FISCAL NOTE FOR PROPOSED AMENDMENT TO RULE 15A NCAC 18A .2816

LEAD POISONING HAZARDS

Rule Amendments:	15A NCAC 18A .2816
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Impact Summary:	State Government: Yes Local Government: Yes Private Impact: Yes Federal Government: No Substantial Impact: Yes
Authority:	G.S. 110-91; 130A-131.5; 130A-131.7(7); 130A-131.8
Necessity:	Child care centers serve infants and young children, who are especially vulnerable to the negative effects of lead exposure. For these populations, especially formula-fed infants, drinking water can be a significant source of lead. In North Carolina, licensed child care centers served by public water systems are not required to test their water for lead at the point of use. The proposed rule amendment requires that child care operators periodically test water from water outlets used for drinking and food preparation in child care centers and mitigate if testing reveals lead concentrations above the lead hazard level. See Appendix for proposed rule text.

I. SUMMARY

The proposed rule amends 15 NCAC 18A .2816 ("Lead Poisoning Hazards") of the Rules Governing the Sanitation of Child Care Centers to require the operators of licensed child care centers (or "centers") to test water from outlets used for drinking and food preparation for lead every three years and mitigate if testing reveals lead concentrations at or greater than the lead hazard level of 15 parts per billion ("ppb").

II. INTRODUCTION AND BACKGROUND

The Environmental Health Section of North Carolina Department of Health and Human Services ("NC DHHS"), Division of Public Health ("DPH") oversees the sanitation requirements for licensed child care centers. Local Environmental Health Specialists inspect each child care center every six months to evaluate their compliance with the sanitation standards outlined in 15A NCAC 18A .2800 ("The Rules Governing the Sanitation of Child Care Centers"). Inspectors assess a checklist of sanitation items that include, for example, proper storage of medications and hazardous waste, cleanliness of play areas, pressure in drinking fountains, and the condition under which food is prepared. When the inspector observes that a child care center is violating a standard, the center is issued demerits which ultimately correspond to the center's sanitation classification (superior, approved, provisional, or disapproved).

Among these sanitation requirements, 15A NCAC 18A .2816 ("Lead Poisoning Hazards") compels "in child care centers, areas accessible to children shall be free of identified lead poisoning hazards as defined under G.S. 130A-131.7(7)." Under G.S. 130A-131.7(7)(g), a "lead poisoning hazard" means "any concentration of lead in drinking water equal to or greater than 15 parts per billion." Lead leaches into drinking water from plumbing and fixtures that contain lead. It was not until 2014 that the Safe Drinking Water Act ("SDWA") reduced the maximum allowable lead content in plumbing and fixtures to 0.25%. Prior to 2014, plumbing and fixtures could still contain a significant amount of lead (up to 8%), posing contamination risks to drinking water.

While the sanitation rules dictate that licensed child care centers shall have less than 15 ppb lead in their drinking water, nothing requires centers that are served by public water systems to actually investigate the presence of lead in their water at the point of use. A small subset of child care centers maintains their own water supply and are thus regulated under the SDWA as public water systems. The SDWA's Lead and Copper Rule requires public water systems to (1) control lead in the source water through implementing corrosion control measures, and (2) collect point-of-use samples from sites served by the public water system to assess the effectiveness of corrosion control. However, the vast majority of centers are served by public water systems and would only test their water for lead at the point-of-use on a voluntary basis.

The proposed rule amends 15 NCAC 18A .2816 of the Rules Governing the Sanitation of Child Care Centers to require the testing of lead in water in licensed child care centers. Under the proposed rule amendment, child care operators would be responsible for collecting water samples from all water outlets used for drinking and food preparation and submitting the samples for lead analysis to a laboratory certified by the North Carolina State Laboratory of Public

Health. Child care operators would be required to test their water within a year of the rule's implementation and every three years thereafter. If testing reveals that all water samples are below the lead hazard level, no further action is required. If NC DHHS is notified by the laboratory that a sample submitted for analysis under the rule has a lead concentration at or above the lead hazard level, the local health department would conduct follow-up testing within seven calendar days of this notification. If follow-up testing confirms the presence of elevated lead, child care operators would be required to reduce lead in the contaminated water outlets.

III. PURPOSE OF RULE CHANGE

Testing and mitigating lead in drinking water in child care centers is fundamental for reducing and preventing children's exposure to lead. Child care centers serve children of very young ages, which is one of the most vulnerable populations to be exposed to lead. The United States Environmental Protection Agency ("EPA") estimates that drinking water can potentially account for up to 20% of a person's exposure. For formula fed infants, who receive all of their nutritional intake from formula mixed with water, lead in water can account for as much as 40 - 60% of exposure.[1] Results of recent studies support that water contaminated with lead is a significant contributor to blood lead levels in children. For example, an increase in the incidents of elevated blood lead levels in children has been linked to an increase in lead in water following source or chemistry changes in Flint, Michigan[2] and Washington DC.[3] Lead in water has also been found to correlate with blood lead levels in areas that were not experiencing system-wide spikes in lead concentrations.[4]

Young children (<6 years of age) more readily absorb lead and are in a critical life stage for brain development. Following intake, lead is carried by the blood throughout the body, where it is then distributed to the brain, liver, kidneys, and bones. There is no safe level of lead exposure for a child. Even children with relatively low concentrations of lead in their blood (<5 micrograms per deciliter or "µg/dL") are at a greater risk of cognitive impairments that can negatively impact their IQ score and academic achievement as well as neurobehavioral disorders including attention-deficit/hyperactivity disorder ("ADHD").[5] The negative effects of lead exposure on a child's cognitive and behavioral development are often irreversible and can have long-term implications for a child's health and economic well-being.

The most effective way to protect children from the negative effects of lead is to prevent exposure. Lead poisoning prevention policies and legislation enacted over the last 50 years have

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[1] Environmental Protection Agency, *Basic Information about Lead in Drinking Water*, https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water (accessed 22 March 2019).
[2] Hanna-Attisha et al., *Elevated Blood Lead Levels in Children Associated with the Flint Drinking Water Crisis: A Spatial Analysis of Risk and Public Health Response*, 106 American Journal of Public Health 283-290 (2016).
[3] Edwards et al., *Elevated Blood Lead in Young Children Due to Lead-Contaminated Drinking Water: Washington, DC*, 2001-2004, 43 Environmental Science and Technology 1618-1623 (2009).
[4] Lanphear *et al., Environmental Exposures to Lead and Urban Children's Blood Lead Levels,* 76 Environmental Research, Section A 120-130 (1998); Ngueta et al., *Use of a Cumulative Exposure Index to Estimate the Impact of Tap Water Lead Concentration on Blood Lead Levels in 1- to 5-Year-Old Children (Montreal, Canada)*, 124(3) Environmental Health Perspectives, 388-395 (2016).
[5] American Academy of Pediatrics (AAP). Prevention of childhood lead toxicity. (July 2016) *Council on Environmental Health*. *Pediatrics*, 138(1): 1-15.

removed or reduced lead in various consumer products such as gasoline and paint. These measures have been accompanied by a significant decrease in the prevalence of children with elevated blood lead levels across the United States.[6] Still, from 2013-2017, an average of 1.7% of tested one- and two-year-old children in North Carolina had at least one test result at or exceeding five µg/dL, the level at which health intervention is recommended.[7] 0.58% of tested children aged six months to six years had confirmed lead levels at or exceeding five µg/dL.[8] A child has a "confirmed" elevated blood lead level when two consecutive tests within a 12-month period indicate a blood lead level at or exceeding five µg/dL.

Upon notice of a confirmed elevated blood lead level, NC DHHS offers to conduct an environmental investigation of the child's primary residence to identify the source of the lead hazard. These investigations have identified paint, dust, soil, water, spices, toys, candy, vinyl miniblinds, and other items as sources of children's elevated blood lead levels. Data on the portion of elevated blood lead levels attributable to each of these sources are not readily available, although lead-based paint has historically been the most common source of exposure for children with blood lead levels at or greater than ten µg/dL. NC DHHS began conducting environmental investigations for children with blood lead levels between five and nine µg/dL only recently, since July 2018. In these recent investigations, NC DHHS has noticed that lead-based paint is less often identified as a source of exposure among children with blood lead levels within this range.

NC DHHS conducts an investigation of a child's primary residence as well as supplemental addresses, such as child care centers, only when a child is confirmed to be "lead poisoned." A child is lead poisoned if he or she has had two consecutive test results at or exceeding ten µg/dL within a 12-month period. As it currently stands, if lead in water in child care centers is contributing to children's blood lead levels, it may never be revealed except in extreme and unusual cases.

The benefits of implementing lead poisoning prevention controls to the individual and to society have been well documented and are extensive. Specifically, the economic and social benefits of reducing childhood blood lead levels fall into four categories, as follows:

1. Health care cost savings: At low blood lead levels, children often require nurse visits to conduct diagnostic testing, venipuncture, and lead assays. At higher blood lead levels, health care costs increase with repeat doctor visits and additional testing. At very high blood lead levels, chelation therapy is required.[9] Additionally, approximately 20% of

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[6] Center for Disease Control and Prevention (CDC), *Lead in Drinking Water and Human Blood Lead Levels in the United States*, Morbidity and Mortality Weekly Report (Aug. 10, 2012).
[7] NC DHHS Children's Environmental Health, Childhood Lead Poisoning Prevention Program, Lead Surveillance Data 2013 - 2017, available at https://ehs.ncpublichealth.com/hhccehb/cehu/lead/data.htm (accessed 21 March 2019).
[8] Kim Angelon-Gaetz, *Running the Numbers: Trends in Lead Poisoning Prevention Date for Children Aged <6 Years in North Carolina*, 79(5) North Carolina Medical Journal, 339-342 (2018).
[9] Elise Gould, *Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control*, 117 Environmental Health Perspectives, 1162-1167 (2009).

