prevents lead leaching. Moving the sampling sites to other Tier 1 locations- for example, homes served by lead service lines- could be problematic” (p 24; GAO Report to Congressional Requesters: EPA Should Strengthen Ongoing Efforts to Ensure that Consumers are Protected from Lead Contamination, January 2006). This is compounded by the fact that conditions change over time for those sites originally used by a utility: “A related problem is that sampling locations have likely changed over time as sites are no longer available or appropriate, and states may not have procedures in place to ensure that these locations continue to represent the highest risk sites” (p 25; GAO Report to Congressional Requesters: EPA Should Strengthen Ongoing Efforts to Ensure that Consumers are Protected from Lead Contamination, January 2006). From the information I was provided I can only surmise that there was agreement between Durham and the State that no known remaining lead service lines exist that need to be included in the LCR sampling plan.

Durham (without approval or requirement by the State) apparently decided to use lead sampling at 8 of the 132 designated compliance sites (3 times at each site for 21 samples total) to demonstrate whether the changes in treatment actually resulted in reduction of lead. They apparently found that lead decreased in all but one site; that OCCT was indeed improved. In addition, they showed that WQPs did not drop out of the permitted range. Finally, they scheduled the LCR sampling that was moved from 2007 to 2006 (with the State's understanding to confirm OCCT) for September, after all OCCT adjustments were made and these results seemed to verify that OCCT was in place. This was reasonable.

**6. Please comment on the City of Durham's public education program. Particular attention should be given to the range of methods used to educate the public, and to the extent possible, to the level of effort given to these methods.**

In 2006, it seems clear that Durham used a variety of tools to reach the public and customers of Durham about the issue of lead in tap water. Their consumer confidence report and web site contained information. Water bills contained a notice in June and August. Apparently 20,000 refrigerator magnets were made and distributed in various ways- with customer requests, through the Health authorities, and so forth. Neighborhood or civic meetings were attended, newsletters from the City contained lead information, and even signs were posted on public transportation. Finally, it seems clear that Durham used appropriate letters explaining lead results and potential health issues for customers receiving results of lead testing.

All of this activity on the part of Durham to reach its customers and the public seems to have been offset by numerous news articles and reports around the region. This seems to have occurred since 2005 when children with elevated blood lead levels were found in Greenville and the State vowed to conduct tap water testing in its cities to make sure this was not happening elsewhere. The news reports continue in 2007. A problem with news reports is that: (1) the reporters typically have little if any understanding of drinking water and its regulations; (2) the reporters do not understand the 90<sup>th</sup> % statistic and its application in the LCR; (3) the reporters expect that the LCR is the only vehicle for making public all lead in tap water measurements made by a lab or water utility.

I did not see Durham's use of all the details contained in the State's public education requirements for lead, although this was not required in 2006. I did not see any analysis of what should be included and what is appropriate according to Durham's understanding of the local sources of lead. It is unclear as to the source of the lead. I understand that lead service lines are not an issue. While leaded solder was brought under regulation, there still may exist some concern that leaded solder is still being used to some extent beyond the time of the ban. I could not find any materials evaluations associated with the plumbing of homes with elevated lead, especially where children had elevated blood lead levels, to better determine how to inform the public about the risk and actions they can take to avoid or mitigate that risk.

Another aspect I could not find in the information provided to me was the public education provided by the State and County health agencies. It would benefit the public to have the Health agencies explain the issue of lead and how certain or uncertain they can be about the link to

drinking water. The State and EPA can help place this in context of the LCR and what a water utility is required to do for lead reduction. Under the larger umbrella of risk communication, a coordinated effort, beyond Durham's authority, seems to be lacking to the detriment of the public's trust.

#### **7. Please comment on the City of Durham's notification procedures.**

On January 25, 2007, the State issued a Notice of Violation to Durham based on the failure to report additional samples in its January 30, 2007 resubmission of LCR data (166 samples submitted for lead). The State's notice stated that "No public notice is required for reporting violations." However, this eventually could require a CCR notice for the 2008 Consumer Confidence Report.

The record shows that Durham did not help its case by consistently being late in submitting information to the State. Reporting problems are still important for regulatory compliance and need to be better addressed. It is Durham's responsibility to pursue effective and timely communication with its regulators.

#### **Additional Notes: Table 1 Data summary and interesting points.**

Table 1 shows a different way of assessing and comparing lead data that were collected in a consistent way (first-draw, 1-liter samples). The 90<sup>th</sup>% statistic provides limited information and trends can be missed. I made an attempt to compile all data as accurately as possible from the records in my possession. Table 1 shows that that the original LCR 2006 compliance data and Durham's 820 customer-requested samples agree quite well with the occurrence of lead throughout the City. In comparison, samples from the Penrith townhomes and the 21 special study samples, though small in number, represent a different occurrence distribution and possibly a different source of elevated lead. Rather than include these samples in LCR compliance and confuse OCCT data, since it appears that a general problem may not be involved here, it would be more useful to investigate these homes further to find the sources of the lead. It is good to know that lead levels above 100 ppb are not the issue- that lead in the range of 30-100 ppb is where the problems are appearing. The resubmission data are thus influenced by the additional samples. Note that if the 21 special samples are withdrawn from the resubmission data, the data compares well with the original LCR data submission and the 90<sup>th</sup>% falls below the AL. Table 1 shows the problem with mixing in data from different populations of sampling sets collected for different reasons.

**Table 1. Frequency Distribution of Lead Sample Results from Various Sampling Programs at Durham during 2006**

Lead Distribution (ppb)	Percent of Total Samples Collected with Results in Specified Range							
	Original 2006 LCR Submission	Durham's customer requested samples	Durham's Samples from Penrith Homes that were Tier 1	21 Special Samples by Durham to check on Treatment Changes	DCHD Lead-only sampling	2007 Resubmission of 2006 LCR	2007 Resubmission of 2006 LCR <i>without 69 Samples lacking Copper Data</i>	2007 Resubmission of 2006 LCR <i>without 21 Special Study Samples</i>
Total Samples	69	820	59	21	210	166	97	145
90 <sup>th</sup> %	0.009	NA	NA	NA	NA	0.028	0.022	0.007
< 3 – 5	<b>85</b>	<b>88</b>	66	33	<b>76</b>	<b>73</b>	<b>72</b>	<b>79</b>
> 5 – 15	10	7	8	14	7	11	13	11
> 15 – 30	<b>2</b>	<b>3</b>	14	19	<b>6</b>	<b>8</b>	<b>9</b>	<b>6</b>
> 30 – 100	<b>2</b>	<b>1</b>	8	29	<b>9</b>	<b>6</b>	<b>4</b>	<b>3</b>
> 100	1	1	4	5	2	2	2	1

See: How to mine your lead and copper data. 2005. Burlingame, G.A. and Sandvig, A. *Opflow* 30:6:16-19.

## **Appendix B.2**

### **External Review by Dr. Robert M. Clark**

#### **Comments on the “2007 City of Durham-Lead and Copper Rule Review”**

I first became aware of the problems caused by the leaching of lead solder into domestic water supplies from a report we received at EPA in 1982. After a child was diagnosed with lead poisoning in Smithtown, New York, his father, a local dentist, requested that the home water supply be tested. At first water was discounted as the source of the lead because the water district had a 15-year record of lead free samples in their distribution system. However, first draw samples showed lead in excess of the Safe Drinking Act Water Standard, which at that time was 50 µg/L. After three minutes the drinking water concentration dropped to a value well below the standard. Lead solder was suspected as the source. Every home in the 8-year old subdivision was tested, and two homes with recent plumbing additions using lead solder showed first draw levels in the neighborhood of 7,100 µg/L. That information was the trigger for our Division to initiate an intensive research program in this area.

I was Director of EPA’s Drinking Water Research Division from 1985 until 1999, and during that time we expended a considerable amount of our resources on identifying the sources of, and developing controls for, leaching of lead into drinking water. During the period leading up to the passage of the Lead and Copper rule, lead related research was a major focus for our program. Therefore, I was truly interested in reading of the events in Durham. Although I found it a little disappointing to learn that these types of problems still exist, I was pleased at the attention given to the issue once the lead poisoning case was discovered. Ultimately, I think the various agencies involved have “done the right thing”, although I thought the initial reactions were excessively bureaucratic and defensive.

While I was with EPA I was involved in investigating a number of water borne disease outbreaks. For example, I was involved in a *Salmonella* outbreak investigation in a small Midwestern town in which nearly half the population (486 out of 1104 residents) became ill, and seven people in a nursing home died. I have always been struck with the personal tragedies that result from these types of preventable disasters. Therefore, I had hoped to see more compassion on the part of the various agencies involved in the investigation. It is disappointing that in all of the correspondence I reviewed, the goal of public health protection was barely mentioned. Most of the correspondence (E-mails, letter, etc) focused on rules, regulations and technical interpretations of the LCR and the Safe Drinking Water Act.

Despite what struck me as an overemphasis on bureaucracy and finger pointing, I am encouraged that the various city, county, state and federal agencies eventually responded in a manner that seems to have addressed the problem. I am also intrigued with the involvement of the press and various environmental and public interest groups in this issue. Even though it was a little messy, I think their involvement helped the government entities find resolution. Although the reactions and interactions among and between the agencies and organizations involved in this situation seems a little chaotic, I believe the ultimate goal of public health protection has been achieved. It is my understanding, based on a communication with Dave Moreau, Director of WRRI, that the child involved in this incident is recovering.

I have addressed each of the questions listed in the WRRRI synopsis as follows:

**1. What do you determine should be the period for compliance sampling from this record and your knowledge of the Lead and Copper Rule?**

It is my opinion that the Durham Department of Water Management (DDWM) acted properly in attempting to meet the requirements of the LCR. As I understand them. Technically, as I will discuss in my response to the other questions, it seems to me that the DDWM has the right to request reduced monitoring status. However, even though technically the DWMD may be able to claim reduced monitoring status, I believe the utility would be wise to work on repairing any negative damage that may have been done to its credibility. One way to do that would be to voluntarily conduct an annual compliance monitoring program using the expanded monitoring pool. It seems to me that the utility should also establish a closer liaison with the Durham County Health Department and any other county health departments in its service area. The ultimate goal should be to ensure that the public health of its customers is protected. As mentioned previously, I have had experience in conducting water borne outbreak investigations, and it has been my experience that county and state health agencies are an invaluable source of information.

