



**UNIVERSITY OF CALGARY**  
O'Brien Institute for Public Health

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# **COMMUNITY WATER FLUORIDATION**

## A REPORT FOR CALGARY CITY COUNCIL

Prepared for:

**City Council**  
**The City of Calgary**

July 2019

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## INTRODUCTION

### PURPOSE

The O'Brien Institute for Public Health is pleased to provide this report to City Council as a scholarly analysis intended to advance collective understanding of the fluoride debate among both City Council members and the Calgary public at large. This report is in specific response to a Notice of Motion from the City Council meeting on February 25, 2019, where Councillors voted to support further study on community water fluoridation and requested the O'Brien Institute for Public Health to provide that information (#C2019-0219). The formal resolution is included as Appendix 1 of this report.

### THE O'BRIEN INSTITUTE

The O'Brien Institute for Public Health at the University of Calgary is one of the university's seven health research institutes. With a formal *vision* of 'better health and health care', and a corresponding *mission* 'to produce knowledge that informs public policy for health', the O'Brien Institute is committed to excellence in population health and health services research. The Institute has over 500 members, consisting of researchers, health professionals, and policy makers; within this membership, there is representation from a multitude of disciplines including medicine, nursing, epidemiology, statistics, psychology, sociology, economics, social work, kinesiology, and architecture and planning, among others.

The Institute contributes to public policy discourse through the production of reports for health agencies and various levels of government. A notable recent example is the Institute's [Raising Canada](#) report (produced in collaboration with Children First Canada) on the health and well-being of children in Canada. The Institute also convenes public symposia and stakeholder summits focusing on a variety of topics including health system sustainability, guaranteed basic income, cannabis legalization, national food policy, mandatory vaccination of healthcare workers, and the health and social impacts of hosting Olympic Games.

Through such formal reports, events, and consultations, the Institute often assumes an *academic diplomacy* role, brokering dialogue and information exchanges across sectors, disciplines and perspectives. When engaged in such a capacity, the Institute's executive team functions differently than do individual faculty members. Whereas the latter have academic freedom to conduct their independent research and to speak freely and advocate as they wish, the Institute executive, in contrast, will often not take positions on policies (especially if not requested to do so). Rather, the Institute executive works to create settings for public discourse, so that scholarly, policymaker, and civil society perspectives can be heard. In its academic diplomacy capacity, the O'Brien Institute's ultimate goals are to foster respectful dialogue, to contribute dispassionate evidence, and to learn from community – in pursuit of *better health and health care*.

More information is available at [www.obrieniph.ucalgary.ca](http://www.obrieniph.ucalgary.ca).

## REPORT PROCESS

### Initiation

- Councillor Colley-Urquhart requests O'Brien Institute guidance and initiates Motion to City Council.
- O'Brien Institute commits time and resources.
- City of Calgary issues directive to O'Brien Institute to provide an informative and unbiased report (without recommendations) regarding potential risks and benefits of community water fluoridation.

### Planning

- O'Brien Institute allocates faculty experts and staff to plan and execute consultation, literature review and report writing.
- City of Calgary assigns Ms. Robin Hopkins (Issue Strategist) as active liaison for consultation and report development.
- O'Brien Institute commits to a simultaneous process of a phased literature review interlocking with City Councillor and community interviews.

### Execution

- O'Brien Institute begins literature review and interview process with City Councillors to identify key issues.
- O'Brien Institute conducts interviews with fluoridation opponents, external experts, and authors of key studies.
- Interview and literature review summaries are compiled.
- Final report written for presentation on July 24, 2019.

The preceding schematic outlines, in broad terms, the steps taken to produce this report. Expanding slightly on the information presented in that figure:

- Councillor Diane Colley-Urquhart approached the O'Brien Institute's leadership in early February of 2019 to determine if the Institute was willing/able to conduct work on behalf of the City of Calgary – specifically to provide information relating to community water fluoridation.
- Councillor Colley-Urquhart brought forward a Notice of Motion to City Council for discussion/debate on February 25, 2019, proposing that the O'Brien Institute for Public Health be approached to provide the City of Calgary with information regarding potential risks and benefits of community water fluoridation.
- The lengthy discussion during the Council session on February 25th permitted most Councillors to ask questions and/or make comments relating to community water fluoridation. Each articulated comment/question was recorded by the Institute team as a starting point. The full listing of questions arising from the February 25th Council hearing is presented in Appendix 2.
- The Institute team then embarked on a process of contacting the Mayor and all Councillors, as requested by Council, with an invitation to meet in person to discuss community water fluoridation and the report development process. A standardized invitation was sent to each invitee, with follow-up as needed to a total of three invitations. From this process, 11 Councillors participated in meetings; each was provided with a clear statement of meeting objectives, and an overview of questions that would be posed during meetings. Meetings were led by either Dr. Aleem Bharwani (O'Brien Institute Lead – Public Policy) or Dr. William Ghali (O'Brien Institute Scientific Director). Ms. Robin Hopkins from Community Services attended all meetings on behalf of the City.
- The list of review topics and questions for this report was refined through this process of interviewing Councillors. Ensuing sections present the final listing of questions/topics (grouped thematically) that were addressed through this O'Brien Institute work. A high-level summary of the Councillor meetings/discussions is presented in Appendix 3.
- A number of O'Brien Institute members were enlisted as experts asked to provide information to support development of this report. These included experts in: 1) the physician specialty of public health/preventive medicine; 2) population health and health equity; 3) dental and oral health; 4) health law; 5) health economics; 6) public policy and governance; 7) endocrinology focusing on thyroid function; 8) endocrinology focusing on bone disease and health; 9) neurology and cognition; and 10) aging and dementia. The full listing of O'Brien Institute and University of Calgary faculty members who were consulted and/or contributed to the report:
  - **Bharwani, Aleem, MD, MPP, FRCPC**, Director Public Policy and Strategic Partnerships, Clinical Associate Professor, Cumming School of Medicine, University of Calgary
  - **Billington, Emma, MD**, Clinical Assistant Professor, Cumming School of Medicine, University of Calgary

- **Boulet, Fiona, BA, MEd**, Coordinator, *makeCalgary* program, University of Calgary
  - **Cabaj, Jason, MD, MSc, FRCPC**, Medical Officer of Health, Calgary Zone, Alberta Health Services  
Provincial Lead Medical Officer of Health, Public Health Surveillance and Infrastructure, Clinical  
Assistant Professor, Community Health Sciences, University of Calgary, Program Director, Public  
Health & Preventive Medicine, University of Calgary
  - **Day, Jamie, PhD**, Administrative Director, O'Brien Institute for Public Health, University of  
Calgary
  - **Elliott, Charlene, PhD**, Professor, Department of Communication, Media and Film, University of  
Calgary
  - **Fernandez, Pablo Richard**, Manager, Strategic Communications, O'Brien Institute for Public  
Health, University of Calgary
  - **Aravind Ganesh, MD, PhD**, Clinical Research Fellow, Junior Dean, Clinical Teaching Associate, St  
John's College, Department of Clinical Neurosciences, University of Oxford, UK
  - **Ghali, William, MD, MPH, FRCPC**, Professor, Faculty of Medicine, Scientific Director, O'Brien  
Institute for Public Health, University of Calgary
  - **Hardcastle, Lorian**, Assistant Professor, Faculty of Law and Community Health Sciences,  
Cumming School of Medicine, University of Calgary
  - **Hogan, David, MD, FACP, FRCPC**, Professor (Geriatrics), Cumming School of Medicine, University  
of Calgary
  - **Hollis, Aidan, PhD**, Professor, Department of Economics, University of Calgary
  - **Leung, Alexander Ah-Chi, MD, MPH, FRCPC**, Assistant Professor, Community Health Sciences,  
Department of Medicine, University of Calgary
  - **Lucas, Jack, PhD**, Associate Professor, Department of Political Science, University of Calgary
  - **McLaren, Lindsay, PhD**, CIHR / PHAC / AI-HS Applied Public Health Chair, Associate Professor,  
Dept Community Health Sciences and O'Brien Institute for Public Health, University of Calgary,  
Senior Editor, Canadian Journal of Public Health, Co-Editor, Critical Public Health
  - **Weijs, Cynthia, RDH PhD**, CIHR and AHS Health System Impact Fellow, Department of  
Community Health Sciences. Cumming School of Medicine, University of Calgary
- Some external stakeholders were also consulted in this report development process. These included:  
1) **Dr. Robert Dickson**, Founder of Safe Water Calgary - a community group opposed to Community  
Water Fluoridation; 2) **Ms. Maria Castro**, Executive Assistant Safe Water Calgary; 3) **Dr. Paul Connett**,  
Executive Director of the Fluoride Action Network, a U.S.-based group that is passionately opposed to  
Community Water Fluoridation; 4) **Dr. Hardy Limeback**, an Ontario-based dentist, and Emeritus  
Professor and former Head of Preventive Dentistry, University of Toronto; 5) **Dr. Morteza Bashash**,  
Adjunct Lecturer, Dalla Lana School of Public Health, University of Toronto – and author of recently-  
published research exploring the link between fluoride and cognition; 6) **Dr. Christine Till**, Associate  
Professor, York University, Toronto, ON – also author of recently-published research exploring  
fluoride and cognition; and 7) **Dr. Rafael Figueiredo**, Alberta's Provincial Dental Public Health Officer,  
Alberta Health Services. Each of these consultations were led by Dr. William Ghali, +/- other O'Brien