ADHD cases are attributable to blood lead levels greater than two μg/dL which has costs associated with the management and treatment.[10]

2. Special education cost savings: The negative effects of childhood blood lead levels on one's intelligence quotient ("IQ") along with other learning abilities increases in the need for special education. Elevated childhood blood lead levels impede speech and language processing, ability to focus and pay attention, and overall classroom performance.[11] Studies have estimated 20% of children with blood lead levels above 25 μg/dL require special education for an average of three years.[12]

3. Avoided losses in lifetime earnings: One of the most established consequences of childhood lead poisoning is the influence of childhood blood lead levels on IQ, and the subsequent negative repercussions on lifetime earning potential. Blood lead levels are associated with lowered IQ scores, which are associated with losses in lifetime earnings.[13]

4. Crime and enforcement cost savings: Many studies have linked the presence of childhood blood lead levels to the likelihood of criminal activity later in life, as elevated blood lead levels influence behavioral disorders which are associated with increased criminal activity.[14] Costs associated with crimes can include victim costs, legal proceedings, incarceration fees, and lost earnings of both the criminal and the victim.

IV. ANALYSIS

The proposed rule amendment will have an economic impact on State Government, Local Government, and the Private Sector. Costs are estimated for the five-year period following the implementation of the rule (2020 - 2025). We expect that testing costs incurred by child care centers during the first three-year cycle of the rule's implementation will repeat for every three-year cycle thereafter. Mitigation costs incurred by child care centers will be highest during the first year of the rule and are expected to substantially decline in the subsequent testing cycles, as the vast majority of water outlets with elevated lead would have been mitigated after the first testing cycle. Mitigation costs that arise during future testing cycles could be attributed to the licensure of new centers and the presence of unforeseen plumbing issues or water changes that result in elevated lead in the water from outlets that were previously in compliance.

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[10] Braun et al., *Exposures to Environmental Toxicants and Attention Deficit Hyperactivity Disorder in U.S. Children*, 114 Environmental Health Perspectives, 1904-1909 (2006).
[11] Elise Gould, *Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control*, 117 Environmental Health Perspectives, 1162-1167 (2009); N. Zhang *et al.*, *Early Childhood Lead Exposure and Academic Achievement: Evidence from Detroit Public Schools, 2008-2010*, 103 American Journal of Public Health, 72-77 (2013).
[12]Joel Schwartz, *Societal Benefits of Reducing Lead Exposure*, 66 Environmental Research, 105-124 (1994).
[13] Grosse *et al.*, *Economic Gains Resulting from the Reduction in Children's Exposure to Lead in the United States*, 110 Environmental Health Perspectives 563- 570 (2002).
[14] Rick Nevin, *Understanding International Crime Trends: The Legacy of Preschool Lead Exposure*, 104 Environmental Research, 315-336 (2007).

We anticipate that costs associated with the initial round of testing would be funded by EPA's Lead Testing in School and Child Care Programs Drinking Water Grant, authorized under the Water Infrastructure Improvements for the Nation (WIIN) Act. On April 29th, 2019, the EPA announced that $964,000 would be allocated to North Carolina to fund testing for lead in water in schools and child care centers. NC DHHS intends to submit a grant application to receive this funding, which is non-competitive, and use the funds to reimburse testing costs to child care operators, the State Laboratory of Public Health, and local health departments in fiscal year 2020.

We estimate the benefits accrued over this same time period (2020 - 2025) which include increased revenue from lead testing at private laboratories and the State Laboratory of Public Health as well as avoided health care costs. In addition to these immediate benefits, reducing lead in water in child care centers is expected to result in benefits that will be accrued over the lifetime of the enrolled cohort of children in the form of avoided losses in lifetime earnings. Potential benefits in the form of avoided special education costs and avoided crime costs would also be accrued over the lifetime of the cohort and are presented for each child that experiences the benefits. However, any special education and crime benefits from the proposed rule amendment are likely to be small, and this analysis does not attempt to quantify how many children are expected to receive these benefits.

Benefits in the form of avoided health care costs are quantified for one- and two-year-old children only for the following reasons: 1) the North Carolina Childhood Lead Poisoning Prevention Program encourages lead screening when children are one- and two-years-old, providing a robust dataset of children's baseline blood lead levels for this age group, and 2) since lead screening is most often conducted at ages one and two, these are the ages that health interventions would typically be implemented. Benefits in the form of avoided losses in lifetime earnings are quantified for children five years of age and younger.

The following sections anticipate the number of children that will be subject to the rule amendment and could experience the mentioned benefits, both short term and long term, from avoided or reduced exposure to lead. However, the magnitude of the benefits that these children could experience is uncertain, as it depends on the baseline lead concentrations of the center's drinking water and the contribution of the center's water to the child's overall exposure. These uncertainties are explored further in the sensitivity analysis presented in Section VI.

Licensed Child Care Center Characteristics and Projections

The rule amendment applies to child care centers licensed through NC DHHS. As of March 2019, there are 4,453 licensed child care centers, ranging in size from 0 to 394 children and serving a total of 237,683 children (mean average of 53 children per center; median average of

39 children per center).[15] The age distribution of children enrolled in centers is provided in Table 1 and is assumed to be constant in future years.[16]

Data from the Division of Child Development and Early Education's Statistical Summary Reports from 2014 - 2018[17] suggest that the number of child care centers is slightly decreasing from year to year while the number of enrolled children does not show a strong increasing or decreasing trend. This analysis was done by averaging the monthly data from each year and conducting a simple linear regression. We use this linear regression to project the number of child care centers from 2020 to 2022 that will be subject to the rule amendment and assume that the number of children enrolled across all centers will remain constant (Figures 1 and 2). In 2020, we project that 4,375 centers will serve 237,683 children (mean average of 54 children per center).

Table 1. Age distribution of children enrolled in all licensed child care centers as of March 2019.

Age Category	**Number (%) of Children Enrolled in Centers (as of March 2019)**
Infants (<12 months)	12,373 (5.2%)
1 - 2 years old	52,116 (21.9%)
3 - 5PS years old	117,930 (49.6%)
5-12 years old	55,264 (23.3%)
Sum	237,683 (100%)

[15] Personal correspondence with Mandy Holland, Information Specialist, Division of Child Development and Early Education, Regulatory Services Section (13 March 2019)
[16] North Carolina DHHS Division of Child Development and Early Education Child Care March 2019 Statistical Report available at https://ncchildcare.ncdhhs.gov/County/Child-Care-Snapshot/Child-Care-Statistical-Report (accessed 25 April 2019).
[17] North Carolina DHHS Division of Child Development and Early Education Child Care Statistical Reports available at https://ncchildcare.ncdhhs.gov/County/Child-Care-Snapshot/Child-Care-Statistical-Report (accessed 13 March 2019).

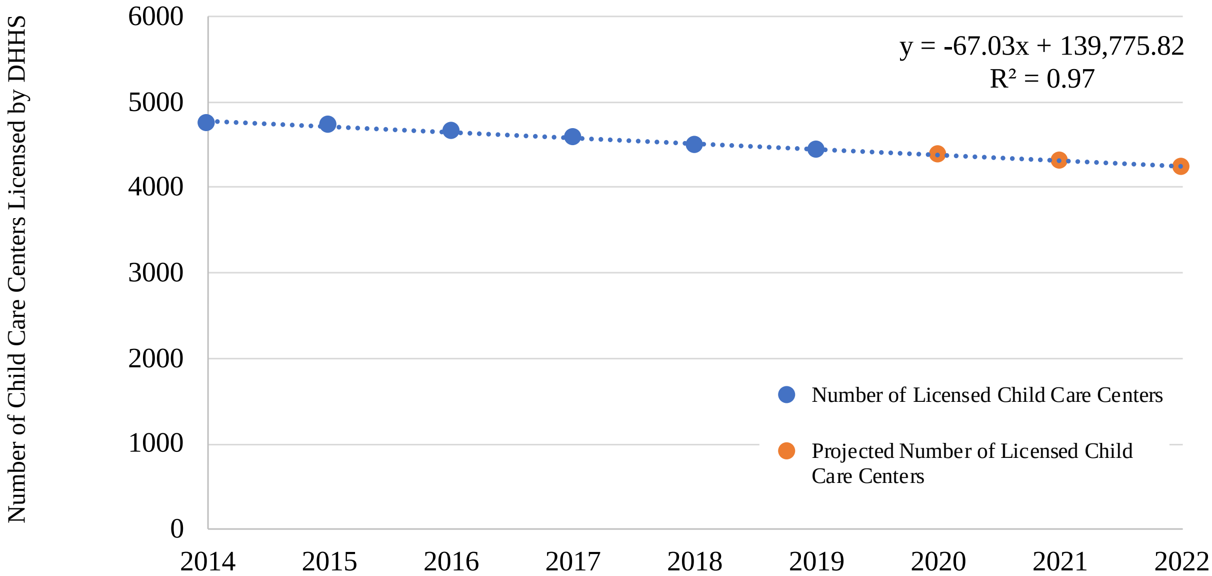

Figure 1. Number of child care centers licensed by NC DHHS from 2014 to January 2019 (shown by blue circles) and the projected number of licensed centers from 2020-2022 (shown by orange circles).

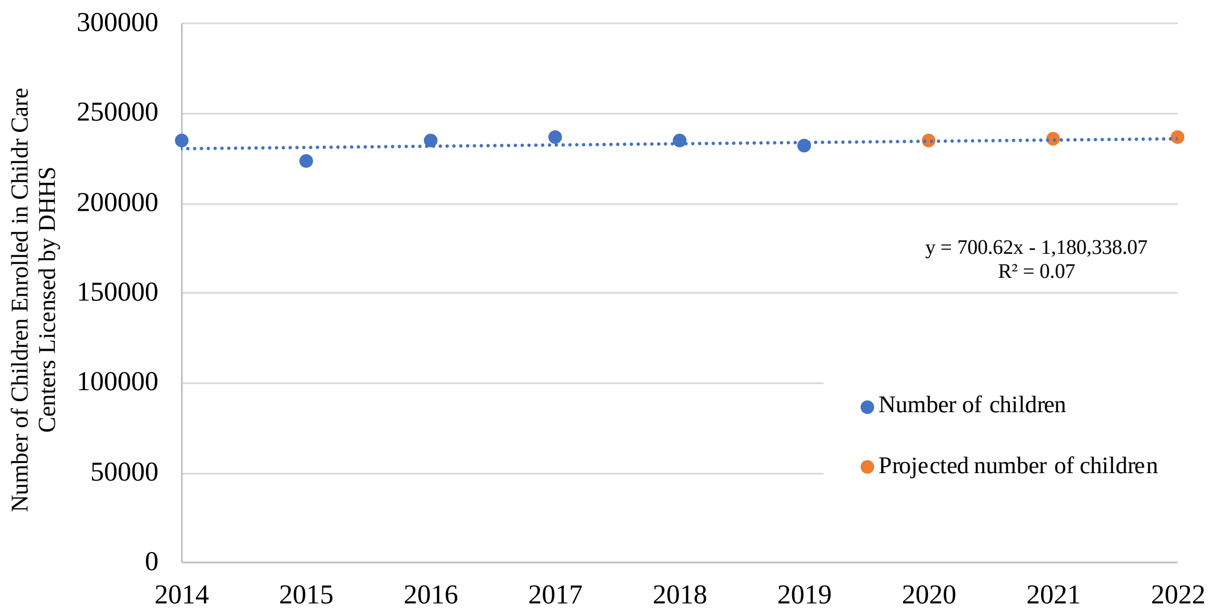

Figure 2. Number of children enrolled in all licensed centers from 2014 to January 2019 (shown by blue circles) and the projected number of children enrolled in licensed centers from 2020-2022 (shown by orange circles).