**2. Which samples should have been included in the determination of the 90<sup>th</sup> percentile value for determining whether the City of Durham would continue under the reduced sampling protocol or be required to operate the more frequent protocol.**

In my opinion the City of Durham received mixed messages regarding their sampling program. When Durham began their expanded monitoring program in the Penrith Apartment area they were operating under the assumption that they were engaging in a treatment optimization study. The study was designed to evaluate treatment changes that had been made to minimize the formation of disinfection by-products, while simultaneously controlling corrosion in consumers' plumbing. Therefore, I believe the samples (collected June –August, 2006) should not be included as part of the utilities' compliance monitoring program. This opinion is supported by various E-mails and correspondence between Michael Douglas, Regional Engineer for the PWSS, to various members of the DDWM (for example, the letter from Michael Douglas to Terry Rolan on June 29, 2006).

Subsequently, the EPA Regional Office (Chris Thomas) identified a memo from Benjamin Grumbles of EPA providing guidance as to which samples should be included in compliance calculations. Using this memo the State PWSS issued a determination that the "optimization" samples should be included in the compliance calculations, as well ultimately resulting in Durham being in violation of the LCR.

My interpretation of the "Grumbles" memo is that it deals only with "compliance" calculations, and does not address the issue of "optimization" studies. Therefore, it is my opinion that the "optimization" samples should not have been included in the compliance calculations. However, as a matter of prudence it is my advice to the Durham Water

Management Department that they operate on the more frequent sampling protocol, using the expanded sampling pool.

**3. Did the City of Durham do what was expected of them? Did they comply with the Lead and Copper Rule and guidance provided?**

I believe that the record shows that the City of Durham was complying with the Lead and Copper Rule under the guidance provided them by the State PWSS. After the high blood lead levels were reported the City took a set of reasonable steps to deal with the problem. They reviewed the samples that were collected, started their own monitoring program, and began investigating the effect of treatment changes intended to bring down the level of lead at the targeted sample locations. In short, I believe they did what was expected of them.

However, I would have been more comfortable if the utility had been more “proactive”, and embarked on an expanded sampling program once they began to make changes in their treatment process without having to be prodded by the State. The issue of chloramines and increased lead leaching has been reported widely in the literature.

**4. Did the City of Durham act within the rules in making changes to its water treatment processes, and did the City have a reasonable basis for making those changes? Please comment on the process changes associated with the special studies sampling. You are not being asked to comment on the effectiveness of those changes.**

The reasons given for making the process changes were in anticipation of more stringent EPA regulations on disinfection by-products. In my opinion, the utility did have a reasonable basis for making these changes. However, given the well publicized problems that have been associated with similar changes in the Washington DC system, the problems in Durham might have been anticipated (of course hindsight is always perfect). EPA recently issued (July 18, 2006) “40 CFR Part 141, National Primary Drinking Water Regulations for Lead and Copper: Short-term Regulatory Revisions and Clarifications; Proposed Rule” which explores some of the issues related to the LCR and changes in treatment similar to those made by DDWM. This document might provide some useful insights to the utility staff.

**5. Did the City of Durham conduct the proper monitoring of the distribution system during the time frame in question?**

In my opinion, the City of Durham did conduct a proper LCR monitoring program based on guidance provided under the Rule. When they realized that they might have a problem they, in cooperation with other agencies, and with input from the PWSS, stepped-up their program to target specific areas of concern. They used a rational approach in selecting monitoring locations, and based on the record, freely shared this information with other state and local agencies and the press,

I believe the utility might have been more aggressive in anticipating the changes that took place in lead leaching from household plumbing as a result of the changes in treatment that

were instituted. Another improvement in their monitoring program would be to coordinate with county and state health agencies. Although it is difficult to tell from the correspondence record, I sensed that there is only minimal information exchange between the utility and the Durham County Health Department. I believe that relationship could and should be improved. Perhaps periodic meetings between the two agencies would be helpful in order to establish a better relationship.

I also suggest that the utility consider developing at least a “skelationized” model of the service area. Such a model could be very useful in assessing the impact of differing water qualities from the two water treatment plants on water quality at various points in the distribution system. Even a minimal model would provide information on “blending” zones in the distribution system.

**6. Please comment on the City of Durham’s public education program. Particular attention should be given to the range of methods used to educate the public, and, to the extent possible, to the level of effort given to these methods.**

In my opinion, the DDWM has done a very good job in conducting a public education program regarding lead concerns in the service area. The list of public education activities provided in the WRRI notebook is extensive. The utility also used the press to convey the status of their monitoring and remediation program. Terry Rolan even contributed a newspaper editorial on the issue, which I think is impressive. I would give the utility high marks for their efforts in this area.

**7. Please comment on the City of Durham’s notification procedures.**

The utility seems to have conducted a very effective notification program, including the use of the City’s website. My only concern in this area is to make sure the utility is in contact with organizations that may not be connected to traditional media outlets. For example, day care centers, schools and nursing homes are facilities that house vulnerable populations. I believe an effective relationship with the county health department would be helpful here.

**Summary and Conclusions**

It is my understanding that the LCR has four major functions: (1) requires water suppliers to optimize their treatment systems to control corrosion in customers’ plumbing; (2) to determine tap water levels of lead and copper for customers who have lead service lines and lead-based solder in consumers’ plumbing systems; (3) to rule out source water as a source of significant lead levels; and (4) if action levels are exceeded, require suppliers to educate their customers about lead and suggest actions they can take to reduce their exposure to lead using public notices and public education programs.

Based on my review of the record provided to me by WRRI, I believe the DDWM **did** comply with the rules and regulations promulgated under the LCR and with the guidance provided by the PWSS. In my opinion, the data collected from June through August should be categorized as

collected for optimization purposes, and should not be included in the compliance calculations. I believe the Grumbles memo referred to compliance, not optimization.

The DDWM has a reputation for being extremely well run and progressive, and I believe the election of Terry Rolan as President of the American Water Works Association is a reflection of the high regard in which he is held by his fellow water supply professionals. However, I am disappointed that the utility did not take a more proactive stance in attempting to assess the changes in lead leaching that might be expected as a result of the changes it made in water treatment. I strongly suspect that the reputation of DDWM has been damaged because of the circumstances surrounding this event. In order to restore public trust I suggest that the utility consider returning to a yearly monitoring program. I also suggest that the utility consider developing a water quality model for its distribution system. Such a model should provide useful insight into the location of mixing and blending zones for water from the two plants, and should be useful in locating monitoring sites. I believe that the utility should consider establishing a pool of random monitoring sites that could be selected in such a way as to identify unanticipated water quality problems in the distribution system.

I suggest that the utility consider working more closely with state and county health agencies. Perhaps this could take the form of periodic meetings between state and county health officials, and DDWM staff.

I hope my comments have been useful, and please feel free to contact me if you have any questions.

## APPENDIX A

### **Time Line For LCR Events In Durham**

- **Activities in 2004**
  - In March 2004 lead was detected in a baby's blood in Greenville, NC according to an article in the News & Observer (N&O). Durham staff worked with the City webmaster to provide drinking water information on the City's website. Staff also released information regarding successful LCR testing in September of 2004. The N&O reported this occurrence on March 28, 2006.
- **Activities in 2005**
  - Durham water staff was consulted by Greenville as they developed public notification tools and received advanced copies of brochure.
  - July, 2005, City staff were contacted by CPAL (Concerned Partners Against Lead) and the Durham Affordable Housing Coalition to discuss lead in drinking water issues.
  - A series of meetings were held with these groups, including Durham County Health Department staff and personnel from the Childhood Lead program (State). A request was made for assistance and cooperation from the Durham Department of Water Management and was part of a four city testing program.
  - September, 2005-Durham provided copies of literature and sample customer letters and chain-of-custody forms for the group to use. Staff reviewed the proposed list of sites to be sampled to ensure they were City water customers.
  - Late September and early October (2005) was the scheduled time period for sampling but due to a back-log in the state lab, the state deferred the sampling until the spring of 2006.
  - Late summer of 2005-N&O initiated an investigation into the State's regulation of drinking water.
- **Activities in 2006**
  - March 24, 2006-The North Carolina Public Water Supply Section (PWSS) mailed a letter to all public water supplies asking them to review their sampling programs to comply with the LCR. These revised plans were due to PWSS by July 14, 2006.
  - Late March, 2006-A lead poisoning case was discovered by the Durham County Health Department (DCHD) in a child who lived in an apartment in the Penrith area.
  - April 3, 2006-DCHD began taking samples at the Penrith Apartments in Durham and collected 210 samples at 183 sites from April 3-August 3, 2006. County staff relayed only the information they were allowed to release based on HIPPA regulations: an asymptomatic child tested as a part of a routine check was determined to have elevated blood lead levels (BLL) - in excess 10 deciliters per milligram which is considered to be a critical threshold. The tap water tested at the child's former residence had very high lead levels (837 ppb) leading county officials to attribute the cause of the elevated BLL to the tap water. County staff commented that when they arrived to test collect water samples at the apartment, it was obvious to them that the family had moved all but a very few possessions to their new residence in another county. They suggested that the water may have been standing unused in the pipes at least two weeks.

- April 20, 2006- N&O published an editorial stating that widespread confusion and an appalling lack of consistency in water testing across the state was had been documented.
- May 3, 2006-Boris Hrebeniuk of PWSS sent an E-mail to Michael Douglas of PWSS summarizing Durham's Pb and Cu sampling program from 1994-2004.
- May 4, 2006-Boris H sent an E-mail to Jessica Miles related to samples at an apartment complex on Penrith Drive. This was the residence of the child diagnosed with an elevated blood Pb level.
- May 10, 2006-Boris H. sent an E-mail to Jessica Miles, Chief of PWSS, giving the address for sample results.
- May 16, 2006- Representatives from the County Health Department, Durham City Water Management Department, State Childhood Lead Prevention group and the apartment complex management met to review information and develop an action plan. The apartment complex staff developed and distributed a public health notice to their residents. Additional testing was performed by the County and City at the complex and in homes surrounding the area. Many of the samples collected were above the action level. The apartment management also contracted with Va. Tech professor Marc Edwards to collect and review data. City staff provided lead education materials to County staff. County staff, working with apartment staff, promoted free blood lead testing for area children under the age of six.
- May 19, 2006-N&O reported that Durham County Health Department had identified a child with lead poisoning. The poisoning was traced to the Penrith Townhomes apartment served by the City of Durham's Department of Water Management (DDWM).
- May 20, 2006- Vicki Westbrook of DDWM issued a statement indicating that the elevated lead levels in Durham were not a utility wide problem.
- June 1, 2006- Durham water utility began its own sampling program. The City offered testing to any water customer regardless of the age of their home plumbing. Department staff worked closely with Durham One Call (DOC) to develop protocols for submittal of service requests for lead testing and also with the City's webmaster to keep information highly visible and up-to-date and develop an on-line lead test request form. Durham's file showed that 704 customer samples were requested from April 28, 2006 through September 30, 2007. Among those samples 697 had first-draw lead concentrations. Eighty six of them had lead levels above the action limit. It should be noted that those samples included 21 samples labeled "special investigational samples". Another six were hydrant tests, and another six were master meter tests at the Penrith Apartments. There were 39 samples that had the same address as another sample in the list. Of the 166 samples included in the Final Submission on January 29, 2007, 94 are also in Customer Requested file. Those 94 samples were taken at 80 sites (11 sites had at least two samples). The action level for Pb was exceeded in 22 of the 94 samples at 17 sites. The timing of the 94 samples was: approximately 8 percent in June, approximately 32 percent in July, 43 percent in August, and 11 percent in September. There were 21 Special Investigational Samples in the 97 samples that appeared in both the Final and CR submissions and 10 of those exceeded the action level.

