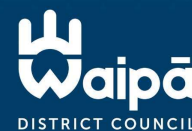


COMMUNITY BOARD REPORT



To: The Chairperson and Members of the Te Awamutu and Kihikihi Community Board

From: Board Member Titchener

Subject: **Notice of Motion**

Meeting Date: 23 October 2024

1 EXECUTIVE SUMMARY – WHAKARĀPOPOTOTANGA MATUA

A Notice of Motion has been received from Board Member Titchener

2 APPENDIX - ĀPITITANGA

No:	Appendix Title
1	Notice of Motion

APPENDIX 1

Notice of Motion from Board Member Titchener

Notice of Motion – Fluoridation US Court Ruling and Recent Research published.

Background

The Director General of Health has directed Waipa District Council to fluoridate Cambridge's public water supply per Direction Letter Waipa 27 July 2022. In 2018, the Supreme Court ruled that fluoridation of the water was compulsory medical treatment, meaning that if an area is fluoridated, the fluoridated water is unavoidable to be consumed by residents.

Two recently published pieces of major research, National Toxicology Program (NTP) review (21 August 2024) and the Cochrane Collaboration review (4 October 2024), and a recent US Federal Court ruling (24 September 2024) have dramatically changed the landscape on the fluoridation issue. There is now clear scientific evidence that shows that fluoridation needs to cease immediately in New Zealand, and we certainly should not be starting fluoridation in Cambridge. If Cambridge is fluoridated then it will be the intention of the Director General of Health to continue the expansion of fluoridation into other the other townships namely, Te Awamutu, Pirongia, Ohaupo and Kihikihi. This is the reason why the Te Awamutu and Kihikihi Community Board is raising this notice of motion. Attached is a letter of response from the Ministry of Health which does not address the concerns of the US Federal Court ruling.

Legally, Waipa District Council could apply for an interim order. This is based on point 11 of the NHNZ Ruling (see attached). *"Any decision on enforcement action would need to be informed by the Solicitor-General's guidelines. In the event that enforcement action was threatened, then the most appropriate course would be for any council affected to seek interim orders".*

National Toxicology Program

The National Toxicology Program has been finalised. The NTP concluded that “with moderate confidence, that higher estimated fluoride exposures (e.g., as in approximations of exposure such as drinking water fluoride concentrations that exceed the World Health Organization Guidelines for Drinking-water Quality of 1.5 mg/L of fluoride) are consistently associated with lower IQ in children.”

NTP Review abstract is included as an appendix and the full report can be found at this link:

<https://ntp.niehs.nih.gov/publications/monographs/mgraph08>

Ten consecutive NIH-funded studies between 2017 and 2024 show fluoride significantly impacts brain development in young children. 9 of the 10 peer reviewed studies make up the just-released NTP report on fluoride neurotoxicity. All were conducted at 0.7ppm equivalent. 6 were conducted in water fluoridated Canada and 4 were conducted in Mexico where they have salt Fluoridation.

#1. Bashash et al. (2017) – Fluoride & IQ

#2. Thomas et al. (2018) – Fluoride & IQ

#3. Bashash et al. (2018) – Fluoride & ADHD

#4. Green et al. (2019) – Fluoride & IQ

#5. Till et al. (2020) – Fluoride & IQ

#6. Cantoral et al. (2021) – Fluoride & IQ

#7. Adkins et al. (2022) – Fluoride & Behavior

#8. Goodman et al. (2022) – Fluoride & IQ

#9. Hall et al. (2023) – Fluoride & IQ

#10. Malin et al. (2024) – Fluoride & Behavior (published after NTP cutoff date for inclusion)

Research

Cochrane Review

The Cochrane Collaboration Review 2024 has been finalised and published. The Cochrane Collaboration is considered the gold standard in systematic reviews and the Cochrane Review 2015 was used as evidence by the Director General of Health to support the Waipa District Council directive to fluoridate. This updated review should force a reassessment of the directive to fluoridate Cambridge.

The Cochrane Review 2024 concluded that Water fluoridation might result in 1/4 less filling per person. “There is insufficient evidence to determine the effect of cessation of CWF on caries and whether water fluoridation results in a change in disparities in caries according to socioeconomic status. We found no eligible studies that report caries outcomes in adults.”

Their key conclusion was that “The implementation or cessation of CWF requires careful consideration of this current evidence, in the broader context of a population’s oral health, diet and consumption of tap water, movement or migration, and the availability and uptake of other caries-prevention strategies.”

Water fluoridation might result in 1/4 less filling per person or 3-4% more people without any tooth decay – or it might have no benefit at all!

Cochrane 2024 abstract only: Conclusions - Contemporary studies indicate initiation of CWF may lead to a slightly greater reduction in dmft and may lead to a slightly greater increase in proportion of caries-free children. There is insufficient evidence to determine the effect of CWF cessation on caries and whether water fluoridation results in a change in disparities in caries according to socio-economic status.

The Cochrane review abstract is included as an appendix and the full report can be found at this link: <https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD010856.pub3/full>

US Federal Court Ruling

US Federal Court Ruling made by Judge Chen attachment.

	UNITED STATES OF AMERICA
Background	Food and Water Watch v the US EPA

UNSAFE	<p>p. 2: the Court finds that fluoridation of water at 0.7 milligrams per liter (“mg/L”) – the level presently considered “optimal” in the United States – poses an unreasonable risk of reduced IQ in children.</p> <p>"In all, there is substantial and scientifically credible evidence establishing that fluoride poses a risk to human health; it is associated with a reduction in the IQ of children and is hazardous at dosages that are far too close to fluoride levels in the drinking water of the United States...Reduced IQ poses serious harm. Studies have linked IQ decrements of even one or two points to, e.g., reduced educational attainment, employment status, productivity, and earned wages."</p> <p>p. 3: There is little dispute in this suit as to whether fluoride poses a hazard to human health. Indeed, EPA’s own expert agrees that fluoride is hazardous at some level of exposure. And ample evidence establishes that a mother’s exposure to fluoride during pregnancy is associated with IQ decrements in her offspring.</p>
EXPOSURE	<p>p. 5: The pooled benchmark dose analysis concluded that a 1-point drop in IQ of a child is to be expected for each 0.28 mg/L of fluoride in a pregnant mother’s urine. This is highly concerning, because maternal urinary fluoride levels for pregnant mothers in the United States range from 0.8 mg/L at the median and 1.89 mg/L depending upon the degree of exposure. Not only is there an insufficient margin between the hazard level and these exposure levels, for many, the exposure levels exceed the hazard level of 0.28 mg/L.</p> <p>p. 5: Even if the toxicologically determined hazard level of 0.28 mg/L were deemed insufficiently substantiated, evidence in the record still establishes with little doubt that fluoridated drinking water presents a risk of injury to health.</p> <p>p. 6: “The EPA’s default margin of error requires a factor of 10 between the hazard level and exposure level due to variability in human sensitivities...Here, an even greater margin (100x) is owed because the methodology (which yields the 4 mg/L hazard level) uses the lowest observed adverse effect level (“LOAEL”); this methodology adds an additional level of uncertainty (and hence the application of a 100x rather than 10x margin). But even if only the default 10x margin is required, the safe level of fluoride exposure would be 0.4 mg/L (4 mg/L (hazard level) divided by 10). The “optimal” water fluoridation level in the United States of 0.7 mg/L is nearly double that safe level of 0.4 mg/L for pregnant women and their offspring.”</p>
RISK	<p>p. 77: The scientific literature in the record provides a high level of certainty that a hazard is present; fluoride is associated with reduced IQ. There are uncertainties presented by the underlying data regarding the appropriate point of departure and exposure level to utilize in this risk evaluation. But those uncertainties do not undermine the finding of an unreasonable risk; in every scenario utilizing any of the various possible points of departures, exposure levels and metrics, a risk is present in view of the applicable uncertainty factors that apply.</p>
CERTAINTY	<p>p. 78: There is significant <i>certainty</i> in the data set regarding the association between fluoride and reduced IQ. Namely, there is a robust body of evidence finding a statistically significant adverse association between fluoride and IQ. A large majority of the 72</p>

	<p>epidemiological studies assessed by the NTP Monograph observed this relationship including all but one of the 19 high-quality studies, see ¶¶ 34-36, and literature published after the NTP Monograph cutoff date observed the same relationship, see ¶ 37 – and countervailing evidence, for various reasons described previously, are of little impact on this repeated, and consistently observed association between fluoride and reduced IQ, see ¶ 39. Moreover, complete consistency amongst studies is not expected. See Dkt. No. 414, Feb. 9, 20240, Trial Tr. at 1172:23-1173:6 (Savitz). Notably, notwithstanding inherent difficulties in observing this association at lower exposure levels, studies assessing such levels still observed a statistically significant relationship between fluoride and reduced IQ. See ¶¶ 42-44. Again, to put the breadth of evidence supporting this finding in perspective, the EPA has identified a LOAEL based upon far less in other contexts. For instance, in the EPA’s risk evaluation of Methylene, conducted pursuant to Amended TSCA, the EPA used a LOAEL for developmental neurotoxicity, derived from the analysis of one study conducted upon mouse pups (Fredriksson et al., 1992). See Methylene Risk Evaluation at 262. Compare this with 6 (water fluoride) and 9 (urinary fluoride), high-quality, epidemiological studies of human populations underling the 4 mg/L LOAEL underlying the POD here. Dkt. No. 431-2, Trial Ex. 68 at 39, 41 (eTable 4). The scientific literature in the record provides a high level of certainty that a hazard is present; fluoride is associated with reduced IQ. The qualitative evidence is superior.</p>
VULNERABLE POPULATION	<p>p. 76: The size of the affected population is vast. Approximately 200 million Americans have fluoride intentionally added to their drinking water at a concentration of 0.7 mg/L. See Dkt. No. 421 at 206-07 (undisputed). Other Americans are indirectly exposed to fluoridated water through consumption of commercial beverages and food manufactured with fluoridated water.</p>
SUSCEPTIBLE POPULATION	<p>p. 76: Approximately two million pregnant women, and over 300,000 exclusively formula-fed babies are exposed to fluoridated water. The number of pregnant women and formula-fed babies alone who are exposed to water fluoridation each year exceeds entire populations exposed to conditions of use for which EPA has found unreasonable risk; the EPA has found risks unreasonable where the population impacted was less than 500 has found unreasonable risk; the EPA has found risks unreasonable where the population impacted was less than 500 people.</p>
RULING	<p>p. 79: Plaintiffs have proven, by a preponderance of the evidence, that water fluoridation at the level of 0.7 mg/L – the prescribed optimal level of fluoridation in the United States – presents an “unreasonable risk of injury to health or the environment, without consideration of costs or other non-risk factors, including an unreasonable risk to a potentially exposed or susceptible subpopulation under the conditions of use.”</p> <p>The Court thus orders the Administrator to initiate rulemaking pursuant to Subsection 6(a) of TSCA. See id. §§ 2605(a), 2620(a)</p>
DIRECTION	<p>The ruling did not specify exactly what measures must be adopted by the EPA, but under the Toxic Substances Control Act (TSCA), once the court rules that a chemical poses an unreasonable risk, the EPA is obligated by law to restrict or eliminate the risk.</p>

	Judge Chen described a range of options for regulating fluoridation, including banning it, but he warned, "One thing the EPA cannot do, however, in the face of this Court's finding, is to ignore that risk."
IMPORTANCE OF THE NTP	The US Federal Court leant heavily on the finalisation of the NTP review hence why the ruling came soon after the publishing of the NTP report. The NTP concluded: "with moderate confidence, that higher estimated fluoride exposures (e.g., as in approximations of exposure such as drinking water fluoride concentrations that exceed the World Health Organization Guidelines for Drinking-water Quality of 1.5 mg/L of fluoride) are consistently associated with lower IQ in children."].

New Zealand implications

The same hazard exposure identified by the US Federal Court also applies to New Zealand. New Zealand has a higher level of fluoridation 0.85ppm (0.7 -1ppm) than the US single target of 0.7ppm.

Maternal urinary fluoride levels for pregnant mothers in the United States range from 0.8 mg/L at the median and 1.89 mg/L. The maternal urinary fluoride levels found in the of pregnant women of Palmerston North by Brough et al, 2015 found a median concentration of 0.82 (0.62, 1.03) mg/L urine F. Bashash et al. (2017) found that the mean urinary fluoride in mothers was 0.90 mg/L (Mexico). <https://nutr2015.p.events4you.currinda.com/days/2015-12-02/abstract/307>

Notice of Motion

That the Te Awamutu and Kihikihi Community Board request that the Waipa District Council seek an Interim Order, or some other appropriate legal remedy, so that fluoridation would be put on hold until the end of the New Health New Zealand Court Case.

That the Te Awamutu and Kihikihi Community Board request that Waipa District Council liaise and work together with one or more of the 13 other directed Councils to push back against the Director General of Health's directives to add fluoride chemicals to the public water supply.

That the Te Awamutu and Kihikihi Community Board request that the Waipa District Council acknowledge to the Waipa community that the US Federal Court has ruled that adding fluoride to the water supply at 0.7 to 1ppm is an unreasonable risk relating to neurotoxicity.

KANE TITCHENER



Name and Signature of Mover

1 UNITED STATES DISTRICT COURT
2 NORTHERN DISTRICT OF CALIFORNIA

3
4 FOOD & WATER WATCH, INC., et al.,

5 Plaintiffs,

6 v.

7 UNITED STATES ENVIRONMENTAL
8 PROTECTION AGENCY, et al.,

9 Defendants.

Case No. 17-cv-02162-EMC

**FINDINGS OF FACT AND
CONCLUSIONS OF LAW**

10 **I. INTRODUCTION**

11 In 2016, Congress amended the Toxic Substances Control Act (“TSCA”), empowering
12 United States citizens to petition the Environmental Protection Agency (“EPA”) to consider
13 whether a chemical presents an unreasonable risk of injury to health. *See* Pub. L. No. 114-182,
14 114th Congress (Frank R. Lautenberg Chemical Safety for the 21st Century Act) (the “Act”). The
15 Act addresses the modern day reality that “human beings and the environment are being exposed
16 each year to a large number of chemical substances and mixtures,” 15 U.S.C. § 2601(a)(1), and
17 that, “among the many chemical substances and mixtures which are constantly being developed
18 and produced, there are some whose manufacture, processing, distribution in commerce, use, or
19 disposal may present an unreasonable risk of injury to health or the environment,” *id.* §
20 2601(a)(2).

21 To this end, under TSCA, as amended by the Act (“Amended TSCA”), a citizen is entitled
22 to judicial review of the EPA’s denial of the citizen’s petition, wherein a court considers whether
23 the chemical poses an unreasonable risk *de novo*, *i.e.*, without deference to the EPA’s decision.
24 *See id.* § 2620(b)(4)(B). Amended TSCA sets up a system of judicial review that is remarkably
25 different from the usual scope of judicial review of administrative actions under the
26 Administrative Procedure Act, which confers substantial deference to administrative agencies.
27 *See id.* Under Amended TSCA, the Court owes no deference to the EPA in assessing the risk
28 posed by chemical substances. *See id.* If the Court finds anew that the chemical at issue presents

1 an unreasonable risk, it then orders the EPA to engage in rulemaking regarding the chemical. *See*
 2 *id.* The EPA is afforded in the first instance the authority to respond; regulatory actions can range
 3 from requiring a mere warning label to banning the chemical. *See id.* § 2605(a)(1)-(7). The EPA,
 4 in short, has options. *See id.*

5 The issue before this Court is whether the Plaintiffs have established by a preponderance
 6 of the evidence that the fluoridation of drinking water at levels typical in the United States poses
 7 an unreasonable risk of injury to health of the public within the meaning of Amended TSCA. For
 8 the reasons set forth below, the Court so finds. Specifically, the Court finds that fluoridation of
 9 water at 0.7 milligrams per liter (“mg/L”) – the level presently considered “optimal” in the United
 10 States – poses an unreasonable risk of reduced IQ in children. It should be noted that this finding
 11 does not conclude with certainty that fluoridated water is injurious to public health; rather, as
 12 required by the Amended TSCA, the Court finds there is an unreasonable *risk* of such injury, a
 13 risk sufficient to require the EPA to engage with a regulatory response. This order does not dictate
 14 precisely what that response must be. Amended TSCA leaves that decision in the first instance to
 15 the EPA. One thing the EPA cannot do, however, in the face of this Court’s finding, is to ignore
 16 that risk.

17 A. Context

18 Water fluoridation has a long history in the United States and has been a source of political
 19 discord, at times. *See, e.g.*, Dkt. No. 429-3, Trial Ex. 13 at 15.¹ In 1975 the EPA recommended
 20 adding fluoride to water, with an optimal level up to 1.2 mg/L for its dental health benefits. *Id.* at
 21 16. Between 1981 and 1984, fluoride’s association with adverse effects including osteosclerosis,
 22 enamel fluorosis, and psychological and behavioral problems was contested. *Id.* at 17-18. Still, as
 23 of 1986, up to 1.2 mg/L water fluoridation was considered optimal, and the maximum level was 4
 24 mg/L. *Id.* at 14-18. After evidence increasingly established fluoride’s connection to adverse

25
 26 ¹ Controversy over fluoridation of drinking water has even found its way into Hollywood. *See* DR.
 27 STRANGELOVE (Columbia Pictures 1964) (General Ripper characterizing fluoridation as a threat to
 28 our “precious bodily fluids” and “the most monstrously conceived and dangerous communist plot
 we’ve ever had to face”).

1 effects, including severe enamel fluorosis, risk of bone fracture, and potential skeletal fluorosis,
2 recommended levels were lowered in 2006. *Id.* at 10. Community water fluoridation has since
3 continued at levels believed to be safe for its dental health benefits. At present, fluoride is added
4 to tap water in the United States, with an optimal level of 0.7 mg/L.

5 However, scientific evidence has increasingly identified a link between fluoride exposure
6 and adverse cognitive effects in children (reduced IQ). Accordingly, Plaintiffs exercised their
7 power under Amended TSCA and petitioned the EPA to consider whether fluoride in drinking
8 water presents an unreasonable risk of injury to human health. Notwithstanding the growing and
9 robust body of evidence indicating an association between fluoride intake and cognitive
10 impairment in children, the EPA denied Plaintiffs' petition. Plaintiffs filed suit in this Court,
11 arguing that the EPA was wrong and that community water fluoridation at 0.7 mg/L (the
12 "condition of use") poses an unreasonable risk of injury to human health.

13 B. Summary

14 To succeed in a suit brought under the Amended TSCA, Plaintiffs must prove, by a
15 preponderance of the evidence, that a risk of injury to human health is present and that such risk is
16 unreasonable. For a risk to be present, Plaintiffs must show that some segment of the United
17 States population is exposed to the chemical at issue at levels that either exceed, or are too close to
18 the dosage at which the chemical presents a hazard.² The reasonableness of the risk is informed
19 by several factors, including *inter alia*, the size and susceptibility of impacted populations,
20 severity of the harm at issue, and the frequency and duration of exposure.

21 There is little dispute in this suit as to whether fluoride poses a hazard to human health.
22 Indeed, EPA's *own expert* agrees that fluoride is hazardous at some level of exposure. And ample
23 evidence establishes that a mother's exposure to fluoride during pregnancy is associated with IQ
24 decrements in her offspring. The United States National Toxicology Program ("NTP") – the
25 federal agency regarded as experts in toxicity – undertook a systematic review of all available
26 literature near the time of publication considering whether fluoride poses cognitive harm,

27
28 ² The level at which the chemical presents a hazard is known as the "hazard level." The level at which human populations are exposed to the chemical is known as the "exposure level."

1 reviewing 72 human epidemiological studies considering this question. The NTP concluded that
2 fluoride is indeed associated with reduced IQ in children, at least at exposure levels at or above 1.5
3 mg/L (*i.e.*, “higher” exposure levels). And notwithstanding inherent difficulties in observing
4 effects at lower exposure levels, explained in further detail below, scientists have observed a
5 statistically significant association between fluoride and adverse effects in children even at such
6 “lower” exposure levels (less than 1.5 mg/L).

7 Notwithstanding recognition by EPA’s expert that fluoride is hazardous, the EPA points to
8 technicalities at various steps of the risk evaluation to conclude that fluoride does not present an
9 unreasonable risk. Primarily, the EPA argues the hazard level and the precise relationship between
10 dosage and response at lower exposure levels are not entirely clear. These arguments are not
11 persuasive.

12 Importantly, the chemical at issue need not be found hazardous at the exposure level to
13 establish that a risk is present under Amended TSCA. Instead, the EPA requires a *margin* exist
14 between the hazard level and exposure level to ensure safety; if there is an insufficient margin then
15 the chemical poses a risk. The trial evidence in this case establishes that even if there is some
16 uncertainty as to the precise level at which fluoride becomes hazardous (hazard level), under even
17 the most conservative estimates of this level, there is not enough of a margin between the accepted
18 hazard level and the actual human exposure levels to find that fluoride is safe. Simply put, the risk
19 to health at exposure levels in United States drinking water is sufficiently high to trigger
20 regulatory response by the EPA under Amended TSCA.

21 To this end, as mentioned previously, the NTP compiled and analyzed all relevant studies it
22 could find and concluded that, at least at dosages of 1.5 mg/L or higher, fluoride is associated with
23 reduced IQ in children. Subsequently, toxicology experts endeavored to put a finer point on the
24 impact of fluoride on children’s IQ at “lower” exposure levels, *i.e.*, those below 1.5 mg/L, and
25 conducted a pooled benchmark dose analysis to define the precise hazard level of fluoride. For
26 reasons described below, this pooled benchmark dose analysis benefited from increased statistical
27 power relative to the NTP’s assessment due to its methodology (*i.e.*, the benchmark dose analysis
28 used individualized, continuous data, while the NTP assessment did not, due to quantity and variety

1 of studies the NTP reviewed in that assessment). The pooled benchmark dose analysis concluded
 2 that a **1-point drop in IQ of a child is to be expected for each 0.28 mg/L of fluoride in a**
 3 **pregnant mother's urine**. This is highly concerning, because maternal urinary fluoride levels for
 4 pregnant mothers in the United States range from **0.8 mg/L** at the median and **1.89 mg/L**
 5 depending upon the degree of exposure. Not only is there an insufficient *margin* between the
 6 hazard level and these exposure levels, for many, the exposure levels *exceed* the hazard level of
 7 0.28 mg/L.