Predicted Deviation from Baseline following Rule's Implementation

The goal of the rule amendment is to reduce children's exposure to lead in water and ultimately reduce the prevalence of children with elevated blood lead levels (≥5 µg/dL) in North Carolina. Blood lead screening data from 2017 indicates that 1.3% of one- and two-year-old children in North Carolina have blood lead levels at or exceeding five µg/dL. The majority of children with elevated blood lead levels tested at or very near this threshold (32% of elevated blood lead level test results were five µg/dL and 18% were six µg/dL; Figure 3). Since 2013, lead screenings indicate that the percent of one- and two-year-old children with blood lead levels greater than five µg/dL has been decreasing (Figure 4). We use a simple linear regression to project how blood lead levels might continue to decrease in future years. This regression predicts that, in 2020, approximately 1.0% of tested one- and two-year-old children will have blood lead levels greater than five µg/dL.

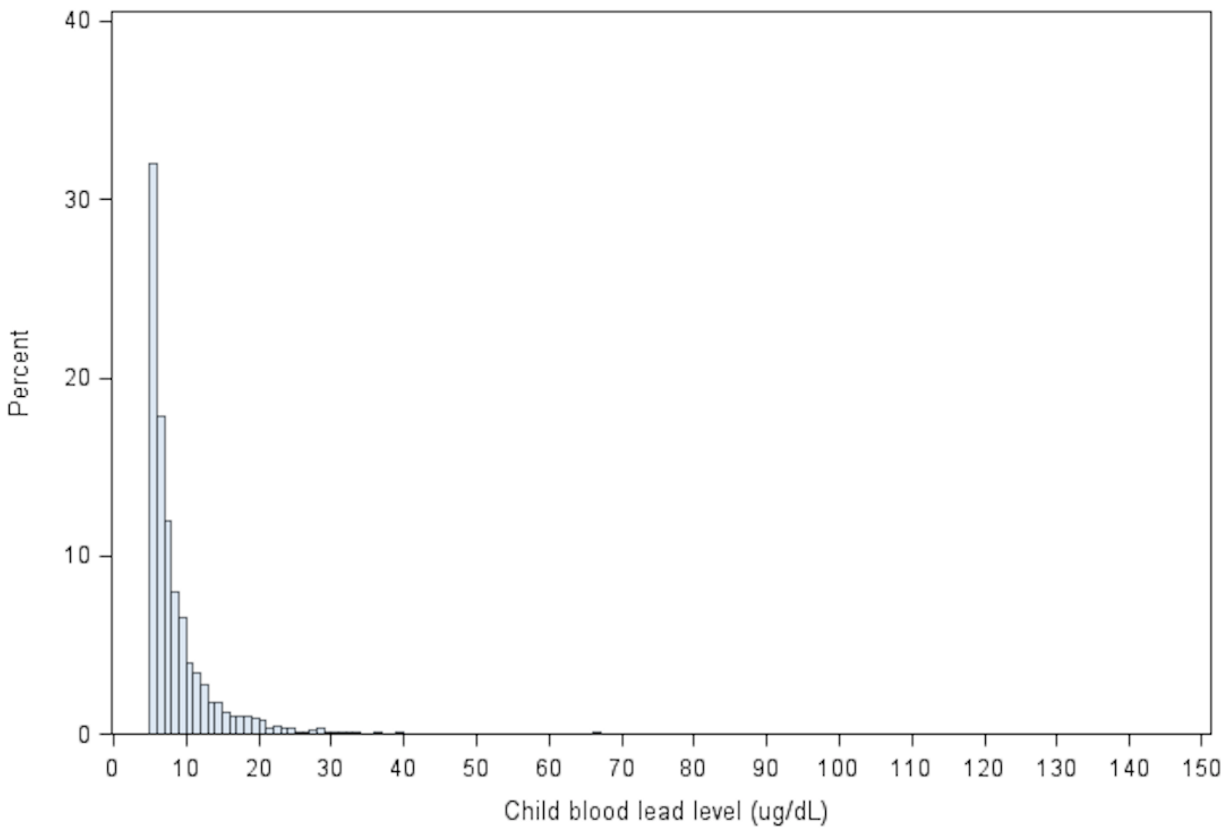

Figure 3. Distribution of blood lead test results greater than or equal to five µg/dL for one- and two-year-old children in 2017.

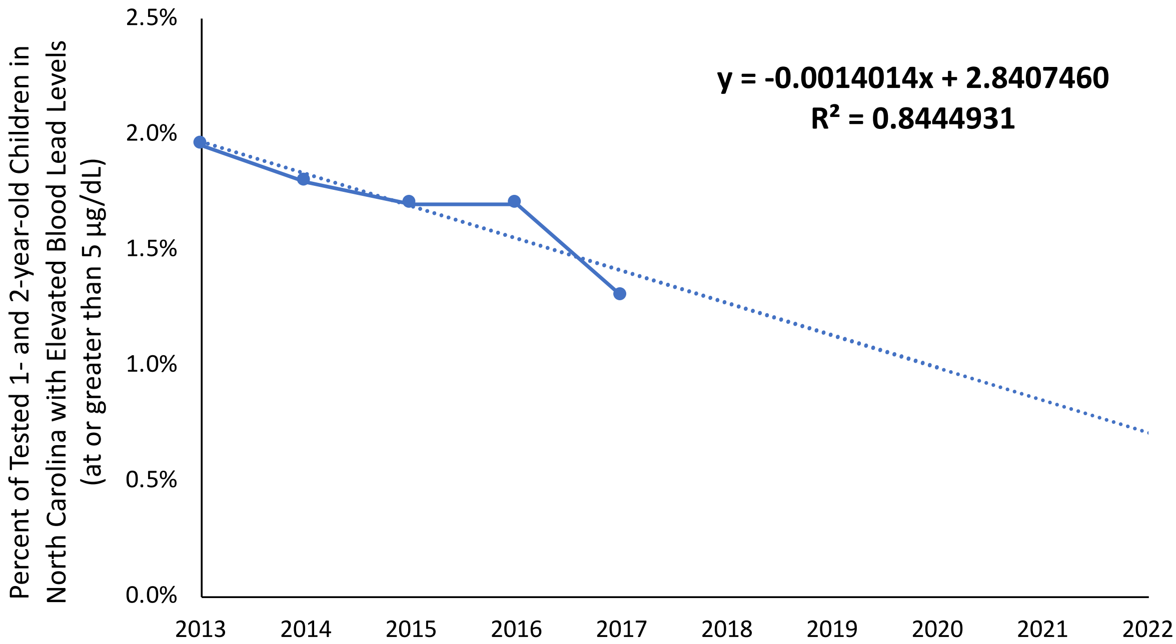

Figure 4. Percent of tested one- and two-year-old children in North Carolina with at least one elevated blood lead test result (≥5 µg/dL) from 2013 to 2017 (shown by blue circles) and the projected percent of tested one- and two-year-old children with at least one elevated blood lead test result from 2020 to 2022 (shown by the blue dotted line).

Of the 237,683 children enrolled in child care centers, we estimate that 38,029 (16%) of them attend child care centers that have at least one water outlet with lead at or above the action level and could be protected from this source of exposure if rule amendment is implemented.[18] 28,028 of these children are likely five years of age and younger (Table 2). If we assume that the distribution of blood lead levels in one- and two-year-old children enrolled in child care centers with elevated lead in the water mimics that of all tested children, 83 (1% of 8,328) one- and two-year-old children with elevated blood lead levels will be enrolled in the affected centers and could have avoided or lessened exposure under the proposed rule amendment. In reality, the number of one- and two-year-old children in centers with contaminated water could be higher than the state average due to the added exposure from contaminated water outlets, but likely does not exceed 521 children (1% of all 52,116 one- and two- year old children enrolled in all centers).

[18] Preliminary results obtained from personal correspondence with Jennifer Redmon, Senior Environmental Health Scientist at RTI International (7 February 2019).

Table 2. Estimated age distribution of children enrolled in licensed child care centers with elevated lead in the drinking water.

Age Category	Number (%) of Children Enrolled in Centers
Infants (<12 months)	1,978 (5.2%)
1 - 2 years old	8,328 (21.9%)
3 - 5 years old	17,722 (46.6%)

It is difficult to predict how many of the estimated 83 - 521 cases of elevated blood lead levels could be avoided under the proposed rule amendment. Data on baseline lead concentrations of the center's drinking water and the contribution of the center's water to the child's overall exposure are imperative to estimating the rule's effect on children's blood lead levels. We employ EPA's lead exposure model to better characterize the impact of exposure to lead in water in child care centers on children's blood lead levels but acknowledge that the magnitude of the exposure that drinking water in child care centers poses to children in North Carolina cannot truly be determined without robust and consistent testing. The model suggests that if the proposed rule amendment can prevent the 8,328 one- and one-year-old children in the affected centers from each receiving 8% of their total water from an outlet contaminated with 30 ppb lead, we estimate that 15 fewer one- and one-year-old children would have elevated blood lead levels. Depending on the portion of water that a child receives from the contaminated outlets and the concentration of lead in the outlet, sensitivity analysis suggests a range of 11 - 208 one- and two-year-old children could avoid elevated blood lead levels. For all 28,028 children five years of age and younger attending centers with elevated lead in the drinking water, we estimate an average avoided blood lead level increase of 0.2 μg/dL under the proposed rule amendment. For individual children that receive a relatively greater proportion of their water from a contaminated outlet, compared to the average child represented in this analysis, the avoided blood lead level increase would likely be higher.