- Also in June-The deferred special State study started. City staff reviewed the updated site list; Durham County Health Department staff assisted in the distribution and collection of sample kits. Results were referenced in the 8/10/06 State Department of Public Health advisory.
- June 1, 2006-Sometime before this date, DDMW requested an extension of time to submit its updated lead and copper sampling sites as requested by PWSS in its March 24, 2006 directive. An extension was granted until July 1, 2006.
- June 1, 2006-Boris H. sent an E-mail to Renee Lawrence (Durham) granting time extension.
- June 13, 2006-Bobby Whisnant (Durham) sent an E-mail to Michael Adcock (Durham) regarding the sampling effort at the Penrith Apartments. According to E-mails Michael Douglas indicated PWSS was not interested in the sampling because samples were not for compliance.
- June 13, 2006-Michael Douglas sent an E-mail to Bobby Whisnant which transmitted an E-mail from Boris H to Jessica Miles (June 9) acknowledging the results from the Penrith sampling effort.
- June 14, 2006-Boris H. sent an E-mail to Laura Leonard (DENR) indicating that between 1992-2004 Durham had not exceeded either the lead or copper action level on a system wide basis.
- June 21, 2006- Final pH for both treatment plants decreased to a target range of 8.0 to 8.3 from 8.2 to 8.5 based on recommendations from Marc Edwards.
- June 28, 2006- Michael Douglas of PWSS met with members of the DDMW staff to discuss the DDMW program for lead and copper. He had completed an audit of the City's Lead and Copper program, approving the existing, compliance sampling pool. The documentation letter acknowledged that the City's 90 percentile had not been exceeded for either lead or copper during the sampling periods of 1992, 1993, 1994, 1995, 1998, 2001 or 2004. The Department offered to conduct its triennial LCR compliance sampling one year early-in September 2006 rather than 2007. The City also indicated that "we expect the 2006 compliance monitoring to include approximately ten sampling sites from the Penrith area. Samples will be collected during the month of September." The follow-up letter also stated that if the 90<sup>th</sup> percentile of the September 2006 sampling was below the action level, Durham's next required sampling would be due in 2009
- June 28, 2006-Letter from Linda Raynor of PWSS that indicated the Durham Lead and Copper Sampling Site Plan is Past Due.
- During this time, Dr. Edwards of Va. Tech shared research with City staff regarding his theory that the chloride/sulfate ratio in water chemistry was critical to minimizing the corrosivity of drinking water. Dr. Edwards had proposed this concept to staff of Greenville Utilities as well. Based on Dr. Edwards's research, Durham decided to cease using ferric chloride (July 6, 2006) as a coagulant and change back to using aluminum sulfate. The change to ferric chloride had been made - at the Brown Water Plant only - in February of 2003, in an effort to reduce DBP formation in the distribution system. To monitor the effects of the change back to alum and other anticipated process changes, the Department also began an investigational sampling of selected sites in July. Staff chose homes with a noted increase in lead levels between the 2001 and 2004 compliance samplings.

Independent literature review by staff revealed other factors that were considered for potential treatment adjustments that might beneficially impact the levels of lead leaching from customer plumbing. Accordingly, additional process changes were made during the months of July and August which included decreasing the pH and increasing the zinc orthophosphate dosage. Results of this special study testing showed decreased lead levels in all but one of the nine homes, with levels decreasing by the time of compliance monitoring in September.

- June 29, 2006-Letter in which Mr Douglas of PWSS and Ms Westbrook of DDMW appear to have agreed to move compliance monitoring for LCR to 2006 (would have been in 2007). Discussion in the letter including making the month of September as period of compliance sampling (contested by PWSS) Ms. Westbrook indicated she expected to include 10 sites in the Penrith Apartment Area.
- June 29, 2007-Letter from Mr. Douglas directing Durham to submit a revised lead and copper sampling site plan to PWSS for review. At this point there is no confirmation that PWSS has formally approved the sampling plan.
- June 29, 2006-Renee Lawrence sent E-mail to Michael Douglas and Jessica Miles informing them of release of Marc Edwards report.
- July 6, 2006-W.G Brown Plant coagulant switched back to Aluminum Sulfate from Ferric Chloride (based on review by Marc Edwards).
- July 21, 2006-Finished water Zinc Orthophosphate residual increased to 0.60 ppm from the initial range of 0.30-0.35 ppm.
- July 21, 2006- Final pH for treatment plants decreased again to target of 7.8 based on additional studies.
- July 21, 2006- The City of Durham and the County Health Department hosted a joint news conference to address concerns related to the Penrith case. Statements were made by representatives of the NC Department of Public Health, the Durham County Health Department and the City Department of Water Management.
- July 26, 2006-Renee Lawrence (Durham) sent E-mail to Michael Douglas indicating some confusion exists over Durham lead tests.
- August 1, 2006-Finished water Zinc Orthophosphate residual was increased to a target of 0.8-1.0 ppm.
- August 10, 2006-The Director of the State Department of Public Health issued a health alert encouraging people living in homes built prior to 1986, with copper piping and lead based solder, to flush their taps if water had been standing in excess of six hours. The alert further encouraged families with children under six, and pregnant or breastfeeding mothers living in these homes to have their tap water tested if they were concerned about the risk of exposure to lead in drinking water. The alert was for homes built in this time frame state-wide. As a part of the August 10<sup>th</sup> alert, the state released the results of the study conducted in June and July collaboratively between the DPH/Childhood Lead group and the Durham County Health Department. Overall results indicated that fewer than 8 % of samples had lead at or above the action level.
- August 14, 2006-Boris H. sent E-mail to Jessica Miles with State lab results. Starts with samples taken on July 13, 2006.
- August 21, 2006-Renee Lawrence sent out letter to residents selected for inclusion in the lead and copper survey.

- Throughout the summer and fall of 2006, the level of public education efforts in regard to lead was increased, including distribution of "Get the lead out" magnets, information was provided on how to reduce the risk of exposure to lead; bus signs were posted in all buses (in English and Spanish), fact sheets, an increased web presence, televised. programming, participation in multiple public events and presentations to civic and community groups. In late August and early September, letters were mailed to the existing compliance pool customers, requesting participation in the sampling. Later, additional customers from the SW Durham/Penrith area were contacted by telephone to request participation. By the end of September, a total of 69 samples had been collected from homes among the existing compliance customer pool and the newly identified "Penrith" data pool. Results of the sampling indicated that the 90<sup>th</sup> percentile was 0.009 mg/L, below the EPA action level of 0.015 mg/L.
- September 3, 2006- Letter from George Carter of Durham to John McFadyen requested reduced monitoring status for Durham.
- September 28, 2006-Renee Lawrence sent out results from Lead and Copper survey to participants in the study.
- Several customers failed to collect samples before the September 30<sup>th</sup> cut-off date.
- October 5, 2006-Renee Lawrence sent E-mail to Jimmy Coor indicating that Durham was having trouble getting enough Tier 1 homes.
- October 20, 2006-Durham received notification that EPA had issued a new guidance memo regarding faucet aerators. The City's protocol had required that customers remove their faucet aerators prior to collecting lead and copper samples. This was based on long standing practices, updated and documented in an EPA guidance document issued in 2004. Upon receiving notification of the new guidance, staff immediately revised the sample collection protocol which required that aerators be left in place while sampling for lead and copper. Staff surveyed other NC water providers and found that approximately 50% of those surveyed had followed the same practices as Durham. All have revised their protocols to incorporate the October 2006 EPA guidance.
- October 23-DDWM submitted results of 69 LCR compliance samples taken from Sept 1-Sept 30, 2006 to PWSS. These samples showed Durham in compliance. There was a question about chain of custody of one sample. Department staff had sought guidance from the LCR Rule Manager regarding inclusion of early October samples from both site pools referenced above. Staff missed the 10<sup>th</sup> of the month submission data waiting for a formal response from PWSS staff. Five sites were omitted from the compliance calculation because they were collected during the first 7 days of October. Public education efforts, such as meetings with neighborhood and civic groups, and sampling for customers continued upon request. Customer requested samples significantly decreased after October, 2006.
- October 25, 2006- Jessica Miles of PWSS asked Boris Hrebenuk via E-mail of PWSS to agree or disagree with Durham report.
- October 30, 2006- Boris H sent E-mail to Linda Raynor PWSS concerning Durham news release. Included E-mail from Vicki Westbrook to Jessica Miles of October 23 including a letter from Renee Lawrence to Jessica Miles indicating that the September 2006 monitoring program showed that the City's corrosion control program was effective.