8 The EPA challenges, for a variety of reasons, whether this 0.28 mg/L hazard level
 9 (measured in maternal urinary fluoride) is appropriate for this risk evaluation. The EPA argues,
 10 among other things, that the hazard and exposure levels should not be expressed in maternal
 11 urinary fluoride because that metric reflects total fluoride exposure – not just exposure resulting
 12 from drinking fluoridated water from one's community. Fluoride may also be ingested through,
 13 *e.g.*, tea, fish, toothpaste, and commercial food and beverage made with fluoridated water.
 14 Nonetheless, the risk analysis should consider the *additive* effect of the chemical under the
 15 subjected condition of use (here, fluoridated community drinking water), especially where, as here,
 16 the fluoridated drinking water is a significant (and likely primary) contributor to aggregate
 17 exposure to fluoride. Indeed, the Amended TSCA, expressly contemplates that the *aggregate*
 18 exposure to a chemical will be considered when conducting a risk assessment. *See* 15 U.S.C. §
 19 2605(b)(4)(F). In this sense, maternal urinary fluoride is not just an acceptable metric, it is highly
 20 useful in assessing the real-world end result of exposure from drinking fluoridated water along
 21 with other sources.

22 Even if urinary fluoride were not the appropriate metric in assessing health risk, or even if
 23 the toxicologically determined hazard level of 0.28 mg/L were deemed insufficiently
 24 substantiated, evidence in the record still establishes with little doubt that fluoridated drinking
 25 water presents a risk of injury to health. Using a highly conservative estimate of the hazard level
 26 of 4 mg/L measured in drinking water fluoride (well above the 1.5 mg/L identified as hazardous to
 27 children by the NTP) based on the consistent and repeated observation of adverse effects
 28 summarized in the NTP's assessment, a risk is present. There is little dispute that there is a

1 statistically significant association between IQ decrements in children and fluoride concentration
2 levels at 4 mg/L.

3 The EPA's default margin of error requires a factor of 10 between the hazard level and
4 exposure level due to variability in human sensitivities. Put differently, only an exposure that is
5 below 1/10th of the hazard level would be deemed safe under Amended TSCA, given the margin
6 of error required. Here, an even greater margin (100x) is owed because the methodology (which
7 yields the 4 mg/L hazard level) uses the lowest observed adverse effect level ("LOAEL"); this
8 methodology adds an additional level of uncertainty (and hence the application of a 100x rather
9 than 10x margin). But even if only the default 10x margin is required, the safe level of fluoride
10 exposure would be 0.4 mg/L (4 mg/L (hazard level) divided by 10). The "optimal" water
11 fluoridation level in the United States of 0.7 mg/L is nearly double that safe level of 0.4 mg/L for
12 pregnant women and their offspring.

13 In all, there is substantial and scientifically credible evidence establishing that fluoride
14 poses a risk to human health; it is associated with a reduction in the IQ of children and is
15 hazardous at dosages that are far too close to fluoride levels in the drinking water of the United
16 States. And this risk is unreasonable under Amended TSCA. Reduced IQ poses serious harm.
17 Studies have linked IQ decrements of even one or two points to *e.g.*, reduced educational
18 attainment, employment status, productivity, and earned wages. Indeed, the EPA recognizes that
19 reduction of IQ poses a serious community health issue. Moreover, highly susceptible populations
20 are impacted, including over two million pregnant women and babies, a number far exceeding
21 population size the EPA has looked to in determining whether regulatory action was warranted in
22 other risk evaluations (*i.e.*, 500 people or less).

23 Thus, the Court finds Plaintiffs have met their burden in establishing, by a preponderance
24 of the evidence, that community water fluoridation at 0.7 mg/L presents an unreasonable risk of
25 injury to health under Amended TSCA and that the EPA is thus obliged to take regulatory action
26 in response. The Court does not in this order prescribe what that response should be.

II. BACKGROUND

A. Factual and Procedural Background

1. Section 6(a) of the Toxic Substances Control Act (“TSCA”) requires Defendant United States EPA³ to regulate the use of certain chemical substances that it determines pose an unreasonable risk to health or the environment. 15 U.S.C. § 2605(a).

2. The TSCA was initially passed in 1976, codified at 15 U.S.C. § 2601 *et seq.* Congress enacted the original TSCA, motivated by findings that “human beings and the environment are being exposed each year to a large number of chemical substances and mixtures,” 15 U.S.C. § 2601(a)(1), and that, “among the many chemical substances and mixtures which are constantly being developed and produced, there are some whose manufacture, processing, distribution in commerce, use, or disposal may present an unreasonable risk of injury to health or the environment,” *id.* § 2601(a)(2).

3. On June 22, 2016, the Frank R. Lautenberg Chemical Safety for the 21st Century Act was signed into law. *See* Pub. L. No. 114-182, 114th Congress. The Act amended the TSCA. *See id.*

4. Amended TSCA requires the EPA to regulate the use of certain chemical substances that pose an unreasonable risk of harm to health or the environment. 15 U.S.C. § 2605(a). If a chemical substance poses a risk of unreasonable harm, the EPA must promulgate a rule imposing one or more of a wide range of possible requirements. *See id.* § 2605(a)(2). Specifically, the rule adopted by the EPA must impose one or more of the following: a prohibition, restriction, or limitation of the amount of such substance that may be manufactured, processed, or distributed in commerce, *id.* § 2605(a)(1); a prohibition, restriction, or limitation upon such manufacture, processing, or use in connection with “a particular use” or “a particular use in a concentration in excess of a level specified by the Administrator,” *id.* § 2605(a)(2); labeling requirements for such substance, *id.* § 2605(a)(3); record-keeping requirements for manufacturers or processors of the substance, *id.* § 2605(a)(4); commercial-use regulations, *id.* § 2605(a)(5); disposal requirements,

³ Scott Pruitt, Administrator of the EPA is also named as a Defendant in his official capacity. Dkt. No. 372 (Supplemental Complaint (“FAC”)) ¶ 1.

1 *id.* § 2605(a)(6); and/or notice requirements, *id.* § 2605(a)(7). The EPA may limit the application
2 of such requirements to “specified geographic areas.” *Id.* § 2605(a).

3 5. After the Act’s amendment to TSCA, there are three pathways to obtain a Section 6(a) rule
4 regulating a chemical: (1) an EPA’s *sua sponte* designation of a chemical as “high priority,”
5 resulting in a finding that it presents an unreasonable risk,⁴ 15 U.S.C. § 2605(c)(1); (2) an EPA
6 risk evaluation of a chemical at the request of a manufacturer, *see id.* § 2605(b)(4)(C)(ii), which
7 results in a finding of unreasonable risk; or (3) a successful Section 21 “citizen petition,” *see id.* §§
8 2620(a), (b)(3).

9 6. A Section 21 citizen’s petition to the EPA to initiate Section 6(a) rulemaking is to be
10 granted if the petitioner demonstrates a chemical substance poses an unreasonable risk of harm.
11 *Id.* § 2620(a). Amended TSCA provides judicial review of a denial of such a petition to the EPA.
12 *Id.* § 2620(b)(4). In contrast to the typical standard of judicial review under the Administrative
13 Procedure Act, in considering a Section 21 citizen’s petition, the Court considers the issue *de*
14 *novo*; no deference is owed under to the EPA’s denial of the petition. *See id.* § 2620(b)(4)(B).

15 7. Plaintiffs in the instant suit are non-profit advocacy organizations and associations and
16 individuals suing on behalf of themselves and their children. FAC ¶ 1.⁵

17
18 ⁴ To elaborate, Section 6(b) requires the EPA to perform its own evaluations of the risks posed by
19 certain chemical substances. 15 U.S.C. § 2605(b)(4)(A). To this end, the EPA is required by
20 Amended TSCA to designate chemical substances as “high-priority” or “low-priority” based on a
21 risk screening process. *See id.* § 2605(b)(1). “High-priority” chemicals are those that “may
22 present an unreasonable risk to health or the environment because of potential hazard and a
23 potential route of exposure under the conditions of use.” *Id.* § 2605(b)(1)(B)(i). A “low-priority”
24 substance, in contrast, is one that the Administrator “concludes, based on information sufficient to
25 establish . . . does not meet the standard” to be designated a high-priority substance. *Id.* §
26 2605(b)(1)(B)(ii). Once the EPA has designated a chemical substance “high-priority,” it must
27 initiate a Section 6(b) “risk evaluation.” *Id.* §§ 2605(b)(3)(A), (4)(C)(i). A risk evaluation is not
28 required for a “low-priority” substance. *Id.* § 2605(b)(1)(A). The EPA must pursue these risk
evaluations at a minimum pace established by statute: within 6 months, risk evaluations must be
underway on at least 10 substances drawn from the 2014 TSCA Work Plan for Chemical
Assessments, *id.* § 2605(b)(2)(A); within three and a half years, risk evaluations must be
underway on “at least 20 high-priority substances,” *id.* § 2605(b)(2)(B); a new high-priority
substance must be designated anytime a risk evaluation has been completed (other than those
commenced at the request of a manufacturer), *id.* § 2605(b)(3)(C); and, generally, the EPA must
continue designating substances and conducting evaluations “at a pace consistent” with its ability
to meet the 3-year deadline to complete each risk evaluation, *id.* § 2605(b)(2)(C).

⁵ Specifically, Plaintiffs are Food & Water Watch, Fluoride Action Network, and Moms Against
Fluoridation (“Organizational Plaintiffs”), and Audrey Adams individually and on behalf of Kyle

1 8. On November 22, 2016, a group of organizations and individuals including Plaintiffs
2 petitioned the EPA under Section 21 of Amended TSCA to regulate the fluoridation of drinking
3 water supplies under Section 6(a). Dkt. No. 117-1, Ex. 1. Plaintiffs asserted that the ingestion of
4 fluoride poses an unreasonable risk of neurotoxic harm to humans including IQ loss and other
5 neurotoxic effects, particularly for infants, young children, and other subpopulations standing at
6 elevated risk. *Id.*

7 9. On February 17, 2017, the EPA denied Plaintiffs' petition. Dkt. No. 28-1; 82 Fed. Reg.
8 11,878 (Feb. 27, 2017).

9 10. After the EPA denied Plaintiffs' petition, Plaintiffs filed this suit seeking judicial review of
10 the EPA's denial pursuant to 15 U.S.C. § 2620. Dkt. No. 1 (Complaint ("Compl.")). ¶¶ 106-07.

11 11. Beginning on June 8, 2020, after the parties engaged in fact and expert discovery, the
12 Court held a seven-day bench trial, which included expert testimony regarding the state of the
13 scientific research on fluoride neurotoxicity ("Trial Phase 1"). *See* Dkt. Nos. 219, 238.

14 12. On August 10, 2020, the Court stayed the case due to concerns about Plaintiffs' standing
15 and developments in scientific literature regarding fluoride. *See* Dkt. No. 262. The Court
16 explained that the stay would allow EPA to consider new scientific studies published after EPA's
17 denial of Plaintiffs' administrative petition and allow the Court to consider the imminent
18 publication of the NTP systematic review "Monograph on the Systematic Review of Fluoride
19 Exposure and Neurodevelopmental and Cognitive Health Effects." *Id.* at 3-5.

20 13. Thereafter, Plaintiffs filed a supplemental administrative petition for reconsideration to the
21 EPA. Dkt. No. 270.

22 14. EPA again denied the petition. Dkt. No. 278.

23 15. On October 28, 2022, the Court granted Plaintiffs' motion to lift the stay and take the case
24 out of abeyance, finding that Plaintiffs had standing and that there was new evidence that scientific
25 developments had changed, including the fact that the aforementioned NTP's systematic review
26

27 Adams, Kristen Lavelle individually and on behalf of Neal Lavell, and Brenda Staudenmaier
28 individually and on behalf of Ko Staudenmaier and Hayden Staudenmaier ("Individual Plaintiffs")
 (collectively "Plaintiffs" or "FWW"). FAC ¶ 1.

1 had since undergone three additional rounds of peer review resulting in a near-final version of the
2 document. *See* Dkt. No. 319 at 2-5.

3 16. Beginning on January 31, 2024, the Court held a second, ten-day bench trial (“Trial Phase
4 2”) which included expert testimony regarding the updated state of the scientific research on
5 fluoride neurotoxicity. *See* Dkt. Nos. 407-413, 422-424.

6 B. Relief Requested

7 17. Plaintiffs contend that the addition of fluoridation chemicals to drinking water at levels
8 recommended in the United States (0.7 mg/L) presents an unreasonable risk of neurological harm
9 when assessed under the risk evaluation framework that EPA uses under the Amended TSCA.
10 Dkt. No. 378 (Joint Pretrial Conference Statement (“PTC Statement”)) at 1-2.

11 18. Plaintiffs seek a declaration that fluoridation of water at 0.7 mg/L presents an unreasonable
12 risk of injury to health and injunctive relief requiring the EPA to initiate the rulemaking
13 proceeding requested by Plaintiffs in their Petition to the EPA. PTC Statement at 2. Specifically,
14 Plaintiffs seek an order requiring the EPA to “initiate a proceeding for the issuance of a rule,” but
15 the order would not “prescribe the content of a rule or the outcome of such a proceeding.” *Id.* In
16 short, rulemaking would be left in the first instance to the EPA.

17 19. Plaintiffs also seek recovery of their costs of suit and reasonable fees for attorneys and
18 expert witnesses, as permitted by 15 U.S.C. § 2620(b)(4)(C), and such further relief that the Court
19 may deem just and proper. PTC Statement at 2.

20 C. Statutory Standard and Burden

21 20. Plaintiffs bear the burden of proving, by a preponderance of the evidence, that the
22 chemical substance at issue presents an “unreasonable risk of injury to health or the environment,
23 without consideration of costs or other nonrisk factors, including an unreasonable risk to a
24 potentially exposed or susceptible subpopulation under the conditions of use.” 15 U.S.C. §
25 2620(b)(4)(B)(ii). The Court considers the issue *de novo*; no deference is owed under TSCA to
26 the EPA’s denial of the petition. *Id.* § 2620(b)(4)(B).

27 21. If the Court determines that petitioner has met its burden, demonstrating unreasonable risk
28 by a preponderance of the evidence, the Court “shall order the Administrator to initiate the action

1 requested by the petitioner.” *Id.* Specifically, EPA would be directed to engage in rulemaking
 2 pursuant to Subsection 6(a) of TSCA wherein the EPA would consider applying one or more
 3 methods to neutralize the risk, ranging from requiring a notice be provided to the public of risks
 4 (*i.e.*, utilizing a warning label or disseminating a public advisory), *see id.* § 2605(a)(7), to
 5 prohibiting manufacturing or distributing the chemical at issue, *see id.* § 2605(a)(1).

6 D. Standing

7 22. The Court previously held, in lifting its stay on proceedings and allowing the case to
 8 proceed to phase two of trial, that Plaintiffs had standing. Dkt. No. 319 at 2-3. The Court
 9 reaffirms this finding. At a minimum, Organizational Plaintiff FWW has standing in a
 10 representative capacity. An association has standing to sue on behalf of its members when: “(1)
 11 its members would otherwise have standing to sue in their own right; (2) the interests it seeks to
 12 protect are germane to the organization’s purpose; and (3) neither the claim asserted nor the relief
 13 requested requires the participation of individual members in the lawsuit.” *Am. Unites for Kids v.*
 14 *Rousseau*, 985 F.3d 1075, 1096 (9th Cir. 2021) (citing *Hunt v. Wash. State Apple Advert. Comm’n*,
 15 432 U.S. 333, 343 (1977)). Each prong is satisfied:

16 a. In its previous order, the Court found that Jessica Trader, a member of FWW, has
 17 standing. Dkt. No. 319 at 2-3. Article III standing requires: (1) an injury-in-fact that is concrete
 18 and particularized and actual or imminent, (2) a causal connection between the injury and the
 19 conduct complained of, and (3) probable redressability. *Id.* (citing *Lujan v. Defs. of Wildlife*, 504
 20 U.S. 555, 560–61 (1992)). Ms. Trader became pregnant in November 2020 and gave birth in
 21 August 2021 (during the pendency of this lawsuit) and testifies that she plans to have several more
 22 children; she has taken steps to effectuate this goal including discontinuing her use of birth control
 23 medication. Dkt. No. 430-18, Trial Ex. 66 (Declaration of Jessica Trader) ¶¶ 5-8 & Ex. A. Ms.
 24 Trader has incurred costs and taken measures to avoid fluoridated water during her first pregnancy
 25 and continues to do so to protect her future children. *Id.* ¶¶ 9-16. As the Court previously
 26 explained, neurodevelopmental harm from fluoride exposure to Ms. Trader’s child and future
 27 children is concrete and imminent; there is a credible causal connection between that
 28 neurodevelopmental harm and EPA’s regulation of fluoride exposure or lack thereof; and the harm

1 would likely be redressed if EPA were to pass a rule prohibiting the addition of fluoridation
 2 chemicals to public drinking water supplies. Dkt. No. 319 at 2-3. Moreover, the EPA has
 3 conceded that standing would be satisfied by “someone who is an expectant parent who – who
 4 could be consuming fluoridated water, and, and – that could have potential effects on the baby
 5 she’s carrying in utero. It could be a potential – a parent, someone with very young children.” *Id.*
 6 (quoting Dkt. No. 133 at 14:9-17). Ms. Trader is such an individual. Thus, the first prong is
 7 satisfied; a member has standing.

8 b. As for the second prong, there is no dispute that FWW’s mission is to ensure
 9 “clean, safe water for drinking” which it views as a “fundamental right that should be afforded to
 10 all people,” and to “advocate for more government responsibility in protecting our drinking water
 11 resources.” Dkt. No. 430-8, Trial Ex. 52 (Second Amended Declaration of Scott Edwards, Co-
 12 Director of FWW) ¶¶ 4, 6. Thus, the interests at stake in this suit – regulation of water
 13 fluoridation to protect public health – are germane to the organization’s purpose. *See, e.g., Am.*
 14 *Unites for Kids*, 985 F.3d at 1097 (explaining that where there is a close connection between the
 15 organization’s mission and the interests of others it seeks to represent, organizational standing is
 16 appropriate); *G.G. by & through A.G. v. Meneses*, 638 F. Supp. 3d 1231, 1241 (W.D. Wash. 2022)
 17 (finding nonprofit disability rights organization had associational standing to bring claims on
 18 behalf of disabled members as rights of people with developmental disabilities was an interest the
 19 organization sought to protect).

20 c. The third prong is a “judicially fashioned and prudentially imposed” question, as
 21 opposed to a constitutional requirement of standing. *Or. Advocacy Ctr. v. Mink*, 332 F.3d 1101,
 22 1109 (9th Cir. 2003). This suit is appropriately brought by a representative plaintiff; analysis
 23 under Amended TSCA focuses on scientific evidence substantiating the alleged risk to public
 24 health rather than focusing upon anecdotal evidence from plaintiffs. *See* ¶¶ 26-95; *accord*
 25 *Laborers Int’l Union Loc. 261 v. City & Cnty. of San Francisco*, 2022 WL 2528602, at *6 (N.D.
 26 Cal. July 6, 2022) (explaining that unlike claims seeking damages which require individualized
 27 proof, claims seeking injunctive relief are well-suited for adjudication by organizational plaintiff)
 28 (citing *Comm. for Immigrant Rts. of Sonoma Cnty. v. Cnty. of Sonoma*, 644 F. Supp. 2d 1177,

1 1194 (N.D. Cal. 2009)). The harm redressable herein is precisely the kind of harm that Amended
 2 TSCA is designed to address. For these reasons, the Court reaffirms its finding that requirements
 3 of standing have been satisfied.

4 **III. FINDINGS OF FACT**

5 23. To discern whether a chemical substance presents an unreasonable risk of injury to health
 6 or the environment, without consideration of costs or other non-risk factors, including an
 7 unreasonable risk to a potentially exposed or susceptible subpopulation, under the conditions of
 8 use, under TSCA section 6, the EPA engages in a TSCA risk evaluation process. 15 U.S.C. §
 9 2605(b)(4); 82 Fed. Reg. 33,726 (July 20, 2017); Dkt. No. 434-18, Trial Ex. 544.

10 24. The TSCA risk evaluation is comprised of a risk assessment and risk determination. *See*
 11 Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 653:22-655:11 (Barone). The National Research Council
 12 (NRC, 1983) has defined risk assessment as including the following components: (1) hazard
 13 assessment (including hazard identification and quantitative dose response analysis); (2) exposure
 14 assessment; and (3) risk characterization. A risk evaluation under the Amended TSCA includes
 15 the three aforementioned steps of a risk assessment, as well as a fourth and final step: (4) a risk
 16 determination. *See id.* The “risk assessment” is the scientific technical evaluation, encompassing
 17 the first three parts of this process, resulting in an unbiased, transparent, and reproducible
 18 description of the risk. *See id.* The “risk determination” is the final step of the risk evaluation
 19 process, where EPA summarizes its findings and determines whether a chemical does or does not
 20 present unreasonable risk. *See id.*

21 25. The following is a summary of the risk evaluation steps. *See id.*; *accord* 15 U.S.C. §
 22 2605(b)(4)(F)(i)-(v).

23 a. At step 1 (hazard assessment) the EPA determines if a chemical is considered
 24 hazardous and if so, the EPA endeavors to determine the point at which the chemical becomes
 25 hazardous (“point of departure” or “hazard level”). *See* Dkt. No. 400, Feb. 5, 2024, Trial Tr. at
 26 653:22-655:11 (Barone); *accord* 15 U.S.C. § 2605(b)(4)(F)(i)-(iii), (v).

27 b. At step 2 (exposure assessment) the EPA determines the level at which populations
 28 are exposed to the chemical. *See* Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 653:22-655:11 (Barone);

1 accord 15 U.S.C. § 2605(b)(4)(F)(i)-(iii), (v).

2 c. At step 3 (risk characterization), the EPA compares the point of departure with the
3 exposure level to determine if a risk is present. *See* Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 575:8-
4 583:13 (Barone). Because of uncertainty in data, the EPA establishes a margin between the point
5 of departure and the community's exposure level. There must be a sufficient margin to find
6 absence of risk. *See id.* The appropriate margin varies based upon how much uncertainty there is
7 in the chosen point of departure. *See id.* The appropriate or required margin is referred to as the
8 benchmark margin of exposure ("benchmark MOE"). *See id.* The actual margin is the actual
9 margin of exposure ("actual MOE"). If there is an insufficient margin, *i.e.*, the actual MOE is less
10 than the benchmark MOE, a risk has been identified. *See id.*

11 d. At step 4 (risk determination) if a risk is identified, the EPA will then determine if
12 that risk is unreasonable, considering various factors such as the type of harm at issue and number
13 of people exposed. *See* Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 653:22-655:11 (Barone); accord
14 15 U.S.C. § 2605(b)(4)(F)(iii)-(v). Each step of the risk assessment is discussed in turn below.⁶

15 A. Step 1: Hazard Assessment

16 26. The Hazard Assessment step is comprised of three subparts: (a) hazard identification; (b)
17 weight-of-the-scientific evidence; and (c) dose-response assessment. *See* Dkt. No. 400, Feb. 5,
18 2024, Trial Tr. at 654:19-655:11 (Barone). Each are addressed in turn below.

