Appendix B

The Potential Health Impacts of Partial Lead Service Line Replacement: A Summary of the Evidence.

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Partial lead service line replacements are conducted throughout North America. Replacements of lead service lines are primarily partial because municipalities do not have jurisdiction over the home-owner's portion of the lead service line. It has been broadly assumed that this practice results in health benefits through a reduction in the mass of lead in the system (Sadvig and Kan, 2007; US EPA, 2000). However, over the last five years, concerns have been raised about the potential health impacts of partial lead service line replacements.

As requested by the Public Works and Infrastructure Committee in September 2012, this report summarizes the recent research on potential health impacts of partial lead service line replacements.

Risks from Immediate Increases in Lead after Partial Lead Service Line Replacement

In 2011, the US Environmental Protection Agency (US EPA) convened a Science Advisory Board (SAB) to review the evidence on partial lead service line replacement and report back to advise the US EPA Office of Water. The US EPA SAB concluded that partial lead service line replacement often causes drinking water levels of lead to significantly increase for a period of days to weeks, or even for a longer duration. The risks of immediate[1] spikes in lead from the physical disturbance of the pipe during lead service line replacements are well known (US EPA SAB, 2011; Health Canada, 2009). The US EPA SAB note that the health risks associated with even relatively short-term exposures to lead could be substantial depending on the magnitude and duration of elevated lead levels, the water intake and vulnerability of the person exposed. In the past, these spikes in lead concentrations were assumed to be acceptable as acute exposures to lead were considered not as relevant as chronic exposures; however, this assumption is being reconsidered in light of a new understanding of the toxicity of lead (US EPA SAB, 2011).

Risks from Longer-term Increases in Lead after Partial Lead Service Line Replacement

Research is emerging to suggest that partial lead service line replacement may also pose a risk of longer-term releases of lead into the drinking water (Triantafyllidou and Edwards, 2012; US EPA, 2011; OMOE, undated). The potential for longer-term risks was raised by the US Centre for Disease Control (CDC) in June 2010 (US CDC, 2010). Since that time, there has been significant debate and dialogue among regulators, experts and drinking water suppliers on the merits of the partial lead service line replacement programs and the policies designed to encourage them[2].

[1] Immediate is defined as within the first few days after disturbance of the pipe.

[2] For example, partial lead service line replacements are sometimes mandatory in the United States (US Lead and Copper Rule, US EPA, 2000). In Ontario, they are considered in cases where corrosion control cannot achieve the necessary reduction in lead concentrations (Ontario Safe Drinking Water Act, 2002).

The longer-term releases of lead into the drinking water are thought to occur due to direct contact between the new copper and the old lead parts of the services line[3] (US EPA SAB, 2011; OMOE, undated). The available data suggest that elevated drinking water levels of lead tend to gradually stabilize over time, sometimes to levels below and sometimes at levels similar to those before the partial replacement (US EPA SAB, 2011).

A comprehensive study was recently undertaken by the US Centre for Disease Control on lead in drinking water (Brown *et al.*, 2011)[4]. This study found the presence of a lead service line was a risk factor for increased blood lead levels for children compared to homes with no lead service line. The study also found that partial lead service line replacement did not result in a measurable benefit as determined by a lower blood lead level compared to children living in homes with intact lead service lines. Based on this study, the US EPA SAB (2011) concluded that there is potential for harm from partial lead service line replacement in the short-term with no demonstrated long-term health benefit.

Limitations to the Evidence

There is insufficient research to fully evaluate the beneficial or adverse impacts of partial lead service line replacements in Toronto. The mechanisms that influence the release of lead into the drinking water system are highly complex and site-specific. Studies to examine the issue are very challenging due to the intensity of the sampling protocol[5] (Brown and Margolis, 2012; Triantafyllidou and Edwards, 2012; Prevost, M. pers.comm, 2009; Shock, M. pers.comm, 2009). Moreover, researchers have identified significant issues in the methods used to collect, store and analyze lead in drinking water (US EPA SAB, 2011). Thus, there are significant uncertainties in applying the limited research conducted in other municipalities to the City of Toronto.

[3] Toronto Water uses a brass connector between the copper and lead pipes, which is the current industry standard.

[4] Undisturbed lead service lines have a protective layer of mineral scale in the inside of the pipes protecting the drinking water from the lead pipe. Changes to the water disinfection process in Washington DC caused this mineral scale to dissolve releasing lead into the drinking water. To evaluate the public health impacts, the blood lead levels of over 60,000 children were taken. The study also investigated the effect of partial lead service line replacement on the blood lead levels of children.

[5] Particulate lead release happens sporadically and can easily go undetected. A large number of samples (in the thousands) are needed in order to capture the potential for high levels of lead to be released into drinking water. Moreover, there are many sources of lead in the drinking water. It is cost prohibitive to conduct a sampling protocol to isolate the contribution of lead from the service line (Triantafyllidou and Edwards, 2012; Provost, M. pers comm. 2010).