- November 14, 2006-Renee Lawrence sent E-mail to Jimmy Coor about need for clarification on Pb and Cu sampling items.
- November 15, 2006-Renee Lawrence sent out corrected Lead and Copper Analytical sheets to Jim Coor PWSS Lead and Copper Rule Manager.
- December 5, 2006- In a phone conversation with DENR/PWSS staff, Department was informed that all results from *customer requested analyses* should be reported to State. Based on that information, staff processed data for 800+ samples into the appropriate format and submitted reports to the state. This submittal included results from the City's state-certified laboratory and a reference laboratory that was contracted to perform some of the analyses.
- December 7, 2006-Chris Thomas of EPA sent an E-mail to Jessica Miles regarding a conversation with a newspaper reporter alleging that Durham did not properly disclose results to PWSS.
- December 7, 2006- Boris H. sent an E-mail to Jessica Miles regarding interview with reporter. The reporter believed that Durham had taken samples that were not reported to the state. Also included E-mail from Chris Thomas to Jessica Miles raising questions (based on conversation with reporter) about Durham's sampling program.
- December 8, 2006-Customer-requested sample results were submitted (marked "special non-compliance").
- December 15, 2006-Boris H. sent an E-mail to Renee Lawrence and Vicki Westbrook to request information on ten new compliance sites.
- December 22, 2006- Staff had learned that the reference laboratory that conducted the special studies tests had not submitted the results to the state. After conferring with the reference lab, the samples were submitted to the state (marked, "special non-compliance").
- December 27, 2006- Boris H of PWSS in an E-mail to EPA raised four questions about compliance sampling.
- **Activities in 2007**
  - January 3, 2007- Boris H. posed follow-up questions to USEPA about special samples taken by DCHD with assistance by the city.
  - January 4, 2007-Finished water Zinc Orthophosphate residual targeted to maintain a residual of 1.0 ppm based on results from sample collected in September 2006. Durham felt that the corrosion control process had been optimized.
  - January 5, 2007- Letter from Durham addressed questions raised by PWSS about 10 additional sites in the Penrith area.
  - January 5, 2007- City management and Department staff met with State officials to discuss the state's and city's position on the lead results and related issues and to review data that would be included in a re-submittal of compliance calculations. At this meeting, the City offered to further increase public notification efforts and take other efforts such as a corrosion control study, as if the City had exceeded the action level. City Manager Patrick Baker also stated that City staff would provide a formal request to EPA, through the State, detailing the City's understanding of the results that should be included in the 90<sup>th</sup> percentile calculation and why the City excluded the results of the special study. After this meeting, several City staff met and determined that submitting a hastily developed document would not be prudent and therefore requested that the state allow more time to develop the document and

also requested that the state set up a conference call with EPA officials at either Region 4 or Headquarters or both.

- January 8, 2007-Renee Lawrence sent an E-mail to Jessica Miles explaining how samples were taken in the Lead and Copper rule compliance study.
- Not sure of date-City staff provided additional information to PWSS staff which was forwarded to EPA for additional comment and guidance. State personnel indicated that EPA was not willing to participate in a conference call with City representatives. Based on initial guidance given by PWSS staff, Durham staff began compiling data" and providing tax documentation of customer request sites.
- January 10, 2007-Chris Thomas of EPA sent a E-mail to Jessica Miles of PWSS responding to questions from Boris H from PWSS. Recommended that Durham include samples that were taken as part of a special investigation should be part of the compliance calculation.
- January 10, 2007- Boris H. sent an E-mail to Vicki Westbrook and Renee Lawrence of Durham asking Durham to submit lead and copper sampling data that that was completed from June 1-September 30.
- January 10, 2007- Boris H sent an E-mail to Renee Lawrence, Vicki Westbrook and Terry Rolan of Durham provided responses to EPA's questions raised as to which samples should be included in compliance pool.
- January 11, 2007- Ted Voorhees sent E-mail to Jessica Miles justifying that only the September compliance data should be used in calculating compliance for the city of Durham. Included what seemed to a letter supporting this position from Michael Douglas Regional Engineer, PWSS.
- January 17, 2007- Jessica Miles sent E-mail to Ted Vorhees, Durham Assistant City Manager. PWSS would hold off on making a final determination on the 90<sup>th</sup> percentile calculation pending any protest by the City of Durham. Ms. Miles took exception to the characterization that PWSS approved a different monitoring period than was provided for in the regulation.
- January 24, 2006-City staff forwarded additional documentation to PWSS staff and requested additional guidance on results to use in the compliance determination. Staff noted that upon receipt of the final guidance, a full day would be needed to compile the complete report with full documentation.
- January 24, 2007-Boris H. sent E-mail to Jessica Miles, and other PWSS staff forwarding comments from Vicki Westbrook (Durham) on EPA position.
- January 24, 2007-Boris H. sent E-mail to Jessica Miles and other PWSS staff forwarding additional attachment.
- January 25, 2007- Linda Raynor of PWSS issued a notice of a monitoring violation to the City of Durham citing a monitoring period from June-September 2006.
- January 29, 2007- Durham submitted an electronic file containing 166 samples covering the period from June 17, 2006 through the month of September.
- January 29, 2007-Boris H sent E-mail to Vicki Westbrook and Renee Lawrence indicating that all of the samples collected during the "special" study should be included in the compliance calculation and citing the Grumbles memo. Vicki Westbrook indicating Durham will recalculate the 90<sup>th</sup> percentile.
- January 29, 2007-At 1:55 PM Durham staff received the final guidance from PWSS staff while in a meeting. Follow-up phone calls with state staff ensued and

although the compiled report was not complete, State staff insisted that Durham forward a spreadsheet with the recalculated results. This was done electronically at 5:15 PM with the complete package hand delivered the next day. The re-interpretation of the LCR required that the City include all customer-requested samples that met the criteria for compliance sampling that were collected between June 1 and September 30, 2006 in Durham's compliance report. This also included the results of those multiple samples taken as part of the special investigational study. Compliance criteria dictate that the home must be built in 1983, 1984 or 1985 and be a single family home. Historically, Durham's compliance testing had been conducted during the month of September. The final determination, using the 69 September sites, the customer-requested results from June through September and the special study results (21 tests from 8 sites) indicated that the 90<sup>th</sup> percentile was at 0.028 mg/L, in exceedance of the action level at 0.015 mg/L. It is important to note that without the inclusion of the special study results, the September only samples (customer-request and previous compliance pool) yield a 90<sup>th</sup> percentile calculation of 0.007 mg/L, well below the action level. This result seemed to demonstrate that Durham's proactive adjustments made during the summer of 2006 effectively optimized the corrosion control program.

- January 30, 2007-Renee Lawrence sent letter to Jessica Miles with resubmitted results from the September sampling program.
- January 31, 2007-Boris H. sent E-mail to Vicki Westbrook requesting additional information on compliance samples.
- February 2, 2007-Vicki Westbrook sent memorandum to Boris H with supporting documentation for Durham Lead and Copper re-submittal.
- February 2, 2007- Boris H sent E-mail to Vicki Lawrence regarding the compliance samples.
- February 5, 2007-Boris H. sent memorandum to Vicki Westbrook with supporting documentation for Durham Lead and Copper re-submittal.

**Appendix B.3**  
**External Review by Mr. Jeffrey W. Swertfeger**

Comments on 2006 Durham, N.C. Lead Compliance

By

Jeff Swertfeger

*Disclaimer: The opinions and conclusions expressed in this document are based upon the documentation provided by Dr. David Moreau, federal regulations and guidance, and my experience dealing with federal regulations including the Lead and Copper Rule. They are mine alone and have not been reviewed nor endorsed by the City of Cincinnati or the Greater Cincinnati Water Works where I am currently employed.*

**Introduction**

Of all of the drinking water regulations that have been promulgated by the USEPA, the Lead and Copper Rule is one of the most confusing. Unlike other rules, there is no contaminant level which is monitored in a defined location. Rather the rule is a series of actions that a utility must undertake and requires participation by the general public to assist in these actions. Compliance with this rule is judged not by the safety of the water, but on whether these actions are completed as prescribed within certain timeframes. As a result, there has been much confusion in the rules implementation on the part of utilities, states, the EPA regions, and the federal level of the EPA. Adding to the confusion, since the original rule was published, there have also been several “updates” to the rule published in the Federal Register, several clarifying memos put out by EPA’s Office of Water, and many modifications and interpretations that have been made by each of the primacy agencies.

Nevertheless, utilities are expected to follow the requirements of the rule and to work with their primacy agency (usually the state) to assure the rule is being interpreted and implemented correctly. It is this interpretation and implementation that is in question in the Durham case.

This document is part of an independent review solicited by the city of Durham, NC over actions regarding compliance with the Lead and Copper Rule during 2006. As part of this review, several industry professionals were given information on the situation and given their knowledge of the Lead and Copper Rule asked to provide comments. Specifically, these reviewers were asked to address a list of 7 issues in relation with Durham’s Lead and Copper Rule (hereafter referred to as “the Rule”) compliance in 2006. Below is a list of the issues and the results of my review of the record from the perspective of an industry professional not associated with the City of Durham.

**Issues**

*Issue 1: What do you determine should be the period of compliance sampling from this record and your knowledge of the Lead and Copper Rule?*

The purpose of the monitoring program under the Rule is to ensure that long-term optimal corrosion control is being maintained by the system after it is established. To accomplish this goal, monitoring should be performed when the system has established its optimal corrosion control. In the case in Durham, sampling earlier in the summer would not achieve this goal as the system was undergoing transition with the pH and the phosphate dose being adjusted to the optimal level. A completely different sampling plan was needed in order to track the effectiveness of the treatment changes over the short-term. Such a plan was implemented in the special study sampling in which the Durham Department of Water Management (DWM) tracked 8 locations which had historically higher lead levels. So when DWM and the State met at the end of June, the implementation of this special study sample plan was agreed by both parties.

From the Lead and Copper Rule section 141.86(d)(4), systems such as Durham which are on a reduced monitoring schedule are required to collect samples June through September for compliance determination. Paragraph (B) of that section goes on to reduce monitoring to every three years. However, paragraph (A) in that section specifically gives the states the authority to change the sampling period to an alternative time frame. Durham believed that the state did change the sampling period to only September of 2006 based upon an e-mail from Michael Douglas dated June 29. However, later in an e-mail from Jessica Miles to Ted Voorhees, she states that the state does not have the authority because North Carolina did not claim that authority in its primacy application with the EPA. If this were true (I could not verify nor do I have any reason to disbelieve) then even if the state did agree to limiting the compliance monitoring to just September, then it would not have had the authority to have done so.

If the State does not have the primacy authority to change the time frame of the compliance period, the ability of the state to move the compliance period up one year may also be questioned. However, in the Rule section 141.86(d)(4)(vii) says that for systems under reduced monitoring, if they make changes to their treatment process the State may require systems to return to normal monitoring or “take other appropriate steps” to re-evaluate its corrosion control. The state did not make them go back to normal monitoring, but it could probably be argued that moving the compliance up a year is an “appropriate step” to assure corrosion control given that the system had just made a couple of treatment changes that could affect corrosion control. I would assume that the state would have claimed that right under their primacy application as that could be a pretty important tool for the state to assure proper corrosion control.

It is my opinion that the Durham Department of Water (DWM) had good reason to believe that compliance monitoring was limited to September and consistently acted in good faith based on that belief. However, given what is written in the Rule and the lack of state authority to change it, the actual compliance period was June through September.