19 1. Step 1A: Hazard identification

20 a. Framework

21 27. The first component of the hazard assessment is hazard identification. Dkt. No. 417, Feb.
22 2, 2024, Trial Tr. at 489:11-17 (Barone), 656:8-661:16 (Barone). At the hazard identification step
23 of the risk evaluation framework, the reviewer determines if an adverse effect is associated with a
24 chemical exposure. *See* Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 489:11-17 (Barone), 656:8-661:16
25 (Barone).

26
27 ⁶ The evaluation of fluoridation chemicals under TSCA follows the same standards for
28 demonstrating hazard and risk that EPA uses for its evaluations of other industrial chemicals under
TSCA; there is no justification for holding fluoridation chemicals to a higher burden. *See* Dkt.
No. 401, Feb. 6, 2024, Trial Tr. at 742:25-743:8 (Barone).

28. Proof of causation is not required to establish a hazard of neurotoxicity, only association between the chemical exposure and the adverse effect is required for a hazard to be identified. *See id.* at 490:1-5.

29. At this stage of the process EPA reviews, searches, screens, and evaluates all studies related to different hazards to determine whether the data are sufficient or insufficient for identified adverse effects. *Id.* at 492:24-494:9.

b. Key finding

30. The hazard identification step of the hazard assessment here is satisfied; exposure to the chemical fluoride is associated with the adverse effect of reduced IQ in children, and particularly in boys.

c. Underlying findings

31. The NTP is headquartered within the National Institute of Environmental Health Sciences (“NIEHS”). Dkt. No. 440, Feb. 13, 2024, Trial Tr. at 1425:23-1426:8 (Barone). By May of 2022, the NTP completed its systematic review of fluoride, titled *NTP Monograph on the State of the Science Concerning Fluoride Exposure and Neurodevelopmental and Cognitive Health Effects: A Systematic Review* (hereafter “NTP Monograph”). Dkt. No. 431-1, Trial Ex. 67. *See also* Dkt. No. 440, Feb. 13, 2024, Trial Tr. at 1427:5-8 (Barone); Dkt. No. 400, Feb. 4, 2024, Trial Tr. at 535:15-21 (Berridge). In August 2024, the NTP Monograph was formally published. *See* Dkt No. 442 (letter from parties recognizing publishing of document). The parties agree that there are no material differences between the published Monograph and the pre-publication version that was the subject of testimony and argument at trial (*i.e.*, Trial Exhibit 67). *Id.*⁷

⁷ The parties originally filed a letter agreeing that the published version of the NTP Monograph was the same in all material respects as the Monograph this Court reviewed at trial. Dkt. No. 442. Subsequently, Plaintiffs filed a letter suggesting that certain aspects of the published NTP Monograph were modified in a way that lends *additional* support for their case. *See* Dkt. No. 443. In particular, Plaintiffs assert:

Page 101 of the now-published version of the NTP Monograph summarizes the findings of the “in-press” meta-analysis as follows:

The group-level meta-analysis of 59 studies (n = 20,932 children) used SMD as the effect measure and reported statistically significant

32. According to the EPA, a systematic review is “a scientific investigation that focuses on a specific question and uses explicit, pre-specified methods to identify, select, assess, and summarize the findings of similar but separate studies.” Dkt. No. 255 (EPA Proposed Findings of Fact, Trial Phase 1) at 15 (citing 82 Fed. Reg. at 33,734). Moreover, “[t]he goal of systemic review methods is to ensure that the review is complete, unbiased, reproducible, and transparent.” *Id.* The EPA explains that a systematic review is pertinent and is ideal in conducting a risk assessment under TSCA. *See id.* at 14-19 (arguing that during the first phase of trial, before the NTP Monograph was finalized, that Plaintiffs failed to meet their burden because they did not conduct a systematic review).

33. The NTP Monograph is a systematic review as the EPA has defined that term. The NTP Monograph is a scientific investigation, focusing on a specific question using explicit, pre-

inverse associations between fluoride exposure measures and children’s IQ. There was also a significant dose response relationship between group-level fluoride exposure and IQ. **In stratified dose-response meta-analyses of the low risk-of-bias studies, the direction of association remained consistent when group-level exposure was restricted to <4mg/L, <2 mg/L, and <1.5 mg/L fluoride in drinking water and <4 mg/L, <2 mg/L, and <1.5 mg/L fluoride in urine.** The regression slopes meta-analysis of 13 studies (n = 4,475 children) with individual-level measures of fluoride found **a significant decrease in IQ of 1.63 points (95% CI: -2.33,-0.93; p-value <0.001) per 1-mg/L increase in urinary fluoride.** In subgroup analyses of both group-level and individual level data, the direction of the association remained inverse when stratified by study quality (high versus low risk of bias), sex, age group, outcome assessment, study location, exposure timing, and exposure metric.

Dkt. No. 443 (citing *NTP Monograph on the State of the Science Concerning Fluoride Exposure and Neurodevelopment and Cognition: A Systematic Review*, National Toxicology Program (August 2024), https://ntp.niehs.nih.gov/sites/default/files/2024-08/fluoride_final_508.pdf (emphases added)).

The EPA disputes whether the post-trial version of the NTP Monograph is properly considered by this Court. *See* Dkt. No. 444. Because the Court finds in Plaintiffs favor based upon the version of the NTP Monograph that the Court reviewed at trial, and because neither party suggests the aspects of the NTP Monograph that the Court reviewed therein have changed in a way that undermines Plaintiffs’ case, the Court need not resolve this dispute. Instead, the Court bases its finding upon the version of the NTP Monograph reviewed at trial (Trial Exhibit 67), though noting that it has since been published formally, and that if it were considered, it would find the published Monograph even more supportive of the decision reached herein.

1 specified methods. Namely, the objective of the NTP Monograph was “[t]o conduct a systematic
 2 review of the human, experimental animal, and mechanistic literature to evaluate the extent and
 3 quality of the evidence linking fluoride exposure to neurodevelopmental and cognitive effects in
 4 humans.” NTP Monograph at xii (Abstract). Regarding the methods: “[a] systematic review
 5 protocol was used following the standardized OHAT [referring to the Office of Health Assessment
 6 and Translation] systematic review approach for conducting literature-based health assessments.
 7 This monograph presents the current state of evidence associating fluoride exposure with
 8 neurocognitive or neurodevelopmental health effects and incorporated predefined assessments of
 9 study quality and confidence levels. Benefits of fluoride with respect to oral health are not
 10 addressed in this monograph.” *Id.* Ultimately, the NTP Monograph analyzed all available studies
 11 assessing impacts of fluoride, including seventy-two human studies that assessed the association
 12 between fluoride exposure and IQ in children and integrated the findings in the studies to draw
 13 conclusions about the impact of fluoride to neurodevelopmental and cognitive effects in humans.
 14 *Id.* at xii-xiii. Moreover, the NTP Monograph’s protocol underwent multiple rounds of peer
 15 review. *Id.* at G-1. And the Monograph’s substance underwent multiple rounds of peer review,
 16 including assessment of technical accuracy, and the sufficiency of evidence supporting the NTP
 17 Monograph’s conclusion. *Id.* at x. The peer review panel includes professors from Brown
 18 University School of Public Health, Columbia University Medical Center, Johns Hopkins
 19 Bloomberg School of Public Health, and other epidemiological experts. *See id.* The EPA does
 20 not dispute that the NTP Monograph is likely to have captured all relevant studies that were in
 21 existence as of the Monograph’s literature cutoff date analyzing human data regarding
 22 neurodevelopmental impacts of fluoride. Dkt. No. 421 at 12-13. Even before the NTP
 23 Monograph was formally published, the EPA agreed that the NTP Monograph “followed the rules
 24 that have been developed by NTP for conducting systematic reviews” and utilized a “rigorous
 25 approach to assembling the evidence,” “clearly defined rules for identifying and evaluating
 26 studies,” and “a well-defined protocol for drawing inferences” from the studies. *Id.*⁸ Indeed,

27
 28 ⁸ Plaintiffs submitted evidence indicating that the delay in publication was highly irregular, and perhaps politically motivated. *See* Dkt. No. 385 at 12-13. The Court excluded evidence regarding

1 EPA’s expert, Dr. Barone agreed that the NTP Monograph is a “high quality review.” Dkt. No.
2 440, Feb. 13, 2024, Trial Tr. at 1427:2-4 (Barone). Accordingly, the Court finds that the NTP
3 Monograph is probative and afforded significant weight in the risk evaluation analysis.

4 34. The NTP Monograph concludes that the majority of the 72 epidemiological studies on
5 fluoride and IQ that had been published by April 2021 found an association between fluoride and
6 reduced IQ in children, including 18 of the 19 studies the NTP Monograph deemed “high quality”
7 and “low-risk-of-bias” as well as 46 of the 53 lower-quality studies. NTP Monograph at xii (NTP
8 Monograph Abstract describing 46 of the 53 low-quality studies found an association between
9 higher fluoride exposure and lower IQ in children and 18 of 19 high-quality studies reported an
10 association between higher fluoride exposure and lower IQ in children including 3 prospective
11 cohort studies and 15 cross-sectional studies); *accord* Dkt. No. 428-1, Trial Ex. 69 at 65 (NTP
12 Board of Scientific Counselors Working Group Report agreeing that low-risk-of-bias studies were
13 “consistent,” meaning generating results in the same direction, in finding a negative association
14 between fluoride exposure and children’s IQ); Dkt. No. 396, Feb. 1, 2024, Trial Tr. at 313:25-
15 314:5 (Grandjean) (summarizing and agreeing with NTP Monograph’s finding that higher
16 fluoride exposure (at or above 1.5 mg/L) was found to be associated with lower IQ scores in
17 children in the majority of both low- and high-quality studies the NTP Monograph reviewed); Dkt.
18 No. 414, Feb. 9, 2024, Trial Tr. at 1197:2-15 (Savitz) (expressing confidence in NTP’s literature
19 search strategy and its ability to identify all relevant studies on fluoride exposure published prior
20 to the closing date of April 21, 2021, and confirming that the “vast majority of studies” that NTP
21 reviewed identified an association between fluoride and reduced IQ), 1114:24-1115:1 (describing
22 NASEM critique of adequate definition of the term “consistent” in NTP Monograph, but not
23 disagreeing with characterization of NTP Monograph finding association between IQ and
24 fluoride). The NTP Monograph explained its key finding regarding the impact of fluoride on
25 children’s IQ as follows:

26
27
28
partisanship relating to publishing of the Monograph, in large part because the EPA did not argue
the Monograph be afforded less weight for its draft status. *Id.* at 17. Eventually, the NTP
Monograph was published, in August 2024. *See* Dkt. No. 442.

In summary, the high-quality studies (i.e., studies with low potential for bias) consistently demonstrate lower IQ scores with higher fluoride exposure [e.g., represented by populations whose total fluoride exposure approximates or exceeds the WHO Guidelines for Drinking-water Quality of 1.5 mg/L of fluoride (WHO 2017)]. The consistency in association is observed among studies of varying study designs, exposure measures, and study populations. Although some studies that conducted multiple analyses observed within-study variations in results (e.g., differences between subsets of IQ tests), these variations were unique to individual studies and did not detract from the overall consistency in the findings that higher fluoride is associated with lower IQ scores.

Trial Ex. 67 at 47 (emphasis added).

35. To come to this conclusion: the NTP Monograph identified 19 studies as being high-quality (*i.e.*, low risk-of-bias); all but one identified an association between fluoride and reduced IQ in children: Bashash et al. 2017; Choi et al. 2015; Cui et al. 2018; Ding et al. 2011; Green et al. 2019; Rocha-Amador et al. 2007; Saxena et al. 2012; Seraj et al. 2012; Sudhir et al. 2009; Till et al. 2020; Trivedi et al. 2012; Wang et al. 2012; Wang et al. 2020b; Xiang et al. 2003a; Xiang et al. 2011; Yu et al. 2018; Zhang et al. 2015b. NTP Monograph at 40, 29-39 (Table 6). To summarize these high-quality studies:

a. Bashash (2017): This study evaluated 211 mother-child pairs that were participants in The Early Life Exposures in Mexico to Environmental Toxicants Project (“ELEMENT Cohort”)⁹ and concluded that higher prenatal fluoride exposure was associated with statistically

⁹ Bashash (2017) (like Green (2019) and Till (2020), discussed in subparagraphs (b) and (c)), is a longitudinal cohort study, evaluating fluoride in the urine of pregnant mothers. In such a cohort study design:

[A] healthy group of people is assembled and followed forward in time and observed for the development of dysfunction. Such studies are invaluable for determining the time course for development of dysfunction (e.g., follow-up studies performed in various cities on the effects of lead on child development). This approach allows the direct estimate of risks attributed to a particular exposure, since toxic incidence rates in the cohort can be determined. Prospective study designs also allow the study of chronic effects of exposure. One major strength of the cohort design is that it allows the calculation of rates to determine the excess risk associated with an exposure. Also, biases are reduced by obtaining information before the disease develops. This approach, however, can be very time-consuming and costly. In cohort studies information bias can be introduced when individuals provide distorted information about their health because they know their exposure status and may have been told of the expected health effects of the exposure under study.

1 significant lower scores on tests of cognitive function in offspring at ages 4 and 6-12 years; an
 2 increase in maternal urine fluoride of 0.5 mg/L predicted a 3.15 lower General Cognitive Index
 3 (“GCI”) score and 2.50 lower IQ score of the offspring. Dkt. No. 432-2, Trial Ex. 106 at 1.
 4 ELEMENT collected urinary samples from women during pregnancy and from their children
 5 when the children were 6-12 years old (299 mother-child pairs) recruited from hospitals caring for
 6 low to moderate income populations in Mexico City. *Id.* at 1-2. The mean urinary fluoride in
 7 mothers and children was 0.90 mg/L (mothers) and 0.82 mg/L (children). *Id.* Child intelligence
 8 was measured via GCI for children at age 4 and IQ and from the Wechsler Abbreviate Scale of
 9 Intelligence (“WASI”) at ages 6-12. *Id.* Fluoride exposure derived from fluoridated salt and
 10 naturally occurring fluoride in drinking water in Mexico City, ranging from 0.15 to 1.38 mg/L. *Id.*
 11 at 2. A second morning void (“spot”) urine sample was targeted for collection during each
 12 trimester of pregnancy from mothers and the offspring children at time of measurements of
 13 intelligence. *Id.* A total of 1,484 prenatal samples was measured; after controlling for, *e.g.*,
 14 quality, duplicates, covariates, and outliers, 877 urine samples adjusted for creatinine were
 15 retained, stemming from 512 unique mothers. *Id.* at 3. A total of 287 mother-child pairs had
 16 complete data on exposure and outcome for children at 4 years and 211 for children at 6-12 years.
 17 Dkt. No. 434-27, Trial Ex. 656 (Savitz Summary of Methods in Key Studies of Fluoride Exposure
 18 and Neurodevelopment).

19 b. Green (2019): Green et al. (2019) studied mother-child pairs in Canada that were

21 More credence should be given to those studies in which both
 22 observer and subject bias are carefully controlled (*e.g.*, double-blind
 23 studies). A special type of cohort study is the retrospective cohort
 24 study, in which the investigator goes back in time to select the study
 25 groups and traces them over time, often to the present. The studies
 26 usually involve specially exposed groups and have provided much
 27 assistance in estimating risks due to occupational exposures.
 28 Occupational retrospective cohort studies rely on company records
 of past and current employees that include information on the dates
 of employment, age at employment, date of departure, and whether
 diseased (or dead in the case of mortality studies). Workers can then
 be classified by duration and degree of exposure.

Dkt. No. 429-7, Trial Ex. 17 at 17-18. Moreover, “[p]ositive or negative results
 from a properly controlled prospective study *should weigh heavily* in the risk
 assessment process.” *Id.* (emphasis added).

1 participants in the Maternal-Infant Research on Environmental Chemicals program (“MIREC
2 Cohort”) and found a statistically significant, negative association between fluoride exposure and
3 IQ in boys, but not girls. Dkt. No. 432-5, Trial Ex. 109 at 940, 944. The study concluded that 1
4 mg/L increase in maternal urinary fluoride was associated with a 4.49-point lower IQ score in
5 boys and 1 mg higher daily intake of fluoride among pregnant women was associated with a 3.66
6 lower IQ score in boys and girls. *Id.* MIREC collected urinary spot samples and estimates of
7 daily fluoride intake from water consumption for pregnant women recruited from cities across
8 Canada (Vancouver, Montreal, Kingston, Toronto, Hamilton, Halifax). *Id.* at 941-942. Urinary
9 samples from the women were collected across each trimester of pregnancy; the mean maternal
10 urinary fluoride of mothers was 0.42 mg/L in fluoridated communities and 0.27 mg/L in non-
11 fluoridated communities. *Id.* at 944. The mean estimated intake of water fluoride concentration
12 was 0.39 mg/day; 0.43 mg for women in communities with fluoridated drinking water and 0.26 for
13 those living in communities without fluoridated drinking water. *Id.* Children were between ages 3
14 and 4 years at testing. *Id.* at 940. Data on exposure and outcome was complete for 512 mother-
15 child pairs measuring exposure through maternal urinary fluoride and 400 mother-child pairs
16 estimating water fluoride intake. *Id.*

17 c. Till (2020): Till (2020) studied samples taken from 398 mother-child pairs that
18 participated in the MIREC Cohort project (the cohort studied in Green (2019)), to evaluate IQ of
19 children that were breastfed compared to formula-fed as infants in areas that had fluoridated and
20 non-fluoridated water. Dkt. No. 432-19, Trial Ex. 123 at 1. This study found that an increase in
21 fluoride intake from infant formula corresponded to an 8.8 decrement in performance IQ which
22 was statistically significant, including after controlling for fetal fluoride exposure. *Id.*¹⁰

23 d. Cross-sectional studies¹¹ of children in China found significant inverse association
24

25 ¹⁰ Till (2020) and Green (2019) exemplify how the same samples from one cohort may be
26 analyzed in multiple studies to either confirm results from a previous study or to extract different
information from the same samples from a given cohort.

27 ¹¹ Cross-sectional studies are afforded less weight than cohort studies. As the EPA guidelines
28 explain:

In cross-sectional studies or surveys, both the disease and suspected
risk factors are ascertained at the same time, and the findings are

1 between fluoride and children's IQ score: Xiang (2003a) (finding significant inverse correlation
 2 between IQ and urinary fluoride; significant association of fluoride on IQ score based on drinking
 3 water levels); Ding (2011) (significant association between urinary fluoride and decrease in IQ
 4 score); Xiang (2011) (significant association between serum (blood-derived sample) fluoride and
 5 reduced IQ score in children); Wang (2012) (significant correlation between total fluoride intake
 6 and reduced IQ); Zhang (2015b) (significant correlation between reduced IQ score and children's
 7 serum fluoride, and urinary fluoride), Cui (2018) (significant association between IQ score and
 8 urinary fluoride); Yu (2018) (significant difference in mean IQ scores in high water fluoride areas
 9 compared to normal water fluoride areas); and Wang (2020b) (significant negative association
 10 between IQ and water and urinary fluoride and IQ in boys and girls). NTP Monograph at 29-33
 11 (Table 6). One study, Cui (2020) identified a directionally negative, though not statistically
 12 significant decrease in mean IQ score with increasing fluoride levels. *Id.* at 32.

13 e. Rocha-Amador (2007), a cross-sectional study of children in Mexico found
 14 significant associations between fluoride and IQ scores. *Id.* at 33.

15 f. Cross-sectional studies of children in India found significant association between
 16 fluoride and intellectual impairment: Sudhir (2009) (found a significant increase in proportion of
 17 children with intellectual impairment with increasing drinking water fluoride levels); Saxena
 18 (2012) (significant correlations between reduced IQ and water fluoride and urinary fluoride
 19 levels); Trivedi (2012) (found significantly lower mean IQ scores in high fluoride villages
 20 compares to low-fluoride villages for boys and girls combined and separately). *Id.* at 38.

21 g. Siraj (2012), a cross-sectional study of children in Iran found a significant negative
 22 association between water fluoride and IQ score. *Id.* at 39.

24 useful in generating hypotheses. A group of people are interviewed,
 25 examined, and tested at a single point in time to ascertain a
 26 relationship between a disease and a neurotoxic exposure. This
 27 study design does not allow the investigator to determine whether
 28 the disease or the exposure came first, rendering it less useful in
 estimating risk. These studies are intermediate in cost and time
 required to complete compared with case reports and more complex
 analytical studies, but should be augmented with additional data.

Dkt. No. 429-7, Trial Ex. 17 at 16.

1 h. Soto-barreras (2019), a cross-sectional study of children in Mexico 9-10 years of
2 age did *not* find a significant association between fluoride and IQ levels. *Id.* at 34.

3 36. In addition to the studies that the NTP Monograph deemed “high-quality,” and thus most
4 relevant to understanding impact of fluoride, the NTP Monograph explains that 46 of the 53
5 studies deemed low-quality by the NTP Monograph also found an association between fluoride
6 exposure and reduced IQ in children. NTP Monograph at xii.