Private Sector Impact

Here we present the costs and benefits incurred by the private sector. Costs incurred by the child care center operator are associated with 1) testing all water taps used for drinking or food preparation in licensed child care centers in North Carolina, and 2) mitigating all taps that reveal lead concentrations above the lead hazard level of 15 ppb. Benefits accrued by the private sector include increased revenue at private labs, avoided health care costs, and avoided losses in lifetime earnings.

Costs of Testing to the Private Sector

Under the rule amendment, licensed child care centers will be required to test water from all water outlets used for drinking and food preparation within one year of the implementation of the rule and at least every three years thereafter. These outlets could include faucets in kitchens, classrooms, and bathrooms as well as drinking water fountains, water coolers, and other drinking water sources. In 2018, RTI International investigated the presence of lead in water in 86 child care facilities in Orange, Durham, Wake, and Guilford counties in their Clean Water for North Carolina Kids study. In this study, RTI International surveyed the number of water outlets in child care centers, and the preliminary results suggest that the number of water outlets in child care centers used specifically for drinking can range from 0 - 26, with a median of three water outlets; the number of water outlets used for cooking range from 0 - 3, with a median of one water outlet.[19] Therefore, we assume that the median sized child care center (39 children) has four water outlets that are used for drinking and/or food preparation, suggesting that child care centers typically rely on approximately one tap for every ten children enrolled. Since child care centers are expected to serve a mean average of 54 children in 2020, we estimate that centers will have an average of five water outlets used for drinking or food preparation that will need to be tested under the rule amendment.

Laboratory testing for lead ranges from $9-20 per water sample, depending on the number of samples submitted for testing and the state certified laboratory chosen to complete the lead analysis.[20] The assumed average testing cost per sample is $15, which would amount to $75 per center for an average sized center with five water outlets. Centers will pay higher testing costs, potentially exceeding $50 per sample, if they decide to hire a consultant or laboratory technician to perform the sampling, in which case the center would pay for someone to collect and test each sample. However, hiring a consultant to collect samples is likely unnecessary given that most centers will have relatively few water outlets and collecting samples for lead analysis can be done easily by a child care operator.

We do not anticipate any additional costs associated with training child care operators to conduct sampling. Written instructions are expected to be sufficient to explain the sampling procedure which includes, in short, labelling the sample bottle, removing the lid of the sample bottle, placing the bottle under the faucet or fountain spigot where you anticipate the water to come out, and filling the bottle to the neck with tap water. Child care operators will be required to collect one first-draw sample at each water outlet used for cooking or drinking in the morning before any water in the building has been used.

Statewide, we estimate that licensed child care centers will incur a total testing cost of $328,125 within the first year of the implementation of the rule (Table 3). Centers will incur this testing cost every three years thereafter. We anticipate that testing costs to child care operators in fiscal year 2020 would be reimbursed with funds from the EPA WIIN grant.

Table 3. Calculation of total testing costs incurred by child care centers in the first year of the implementation of the rule amendment and every three years thereafter.

Number of licensed child care centers	4375 centers
Average number of water outlets per child care center used for drinking or food preparation	5 outlets
Lead analysis cost per sample at a certified laboratory	$15
Total cost of testing across all centers (4,375 centers x 5 water outlets x $15)	$328,125

[19] Personal correspondence with Anna Aceituno, RTI International (21 June 2018).
[20] Personal correspondence with Jennifer Redmon, Senior Environmental Health Scientist at RTI International (22 March 2018).

Costs of Mitigation to the Private Sector

If testing reveals that a water outlet has lead above the action level, the child care center operator would be required to implement mitigation measures to ensure that children attending the center do not continue to be exposed to contaminated water. The preliminary results of RTI International's Clean Water for North Carolina Kids study indicate that 16% of centers had at least one outlet with lead above 15 ppb, with an average of 1.2 outlets.[21] Based on the preliminary results of RTI International's Clean Water for Carolina Kids study, we assume that 700 centers (16% of the 4375 licensed centers across the state) will have to mitigate an average of 1.2 outlets following the first round of testing.

Mitigation options that are considered in this analysis are filtration, fixture replacement, and completely removing the water outlet. A child care center must consider several factors to determine the most appropriate mitigation technique for their situation. These considerations are discussed in the following paragraphs. This analysis does not consider bottled water or lead service line replacements, as they would not be viable options for child care centers in the majority of cases. Bottled water is exceptionally costly ($1-2/gallon) and is not recommended as a long-term solution for child care centers. Lead service line replacements are also costly, can be disruptive to the day-to-day operations of the center, and can potentially result in large spikes in lead concentrations if only a portion of the leaded line is replaced.

Installation of filters at the point-of-use can be a cost effective and reliable mitigation technique for child care centers. Following the distribution of independently certified point-of-use filters in Flint, Michigan in the midst of the lead contamination crisis, the EPA found that filters were able to reduce the concentration of lead in nearly all drinking water samples to below one ppb.[22] The total cost of mitigation by filtration includes the cost of initial filter purchase and the cost of replacement filter cartridges. If a center chooses to mitigate taps using point-of-use filters, one filter will need to be purchased per tap. Typically, the initial purchase cost of a filter ranges from $30-500. Note that this cost does not include installation fees, which may be incurred for under counter filters that are plumbed into a separate tap. An average filter cost of $150 can be assumed, based on the mean average cost of 20 commercially available faucet mount, counter top, and under counter filters. Filter maintenance is, on average, $0.10 per gallon.

The total cost of replacement filter cartridges is a function of the amount of water consumed at centers. The EPA suggests a total tap water intake rate for children of one liter per day.[23] Since this consumption takes place during waking hours (assumed to be approximately 12 hours), a

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[21] Preliminary results obtained from personal correspondence with Jennifer Redmon, Senior Environmental Health Scientist at RTI International (7 February 2019).

[22] US EPA Flint, MI Filter Challenge Assessment (2016), available at https://www.epa.gov/sites/production/files/2016-06/documents/filter_challenge_assesment_field_report_-_epa_v5.pdf (accessed 5/24/18); US EPA, Flint Water Sampling Objectives: Testing In-Home Lead Filters, available at https://www.epa.gov/flint/flint-water-sampling-objectives#FilterEfficacy (accessed 5/23/18).

[23] *Total tap water* is defined as all water from the household tap consumed directly as a beverage or used to prepare foods and beverages; U.S. Environmental Protection Agency, National Center for Environmental Assessment, Office of Research and Development, *Exposure Factors Handbook*, Washington, DC: US Environmental Protection Agency, 1997. Available at https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=12464 (accessed 21 March 2019).

child's average water consumption rate is 0.083 liters per hour. The U.S. Census Bureau found that children spend an average of 25 to 33 hours at day care facilities each week, depending on the working situation of the parents.[24] If we assume that children spend an average of 29 hours per week at child care, it can be estimated that each child consumes 2.4 liters of water per week at his or her child care center, equaling roughly 120 liters per year (50 weeks). Therefore, a center with the average number of enrolled children (54) will consume an estimated 6,480 liters (1,714 gallons) of water for drinking and food preparation over the course of a year. Assuming that water is drawn equally from water outlets in each child care center, each water outlet will supply approximately 1296 liters (343 gallons) of water per year. Accordingly, filter cartridge replacements for each filter would cost approximately $34 per year, or $41 per center per year, on average, as affected centers have an average of 1.2 contaminated water outlets.

Child care centers with faucets or drinking fountains purchased prior to 2014 may be able to mitigate elevated concentrations of lead in drinking water by replacing old fixtures with modern ones. For this mitigation technique to be efficacious, the operator of the child care center must determine that the fixture is the source of the lead. Operators would have a hunch as to whether a fixture is a source of lead when the local health department conducts follow-up testing. As instructed by the sampling protocol in the rule language,[25] the local health department will collect a first draw sample and a 30-second flush sample. If lead is present in the first draw sample and significantly lower in the 30-second flush sample, then the lead could be sourced from the fixture.[26] However, the success of this mitigation technique still would not be certain until an additional lead test, conducted after fixture replacement, confirms that lead has been reduced to below the lead hazard level. The total costs associated with this fixture replacement include the purchase cost and the installation cost of one fixture per water outlet. Typically, bathroom and kitchen faucets range in price from $50 - $200.[27] Wall mounted water coolers and fountains range in price from $400 - $1,000. If a contractor is hired to install the new fixture, installation costs are expected to range from $150 - $330 per outlet.[28]

A report from the Environmental Defense Fund ("EDF") on lead in water in child care facilities investigated the effectiveness of fixture replacement in reducing lead concentrations in water.[29] The report found that fixture replacement is successful some of the time, but lead can still be present in drinking water following fixture replacement due to 1) lead contributions from other places in the plumbing system, and 2) the leaching of lead from new fixtures, as NSF International's current standard allows up to five ppb lead to leach from modern faucets.

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[24] Lynda Laughlin, *Who's Minding the Kids? Child Care Arrangements: Spring 2011,* U.S. Census Bureau (2013), available at https://www2.census.gov/library/publications/2013/demo/p70-135.pdf.

[25] The proposed rule amendment requires that sample collection is carried out according the EPA *3T's for Reducing Lead in Drinking Water in Schools and Child Care Facilities*.

[26] EPA, *3T's for Reducing Lead in Drinking Water in Schools and Child Care Facilities: Revised Manual* (2018), available at https://www.epa.gov/ground-water-and-drinking-water/3ts-reducing-lead-drinking-water-toolkit.

[27] Home Depot, *Kitchen Faucets*, available at https://www.homedepot.com/b/Kitchen-Kitchen-Faucets/N-5yc1vZar0k?catStyle=ShowProducts (Accessed 13 August 2018). Home Depot, *Bathroom Faucets*, available at https://www.homedepot.com/b/Bath-Bathroom-Faucets-Bathroom-Sink-Faucets/N-5yc1vZc8d3?catStyle=ShowProducts (Accessed 13 August 2018).

[28] HomeAdvisor, *True Cost Guide*, available at https://www.homeadvisor.com/cost/ (Accessed 13 August 2018).

[29] Lindsay A. McCormick and Sam C. Lovell, *Putting children first: Tackling lead in water at child care facilities*, Environmental Defense Fund (2019), available at https://www.edf.org/sites/default/files/edf_child_care_report_01-19.pdf.