It should also be noted that the DWM, and the state were not the only ones to be confused about the actual compliance period. The USEPA found the definition of a compliance period to be confusing enough that on July 18, 2006 they proposed a clarification to the rule which specifically addressed the definition of a compliance period.<sup>1</sup>

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<sup>1</sup> U.S.EPA. 2006. Federal Register. Vol 71, No. 137. Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper; Short-term Regulatory Revisions and Clarifications; Proposed Rule (Tue. July. 18, 2006), 40828– 40863. [56 FR 40828].

*Issue 2: Which samples should have been included in the determination of the 90<sup>th</sup> percentile value for determining whether the City of Durham would continue to operate under the reduced sampling protocol or be required to operate under the more frequent protocol?*

The purpose of the monitoring requirement of the Rule is to ensure that systems which optimize their treatment for lead and copper protection stay optimized over time. Optimization is considered successful if the 90<sup>th</sup> percentile of samples taken in each compliance period is below 0.015 mg/L. The best way to track changes would be to monitor the same set of locations each monitoring period and see how they change. By using the same set of locations, the only variable would be any changing water chemistry that could affect corrosion. In Section 141.86(b)(4), the EPA tries to maintain the same sampling pool by requiring systems to return to the same locations as it did in previous samplings or provide justification why it could not return to the same location. In order to prevent systems from only “cherry picking” locations that are low in lead and to prevent systems from trying to throw out high values, the EPA also requires systems to report any other lead sample that meets the sample location criteria and the sample collection and analysis criteria.

In contrast, the state of North Carolina requires that systems get pre-approval for their sample pool in order to use the results for calculation of the 90<sup>th</sup> percentile. This seems to be in conflict with the requirements of the federal regulation which requires all proper samples to be included. North Carolina is not alone with its interpretation of the sample results which prompted Benjamin Grumbles of the EPA Office of Water to write a clarifying memo in November 2004 to the regions instructing the regions to count all qualifying samples in the calculation. It is important to note that this memo was written to the EPA Regions and may or may not have been received by the State or DWM. I would assume judging by e-mail questions from Boris Hrebeiuk to EPA Region 4 on December 27 and January 3 that the state was not familiar with how to use these data either.

Unless North Carolina’s primacy application addresses this issue to the contrary (which I doubt), then all of the samples taken between June 1 and September 31 which were collected by the proper protocol from locations that qualify as Tier 1 locations should be included in the 90<sup>th</sup> percentile calculation. This includes special studies, customer request, compliance samples, etc.

Inclusion of all of these samples is unfortunate because including all of these samples into the 90<sup>th</sup> calculation interferes with the intended purpose of the Rule’s monitoring. This issue needs to be addressed by the EPA when it next reviews the Rule.

*Issue 3: Did the City of Durham do what was expected of them? Did they comply with the Lead and Copper Rule and guidance provided?*

The City of Durham and DWM in particular did an exemplary job as guardians of public health. Under Issues 4,5,6, and 7 are examples where the city took quick action in response to lead problems to protect public health(see especially #4). They continued to act professionally and their actions with regard to the regulations show an understanding to try to fulfill the intent of the regulations. Unfortunately, by abiding by the spirit of the rules they did not comply with the letter of the law. They did not submit all of the sample data to the state in the time frame required and they did not include all of the data in making their initial determination of the 90<sup>th</sup> percentile.

However, I saw no evidence that anyone in the city intentionally hid any data or purposefully deceived anyone with regard to lead compliance.

*Issue 4: Did the City of Durham act within the rules in making changes to its water treatment process, and did the City have a reasonable basis for making those changes? Please comment on the process changes associated with the special studies sampling.*

There were actually 4 different changes in the water treatment process that were identified that may have influenced lead values: switch from free chlorine to chloramines, switch from alum (aluminum sulfate) to ferric sulfate, switch back to alum from ferric sulfate, and slightly adjusting the pH and phosphate dose. Each change is discussed below.

1) Switch from free chlorine to chloramines – The city of Durham, as did many utilities across the country, switched the chemical that it used for secondary disinfection from free chlorine to chloramines in an effort to reduce disinfection by-products and remain in compliance with EPA’s Stage 1 Disinfectant/Disinfection By-products Rule and to prepare for the Stage 2 Disinfectant/Disinfection By-products Rule. These rule lower the allowable limit on chemical compounds formed as a reaction with disinfectants such as free chlorine. Chloramines form less of these byproduct compounds than free chlorine. At the time of the switch, the effects of changing disinfectant on lead was not known. Since that time, some systems have found that switching to chloramines may have caused their lead values to increase. Whether the switch has caused the lead values to go up is currently being debated. At the time of the switch though, switching to chloramines was common practice to comply with the Stage 1 Rule. In addition, the Stage 2 Disinfectant/Disinfection By-Product Rule specifically lists chloramine as a best available technology (BAT) in some cases to control disinfection by-products. Therefore, it was reasonable that DWM chose the switch to chloramines as part of its compliance strategy and would not have foreseen a problem with lead as a result.

The Lead and Copper Rule section 141.90(3)(a) requires that systems performing changes in source water or treatment process notify the state within 60 days of making that change presumably so that the state could order a review if they judged that the change could impact lead at which time the state could require the system to perform lead monitoring sooner than they ordinarily would. Assuming the DWM notified the state within 60 days, then DWM acted within the rules for this treatment change.

2) Switch from alum to ferric chloride – Switching from alum (aluminum sulfate) to ferric chloride is another common practice in order to help with disinfection by-product control. This switch was made at the Wade G. Brown plant in early 2003. In an op-ed article written by Terry Rolan<sup>2</sup>, he mentioned that this switch was made after pilot testing and after working extensively with a consultant. Unlike the theoretical chloramine affect on lead, the affect of switching from alum to ferric chloride it was somewhat known that in some situations an increase in lead levels could result from changing the chloride to sulfate ratio. This exact situation was even used as a case study in one of the EPA’s guidance manuals that accompanied EPA’s Stage 1 D/DBP rule.<sup>3</sup> Although the effects were known to be possible, there was not a way to predict if they would happen in any given system nor to what extent lead levels may have increased.

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<sup>2</sup> Rolan, Terry. “Keeping our Waters Safe.” Harold-Sun. August 20, 2006. Pg. A9.

<sup>3</sup> See Case Study 5, page 4-19 of EPA’s *Microbial and Disinfection Byproducts Rules Simultaneous Compliance Guidance Manual*. 1999.

Under the mandate to lower disinfection by-products many systems across the country have switched to ferric chloride with no observed effects and the switch seemed to be a reasonable one. I have no knowledge if this issue was examined in the pilot experiments, was discussed with the consultant before implementation, or was discussed with the state. Assuming that DWM notified the state within 60 days of the switch, they acted within the rules to do so.

3) The switch back to alum from ferric sulfate – Two changes to the water quality happened between the 2001 and 2004 compliance samplings: the switch to chloramines and the switch to ferric. Either of the two could theoretically explain the slightly higher lead values observed in a few of the samples in the 2004 compliance period. So it was entirely reasonable that when the high lead values were found in the health department's sampling program that both of these would have been the suspected cause. The information supplied by Dr. Marc Edwards implicating the change to ferric was especially useful in determining the next step of switching back to alum at the Wade G. Brown plant. DWM already had years of experience using alum and, fortunately, the equipment was still in working condition, so the switch back to alum was a very low risk one and one that could potentially have very good benefits in terms of lead. In addition, they set up an appropriate monitoring program (i.e. the special study samples) to track the efficacy of the change. The information gathered by this monitoring program was able to give feedback that the switch back to alum was successful in lowering of the lead levels. By monitoring frequently, the system was able to gauge effectiveness within a relatively short time rather than waiting until September or even the next round of sampling to occur.

I cannot tell from the record if the state was officially notified in writing nor am I sure if this type of switch even required state notification. The state was informed at least verbally about the switch and at that point they should have notified DWM if written notification was required.

4) Slightly changing the pH and phosphate dose – As part of its water quality review process, DWM determined that the pH and phosphate dose needed to be slightly altered in order to work optimally. DWM asserts that the changes made to the water quality were within the range allowed by the water quality parameters agreed to with the state as part of the Lead and Copper Rule desktop study. I saw no objection by the state so I assume that this is true. If so, then notification to the state would not have been required.

Slight changes in pH and phosphate are typically appropriate for systems using a phosphate based corrosion control strategy and these changes seemed to be ordinary.

*Issue 5 – Did the City of Durham conduct the proper monitoring of the distribution system during the time frame in question?*

This question can be broken into two parts. The first part defines proper monitoring as the monitoring as required by the Rule. The answer to that is yes, DWM fulfilled all of the monitoring required by the Rule. In their Lead and Copper Rule Submittal they clearly explain why each sample was taken and the samples that were different than the previous round were explained. Any questions from the state on individual samples were eventually addressed. They collected samples in excess of the required 50 from their sampling pool. They also conducted the required water quality parameter monitoring as prescribed.

The second part of the question defines proper monitoring as monitoring that is protective of public health. The answer to that question is also yes. This is especially true considering the

special study sampling that was performed to ascertain the effectiveness of the switch back to alum. This special study was well designed and intentionally targeted some of the worst lead locations. Clearly if DWM was concerned with just complying with the regulation rather than being protective of public health then the sampling program would have included many homes of historical non-detections, or it would not have been done at all. This was recognized by Jessica Miles in her e-mail dated January 17. It should be noted that due to the nature of the 90<sup>th</sup> percentile monitoring, for every value above 0.015, the system also needs to collect 9 values below 0.015 just to stay even.

In addition to the special study sampling, DWM also was able to handle an additional 700-800 samples that came in from customer request. This is an enormous feat for a utility laboratory to handle in a short period of time.

It is not clear from the record to what extent DWM used the customer request and the health department or even their own data when making the treatment changes, but because of their monitoring efforts, the data was available.

*Issue 6 – Please comment on the City of Durham’s public education program. Particular attention should be given to the range of methods used to educate the public, and to the extent possible, to the level of effort given to these methods.*

During the summer into the fall and winter, it is apparent that the City has used many different approaches to educate the public about lead in the drinking water and steps that can be taken to avoid it. In most of the press articles that were included in the materials, City staff always discussed that the source of lead is internal piping and the risks can be lowered by letting the water run, not using hot water to cook or drink, and clean the faucet aerators periodically.

Besides the mainstream press articles about the lead situation, the city used a good variety of methods to convey the message of how lead exposure could be minimized. Web pages, refrigerator magnets, inclusion in various city publications, bus advertisements, and direct presentations to civic groups, television spots and other methods were utilized. Of the materials that were provided, the message appeared consistent, direct, and clear. Messages were provided in English as well as Spanish.