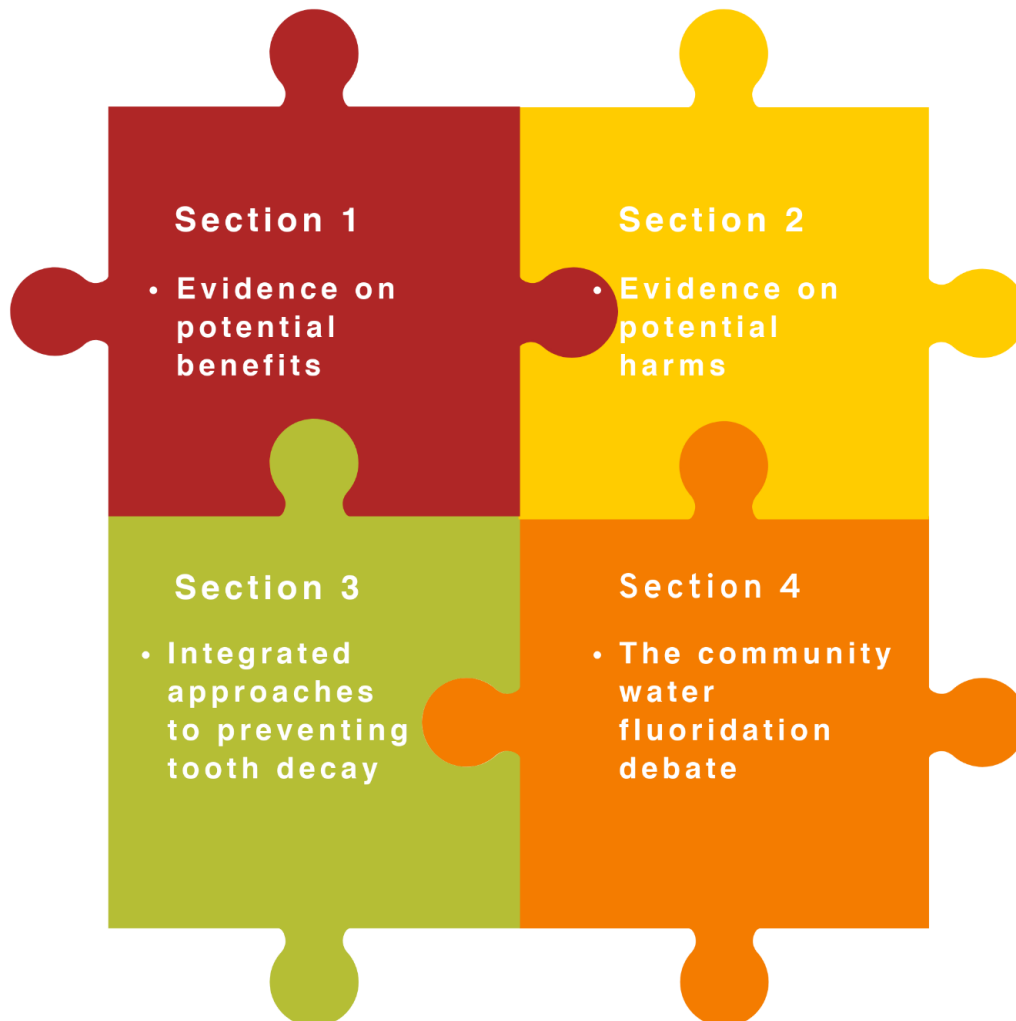
team members present, and also +/- Ms. Hopkins from the City (when scheduling permitted others to participate).

- A relevant backdrop to this O'Brien Institute work is a February 2019 report on community water fluoridation produced by the Canadian Agency for Drugs and Technologies in Health (CADTH). The [CADTH report](#) was a resource for the O'Brien Institute's work, because it highlights some, but not all, of the literature relevant to this Institute report. Also, the report formally presents the findings of an important Canadian health agency. The agency was established in 1989 by federal, provincial, and territorial governments, as an independent, not-for-profit organization with a mandate to conduct comprehensive evidence assessments of new drugs and technologies. In its multitude of reports on various drugs and technologies, CADTH has informed provincial health systems on both the efficacy of various health interventions, and the economic considerations around drug and technology funding decisions. Through its reports, CADTH seeks to inform governments and health systems on important public policy decisions that affect Canadians' health. A summary of the recent CADTH report on community water fluoridation is available online — [CADTH Evidence Highlights](#).
- Submissions of supporting documents and reference materials were welcomed from all sources. These included materials provided by any or all of the above-mentioned individuals, as well as document submissions from external stakeholders who were not interviewed. For the latter, Councillor Colley-Urquhart regularly forwarded materials received by her office (+/- other Councillors' offices) to the O'Brien Institute team for review and consideration.
- This final report was compiled and written by an Institute writing team led by Dr. William Ghali in his capacity as Director of the O'Brien Institute, with support from Dr. Jamie Day (the Institute's Administrative Director), Dr. Aleem Bharwani (the Institute's Public Policy Lead), Ms. Fiona Boulet (Coordinator of the University of Calgary's *makeCalgary* initiative), and the Institute's Communications team.

## REPORT ROADMAP

This report is written in a question-answer format and divided into the following thematic sections, which align with questions from Councillors. Sections 1 to 3 provide research evidence summaries on various aspects of community water fluoridation and oral health – with a review of potential benefits of fluoridation (Section 1), potential harms (Section 2), and integrated and/or alternative approaches to preventing tooth decay (Section 3). For each of these three evidence review sections, O’Brien Institute experts contributed knowledge from their respective areas of specialization. Section 4 then discusses several other dimensions of the community water fluoridation issue (and debate), with, in particular, a discussion of economic considerations, the ethical/legal context, intergovernmental jurisdiction considerations, and miscellaneous other topics.

Summary of this report’s FOUR SECTIONS:





## HIGH-LEVEL OBSERVATIONS ON THE COMMUNITY WATER FLUORIDATION ISSUE

Before the granular presentation of information in Sections 1 through 4, we consider it important to present some high-level observations at the outset, so that readers are aware of the overriding findings and impressions, before reading the more detailed evidence sections. O'Brien Institute observations:

- The community water fluoridation issue is contentious, with passionate views held by individuals on both sides of what has become a high-decibel public policy debate. Further, ***there is a large amount of advocacy work being done by individuals on both sides of the debate, with use of a variety of communication strategies for that advocacy***, including proactive social media campaigns, the staging of community events, targeted communications to City Councillors and other decision-makers.
- As mentioned in the earlier Report Process section, the Institute team actively sought out meetings with anti-fluoride stakeholders, while also having meetings with proponents of community water fluoridation. Our various discussions with individuals on both sides of this fractious issue highlight that ***both sides bring knowledge and thoughtful perspectives***.
- Importantly, all stakeholders (proponents, opponents, and any who may be in the middle without a strongly formed opinion) appear to be looking at the same general body of evidence, and ***overall there is agreement on a number of core findings***. Namely, most seem to acknowledge that:
  - community water fluoridation reduces the number of cavities at a population level;
  - community water fluoridation increases the prevalence of dental fluorosis;
  - there is a mixed (and therefore somewhat confusing) literature around the potential harms associated with ingested fluoride; and
  - within that harm literature, there are very recent studies (and notably some methodologically strong studies published in late 2018 and 2019) on potential detrimental cognitive effects.
- However, the proponents and opponents then differ considerably in how they approach the above findings, specifically in relation to:
  - ***how they convey their evaluations (critique) of the quality of the respective research studies*** relating to each of the evidence points above; and
  - ***how heavily they weight the negative health impacts*** associated with each of the relevant conditions (e.g., the extent of suffering associated with dental cavities vs. the extent of psychological distress associated with varying degrees of dental fluorosis).
- Further, both sides seem to selectively highlight the parts of the evidence that best support either pro- or anti-fluoride positions. Reflecting this, reactions to the recent CADTH report are similarly polarized – either strong endorsement of the report, or criticism on multiple levels.

- ***There are several areas of uncertainty that must be highlighted***, because these will continue to be points of discussion and debate in scientific circles. Municipal and health decision-makers (like Calgary's City Councillors) will also continue to be confronted by these points of uncertainty, because they will be highlighted in overtures from proponents and opponents alike. Areas of uncertainty:

- Many of the studies on benefits of fluoride for reducing dental cavities were based on fluoridation levels of 1.0ppm or greater. There is comparatively less information on the extent to which community water fluoridation is effective at the current lower North American community fluoridation standard fluoride concentration of 0.7ppm.
  - Dental fluorosis, when present, is usually mild. However, there is some inconsistency in the reported prevalence of moderate and/or severe dental fluorosis in Canada – with reported rates varying from less than 1% in research using the Canadian Health Measures Survey to over 14% in some population-based research done in Ontario.
  - New evidence has emerged on potential cognitive effects of fluoride, arising from fluoride ingestion by pregnant women +/- fluoride intake from water consumed by infants. Recent National Institutes of Health funding decisions in the U.S., and corresponding new research funding decisions in Australia highlight that funding agencies and leading researchers in these two peer countries acknowledge the need to actively study/invest in understanding any potential cognitive effects.
- ***There is a need to consider both individual and population perspectives*** when quantifying and discussing health impacts. Risk differences, both positive and negative, can be communicated by stakeholders with a focus on only describing the impact of health interventions on individuals (e.g., “a small reduction of only 1 to 2 cavities over a person’s lifetime” or “a tiny 1% increase in fluorosis”), but these differences also must also be considered through a population impact lens, where even very small differences in a health measure can add up to significant benefit/harm when projected over an entire population of over 1 million Calgarians, or over 35 million Canadians. Public health decision-making must consider both of these perspectives on the positive and negative sides of the ledger.
  - In our preceding mentions of proponents and opponents of fluoride, we have been non-explicit in our characterization of the many health agencies – provincial, national, and international – that must contemplate and make recommendations on water fluoridation. And to do so, they have a mandate (and significant ongoing challenge) of getting their positions right in the face of continuously evolving evidence. Health agencies have endorsed community water fluoridation since its introduction in the 1940s, and they have reviewed evidence iteratively over several decades as a basis for those endorsements. The O’Brien Institute team has learned that the areas of uncertainty just described are being actively reviewed by health agencies (including Alberta Health Services, which is carefully tracking and reviewing emerging cognition studies), and time will tell whether new evidence leads to a change in the official agency positions. In this regard, we note also that this decision-making accountability for health agencies is not confined to fluoride, but that it also applies to countless other issues, such as immunization policy, various environmental matters, and drug approval decisions, among others.

A final point to make in this high-level overview of the O'Brien Institute's work and overall impressions is that ***we have found the completion of this report to be a very challenging exercise.*** We have encountered a high level of passion among those who actively advocate for or against fluoride from firmly-held "yes" vs. "no" positions. Yet, there is also a nuanced middle ground that must be considered, where risks and benefits must be carefully weighted, while also fully understanding and acknowledging that there are still very definitely areas of persisting uncertainty, as just discussed. More knowledge is needed in a few key areas (the cognitive domain in particular), and from our expert interviews regarding new research that is happening around the world, more research evidence will emerge as time passes.

The City of Calgary Notice of Motion very explicitly tasks the O'Brien Institute with providing information, *but not recommendations*, for City decision-makers to consider. This report therefore stops short of ending with a simplistic "yes" or "no" recommendation for community water fluoridation. Our overall report findings suggest that such a simplistic response is not appropriate in any case. We hope that the bottom-line information just outlined is more enlightening than it is confusing.

## SECTION 1: POTENTIAL BENEFITS OF COMMUNITY WATER FLUORIDATION

### ❖ *Are community water fluoridation programs beneficial for reducing tooth decay (cavities) in children?*

As with other areas of science, to answer questions like this it is useful to rely on systematic reviews, which involve identifying and synthesizing individual studies in a comprehensive and reproducible manner, and then evaluating their methodological quality. Such reviews also need to assess studies for relevance (for example, some studies consider fluoride at very high levels, which is not necessarily relevant to community water fluoridation, where controlled levels of fluoride are added to drinking water).

For this particular topic, the recent [CADTH Report \(Sub-Report on Dental Caries and Other Health Outcomes\)](#) is a useful resource, as it summarizes a large and rather consistent body of literature showing that community water fluoridation is associated with a lower rate of dental cavities, especially in children. Further, this appears to be true for both deciduous teeth (i.e., baby teeth) and the new permanent teeth of older children. Some details on this evidence:

### Benefits of water fluoridation - children



44% relative reduction in baby teeth affected by dental decay and cavities.