A center may choose to close down a water outlet entirely by physically removing it or shutting off the water that flows to it, which may come at almost no cost to the center. Centers may implement this mitigation technique when a water outlet is rarely used and not in a prominent location in the center. However, if the water outlet is the only one available in the center or if it is in a prominent location, closing down the outlet may impede the centers ability to provide sufficient access to water.

Statewide, we estimate that licensed child care centers will incur a total mitigation cost of $126,000 within the first year of the implementation of the rule, assuming all centers choose to mitigate with a filter that costs, on average, $150 (Table 4). Centers that choose to mitigate by installing a filter will incur an average cost of $41 each year thereafter as they will need to purchase replacement filter cartridges, totaling $28,700 across all centers. In the sensitivity analysis in section VI, we show the range of mitigation costs that could be expected due to centers employing mitigation techniques other than filtration.

Table 4. Calculation of total mitigation costs incurred by child care centers in the first year of the proposed rule amendment.

Number of centers with at least one sample above 15 ppb (16% x 4375 centers)	700 centers
Average number of water outlets with lead above action level at affected centers	1.2 outlets
Total number of water outlets requiring mitigation (1.2 outlets x 700 centers)	840 outlets
Average cost of filter	$150
Total mitigation cost across all centers if filtration is chosen as the mitigation technique (700 centers x 1.2 water outlets x $150 per filter)	$126,000

Benefits to the Private Sector: Increased Revenue at Private Labs

Private laboratories are expected to receive an additional $328,125 from licensed child care centers for lead analyses every three years.

Benefits to the Private Sector: Avoided Health Care Costs

Even children with relatively low blood lead levels require regular monitoring and medical intervention. As blood lead levels increase, the costs associated with uncovering and treating the health effects also increase. For example, at low blood lead levels, children may require a nurse visit to conduct diagnostic testing, venipuncture, and a lead assay at an estimated cost of $94. At high blood lead levels, chelation therapy is required, at a cost of $1,702 for oral chelation or $4,390 for intravenous chelation.[30] This cost range, $94 - $4,390, is possible across all blood lead

[30] Elise Gould, *Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control*, 117 Environmental Health Perspectives, 1162-1167 (2009); Kemper et al., *Cost-effectiveness*

levels, but the higher costs are generally associated with the small number of children with very high blood lead levels (>45 μg/dL). We assume that the immediate health care costs for the vast majority of children with blood lead levels greater than five μg/dL will cost $94.

The total benefit to the private sector in the form of avoided health care costs is a function of the number of one- and two-year-old children that are expected to avoid a blood lead level at or greater than five μg/dL, since it is at a blood lead level of five μg/dL that it is recommended that children receive medical intervention. It is difficult to predict how many of the estimated 83-521 cases of elevated blood lead levels could be avoided under the proposed rule amendment without knowledge of the baseline lead concentrations of the center's drinking water and the contribution of the center's water to the child's overall exposure, but this analysis attempts to constrain these parameters with the best-available information.

Children receive only a portion of their water from child care centers, and likely an even smaller portion from the contaminated outlet if only a fraction of the outlets are affected. Based on the average number of hours (29) that a child spends at a center, we estimate that children receive approximately 35% of their water from a child care center, which would be the maximum portion that a contaminated water outlet at the child care center could contribute to a child's overall water intake. If a child drinks equally from each water outlet, we estimate that 8%, on average, of his or her water will come from outlets that are contaminated. We expect that lead concentrations in water outlets that need to be mitigated could range from 15 ppb, the lead hazard level, to 100 ppb (EDF measured 91 ppb as the highest level in the 11 child care facilities tested in their study).[31] It should be noted that, while less common, studies have found that lead concentrations in drinking water can far exceed 100 ppb. For instance, a school in Seattle, Washington had a water outlet with a lead concentration of 1,600 ppb.[32]

We used EPA's Integrated Exposure Uptake Biokinetic ("IEUBK") model to assess the effect of water in child care centers on children's blood lead levels. The IEUBK model predicts the distribution of blood lead levels for children up to seven years of age given various environmental exposures including lead in soil, dust, food, and water. We used IEUBK default values for all parameters except soil and water. For soil, we selected an input value of 19.4 ppm, the median concentration of lead in soil in North Carolina as found in the United States Geological Survey's Background Soil-Lead Survey.[33] For water, we selected the EPA's default value of 4 ppb for the concentration of lead at the child's home and in uncontaminated water outlets at the child care center. With these and all other parameters fixed, we ran the model using various combinations of the portion of water consumed from contaminated outlets (8-35%) and the concentration of lead in those contaminated outlets (15-100 ppb) to demonstrate the range of possible impacts that the rule could have on children's blood lead levels. The full range of

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Analysis of Lead Poisoning Screening Strategies following the 1997 Guidelines of the Centers for Disease Control and Prevention, 152 Archives of Pediatrics and Adolescence Medicine, 1202-1208; inflated to 2018 USD.

[31] Lindsay A. McCormick and Sam C. Lovell, *Putting children first: Tackling lead in water at child care facilities*, Environmental Defense Fund (2019), available at https://www.edf.org/sites/default/files/edf_child_care_report_01-19.pdf.

[32] Sathyanarayana et al., *Predicting Children's Blood Lead Levels from Exposure to School Drinking Water in Seattle*, Washington, USA, 6 Ambulatory Pediatrics, 288-292 (2006).

[33] Smith et al., Geochemical and Mineralogical Data for Soils of the Conterminous United States, U.S. Geological Survey Data Series (2013), available at https://pubs.usgs.gov/ds/801/.

scenarios are presented for one- and two-year-old children in the uncertainty analysis in Section VI.

Figure 5 presents the modelled effect of elevated lead in water in child care centers for infants (<12 months; formula-fed[34] and not formula-fed), one- and two-year-old children, and three- to five-year-old children when these children receive 8% of their total water intake from contaminated taps at their child care center. The model suggests that when 8% of children's water intake is 30 ppb, 0.26% of the one- and two-year old children will have blood lead levels at or exceeding five μg/dL, amounting to 21 children across the estimated 700 centers expected to have elevated lead in at least one water outlet. This projection is lower than our previous baseline estimate, based on state lead screening results, of 83 - 521 children with elevated blood lead levels in child care centers with contaminated water likely due to the limitations of the model analysis. The IEUBK model does not account for the more unusual sources of lead exposure such as vinyl miniblinds, ceramic glazed pottery, and fishing weights – all of which have been found in environmental investigations to contribute to children's elevated blood lead levels. Additionally, the results of the model are most reliable on small scales, when site-specific data can be gathered and used as inputs. Using median values for parameters such as soil, and the default value of 4 ppb for background water, does not account for the contribution of extreme outliers that could also be responsible for cases of elevated blood lead levels. Still, the model exhibits the relationship between lead in water and the blood lead levels of children whose primary source of exposure are at average levels of these common sources. The results of the model give a sense of the magnitude of the number of elevated blood lead levels that could potentially be avoided under the proposed rule amendment. However, it should be emphasized that the true magnitude of the benefits of the rule cannot be known without results from comprehensive testing as proposed by the rule amendment.

The model suggests that when 8% of children's water intake is reduced from 30 ppb to 0.5 ppb, a typical scenario for centers that would be required to mitigate under the proposed rule amendment, the percent of one- and two-year-old children enrolled in these centers and expected to have elevated blood lead levels would drop from 0.26% to 0.08%, translating to approximately 15 children per year that would avoid elevated blood lead levels and the associated health care costs (Figure 5; Table 5).

The model suggests that lead in water has the largest effect on the blood lead levels of formula-fed infants, who receive nearly all of their nutritional intake from formula mixed with water. For this population, a reduction in lead from 30 ppb to 0.5 ppb in 8% of their water could result a decrease in the prevalence of formula-fed infants with elevated blood lead levels from 0.7% to 0.1%. If all infants enrolled in child care centers with elevated lead are formula-fed, 12 infants could potentially avoid elevated blood lead levels. Finally, for three- to five-year-old children, the model suggests that 0.07% (12 children) could potentially avoid elevated blood lead levels.

[34] To model the effect of lead in water on formula-fed infants, the IEUBK default values for water intake and diet were changed to 0.8 liters/day and 0 μg/day, respectively.

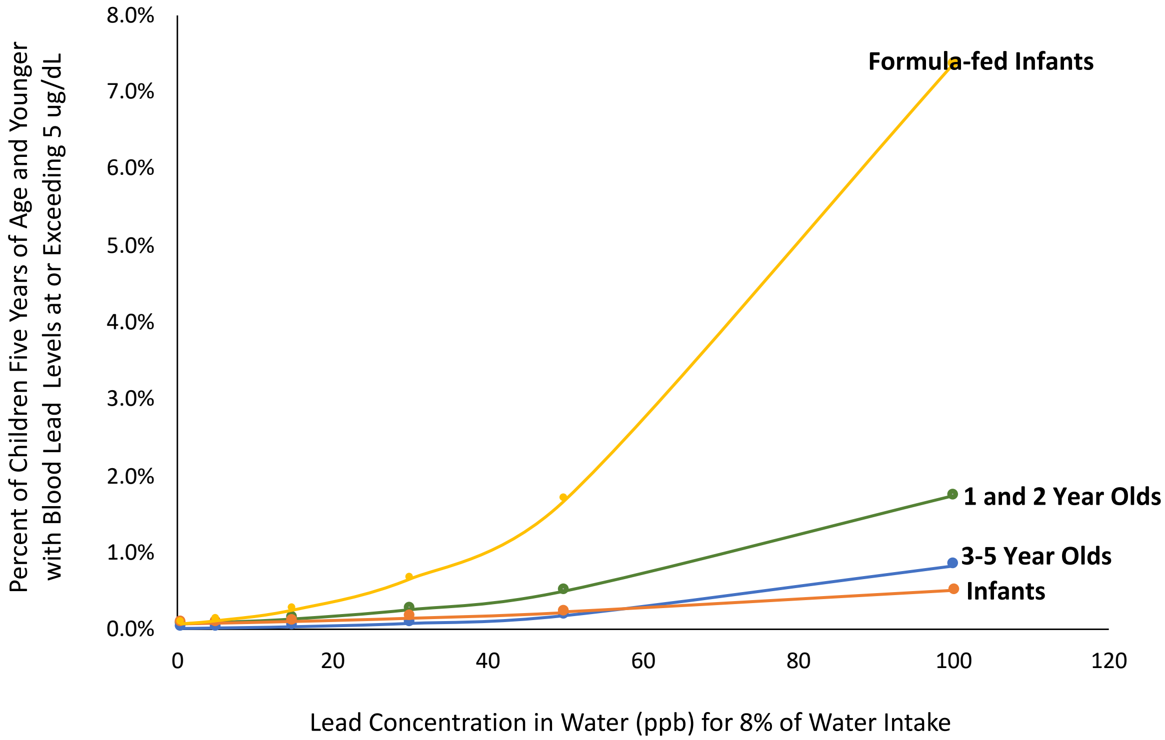

Figure 5. Percent of children five years of age and younger modelled to have elevated blood lead levels in response to consuming 8% of their water with various lead levels.