The efforts here are a good beginning to a public education program and are especially noteworthy as they were implemented well before the City was aware that they would exceed the action level for lead. The level of effort provided thus far by the City on the lead issue has been more than what would be expected of a similar sized city facing the same issues. Unfortunately, the City and in particular DWM has lost some credibility judging by some of the press coverage over the past 6 months. This would be an excellent opportunity for the City to partner with local and state health agencies who may be seen as more of an authority on health related issues. The PWSS could also be of assistance in this effort by either confirming the messages put out by the City or by providing their own messages in parallel with the City’s plan. This would especially be important in helping to re-establish the credibility of the City with the public.

Because they did exceed the action level though, Section 141.85 of the Rule has some very prescriptive actions that are required and some exact language that must be used in the public education program for utilities that exceed the action level. It does not appear from what is provided that the City is in full compliance with these requirements yet. However, because of the

work that the city has already done, there is already a keen awareness of lead issues in the city. The current program could easily be modified to fit the requirements of the rule.

*Issue 7 – Please comment on the City of Durham’s notification procedures.*

Ideally, a utility which analyzed lead from any customer’s home should strive to analyze the sample and notify the customer with the results as soon as possible. Although it is not directly required in this situation, Section 141.84(d)(1) of the Rule requires systems that are required to do lead service line replacements must offer to perform lead analyses and report the results back to the customer within three days after receiving the results. Durham will not be doing lead line replacements, but the notice within three days of the analysis is a good goal.

In the file “Customer Request Pb Database 2006.xls” can be found details about the customer request sampling program including columns for sample date, analysis date, and written results. There is also a comment field and in many of the comments the date of phone call notification of the results is noted. Unfortunately, this file is incomplete with many of the dates not filled in for the notification date so I cannot comment on the timeliness of the notifications. This type of spreadsheet would yield great information to the utility to track its own responsiveness to the customers. I would also recommend adding a column for date of phone call instead of recording that in the comment field. Doing so would make it very easy to be able to determine the time between sample collection and notification. I also did find it interesting that so many of the notifications were done via a call directly to the customer rather than relying on only a letter. This personal contact is very important especially the urgency which this conveys to the customer with high lead values.

The language that is included in the customer analysis letters is very direct and understandable for the two “Blank Letters to Customer” letters, but I would caution against using the word “exceeds.” By stating “exceeds the EPA and State of North Carolina guidelines for safe drinking water,” the customer could interpret this as meaning that the water is better than the regulations. I would suggest that the language be changed to “is above the allowable level.” The language used in the “AL Customer Notification form 011207.pdf” letter seems to be un-necessarily complicated and I would suggest re-wording it if possible to simplify the language. I could not find reference in the Lead and Copper Rule as to specific language to use in such a notification.

One thing to keep in mind though is that the 0.015 mg/L lead level is not a health-based level. This level is what the EPA believed is achievable for a system practicing optimal corrosion control. The EPA does refer to this level in some of their public notification material and a lot of utilities around the country use this level in the same manner that the City does in their notifications. However, the 0.015 mg/L is not an MCL nor does it have a health related meaning. The health community seems to be split on the health effect level in water. Some say that any lead is bad, others say as a route of exposure the levels in drinking water are insignificant. Given that, I would caution the City to error on the safe side and to not underplay the significance of finding low levels of lead even if those levels are below the action level. In the file “Blank Letter to Customer for Pb Results below AL.pdf” the City does a good job in stating the water meets the guidelines but still offers advice to minimize lead exposure. I also recommend that for any sample that has a detection of lead to include the EPA brochure titled “Lead in Your Drinking Water” which is available free of charge from the EPA (EPA publication 810-F-93-001).

## Final Comments

In my opinion from what I have seen of the record, DWM was forced into a very difficult situation in trying to comply with one federal regulation (the DBP rules) which had unintended consequences of causing a situation ultimately resulting in non-compliance with another regulation (the Lead and Copper Rule). It should be noted here that having a lead 90<sup>th</sup> percentile above 0.015 mg/L is not a violation of the Lead and Copper Rule nor is it considered non-compliance with the rule. The only violation that occurred was for not reporting all of the required data in the correct time period. There was no intent to hide these results or to not take the appropriate samples. In contrast, what was at issue was that Durham took hundreds of additional samples to check the quality of water in the distribution system and in the homes of any individual who requested it. The rules on the reporting requirements are not clear and are not consistent with other regulations. It was not until after many conversations and several e-mails between the state and the EPA Regional office that it was determined that the results needed to be reported.

The real tragedy of the situation is seen in an editorial found in an Herald-Sun editorial<sup>4</sup>. The article states “city fumbled badly by placing more importance on complying with the letter of EPA regulations than finding out whether homes in Durham actually had problems with lead.” This is exactly the opposite of what actually happened. It was the City’s extra sampling and willingness to run all of the customer request lead samples that caused the quandary. The real health issue was quickly identified through the health department sampling and the follow-up sampling by DWM. DWM then took quick action and made changes at the treatment plant to reverse the trend in lead. As a result of these actions, the lead levels dropped and were in the range generally considered acceptable by September.

The role that the state played in this mischaracterization should not be overlooked. PWSS’s past failure to properly implement the Lead and Copper Rule was well documented in News and Observer articles in 2005. Certainly if there were allegations of data manipulation, intentionally hiding data, or gross misconduct the state should investigate. However, the state should also have stepped up and explained the sample pool requirements to the press and how systems are required to sample the same sites every compliance period. The state could have easily come in at several points in the public discussion and helped the press to understand why things had to be done the way they were and the very positive things that DWM was doing to correct the situation, or even that it had faith in DWM. Doing so would have helped the image that the public has of DWM and would have helped established DWMs credibility so that when it does more of the public education program it will be believed and trusted.

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<sup>4</sup> “Leaders Stumble when Trouble Hits.” Editorial. February 4, 2007.

## **Appendix C**

### **Resumes of External Reviewers**

## Appendix C.1

# Gary A. Burlingame

*Administrative Scientist*

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**Bureau of Laboratory Services, Philadelphia Water Department,  
1500 E. Hunting Park Avenue, Philadelphia, PA 19124  
Phone: (215) 685-1417 FAX: (215) 743-5594 gary.burlingame@phila.gov**

### Education

MS Environmental Science  
1983 Drexel University,  
Philadelphia

BS Environmental Science  
1981 Drexel University, Philadelphia

### Associations

American Water Works Association  
Research Foundation's Project  
Advisory Committee

Water Environment Federation

American Water Works Association  
Member since 05/01/1984

AWWA Technical Advisory  
Workgroup for Total Coliform  
Rule/Distribution System Rule

International Water Association's  
Committee on Off-Flavors in the  
Aquatic Environment

Standard Methods Joint Task Group  
Chair for Method 2170  
Eastern Pennsylvania Water  
Pollution Control Operators  
Association

Pennsylvania Section AWWA

### Awards

AWWA Water Quality Division's  
Golden Spigot Award (2000) for  
outstanding volunteer service to the  
division.

AWWA *Opflow* Publications  
Award for Year 2001

PA AWWA Special Recognition  
Award for noteworthy service for  
Year 2006.

Gary A. Burlingame manages the Philadelphia Water Department's Organic Chemistry and Aquatic Biology laboratories within the Bureau of Laboratory Services, and oversees related research. The program includes disinfection by-products, natural organic matter, PCBs, emerging chemicals, VOCs and SOCs, algae, coliforms, *Giardia/Cryptosporidium*, etc... for a full service, state certified environmental laboratory. Analyses are done on drinking water, source water, wastewater, sediment, sludge, and related media. The management of research involves in-house projects as well as joint projects with the AWWA Research Foundation. Special in-house research is being done on persistent contaminants in sediment, emerging chemicals occurrence, and bacterial source tracking. Mr. Burlingame is also coordinating the laboratory's development of water contamination response protocols.

Mr. Burlingame is known for his contributions to taste and odor control of drinking water and odor control at wastewater treatment plants. This work included studying blue-green algae and geosmin in the watershed, identifying sources of odors in distribution, a consumer taste survey, public appearances on television and in local newspapers, the standardization of Flavor Profile Analysis, the development of odor reference standards, and directing the organics testing for trace odorants. Mr. Burlingame also developed a sensory method for odor control to evaluate wastewater treatment plants for odors, identify unit operations that cause the odors, and evaluate solutions.

Mr. Burlingame is a trained media representative for the Philadelphia Water Department, appearing in press releases, on television news and on radio. Mr. Burlingame is currently providing workshops through PaAWWA for operators to obtain continuing education credits.

Mr. Burlingame's employment history includes:

- Administrative Scientist for the Bureau of Laboratory Services, Philadelphia Water Department (2003-present)
- Adjunct Associate Professor: Teaching Sanitary Microbiology in the School for Environmental Science, Engineering and Policy at Drexel University (1981-2003)
- Supervisor, Water Quality and Research for the Philadelphia Water Department (1995-2003)
- Program Scientist for the Philadelphia Water Department (1989-1995)
- Aquatic Biologist for the Philadelphia Water Department (1982-1989)
- Research Assistant at Drexel University 1979-1982

## **AUTHORED PUBLICATIONS in Peer Reviewed Journals**

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- Toward a Lead-Free Public Water Supply: The Course is Set but the Pace Must Quicken. With J. Swertfeger. *J AWWA* 97:9:42-44.
- Maintaining Water Quality in the Distribution System. 2004. *Journal of the New England Water Works Association*, 118:3:143-150.
- Development of an Odor Wheel Classification Scheme for Wastewater. 2004. With I.H. Suffet, D. Khiari, and A.L.Bruchet. *Water Science and Technology* 49:9:201-209.
- Algal Blooms –Impact on Treatment, Taste and Odor Problems. 2002. *Encyclopedia of Environmental Microbiology* (ed., G. Bitton). J. Wiley & Sons, Inc.
- Managing Water Supply Infrastructure. 2002. With J. Rahman, E. Navera, and J.E. Durrant. Pp 83-101. In *Assessing the Future: Water Supply Infrastructure Management*, AWWA, Denver, CO.

