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THE NEW CORROSION CONTROL BUILDING AT THE WOODWARD AVENUE WATER TREATMENT PLANT

Hamilton has implemented a corrosion control program that will reduce lead concentration levels at the consumer's tap to maintain high quality drinking water across the City

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Introduction

This project responds to concerns about elevated levels of lead in Hamilton's drinking water. The toxic material was leaching into the water following corrosion within lead service lines, which were typically constructed within the first five decades of the 20th century before the dangers of lead were well known. Today we know that exposure to even low levels of lead can cause serious health problems, particularly for pregnant women, babies, and young children.

Replacing all the lead water lines could have taken decades so the City investigated an alternate solution that could involve a phosphate-based chemical addition at the City's 909 ML/d Woodward Avenue Water Treatment Plant. The method would form a protective film within the City's distribution system to prevent lead from flaking off the pipes, thereby reducing lead concentration in the drinking water.

Following the determination that phosphoric acid and orthopolyphosphate chemicals were the most viable solutions for corrosion control, a year-long pilot study replicated the City's lead service line piping to assess the chemical performance. Following a detailed analysis, phosphoric acid was selected.

The City then retained AECOM consultants to design the corrosion control facilities at the Woodward Avenue treatment plant. AECOM began the design in 2016, completed it in 2018 and put the job out to tender. The facilities were constructed and fully operational by November 2018, two months ahead of schedule.

Key technical issues included the location of the dosing in relation to the plant's filters and the level of dosage. Moreover, any necessary shutdowns or bypassing of flow had to be handled very carefully since the plant is the City's primary source of potable water: Operational continuity could not be compromised. Other major project issues involved public reaction to the addition of a chemical (particularly one with "acid" in its name) to the city's drinking water. All the issues were successfully dealt with and – most importantly – lead levels at the tap are down. Based on pipe-loop studies and initial sampling in the distribution system, it is confidently expected that the lead concentration will be reduced well below the MAC.

Why We Chose This Project

We chose this project because of its direct bearing on public health. The extent of the lead in Canadian drinking water problem can be hard to pinpoint. In its 2014-2015 annual report on drinking water, Ontario announced that 5% of the state's residences did not meet the standard. However, another study published in 2015 showed that the water in 13% of Toronto households showed elevated lead levels.

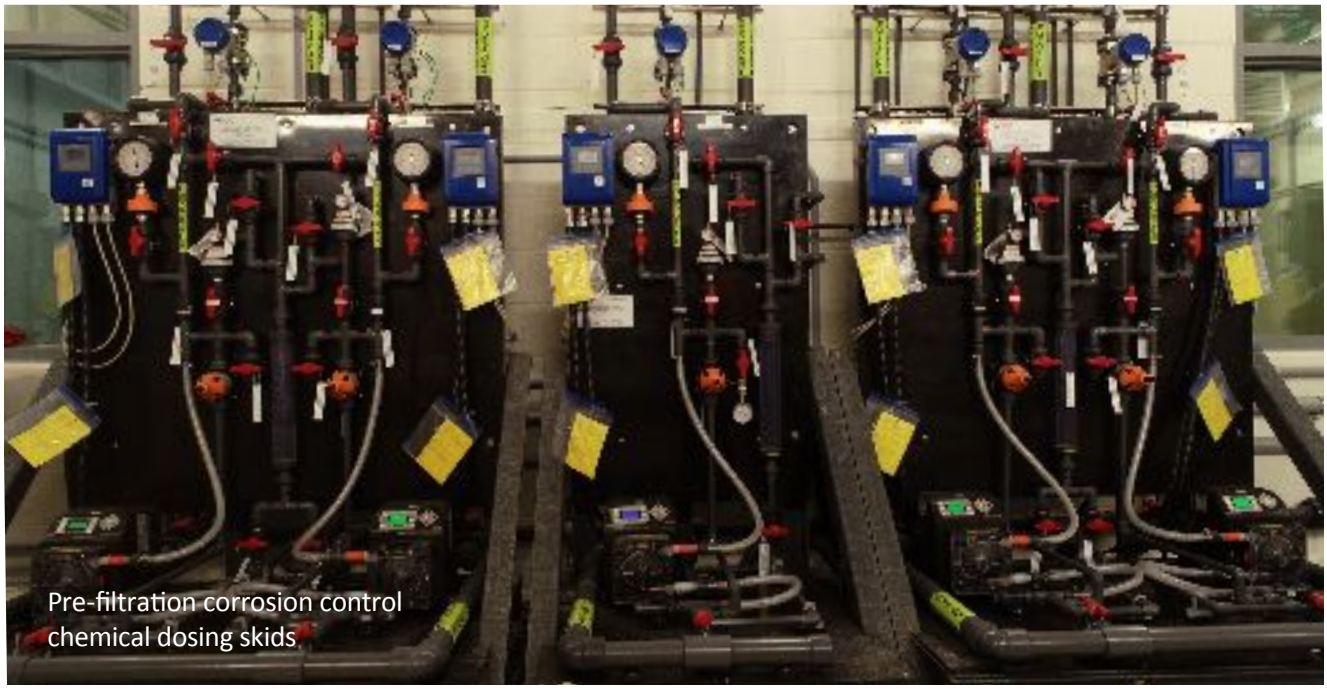
The actual number of people that lies behind these percentages provides another, more striking perspective. In Hamilton, studies from some ten years earlier showed 20,000 households falling into this category, so over 50,000 people in the City were at risk from lead in their drinking water.