Table 5. Calculation of benefits as avoided health care costs.

Number of children enrolled in centers with lead in water above lead hazard level (16% x 237,683 children)	38,029 children
Number of one- and two-year-old children enrolled in centers with lead in water above lead hazard level (21.9% x 38,029 children)	8,328 children
Estimated number of one- and two-year-old children with blood lead levels ≥5 μg/dL in child care centers with lead in water above lead hazard level, based on state lead screening results (1% x 8,328) – (1% x 52,116)	83-521
Reduction in the number of 1- and 2-year-old children with blood lead levels ≥5 μg/dL when lead in water is reduced (0.18% x 8,328)	15 children
Health care costs associated with blood lead levels ≥5 μg/dL per child per year	$94-$4,390
Total health care costs associated with blood lead levels ≥5 μg/dL (15 children x $94)	$1,410

Benefits to the Private Sector: Avoided Losses in Lifetime Earnings

Lead in water can influence children's blood lead levels, leading to decreased IQ and ultimately lower lifetime earnings due to loss of productivity. Lanphear *et al.* compared the blood lead levels of a random sample of 183 children ages 12 – 31 months, taking into account various environmental lead exposures including paint, soil, and water.[35] After controlling for other environmental factors, lead in water was found to be independently associated with blood lead levels and their relationship can be modelled by a logarithmic relationship (Figure 6). According to this model, a child's exposure by reducing lead in water from 30 ppb to 0.5 ppb is associated with an avoided blood lead level increase of 1.9 μg/dL.

We quantify avoided losses in lifetime earnings from reducing lead in water from 30 ppb to background levels assuming that, on average, each child in an affected center is consuming 8% of their water from a tap with 30 ppb lead. The background level of 0.5 ppb used in this analysis aligns with the expected concentration of lead that would be present in water following mitigation through filtration. We estimate that children in centers with lead above the lead hazard level will avoid an average increase of 0.2 μg/dL in their blood lead level under the proposed rule amendment if they are receiving 8% of their water from a contaminated tap with 30 ppb lead, and 92% of their water from other sources with an average of 4 ppb lead (volume-weighted average lead concentration of intake water is 6.1 ppb prior to the rule amendment, volume-weighted average lead concentration of intake water is 3.7 ppb following the rule amendment).

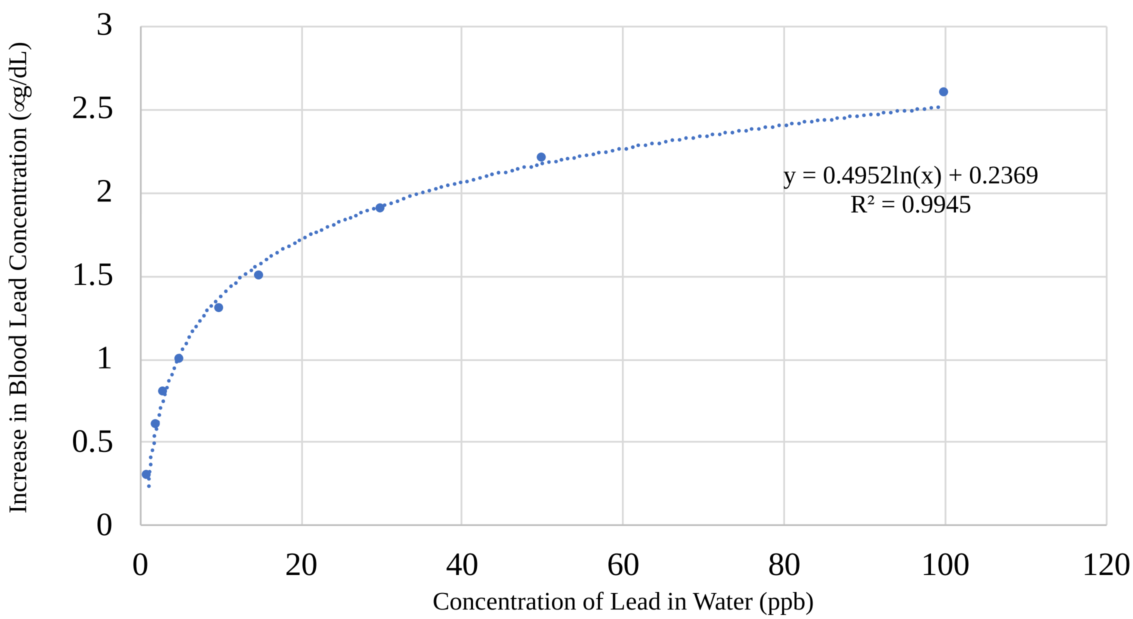

Figure 6. Modelled increase in children's blood lead levels due to an increase in lead concentrations in water from background concentrations. Data from *Lanphear et al. 1998*.

[35]Bruce P. Lanphear *et al., Environmental Exposures to Lead and Urban Children's Blood Lead Levels,* 76 Environmental Research, Section A 120-130 (1998).

Grosse *et al.* suggests that a one μg/dL increase in blood lead level is associated with a decrease in IQ of 0.185-0.323 points (average = 0.254 points) and, for every IQ point lost, a loss in lifetime earnings of 1.76-2.38% (average= 2.07%), due to the negative impact of lowered IQ on productivity.[36] A child who is now two years old is expected to earn the equivalent present-day value of $259,129 over the course of his or her life (using a 7% discount rate, assuming a 1% annual growth in labor productivity, and adjusted for inflation to 2019 USD using the CPI).[37] The undiscounted value of expected lifetime earnings is $2,357,000. Using this estimate, a 0.2 μg/dL increase in blood lead levels could result in $169 - $398 (average = $272) lost in lifetime earnings per child (Table 6). Grosse *et al.* suggests that the linear slope coefficient used to relate children's blood lead levels and IQ score likely underestimates the change in IQ attributable to lowered blood lead levels, as the relationship is most likely non-linear, with greater slopes for blood lead levels below ten μg/dL. Accordingly, the avoided losses in lifetime earnings projected in this analysis are likely a conservative estimate.

Table 6. Calculation of benefits as avoided losses in lifetime earnings.

Reduction in blood lead levels when lead in water is reduced from 30 ppb to 0.5 ppb in child care centers	0.2 μg/dL
Avoided loss in IQ points per one μg/dL drop in blood lead level	0.254 points
Avoided percent loss in lifetime earnings per IQ point	2.07%
Expected lifetime earnings per child for two-year-old cohort	$259,129
Benefits in avoided losses in lifetime earnings per child (0.2 x 0.254 points x 2.07% per point x $259,129)	$272
Total benefits as avoided losses in lifetime earnings for cohort of children five years of age or younger enrolled in centers with lead in water above lead hazard level (28,028 children x $272 per child)	$7,637,338

Benefits to the Private Sector: Avoided Special Education and Crime Costs

Children with elevated blood lead levels have an increased need for special education due to their developmental and cognitive impairments. Schwartz (1994) found that 20% of children with blood lead levels above 25 μg/dL require special education for an average of three years.[38] Kormacher (2003) suggests that special education costs $19,778 annually per child.[39] In North

[36] Scott D. Grosse *et al.*, *Economic Gains Resulting from the Reduction in Children's Exposure to Lead in the United States*, 110 Environmental Health Perspectives 563- 570 (2002).
[37] OSBM regression analysis of U.S. Census Bureau's American Community Survey Public Use Microdata Sample (PUMS) data to compute the average earnings per person by single year of age for the US. OSBM used data that attempts to match the November 2001 to June 2009 business cycle as reported by the National Bureau of Economic Research (NBER). Thus, OSBM used the 2002 through 2010 March CPS files given that these files cover earnings for the prior year. The sample was restricted to persons age 18 to 65 inclusive. Data source: Steven Ruggles, Sarah Flood, Ronald Goeken, Josiah Grover, Erin Meyer, Jose Pacas, and Matthew Sobek. IPUMS USA: Version 9.0 [dataset]. Minneapolis, MN: IPUMS, 2019.
[38] Joel Schwartz, *Societal Benefits of Reducing Lead Exposure*, 66 Environmental Research, 105-124 (1994).
[39] Katrina Korfmacher, *Long-Term Costs of Lead Poisoning: How Much Can New York Save by Stopping Lead?* Working Paper: Environmental Health Sciences Center, University of Rochester (2003); inflated to 2018 USD.

Carolina in 2017, less than 0.01% of blood lead level tests for one- and two-year-old children were above 25 μg/dL, and the expected average reduction in blood lead levels attributable to the proposed rule amendment is 0.2μg/dL. We suggest that regulatory benefits in the form of avoided special education costs are likely small due to the low frequency of blood lead poisoning at this level and the size of the estimated reduction in blood lead levels. However, in the unusual occurrence where a center's baseline lead level is exceptionally high, the rule amendment could still generate benefits in this category.

Similarly, benefits from reduced crime costs are possible but likely modest due to the estimated number of treated children and the size of the reduction in blood lead levels. Crimes including burglaries, robberies, aggravated assault, rape, and murder are correlated with blood lead levels, based on evidence of the effect of preschool blood lead levels on future criminal activity.[40] A one ug/dL reduction in blood lead levels among all preschool-aged children would result in avoiding 2.9% of burglaries, 0.4% of robberies, 5.1% of aggravated assaults, 3.7% of rapes, and 2.9% of murders. The following costs have been estimated for each type of crime: $5,112 for burglaries, $29,154 for robberies, $25,957 for aggravated assault, $36,221 for rape, $39,656 for murder.[41] Additionally, studies have demonstrated the prevalence and cost of juvenile incarceration associated with lead exposure, which has indicated that frequency and cost associated with juvenile crime could be reduced by reducing childhood blood lead levels.