## **AUTHORED PUBLICATIONS in Proceedings and Other Sources**

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- Ratcheting Up Lab Response to Water Quality Warnings. *Opflow* February 2007, 33:2:24-27.
- Why Red Water? Understanding Iron Release in Distribution Systems. With D.A. Lytle and V.L. Snoeyink. *Opflow* December 2006, 32:12:12-16.
- Knowing Chemistry Can Help Get the Lead Out. 2006. With M.R. Schock and M.A. Edwards. *Opflow* September, 32:9:24-26.
- Visualizing the Future: Water Quality Control in the Year 2050. 2006. *Opflow* 32:7:10-11.
- How Much Water Should We Drink? 2006. *Opflow* 32:2:8-9.
- Developing a Sustainable Contamination Response Plan for Water Quality Managers and Laboratories. 2005. In *Proceedings of AWWA Water Security Congress*, Oklahoma City, April.
- How to Mine Your Lead and Copper Data. 2004. With A. Sandvig. *Opflow* 30:6:16-19.
- Evaluating Trends in Post-Optimization Lead and Copper Levels. 2003. With A. Sandvig. In *Proceedings of AWWA Water Quality Technology Conference*, Philadelphia, November.
- Choosing an Optimal Chloramine Residual Goal for Philadelphia's Tap Water. 2003. With E.D. Mackey and J. Choi. In *Proceedings of AWWA Water Quality Technology Conference*, Philadelphia, November.
- Water Care Critical for Kidney Dialysis. 2003. With W. J. Gaughan, M.D. *Opflow* 29:5: 8-10.

## **CO-AUTHORED PUBLICATIONS in Various Sources**

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- Snoeyink, V.L., Haas, C.N., Boulous, P.F., Burlingame, G.A., Camper, A.K., Clark, R.M., Edwards, M.A., LeChevallier, M.W., McMullen, L.D., Moe, C.L., Nieminski, E.C., Smith, C.D., Spath, D.P., and Valentine, R.L. 2006. *Drinking Water Distribution Systems: Assessing and Reducing Risks*. (L.J. Ehlers and E.A. De Guzman, eds). The National Academies Press, Washington, D.C.
- Cheng, X., Peterkin, E. and Burlingame, G. A. 2005. A study of volatile organic sulfide causes of odors at Philadelphia's Northeast Water Pollution Control Plant. *Water Research* 39:16:3781-3790.
- McGuire, M.J., Hund, R. and Burlingame, G. 2005. A practical decision tree tool that water utilities can use to solve taste and odor problems. *J Water Supply: Research and Technology-AQUA*. 54.5: 321-327.
- Dietrich, A. M., Hoehn, R. C., Burlingame, G.A. and Gittelman, T. 2004. *Practical Taste-and-Odor Methods for Routine Operations: Decision Tree*. AWWA Research Foundation, Denver, CO.

- Whelton, A.J., Dietrich, A.M., Burlingame, G.A. and Cooney, M.F. 2004. Detecting Contaminated Drinking Water: Harnessing Consumer Complaints. In Proceedings of AWWA Water Quality Technology Conference, San Antonio, November.
- Dietrich, A. M., Bae, B., Kim, Y., Johnson, M. and Burlingame, G.A. 2004. Two-of-Five Odor Test: A Practical Method for Routine Sensory Analysis. Proceedings of AWWA Water Quality Technology Conference, San Antonio, November.
- Porter, R., Witherspoon, J., Daigger, G., Fahnestock, L., Noval, J., Glindemann, D., Burlingame, G., Choudhary, S.A., Lenzinski, R., Suffer, M. and Rosenfeld, P. 2004. Assessment of Odor Formation Mechanisms in an Activated Sludge Basin at the Northeast Wastewater Treatment Plant. In Proceedings of Water Environment Federation's WEFTEC, New Orleans.
- Johnson, M.A. and Burlingame, G.A. 2004 Lab or Field Testing for Chloramine Residual? *Opflow* 30:7:14-17.
- Matia, L.I., Burlingame, G.A., Bruchet, A., Khiari, D., Stuetz, R., Suffet, I.H. and Ventura, F. (issue editors) 2004. *Off-Flavors in the Aquatic Environment VI*. Water Science and Technology 49.
- Dietrich, A.M., Burlingame, G.A. and Hopkins, P. 2004. Rating Method for Evaluating Distribution-System Odors Compared to a Control. *Water Science and Technology* 49:9:55-60.
- Kirmeyer, G.J., Murphy, B.M., Sandvig, A., Korshin, G., Shaha, B., Fabbricino, M., and Burlingame, G. 2004. *Post-Optimization Lead and Copper Monitoring Strategies*. AWWA Research Foundation, Denver, CO.
- McGuire, M., Graziano, N., Sullivan, L., Hund, R., and Burlingame, G. 2004. *Water Utility Self-Assessment for the Management of Aesthetic Issues*. AWWA Research Foundation, Denver, CO.
- Dietrich, A.M., Glindemann, D., Pizarro, F., Gidi, V. Olivaries, M., Araya, M., Camper, A., Duncan, S., Dwyer, S., Whelton . A.J., Younos, T., Subramanian, S., Burlingame, G.A., Khiari, D., and Edwards, M. 2004. Health and Aesthetic Impacts of Copper Corrosion on Drinking Water. *Water Science and Technology* 49:2:55-62.
- Burlingame, G.A. and Sandvig, A. Evaluating Trends in Post-Optimized Lead and Copper Levels. AWWA Water Quality Technology Conference, Philadelphia, November, 2003.
- Dietrich, A. M., Burlingame, G. A. and Hoehn, R. C. 2003. What the Nose Knows- Strategies for Taste-and-Odor Testing Methods. *Opflow* 29:10:10-14.
- Bae, B-U, Kim, Y-I, Dugas, D.W., Burlingame, G.A. and Dietrich, A.M. 2002. Demonstration of new sensory methods for drinking water taste-and-odor control. *Water Science and Technology* 2:5-6:241-247.
- Burlingame, G.A., Dietrich, A.M. and Hoehn, R.C. 2003. Strategies for Selecting Appropriate Methods for Taste-and-Odor Testing. Proceedings of AWWA ACE, Anaheim, CA.
- Rahman, J. and Burlingame, G.A. 2003. What's That Stuff in the Tap water? AWWA *Opflow* 29:2:1, 4-6.

## COMMITTEE PARTICIPATION

- 
- The National Academies, National Research Council's Committee on Public Water Distribution Systems: Assessing and Reducing Risks, 2004-2006
  - AWWA Research Foundation's Unsolicited Proposal Review Committee, (Chairman) 2003-2005
  - AWWA Water Quality Division, Distribution Water Quality Committee, 2004-2006
  - AWWA Water Quality Division, Taste and Odor Committee, 1999-2004 and 2006-current

## Appendix C.2

### Biographical Sketch for Robert M. Clark

Robert M. Clark received a B.S. Degree in Civil Engineering from Oregon State University (1960), a B.S. Degree in Mathematics from Portland State University (1961), an M.S. in Mathematics from Xavier University (1964), an M.S. in Civil Engineering from Cornell University (1968) and a Ph.D. in Environmental Engineering from the University of Cincinnati (1976). Dr. Clark is a registered engineer in the State of Ohio and worked as an environmental engineer in the U.S. Public Health Service and the US EPA since 1961. He was Director of the EPA's Water Supply and Water Resources Division (WSWRD) in the Office of Research and Development's (ORDs) National Risk Management Research Laboratory (NRMRL) for fourteen years (1985-1999). In 1999 he was appointed to a Senior Expert Position in EPA with the title Senior Research Engineering Advisor. Dr. Clark retired from EPA in August of 2002 and is now an independent consultant. Dr Clark is an Adjunct Professor of Civil and Environmental Engineering at the University of Cincinnati and was a member of the National Research Council's Committee on "Public Water Distribution Systems: Assessing and Reducing Risks."

Dr. Clark has published over 350 papers and five books and has been professionally active in the American Water Works Association (AWWA) where he is a life-time member and the American Society of Civil Engineers (ASCE) where he is also a life-time member. He served as a trustee of AWWA's Research Division from 1984-1987 and was chairman in 1988. He is currently a member of AWWA's Total Coliform Rule Review Committee and is a member of several Project Advisory Committees for the American Water Works Association Research Foundation. He recently served on the organizing committee for ASCE's Water Distribution System Symposium held in Cincinnati in August 2006.

Dr. Clark has received numerous awards for his work including:

- Recipient of Environmental and Water Resources Institute's (American Society of Civil Engineers) Best Paper Award from the Journal of Water resources Planning and Management for 2006

- American Society Of Civil Engineers (Environmental and Water Resources Institute): 2004 Lifetime Achievement Award in recognition of a life-long and eminent contribution to the environmental and water resources engineering disciplines through practice, research and public service.
- U.S. EPA Distinguished Service Career Award for lifetime accomplishments, and leadership as a researcher and manager in the field of water supply (2002)
- American Society of Civil Engineers: Recipient of Rudolph Hering Medal (1996) for the best paper published by the Environmental Engineering Division
- U.S. EPA Gold Medal Award (1994) for assisting the City of Milwaukee in providing solutions to the cryptosporidiosis outbreak of 1993
- The A.P. Black Award for Outstanding Achievement in Water Supply Research (1993) from the American Water Works Association
- American Water Works Association Publication Award (1990)

## Appendix C.3

**Jeffrey W. Swertfeger**  
**7916 Kimbee Dr.**  
**Cincinnati, OH 45244**  
**(513) 231-7005**

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### **PROFESSIONAL PROFILE**

Goal oriented water quality professional with 16 years of proven management, supervisory, research and problem solving skills.

- Leadership – Vision derived from a passion for public health protection, understanding customer expectations and a sense of personal responsibility. Guided by GCWW’s core values with strengths in communication, cooperation, and character. Practices leadership by example and is respected by peers and an inspiration to co-workers.
- Expertise - Broad spectrum expertise in management of surface water treatment, ground water treatment, and distribution system water quality. Applies knowledge of hydraulics, scientific and engineering principles and research to improve drinking water quality. Nationally recognized expert who is frequently requested as a speaker and subject matter expert for USEPA, AWWA, and other state and national projects.
- Team Building - Excels in collaborative situations by sharing perspective, expertise and resources to achieve team success. Effectively accomplishes organizational mission by creating effective teams and utilizing superior project management skills to set goals, identify resource needs, motivate team members and create focus.

### **HONORS AND ACTIVITIES**

**Appointed to the American Water Works Association Research Foundation’s High Quality Water Research Advisory Committee (RAC).** As the Foundation's senior body of technical advisors, the RAC develops and recommends an annual 4 million dollar solicited research agenda to the board for final selection and funding. It also develops a strategic research plan based on the input of subscribers. In addition, the RAC monitors the results of the research effort with respect to implications for planning and program direction.