7 37. Several studies published after the NTP Monograph literature cut-off date (April 2021), *see*
8 NTP Monograph at 5-12, 12 n.8, B-2, C-2-C-44, also found negative association between fluoride
9 and IQ, and acutely, for boys – bolstering the NTP Monograph’s finding of a negative association
10 between IQ in children and fluoride exposure:

11 a. Goodman (2022a): studied samples from the ELEMENT cohort and concluded that
12 an increase in maternal urinary fluoride predicated an average 2.12-point decrease in GCI scores
13 of 4-year-olds and a 2.63 decrease in performance IQ of 6- to 10-year-olds. Dkt. No. 432-11, Trial
14 Ex. 115 at 1-2. The study also found a marginal association with maternal urinary fluoride and
15 verbal IQ across time. *Id.* at 2. The study concluded that visual-spatial and perceptual reasoning
16 ability may be more impacted by prenatal fluoride exposure as compared to verbal abilities. *Id.*

17 b. Cantoral (2021): studied 103 mother-child pairs from the Programming Research in
18 Obesity, Growth, Environment and Social Stressors (“PROGRESS Cohort”) program. Dkt. No.
19 432-6, Trial Ex. 110 at 2. The PROGRESS Cohort collected data regarding dietary fluoride intake
20 from mothers (via food and beverage) during pregnancy and neurodevelopmental testing from
21 their offspring for 948 mother-child pairs from Mexico City. *Id.* at 2. Dietary fluoride intake was
22 measured via food frequency questionnaires from mothers in trimesters two and three of
23 pregnancy and children’s cognitive, motor, and language outcomes were measured at 12 and 24
24 months. *Id.* at 1. Cantoral (2021) studied data from 103 mother-child pairs from the PROGRESS
25 Cohort to understand if dietary fluoride intake during pregnancy is associated with toddlers’
26 neurodevelopment. *Id.* The study found a statistically significant association between maternal
27 fluoride intake and cognitive outcome in 24-month-old boys (0.5 mg/day increase in overall
28 dietary fluoride intake associated with 3.5-point lower cognitive outcome). *Id.* There was no

1 statistical association for girls or boys at 12 months of age. *Id.* Averaging across the entire age
 2 group, a 0.5 mg/day increase was associated with a 3.46-point lower cognitive outcome in boys,
 3 which was statistically significant. *Id.* The study concludes: “[t]hese findings suggest that the
 4 development of nonverbal abilities in males may be more vulnerable to prenatal fluoride exposure
 5 than language or motor abilities, even at levels within the recommended intake range.” *Id.*

6 c. Godebo (2023): this study assessed the association between chronic exposure to
 7 naturally occurring fluoride and drinking water and cognitive function in school-aged children,
 8 measured by two distinct assessments: a drawing test with familiar objects and the Cambridge
 9 Neuropsychological Test Automated Battery, Paired Associate Learning (“CANTAB PAL”)¹² test.
 10 Dkt. No. 432-14, Trial Ex. 118 at 15-16. The population studied was recruited from eight
 11 communities exposed to chronic fluoride ranging from 0.41 to 15.5 mg/L fluoride in water
 12 sources. *Id.* at 15. The study reported adverse associations of fluoride exposure in drinking water
 13 with children’s drawing and CANTAB task performance, with the most significant negative
 14 impacts observed for more challenging drawing tasks (*i.e.*, drawing a donkey rather than a house
 15 or a person). *Id.* at 16. The study concluded that this may be indicative of a greater challenge
 16 “accessing working memory for this task.” *Id.*

17 d. Adkins (2022): this study evaluated data collected from the Cincinnati Childhood
 18 Allergy and Air Pollution Study (“CCAAPS”). Dkt. No. 432-8, Trial Ex. 112 at 1. CCAAPS
 19 collected urine samples from children at 12 years of age and collected Behavior Assessment
 20 System for Children-2 which evaluates internalizing symptoms such as anxiety depression and
 21 somatization. *Id.* at 2. The study found that higher children’s urinary fluoride concentrations were
 22 significantly associated with increased somatization, but not depression or anxiety. *Id.* The study
 23 found that male participants exhibited higher internalizing and somatization behaviors relative to
 24 female participants. *Id.* at 6. The study concluded that “[d]espite males and females having
 25 comparable urinary fluoride concentrations, males may be at greater risk for adverse effects of

26
 27 ¹² The tests present patterns and shapes on a screen and ask children to touch and recount the
 28 patterns to assess spatial memory and learning. Dkt. No. 432-14, Trial Ex. 118 at 10-11. Spatial
 memory and learning are linked to the medial temporal lobe *e.g.*, hippocampus, which the study
 reports is the brain region thought to be most affected by fluoride toxicity. *Id.* at 5.

1 fluoride exposure as the association between fluoride concentrations and internalizing symptoms
2 was more robust among males.” *Id.* at 9.

3 e. Risk Sciences International (“RSI”), under contract with Health Canada, also
4 conducted an extensive systematic review of the fluoride neurotoxicity literature: Taher (2024).
5 Dkt. No. 433-4, Trial Ex. 129; Dkt. No. 433-6, Trial Ex. 131 (Taher (2024) Supplementary
6 Materials). Taher (2024) came to a similar conclusion as the NTP Monograph, finding a
7 “moderate to strong magnitude (strength) of association between fluoride and neurocognitive
8 effects with consistent evidence across studies for the impact on childhood IQ.” Dkt. No. 433-4,
9 Trial Ex. 129 at 21; Dkt. No. 433-6, Trial Ex. 131 at 1516 (“The overall evidence identified to date
10 strongly suggests that fluoride can affect cognitive outcomes in children (specifically, reduction in
11 IQ scores), at levels close to those currently seen in North American drinking water.”).¹³

12 38. Other post-NTP Monograph studies did not find fluoride was associated with adverse
13 cognitive outcomes in children:

14 a. Ibarluzea (2021): the study evaluated data from 316 to 248 mother-child pairs from
15 the Infancia y Medio Ambiente cohort project (“INMA Cohort”). Dkt. No. 432-10, Trial Ex. 114
16 at 1. The INMA Cohort draws on data from mothers and children in Gipuzkoa, Spain (Basque
17 Country) living in fluoridated and non-fluoridated water communities that supplied water with the
18 mean fluoride level of 0.81 mg/L. *Id.* at 1, 3. The INMA study collected maternal urinary
19 fluoride levels in the first and third trimesters of pregnancy, and children’s cognitive domains and
20

21 ¹³ Unlike the NTP Monograph, Taher (2024) considered evidence relating to multiple endpoints
22 (*i.e.*, a particular adverse effect, *see* Dkt. No. 434-15, Trial Ex. 535 at 43) aside from reduced IQ to
23 decide which endpoints need be accounted for by regulators; endpoints considered included
24 kidney dysfunction, sex hormone disruptions, and dental fluorosis, *see* Dkt. No. 433-4, Trial Ex.
25 129 at 21-23. Taher (2024) concluded that dental fluorosis and reduced IQ are critical endpoints;
26 evidence supported the association between fluoride and those two adverse effects. *See id.* at 27.
27 Taher (2024) did find that dental fluorosis should be the primary endpoint used by regulators
28 because data regarding the association between dental fluorosis and fluoride was more certain than
evidence regarding the association between IQ reduction and fluoride. *Id.* However, Taher (2024)
explained that *both* dental fluorosis, and separately, IQ reduction in children should be considered
by regulatory bodies, including the United States EPA, when assessing regulation of fluoride. *Id.*
To this end, the review recommended that fluoride at 1.56 mg/L be deemed hazardous, explaining
that this level should be utilized by regulators in its calculations to protect the public against *both*
dental fluorosis *and* IQ reduction. *See id.* Thus, the findings of Taher (2024) are consistent with
the NTP Monograph’s finding that fluoride is associated with reduced IQ, particularly at exposure
levels above 1.5 mg/L.

1 intelligence indexes, evaluated used the Bayley Scales (age 1) and McCarthy Scales (age 4). *Id.* at
 2 1. The study concluded that per unit of maternal fluoride across the pregnancy was associated
 3 with a sizeable *increase* in IQ scores (15-point increase) and an increase in verbal, performance,
 4 numeric, and memory domains in boys. *Id.* For girls, there was no significant association
 5 between maternal fluoride and cognitive score. *Id.*

6 b. Dewey (2023): This study compared data collected from maternal-child pairs in
 7 Calgary, Canada pre- and post-May 19, 2011, when the city stopped fluoridating its drinking water
 8 (with a recommended level of 0.7 mg/L) to discern if fluoridated drinking water was associated
 9 with children's intelligence and executive function at 3-5 years of age. Dkt. No. 432-13, Trial Ex.
 10 117 at 1. The study compared data from maternal-child pairs that were either fully exposed to
 11 fluoridated drinking water throughout pregnancy, exposed for part of the pregnancy, and those not
 12 exposed to fluoridated drinking water. *Id.* The study found no adverse associations between
 13 maternal exposure to fluoridated drinking water for intelligence. *Id.* at 7. The study observed that
 14 maternal exposure to fluoridated drinking water was associated with poorer executive function in
 15 preschool aged children and, particularly, girls. *Id.*

16 c. Do (2022): This study collected additional data from participants in Australia's
 17 National Child Oral Health Study 2012-14, which gathered data from children aged 5-10 years,
 18 and collected additional data from them again 7-8 years later but before the children turned 18
 19 years of age. Dkt. No. 432-9, Trial Ex. 113 at 1. The study estimated lifetime exposure to
 20 fluoridated water based upon residential history and postcode-level fluoride levels in public tap
 21 water and measured children's emotional and behavioral development and executive functioning
 22 using questionnaires. *Id.* The study concluded that exposure to fluoridated water during the first 5
 23 years of life (post-birth) was not associated with altered measures of child emotional and
 24 behavioral development and executive functioning by 18 years of age. *Id.*

25 39. For several reasons, the studies that did not find a negative association between fluoride
 26 and IQ, or that observed the association in some groups (boys) but not others (girls) do not
 27 undermine the significant evidence finding such an association, reflected in the NTP Monograph
 28 and studies published after the Monograph. The Court affords less weight to these studies finding

1 lack of an association due to various characteristics of those studies:

2 a. The reliability of Ibarluzea (2021) is questionable in several respects:

3 i. This study found that per one unit increase in the mg/L maternal urinary
4 fluoride, there was an association with a 15-point increase in the IQ of boys associated with
5 maternal urinary fluoride. Dkt. No. 432-10, Trial Ex. 114 at 1. Dr. Savitz, EPA's expert, agrees
6 that this finding is an outlier and unexpected, insofar as no other study has reported a *positive*
7 association between fluoride exposure upon IQ, and does not meaningfully support that fluoride is
8 beneficial. *See* Dkt. No. 414, Feb. 9, 2024, Trial Tr. at 1067:2-1069:11 (Savitz) ("Again, based on
9 what I know, I would doubt that that is an accurate reflection of the causal impact of fluoride on
10 IQ."). Experts also testified that they were not aware of *any* other chemical known to increase the
11 IQ of humans by 15 points. Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 372:14-16 (Grandjean); Dkt.
12 No. 395, Jan. 31, 2024, Trial Tr. at 111:4-6 (Hu). This association appears scientifically
13 implausible and raises questions about the overall reliability of this study.

14 ii. Further, the 15-point increase in IQ disappeared to reflect a null finding
15 when the maternal urinary fluoride was not adjusted for creatinine. Dkt. No. 395, Jan. 31, 2024,
16 Trial Tr. at 109:5-11 (Hu). Adjusting maternal urinary fluoride for creatinine is standard practice,
17 and results from creatinine-adjusted urinary fluoride are considered the informative and reliable
18 results of a study. Dkt. No. 395, Jan. 31, 2024, Trial Tr. at 108:7-10 (Hu); Dkt. No. 414, Feb. 9,
19 2024, Trial Tr. at 1089:5-17 (Savitz), 1090:24-1091:2 (Savitz). However, adjusting for creatinine
20 is expected to sharpen results, because the adjustment countervails for urinary dilution which
21 might introduce noise into a study; the adjustment is *not*, however, expected to have any
22 significant impact on the direction of results of the study. Dkt. No. 395, Jan. 31, 2024, Trial Tr. at
23 108:11-22 (Hu); Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 372:25-373:22 (Grandjean), 376:15-
24 378:24 (Grandjean). The results in the Ibarluzea (2021) study, which transitioned from a
25 significant positive association to a null finding when urinary fluoride was adjusted for creatinine,
26 was considered surprising and not a plausible result. Dkt. No. 395, Jan. 31, 2024, Trial Tr. at
27 109:13-110:7 (Hu); Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 372:25-373:22 (Grandjean), 376:15-
28 378:24 (Grandjean). Plaintiffs' experts credibly testified that this discrepancy suggests there was

1 an error when matching fluoride and creatinine data. Dkt. No. 417, Feb. 2, 2024, Trial Tr. at
2 372:25-373:22 (Grandjean). EPA’s experts at trial could not explain or account for this aspect of
3 the study. Dkt. No. 414, Feb. 9, 2024, Trial Tr. at 1091:3-1093:8 (Savitz).

4 iii. Another concern with the Ibarluzea (2021) study is that it did not adjust for
5 seafood as a covariate in the analysis of fluoride and IQ. Dkt. No. 397, Feb. 2, 2024, Trial Tr. at
6 453:12-17 (Grandjean). Seafood is both high in fluoride content and omega 3 fatty acids. Dkt.
7 No. 395, Jan. 31, 2024, Trial Tr. at 110:20-23 (Hu). This is problematic because omega 3 fatty
8 acids have beneficial effects on cognition, and thus seafood may be a confounding factor, skewing
9 results of a study if the population has a high seafood ingestion rate. Dkt. No. 395, Jan. 31, 2024,
10 Trial Tr. at 110:20-111:3 (Hu). The study did adjust for cord blood mercury levels, which could
11 operate as an adjustment for fish consumption because fish often contain mercury. Dkt. No. 414,
12 Feb. 9, 2024, Trial Tr. at 1073:20-1074:14 (Savitz). However, the bigger the fish, the more likely
13 the accumulation of mercury; conversely, the smaller the fish, the less likely the accumulation of
14 mercury. *Id.* at 1076:20-1078:9. Yet, in coastal Spain where the study was conducted, sardines
15 and anchovies are popular, which are small fish that are lower on the food chain and accordingly
16 low in mercury. *See* Dkt. No. 417, Feb. 2, 2024 at 458:23-459:17 (Grandjean); Dkt. No. 414, Feb.
17 9, 2024, Trial Tr. at 1269:24-1270:12 (Savitz). Thus, it is not clear that the adjustment for cord
18 blood mercury levels is a sufficient proxy for seafood consumption. To this end, Dr. Savitz agreed
19 that it is a reasonable hypothesis that fish consumption accounted for the beneficial results
20 associated with IQ observed in the Ibarluzea (2021) study. Dkt. No. 414, Feb. 9, 2024, Trial Tr. at
21 1069:23-1070:18 (Savitz).

22 iv. Taher (2024) likewise concluded that Ibarluzea (2021) does not overcome
23 evidence linking fluoride to reduced IQ in children. Namely, Taher (2024) concluded that “[t]he
24 available evidence demonstrated a moderate to strong magnitude (strength) of association between
25 fluoride and neurocognitive effects with consistent evidence across studies for the impact on
26 childhood IQ at fluoride exposures relevant to current North American drinking water levels.”
27 Dkt. No. 433-4, Trial Ex. 129 at 21. This is because, “[f]ocusing on high quality cohort studies,
28 most of the evidence suggests a reduction in childhood IQ scores associated with fluoride levels,

1 though results from one 2023 study in Spain (Ibarluzea et al. 2022) documented an improvement
2 in specific cognitive domain scores in boys.” *Id.*

3 b. Dewey (2023) is not strong evidence regarding the association between fluoride
4 and reduced IQ because of the design of this study. The study attempted to take advantage of
5 what was thought to be a naturally occurring cohort with an exposure contrast (*i.e.*, one cohort
6 exposed to fluoride and one not exposed to fluoride) to see if there was a meaningful difference in
7 cognitive outcomes amongst the two groups. Dkt. No. 397, Jan. 31, 2024, Trial Tr. at 368:22-
8 369:7 (Grandjean). Specifically, the study looked at individuals from a Canadian community that,
9 for a long time, fluoridated its water and stopped fluoridating the water; the study compared the
10 cognition of children in fluoridated and non-fluoridated groups to discern the impact of fluoride.
11 Dkt. No. 397, Jan. 31, 2024, Trial Tr. at 368:22-369:7 (Grandjean). However, the study did not
12 collect data on the urinary fluoride levels of the mother or assess how long pregnant mothers lived
13 in the area prior to their pregnancy. Dkt. No. 397, Jan. 31, 2024, Trial Tr. at 368:22-369:18
14 (Grandjean). This is relevant because women who live in a fluoridated area throughout their lives
15 will have fluoride which accumulates in her bones from consumption of fluoridated water, along
16 with other sources; for several years after cessation of fluoride exposure she is likely to release
17 accumulated fluoride from her bones into blood due to skeletal breakdown. Dkt. No. 397, Jan. 31,
18 2024, Trial Tr. at 370:6-371:12 (Grandjean); Dkt. No. 402, Feb. 8, 2024, Trial Tr. at 932:16-20
19 (Thiessen). This skeletal breakdown is particularly present during pregnancy, as the maternal
20 skeleton dissolves itself to provide calcium to the growing fetal skeleton. Dkt. No. 395, Jan. 31,
21 2024, Trial Tr. at 121:10-20 (Hu). Accordingly, the group that was considered non-fluoridated in
22 the study, thus creating an exposure contrast between the two groups allowing for a potential
23 association to be observed, may have in fact exposed the child to fluoride during pregnancy if she
24 lived in a fluoridated area prior to the study (a phenomenon that is not reported or considered by
25 the study). This could lessen the exposure contrast and calls the results of the study into question.
26 *See* Dkt. No. 397, Jan. 31, 2024, Trial Tr. at 368:22-369:18 (Grandjean). EPA’s expert witnesses
27 did not account for this concern regarding the study design. Thus, the Dewey study is accorded
28 diminished weight.

c. Do (2022) assessed primarily behavioral outcomes rather than impact on IQ in children and, as Dr. Savitz testified, “doesn’t stand out as definitive or more persuasive,” relative to other studies directly on point to association of fluoride on the IQ of children. Dkt. No. 414, Feb. 9, 2024 Trial Tr. at 1106:22-1107:10 (Savitz). Plaintiffs’ experts also expressed concerns with the study. The study utilized the “SDQ” test to measure impact of fluoride on children in Australia, which is a test that, for certain cultural or linguistic reasons, has been determined to be unreliable for Australians by another study conducted by the co-author of Do (2022). Dkt. No. 397, Jan. 31, 2024, Trial Tr. at 364:8-14, 365:15-366:4 (Grandjean). EPA’s expert witness did not rebut evidence that there were significant problems with the validity of the SDQ test in Australia. Dkt. No. 415, Feb. 12, 2024, Trial Tr. at 1240:1-6 (Savitz). Further, the value of this study is weakened because it did not analyze individualized data, but instead measured exposure based on residence of the child and community-wide data on fluoride in that area. *See* Dkt. No. 396, Feb. 1, 2024, Trial Tr. at 240:17-19 (Lanphear) (explaining that individualized data is generally a strength of a study); Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 366:5-367:4, 367:15-368:4 (Grandjean). Lack of individualized data can lead to exposure imprecision, creating “noise” in the data, which may bias results toward the null, *i.e.*, noise makes it less likely to show an association between the chemical and a result. Dkt. No. 395, Jan. 31, 2024, Trial Tr. at 106:18-107:16 (Hu); Dkt. No. 396, Feb. 1, 2024, Trial Tr. at 281:14-17 (Lanphear), 281:24-282:3 (Lanphear), 317:16-24 (Grandjean); Dkt. No. 414, Feb. 9, 2024, Trial Tr. at 1176:4-17 (Savitz) (agreeing with a statement made in his textbook that in general exposure misclassification tends to produce results with a bias towards the null). Thus, this study is not particularly probative evidence as to association between fluoride and IQ of children.

40. EPA experts agreed, in line with the NTP Monograph’s conclusion, that fluoride is associated with adverse IQ in children at “higher” levels of exposure. Namely, Dr. Barone testified that he agreed that there is “something going on” at higher-dose levels, though unclear about where the threshold is. Dkt. No. 415, Feb. 12, 2024, Trial Tr. at 1372:9-1373:9 (Barone). Dr. Barone agreed that, at 4 mg/L of fluoride exposure and above, there is more data to support a finding of an adverse effect associated with fluoride. *Id.* at 1373:1-9 (Barone). Dr. Barone further

1 testified: “I agree with the NTP’s conclusions that at some level above 1.5 mg/L that there is
 2 moderate evidence to support an association between fluoride and developmental IQ decrements.”
 3 Dkt. No. 416, Feb. 12, 2024, Trial Tr. at 1428:4-11 (Barone).¹⁴ The primary concern presented by
 4 EPA’s experts relates to lack of clarity as to whether *lower* exposure levels of fluoride (below 1.5
 5 mg/L) results in an adverse outcome and the precise relationship between dose and response. *See*
 6 Dkt. No. 415, Feb. 12, 2024, Trial Tr. at 1357:9-1360:10 (Barone). For example, Dr. Savitz
 7 (EPA’s expert witness) did not opine that the NTP Monograph’s main conclusion that fluoride is
 8 presumed to be a cognitive neurodevelopmental hazard to humans was incorrect, though
 9 expressing concerns as to a previous draft of the Monograph regarding whether its conclusion was
 10 well explained and qualified. Dkt. No. 414, Feb. 9, 2024, Trial Tr. at 1113:16-1115:23 (Savitz)
 11 (“Whether [a committee reviewing a draft of the NTP Monograph] agreed with [the NTP
 12 Monograph’s conclusion] was not the issue. It was – the story that gets to the punchline at the end
 13 we did not find persuasive.”). Indeed, Dr. Savitz explained that he does not have a basis to
 14 challenge the NTP’s conclusion that, with moderate confidence, there is an association or appears
 15 to be an association between neurological decrements in fluoride concentrations above 1.5 mg/L.
 16 *Id.* at 1140:10-19 (Savitz) (“I don’t have any reason to challenge [this conclusion], but I haven’t
 17 corroborated it by going through the dozens of studies one-by-one to make my own assessment.”).
 18 Dr. Savitz likewise made clear he did not undertake a complete review of the NTP Monograph,
 19 but testified his primary concern was the Monograph’s “inferences regarding lower levels of
 20 fluoride exposure.” *Id.* at 1129:11-1131:3 (Savitz).

21 41. The robust body of scientific literature systematically assessed by the NTP Monograph
 22 (described above, ¶ 35) and literature published after the NTP Monograph cutoff date (described
 23 above, ¶ 37), even considering some countervailing scientific literature (described above, ¶¶ 38-
 24 39) establishes by a preponderance of the evidence that fluoride is associated with reduced IQ in

25
 26 ¹⁴ Dr. Barone testified that the NTP Monograph was helpful but not complete and thus insufficient
 27 to satisfy the hazard identification prong of TSCA hazard assessment. Dkt. No. 440, Feb. 13,
 28 2024, Trial Tr. at 1428:22-1429:3 (Barone). That testimony is not credible because it directly
 contradicts Dr. Barone’s prior testimony during his deposition that the literature the NTP reviewed
 through April 2021 was sufficient to satisfy the human evidence standard for identifying a hazard
 under the EPA’s TSCA guidelines. *Id.* at 11-21.