Local Government Impact

Costs to Local Government

Under the proposed rule amendment, local health departments would incur additional costs that result from collecting and testing follow-up samples in the event that the initial testing done by the child care operator reveals a water outlet is producing water with lead at or above the hazard level. We estimated that 700 centers will have a total of 840 water outlets with lead exceeding 15 ppb. Under the proposed rule, the local health departments would be required to collect and test two samples, a first draw sample and a 30-second flush sample, as instructed by the sampling protocol outlined in the language.[42] These samples will be submitted for analysis at the North Carolina State Laboratory of Public Health at a cost of $20 per sample.[43]

There is an opportunity cost associated with the time it will take the local health inspectors to visit the 700 centers with elevated lead and submit the samples to the State Laboratory of Public Health for analysis. We estimate that these activities would take two hours per center, a total

[40] Rick Nevin, *Understanding International Crime Trends: The Legacy of Preschool Lead Exposure*, 104 Environmental Research, 315-336 (2007).
[41] Elise Gould, *Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control*, 117 Environmental Health Perspectives, 1162-1167 (2009); inflated to 2018 USD; These cost estimates incorporate the victim costs, legal proceedings, incarceration fees, and lost earnings of both the criminal and the victim. These estimates are conservative as they do not account for lost wages, pain, suffering, other physical and mental health care costs, and lost quality of life.
[42] The proposed rule amendment requires that sample collection is carried out according the EPA *3T's for Reducing Lead in Drinking Water in Schools and Child Care Facilities*.
[43] Personal correspondence with Cindy Price, Environmental Services Manager, State Laboratory of Public Health, Department of Health and Human Services (21 March 2019).

1,400 hours of additional time across all local health inspectors. The statewide average salary for a local Environmental Health Specialist is $46,862,[44] with benefits valued at $25,680 (54.8% of wages).[45] Assuming that local Environmental Health Specialists work 40 hours per week for 50 weeks per year (2,000 hours), the prorated hourly wage is $36.27. Therefore, each visit by an Environmental Health Specialist would cost $72.54, totaling $50,779 plus the cost of sample analysis ($33,600; Table 7). We anticipate that testing costs to local health departments in fiscal year 2020 would be reimbursed with funds from the EPA WIIN grant.

Table 7. Calculation of total testing costs incurred by local health departments in the first year of the proposed rule amendment.

Number of licensed child care centers with lead at or greater than the lead hazard level in at least one water outlet	700 centers
Average number of water outlets per affected center with lead at or greater than the lead hazard level	1.2 outlets
Total number of water outlets that will require follow up testing by local health departments (1.2 outlets x 700 centers)	840 outlets
Total number of samples submitted to North Carolina Laboratory for Public Health (2 samples per outlet x 840 outlets)	1680 samples
Total cost incurred by local health departments for site visit and lead analysis (700 centers to visit x $72.54 per visit) + (1680 samples x $20 per lead analysis)	$84,378

State Government Impact

Costs to State Government

Under the proposed rule amendment, we do not expect any additional costs to the State except for the opportunity costs associated with the time that the staff will spend overseeing the rule's implementation. The Centers for Disease Control and Prevention Childhood Lead grant already supports three state epidemiologists who would be involved in data collection, analysis, and management. Certified laboratories would submit lead data to NC DHHS following the same process developed for submission of blood lead data, and the water lead data would be managed in the same data system used for blood lead data.

We anticipate that one of the current state epidemiologists would spend their full time overseeing the implementation of this rule and managing the generated data. The midpoint salary for a state epidemiologist is $60,063 plus fringe benefits, totaling an opportunity cost to the State of $81,904.

[44] The statewide Environmental Health Specialist salary was estimated from https://www.sog.unc.edu/publications/reports/county-salaries-north-carolina-2019.

[45] National BLS data on wages and benefits for management, professional, and related occupations in the state and local government sectors indicates that benefits are valued at 54.8% of wages, https://www.bls.gov/news.release/ecec.t04.htm (23 April 2019).

Table 8. Calculation of total costs incurred by the state in the first year of the proposed rule amendment.

Midpoint salary for state epidemiologist	$60,063
Retirement contribution (18.55% x $60,063)	$11,142
FICA contribution (7.65% x $60,063)	$4,595
Health insurance cost	$6,104
Total opportunity cost for one state epidemiologist to oversee the rule's implementation ($60,063 +$11,142 + $4,595 + $6,104)	$81,904

Benefits to State Government

The State Laboratory of Public Health is expected to receive an additional $33,600 from local health departments for lead analyses.

V. ALTERNATIVES

Alternative #1: Only require testing in child care centers that were built before 1988, when revisions to the Safe Drinking Water Act went into effect. These revisions require plumbing and fixtures to have <8% lead; solder to have <0.2% lead.

Under the current rule amendment, all child care centers, regardless of age, are subject to lead testing. Under this alternative option, only child care centers housed in buildings constructed before 1988 would be subject to testing. Alternative #1 effectively reduced the number of child care centers that would have to test their water for lead. However, water in child care centers constructed after 1988 is still at risk of lead contamination, and this option fails to identify and reduce lead concentrations in these centers.

In 1986, the Safe Drinking Water Act was revised to require that water faucets and pipes be "lead free," but "lead free" was defined as materials containing less than 8% lead. This amendment went into effect in June of 1988. This definition allowed for a significant amount of lead to remain in plumbing that conveys drinking water from the public water supply to buildings and in fixtures inside the building. It was not until 2011 that Congress revised the definition of "lead free" under the SDWA to require faucets and pipes to contain less than 0.25% lead.[46] This latest amendment went into effect in 2014. Accordingly, buildings constructed between 1988 and 2014 could still contain plumbing and fixtures with a significant amount of lead. Further, lead in drinking water can originate from sources outside the building, notably the utility service lines that convey water from the public water supply to the center. Restricting the testing of water for lead to those buildings constructed before 1988 would miss centers that have elevated lead in water due to contamination from leaded service lines. Finally, preliminary data

[46] Environmental Protection Agency, *Use of Lead Free Pipes, Fittings, Fixtures, Solder and Flux for Drinking Water*, https://www.epa.gov/dwstandardsregulations/use-lead-free-pipes-fittings-fixtures-solder-and-flux-drinking-water (accessed 04 March 2019).

from RTI International's Clean Water for Carolina Kids indicates that there is virtually no difference in lead concentrations in water between buildings constructed before and after 1988.[47]

As child care centers built between 1988 and 2014 may still contain significant lead in plumbing and fixtures, testing all buildings despite age will ensure that no building poses a considerable risk of lead exposure.

Alternative #2: Only require child care centers to test their water for lead once.

Under the current rule amendment, child care centers are subject to testing once every three years. Under this alternative, child care centers would only be required to test once. For new centers, child care operators would test during the license application process. For existing centers, child care operators would test within one year of the adoption off the rule. Alternative #2 reduces the testing costs incurred by child care operators as they would only have to test their water within the first year of the rule or when applying for a license.

However, testing every three years is imperative to capture changes that could affect lead concentrations in water at child care centers, such as:

1. Changes in water source and chemistry (e.g. pH or hardness) can encourage leaching of lead into a water supply that was previously in compliance. An infamous example of this phenomenon is Flint, Michigan, where elevated lead concentrations were discovered in tap water after the city switched the drinking water source to the Flint River.

2. Plumbing issues, such as partial clogs or dirty aerators can arise at any time and result in spikes in lead concentrations in water.

3. Neglecting to replace filter cartridges in a timely manner and according to manufacturer recommendations can result in the filter failing to reduce lead to the required levels.

VI. UNCERTAINTY AND RISK ANLAYSIS

The greatest uncertainties in this analysis are 1) the baseline lead levels in child care centers, 2) the contribution of a contaminated water outlet to a child's overall lead exposure, and 3) the mitigation technique chosen by a child care center. To address the first two uncertainties, we use EPA's IEUBK model to demonstrate the effect of various water intake levels and water-lead concentrations on children's blood lead levels (Figure 7). In an extreme situation (one- and two-year-old children in affected centers receiving 35% of their total water intake from water outlets with 100 ppb lead), the model suggests that 33% of children would have blood lead levels at or exceeding five ug/dL. In a more reasonable scenario, where children are receiving 8-20% of their total water intake from water outlets with 15-50 ppb lead, the model suggests 0.14 to 2.5% of one- and two-year-old children, or 11 - 208 children in affected centers, would have blood lead levels at or exceeding five ug/dL.

[47] Redmon, J.H., *Safeguarding Children's Health: Time to Enact a Health-Based Standard and Comprehensive Testing, Mitigation and Communication Protocol for Lead in Drinking Water*, presented at the Environmental Health Scholars Program Fall Forum in Durham, NC (November 2, 2018).

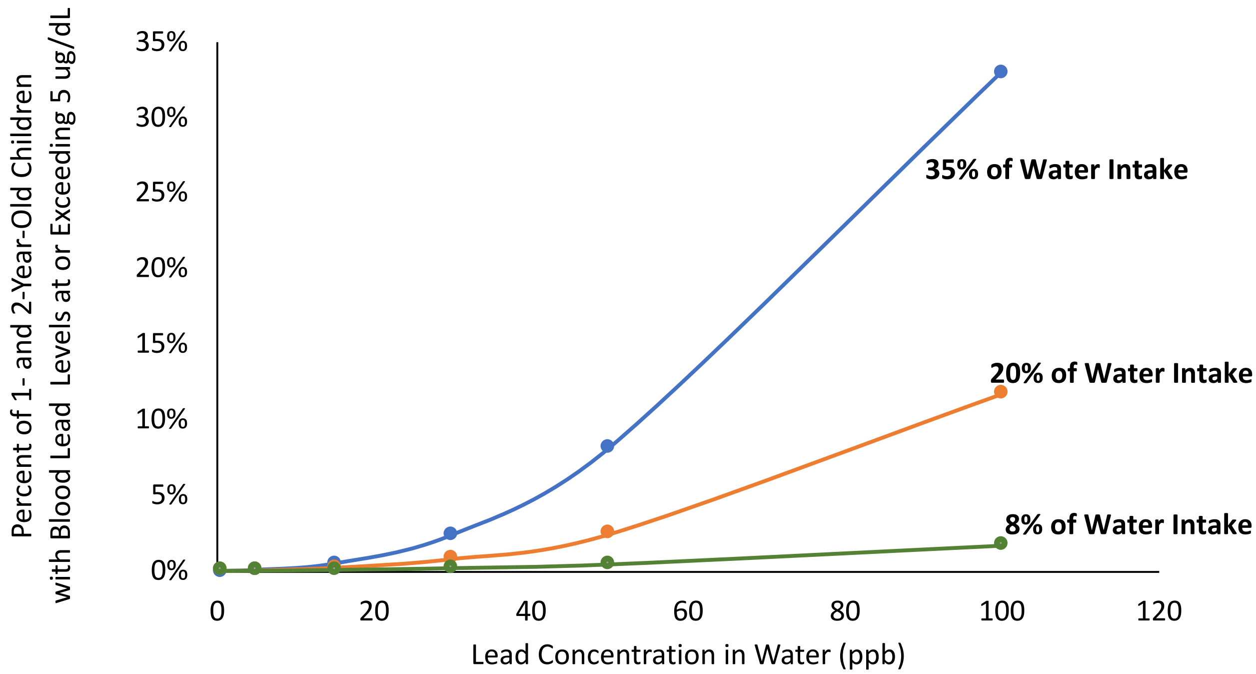

Figure 7. The relationship between lead in drinking water at child care centers and the percent of one- and two-year-old children expected to have blood lead levels at or exceeding five ug/dL.