37% relative reduction in children's permanent teeth affected by cavities.



50% lower rates of hospital admissions for surgical treatment of tooth decay.

- A series of systematic reviews examining variable numbers of primary studies finds that children in communities with fluoridated water had on average 1.8 fewer baby teeth affected by dental decay and cavities. Stated in relative terms, this equates to a 44% relative reduction in the number of baby teeth affected by dental decay and cavities.
  - For permanent teeth in children, the corresponding findings are that there were 1.2 fewer permanent teeth with tooth decay in children living in communities with water fluoridation. This represents a 37% relative reduction in children's permanent teeth affected by cavities.
  - A smaller number of studies go beyond simple counts of affected teeth, to examine more significant outcomes such as numbers of teeth lost entirely, or the need for hospital admission to treat severe tooth decay. A total of five studies show lower rates of tooth loss in children and adolescents in communities with fluoridated water, and one study from the U.K. reports lower rates of hospital admission for surgical treatment of tooth decay (approximately 50% lower in relative terms).
- Our review of this evidence on dental cavities also identifies some caveats and limitations of the available evidence. These include:
- Acknowledging that many of the studies are from early in fluoridation's history (prior to 1970).

- Noting that a large proportion of the studies done to date were from jurisdictions with water fluoride concentrations of 1.0ppm or greater, which is higher than the current Canadian standard of 0.7ppm for community water fluoridation.
- Recognizing that there is limited primary evidence from Canadian contexts (— this is one of the factors that motivated Dr. Lindsay McLaren’s Calgary-Edmonton study, which is discussed below).

Community water fluoridation is a public policy employed variably across provinces in Canada, and variably around the world, and decisions on its use are highly political and variable. In this context, the assignment of communities to receive fluoride (vs. not) is not controlled by researchers. As a result, the studies done to date are not randomized controlled trials. While some critics call for randomized controlled trials (RCTs) to be conducted to determine a true effect on cavities, such studies to determine *community-based effects* (i.e., the ultimate question in such research) are plain and simply not feasible. Researchers would need to identify a number of communities willing to be randomized as entire jurisdictions to have community water fluoridation vs. not – something that is clearly neither feasible nor practical. (Note: Simply randomizing some individuals to receive fluoridated vs. non-fluoridated water would not represent a study of *population-based* community water fluoridation.)

As a result, existing research studies on community water fluoridation (and many other population health interventions outside of fluoride) are observational in nature. These involve observing whole communities, either the same community over time, or comparing two or more communities, and carefully considering the various factors other than fluoridation that contribute to tooth decay for the populations and settings being studied. Such studies of course need to be interpreted with caution, with careful consideration of potential confounding factors like socioeconomic status, educational level, and prevailing health behaviours of the communities being studied.

### ❖ ***Do community water fluoridation programs also reduce dental cavities in adults?***

Again, drawing most heavily from the [CADTH Report \(Sub-Report on Dental Caries and Other Health Outcomes\)](#) we find evidence that community water fluoridation is also beneficial to adult populations. The extent of research evidence is somewhat less than for children, but studies of adults still show benefit:

- Systematic reviews suggest a 35% relative reduction in the number of teeth affected by decay and cavities.
- Different approaches have been used to estimate the corresponding absolute reductions in numbers of teeth affected by decay and cavities. It has been projected that the above-mentioned relative reduction corresponds to an average of 1 to 2 fewer cavities per person, experienced over 40 years (— the range of this estimate relates to varying assumptions made for these projections).

- Individual and population perspectives need to be considered in interpreting the above numbers. A relative small difference in individuals can amount to very significant overall morbidity in an entire population.

There is interest in determining whether community water fluoridation helps prevent tooth decay in the vulnerable elderly, either living in the community or in long-term care. Evidence for this sub-group is very limited, but new local data will emerge, as a team based at the University of Calgary has Canadian Institutes of Health Research funding to explore potential dental benefits in the elderly.

Importantly, we reiterate that this review suggests that the benefit of community water fluoridation for tooth decay and cavities is not confined to children.

### ❖ ***What are the effects of removing a community water fluoridation program?***

- Cessation of community water fluoridation is a relatively recent phenomenon in the life course of fluoridation. Because of that, there are fewer studies available; this is problematic because for communities that are revisiting their fluoridation status, there is limited information on which to base their decision. This is in part what prompted the Calgary-Edmonton study led by Dr. Lindsay McLaren.
- Prior to the publication of that Calgary-Edmonton study, McLaren & Singhal published [a systematic review of all fluoride cessation studies](#) conducted internationally. The systematic review revealed:
  - 15 studied instances of fluoride cessation (from 15 cities/regions in 13 countries).
  - Among these, nine of the studies are of moderate-to-high methodological quality.
  - Among the higher quality studies, five found an increase in dental cavities after cessation, whereas three did not. Among the latter, alternative dental care programs were initiated upon cessation of water fluoridation, and it is possible that these mitigated the impact of cessation.
- The highly publicized [Calgary-Edmonton fluoride cessation comparison study by McLaren](#) and colleagues was published in May 2017. It is clearly of relevance to Calgarians and Calgary City Council, given that the data are local. Its findings include:

## Benefits of water fluoridation - adults



35% relative reduction in the number of teeth affected by decay and cavities.

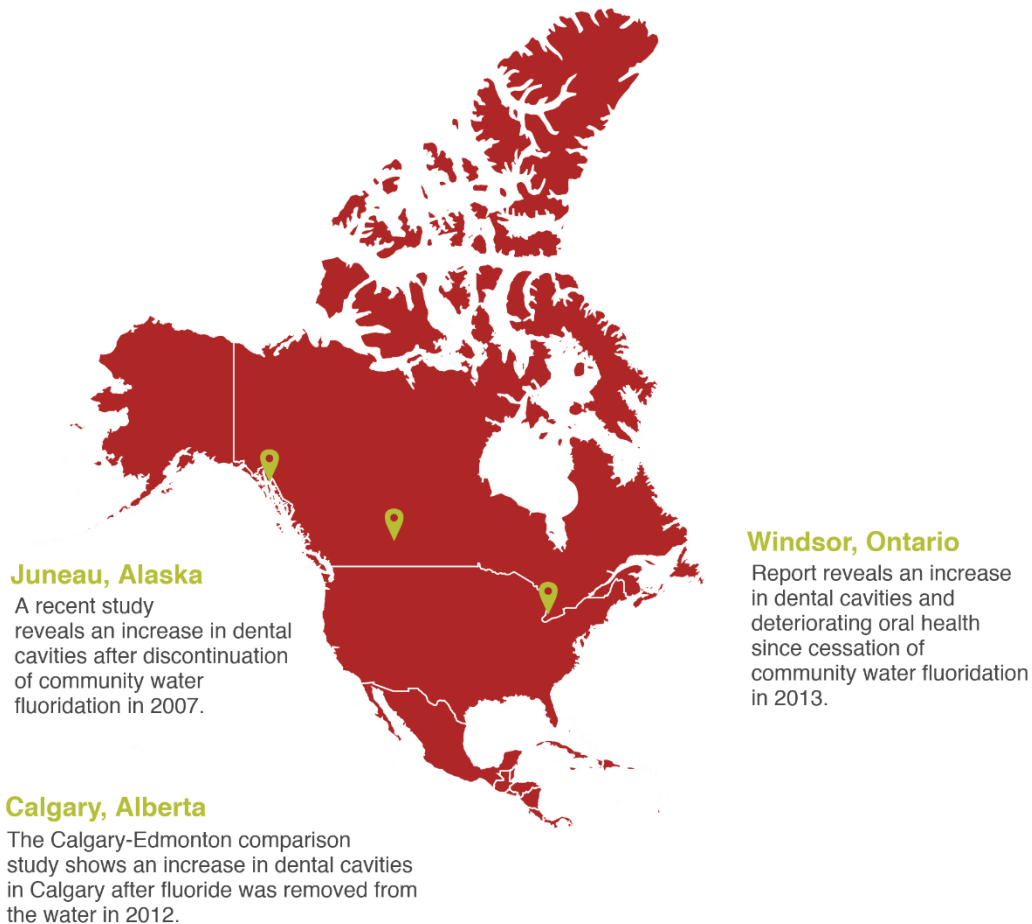
Projected reduction of an average of just over 1 cavity per person, over a 40 year time span.



The benefit of community water fluoridation for tooth decay and cavities is not confined to children.

- Evidence of an increase in dental cavities in *both* Calgary and Edmonton – an indication of deteriorating oral health in Alberta as a whole.
- The magnitude of increase in number of cavities was greater in Calgary than in Edmonton, and this was despite the fact that there was evidence of better dental treatment activities in Calgary.

## Community water fluoridation cessation



- An increase in oral health disparities across socioeconomic groupings (described in more detail in the next section).
- Since the systematic review and Calgary-Edmonton studies just described above, we are aware of two other North American studies on cessation of water fluoridation:
  - A recent [report from Windsor, Ontario](#) has revealed an increase in dental cavities and deteriorating oral health since cessation of community water fluoridation in 2013.
  - An even more [recent study from Juneau, Alaska](#) similarly reveals an increase in dental cavities after discontinuation of community water fluoridation in 2007. This included increases in both

the number of cavity-related procedures in children, and the overall costs incurred by individuals and the population as a whole. Of note, costs incurred for dental care were more than doubled for some subgroups of the population.

- As noted earlier, community water fluoridation is a public policy that is not controlled by researchers. Therefore, research studies like the ones summarized in this section are inherently challenging and messy because a population-based phenomenon is being studied. Research of this type involves observing whole communities, either the same community over time, or comparing two or more communities, and carefully considering the various factors, other than fluoridation, that contribute to tooth decay for the populations and settings being studied.

We end this section by highlighting that the McLaren study of Calgary and Edmonton is not standing alone with its findings of increased dental cavities after fluoride cessation. It stands alongside a number of other studies showing the same thing, both prior to and after the Calgary-Edmonton study. This is hardly surprising, as these cessation study findings are entirely in keeping with the studies on dental benefits reviewed in preceding sections (-- indeed, it would have been quite surprising for cessation studies to show anything different.)