AECOM therefore selected this project because it **successfully addressed such a glaring flaw in our management of public health.** We also chose it because it illustrates so very clearly the progression of a water infrastructure initiative through multiple phases: from development of an initial plan, to the generation and then testing of options, to full-scale implementation, followed by further testing to calibrate operations, and then (what is still to come) the monitoring of results to maintain the successful outcome. And the project also emphasizes how important it is to keep the public on-side during significant change to the infrastructure that underpins our daily lives.

The comprehensive nature of the project in turn speaks to the way in which no one entity can really claim the full credit. While the City was the prime driver of the project, it benefited from the skill and commitment of multiple players. This project shows that engineering and construction is truly a team sport.

50,000 people in the City were at risk from lead in their drinking water.

Innovation



Pre-filtration corrosion control chemical dosing skids

National concern about the lead leaching from water service line pipes into the drinking water supply just before it enters people's homes.

Over 20,000 homes in Hamilton with lead water service lines.

A tight deadline from Hamilton's local Regulator to reduce the lead concentration at the tap below the maximum allowable concentration (MAC).

This was the situation facing the City of Hamilton – challenge accepted.

Following the local Water Regulator's request, the City immediately developed a Corrosion Control Plan to identify the methods available to reduce and ultimately eliminate the lead concentration in the drinking water from lead service lines. Based on the strict deadline, there was insufficient time to physically remove all lead pipes. This prompted the City to investigate and then implement an alternate solution that involved a phosphate-based chemical addition at the City's 909 ML/d Woodward Avenue Water Treatment Plant. The method forms a protective film within the City's distribution system to prevent lead from flaking off the pipes, thereby reducing lead concentration in the drinking water.

Three Elements of this project that reflect innovative application of engineering principles or techniques:

1. **Complete holistic approach from planning to studies to pilot testing to full scale design and construction (this is rarely seen nowadays and the City did not cut any corners to make sure the proper chemical was selected while considering health impacts and costs).**
2. **One of the largest facilities in Canada to have corrosion control chemical dosing implemented – design includes provisions for future increased demand and associated material selection that will last a long time.**
3. **Significant planning for construction staging and installation since this is the only water treatment plant for the City of Hamilton and the facility had to remain operational at all times – even for tie-ins where there were no redundant process trains or other elements to bypass the flow of water. Also had to be cognitive that a precipitate could easily form if chemical was dosed in the wrong location during commissioning, careful significant strategizing to test all equipment was necessary.**

VFD and control panel for energy efficient HVAC system

There are four major elements of this project that make it different from similar corrosion control initiatives and reflect innovative application of engineering principles or techniques:

First, the City committed from Day 1 to a complete and holistic approach: from planning to studies to pilot testing to full scale design and construction. The City did not cut any initial corners to make sure the proper chemical was selected while also considering health impacts and costs.

Second, the City considered the entire system and based decisions on how the corrosion control dosing will impact the water treatment plant, the distribution system and the wastewater treatment plant (where so much of the treated water, once used, finally ends up).

Third, there was significant planning for construction staging and installation, since this is the only water treatment plant for the City of Hamilton and the facility had to remain operational at all times. The City was also aware that a precipitate could easily form if the chemical was dosed in the wrong location during commissioning, therefore significant strategizing and testing was required.

Finally, the scale of this project was unusual. The Woodward Avenue plant is one of the largest facilities in Canada to have corrosion control chemical dosing implemented. Moreover, the design needed to include includes provisions for future increased demand and the selection of associated, long-lasting materials.

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Complexity

The public perception issue was a genuine concern for the City's Community Outreach and Engineering teams. Hamilton residents, institutional and industrial users could clearly be concerned about the addition of a new chemical into their drinking water, let alone one that had the word "acid" in the name. However, any comprehensive community outreach program, including webpages, pamphlets, and corrosion control chemical health fact sheets, provided education about the in-pipe impacts of the corrosion control and the significant health benefits of dosing with phosphoric acid. Particularly persuasive were "Key Facts" such as the trace amount of the chemical actually present in a glass of tap following the project would be much less than that found in common daily foods such as milk.