Finally, the mitigation technique that a center chooses is difficult to predict. If every center chooses to mitigate using a filter, the estimated costs are $126,000 in the first year of the rule's implementation, and $28,700 every year thereafter for filter replacements. A center could also choose to mitigate by replacing a fixture, but this technique is not guaranteed to reduce lead in all situations. In the extreme case that all centers are able to reduce lead by replacing a fixture, the one-time statewide costs would amount to $168,000-$1,117,200, depending on the type of water outlet needing to be replaced and the installation costs. In reality, a mixture of mitigation techniques that include filter installation, outlet replacement, and shutting down a water outlet will likely be employed.

VII. ECONOMIC IMPACT SUMMARY

The proposed rules will reduce children's risk of exposure to lead in drinking water at child care centers by requiring operators to test water every three years and mitigate if lead concentrations are at or above the lead hazard level. The baseline lead levels in child care centers and the contribution of a contaminated water outlet to a child's overall lead exposure are uncertain. However, modeling based on the best available data suggests that the proposed rules could potentially reduce 15 cases of one- and two-year old children (ranging from 11-208 cases) with elevated blood lead levels within the current population cohort. Data on other age groups is more limited, but modeling suggests that elevated blood lead levels could also be averted in 12 children aged 3-5 and 0.6% of formula fed infants (up to 12 infants) for the first cohort. For this analysis, the cohort includes the population of children under six years old enrolled in child care centers in fiscal year 2020.

The primary benefits of reduced lead exposure include avoided losses in lifetime earnings, estimated at $272 per treated child under age six (28,028) and avoided healthcare costs of $94 for each averted case of elevated blood lead levels in one- and two-year-olds (15). Any potential benefits from reduced special education and crime costs are likely to be small. Future cohorts of children would also receive equivalent benefits. Table 9 presents a conservatively low picture of net benefits of the proposed rule because partial benefits for subsequent cohorts are excluded.

The greatest cost will be to the private sector, specifically child care center operators who will be required to pay for the first round of testing and mitigation, followed by testing every three years thereafter. Local health departments will also incur additional costs as they will be responsible for collecting follow up samples and submitting the samples for analysis at the North Carolina State Laboratory of Public Health. However, we anticipate that funding from the EPA's WIIN grant will reimburse all testing costs to child care operators and local health departments in the first year of the rule's implementation. The state will have opportunity costs for the time to manage the program and will receive benefits in the form of increased revenue at the State Laboratory of Public Health. The summary of the costs and benefits are presented in Table 9.

Costs are highest within the first year of the rule's implementation during which all centers will be tested for lead and required to mitigate water outlets with lead above the lead hazard level. Testing costs average $75 per center. Preliminary results of RTI International's Clean Water for Carolina Kids study suggests that 16% of centers (700) could require mitigation. Mitigation costs range from $0 to $1330 per center depending upon the appropriate intervention. Testing and mitigation costs that arise in the second and third year of the rule's implementation would be attributed to 1) purchase of replacement filters (quantified) or 2) licensure of new centers (unquantified). During subsequent three-year testing cycles, we expect costs associated with follow up testing and mitigation to substantially decrease, as centers would have mitigated the vast majority of water outlets that were not in compliance during the first testing cycle.

Table 9. Costs within the first six years of the rule's implementation and benefits for one cohort <6 years old**

	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025
IMMEDIATE BENEFITS						
State Government						
Increased Revenue at Laboratory	$33,600	U*	U*	$33,600	U*	U*
Private- Children						
Health Care Cost Savings at Ages 1-2 for 1 Cohort 0-5yo	$1,410	$1,410				
Private- Labs						
Increased Revenue at Labs	$328,125	U*	U*	$328,125	U*	U*
LIFETIME BENEFITS						
Private- Children						
Increased Lifetime Earnings - Present Value for 1 Cohort 0-5yo	$7,637,338					
Total Benefits	**$8,000,473**	**$1,410**	**$0**	**$361,725**	**$0**	**$0**
COSTS						
State Government						
Epidemiologist Salary	$81,904	$81,904	$81,904	$81,904	$81,904	$81,904
Local Government						
Health Inspector Salary	$50,778	U*	U*	$50,778	U*	U*
Lead Testing	$33,600	U*	U*	$33,600	U*	U*
Private- Child Care Centers						
Lead Testing	$328,125	U*	U*	$328,125	U*	U*
Mitigation	$126,000	$28,700	$28,700	$28,700	$28,700	$28,700
Total Costs	**$620,407**	**$110,604**	**$110,604**	**$523,107**	**$110,604**	**$110,604**
Net Impact	**$7,380,066**	**($109,194)**	**($110,604)**	**($161,382)**	**($110,604)**	**($110,604)**
NPV, 2019$ at 7% discount rate	**$6,435,921**					

*"U" represents the unquantified costs and benefits associated with testing new centers during their licensure.
** Presents a conservatively low picture of net benefits because partial benefits for subsequent cohorts are excluded.

APPENDIX

15A NCAC 18A .2816 is proposed for amendment as follows:

15A NCAC 18A .2816 LEAD POISONING HAZARDS IN CHILD CARE CENTERS

(a) In child care centers, areas accessible to children shall be free of identified lead poisoning hazards as defined under G.S. 130A-131.7(7).

(b) The following actions shall be taken to ensure that drinking water in child care centers is free of identified lead poisoning hazards as defined under G.S. 130A-131.7(7)(g).

(1) Child care operators, as defined under G.S. 110-86(7), shall test, at least once every three years, all water outlets used for drinking or food preparation. Samples shall also be collected and tested within 30 calendar days of completion of any renovations or repairs that may impact the facility's drinking water infrastructure, such as repair or replacement of all or part of drinking water service lines or faucets. The operator shall provide documentation of testing results for review by the Department of Health and Human Services (Department) during each unannounced routine sanitation inspection under Rule .2834(b) of this Section.

(2) For centers that submit an application for licensure after the effective date of this Rule, initial samples shall be collected by the child care operator and tested in accordance with Subparagraph (b)(4) of this Rule during the license application process, in accordance with 10A NCAC 09 .0302(b).

(3) For all other centers, initial samples shall be collected by the child care operator and tested in accordance with Subparagraph (b)(4) of this Rule within one year of the effective date of this Rule.

(4) Samples shall be collected and tested in accordance with guidance specified by the United States Environmental Protection Agency in its publication, 3Ts for Reducing Lead in Drinking Water in Schools and Child Care Facilities, which is incorporated by reference with subsequent changes or amendments and available free of charge at https://www.epa.gov/dwreginfo/3ts-reducing-lead-drinking-water-schools-and-child-care-facilities. Notwithstanding the foregoing guidance, samples may be collected with a stagnation period of up to 72 hours. Samples shall be analyzed by a laboratory certified by the North Carolina State Laboratory of Public Health to analyze for lead in drinking water.

(5) When a water sample is analyzed for lead content by a laboratory under this Rule, the laboratory shall notify the Department of the test results by electronic submission in accordance with G.S. 130A-131.8.

(6) When a child care center receives test results from a laboratory indicating that a water sample collected by the child care operator contains a lead concentration at or above the lead poisoning hazard level defined in G.S. 130A-131.7(7)(g), the child care operator shall immediately:

(A) restrict access to any water outlet(s) used for drinking or food preparation that have lead concentrations at or above the lead poisoning hazard level; and

(B) ensure that all children and staff have access to water free of cost that does not contain lead concentrations at or above the lead poisoning hazard level for drinking and food preparation.

(7) When notified of a water lead level at or above the lead poisoning hazard level, the Department shall conduct sampling at the water outlet identified to have a water lead level at or above the lead poisoning hazard level within seven (7) calendar days of notification.

(8) If a water sample collected by the Department reveals a water lead level at or above the lead poisoning hazard level, the child care operator shall continue to restrict access to water outlet(s) and provide alternate water as set out in Subparagraph (b)(6) of this Rule until the Department determines the water outlet(s) are not producing water lead levels at or above the lead poisoning hazard level and notifies the child care operator and the Division of Child Development and Early Education in writing of this determination.

(9) Failure to comply with Paragraph (a) or any one or more components of Paragraph (b), shall be deemed a violation of this Rule subject to demerits under Rule.2834(c)(20) of this Section.

(10) Within three (3) business days of receiving the test results of the Department's water analysis that indicate a water lead level at or above the lead poisoning hazard level, the child care operator shall provide written notification of the test results to the parents or legal guardians of the children attending the child care center and the staff of the child care center, in accordance with the United States Environmental Protection Agency guidance specified in Subparagraph (b)(4) of this Rule.

(11) Within five (5) business days of receiving the test results of the Department's water analysis that indicate a water lead level at or above the lead poisoning hazard level, the child care operator shall make the test results available to the public, free of charge. The child care operator may post test results to the child care center's website to satisfy the requirement to make the test results available to the public.

History Note: *Authority G.S. 110-91;130A-131.5; 130A-131.7(7); 130A-131.8;*
Eff. July 1, 1991;
Amended Eff. January 1, 2006; February 1, 1995.