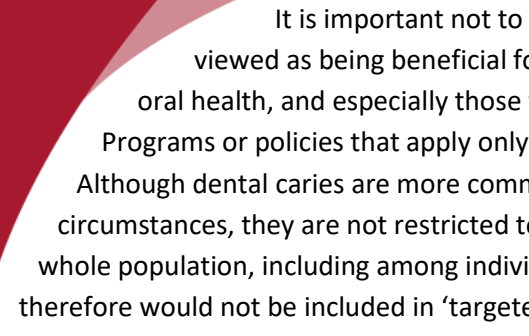
### ❖ ***Does community water fluoridation contribute to reducing socioeconomic inequities in dental health?***

The best research we have indicates that fluoridation reduces socio-economic inequities in dental health among children. This is noted in both the international health literature, and in Calgary-based research:

- The [CADTH Report \(Sub-Report on Dental Caries and Other Health Outcomes\)](#) summarizes literature for both children (15 studies) and adults (one study) revealing a decrease in oral health inequities across socioeconomic strata.
- In Calgary, the recent McLaren study of fluoride cessation has permitted a [sub-study evaluating inequity in dental health in Calgary](#). Importantly, this local work reveals that cessation of community water fluoridation in 2012 was associated with an increase in health disparities (i.e., differences in numbers of cavities for advantaged vs. disadvantaged children) across socioeconomic groupings defined by dental insurance status and level of household material deprivation.

Because a community water fluoridation program is population-wide in nature, it impacts the population as a whole and requires no special effort from community members. Fluoridation is beneficial for health equity, because it benefits everyone, but especially those who have limited resources to access oral hygiene and dental care. Evidence shows that socioeconomically disadvantaged community members have the least access to formal dental care due to cost and access challenges. This is very applicable to Calgary (and Alberta), where dental care is recognized as being particularly costly.





It is important not to confuse 'equity' with 'poverty'. Fluoridation has historically been viewed as being beneficial for health equity because it has potential to benefit everyone for oral health, and especially those who have limited resources for oral hygiene and dental care. Programs or policies that apply only to people living with low-income circumstances are incomplete. Although dental caries are more common in individuals and families with lower socioeconomic circumstances, they are not restricted to those population groups. Dental caries are distributed across the whole population, including among individuals and families who are relatively advantaged, and who therefore would not be included in 'targeted' policies such as the programs that were briefly funded by the City of Calgary in inner-city health clinics upon cessation of community water fluoridation.

We must emphasize in closing that community water fluoridation is not, in and of itself, a fundamental solution to oral health inequities, or health inequities beyond oral health. Health is determined by many factors, and societies need to develop integrated approaches to reducing health disparities of all types across socioeconomic strata, as these relate to income, education, social support, location of residence, housing, and countless other factors. A later discussion in Section 3 below discusses integrated approaches to oral health.

## SECTION 2: POTENTIAL HARMS OF COMMUNITY WATER FLUORIDATION

The [CADTH Report \(Sub-Report on Dental Caries and Other Health Outcomes\)](#) presents information on the associations between community water fluoridation and 22 different non-dental health conditions. In addition, the report presents findings in relation to the prevalence of dental fluorosis in communities with water fluoridation. For 16 of the 22 non-dental conditions, the bottom-line CADTH finding is simply to report that there is insufficient evidence to indicate risk from water fluoridation for the particular condition(s) in question.

Below, we summarize evidence on potential harms relating to: 1) dental fluorosis; 2) cognition; 3) thyroid disease; and 4) bone health. The CADTH report was a partial resource for these sections of the O'Brien Institute report, as some additional literature and interviews with key informants were needed to obtain additional information.

### ❖ ***Does community water fluoridation increase the prevalence of dental fluorosis?***


Dental fluorosis is a condition that arises from disruption of enamel formation by fluoride. The condition is broadly considered to be cosmetic, though it is not necessarily of negligible importance to individuals who have moderate-to-severe cases. Fluorosis can vary in severity from very mild forms (with subtle white spots on the teeth) to severe forms (with significant brownish discoloration of teeth).


The prevalence of dental fluorosis has been studied extensively, and existing evidence appears to be well-described in the CADTH Report, where the bottom-line conclusion is that community water fluoridation increases the prevalence of dental fluorosis. Highlights of this evidence:

- Two comprehensive systematic reviews of dental fluorosis are highlighted, one of which is a Cochrane Systematic Review presenting comprehensive data on dental fluorosis, for which 135 studies were reviewed.
- The Cochrane review reports a prevalence of 'any fluorosis' of 40%, linked to water fluoridation concentrations of 0.7ppm. If only aesthetically-concerning fluorosis is considered (i.e., fluorosis rated to be moderate or severe in a standardized fluorosis rating system), the prevalence is lower at about 12%.

### Harms of water fluoridation


Consistent evidence that fluoride causes fluorosis.






Active research still needed on effect of fluoride on cognition.

Consistent evidence shows no adverse effects on bones.





Possible minor effects on thyroid function.

- Higher fluoride concentrations (as high as 5.0ppm) in older community water fluoridation studies (and/or studies where the fluoride content of groundwater is very high) reveal higher prevalence of dental fluorosis.

There is some inconsistency across Canadian studies surrounding the prevalence of dental fluorosis. The [Canadian Health Measures Survey 2007-2009 Oral Health Component](#) reports a prevalence of less than 1% for more severe forms of fluorosis. This differs from some Ontario studies that report a rate of over 14% (e.g., [Leake and colleagues, studying fluorosis in Toronto](#)). The alignment of the prevalence from that latter study with the Cochrane review's reported prevalence of 12% for community water fluoridation at the Canadian level of 0.7ppm certainly lends some credibility to that higher prevalence estimate.

Through our stakeholder interviews, we also note variable descriptions of the relative importance of dental fluorosis as a health condition – i.e., varying from its description as an 'entirely negligible' condition by some, to its being described as a 'devastating condition' that affects mental health. We reserve judgement on which of these descriptions is more valid, suspecting that the degree of distress is likely to vary from one person to the next, partially affected by the severity of one's fluorosis.

### ❖ ***Does ingested fluoride affect cognition?***

This is an important section of our report, because it highlights an area where the evidence is evolving quite rapidly. Recognizing this, we present descriptions of new studies from the past eight months that were not covered in the recent CADTH report published in February of 2019. These are presented alongside some older studies on fluoride and cognition.

- During fetal life and early infancy, the blood-brain barrier only partially prevents entry of chemicals into the brain and the developing brain is known to be sensitive to injury from toxic chemicals.
- Several Chinese studies reported lower IQ among children exposed to fluoride in drinking water at average concentrations of 2.5-4.1ppm (several times higher than recommended fluoridation levels); these were published in journals specifically interested in fluoride (— namely, the journal *Fluoride*).
- [A meta-analysis of 27 studies](#) led by a team at Harvard University, summarizing primary studies mostly done in China and Iran, reported an association between high fluoride exposure (upper limit of exposure up to 11.5mg/L) and lower IQ scores. The relevance of this study to the context of North American water fluoridation has rightly been questioned on the basis that the levels of fluoride exposure were generally higher than those seen in fluoridated Canadian water systems. Furthermore, the primary studies reviewed were generally either cross-sectional studies or ecological studies – i.e., weaker study designs for inferring causation. However, it should still be noted that the systematic review itself was very well done in reviewing an existing body of primary literature, and it certainly appears to have contributed to convincing national peer reviewed agencies like the National Institutes of Health in the U.S. to fund major studies (expensive studies) exploring the link between fluoride ingestion and cognition.
- A later [prospective study of a birth cohort in Dunedin, New Zealand](#) found no association between fluoride exposure and IQ measurements performed repeatedly during childhood and at age 38. The cohort study design of this study, published in 2015, is stronger than prior study designs. However, there were also some important limitations to this study, including the fact that there were only a small number of control subjects (one-tenth the number of subjects exposed to fluoridated water), and as a

result, a lack of statistical power to make definitive conclusions. Also, various forms of oral fluoride supplements were in use in New Zealand in the 1970s, and it is likely that controls received fluoride from non-water sources – a factor that could bias the study toward finding no association.

- Inconsistent results were found in a [cross-sectional population-based study of Canadian children](#) aged 3-12 years that examined the association between different measures of fluoride exposure (urinary fluoride, adjusted for kidney function and specific gravity, and fluoride concentration of tap water) and learning disability, as measured in the Canadian Health Measures Survey. In the combined sample, there was a small but significantly higher odds of learning disability among children with higher urinary fluoride, but this was not observed when examining adjusted measures of urinary fluoride (generally more accurate). Limitations included the absence of objective assessments of IQ or similar measures and the absence of data on pre-natal exposure which is now the major concern (see below).
- [A high-quality cohort study \(ELEMENT: Early Life Exposures in Mexico to Environmental Toxicants\)](#) studied urinary fluoride in mothers during pregnancy and then from their children at 6-12 years (299 mother-child pairs). An increase in the mother's urinary fluoride by 0.5mg/L predicted a lowering of 2.5 IQ points. The mean urinary fluoride was 0.9mg/L which is in the general range of exposures reported for other populations of adults. Though this study is based on subjects and fluoride consumption patterns in Mexico, the research was funded by the U.S. National Institutes of Health, and the work was led by Canadian researchers (Dr. Howard Hu, the former Dean of the Dalla Lana School of Public Health at the University of Toronto, and lead author Dr. Morteza Bashash, a public health researcher, also at the University of Toronto).
- [Another similar analysis from ELEMENT](#) found that higher levels of fluoride exposure during pregnancy were associated with global measures of attention deficit hyperactivity disorder (ADHD) and more symptoms of poor attention in children. One widely-stated caveat/criticism for these two ELEMENT studies just described is that the levels of urinary fluoride measured in pregnant Mexican women may not be relevant to Canada.
- This criticism is, however, addressed by a recent Canadian study. The [MIREC \(Maternal-Infant Research on Environmental Chemicals\)](#) cohort found that community water fluoridation appears to be a major source of fluoride exposure for pregnant women living in Canada, with urinary fluoride reflecting this exposure well. Further, this study reveals that the maternal urinary fluoride levels for women in communities with water fluoridation is comparable to that of Mexican women in the ELEMENT cohort. The amount of black tea consumed may further increase the exposure to fluoride.
- Of great relevance to the evolving evidence in this domain, another [MIREC study focusing on cognition](#) also examined the association between fluoride exposure and childhood IQ using similar methods to the Mexico study, but in a Canadian sample of 510 mother-child pairs; 38% received recommended levels of community fluoridated water in major Canadian cities. Women from fluoridated communities had higher urinary fluoride (average 0.69mg/L vs 0.40mg/L), and higher levels were associated with lower IQ scores in boys at age 3-4 years (each 1mg/L increase in urinary fluoride associated with 4.5 IQ points lower) but not in girls. The new Canadian cognition evidence is currently in the public domain as a [published and approved thesis \(Ms. Rivka Green, York University\)](#), and it is also officially 'in press' with a leading medical journal, due to appear in the late summer or early fall. Of note, the MIREC studies just described were, like the ELEMENT study, funded by the U.S. National Institutes of Health. The lead

investigator for this research is a Canadian colleague, Dr. Christine Till, Associate Professor of Psychology at York University.