1 children – at least at “higher” concentration levels, *i.e.*, above 1.5 mg/L (measured in either water
2 fluoride levels or urinary fluoride levels). At the hazard identification step, the EPA does not
3 require showing that an adverse effect is present at the level akin to the exposure in the community
4 (*i.e.*, 0.7 mg/L) or require the establishment of a dose-response relationship of the chemical at
5 “lower” levels. Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 493:16-495:12 (Barone). The evidence
6 regarding the “higher” exposure levels is sufficient to satisfy the hazard identification step of the
7 analysis.

8 42. Regardless, scientific literature in the record also indicates there is an association between
9 fluoride and reduced IQ in children even at “lower” levels of exposure (*i.e.*, below 1.5 mg/L).

10 43. Two of the three high-quality studies that evaluated the effects of “lower” levels of fluoride
11 exposure (below 1.5 mg/L) did observe an association between fluoride and reduced IQ in
12 children or boys. Namely: (1) Bashash (2017), studied mother-child pairs from the ELEMENT
13 Cohort (Mexican population) and observed a statistically significant decrement of 3.15 GCI score
14 and 2.5 IQ score of offspring per an increase of 0.5 mg/L of maternal urinary fluoride where the
15 mean maternal urinary fluoride in mothers was **0.9 mg/L**, Dkt. No. 432-2, Trial Ex. 106 at 1; and
16 (2) Green (2019) studied mother-child pairs in the MIREC Cohort (Canadian population) and
17 found a statistically significant decrement of 3.66 IQ score in boys only (3.66 IQ score decrement
18 per a 1 mg/L per day increase in maternal urinary fluoride) where the mean maternal urinary
19 fluoride of mothers was **0.42 mg/L**, Dkt. No. 432-5, Trial Ex. 109 at 1-3, 5.

20 44. Another program collected samples from 837 mother-child pairs from the Odense
21 municipality in Denmark: the Odense Child Cohort (“OCC Cohort”). Dkt. No. 432-15, Trial Ex.
22 119 at 1. The OCC Cohort measured maternal urinary fluoride during pregnancy and the IQ of
23 school-aged offspring of those mothers. *Id.* The maternal urinary fluoride concentrations
24 averaged at **0.58 mg/L** per day. *Id.* at 2. The study, when accounting for covariables did **not**
25 observe a statistically significant association between maternal urinary fluoride and child Full-
26 Scale IQ score, with no clear interaction between sex and fluoride exposure. *Id.*

27 45. The result of the OCC Cohort does not negate the findings regarding the MIREC and
28 ELEMENT cohorts. It is inherently more difficult to observe an adverse effect of a chemical at

1 lower exposure levels because of reduced exposure contrast¹⁵ at those levels. Dkt. No. 395, Jan.
 2 31, 2024, Trial Tr. at 113:2-25 (Hu), 114:8-14 (Hu); Dkt. No 396, Feb. 1, 2024, Trial Tr. at 213:5-
 3 25 (Lanphear); Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 525:9-526:13 (Berridge). EPA’s expert,
 4 Dr. Savitz, agreed. Dkt. No. 402, Feb. 8, 2024, Trial Tr. at 1009:7-23 (Savitz) (“[Y]ou could think
 5 of the worst cases, if we all had the exact same value, everybody in the population had the same
 6 exposure, you could not do an informative study of the association of exposure with a disease.
 7 And if it’s very narrow, of course, you’re only able to study – if you’re only able to study, let’s
 8 say, the contrast of, you know, .4 and .5 milligrams per liter fluoride, you’re going to have a tough
 9 time, even if there were an effect, it’s going to be difficult to find because you have a very limited
 10 contrast. As you spread that out more, of course, you are – you have a larger contrast and you’re
 11 able to address a more informative range of exposure.”). It is particularly difficult to observe
 12 effects of fluoride at lower exposure levels because of challenges in finding a control group with
 13 zero or very little fluoride exposure. Dkt. No 396, Feb. 1, 2024, Trial Tr. at 212:7-213:25
 14 (Lanphear). This is because fluoride exposure is prevalent. Some common sources aside from
 15 fluoridated water include naturally occurring fluoride in food and beverage, fluoride in food and
 16 beverage made with fluoridated water, and other products, like toothpaste. *Id.* at 212:10-19
 17 (Lanphear). Thus, it is difficult to find a control group without any fluoride exposure; the “noise”
 18 created by background fluoride exposure tends to obscure the contrast between those who
 19 consume fluoridated water and those who do not. *Id.* at 212:19-23 (Lanphear) (“And so if we
 20 wanted to ask a question . . . is there a difference in children who are unexposed to fluoride? Well,
 21 we really can’t find children who are unexposed to fluoride versus kids who have levels in a
 22 nonfluoridated community or a fluoridated community.”). It is thus more challenging to observe

23
 24 ¹⁵ Exposure contrast refers to the difference between exposure of a chemical in one group (a
 25 control group) and another group (the group exposed to the chemical). Dkt. No. 395, Jan. 31,
 26 2024, Trial Tr. at 113:6-22 (Hu). For example, an observer would compare a group with less or
 27 no fluoride exposure to a group with more exposure to determine if there is a meaningful
 28 difference in the group with more exposure. *See* Dkt. No 396, Feb. 1, 2024, Trial Tr. at 212:10-23
 (Lanphear). When trying to observe effects of a chemical at lower levels, there is less “exposure
 contrast” between the control group and exposed group. *See id.* at 212:10-213:25. Dr. Hu
 provided an illustration: “It’s sort of like looking at, you know, a picture and trying to determine
 whether this shade is different from that shade. If you increase the contrast, it’s easier to see.”
 Dkt. No. 395, Jan. 31, 2024, Trial Tr. at 114:12-14 (Hu).

1 effects at lower concentration levels of fluoridated water. *Id.* at 212:24-213:25 (Lanphear).
 2 Accordingly, the Court finds convincing and credible the expert testimony that studies analyzing
 3 the OCC Cohort are not inconsistent with studies analyzing the ELEMENT and MIREC Cohorts;
 4 the lower exposure levels account for some difficulty in repeating observed effects. Dkt. No. 395,
 5 Jan. 31, 2024, Trial Tr. at 116:24-117:4 (Hu).¹⁶ In short, the association between intake of water
 6 at lower fluoridated levels and IQ is likely harder to detect. Inconsistent results between studies
 7 are not unexpected. The two high-quality studies which detected such an association at lower
 8 concentration levels of fluoride remain significant and are not undermined by the OCC Cohort
 9 study.

10 46. In conclusion, Plaintiffs have established by a preponderance of the evidence that exposure
 11 to fluoride is associated with the adverse effect of reduced IQ in children, and particularly, young
 12 boys. Hence, the hazard identification step of the analysis is satisfied.

13 2. Step 1B: Weight of the scientific evidence

14 a. Framework

15 47. Once a hazard has been identified, the EPA assesses the weight of the scientific evidence,
 16 wherein the risk assessor considers the weight of that evidence, determining which adverse effects
 17 (endpoints) are to be assessed, and which studies are appropriate for use in quantifying the
 18 relationship between the dose of the chemical and adverse effect(s) (response) at issue (the “dose-
 19 response” assessment). Dkt. No. 400, Feb. 4, 2024, Trial Tr. at 661:18-666:14 (Barone). To this
 20 end, not all studies are appropriately utilized in the dose-response assessment. *See* Dkt. No. 417,
 21 Feb. 2, 2024, Trial Tr. at 494:17-495:12 (Barone). Rather, the EPA identifies the studies from the
 22 hazard identification step that are generally of high or medium quality, and thus are deemed
 23 permissible to use in the dose-response assessment. *Id.* at 494:17-495:12; Dkt. No. 421 at 5
 24 (undisputed fact).

25
 26 ¹⁶ Expert witnesses also testified credibly that there are some possible explanations for the
 27 differing study results; for example, it is possible that Denmark has higher iodine consumption,
 28 accounting for the discrepancy, as iodine deficiency is theorized to be an aggravating factor for
 impacts of fluoride on neurodevelopment. *See* Dkt. No. 396, Feb. 1, 2024, Trial Tr. at 248:10-
 250:3 (Lanphear).

48. The parties disagree as to precisely how the weight-of-the-scientific evidence analysis intersects with the subsequent step of the analysis: the dose-response assessment wherein a point of departure¹⁷ is identified (Step 1C, discussed in Section III.A.3.). *See* Dkt. No. 421 at 22-23. Plaintiffs assert that the weight-of-the-scientific evidence analysis is a distinct, qualitative characterization of the evidence regarding a “chemical’s potential to produce neurotoxicity,” separate from the quantitative dose-response assessment wherein a point of departure is calculated (Step 1C, discussed in Section III.A.3.). *Id.* The EPA asserts that there is not a clear distinction between the qualitative and quantitative dose-response assessment. *See id.* Dr. Barone, EPA’s expert does recognize that risk evaluation includes a “quantitative track wherein the agency is doing a quantitative measurement, deriving a point of departure, and a qualitative track where [the assessor is] assessing whether that evidence is appropriate for that purpose.” *See* Dkt. No. 400, Feb. 4, 2024, Trial Tr. at 666:9-14 (Barone). Moreover, Dr. Barone stated that: “in this weight of the scientific evidence evaluation . . . [we ask] how much data do we actually have for that particular endpoint or that particular outcome, and are there a series of outcomes that are related to neurotoxicity that we should consider as an example or reproductive toxicity. So we may have multiple endpoints to consider and multiple studies within that, that can be *carried forward* to dose response.” *Id.* at 662:2-19 (emphasis added). This testimony intimates that the weight-of-scientific-evidence analysis occurs prior to, and separately from, the quantitative dose-response assessment wherein a point of departure is calculated. *See id.* However, to avoid any doubt, the Court assesses the weight-of-the-scientific evidence both as a standalone, qualitative issue, characterizing the weight of the evidence assessing the association between the chemical and endpoint (in this section of the analysis (Section III.A.2., as Step 1B)) and also assesses the weight-of-the-scientific-evidence, as part of the quantitative dose-response assessment wherein a point of departure is identified (Section III.A.3, as Step 1C, discussed below).

b. Key finding

49. The weight of the scientific evidence regarding fluoride’s association with reduced IQ is

¹⁷ As explained in depth in Section III.A.3., the point of departure represents the level at which the chemical at issue becomes hazardous.

1 sufficient to proceed to the dose-response assessment; the evidence in the record is appropriate for
2 use in calculating a point of departure.

3 c. Underlying findings

4 50. The term “weight of the scientific evidence” is supported by EPA’s systematic analysis of
5 the related information to support the Agency’s findings. *Id.* at 651:22–652:5; *accord* 40 CFR
6 702.33. The assessor uses the “best available science,” in the analysis, which means that TSCA
7 risk evaluations need to be unbiased and objective, and the methodologies employed must be
8 transparent and reproducible and generally peer reviewed. Dkt. No. 400, Feb. 5, 2024, Trial Tr. at
9 652:6-16 (Barone); *accord* 40 C.F.R. 702.33.

10 51. In the weight-of-the-scientific-evidence analysis, generally, high- or medium-quality
11 studies are adequate to move to the dose-response determination. Dkt. No. 417, Feb. 2, 2024,
12 Trial Tr. at 494:17-495:12 (Barone); Dkt. No. 421 at 5 (undisputed fact). Still, the EPA
13 sometimes carries over low-quality studies into the dose-response analysis as well. Dkt. No. 417,
14 Feb. 2, 2024, Trial Tr. at 494:21-495:1 (Barone). In this weight-of-the-scientific-evidence
15 analysis, some or all factors referred to as the “Bradford Hill” factors may be considered. Dkt.
16 No. 400, Feb. 5, 2024, Trial Tr. at 626:8-24 (Barone). The nine Bradford Hill factors are: (1)
17 strength of the association, (2) consistency of the association; (3) specificity of the association; (4)
18 temporality of the association; (5) biological gradient (*i.e.*, dose response) of the association; (6)
19 plausibility of the association; (7) coherence of the association, (8) experimental support for the
20 association, and (9) analogies for the association. *See* Dkt. No. 198-3, Grandjean Trial Decl. ¶¶
21 111-125. However, there is no mandate that each of the Bradford Hill factors be considered in the
22 weight-of-the-evidence assessment in a non-cancer TSCA risk evaluation such as this one. *See*
23 Dkt. No. 437-1, Trial Ex. 96 (hereinafter “PCE Risk Evaluation”) at 326 (considering only
24 consistency of association factor); Dkt. No. 437-7, Trial Ex. 102 (hereinafter “Methylene Risk
25 Evaluation”) at 285-95 (considering some, but not all, of the Bradford Hill factors).

26 52. As discussed previously, not every epidemiological study on fluoride has found
27 associations with reduced IQ in children. *See* ¶¶ 35, 38. However, the evidence at issue is overall
28 **consistent** as to the finding that fluoride is associated with reduced IQ in children, and there is a

1 vast amount of **experimental support** for the association:

2 a. The NTP Monograph studied a robust amount of literature regarding fluoride's
3 impact on children's IQ: 72 epidemiological studies – 19 of which were deemed “high quality”
4 and “low-risk-of-bias,” and 53 lower-quality studies – a large majority of which identified an
5 association between fluoride and reduced IQ. NTP Monograph at xii (describing that 46 of the 53
6 low-quality studies found an association between higher fluoride exposure and lower IQ in
7 children and 18 of 19 high-quality studies reported an association between higher fluoride
8 exposure and lower IQ in children including 3 prospective cohort studies and 15 cross-sectional
9 studies). Indeed, when narrowing evidence to view only 19 studies that are high quality and low
10 risk-of-bias, all but one identified an association between fluoride and reduced IQ: Bashash et al.
11 2017; Choi et al. 2015; Cui et al. 2018; Ding et al. 2011; Green et al. 2019; Rocha-Amador et al.
12 2007; Saxena et al. 2012; Seraj et al. 2012; Sudhir et al. 2009; Till et al. 2020; Trivedi et al. 2012;
13 Wang et al. 2012; Wang et al. 2020b; Xiang et al. 2003a; Xiang et al. 2011; Yu et al. 2018; Zhang
14 et al. 2015b). NTP Monograph at 29-40 (Table 6).

15 b. The findings of the NTP Monograph are properly afforded substantial weight. The
16 NTP is headquartered within NIEHS, which is “is one of the premier environmental health
17 sciences research institutions in the world.” Dkt. No. 440, Feb. 13, 2024, Trial Tr. at 1425:23-
18 1426:2 (Barone). The EPA does not dispute this fact. Dkt. No. 421 at 10. Even before the NTP
19 Monograph was formally published, the EPA agreed the NTP Monograph is a high-quality review,
20 followed rules that have been developed by NTP for conducting systematic review, had a
21 “rigorous approach to assembling the evidence,” “clearly defined rules for identifying and
22 evaluating studies,” and “a well-defined protocol for drawing inferences” from the studies. Dkt.
23 No. 440, Feb. 13, 2024, Trial Tr. at 1427:9-21 (Barone), 1427:2-8 (Barone).

24 c. Though there were some critical peer review comments on earlier drafts of the NTP
25 Monograph, the core conclusion of the NTP Monograph regarding the high-quality studies was
26 not called into question by reviewers. *See, e.g.*, Dkt. No. 438-1, Trial Ex. 69 at 65 (NTP Board of
27 Scientific Counselors Working Group Report agreeing that low-risk-of-bias studies were
28 “consistent,” meaning generating results in the same direction, in finding a negative association

1 between fluoride exposure and children’s IQ); Dkt. No. 414, Feb. 9, 2024, Trial Tr. at 1114:24-
 2 1115:1 (Savitz) (describing NASEM critique of adequate definition of the term “consistent” in
 3 NTP Monograph, but not disagreeing with characterization of NTP Monograph finding
 4 association between IQ and fluoride). Indeed, EPA’s experts at trial expressed confidence in the
 5 NTP Monograph’s methodologies. Dkt. No. 414, Feb. 9, 2024, Trial Tr. at 1197:2-15 (Savitz)
 6 (expressing confidence in NTP’s literature search strategy and its ability to identify all relevant
 7 studies on fluoride exposure published prior to the closing date of April 21, 2021, and agreeing
 8 that the “vast majority of studies” that NTP reviewed identified an association between fluoride
 9 and reduced IQ). *See also* Dkt. No. 414, Feb. 9, 2024, Trial Tr. at 1140:10-19 (Savitz) (“I don’t
 10 have any reason to challenge [this conclusion], but I haven’t corroborated it by going through the
 11 dozens of studies one-by-one to make my own assessment.”). Further, Dr. Savitz, the expert
 12 called by the EPA herein, acknowledged he is not an expert in conducting risk assessment, and
 13 particularly not under Amended TSCA. Dkt. No. 415, Feb. 9, 2024, Trial Tr. at 1264:2-6 (Savitz).
 14 Formal publication of the NTP Monograph affirms its quality. *See also* ¶ 33.

15 d. As explained previously, studies published after the NTP Monograph’s literature
 16 cut-off date likewise observed a negative association between fluoride and children’s cognition:
 17 Goodman (2022(a)), Cantoral (2021), Godebo (2023), and Adkins (2022)). *See* ¶ 37.

18 e. Further, notwithstanding difficulties in observing effects of a chemical at lower
 19 levels, *see* ¶ 45, adverse outcomes have even been observed at those levels with statistical
 20 significance: Green (2019) and Bashash (2017), ¶¶ 42-43.

21 f. As explained previously, some studies have not observed an association between
 22 fluoride and reduced IQ: Soto-barreras (2019), ¶ 35(h); Ibarluzea (2021), ¶ 38(a); Dewey 2023, ¶
 23 38(b); Do (2022), ¶ 38(c); and the OCC Cohort, ¶ 44. However, complete consistency amongst
 24 studies is not expected. Dkt. No. 414, Feb. 9, 2024, Trial Tr. at 1172:23-1173:6 (Savitz). To this
 25 end, various co-factors or susceptibilities can influence the impact or manifestation of
 26 neurotoxicants, and as such, it is to be expected that there will be some variability in results across
 27 studies of different populations. *See id.* What may appear to be a discrepant result may, in fact,
 28 reflect unmeasured differences in cofactors that influence the course of a chemical’s

neurotoxicity. *See* Dkt. No. 395, Jan. 31, 2024, Trial Tr. at 102:22-104:24 (Hu); Dkt. No. 417, Feb. 1, 2024, Trial Tr. at 242:21-243:9 (Lanphear), 328:14-23 (Grandjean). And, as also explained previously, particular characteristics of these studies finding null outcomes render them less probative here. *See* ¶ 39. Namely, Ibarluzea (2021) found an unrealistic 15-point IQ benefit, included unexplained and implausible results regarding creatinine adjustments, and failed to control for seafood, ¶ 39(a); Dewey (2023) did not account for previous residence of mothers or continued excretion of fluoride from skeletal breakdown during pregnancy in the control group, ¶ 39(b); Do (2022) utilized an unreliable IQ test and did not analyze individualized data, ¶ 39(c); and the OCC Cohort measured lower exposure levels which makes it more difficult to observe adverse effects, ¶ 45.

53. Though not definitive, there is additional evidence that supports the **plausibility** of the association by assessing potential *mechanisms* for fluoride to impact IQ. Specifically, studies have endeavored to consider explanations for the observed association between fluoride and IQ and hypothesize that thyroid disruption may be the mechanism by which fluoride impacts cognitive function:

a. Goodman (2022b) studied samples from the MIREC Cohort to assess the three-way interplay between prenatal fluoride exposure, maternal iodine status, and child IQ. Dkt. No. 432-12, Trial Ex. 116 at 1, 8. The study found that the negative association between fluoride exposure and IQ observed in Green (2019) was exacerbated by low maternal iodine in pregnancy among boys. *Id.* The study hypothesized that change in thyroid function may be a mechanism by which fluoride impacts cognition; iodine impacts thyroid function. *Id.* at 1-2.

b. Hall (2023): studied samples from the MIREC Cohort and concluded that fluoride in drinking water was associated with increased risk of hypothyroidism in pregnant women, and that thyroid disruption may contribute to developmental neurotoxicity of fluoride. Dkt. No. 432-16, Trial Ex. 120 at 1-2.

54. A lack of a dose-response relationship in the data may suggest that the effect is not related to the putative neurotoxic effect or that the study was not appropriately controlled. Dkt. No. 429-7, Trial Ex. 17 (Guidelines for Neurotoxicity Risk Assessment, Fed. Reg. 63(93):26926-26954

(hereinafter “EPA Guidelines”))¹⁸ at 50. As discussed in the next section regarding the dose-response assessment, there is some lack of clarity as to the precise dose-response relationship at lower exposure levels of fluoride. However, evidence indicates that there is no **threshold** by which fluoride and adverse IQ cease to be associated. *See* ¶¶ 42-43.

55. In conclusion, this evidence is sufficient to proceed to the dose-response assessment of the analysis. *Cf.* Methylene Risk Evaluation at 262 (conducting dose-response analysis for Methylene under Amended TSCA based upon one animal study).

3. Step 1C: Dose-response assessment

a. Framework

56. The point at which the chemical ceases to be safe is known as the “point of departure” (*i.e.*, “POD”) or “hazard level.” *See* Dkt. No. 429-20, Trial Ex. 38 at 1; Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 495:9-14 (Barone); Dkt. No. 421 at 5. To this end, the dose-response assessment describes the relationship between dosage of the chemical and a response, and endeavors to identify the dosage at which a chemical is safe, and conversely, becomes hazardous; this is the point of departure. *See* EPA Guidelines at 57. *See also* Dkt. No. 429-20, Trial Ex. 38 at 1 (describing that the objective of the dose-response assessment is to “document the relationship between dose and toxic effect”).

57. There are different points of departure that can be used in a risk assessment. EPA Guidelines at 57-58. The first approach is the NOAEL/LOAEL approach. *See* Dkt. No. 429-19, Trial Ex. 38 at 3-4. A No-Observed-Adverse-Effect Level (“NOAEL”) is the “highest exposure level at which no statistically or biologically significant increases are seen in the frequency or severity of adverse effect between the exposed population and its appropriate control population.” *Id.* at 4. In cases in which a NOAEL cannot be identified, the term lowest-observed-adverse-effect level (“LOAEL”) is used, which is the lowest dose tested at which an adverse effect is detected.