Mitigating the Risks from Partial Lead Service Line Replacement

There are mitigation measures available to address the risks of exposure to lead in drinking water. These measures are:

1. corrosion control[6];
2. full lead service line replacement;
3. water filters;
4. public education and outreach to encourage the public to take action to reduce their exposures; and,
5. use of an alternative drinking water supply.

The City of Toronto is utilizing most of these risk mitigation strategies[7] through the implementation of a Corrosion Control Program, the promotion of the Priority Lead Water Service Replacement Program (which achieves full service line replacements) and the provision of a faucet filter whenever the City-owned portion of a water service is replaced to address the short-term increase in lead after partial lead service line replacement.

Additional risk mitigation strategies rely on the public taking action directly after a lead service line replacement. These additional measures are: flushing the cold water system for at least 15 minutes from the lowest faucet in the house[8]; removing all faucet aerators in the home and thoroughly rinsing them to remove any lead particles that may be trapped[9]; using only filtered water for drinking, cooking and infant formula preparation[10]. Exclusive breast-feeding is the most effective way of mitigating infants' exposure to lead in drinking water.

Corrosion control is a strategy that reduces the release of all sources[11] of lead in drinking water. Numerous studies have positively and significantly associated a lowering of blood lead levels and a reduction of lead in drinking water concentrations in response to corrosion control (Triantafyllidou and Edwards, 2012). Corrosion control is a key element of the City of Toronto's comprehensive strategy to address lead in drinking water. In terms of lead service line replacements, the experts are still recommending encouraging full service line replacements even when a municipality has optimized their corrosion control. This is because it is the only way to permanently eliminate the largest source of lead in the system. Corrosion control works by creating a protective coating in the inside of the pipes. That coating can become disturbed

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[6] Corrosion control is widely recognized as one of the best methods to reduce exposure to lead from drinking water. It is not only required by the Ontario Ministry of the Environment (MOE) but is encouraged by authorities such as Health Canada and the US EPA. The City of Toronto's Corrosion Control Plan was submitted to the MOE in October 2010 to comply with Regulation 170/03, made under the Safe Drinking Water Act, 2002.

[7] A report outlining the City of Toronto's *Lead in Drinking Water Mitigation Strategy*, which also includes details on the Corrosion Control Program, is available at:
http://www.toronto.ca/legdocs/mmis/2012/pw/bgrd/backgroundfile-49660.pdf

[8] Flushing of the water pipes after the partial lead service line replacement must be done before anyone in the household uses the water to avoid the particles of lead being drawn into the house plumbing system. The lowest tap in the house is usually in the basement.

[9] Toronto Public Health recommends rinsing the aerators regularly for three months.

[10] Recommended for pregnant women, infants and children under the age of six.

[11] Lead can also be found in the interior plumbing of a house: lead-containing brass fixtures, lead solder, and fittings.

physically or through changes in the chemistry of the drinking water, potentially creating a risk at some point in the future.

Encouraging the Public to Take Action

While Canadian blood lead levels have declined significantly over the last three decades, current day exposures to lead continue to be a concern (Health Canada, 2011). The adverse health effects from exposure to lead are well-documented in children and adults, and no safe blood lead level in children has been identified (Brown and Marolis, 2012; Health Canada, 2011; WHO, 2010; CDC, 2005). Lead adversely affects those that are most vulnerable in our society: infants, children and pregnant women, racialized individuals and those that are of low socio-economic and nutritional status, and newcomers (Health Canada, 2011; WHO, 2010; CDC, 2005). Two recent literature reviews explore the link between exposure to lead in drinking water and blood lead levels (Brown and Margolis, 2012; Triantafyllidou and Edwards, 2012). Both these reviews conclude that lead in drinking water is positively and significantly associated with blood lead levels. Most concerning is that drinking water is recognized as the dominant source of lead for formula-fed infants[12] (Brown and Margolis, 2012; Triantafyllidou and Edwards, 2012). Public health efforts are directed at eliminating and reducing exposures before they occur, including the need to reduce lead concentrations in drinking water as much as possible (Brown and Marolis, 2012).

Toronto Water, in partnership with Toronto Public Health, has developed a comprehensive public education and outreach strategy. The strategy is focussed on raising the awareness of the health risks[13], particularly for those most at risk, and continuing to encourage full lead service line replacement.

Conclusions

There is limited research available on the public health impacts of partial lead service line replacement. The available research indicates that partial lead service line replacement is not an effective risk management measure to reduce lead in drinking water. Additionally, partial lead service line replacements are frequently associated with short-term elevated drinking water lead levels, suggesting potential for harm. The longer-term impacts are unknown. Toronto Water is currently limiting partial lead service line replacement to necessary upgrades and emergency replacements to the system and the Priority Lead Water Service Replacement Program encourages full service line replacements. Toronto Water, in collaboration with Toronto Public Health, will continue to reach out to the public to raise the awareness of the health risks and to encourage the public to take action to reduce their risks.

[12] Drinking water constitutes 90 percent of the diet of a formula-fed infant (assuming powered formula reconstituted with drinking water) (Triantafyllidou and Edwards, 2012).

[13] Results from survey and focus groups of Toronto residents suggest that the public are not aware of the health risks. Consultant reports are available at: http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2012.PW17.15

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