- The O'Brien Institute team conducted interviews with both Dr. Morteza Bashash (ELEMENT study) and Dr. Christine Till (MIREC) to clarify points in both of their respective studies, and to hear their perspectives on the overall fluoride issue. Importantly, we note that both are very clearly taking an objective and neutral scientific perspective in the work they do, and they firmly assert that they are neither pro- nor anti-fluoride in their perspective. Both simply indicate that 'we need to get this right'. In that vein, both are engaged in continuing research that may shed more light on the question of whether ingested fluoride affects cognition.
- These very recent fluoride-cognition studies are being noticed and tracked by public health agencies. In Alberta, public health experts in Alberta Health Services are actively evaluating these new studies, and any others that may appear. [Public Health Ontario has also recently done a careful analysis of the ELEMENT study](#), acknowledging its strengths, and the need for close monitoring of this issue (Note: the Public Health Ontario analysis was released before the Canadian MIREC data became publicly available).

In summary, there is some new emerging evidence that fluoride exposure during pregnancy may be harmful to the brain development of children, with important studies having been published subsequent to the review of this evidence by the National Research Council in the U.S. in 2006. Many uncertainties remain about the mechanisms by which fluoride may harm brain development. Several – but not all – studies indicating toxicity have been performed in places where the ground water contains high levels of fluoride (versus community water fluoridation) and it is difficult to fully account for all the factors that may contribute to observed differences in IQ.

The new emerging studies in this domain need to be tracked very closely, and carefully evaluated as they appear. We expect that health agencies at local, national, and international levels will confer and compare notes as they iteratively review, and re-review, this evidence.

### ❖ ***Does community water fluoridation affect late-life cognition and/or cause dementia?***

There have also been some studies assessing potential associations between community water fluoridation (and/or amount of fluoride ingested) and cognition or dementia in later life. Results of these studies are inconsistent, and quality of these studies is variable. We summarize three studies that we identified:

- [An American study conducted in the 1970s](#) compared the annual incidences of dementia in three counties with differing fluoride concentrations of their water supply. The county with the highest level (4.2 ppm) had an annual incidence of primary neurodegenerative dementia (principally Alzheimer's disease) one-fifth lower than in the other two counties with lower fluoride levels 0.5 & 0.6 ppm.
- [Data from the Ontario Longitudinal Study of Aging](#) (from the late 1980s) shows significantly lower risk of impaired cognitive functioning if fluoride concentrations in the drinking water were higher and significantly less mention of Alzheimer's disease on death certificates if fluoride concentrations were greater than 0.86 ppm.

- [A very recent Scottish study](#) published earlier this year examined the association between fluoride levels in drinking water and dementia risk in 6,990 older subjects followed for just under 3 years. A dose-dependent relationship between fluoride levels and higher dementia risk was found. The authors themselves highlighted a number of methodological caveats surrounding the work, and urged caution and further research.

We conclude that research results on potential dementia risk associated with fluoride have been inconsistent. Methodological challenges include the difficulty of accurately assessing fluoride exposure over the life course, capturing all outcomes of interest, and dealing with potential confounders. An association between drinking fluoridated water and later life cognitive impairment or dementia has not been confirmed.

### ❖ ***Does community water fluoridation affect thyroid health and disease at a population level?***

This section of the report summarizes the studies that were identified by the [CADTH Report \(Sub-Report on Dental Caries and Other Health Outcomes\)](#). A further search of the recent medical literature identified an additional [Canadian study of interest](#) on the link between fluoride exposure and thyroid function, as these relate to a person's iodine status (see below).

The thyroid is a hormone-producing gland located in the neck. It controls metabolism in the body. Hypothyroidism is a common medical condition and refers to an underactive thyroid. There is public interest in understanding whether higher levels of fluoride exposure can lead to a greater risk of having hypothyroidism. Key findings from our evidence review:

- Low thyroid hormone (or hypothyroidism) results in a slow metabolism. This can lead to feelings of lethargy, fatigue, coldness, and weight gain. In children, it can negatively affect brain development, learning, and growth if left untreated. This condition can be diagnosed with a simple blood test. Treatment is usually straight forward with replacement of thyroid hormone.
- Eight studies identified through the CADTH review look at how fluoride exposure may affect thyroid function in humans. In general, most studies found no significant differences in thyroid function or size according to fluoride exposure after accounting for potential confounding factors. A couple of studies reported a small measurable increase in thyroid stimulating hormone levels with higher fluoride levels, but these differences were very small with hormone levels remaining well within the normal range. In contrast, one study reported the opposite, where higher water fluoridation was associated with lower thyroid stimulating hormone levels, but again these differences were very small and within the normal range. Overall, these differences were unlikely to be of any clinical significance, at least in adults, where such minor abnormalities are usually just followed without any need for treatment. Finally, one study suggested that hypothyroidism was more common in selected areas of England where water fluoride levels were higher compared to places where it was lower. But, this latter study has been extensively criticized for its methodological problems. It is also important to note that most of the studies cited above were of low scientific quality, and many looked at fluoride levels much higher than what is considered to be acceptable for drinking water in Canada.

- Of relevance, two studies of strong scientific quality were conducted in Canada. Neither of these found any significant association between fluoride exposure and thyroid hormone levels within the general population. People living with a thyroid condition, when compared to those without any history of thyroid problems, were not more or less likely to be exposed to higher levels of water fluoridation. However, it is possible that higher fluoride exposure may be associated with a slightly higher level of thyroid stimulation hormone in people with moderate-to-severe iodine deficiency, an uncommon condition among Canadian adults, and these differences were very small and also within the normal range.

In conclusion, hypothyroidism is a common condition that is easy to detect and treat in adults. There is insufficient evidence to say that water fluoridation at current Canadian levels is associated with harmful effects on thyroid function in the general population.

In relation to the preceding section reviewing evidence on the link between ingested fluoride and cognition, there is some belief that disturbances in thyroid function may underlie fluoride effects on the developing fetal or neonatal brain. This is certainly a possibility that warrants further exploration, as it would raise the possibility that the relatively small thyroid function effects that we summarize above (for non-pregnant adults, and fully-developed adult brains) may be more concerning in the context of pregnancy and/or neonates.

### ❖ ***Does community water fluoridation affect bone health?***

Skeletal fluorosis is a potentially crippling condition that arises from fluoride-induced increases in bone density. In mild forms, skeletal fluorosis can present with mild joint stiffness and skeletal pain. In more severe forms, stiffness and pain can be quite severe, and be associated with calcification of tendons and deformities of multiple joints.

Fortunately, this condition has never been described in relation to community water fluoridation in Canada. The existing studies linking skeletal fluorosis to fluoride ingestion from water are from India and Iran, where the fluoride levels were naturally present in local groundwater at very high levels (e.g., 10.0ppm) that far exceed the 0.7ppm level for community water fluoridation in Canada.

The CADTH report also reviewed the risk of hip fracture and bone cancer in residents of jurisdictions with community water fluoridation, and review findings indicate consistent evidence that there is no association.

We consider these to be reassuring results in relation to bone health. Fluoride, at high concentrations, is toxic to bone, as evidenced by significant skeletal fluorosis cases reported in relation to very high community water fluoride concentrations. We do not, however, find evidence of harm to bones at the fluoride levels typical of community water fluoridation programs.



## SECTION 3: INTEGRATED APPROACHES TO PREVENTING TOOTH DECAY

This section discusses oral health and tooth decay in a more general manner, focusing less on community water fluoridation, and more on how programs can be structured to support better oral health at a population level. We begin the section by describing the burden of disease associated with suboptimal oral health and tooth decay, and while doing so, also describe the relevance of tooth decay relative to other health conditions. Following this, we discuss integrated and multifaceted approaches to improving oral health and preventing tooth decay.

### ❖ ***What is the burden of disease associated with oral health and tooth decay, and how does this compare to other health conditions?***

The Global Burden of Disease Study in 2010, identified untreated decay in permanent teeth as the number 1 (most prevalent) disease globally among 291 diseases, noting that it affects 35% of the global population. Gum disease was the sixth most prevalent, and cavities in primary (baby) teeth was the tenth most prevalent disease.

According to a [2003 study](#), oral diseases are the fourth most expensive diseases to treat worldwide. Costs of dental treatment are high in most parts of the world, and there is a high prevalence of dental disease globally, resulting in a very high financial burden. The direct cost of treating dental diseases worldwide is estimated at US \$297 billion, with 82% spent in high-income countries. North America alone accounts for US \$120 billion. In addition, there are indirect costs relating to oral diseases affecting productivity (time lost from work or school due to pain and treatment) which are comparable to the range of economic losses associated with the 10 most frequent global causes of death. Further, there are additional intangible costs (e.g., quality of life impacts) that cannot easily be standardized or measured across countries.

Canadian data on prevalence of decay are somewhat limited, but the [Canadian Health Measures Survey](#) suggests that over half of children in Canada have or have had a cavity, and those who have unequal access to care tend to have more tooth decay. According to a [Canadian Academy of Health Sciences report \(2014\)](#), Canadians spend ~\$12 billion yearly on dental services. Of concern, costs could actually be higher, considering that approximately 6 million (~17%) Canadians avoid dental services due to the cost of care. Among the provinces, Alberta has the highest cost of dental care, where despite 70% of the population having private dental insurance, 62% of Albertans report limiting care for themselves, and 47% of Albertans report limiting dental visits for their children due to cost. ([Alberta Dental Review 2016](#)).

Provincial health systems in Canada absorb some of the population burden of dental disease. Patients with dental pain from tooth decay, but who are excluded from the private dental system because of lack of insurance, will often go to physician offices or emergency departments in attempts to access care. Definitive treatments such as a restoration (filling) or extraction, are not available from either family or emergency physicians, and patients will instead receive a prescription for antibiotics/pain killers and/or be advised to see a dentist.



Various age groups are particularly vulnerable to negative effects of suboptimal oral health. Young children, young adults, and seniors suffer important consequences from unaddressed dental decay. Dental decay in primary teeth of young children has consequences for nutrition, sleeping, learning, and social development. Young children are usually further unable to inform their parents of dental pain, as symptoms often progress slowly and subtly, thus becoming normalized. Young adults who are just launching out on their own can often be in employment situations that either do not provide high wage or employment-linked dental insurance. Seniors living in long-term care are also often unable to easily access dental care (because of mobility and/or transportation barriers) and are less likely to be able to carry out homecare (brushing) to care for their teeth. As with young children, tooth decay affects nutrition in the elderly, and as with very young children, some may be unable to communicate about painful teeth.

As reported in the [World Oral Health Report from 2003](#), tooth decay rates dropped in the 1970s and 80s (a drop that has been attributed by some to water fluoridation programs and fluoride toothpastes), but there has been a rebound since the 1990s in observed rates of tooth decay, particularly in primary teeth. The causes of dental cavities have not changed and include three essential factors: 1) cavity-causing bacteria; 2) susceptible tooth surfaces; and 3) the intake of dietary sugars and carbohydrates.