¹⁸ These Guidelines were published in April 1998 and are the currently applied guidelines for EPA Neurotoxicity Risk Assessment according to the EPA’s website. *See Guidelines for Neurotoxicity Risk Assessment*, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (last visited September 12, 2024), <https://www.epa.gov/risk/guidelines-neurotoxicity-risk-assessment>.

1 *Id.* at 4. Alternatively, when possible, the benchmark dose (“BMD”) approach can be used to
2 arrive at a point of departure. *Id.*

3 58. The BMD approach is preferred over the NOAEL/LOAEL approach, and use of a NOAEL
4 is preferred over the LOAEL. *Id.* See also Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 495:23-496:25
5 (Barone); EPA Guidelines at 2-3, 57-58; Dkt. No. 421 at 5 (undisputed fact). The
6 NOAEL/LOAEL approach derives the point of departure from a dosage and corresponding
7 response in subjects that was actually observed. See EPA Guidelines at 57-59. See also Dkt. No.
8 400, Feb. 5, 2024, Trial Tr. at 672:1-11 (Barone) (“So generally a NOAEL or LOAEL, as we
9 described earlier, comes directly from what is the observed concentration for an effect or no effect.
10 So it’s directly coming from the study of where that threshold for non-cancer – generally gets a
11 threshold – where does that concentration occur. And that’s describing, generally speaking, a
12 single dose. It’s within the dose continuum of how many doses were employed in the study, what
13 concentration did they measure an effect.”). See also EPA Guidelines at 57-59. The
14 NOAEL/LOAEL is thus limited to only dosages observed in the study. See EPA Guidelines at 57-
15 59. Other limitations of the NOAEL/LOAEL approach include that this approach is highly
16 dependent upon sample size of a study (*e.g.*, where a sample size is limited, it might present a
17 higher point of departure than the true point of departure), and it does not account for the shape of
18 the dose-response curve from the experiment at issue. *Id.* Because of these limitations, the BMD
19 approach is preferred if the data set is appropriate for such modeling. See Dkt. No. 429-20, Trial
20 Ex. 38 at 4; Dkt. No. 400, Feb. 5, 2024, Trial Tr. at at 479:14-580:9 (Barone).

21 59. In utilizing the BMD approach, a benchmark dose, *i.e.*, BMD or benchmark concentration
22 (“BMC”) is identified. See Dkt. No. 429-20, Trial Ex. 38 at 4. The BMD/BMC is the dose of a
23 substance that produces a “predetermined change in the response rate of an adverse effect.” *Id.*
24 The benchmark dose level (“BMDL”) or benchmark concentration level (“BMCL”) is the lower
25 end of the statistical confidence limit on the dose that produces the selected response. *Id.* In other
26 words, there is a statistical confidence interval on either side of the BMD/BMC; the
27 BMDL/BMCL is the point at the lower side of that confidence interval. See *id.* Like the
28 NOAEL/LOAEL, the BMCL/BMDL can be used as the point of departure. *Id.*

b. Key findings

60. 0.28 mg/L, or alternatively, 0.768 and/or 1.536 mg/L measured in maternal urinary fluoride is associated with a 1-point decrease in IQ of girls and boys and is a legitimate point of departure (BMCL) to use in this risk evaluation.

61. Alternatively, 4 mg/L measured in either urinary fluoride or water fluoride, is a legitimate, conservative point of departure (LOAEL) to use in the risk evaluation.

62. Regarding the weight of the scientific evidence, the quality and weight of the evidence in the record substantiates points of departure derived from either BMD modeling of the data or from a LOAEL/NOAEL approach.

c. Underlying findings

- (a) POD: 0.28 mg/L BMCL (Grandjean (2023)) or in the alternative, 0.768 mg/L and/or 1.536 mg/L BMCL (Grandjean (2022))

63. Dr. Philippe Grandjean (“Grandjean”) was the lead author of two pooled BMCL analyses, one published in 2022 and another in 2023. Dkt. No. 432-20, Trial Ex. 124. (hereinafter “Grandjean (2022)”; Dkt. No. 432-15, Trial Ex. 119 (hereinafter “Grandjean (2023)”).

64. Dr. Grandjean and his co-authors are well-regarded for their benchmark dose analyses. To this end, EPA cited a pooled benchmark dose analysis authored by Grandjean as an example of how to perform such an analysis in its Benchmark Dose Technical Guidance Manual, and EPA has relied upon the authors’ benchmark dose analysis work in its assessment of other chemicals. Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 287:16-288:18 (Grandjean), 479:25-5 (Grandjean); Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 748:19-750:6 (Barone).

65. Grandjean (2022) analyzed data from two cohorts, the ELEMENT Cohort and the MIREC Cohort to conduct its BMCL analysis. Grandjean (2022) at 1-2. Grandjean (2023) analyzed three cohorts: ELEMENT, MIREC, and the OCC cohorts. Grandjean (2023) at 1.

66. The pooled BMCL analyses of the birth cohorts sought to determine the level of fluoride in maternal urine (“MUF”) that is associated with a 1-point drop in the IQ of the mothers’ offspring. Dkt. No. 417, Feb. 1, 2024, Trial Tr. at 339:13-23 (Grandjean). As described by RSI, “[t]he choice of a BMR of 1 IQ point (corresponding to a 1% reduction from a mean IQ of 100)

1 has been adopted as an appropriate benchmark on this endpoint by several regulatory bodies,
2 including the US EPA and EFSA.” Dkt. No. 433-4, Trial Ex. 129 at 27. Pooled analyses are also
3 particularly useful because a pooled analysis benefits from heightened statistical power and
4 precision that comes from large samples sizes. Dkt. No. 395, Jan. 31, 2024, Trial Tr. at 111:9-
5 112:16 (Hu).

6 67. Grandjean (2023) concluded that “[t]he joint analysis of all three cohorts showed a
7 statistically significant association between urine-fluoride and IQ, with a BMC of 0.45 mg/L
8 (BMCL, 0.28 mg/L).” Grandjean (2023) at 1-2. Specifically, Grandjean (2023) found that the
9 BMCL associated with a 1-point decrease in IQ scores of boys and girls was 0.28 mg/L maternal
10 urinary fluoride; this BMCL was adjusted for creatinine and derived from use of a linear dose-
11 response model. Grandjean (2023) at 1-2, 9. This BMCL is a legitimate point of departure to use
12 in the risk evaluation for fluoride.

13 68. When determining whether the point of departure can be derived using the BMD or BMC
14 approach, as opposed to identifying a LOAEL or NOAEL, it is necessary to consider whether the
15 data set is appropriate for use in the BMD/BMC modeling. *See* Dkt. No. 400, Feb. 5, 2024, Trial
16 Tr. at 658:9-659:10 (Barone) (explaining that in identifying studies and key endpoints to “carry
17 forward to the dose-response analysis,” the assessor considers whether “are [the studies] amenable
18 to BMDS, benchmark dose modeling? Are they amenable to a LOAEL/NOAEL approach?
19 Should we use some other type of approach?”). To this end, the EPA’s technical guidance
20 provides that the following should be considered as to whether the data set is appropriate for BMD
21 modeling: (1) whether there is a statistically or biologically significant dose-related trend in the
22 selected endpoint; (2) whether a response is not only seen at a high dose; and (3) where there are
23 adequate model fits. *See* Benchmark Dose Technical Guidance, U.S. ENVIRONMENTAL
24 PROTECTION AGENCY (June 2012) available at [https://www.epa.gov/sites/default/files/2015-](https://www.epa.gov/sites/default/files/2015-01/documents/benchmark_dose_guidance.pdf)
25 [01/documents/benchmark_dose_guidance.pdf](https://www.epa.gov/sites/default/files/2015-01/documents/benchmark_dose_guidance.pdf) (hereinafter “EPA’s Benchmark Dose Technical
26 Guidance”) at 12-18.¹⁹

27
28 ¹⁹ This document was not submitted as an exhibit, but the EPA’s witnesses rely on the document
for their testimony. *See, e.g.*, Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 745:9-25 (Barone) (“Q:

69. For the reasons discussed below, the data that Dr. Grandjean analyzed is appropriate for use in BMD modeling, and for similar reasons, his point of departure is supported by the weight of the scientific evidence. *See* ¶ 51 (discussing weight-of-scientific-evidence factors). It is demonstrated by a preponderance of the evidence.

70. As explained previously, there is a well-supported and documented, statistically significant dose-related trend in the selected endpoint (reduced IQ). *See* ¶¶ 52-53 (discussing the robust body of evidence establishing the relationship between fluoride and reduced IQ, including studies observing this relationship at “lower” exposure levels).

71. Dr. Grandjean rests his BMCL analysis upon studies observing the ELEMENT, MIREC, and OCC cohorts. Grandjean (2023) at 1-2. These high-quality studies are appropriate for use in BMD modeling, particularly because they include data regarding dose-response at “lower” exposure levels, *i.e.*, 0.9 mg/L (mean maternal urinary fluoride in ELEMENT cohort), 0.42 mg/L (mean maternal urinary fluoride in MIREC cohort), and 0.58 mg/L (average maternal urinary fluoride in the OCC cohort). *See* ¶¶ 42-44. Thus, rather than observing only a response at high dosages, the data set utilized by Dr. Grandjean observes dose-response at low exposure levels. The data set are thus appropriate for BMD modeling. To this end, RSI found that the MIREC and ELEMENT cohorts represent a “high quality of evidence partly based on Canadian population, conducted within a context relevant to Canadian drinking water fluoride exposure levels.”^[20] Both studies included prospective data collection, with prenatal exposure assessment (maternal urine collection over successive trimesters) and follow-up during the early life of the infants and children.” Dkt. No. 433-4, Trial Ex. 129 at 23. And the ELEMENT and MIREC cohort studies

Now, moving beyond semantics, I wanted to ask you about your testimony about benchmark dose, okay? You made comments in your testimony about Dr. Grand[j]ean's BMCL analysis, correct? A. Yes, I did. Q. You based your comments on EPA’s BMD guidance technical manual, correct? A. Yes, I did.”). The Court thus considers this technical guidance document.

²⁰ The United States and Canada take a similar approach to water fluoridation; this finding is applicable to United States drinking water fluoride exposure levels. *See* Tr. Ex. 129, Dkt. No. 433-4 at 16 (describing optimal water fluoride levels in Canada of 0.7 mg/L). *See also* Dkt. No. 396, Feb. 1, 2024 Trial Tr. at 245:1-22 (Lanphear) (describing optimal 0.7 mg/L water fluoride standard in Canada).

1 are strong for their extensive control for covariates and individualized measurements of fluoride
2 exposure during the prenatal period. Dkt. No. 395, Jan. 31, 2024, Trial Tr. at 95:2-96:5 (Hu).

3 72. The model fits of the data utilized by Grandjean's BMCL are also adequately supported.
4 On this point, the EPA takes issue with the fact that Dr. Grandjean's BMCL of 0.28 mg/L was
5 derived by applying a linear model of the dose-response curve.²¹ Grandjean (2023) at 1-2, 9. To
6 discern the best model fit for a set of data, a model is used to find a fit to the data, and based upon
7 that fit, an "AIC" score is generated; the lower the AIC score, the better the model fit. Dkt. No.
8 417, Feb. 2, 2024, Trial Tr. at 421:20-21 (Grandjean). To EPA's point, Grandjean (2023) did not
9 include a published table illustrating the AIC scores for all model fits, but did so only for the linear
10 model and piece-wise model, though not the squared model. *See* Grandjean (2023) at 9 (Table
11 S3). The government thus argued at trial that Dr. Grandjean improperly assumed, without testing
12 the assumption, that the linear model was appropriate for the data set evaluated. However, the use
13 of the linear model in Grandjean (2023) to generate the BMCL is sufficiently justified:

14 i. Dr. Grandjean testified, and the Court finds this testimony credible,
15 that he did not assume that the linear model was the best fit, but rather that he and his co-authors
16 compared various models and determined that the linear model was the preferred model for the
17 data. Dkt. No. 396, Feb. 1, 2024, Trial Tr. at 333:6-19 (Grandjean). Dr. Grandjean did state that
18 "[i]n my communications with the EPA, I was told that the default curve function was the linear
19 one." *Id.* at 333:8-9. However, Dr. Grandjean clarified that this default was only a starting point
20

21 ²¹ When a curve is linear, generally the dose and effect increase or decrease in a somewhat
22 uniform fashion, *i.e.*, when the dose increases, the effect increases; when the dose decreases, the
23 effect decreases. *See* EPA's Benchmark Dose Technical Guidance at 25-26, 77-78 (describing
24 linear, quadratic, and other models), 71 (defining "Linear Dose-Response Model" as "[a]
25 mathematical relationship in which a change in response is proportional to a fixed amount of
26 change in dose, e.g., $\text{Response} = a + b \times \text{Dose}$. This is in distinction from a more general linear
27 mathematical model, which is a linear combination of parameters"). The shape of the dose-
28 response curve is relevant, particularly because it is used to extrapolate to lower levels of exposure
not observed in the study, and thus to calculate the BMCL. *See id.* at 5 ("The dose response
assessment under the guidelines is a two-step process: (1) response data are modeled in the range
of empirical observation — modeling in the observed range is done with biologically based or
curve-fitting models; and then (2) extrapolation below the range of observation is accomplished by
modeling, if there are sufficient data, or by a default procedure (linear, nonlinear, or both)."). The
model will thus determine the BMCL identified. *See id.* at 5, 25-26, 77-78.

and that “what we’ve done in our work is to compare that to some variations and the statistical methods so that you can actually compare the fit if, let’s say, curvilinear or a broken line fits better. And in our case the linear was actually – was the best fit.” *Id.* at 333:10-14. And further, Dr. Grandjean testified that he also used “nonlinear methods to assess whether the dose-response relationship is linear,” *id.* at 333:15-19. *See also id.* at 339:24-340:7 (“We started out with EPA’s default recommendation, namely that linear association. But we then also looked at a curvilinear, for example, log 2 transformation of exposure. We also looked at broken lines of – and overall the linear association was not inferior to anything. It was sometimes clearly superior.”); Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 440:23-419:1 (Grandjean) (“[W]e certainly did look at other models.”). Dr. Grandjean and his co-authors did not simply assume that the linear model was the best fit for the data. It was chosen through an analytical process.

ii. Moreover, Grandjean (2022) includes a table that reports the AIC scores for squared models as they fit to data from the MIREC and ELEMENT cohorts and reveals comparable fit scores and supports Dr. Grandjean’s testimony as to the validity of the linear model fit:

Table 2.

Benchmark Concentration Results (mg/L Urinary Fluoride, Creatinine-Adjusted) for a BMR of 1 IQ Point Obtained from the MIREC Study and the Two Cognitive Assessments from the ELEMENT Study as Well as the Joint Results. Two Concentration-Response Models are used, a Linear and One with the Squared Exposure Variable. For both Models, Sex-Specific and joint benchmark Results are Provided. The fit of the Regression models was Compared by the AIC (Where Lower Values Indicate a Better Fit)

Study	Model	Sex	MIREC (n = 407)		ELEMENT IQ (n = 211)		ELEMENT GCI (n = 287)		MIREC and ELEMENT IQ (n = 618)			MIREC and ELEMENT GCI (n = 694)		
			BMC	BMCL	BMC	BMCL	BMC	BMCL	BMC	BMCL	AIC	BMC	BMCL	AIC
Linear	Both		0.497	0.228	0.200	0.122	0.159	0.099	0.326	0.201	4770.1	0.312	0.192	5491.3
Linear	Boys		0.201	0.125	0.275	0.130	0.148	0.084	0.222	0.144	4766.7	0.184	0.125	5488.4
Linear	Girls	∞	0.609	0.160	0.091	0.169	0.087	1.098	0.275		4766.7	2.972	0.315	5488.4
Squared	Both		1.545	0.896	0.614	0.496	0.611	0.467	1.008	0.768	4768.8	1.133	0.807	5493.9
Squared	Boys		0.840	0.622	0.684	0.496	0.581	0.435	0.787	0.619	4769.4	0.761	0.601	5493.7
Squared	Girls	∞	1.262	0.576	0.449	0.642	0.434	1.637	0.866		4769.4	∞	1.040	5493.7

Abbreviations: AIC, Akaike Information Criterion; BMC, benchmark concentration; BMCL, benchmark concentration level; BMR, benchmark response; GCI, Global Cognitive Index; IQ, Intelligence Quotient.

Grandjean (2022) at 17 (Table 2) (red annotation added). The AIC scores for the linear and squared models were comparable, with the best fit for boys and girls individually, measuring IQ, using a linear model (AIC 4766.7 linear compared to 4769.4 squared), and squared combined (AIC 4768.8 squared compared to 4770.1 linear). *See id.* For GCI (the General Cognitive Index

score), the linear model was a better fit than the squared model for all categories. *See id.* Even if not definitive, the comparable AIC fits for linear and squared models reflected in Grandjean (2022) support that the linear model is a justifiable model to apply to the MIREC and ELEMENT cohort data.

iii. Dr. Grandjean's analysis is also consistent with the NTP's analysis. The NTP Meta-analysis did not publish AIC scores for models restricted to low-risk-of bias studies. *See* Dkt. No. 431-2, Trial Ex. 68 at 40-41 (eTable 4) (hereinafter "NTP Meta-analysis"). However, it did publish AIC scores for model fit of data in all studies, as reflected in the below table:

Exposure Analysis	Parameters	Fluoride Exposure			
		All data	<4 mg/L	<2 mg/L	<1.5 mg/L
Urinary Fluoride – All Studies					
No. Studies/No. Observations		18/32	13/26	7/11	5/8
Number of Children		8,502	6,885	4,654	3,992
Linear Model ^b	Beta (95% CI)	−0.16 (−0.24, −0.08)	−0.17 (−0.30, −0.05)	−0.06 (−0.14, 0.01)	−0.09 (−0.16, −0.01)
	p-value	p < 0.001	p = 0.005	p = 0.094	p = 0.026
	AIC	AIC = 73.8	AIC = 68.0	AIC = 1.2	AIC = 2.8
Quadratic Model ^c	Beta (95% CI); p-value	−0.10 (−0.31, 0.11); p = 0.360	0.07 (−0.23, 0.38); p = 0.645	−0.22 (−0.65, 0.20); p = 0.303	0.65 (−1.46, 2.76); p = 0.548
	Beta (95% CI); p-value	−0.01 (−0.05, 0.02); p = 0.496	−0.07 (−0.16, 0.01); p = 0.071	0.08 (−0.13, 0.30); p = 0.456	−0.66 (−2.11, 0.80); p = 0.379
	AIC	AIC = 84.3	AIC = 75.8	AIC = 9.2	AIC = 8.3
	p-value*	p* = 0.14	p* = 0.08	p* = 0.42	p* = 0.10
Restricted Cubic Splines Model ^d	Beta (95% CI); p-value	−0.12 (−0.28, 0.04); p = 0.150	−0.03 (−0.22, 0.16); p = 0.741	−0.14 (−0.32, 0.04); p = 0.130	−0.52 (−1.65, 0.62); p = 0.371
	Beta (95% CI); p-value	−0.10 (−0.43, 0.23); p = 0.545	−0.24 (−0.47, −0.002); p = 0.048	0.13 (−0.17, 0.43); p = 0.395	0.63 (−1.32, 2.59); p = 0.524
	AIC	AIC = 79.6	AIC = 73.3	AIC = 8.5	AIC = 6.7
	p-value*	p* = 0.13	p* = 0.07	p* = 0.37	p* = 0.07

Id. Using urinary fluoride as the exposure metric, the linear model reflected the lowest AIC score unilaterally. *See id.* And although the linear model did not generate a statistically significant inverse association at all exposure levels, the linear model generated a statistically significant inverse association at <1.5 mg/L (in line with Grandjean (2023)'s finding relating to lower-exposure levels as noted above), and the findings remained directionally negative at all levels which also supports Grandjean (2023)'s use of the linear model. *See* Dkt. No. 395, Jan. 31, 2024, Trial Tr. at 115:16-25 (Hu) ("In fact, epidemiology is moving away from a simple reliance on just P values and saying 'this is significant, this is not significant.' It's really important to also look at the so-called directionality of the relationships."). Additionally, as explained in more detail below, some of the loss of association observed in the NTP Meta-analysis may be explained by the

1 use of the means effect method in the Meta-analysis, which results in loss of statistical power and
 2 sensitivity in the data. *See* ¶ 74(b). Ultimately, the authors of the NTP Meta-analysis concluded
 3 that “[b]ased on the AIC and likelihood ratio tests, the best model fit was achieved when quadratic
 4 or restricted cubic spline exposure levels were added to the linear models for drinking water
 5 (eFigure 17); ***the linear model was the best fit for urinary fluoride*** (eFigure 18).” NTP Meta-
 6 analysis at 10 (emphasis added). This further bolsters the legitimacy of Grandjean (2023)’s use of
 7 a linear model to generate the BMCL, expressed in maternal urinary fluoride.

8 73. Assuming, in the alternative, that the squared model is a more appropriate fit for this data
 9 set, as EPA suggested at trial, a BMCL of 0.768 mg/L and/or 1.536 mg/L is appropriately used to
 10 conduct the risk assessment. Though Grandjean (2023) did not identify a BMCL using the squared
 11 model, Dr. Grandjean’s 2022 BMCL analysis did identify a BMCL of 0.768 mg/L utilizing a
 12 squared model. Grandjean (2022) at 17 (Table 2); Dkt. No. 417, Feb. 2, 2024, Trial Tr. at
 13 423:12-21 (Grandjean). It is true that this BMCL is derived from the ELEMENT and MIREC
 14 cohort data only and excludes data from the OCC Cohort. This is relevant because inclusion of
 15 the OCC Cohort data is likely to increase the BMCL; when the OCC cohort data was added to the
 16 BMCL analysis in Grandjean (2023), the BMCL increased by 0.08 mg/L, or forty percent²² (from
 17 0.20 mg/L (MIREC and ELEMENT alone) to 0.28 mg/L (MIREC, ELEMENT and OCC cohort
 18 data)). *See* Grandjean (2023) at 3 (“The joint BMC was found to be 0.45 mg/l (BMCL, 0.28 mg/l),
 19 *i.e.* slightly higher than previously found (BMC, 0.33 mg/l; BMCL, 0.20 mg/L) for the two North
 20 American cohorts alone.”). But a preponderance of the evidence indicates the inclusion of the
 21 OCC Cohort data would not make a material difference. To be highly conservative, the BMCL of
 22 0.768 mg/L can be *doubled*, to account for any discrepancy caused by the omission of the OCC
 23 data: 1.536 mg/L (0.768 mg/L times two). This could be used conservatively as an alternative
 24 point of departure implied from the data if the squared model is used. As discussed below, even
 25 using this higher point of departure, the ultimate finding of an unreasonable risk would not change.