**2002 Engineers and Scientist of Cincinnati’s Young Scientist of the Year.** Each year this award is given to one scientist in the Cincinnati area to recognize accomplishment in a career. This award was specifically earned for pilot scale research performed at the Richard Miller Treatment Plant and for publications and presentations on various aspects of water quality.

**Water and Wastewater Leadership Center.** Chosen by GCWW to attend this intensive course in leadership designed to prepare and develop leaders and management executives for water and wastewater utilities. This exclusive opportunity is only offered to select individuals based upon their recognized potential to become organizational leaders.

**Member of several AwwaRF and AWWA PACs.** Project Advisory Committee (PAC) members are recognized experts chosen to provide guidance and insight to national research projects. Examples of specific PACs include *AWWA’s WITAF Project on Lead and Copper Rule, Case Study for a Distribution System Emergency Response Tool, Lead and Copper Rule Support, Managing Change and Unintended Consequences, and Susceptibility of Distribution Systems to Negative Pressure Transients.*

**Member of AWWA’s Microbial and DBP TAW.** This technical advisory workgroup consists of a panel of select water industry experts reporting to the Water Utility Council which address specific topics of microbial and disinfection by-product regulations.

**Participant in USEPA Rulemaking Process.** Invited to participate as an expert resource in USEPA's Lead and Copper Rule Simultaneous Compliance Meetings and Total Coliform Rule reviews. These activities were used by the agency in their regulatory review process to determine what changes need to be made in these rules.

**Member of AWWA's Distribution System Operation and Management Standard Committee.** This committee was responsible for development of the first edition of the AWWA Standard G200: *Distribution Systems Operation and Management* which identified best practices for distribution system operation and management. This standard will be the cornerstone for the development of a peer review and accreditation program to be developed by AWWA.

**Past Chair, Ohio Section Research Committee**

**Seasongood Innovation Award**

**Member AWWA Distribution System Water Quality Committee**

**Ohio Class III Water Supply License**

**Member American Water Works Association**

## **SELECT MAJOR PRESENTATIONS AND PUBLICATIONS**

**Jeff Swertfeger.** 1996. "Biological Degradation of Ozone By-Products During Drinking Water Treatment." Master's Thesis. University of Cincinnati, Cincinnati, OH.

**Jeff Swertfeger,** Deborah H. Metz, Jack DeMarco, Joe Jacangelo, Anne Braghetta. "Effect of Filter Media on Cyst and Oocyst Removal." *Journal of the American Water Works Association.* Pages 90-100 September 1999.

**Jeff Swertfeger.** "Water Quality Issues with Lead Line Replacement." AWWA Webcast Are Service Lines the Achilles Heel of Your Distribution System. August 24, 2005.

Gary Burlingame, **Jeff Swertfeger.** "Toward a Lead-Free Public Water Supply: The Course is Set but the Pace Must Quicken." *Journal of the American Water Works Association.* Pages 42-44 September 2005.

**Jeff Swertfeger,** David J. Hartman, Cliff Shrive, Deborah H. Metz, Jack DeMarco. "Water Quality Effects of Partial Lead Line Replacement." Proceedings, 2006 Am Water Works Assoc. Annual Conference. San Antonio, TX.

**Jeff Swertfeger.** "The Stage 2 DBP Rule: What it is and Why You Need to Prepare." Presented at the 2005 Southeastern Regional Technology Transfer Conference. Greenville, SC.

## **EMPLOYMENT AND RELEVANT EXPERIENCE**

Supervising Chemist, Greater Cincinnati Water Works (GCWW) 2004 to Present

Responsibilities focus on the regulatory compliance, operation and water quality optimization of the Greater Cincinnati Water Works distribution system which includes 18 pump stations, 19 reservoirs, and over 3000 miles of mains.

### *Major Responsibilities*

- Work with the USEPA and regional partners to develop and implement the Water Security Initiative (formerly known as Water Sentinel) for counter terrorism detection and response.
- In specific emergencies, direct initial GCWW response as the Water Utility Emergency Response Manager (WUERM)
- Assisted in the development and implementation of the SCADA system and associated data systems.
- Direct supervisory responsibility for technician and professional level staff.
- Responsible for the operation of advanced analytical laboratory including organic, microbial, and metals analysis.
- Develop section operation, personnel, and capital budget and ensure fiscal responsibility.
- Review distribution system design and operation to protect and maintain excellent water quality.
- Review operation and water quality from the treatment plants to identify areas for improvement.
- Assist in oversight of the Bolton treatment plant to assure proper and efficient operation.

- Review current and developing regulations, assess impact and prepare for regulatory compliance.
- Work directly with the USEPA, Ohio EPA, and AWWA in the development of regulations.
- Oversee various capital projects relating to distribution system.
- Direct investigations into corrosion control optimization.
- Direct investigations into disinfection by-product minimization.
- Direct installation and maintenance of water quality monitors in the distribution system.
- Conduct research activities to improve water quality delivered to customers.
- Participate in the development and implementation of distribution system water quality and hydraulic models.
- Review tank and reservoir design for water quality impacts.
- Act as a liaison between GCWW and local police, fire, emergency response, and health departments.

Chemist /Senior Chemist, Cincinnati Water Works 1993 to 2004

Directly involved with operation and optimization of a 220 MGD conventional surface water treatment plant with GAC. Also, responsible for designing and implementing applied research activities to improve treatment.

*Major Responsibilities*

- Help oversee daily operation and optimization of treatment plant, emphasizing microbiological, particulate, and solids removal processes. Includes responding to calls on nights and weekends concerning treatment problems.
- Responsible for the development and management of a Cryptosporidium Control Strategy for the Water Works.
- Review regulations and monitor regulatory environment for potential impact on treatment or monitoring programs.
- Design and implement applied and basic research studies to improve treatment processes.
- Assist in developing a public information / education program for the Water Works.
- Act as liaison to other city departments and outside organizations.
- Responsible for wet chemistry lab to ensure compliance with state and federal regulations.
- Responsible for the operation and maintenance of laboratory and on-line instrumentation including particle counters, turbidimeters, chlorine monitors, and specific ion analyzers.
- Operate pilot plant at the Richard Miller Treatment Plant and conduct research studies designed to improve treatment processes.

Graduate Research Assistant, Univ. of Cincinnati, 1991 to 1993

As part of Master's degree thesis work, conduct investigations of the biodegradation of organic compounds in drinking water including the effects of ozonation, biological filtration, and activated carbon processes in drinking water treatment.

*Major Responsibilities*

- Participate in design and implementation of pilot and bench scale research projects. Responsible for development of a biodegradable dissolved organic carbon (BDOC) test methodology.
- Conduct literature reviews.
- Organize, interpret, and present data from bench and pilot studies

**EDUCATION**

University of North Carolina at Chapel Hill  
 Kenan-Flagler Business School  
 Water and Wastewater Leadership Center, March 2004.

University of Cincinnati, Cincinnati, OH  
 Department of Civil and Environmental Engineering  
 Masters of Science in Environmental Science, September 1996.

Indiana University, Bloomington, IN  
 Bachelor of Arts degree, May 1991  
 Double major in Biology and Environmental Science.

## Appendix C.4

### DAVID HUMPHREYS MOREAU

#### EDUCATION:

Ph.D., Water Resources, Harvard University, 1967  
M.Sc., Engineering, Harvard University, 1964  
M.Sc., Civil Engineering, North Carolina State University, 1963  
B.Sc., Civil Engineering, Mississippi State University, 1960

#### EMPLOYMENT HISTORY:

Director, Water Resources Research Institute of The University of North Carolina, July 2005-present  
Chairman, Department of City and Regional Planning, University of North Carolina, Chapel Hill, 1997-2002  
Director, Water Resources Research Institute of The University of North Carolina, 1983-1995  
Acting Dean, College of Arts and Sciences, University of North Carolina, Chapel Hill, 1983  
Associate Dean for Planning and Programs, College of Arts and Sciences, University of North Carolina, Chapel Hill, 1978-1983  
Professor, Departments of City and Regional Planning and of Environmental Sciences and Engineering, University of North Carolina, Chapel Hill, 1976-present  
Assistant and Associate Professor, Departments of City and Regional Planning and of Environmental Sciences and Engineering, University of North Carolina, Chapel Hill, 1968-1976

#### SELECTED ACTIVITIES:

Chairman, North Carolina Environmental Management Commission (EMC), 1993-present. The EMC is North Carolina's administrative commission for water quality, air quality, and water allocation.  
Chairman, North Carolina Sedimentation Control Commission, 1991-1993  
Chair, Governor's Blue Ribbon Panel on Environmental Indicators, 1989-90  
Member, Blue Ribbon Advisory Panel on Reliability of the New York City Water Supply, 2004-  
Member, Committee on Regional Hurricane Protection System for New Orleans, appointed by the National Academy of Science to provide peer review of investigations by the Interagency Performance Evaluation Team of the failure of levees during Hurricane Katrina, 2005-2006  
Member, Committee to Review Hydrologic and Economic Analysis by the International Joint Commission on the Great Lakes, Water Science and Technology Board, National Research Council, 2005

Member, Committee on Water Quality Management in the Pittsburgh Region, Water Science and Technology Board, National Research Council, 2002-2004

Member, Committee to Review the Upper Mississippi River-Illinois Waterway Navigation System Feasibility Study, Water Science and Technology Board, National Research Council, 2000-2001

Chairman, Committee to Assess the U.S. Army Corps of Engineers Project Planning Procedures, Water Science and Technology Board, National Research Council, 1996-1999

Lecturer, Japan Science Society, Water Resource Management in the United States, Water Quality Management in the United States, and Flood Damage Reduction Strategies in the United States, 2001

Consultant, National Irrigation Commission of Jamaica through Harza Engineering, 1997

Consultant, Federal Council on Potable Water and Sanitation, Buenos Aires, Argentina, 1994

Consultant, United Nations Development Program, Water Management Models for Water Supply, Beijing, China, 1990

Consultant's Review Panel, New York City, review of water demand projections, 1990-1995

Consultant, Water for Sanitation and Health Program (AID), financing of water supply and waste disposal, 1992

Orange Water and Sewer Authority, Board of Directors, member 1977-1985, 1989-1993, Chair for three years

**SPECIAL RECOGNITION:**

Distinguished Engineering Fellow, College of Engineering, Mississippi State University, 1992. One of 100 alumni chosen as charter member during the college's centennial celebration

Friend of the Universities Council on Water Resources, 1989

National Institute for Water Resources award for dedicated and outstanding service as Director of the Water Resources Research Institute of The University of North Carolina, 2000