Of relevance to the primary focus of this report, it is believed that fluoride in saliva contributes to the reduction in cavities seen worldwide since 1950, and that this occurs through three fluoride-driven mechanisms: 1) promotion of remineralization of teeth; 2) reduction of bacteria in the mouth; and 3) strengthening the enamel so it is more acid-resistant.

❖ ***Are other countries or communities following more integrated approaches to oral and dental health, and how are those approaches working?***

It is widely accepted that jurisdictions need to consider integrated and multifaceted approaches to oral health and dental care. Fluoride treatment programs have historically been part of existing programs, and the approaches to delivering fluoride have included various approaches to topical application (gels, rinses, sealant, toothpaste) and ingestion (water fluoridation, fluoridation of salt, and fluoridation of other ingested foods).

Optimal integrated oral health programs are not only about fluoride. Other approaches are also needed, and these can include: 1) coordinated approaches to population-based education on oral health and hygiene; 2) preventive dentistry services; 3) improving the affordability and equity of access to dental services for treatment; and 4) strategies that actively seek out and support vulnerable individuals and populations.

Among higher income countries internationally, those that do not use community water fluoridation as a preventative measure against tooth decay tend to have other measures in place to promote oral health. In some countries, this involves the use of other sources of ingested fluoride such as fluoridated salt. A few countries have developed dental public health care systems that enhance population access to dental care, so that population dental care needs can be met.

The table below presents some high-level information on selected countries' approaches to delivering ingested fluoride as a public health intervention:

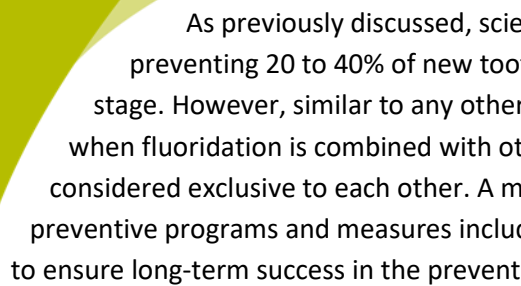
Other nations (beyond Canada) with prevailing community water fluoridation programs	<ul style="list-style-type: none"> <li>• U.S. (began in 1945); as of 2014, 74.4% of population on public water systems have access to fluoridated drinking water</li> <li>• Australia (began in 1960); as of 2017, 89% of population have access to fluoridated drinking water</li> <li>• New Zealand (began in 1954); as of 2014, 56% of population have access to fluoridated drinking water</li> </ul>
Other nations following different approaches to delivering oral fluoride	<ul style="list-style-type: none"> <li>• Switzerland (fluoridated salt since 1955); as of 2004, market share of fluoridated salt was 88%</li> <li>• France (fluoridated salt since 1985); fluoridated salt is consumed by 13% of the population, including at schools</li> </ul>

There are different ways that individuals may receive fluoride, including use of fluoride-containing toothpaste, receiving fluoride treatment at the dentist, consuming foods that were prepared in areas that have community water fluoridation in place, and of course through consumption of water containing fluoride that is either naturally-occurring or that has been added through community water fluoridation.

[An extensive 2009 systematic review on fluoride](#) summarized and ranked different approaches to the administration of fluoride, including ingested fluoride (via water, salt, or food) and various topical administration methods.

**Table: Overall Ranking of Effectiveness of Preventive Programs for Tooth Decay**

Preventive Program	Range of Caries Reduction	Overall Ranking
Community water fluoridation	20-40%	1
Sealant program	23-87% (median 60%)	2
Tooth brushing	24-56%	3
Fluoride varnish	24-46%	4
Fluoride gel	14-28%	5
Fluoride mouth rinses	0-26%	6
Salt fluoridation	13.3-89.5%	7
Milk fluoridation	35.5-78.4%	Cannot be ranked
School water fluoridation	38.9%	Cannot be ranked
Xylitol	62-70%	Cannot be ranked
Casein derivatives	Not available	Cannot be ranked



As previously discussed, scientific evidence reports that community fluoridation is effective in preventing 20 to 40% of new tooth decay and it is capable of reversing tooth decay at an early stage. However, similar to any other preventive measure, prevention of tooth decay is enhanced when fluoridation is combined with other measures. Dental preventive programs should not be considered exclusive to each other. A multifaceted approach that includes a combination of different preventive programs and measures including community-based health promotion activities is the best way to ensure long-term success in the prevention of tooth decay.

Importantly, programs relying on ingested fluoride should not be viewed as the only way to enhance oral health and reducing dental decay at a population level. In this regard, Scotland presents an interesting case study. Scotland has proactively put oral health programs in place, while also making a decision to *not* implement community water fluoridation.

The Government of Scotland has explicitly recognized oral health to be an integral part of overall health, and has committed to improving the oral health of the population. The [National Health System \(NHS\) Scotland has an oral health plan](#) that includes: 1) strategies for educating the public on oral health; 2) approaches to mitigating oral health inequity; 3) support for the vulnerable elderly; 4) workforce planning considerations; and 5) a comprehensive preventive care system for children called [Childsmile](#). The *Childsmile* program is designed to improve the oral health of children in Scotland and reduce inequalities in access to dental services and dental health. The program includes coordinated approaches to education surrounding oral hygiene and effective tooth brushing, alongside a proactive program for fluoride varnish application in nursery and primary schools.

Compared to Canada, the dental public health care system in Scotland is more comprehensive. It includes a dental examination free of charge for everyone, and free dental treatment for everyone under age 18, as well as pregnant women, and low-income individuals. (The O'Brien Institute for Public Health enthusiastically endorses the merit of such programs and national policies.)

Importantly, the Alberta approach is not solely focused on water fluoridation. Alberta Health Services has developed an [Alberta Oral Health Action Plan \(OHAP\)](#), and through that plan establishes similar preventive initiatives tailored to local settings. The OHAP preventive services include the application of fluoride varnish and dental sealants for children, and daily mouth care for seniors living in Continuing Care facilities. Such preventive programs have been in place since 2010 and these are reaching 17% of children in socially vulnerable target groups across the province. The prevention rate for fluoride varnish ranges from 24 to 46%, and this surface treatment approach is classified as the fourth most cost-effective initiative in preventing tooth decay. In comparison, community water fluoridation reaches everyone in the community.

Relative to Scotland's national oral health strategy and its *Childsmile* program, Alberta is somewhat constrained in its ability to more broadly intervene to improve oral health across the entire population. The biggest obstacle in the current Alberta context is that dental care in this province is almost entirely situated within the private sector whereby individuals and families must have private or employer-sponsored insurance, or pay out of pocket, to receive even basic dental care. Dental public health services in Alberta are extremely limited in scope

and are entirely targeted to lower income communities. This is problematic because dental cavities are not restricted to those living in lower income communities, but rather are spread across the population.

In light of this limited dental public health infrastructure and private financing context, there is understandable strategic interest in the pan-population reach of community water fluoridation as an intervention. Indeed, community water fluoridation is an appealing public health intervention, considering its reach to the entire population, remarkably low per-person costs relative to any form of dental treatments, and its demonstrated benefit in reducing tooth decay, particularly when that benefit is measured and considered through a lens of population-wide impact. The corresponding Alberta position statement on water fluoridation has thus been as follows:

“Alberta Health and Alberta Health Services recognize that community water fluoridation effectively prevents tooth decay, especially among people who are most vulnerable. It offers significant benefit with very low risk and reaches all residents who are connected to a municipal water supply. Therefore, Alberta Health and Alberta Health Services endorse community water fluoridation as a foundational public health measure to prevent dental disease and improve oral health.” (*Position statement on community water fluoridation, Government of Alberta, January 2017*)

Now, however, a key finding of this O’Brien Institute report is that this dental public health intervention (i.e., community water fluoridation) does need to be carefully reviewed and continuously tracked for its safety in the face of the very recent cognition studies appearing in the literature. The history of public health, and how public health evidence evolves over time, teaches us that this water fluoridation story will unfold in one of two ways: i.e., either 1) that a flurry of new studies could emerge, reassuring us that the cognition concerns are not that major and perhaps driven by some other confounding factor that comes to light; or alternatively 2) that a flurry of new studies could affirm that the cognition safety findings are replicated, significant, and clarified mechanistically. In this latter scenario, a long-standing public health intervention would then need to be reconsidered, and replaced with only topical fluoride application programs, along with other elements of the integrated oral health programs just discussed above.

In closing, we reiterate that new emerging studies on fluoride and cognition need to be tracked and carefully evaluated on an ongoing basis. In parallel to this, jurisdictions like Alberta should continue to foster and invest in integrated and multifaceted oral health strategies that enhance health at a population level.

## SECTION 4: THE COMMUNITY WATER FLUORIDATION DEBATE

### ❖ ***What are the economic considerations for a community water fluoridation program? Are there opportunities for broad cost savings and efficiencies with respect to overall population health?***

According to the [2019 CADTH Report – Budget Impact Analysis](#), the expected net impact of community water fluoridation on total costs for a large urban municipality such as Calgary is a savings of approximately \$34 per person per year, accrued over a 20-year horizon. Importantly, however, the economic benefits of implementing a community water fluoridation program in Calgary principally accrue to citizens and to their insurers rather than to the City that would typically pay for water fluoridation, since the program will significantly reduce the incident of dental caries. Extrapolating from the CADTH report (Table 18), for a city the size of Calgary, a community water fluoridation program is expected to result in a reduction of about 3 million cases of decayed, missing, and filled teeth over 20 years. This is roughly two incidents per person on average.

We note as a caveat that some critics have questioned the base assumptions of the CADTH report on number of cavities prevented per person over a 20 to 40 year period. Nevertheless, even if estimates of benefit were cut in half, this remains an economically attractive population intervention for protection of teeth against tooth decay, particularly if a *societal perspective* is taken to the consideration of cost savings arising from fluoride. The societal perspective recognizes, and accepts, that a public expenditure paid for by a municipal budgetary silo leads to savings accrued in a different budgetary silo – i.e., either by citizens who save on dental costs, insurance companies, or the provincial healthcare system (none of whom paid for the water fluoridation).

### ❖ ***Since oral health is a topic for all levels of governments in Canada, how are other jurisdictions handling the costs and implementation of programs? Are there examples of shared jurisdiction?***

Across Canada, decisions about fluoridation are made by municipal governments. There are at least two reasons for this. First, water services are a municipal responsibility, and adding fluoride to drinking water is part of that broader municipal process. Second, from a public health ethics point of view, it is argued that decisions about fluoridation are best made at the level of government that is closest to the people – that is the municipal level. The ensuing section on ethical and legal considerations will highlight that decisions about public health interventions such as fluoridation must be made via democratic decision-making procedures, which are the public health counterpart to informed consent. Democratic decision-making procedures may take the form of a city council vote, or a public vote such as a plebiscite.