26
 27
 28 ²² ((.08 / .20) * 100).

1 74. One additional concern with Dr. Grandjean’s BMCL calculation is that it, at first glance,
 2 appears to be in tension with the NTP Monograph’s conclusion that “[m]ore studies are needed to
 3 fully understand the potential for lower fluoride exposure [i.e., below 1.5 mg/L] to affect
 4 children’s IQ.” NTP Monograph at xiii.²³ However, this ultimately does not undermine the
 5 validity of the BMCL identified in Grandjean (2023) for the following reasons:

6 a. Though the authors of the NTP Monograph recognized some lack of clarity in the
 7 precise relationship between fluoride and reduced IQ at lower exposure levels, NTP Monograph at
 8 xiii, given the strength of the association between fluoride and reduced IQ, the authors of the NTP
 9 Monograph refused to limit the applicability of its findings in the systematic review to higher
 10 exposure levels and made clear that its confidence assessment also considered fluoride exposures
 11 “that are similar to, or lower than, those associated with optimally fluoridated water supplies in the
 12 United States,” *i.e.*, 0.7 mg/L. Dkt. No. 438-1, Trial Ex. 69 at 24-25 (comments and responses
 13 from NTP Monograph authors and evaluators of the NTP Monograph).

14 b. The NTP also conducted a Meta-analysis, integrating all of the studies assessed in
 15 the NTP Monograph to analyze the dose-response relationship between fluoride and reduced IQ.
 16 The findings of the NTP Meta-analysis first appear to be in tension with Dr. Grandjean’s findings
 17 but are, in fact, consistent with those findings because of the methodologies used. Namely, the
 18 NTP Meta-analysis concluded that “the consistency of the data supports an inverse association
 19 between fluoride exposure and children’s IQ.” NTP Meta-analysis at 3. However, the Meta-
 20 analysis reported somewhat mixed results regarding the dose-response relationship, particularly at
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 22
 23
 24
 25
 26

27 ²³ Regarding “lower” fluoride exposure levels – both Grandjean (2023) and the NTP Monograph
 28 analyzed data from the ELEMENT and MIREC cohorts though Grandjean (2023) also analyzed
 data from the OCC Cohort, another lower-exposure level study.

lower levels of fluoride exposure:

Exposure Analysis	Parameters	Fluoride Exposure			
		All data	<4 mg/L	<2 mg/L	<1.5 mg/L
Linear model	Beta (95% CI)	-0.15 (-0.23, -0.07)	-0.16 (-0.28, -0.04)	-0.05 (-0.14, 0.04)	-0.08 (-0.16, -0.01)
	p-value	p < 0.001	p = 0.011	p = 0.259	p = 0.036
	AIC	AIC = 74.5	AIC = 68.6	AIC = 1.3	AIC = 3.0
Urinary Fluoride – Low Risk-of-bias Studies					
No. Studies/No. Observations		9/15	9/15	5/8	4/7
Number of Children		5,713	5,713	4,141	3,952
Linear model	Beta (95% CI)	-0.10 (-0.21, 0.01)	-0.10 (-0.21, -0.01)	-0.05 (-0.17, 0.08)	-0.08 (-0.16, -0.01)
	p-value	p = 0.082	p = 0.082	p = 0.472	p = 0.028
	AIC	AIC = 5.9	AIC = 5.9	AIC = 2.8	AIC = 2.5

Id. at 41 (eTable 4) (red annotation added). In reviewing all studies and measuring exposure of fluoride per urinary fluoride the NTP Meta-analysis found a statistically significant inverse association between children’s urinary fluoride exposure and IQ at <4 mg/L urinary fluoride. *Id.* When restricted to <2 mg/L and <1.5 mg/L urinary fluoride, there was still an inverse association. *Id.* This finding is consistent with Grandjean (2023). However, when analyses were restricted to low risk-of-bias publications, the associations at <2 mg/L and <1.5 mg/L became smaller in magnitude and were only statistically significant at <1.5 mg/L, but not at <2 mg/L. *Id.* That finding of an adverse association at <1.5 mg/L is consistent with the conclusion in Dr. Grandjean’s pooled benchmark dose analysis (though appearing somewhat anomalous compared to the finding at <2 mg/L). Dr. Grandjean’s pooled benchmark analysis uses a method with more statistical precision than the NTP Meta-analysis, and thus could account for the more specific findings as to the relationship between fluoride and IQ at lower exposure levels. Specifically, the NTP Meta-analysis used a “means effect analysis,” which is useful for its ability to compare different types of studies with varied methodologies and metrics (72 total and 19 low-risk-of-bias studies) – but it loses sophistication and precision in the underlying data of each study when it converts the findings into standard, comparable metrics. Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 469:3-471:6 (Grandjean). Specifically, so that different studies using different exposures or result metrics could be compared, the data was grouped into buckets (*e.g.*, high exposure, low exposure) and analyzed. *Id.* at 471:6-15. Accordingly, each of the underlying studies lose some of its statistical power when data is simplified to allow for cross-study, like-to-like comparison. *See id.* at 471:6-473:24. On the other hand, the pooled benchmark analysis maintains individualized, continuous

1 data and does not simplify that data for meta-analysis comparison; the benchmark analysis
2 maintains increased sophistication and statistical sensitivity. *Id.* at 473:18-24. Thus, the findings
3 of the NTP Meta-analysis are not inconsistent with Dr. Grandjean’s pooled benchmark analysis.

4 75. Ultimately, TSCA does not require complete certainty as to the threshold level at which a
5 chemical produces the hazard; indeed, such certainty is very difficult to obtain from epidemiologic
6 studies of human populations. Dkt. No. 440, Feb. 13, 2024, Trial Tr. at 1440:18-23 (Barone); Dkt.
7 No. 414, Feb. 9, 2024, Trial Tr. at 1173:7-13 (Savitz). Either BMCL of 0.28 mg/L (linear model
8 per the MIREC, ELEMENT, and OCC cohort data) or 0.768 mg/L (squared model per the MIREC
9 and ELEMENT cohort data) identified by Dr. Grandjean and his co-authors are legitimate points
10 of departure to utilize in a risk analysis. So is the implied BMCL of 1.536 mg/L (were the OCC
11 study taken into account). The Court finds, though not with absolute certainty, Dr. Grandjean’s
12 BMCLs are supported by a preponderance of the evidence.²⁴

13 (b) POD: 4 mg/L urinary or water fluoride (LOAEL)

14 76. As described previously, use of the BMD approach is preferred in identifying a point of
15 departure because of limitations of a NOAEL or LOAEL, but where data is not amenable to
16 benchmark dose modeling, a NOAEL or LOAEL may be utilized instead. *See* ¶¶ 57-59. The
17 Court thus examines this alternative approach to establishing a point of departure.

18 77. Again, notwithstanding the limitations of the NOAEL/LOAEL approach, this approach is
19 properly used, and has been used by the EPA, with the application of uncertainty factors, to
20 determine the point of departure where datasets are, for various reasons, not amenable to BMD
21 modeling. *See* Dkt. No. 429-20, Trial Ex. 38 at 4. For example, the EPA conducted a risk
22 evaluation of Perchloroethylene (“PCE”), pursuant to Amended TSCA, and utilized
23 NOAEL/LOAELs as PODs because it was unable to use BMD modeling. *See* PCE Risk
24 Evaluation at 351 (“For this risk evaluation, non-cancer PODs were all based on NOAELs and
25 LOAELs because the data for the selected endpoints was unable to be BMD modeled. This results

26
27 ²⁴ The government also takes issue with the use of maternal urinary fluoride (“MUF”) as the
28 metric of the exposure or hazard level utilized in the risk assessment analysis. The validity of
maternal urinary fluoride as a metric is taken up subsequently in Section III.B (Exposure
Assessment).

1 in reduced precision in POD estimates because the POD is dependent on the dose selection of the
 2 study as opposed to the response rate/level for the effect of interest.”); Dkt. No. 401, Feb. 6, 2024,
 3 Trial Tr. at 772:3-11 (Thiessen).

4 78. To the extent that the BMD approach is not appropriate based upon the present data set, in
 5 the alternative, 4.0 mg/L (using exposure measurement of water fluoride intake) is a legitimate and
 6 highly conservative LOAEL to utilize as a point of departure to conduct a risk assessment of
 7 fluoride per the findings of the NTP Meta-analysis. Utilizing 4.0 mg/L as the LOAEL is
 8 especially conservative in view of the NTP Monograph’s conclusion with moderate confidence
 9 that exposure to fluoride concentration in drinking water at or above 1.5 mg/L is associated with
 10 lower IQ in children. One could reasonably take 1.5 mg/L as a LOAEL. Nonetheless, the Court
 11 uses the more conservative 4.0 mg/L based on a close analysis of the NTP Meta-analysis which
 12 establishes with consistency an association with reduced IQ at that level. Specifically, the NTP
 13 Meta-analysis observed a statistically significant inverse association between fluoride and reduced
 14 IQ at 4 mg/L measured in water fluoride, based on low-risk-of-bias/high quality studies (*i.e.*, 6
 15 epidemiological studies deemed high quality), which is reflected in the below table from the Meta-

analysis summarizing the NTP's dose-response analysis:²⁵

Table 4. Dose-Response Meta-analysis Using Mean Effects—Model Selection^a

Exposure Analysis	Parameters	Fluoride Exposure			
		All data	<4 mg/L	<2 mg/L	<1.5 mg/L
Water Fluoride – All Studies					
No. Studies/No. Observations		29/39	21/27	7/9	7/7
Number of Children		11,656	8,723	2,971	2,832
Linear Model ^b	Beta (95% CI)	-0.15 (-0.20, -0.11)	-0.22 (-0.27, -0.17)	-0.15 (-0.41, 0.12)	0.05 (-0.36, 0.45)
	p-value	p < 0.001	p < 0.001	p = 0.274	p = 0.816
	AIC	AIC = 53.8	AIC = 16.1	AIC = 11.8	AIC = 8.2
Quadratic Model ^c	Beta (95% CI); p-value	-0.27 (-0.34, -0.21); p < 0.001	-0.12 (-0.35, 0.11); p = 0.318	0.79 (-0.01, 1.58); p = 0.052	0.30 (-0.53, 1.14); p = 0.477
	Beta (95% CI); p-value	0.02 (0.01, 0.03); p < 0.001	-0.04 (-0.10, 0.03); p = 0.280	-0.56 (-0.97, -0.16); p = 0.006	-0.23 (-1.01, 0.55); p = 0.561
	AIC	AIC = 48.8	AIC = 21.2	AIC = 12.5	AIC = 11.3
	p-value*	p* < 0.001	p* = 0.012	p* = 0.007	p* = 0.04
Restricted Cubic Splines Model ^d	Beta (95% CI); p-value	-0.29 (-0.39, -0.20); p < 0.001	-0.14 (-0.34, 0.06); p = 0.162	1.15 (0.07, 2.22) p = 0.037	0.49 (-0.50, 1.47) p = 0.334
	Beta (95% CI); p-value	0.48 (0.18, 0.78); p = 0.002	-0.23 (-0.66, 0.20); p = 0.295	-1.20 (-2.03, -0.36) p = 0.005	-0.69 (-2.40, 1.02) p = 0.428
	AIC	AIC = 42.3	AIC = 16.9	AIC = 10.5	AIC = 10.2
	p-value*	p* < 0.001	p* = 0.009	p* = 0.010	p* = 0.05
Water Fluoride – Low Risk-of-bias Studies					
No. Studies/No. Observations		6/11	6/9	3/4	3/3
Number of Children		4,355	4,251	921	879
Linear model	Beta (95% CI)	-0.19 (-0.34, -0.05)	-0.22 (-0.36, -0.07)	-0.34 (-0.72, 0.03)	-0.32 (-0.91, 0.26)
	p-value	p = 0.009	p = 0.003	p = 0.070	p = 0.276
	AIC	AIC = 10.3	AIC = 3.9	AIC = 4.5	AIC = 4.1

Dkt. No. 431-2, Trial Ex. 68 at 39 (eTable4) (red annotation added). That value was derived from a linear model which, for this group of studies, had the lowest AIC score. *See id.* (identifying AIC of 16.1 (linear for all studies), 21.1 (quadratic for all studies), 16.9 (restricted cubic splines for all studies)).

²⁵ Note that where values in the parenthesis, which represent the confidence interval, are below zero, the finding is statistically significant. *See* Dkt. No. 417, Feb. 2, 2024, Trial Tr. at 394:2-14 (Grandjean).

79. Further, the NTP Meta-analysis observed an association between fluoride and reduced IQ at <4 mg/L measured in urinary fluoride, based on low-risk-of-bias/high-quality studies (9 epidemiological studies deemed high quality):

Exposure Analysis	Parameters	Fluoride Exposure			
		All data	<4 mg/L	<2 mg/L	<1.5 mg/L
Urinary Fluoride – All Studies					
No. Studies/No. Observations		18/32	13/26	7/11	5/8
Number of Children		8,502	6,885	4,654	3,992
Linear Model ^b	Beta (95% CI)	-0.16 (-0.24, -0.08)	-0.17 (-0.30, -0.05)	-0.06 (-0.14, 0.01)	-0.09 (-0.16, -0.01)
	p-value	p < 0.001	p = 0.005	p = 0.094	p = 0.026
	AIC	AIC = 73.8	AIC = 68.0	AIC = 1.2	AIC = 2.8
Quadratic Model ^c	Beta (95% CI); p-value	-0.10 (-0.31, 0.11); p = 0.360	0.07 (-0.23, 0.38); p = 0.645	-0.22 (-0.65, 0.20); p = 0.303	0.65 (-1.46, 2.76); p = 0.548
	Beta (95% CI); p-value	-0.01 (-0.05, 0.02); p = 0.496	-0.07 (-0.16, 0.01); p = 0.071	0.08 (-0.13, 0.30); p = 0.456	-0.66 (-2.11, 0.80); p = 0.379
	AIC	AIC = 84.3	AIC = 75.8	AIC = 9.2	AIC = 8.3
	p-value*	p* = 0.14	p* = 0.08	p* = 0.42	p* = 0.10
Restricted Cubic Splines Model ^d	Beta (95% CI); p-value	-0.12 (-0.28, 0.04); p = 0.150	-0.03 (-0.22, 0.16); p = 0.741	-0.14 (-0.32, 0.04); p = 0.130	-0.52 (-1.65, 0.62); p = 0.371
	Beta (95% CI); p-value	-0.10 (-0.43, 0.23); p = 0.545	-0.24 (-0.47, -0.002); p = 0.048	0.13 (-0.17, 0.43); p = 0.395	0.63 (-1.32, 2.59); p = 0.524
	AIC	AIC = 79.6	AIC = 73.3	AIC = 8.5	AIC = 6.7
	p-value*	p* = 0.13	p* = 0.07	p* = 0.37	p* = 0.07
Urinary Fluoride – Sensitivity analysis including Ibarluzea et al. (2021) ⁸⁷ Bayley MDI scores					
No. Studies/No. Observations		19/33	14/27	8/12	6/9
Number of Children		8,815	7,445	4,967	4,305
Linear model	Beta (95% CI)	-0.15 (-0.23, -0.07)	-0.15 (-0.28, -0.03)	-0.04 (-0.14, 0.05)	-0.08 (-0.15, -0.003)
	p-value	p < 0.001	p = 0.015	p = 0.371	p = 0.043
	AIC	AIC = 75.0	AIC = 69.0	AIC = 1.7	AIC = 3.6
Urinary Fluoride – Sensitivity analysis including Ibarluzea et al. (2021) ⁸⁷ McCarthy GCI scores					
No. Studies/No. Observations		19/33	14/27	8/12	6/9
Number of Children		8,749	7,445	4,901	4,239
Exposure Analysis	Parameters	Fluoride Exposure			
		All data	<4 mg/L	<2 mg/L	<1.5 mg/L
Linear model	Beta (95% CI)	-0.15 (-0.23, -0.07)	-0.16 (-0.28, -0.04)	-0.05 (-0.14, 0.04)	-0.08 (-0.16, -0.01)
	p-value	p < 0.001	p = 0.011	p = 0.259	p = 0.036
	AIC	AIC = 74.5	AIC = 68.6	AIC = 1.3	AIC = 3.0
Urinary Fluoride – Low Risk-of-bias Studies					
No. Studies/No. Observations		9/15	9/15	5/8	4/7
Number of Children		5,713	5,713	4,141	3,952
Linear model	Beta (95% CI)	-0.10 (-0.21, 0.01)	-0.10 (-0.21, -0.01)	-0.05 (-0.17, 0.08)	-0.08 (-0.16, -0.01)
	p-value	p = 0.082	p = 0.082	p = 0.472	p = 0.028
	AIC	AIC = 5.9	AIC = 5.9	AIC = 2.8	AIC = 2.5

Dkt. No. 431-2, Trial Ex. 68 at 39 (eTable 4) (red annotation added). That value was also derived from a linear model which, for this group of studies, likewise had the lowest AIC score. *See id.* (identifying 68 (linear for all studies), 75.8 (quadratic for all studies), 73.3 (restricted cubic splines for all studies)).

80. Even if there may be some uncertainty about the dose-response relationship below that exposure level (4 mg/L), significant data supports that there is an adverse effect *at or above the specified level*. *See* Dkt. No. 415, Feb. 12, 2024, Trial Tr. at 1373:1-9 (Barone) (testimony from

1 Dr. Barone agreeing that at 4 mg/L of fluoride exposure and above there is relatively more data to
 2 support a finding of an adverse effect associated with fluoride.), 1428:4-11 (Barone) (“I agree with
 3 the NTP’s conclusions that at some level above 1.5 that there is moderate evidence to support an
 4 association between fluoride and developmental IQ decrements.”). Again, TSCA does not require
 5 absolute certainty as to the threshold level at which a chemical produces the hazard, and indeed as
 6 noted above such certainty is very difficult to obtain from epidemiologic studies of human
 7 populations. Dkt. No. 440, Feb. 13, 2024, Trial Tr. at 1440:18-23 (Barone); Dkt. No. 414, Feb. 9,
 8 2024, Trial Tr. at 1173:7-13 (Savitz). In view of the record evidence, 4 mg/L as the lowest-
 9 observed-effect-level would be a conservative point of departure to utilize in the analysis; it is
 10 certainly well-supported by scientific evidence as described in the conclusion of the NTP
 11 Monograph: “the high-quality studies (*i.e.*, studies with low potential for bias) consistently
 12 demonstrate lower IQ scores with higher fluoride exposure [*e.g.*, represented by populations
 13 whose total fluoride exposure approximates or exceeds the WHO Guidelines for Drinking-water
 14 Quality of 1.5 mg/L of fluoride (WHO 2017)].” NTP Monograph at 47.

15 81. The EPA has identified a LOAEL based upon far less evidence than that in the record
 16 before this Court. In the EPA’s risk evaluation of Methylene, conducted pursuant to Amended
 17 TSCA, it used a LOAEL for developmental neurotoxicity, derived from the analysis of *one study*
 18 *conducted upon mouse pups* (Fredriksson et al., 1992). *See* Methylene Risk Evaluation at 262.
 19 Here, there are between six and nine²⁶ high-quality, epidemiological studies of human populations
 20 underlying the point of departure. Dkt. No. 431-2, Trial Ex. 68 at 39, 41 (eTable 4).

21 82. To restate, in conclusion, either the LOAEL of 4.0 mg/L, measured either in urinary
 22 fluoride or water fluoride, or the BMCL of 0.28 mg/L, 0.768 mg/L, or even 1.536 mg/L measured
 23 in maternal urinary fluoride, is a well-supported point of departure to utilize in the risk evaluation.
 24 Each of these measures of the point of departure is supported by a preponderance of high-quality
 25 evidence.

26
 27
 28 ²⁶ Six studies measuring fluoride exposure by way of water fluoride and nine studies measuring
 urinary fluoride. Dkt. No. 431-2, Trial Ex. 68 at 39, 41 (eTable 4).

1 B. Step 2: Exposure Assessment

2 a. Framework

3 83. At this step, the EPA conducts an exposure assessment to identify the exposure level under
 4 the conditions of use for the chemical at issue. Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 567:18-
 5 568:2 (Barone); 15 U.S.C. § 2605(b)(4)(F)(iv) (“In conducting a risk evaluation under this
 6 subsection, the Administrator shall . . . take into account, where relevant, the likely duration,
 7 intensity, frequency, and number of exposures under the conditions of use of the chemical
 8 substance.”). Namely, the EPA identifies sources of exposure to the chemical (*e.g.*, food or
 9 water), estimates what the intake level of exposure is, and endeavors to understand and
 10 characterize the population that is exposed. Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 694:4-695:11
 11 (Barone).

12 84. To understand the level of exposure, the EPA estimates a range of exposure levels for a
 13 condition of use from the central tendency exposure (*e.g.*, 50th percentile) to high-end exposure
 14 (*e.g.*, 95th percentile). Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 649:1-650:10 (Barone), 697:15-
 15 698:6 (Barone); *see also* EPA Guidelines at 64 (describing consideration of upper percentile
 16 exposure and highest-exposed individuals in risk assessment).

17 85. As discussed in depth in the next section (Section III.C), the exposure level is important
 18 because it is used to calculate whether the chemical presents a risk to humans. Specifically, in the
 19 next step of the analysis (risk characterization), the exposure level is compared to the point of
 20 departure to determine if a risk is present. *See* Dkt. No. 401, Feb. 6, 2024, Trial Tr. (Barone) at
 21 705:7-706:21. At that step, the EPA determines the appropriate margin that needs to exist from
 22 the point of departure (*i.e.*, point at which the chemical becomes hazardous). *See id.* This is the
 23 benchmark Margin of Exposure (“MOE”). *See id.* The benchmark MOE is calculated by
 24 multiplying the point of departure by Uncertainty Factors (“UFs”) to account for assumptions or
 25 uncertainty in the data. *See id.* The benchmark MOE is then compared to the actual MOE, *i.e.*,
 26 the existing margin between the exposure level and the point of departure, to determine if that
 27 margin is sufficient. *See id.*

b. Key findings

86. For reasons discussed below, **maternal urinary fluoride** is an appropriate metric to use in conducting the risk evaluation of fluoride under the condition of use, *i.e.*, community water fluoridation at 0.7 mg/L.