Another challenge that was overcome was the planning and staging of corrosion control equipment installation and commissioning. Multiple partial shutdowns were planned to allow the chemical injection assembly to be installed, while directing flow through other tanks to keep the plant operational. This also included the use of divers to install chemical diffusers in a working clearwell tank. Furthermore, equipment start-up and commissioning had to be delicately balanced to ensure that precipitate from chemical reaction did not occur downstream of the filters, which could have compromised the appearance of drinking water at the user's tap.

> ***"The Woodward Water Treatment Plant is the primary source of water for the City of Hamilton, so operational continuity could not be compromised"***

Social and/or Economic Benefits

The City of Hamilton placed the public's health at the forefront by reducing lead levels in drinking water that would have otherwise negatively impacted tens of thousands of residents. Due to the installation of lead service water lines during the 1900s through to the 1950s, lead was leaching into the drinking water at a concentration up to 0.2 mg/L, which was greater than the Maximum Allowable Concentration (MAC) of 0.01 mg/L and can impact human health. Based on pipe-loop studies and initial sampling in the distribution system, it is confidently expected that the lead concentration will be reduced well below the MAC. This will prevent large-scale health impacts from lead that have unfortunately recently occurred in major American states.

Serious attention was paid to the cost of the project. The City performed a detailed investigation to compare the performance of various chemicals that can prevent lead from leaching into the drinking water as well as the optimal chemical dosage. Following a year-long initiative that included frequent sample collections, data analysis and a cost-benefit analysis, the City selected a chemical and dosage that would save the City of Hamilton over $1M in operational costs on an annual basis.

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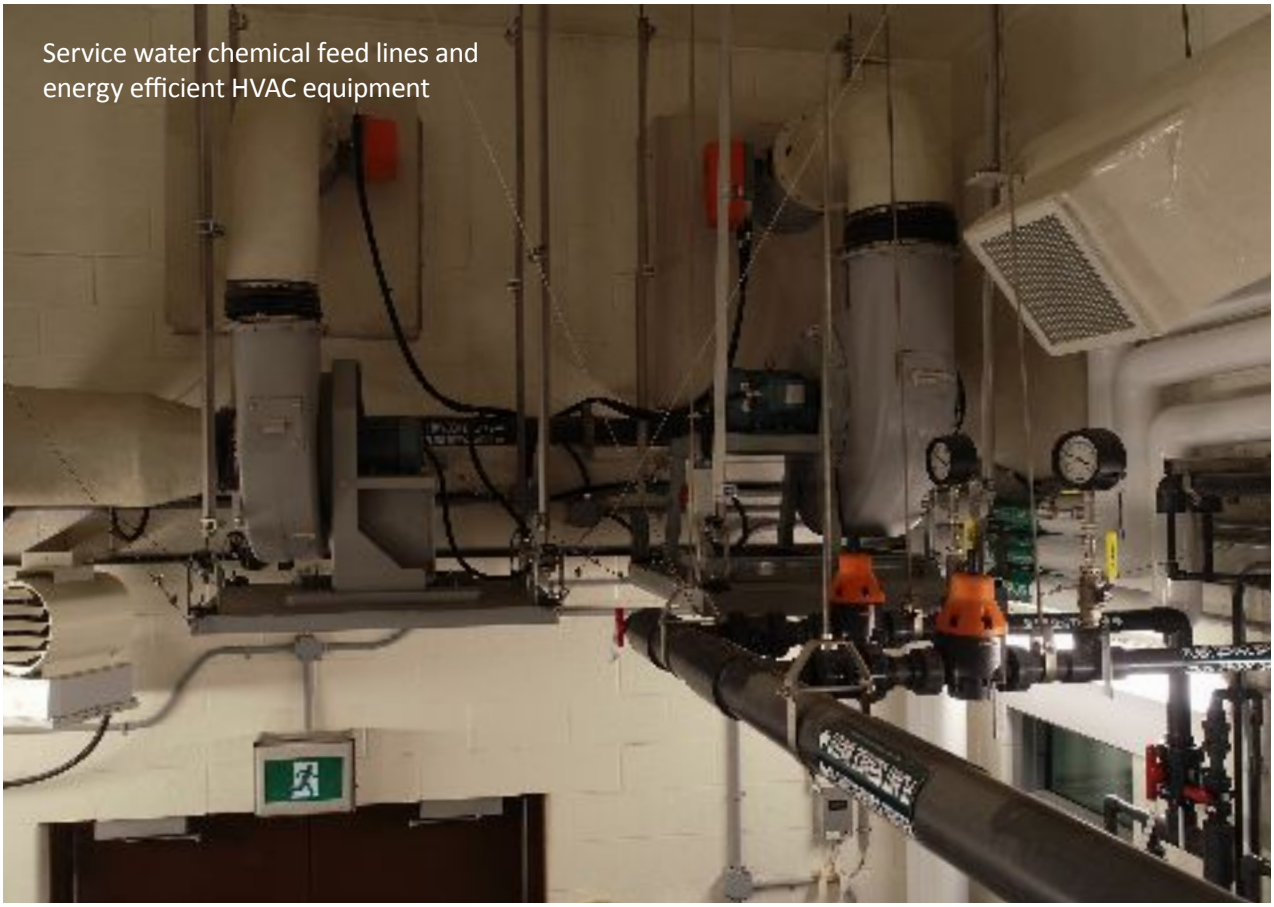
Pre-filtration corrosion control chemical dosing skids