Some people have argued that decision-making and funding for fluoridation should fall to the provincial level, because the province has jurisdictional responsibility for health care. This argument certainly has some merit, but it represents a conflation of public health and health care, which are not the same thing. Provinces are indeed jurisdictionally responsible for health care, which is provided via Alberta Health Services. Public health, defined as ‘the science and art of preventing disease, promoting health, and prolonging life through the organized efforts of society’, goes well beyond the health care system, and demands involvement from different

levels of government including cities. Fluoridation is one of many public health policies for which cities have responsibility. Others include pedestrian and cycling infrastructure, smoking bylaws, waste disposal, green space and trees, and of course water services more generally.

The [2019 CADTH Report – Budget Impact Analysis](#) sub-report addresses the challenging issue of budgetary silos, and the fact that water fluoridation costs are incurred municipally while savings are accrued elsewhere. To address this, novel intergovernmental strategy and integrated policies are encouraged. Indeed, one could certainly think about an arrangement where different levels of government work together to provide the conditions for oral health (perhaps considering *Childsmile* as one example). We would be delighted to hear such a discussion here in Alberta. It is important to note, however, that in our current context, as discussed earlier, dental care is almost entirely situated within the private sector, which means that individuals and families must have private or employer-sponsored insurance, or pay out of pocket, to receive even basic dental care. Dental public health services in Alberta are extremely limited in scope and are targeted to lower income communities. This is problematic because dental cavities are not restricted to those living in lower income communities, but rather are spread across the population. In light of the limited dental public health infrastructure in our Alberta context, significant effort and expense (vastly exceeding the costs of fluoridation) would be required to entertain a truly integrated and multifaceted inter-jurisdictional arrangement.

❖ ***There are many diverging views on community water fluoridation, including the concepts related to individual rights and personal choice with respect to the public water supply. How are these issues being contemplated elsewhere and how can Calgary provide balance here?***

The ethical considerations surrounding community water fluoridation are both complex and controversial. Views are certainly highly polarized on this front, and we note that the [CADTH report – sub-report on ethical considerations](#) and a recent formal submission to Calgary City Council from the Safe Water Calgary advocacy group present diametrically opposed positions on the ethics of water fluoridation.

Recognizing this, the O'Brien Institute team will not weigh in with an unsolicited third position on whether water fluoridation is dichotomously ethical or not. Rather, we will highlight a few of the ethical and legal considerations that are in play. We note that many of these are addressed in the literature review and ensuing discussion presented in the CADTH ethics sub-report.

- Population-level policies can be very powerful in terms of their ability to improve health at a population level, and community water fluoridation is an example of such a population-level policy intended to protect the teeth of all. With that considerable leverage, however, come other issues that could be considered drawbacks by individual citizens.
- When municipalities are considering a policy like community water fluoridation, a decision must be made that balances the potential benefits to the collective against any potential collective drawbacks that might exist, and then also the individual drawback of presenting individuals who do not want to

consume fluoridated water with the challenge of actively needing to pursue ways to opt out of the intervention. Those communities that have fluoridation in place have, implicitly or explicitly, made the decision that the benefits of fluoridation for the population's oral health, outweigh the drawbacks to individuals in terms of the difficulty of opting out.

- A key ethical/legal issue related to community water fluoridation programs centres around individual autonomy and the ability to make personal health-related decisions. Individual autonomy concerns arise because once fluoride is in the water, those who wish to opt out must purchase bottled water or consider filtering solutions. However, these can be costly alternatives. Furthermore, it should be noted that it is particularly challenging to individually opt out of water fluoridation, whereas it is actually simpler for individuals to decline other public health interventions such as vaccinations.
- Autonomy arguments are regularly raised by opponents of community water fluoridation. In these arguments, opponents rightly point out that fluoride does not necessarily need to be ingested through water, because people can get adequate amounts of fluoride through applications to the surfaces of teeth. The notable counterargument to this viewpoint, however, is that socially vulnerable groups cannot access such tooth surface fluoride alternatives. Individual autonomy must therefore be balanced against other ethical values such as protecting the vulnerable. Autonomy arguments are also complicated by the fact that fluoride confers the greatest benefits to children, who by virtue of their young age and dependence on parents or guardians, do not have the capacity to make the autonomous choice to seek out or refuse fluoride.
- Canada's constitution has no freestanding right to autonomous decision-making, but rather all rights are subject to reasonable limitations. Rights can be limited where there is a pressing societal goal, an intervention is rationally connected to that goal, rights are minimally impaired, and there is proportionality between the infringement on rights and the societal benefits.
- Courts have generally found policy interventions of various types to be minimally-impairing when decisions for their implementation are evidence-based, where governments have tried to avoid adopting an all-or-nothing approach (and if necessary, have provided opt-out mechanisms), and where governments have engaged in a deliberate and democratic decision-making process.

We reiterate that the ethical considerations around community water fluoridation are both complex and controversial. Accordingly, there is no simple right or wrong answer on this front. Ongoing multi-stakeholder public discourse is required in democratic processes informed by evolving evidence and societal perspectives.



❖ ***For those who want to opt out of water fluoridation, can fluoride be removed from tap water by filtering systems? Do sources of bottled water contain fluoride?***

At the residential level, fluoride removal can be achieved by activated alumina filters, distillation or through the use of reverse osmosis systems. Depending on the size and type of system purchased, these will remove between 90 and 99% of the fluoride in the water. Importantly, household Brita-type water pitchers and faucet mounts will not remove fluoride from the water.

Meanwhile, the majority of bottled waters on the market do not contain levels of fluoride approximating the North American standard for community water fluoridation (0.7ppm). However, the various types and brands of bottled water can vary substantially in their fluoride content.

❖ ***In today's society with the increasing penetration of social media, how can municipal policy-makers make sense of the multi-media barrage they receive surrounding fluoride?***

Two O'Brien Institute members with expertise in oral health and communications and culture have contributed the following analysis on the social media discourse surrounding fluoride.

- **Social media platforms can serve as a venue for public engagement on health issues. However, our use of social media far outpaces our understanding of how to use it well and respectfully.**
  - The very fast uptake of social media for public comment (i.e., comment sections on news articles in this case) is a big shift from traditional communication about health issues. Usually health organizations use mass media, radio/television advertisements, posters, and population-level intervention campaigns (e.g., to stop texting and driving, to increase acceptance of seat belts).
  - On the pro side, social media activity demonstrates that citizens are engaged around important public health interventions. On the con side, there are some social media growing pains as individuals and organizations adjust to making the best use of a very new tool that is still something of a wild west/new frontier.
  - As with many other aspects of internet use (e.g., ownership of personal digital photos, protection of youths' personal information on social media), the extraordinarily swift uptake of social media means that the public is still collectively learning how to respectfully engage/converse, as we gain consensus on appropriate etiquette (e.g., moderation of comments, options to rate, report, or flag inappropriate comments, shared meanings-ALL CAPS/bold/italics = shouting) ([Binns, 2012](#)). Many are of the opinion that online news site commenting systems are 'broken' ([Zamith & Lewis, 2014](#)). Depending on mood and the context of a discussion online, anyone can troll ([Cheng, 2017](#)), intentionally or unintentionally 'fishing' for other readers to pull into a circular discussion ([Coombs et al, 2005](#); [Herring et al 2002](#)). A lack of civility is rampant in many social media platforms, and fragmentation of threads by random, unrelated messages reduces possibilities for high-quality discussion ([Zamith & Lewis, 2014](#)). Change is needed for online discussion systems to become valuable public spheres for democratic discussion and deliberation of issues.



- **Compared to traditional venues, online discussion of any health intervention will result in more complex and nuanced discussion because the general public cares deeply about health issues.**

- Mass media and population-level campaigns are blunt tools that, by their nature, can provide only simple and non-nuanced messages, e.g., ‘fluoridation is effective for prevention of tooth decay’, ‘seat belts save lives.’ While these may well be accurate messages that reflect the balance of evidence, there is substantial nuance or complexity that cannot easily be communicated with such tools.
- Social media are certainly valuable sources of information to gain a sense of prevailing public views, and various platforms can prove valuable in public deliberation of important issues ([Zamith & Lewis, 2014](#)) including public health issues like fluoridation. However, we continue to face challenges. In a brief search of two Calgary news websites in the past year on the topic of fluoridation, we found that fully one-third of publicly posted comments contained polarizing pro/anti fluoridation content, i.e., comments designed to persuade but without being sufficiently deep in their content to promote meaningful or helpful dialogue. Furthermore, we note (and not surprisingly so) that it is individuals who hold polarized positions on fluoridation who are the most vocal on social media, as opposed to those who are not emotionally invested in the issue, are in middle, are undecided, or are wondering what is best. Unfortunately, polarization is not amenable to dialogue and can quickly degenerate into name calling and stonewalling genuine discussion ([Binns, 2012](#); [Meyer et al, 2019](#)).
- Forums are needed for real concerns and deeper discussion to take place. Venues/opportunities are needed where citizens’ reasonable concerns can be shared and questions asked, with expert responses provided ([Meyer et al, 2019](#)).
- In science, evidence is neither pro- nor anti-, but rather it is better described as strong, average, or weak, in terms of a study’s quality, limitations, and practical significance. These factors are central to determining how new studies contribute to maintaining or challenging the dominant view that the balance of evidence supports or refutes an intervention of interest.

We anticipate that social media platforms will continue to be challenging to municipal decision-makers in coming months to years, as new studies emerge in relation to community water fluoridation. The various platforms will of course continue to operate, and polarized views (often with adversarial tone) will continue to be expressed and disseminated therein. Societally, however, we need to continue to strive for respectful discourse (both within existing social media platforms and through other approaches to public discourse), in which time and care is taken to permit careful and detailed discussion of new information as it emerges.

## CONCLUDING STATEMENT

We end this report with a brief statement from the O’Brien Institute’s fluoride report writing team, on behalf of the Institute’s full membership and the broader University of Calgary community:

We are honoured to have been given the opportunity to contribute this report to the City of Calgary as a knowledge resource. As stated at the outset, the O’Brien Institute is committed to a vision of *better and health care*, achieved through the *promotion and pursuit of evidence-informed public policy for health*. We hope that this report will contribute to just that, and look forward to ensuing dialogue with City Council, City committees, and various other stakeholders as this report is shared and discussed.

## APPENDICES

### APPENDIX 1 – City of Calgary Resolution: Water Fluoridation Calgary

#### **Notice of Motion C2019-0219: WATER FLUORIDATION IN THE CITY OF CALGARY (as approved with amendments, 2019 February 25)**

Moved by Councillor Colley-Urquhart Seconded by Councillor Farkas

That with respect to Notice of Motion C2019-0219, the following be adopted, as amended:

NOW THEREFORE BE IT RESOLVED that Council:

1. Engage the University of Calgary's O'Brien Institute for Public Health (OIPH) to conduct an objective assessment of the evidence:
  - a. In the extant literature; and,
  - b. By enlisting other University of Calgary partners such as the School of Public Policy as appropriate.
  - c. In consideration of jurisdictions in the world where tooth decay rates are decreasing; and,
  - d. In consideration of a cost-benefit analysis of water fluoridation with regard to more direct dental interventions, particularly in consideration of the lack of access to affordable dental care in Calgary; and,
  - e. In consideration of dental health as a public health vector with regard to other disease vectors impacting our population; and,
  - f. In consideration of piloting other potential approaches to public dental health like Scotland's Child Smile program; and,
  - g. In consideration of a more up to date and comprehensive comparison between dental caries rates in Calgary post de-fluoridation and Edmonton; and,
  - h. By examining other questions and concerns from members of City Council by conducting individual interviews; and,
2. Invite the University of Calgary's OIPH to report and present their findings to Council through to the SPC on CPS no later than June 2019, and, invite the study's Principal Investigator, Dr. Lindsay McLaren, to present her findings and recommendations, and respond to questions concurrently.
3. Engage other potential willing and qualified bodies, such as Dr. Hardy Limeback BSc PhD (Biochemistry) DDS, Head, Preventive Dentistry, University of Toronto, to similarly assess water fluoridation and other programs to improve dental health.
4. Invite any other party participating in this inquiry to present findings at the same time.

APPENDIX 2 – Compiled list of questions from the Council Meeting (February 25, 2019)

How will this analysis be put together?
Has this type of analysis been done before?
Is there any proof that water fluoridation is beneficial for children, or other relevant groups, dental health?
Has the CADTH produced any research in the areas of the potential benefits, potential harms, cost, ethics, legal in regards to water fluoridation?
Is the CADTH report something you could analyze on Calgary's behalf?
How do you have civil and respectful conversations about this contentious issue?
What do you say to the people who believe fluoridation should be an individual decision, as opposed to a public health policy for the common good?
Is there a study that is truly scientific, which has a subject, control groups, as well as comparable study groups, that compares cities with things like socio-economics well defined, that shows benefits of water fluoridation?
There were so many things in the McLaren study, for example, 'non-significant trend towards increase,' that didn't give me the confidence to make this multi-million dollar decision. We need clear evidence to say if it is a benefit, or a detriment.
Is there any study that states "what is the best method to treat the teeth with fluoride?"
Are there any studies that show that water fluoridation benefits certain age or subject groups, and what does it do to all of the others?
If water fluoridation is re-introduced, the equipment will need to be upgraded. Would it be better to take the millions of dollars needed to do these upgrades, plus the operating costs, and actually put it into a different method to treat those who are being disproportionately affected by dental health issues?
Is water fluoridation really that important of an issue compared to all of the other health issues we face as a population?
Many groups (newcomers to Canada, those of a lower socio-economic background) may not have the best dental health practices to begin with. Does adding fluoride to the water make a difference in these cases?
What does the research show when it comes to other variables besides fluoridation for oral health? For example, diet.
What about the idea that oral health is as much part of total health as anything else?
What is working in other jurisdictions where tooth decay is decreasing? There are European jurisdictions where they don't fluoridate, but are seeing improvements in oral health outcomes because of things like reducing obesity, diabetes and other health factors. Will you be looking at those jurisdictions?
What has prevented this report from happening in the past eight years? AHS knew City Council was talking about it. There were two public hearings. Alberta was the last province to have a dental fee guide, and 70 per cent of demists are not following it. Children don't have access to affordable dental care. I worry about this single approach, when it needs a far more complicated approach.

Will you be looking at the ethics, and the idea of personal choice when it comes to the water supply, and at other proven interventions, and making recommendations to different levels of government?
Would it be possible for the three orders of government, or the University, to initiate a pilot, something like Childsmile in Scotland, or a similar program?
It's so expensive here to get dental care. How to we have an impact there (reduce cost so more people can get dental care, more often).
If families are drinking water that has had the fluoride removed (either by filtering or by drinking bottled water), is the cost to put it in in the first place even worth it?
There is a report from Harvard that councillor Farrell and I hope you can look at as well.
If it's a public health issue, do you know of any other jurisdictions where the province pays to have this implemented in cities? Can you include a comparable to other jurisdictions to see what they are doing?
What do you say to people who say that the O'Brien Institute and the University of Calgary have already formulated an opinion, and cannot remain unbiased?
There seems to be evidence both for, and against, fluoridation. How are you going to disseminate the studies that show potential for harm?
The different countries that have withdrawn from fluoridation, in Europe for example, are saying that they have reviewed all of the data and research and made the decision to remove it. Will you review those decisions and why they were made?
I trust that this report will look at if there is any evidence for harm, in any organs, etc. What do we know about the long-term effects?

### APPENDIX 3 – A high-level summary of the Councillor meetings/discussions

The O’Brien Institute for Public Health undertook a standardized engagement process with the City of Calgary’s City Council.

Pursuant to the City Council motion on Community Water Fluoridation, each councillor and the Mayor received an introductory invitation email citing context and rationale.

- If the recipient replied affirmatively, a meeting was scheduled.
- If the recipient didn’t reply either affirmatively or negatively, they received up to 3 follow up emails.
- If the recipient declined, there was no further contact.

At least one business day prior to a scheduled meeting, councillors received a complete interview script including a list of proposed questions, as well as the summary of questions compiled from the council hearing. Each meeting was face to face and was scheduled for 30 – 60 minutes based on councillor schedule availability. All but one was held at the council offices. Robin Hopkins, Issue Strategist for the City of Calgary, was present at all meetings. Interviews were conducted by either Dr Aleem Bharwani or Dr William Ghali. During each interview, field notes were taken by Dr Bharwani and sent by email to the participating councillor to review for additions or clarifications. In no case were any additions or clarifications received.

	Result of:		
	First Email	Second Email	Third Email
Invitee a	No Response	Scheduled	
Invitee b	Scheduled		
Invitee c	No Response	Scheduled	
Invitee d	Scheduled		
Invitee e	No Response	Declined	
Invitee f	No Response	Scheduled	
Invitee g	No Response	Scheduled	
Invitee h	No Response	Scheduled	
Invitee i	No Response	No Response	No Response
Invitee j	Scheduled		
Invitee k	No Response	Scheduled	
Invitee l	No Response	Scheduled	
Invitee m	Scheduled		
Invitee n	No Response	No Response	No Response
Invitee o	No Response	No Response	No Response

## SUMMARY OF DISCUSSIONS WITH COUNCILLORS

### *Fluoride Effectiveness:*

What is the relative **effectiveness of Community Water Fluoridation and its alternatives**? Who are the beneficiaries and does effectiveness vary by cost or demographics (age, socioeconomics, new immigrants etc)? Are certain methods more effective than others: painted on teeth vs ingested vs swish/spit. Why did those interventions stop, and are any schools still using those interventions? What is the effectiveness of educational initiatives? From other jurisdictions, compared to community water fluoridation, what is the relative impact of improved access to dental insurance or lower cost dental care? Are caries lower in districts with lower dental costs? What can we learn based on the single funding envelope that supported the Alex when fluoride was removed from the water? What can we learn from European examples such as Childsmile.

### *Community Water Fluoridation Risks:*

What are the risks of community water fluoridation? What are the risks to **city employees handling undiluted fluoride** during the dilution process? What are the risks to **citizens** consuming fluoride, based on i) multiple possible sources and concentrations of fluoride (toothpaste, food, natural levels in water), ii) age, weight of consumer, iii) transportation and storage methods? Has rates of fluorosis changed over time?

### *Community Water Fluoridation Benefits:*

What is the **pocket book impact** to citizens? What is the cost of community water fluoridation per citizen vs the cost savings per citizen arising from not paying for treatment of resulting dental caries? Is the pocket book impact different in someone with vs without insurance (or with a cap on coverage)?  
What is the actual benefit to dental caries reduction?

### *Community Water Fluoridation Opportunity Cost:*

What is the **political** opportunity cost? Among the cadre of important issues, what is the relative ROI of spending time on this vs other public health issues?

### *Causes of Dental Caries:*

What **causes** dental caries? How do we attribute cause of caries from fluoride deficiency vs other causes e.g. diet? How do our outcomes compare to other cities with/without community water fluoridation? Is water fluoridation **mass medication**? What is the role of citizen **choice** on this issue? What is the appropriate term: chemical vs medication vs mineral? If the government doesn't mandate vaccinations how can it mandate fluoride? What are public health comparables?: smoking restrictions, iodized salt, walkable urban design.

### *Ethical Responsibility to Fluoride Opponents:*

In a potential scenario of community water fluoridation, what is the City's **responsibility to provide non fluoridated water alternatives**? What are the reasons someone couldn't or wouldn't drink fluoridated water? What is the risk of fluoride interaction with medications? (dose dependence; drug interaction) What is the incidence of fluoride allergy? How cheap and easy is it to remove fluoride in their homes?

### *Jurisdictional Appropriateness:*

What is the **budgetary** opportunity cost? Often investments that prevent downstream consequences benefit the very same budget down the road. When savings, due to an intervention, accrue to a different budget than that

from which the investment is made, what options exist to share either the cost or benefits with either different orders of government, insurance companies, or family budgets?

Should this decision be under **provincial (not city) jurisdiction**? Do decision, funding and administration necessarily need to be all at the same order of government? If experts on this issue are provincial, shouldn't decision be made by province? If this is a health decision, should the cost not be from a provincial health budget? Why was this issue initially delegated to the City? Was this ultimately a budget issue due to provincial cuts or was it a pure health policy decision?

*Governance:*

If an issue is decided by plebiscite, should it be reversed by anything other than plebiscite? (e.g. city council vote)

*Report Credibility:*

Report will be considered **credible, fair and balanced** if the report:

- articulates guiding principles of the Institute as it relates to this work
- explicitly declare process of data inclusion and analysis, and articulates how it overcomes biases, in relation to this particular knowledge synthesis activity; declares relationship with other national bodies doing similar work; solicits and reviews specific articles or documents from councillors; engages objectively and deliberately with opponents; highlights ability to tap resources locally, provincially, globally
- conveys pros and cons, including relative strength of each pro or con claim

OIPH is considered by some to be disadvantaged due to a prevailing assumption the OIPH is pro fluoride. This arises because there is not a clear understanding of the differential role of scientists vs Institute. The report should make this distinction clear:

- In the City, if anyone makes a statement, that statement is considered a City position. People assume the same about the OIPH: if anyone has stated a position, it is perceived to be the position of the OIPH.
- Start with a letter from the executive that the OIPH does not take a position on any given policy issue – but individual scientists can do so based on their individual research. Give examples from over the last 5 years where this has been the case – where positions were explicitly not taken by OIPH but where Institute members may have. Clarify and educate about academic freedom and its difference from the corporate world.

*Report Usability:*

Report will be **readable** if the average citizen can understand it, helped if information is presented visually; complex numerical information is simplified into low/medium/high categories; comparisons, benchmarks or taxonomies are used to illustrate and contextualise claims (e.g. express the hierarchy of evidence); executive summary is brief with a longer appendix for those interested in details.