Environmental Benefits



Service water chemical feed lines and energy efficient HVAC equipment

Millions of people suffer around the world from health issues due to a lack of treated drinking water. Most recently, the city of Flint, Michigan experienced devastating impacts of lead in their drinking water that impacted public health. Through the City of Hamilton's Corrosion Control Building project, phosphoric acid – a naturally recurring chemical found in fruits and vegetables – is being dosed into the drinking water to prevent similar lead-related health issues. This is a particularly sustainable option. Since this chemical is readily available and used throughout the world in multiple different industries, including water, food, etc., continuous supplies are readily available. The chemical has a long shelf life, which allows the City of Hamilton to purchase bulk volumes and prevent chemical waste. Moreover, cross-linked high density polyethylene storage tanks were purchased at a premium to last several decades into the future and avoid the carbon footprint impact of manufacturing storage tanks on a more-frequent basis.

Not only does this sustainable chemical application positively impact the City of Hamilton's drinking water, it also has minimal impact on the City's Wastewater Treatment Plant. The trace amounts of corrosion control chemical is easily removed in the waste treatment process and eliminated from the water flow that is returned back to Lake Ontario. By avoiding significant additional phosphorus loading at the City's Wastewater Treatment Plant, the City does not need to operate at an increased capacity at that facility, thereby reducing electrical power consumption and the associated environmental carbon footprint.

Meeting Client's Needs

Despite the tight timeline, AECOM and the City of Hamilton project team worked together to devise a plan that allowed the Corrosion Control Building to start dosing almost two months ahead of schedule (November, 2018) and on-budget.

The design provided the flexibility of dosing in two different locations within the Woodward Water Treatment Plant (upstream and downstream of the filters). This allowed the City of Hamilton to dose an initial volume of chemical upstream of the filters, so chemical reactions and the resulting precipitate were captured on the filter beds; the remainder of the chemical was then dosed downstream of the filters, avoiding the potential for "cloudy" water. A uni-directional flushing program mitigated the risk of chemical reactions within the distribution system.

Far in advance of the implementation date, the City of Hamilton's Public Outreach department developed a comprehensive information network, customized for two different audiences: the general public and industrial users. The outreach materials, which included webpages, pamphlets, and corrosion control chemical health fact sheets, received rave reviews and the chemical dosing began without issue.

The City of Hamilton set the following goals:

- **Design and construct** a chemical dosing system that is operational before the end of the 2018 calendar year and will reduce the lead within the drinking water system to a concentration below the MAC of 0.01 mg/L.
- **Minimize impacts to drinking water quality** within the distribution system, specifically "cloudy" water due to chemical reactions.
- **Maintain public awareness** about the benefits of dosing the corrosion control chemical.

Post-filtration corrosion control chemical dosing skids

Cross-linked high density polyethylene corrosion control bulk storage tanks

Project Summary

The City of Hamilton developed a Corrosion Control Plan to identify the methods available to reduce and ultimately eliminate the lead concentration in the drinking water from lead service lines. The method would form a protective film within the City's distribution system to prevent lead from flaking off the pipes, thereby reducing lead concentration in the drinking water. Following a detailed analysis, phosphoric acid was selected as the preferred chemical for the corrosion control dosing. An expedited design phase for a full scale chemical dosing system was completed and the facility is currently completed.

The comprehensive nature of the project speaks to the way in which no one entity can really claim the full credit.

The London Free Press played a key role with their reporting on the risk in the first place, helping to ignite public concern. Obviously, it is the City that then made the project happen, and was the leading, managing entity. But the City also had sterling help initially from the company hired to investigate the chemicals that could be used to control the corrosion problem; the City then benefitted from the work of the company that performed the year-long pilot study that replicated the lead service lines to determine the chemical performance; and it found a committed partner in AECOM, which designed and then oversaw the construction (by Maple Ball JV) of the new facilities at the Woodward plant.

About AECOM

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