87. Pregnant mothers in fluoridated communities in the United States have a median exposure level to fluoride of **0.8 mg/L**, measured in **maternal urinary fluoride**; at the 95th percentile,²⁷ pregnant mothers have an exposure level to fluoride of **1.89 mg/L**, measured in **maternal urinary fluoride**. Approximately half of these maternal urinary fluoride levels is attributed to community water fluoridation.

88. Alternatively, the exposure levels of **0.7 mg/L**, or **0.56 mg/L** measured in **water fluoride**, is an appropriate exposure level to use in this risk evaluation.

c. Underlying findings

89. Two studies are highly probative in assessing exposure levels in this risk evaluation: Till (2018), and Malin (2023). To summarize these studies:

a. Till (2018) studied samples collected from the MIREC Cohort (1,566 pregnant women in Canada) to assess the relationship between maternal urinary fluoride in pregnant women and water fluoride concentrations and concluded that “[c]ommunity water fluoridation is a major source of fluoride exposure” for the pregnant women studied. Dkt. No. 432-4, Trial Ex. 108 at 1. Specifically, the study observed that the mean urinary fluoride values were almost two times higher for pregnant women living in fluoridated regions compared to non-fluoridated regions, and “significantly lower” for women living in non-fluoridated regions. *Id.* at 6. The median concentration of fluoride in drinking water in Canada was 0.56 mg/L in fluoridated areas. *Id.* at 8 (Table 2). Given that the United States fluoridates its water levels at an optimal 0.7 mg/L (higher than the median in Till (2018)), the urinary fluoride levels in this sample are lower, if anything, relative to the condition of use at issue (fluoridation at 0.7 mg/L). The findings of Till (2018),

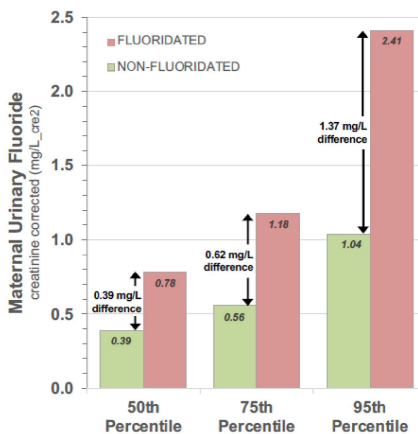
²⁷ The 95th percentile reflects individuals that have exposure levels greater than 95 percent of the population. *See* Dkt. No. 108 at 6. The median, on the other hand, reflects individuals at the mid-point of exposure. *See id.*

comparing the maternal urinary fluoride levels of pregnant women in fluoridated compared to non-fluoridated reasons are exemplified in the below tables, summarizing the key results of this study:

Table S4 Fluoride concentrations in the urine of pregnant women from the MIREC cohort living in fluoridated versus non-fluoridated communities.

	Trimester	N	Arith Mean	Arith SD	Geo Mean	Geo SD	Min	5%	25%	50%	75%	95%	Max
NON-FLUORIDATED													
MUF_Unadjusted	1	541	0.24	0.29	0.15	2.65	0.01	0.03	0.08	0.15	0.30	0.69	3.56
	2	509	0.32	0.33	0.23	2.22	0.03	0.06	0.13	0.22	0.38	0.90	3.54
	3	476	0.47	0.39	0.36	2.05	0.04	0.11	0.22	0.36	0.60	1.23	3.77
MUF ₅₀	1	541	0.31	0.39	0.20	2.56	0.01	0.04	0.12	0.20	0.35	0.84	4.67
	2	507	0.39	0.32	0.31	1.89	0.04	0.12	0.21	0.29	0.46	0.96	2.44
	3	475	0.48	0.32	0.40	1.78	0.08	0.17	0.28	0.38	0.56	1.09	2.71
MUF _{CKRL_1}	1	533	0.50	0.50	0.35	2.40	0.01	0.08	0.22	0.37	0.60	1.41	4.5
	2	502	0.58	0.44	0.48	1.85	0.06	0.19	0.31	0.46	0.69	1.47	3.31
	3 ^a	386	0.67	0.47	0.56	1.75	0.12	0.24	0.40	0.54	0.79	1.45	4.61
MUF _{CKRL_2}	1	534	0.41	0.45	0.29	2.42	0.01	0.06	0.18	0.30	0.49	1.15	4.81
	2	502	0.43	0.32	0.35	1.85	0.04	0.14	0.23	0.34	0.51	1.08	2.43
	3 ^a	386	0.48	0.33	0.40	1.75	0.08	0.17	0.29	0.39	0.56	1.04	3.29
FLUORIDATED													
MUF_Unadjusted	1	762	0.57	0.49	0.40	2.57	0.02	0.06	0.23	0.43	0.79	1.48	3.98
	2	728	0.71	0.53	0.56	2.03	0.04	0.17	0.35	0.56	0.89	1.68	3.77
	3	712	0.82	0.60	0.63	2.04	0.11	0.19	0.39	0.64	1.06	1.99	4.36
MUF ₅₀	1	762	0.52	0.46	0.37	2.44	0.01	0.07	0.25	0.4	0.64	1.30	3.84
	2	728	0.71	0.47	0.59	1.84	0.03	0.23	0.40	0.58	0.87	1.63	3.78
	3	711	0.88	0.55	0.74	1.81	0.08	0.27	0.51	0.77	1.08	1.89	3.97
MUF _{CKRL_1}	1	757	0.83	0.68	0.60	2.44	0.01	0.12	0.39	0.65	1.09	2.19	4.89
	2	723	1.13	0.77	0.93	1.91	0.05	0.32	0.61	0.91	1.42	2.63	4.89
	3 ^a	546	1.30	0.82	1.10	1.86	0.12	0.41	0.72	1.08	1.63	3.10	4.63
MUF _{CKRL_2}	1	759	0.68	0.58	0.49	2.46	0.01	0.09	0.31	0.53	0.88	1.80	4.61
	2	727	0.85	0.60	0.69	1.92	0.04	0.24	0.45	0.67	1.05	2.00	4.66
	3 ^a	553	0.97	0.68	0.80	1.90	0.09	0.29	0.52	0.78	1.18	2.41	4.78

Id. at 25 (Table S4) (red annotations added). This data is reflected in the below bar graph, illustrating that Till (2018) found that fluoride levels were approximately two times higher in fluoridated vs. non-fluoridated areas:²⁸



²⁸ Though not in evidence, the Court includes this demonstrative bar graph (presented to the Court

1 b. Malin (2023) studied the maternal urinary fluoride levels of pregnant women in
2 Los Angeles, California (*i.e.*, samples collected from the Maternal and Developmental Risks from
3 Environmental and Social Stressors cohort (“MADRES Cohort”)) to discern if those levels of
4 American women were comparable to levels observed amongst pregnant women in Mexico and
5 fluoridated communities in Canada. Dkt. No. 432-18, Trial Ex. 122 at 9. Malin (2023) concluded
6 that the maternal urinary levels observed in Los Angeles were comparable to those found in
7 pregnant women in Mexico and Canada. *Id.* at 1, 9. These findings corroborate the conclusions of
8 Till (2018), and further support that water intake is an important contributor to maternal urinary
9 fluoride levels.

10 90. Plaintiffs have shown, by a preponderance of the evidence, that a pregnant mother in the
11 United States, under the condition of use (community water fluoridation of 0.7 mg/L, which is
12 higher than the median water fluoridation levels in the Till (2018) data set of 0.56 mg/L found in
13 Canada) produces a maternal urinary fluoride concentration level of at least **0.8 mg/L** for median
14 water consumption or **1.89 mg/L** for 95th percentile water consumption.

15 a. As explained above, Till (2018) studied urinary fluoride levels in fluoridated areas
16 of Canada, and identified a median (specific gravity adjusted) urinary fluoride level of 0.77
17 mg/L and a 95th percentile urinary fluoride level of 1.89 mg/L. Dkt. No. 432-4, Trial Ex. 108 at
18 25-26 (Table S4); Dkt. No. 395, Jan. 31, 2024, Trial Tr. at 118:5-20 (Hu). Malin (2023) studied
19 pregnant mothers living in Los Angeles, California, a fluoridated city, and similarly observed that
20 those mothers had a median (specific gravity-adjusted) urinary fluoride level of 0.8 mg/L,
21 and a 95th percentile level of 1.89 mg/L, in the third trimester. Dkt. No. 432-18, Trial Ex. 122
22 at 5 (Table 2); Dkt. No. 395, Jan. 31, 2024, Trial Tr. at 124:1-16 (Hu). Dr. Hu testified credibly
23 that the Malin (2023) cohort is representative of mothers in the United States as a whole, though if
24 anything, this cohort would present *lower* fluoride exposure levels relative to other populations
25 because data indicates Hispanic communities have a greater distrust of tap water relative to other
26 communities, in part due to immigration from Mexico where tap water is distrusted. Dkt. No. 395,

27
28 _____
as Plaintiff’s Demonstrative No. 4 at trial) to illustrate fully the trial testimony.

1 Jan. 31, 2024, Trial Tr. at 118:11-119:9 (Hu). Canada and the United States each take a similar
 2 approach to water fluoridation; both countries identify 0.7 mg/L as the optimal fluoridation level.
 3 See NTP Monograph at 1; Dkt. No. 396, Feb. 1, 2024, Trial Tr. at 245:1-22 (Lanphear). It follows
 4 that pregnant woman in the United States, exposed to fluoride under the condition of use at issue
 5 (community water fluoridation at a typical or optimal level of 0.7 mg/L) have an exposure level of
 6 **0.8 mg/L measured in maternal urinary fluoride** (median water intake) and **1.89 mg/L**
 7 **measured in maternal urinary fluoride** (95th percentile water intake), urinary fluoride levels
 8 that reflect the real world results of drinking water fluoride levels at the condition of use at issue in
 9 this case.

10 b. To be sure, maternal urinary fluoride reflects not only fluoride that a pregnant
 11 woman is exposed to from drinking fluoridated water from her community (the condition of use at
 12 issue), but also fluoride from other sources such as food and beverage and household items such as
 13 toothpaste; it reflects aggregate exposure to fluoride. See Dkt. No. 395, Jan 31, 2024, Trial Tr. at
 14 105:10-25 (Hu); Dkt. No. 416, Feb. 12, 2024, Trial Tr. at 1404:19-21 (Barone); Dkt. No. 198-1
 15 (Hu Trial Decl.). The EPA argues that because maternal urinary fluoride reflects *aggregate*
 16 fluoride exposure, rather than exposure attributed solely from community water fluoridation,
 17 maternal urinary fluoride is an inappropriate metric to use in assessing the risk of community
 18 water fluoridation. However, exposure level of fluoride expressed in the metric of maternal
 19 urinary fluoride is properly used in this risk assessment because:

20 i. Maternal urinary fluoride, though not a perfect metric in all respects,
 21 is a valuable metric in assessing risk associated with water fluoridation since it is a comprehensive
 22 metric, reflecting the true aggregate exposure to the chemical at issue. As Dr. Hu explained:
 23 “[T]he primary benefit [of using urinary fluoride as the metric of fluoride exposure] is that you’re
 24 integrating fluoride exposure from whatever exposure source there is. So if it’s dietary, if it’s in
 25 the water, it’s in the food, it’s in the food that was cooked with the fluoridated water; if you
 26 happen to swallow toothpaste or if you’re using other sources of fluoride, it will integrate all of it
 27 and express it in terms of what is the level of fluoride that’s circulating in your blood and then gets
 28 filtered out into the kidneys. And that ultimately is the component of fluoride in the body that’s

1 available to cross the blood-brain barrier to the brain and also to go to other target organs in the
 2 body.” Dkt. No. 395, Jan. 31, 2024, Trial Tr. at 105:13-25 (Hu). Put differently, this metric
 3 reflects that water fluoridation does not occur in a vacuum; in the real world, fluoridating water
 4 means exposing women to fluoride *in addition to* the exposure a woman has to fluoride via other
 5 sources. Because dosage matters, it makes good sense to consider other sources of exposure to
 6 fluoride in deciding if adding to that exposure level presents a risk. *See* Dkt No. 400, Feb. 5,
 7 2024, Trial Tr. at 676:12-21 (Barone) (recognizing that exposure and point of departure can be
 8 expressed in urine content in a risk assessment); Dkt. No. 402, Feb. 8, 2024, Trial Tr. at 1015:9-
 9 1020:13 (Savitz) (discussing pros and cons of using urinary fluoride as a measurement of water
 10 fluoridation and recognizing that urinary fluoride has a “number of positive features,” including
 11 integrating exposure from different sources, that it is a measurement reflecting not just what is in
 12 that body on a given day but for a longer period of time, and explaining that he has used urinary
 13 fluoride as a metric in assessing another chemical, PFAS); Dkt. No. 401, Feb. 6, 2024, Trial Tr. at
 14 790:8-12 (Thiessen) (“there’s no scientific reason why [the exposure level and hazard level] have
 15 to be milligrams per kilogram per day. They could also be milligrams per liter in the drinking
 16 water, they could also be milligrams per liter *in the urine*”) (emphasis added).

17 ii. The EPA permits considering the *additive* risk posed by a chemical
 18 under the condition of use at issue when conducting a risk evaluation. To this end, Dr. Barone
 19 explained that in a situation where the condition of use is additive to other background sources,
 20 “you want to be able to understand, well, what’s the background, be able to subtract the
 21 background; you want to be able to say what’s the dietary component and what is the actual water
 22 intake component. And then if you have information on the other sources, potential sources,
 23 whether it’s pharmaceuticals or other inhaled or orally ingested pollutants having a similar kind of
 24 exposure, additive exposures, *you want to be able to capture that to the best of your ability.*” Dkt.
 25 No. 400, Feb. 5, 2024, Trial Tr. at 678:6-21 (Barone) (emphasis added). *See also* Dkt. No. 400,
 26 Feb. 5, 2024, Trial Tr. (Barone) at 567:18-568:2 (“Q. And the point of the exposure assessment is
 27 to identify what the human exposure level is under the specific conditions of use of the chemical
 28 being evaluated, right? A. It is – it is condition-of-use specific. Q. Now, it is condition-of-use

1 specific, but TSCA specifically permits EPA to consider aggregate exposures to the chemical,
 2 correct? A. *TSCA specifically allows for consideration of aggregate exposures*. It doesn't require
 3 us to quantify based upon aggregate exposures") (emphasis added). Indeed, rather than preventing
 4 a risk evaluator from considering aggregate exposure to a chemical in evaluating risk, Amended
 5 TSCA expressly identifies that a risk evaluator should describe whether *aggregate exposure* was
 6 considered and explain why, or why not. *See* 15 U.S.C. § 2605(b)(4)(F). Specifically, the statute
 7 provides: "[i]n conducting a risk evaluation under this subsection, the Administrator shall . . .
 8 describe *whether aggregate or sentinel exposures to a chemical substance under the conditions of*
 9 *use were considered*, and the basis for that consideration." 15 U.S.C. § 2605(b)(4)(F) (emphasis
 10 added).

11 iii. If water fluoridation was a minor contributor to overall exposure to
 12 fluoride, then it may be less appropriate to utilize an aggregate exposure metric in assessing risk of
 13 water fluoridation. If that were the case, much of the risk at issue would not derive from water
 14 fluoridation but another source; regulating water fluoridation would be of little consequence to the
 15 total exposure. But that is not the case. Instead, as described in depth below at ¶ 91(a), water
 16 fluoridation accounts for more than half of a pregnant woman's aggregate exposure level (*i.e.*,
 17 maternal urinary fluoride level). To this end, Dr. Thiessen credibly testified that fluoride content
 18 of the urine "will be driven by the fluoride content of the water," as "for most individuals, the
 19 intake is driven by the fluoridated water." Dkt. No. 402, Feb. 8, 2024, Trial Tr. at 934:18-22
 20 (Thiessen). Drinking water fluoridation is highly consequential to a pregnant woman's overall
 21 exposure level and so it is wholly appropriate to use maternal urinary fluoride as the metric of
 22 exposure in assessing the risk of community water fluoridation. *See also* Dkt. No. 401, Feb. 6,
 23 2024, Trial Tr. at 790:8-12 (Thiessen) ("[T]here's a consistent association between urinary
 24 fluoride and drinking water fluoride concentrations. As the concentration of fluoride in the
 25 drinking water increases, the fluoride concentration in the urine will increase."), 792:19-2793:16
 26 ("[I]n most cases, the primary driver of the total fluoride intake [is fluoride concentration in the
 27
 28

drinking water]. So you can still make that hazard-to-exposure comparison.”²⁹

91. To the extent that risk assessment requires determining the exposure level attributed solely to the condition of use (community water fluoridation), Plaintiffs have shown, by a preponderance of the evidence, that at least half of the maternal urinary fluoride levels observed, **0.4 mg/L** (median) (*i.e.*, 0.8 mg/L divided by two) maternal urinary fluoride and **0.945 mg/L** (95th percentile) (*i.e.*, 1.89 mg/L divided by two) maternal urinary fluoride can be attributed to the condition of use (community water fluoridation):

a. As explained above, ¶ 89(a), Till (2018) observed that the maternal urinary fluoride levels were approximately **two-times higher** for pregnant women living in fluoridated regions compared to non-fluoridated regions. Dkt. No. 432-4, Trial Ex. 108 at 6, 25-26 (Table S4). Dr. Thiessen credibly testified that it is reasonable to conclude from Till (2018) that the 2x increase in maternal urinary fluoride levels in fluoridated areas can be attributed to community water fluoridation in those areas. *See* Dkt. 401, Feb. 6, 2024, Trial Tr. at 784:1-16 (Thiessen) (“The primary difference and the only main group difference that we’re aware of is that one group is fluoridated and one is not. So a difference in the urinary fluoride would be attributable to the fluoride in the drinking water.”); Dkt. No. 402, Feb. 8, 2024, Trial Tr. at 934:18-22 (Thiessen). And the EPA’s expert witness agreed that the increase in maternal urinary fluoride levels can largely be attributed to intake of fluoridated water. Dkt. No. 416, Feb. 13, 2024, Trial Tr. at 1408:10-1409:11 (Barone) (explaining that the “parsimonious” explanation as to the 2x increase of maternal urinary fluoride levels observed in Till (2018) is that it is “due to intake, total intake,

²⁹ In Thippeswamy (2021), the researchers compared fluoride concentrations in urine, serum, and cord blood of women consuming water with designated “low” and “optimum” concentrations of fluoride to understand the relationship of these metrics. Dkt. No. 432-7, Trial Ex. 111 at 1. Thippeswamy (2021) did not observe a one-to-one correlation between urinary fluoride and water fluoride concentration, but concluded that “the low/optimum fluoride concentration in drinking water compared to urine . . . correlated significantly.” *Id.* The strong relationship between the fluoride concentration in water and urinary fluoride is further corroborated by Green (2019). Green (2019) studied samples collected from the MIREC Cohort (Canadian women and offspring) and identified a moderate correlation between maternal urinary fluoride intake and water fluoride concentration. Dkt. No. 432-5, Trial Ex. 109 at 1, 5 (“The MUF, was moderately correlated with fluoride intake ($r = 0.49$; $P < .001$) and water fluoride concentration ($r = 0.37$; $P < .001$).”). Though not a one-to-one comparison, the correlation observed in these studies further corroborates Dr. Thiessen’s testimony as to the relationship between water fluoride and urinary fluoride.

1 and that’s probably both food and water . . . [a]nd water is a significant portion . . . of that”).
 2 Moreover, water fluoridation also contributes to fluoride exposure indirectly because commercial
 3 food and beverages are made using fluoridated water; this is known in the scientific community as
 4 the “halo effect” of water fluoridation. *See, e.g.*, Dkt. No. 401, Feb. 6, 2024, Trial Tr. at
 5 799:7:800:13 (Thiessen) (describing the “halo effect” of water fluoridation wherein individuals
 6 ingest water that has been fluoridated by way of beverages such as colas, juices, beer and wine,
 7 that were made using water from a fluoridated community); Dkt. No. 396, Feb. 1, 2024, Trial Tr.
 8 at 212:7-23 (Lanphear) (describing the “halo effect” of communities that fluoridate water, causing
 9 exposure of fluoride in surrounding areas by way of food and beverage). *See also* Dkt. No. 432-4,
 10 Trial Ex. 108 at 6-7 (describing the “diffusion or halo effect” . . . “which refers to the extension of
 11 fluoridation to residents of nonfluoridated communities as a result of foods and beverages that are
 12 commercially processed in fluoridated areas and consumed in nonfluoridated communities”)
 13 (citing Griffin et al. 2001; Ripa 1993). Accordingly, it is appropriate to infer conservatively that
 14 approximately **half** of the maternal urinary fluoride observed in a pregnant woman’s urine is
 15 attributed to community water fluoridation.³⁰ Here, that is **0.4 mg/L** (0.8 mg/L divided by two)
 16 (median) maternal urinary fluoride and **0.945 mg/L** (1.89 mg/L divided by two) (95th percentile)
 17 maternal urinary fluoride.

18 b. One concern regarding extrapolating water intake from maternal urinary fluoride is
 19 that fluoride intake is not necessarily equivalent with fluoride excretion; the absorption and
 20 excretion process adds complexity. For example, a pregnant woman will experience the
 21 breakdown of her own skeleton during pregnancy to form the fetal skeleton, releasing fluoride
 22 absorbed in her bones, resulting in an increase in excretion of urine not tied to additional fluoride
 23 consumption. *See* Dkt. No. 395, Jan. 1, 2024, Trial Tr. at 121:10-20 (Hu). To this end the EPA
 24 argues that because of the complexities regarding absorption and excretion of fluoride, use of a
 25 physiologically based pharmacokinetic (“PBPK”) modeling³¹ is necessary to convert maternal

26
 27 ³⁰ As noted below in Paragraph 91(b)(i), the EPA allows for assumptions, including, *e.g.*,
 absorption rates, when specific data is not available.

28 ³¹ PBPK model is “a computer model that estimates concentrations of a substance in other parts of

1 urinary fluoride levels to estimate the fluoride intake level. Because Plaintiffs have not done
 2 PBPK modeling, EPA argues, it is inappropriate to estimate exposure attributed to the condition of
 3 use from maternal urinary fluoride. *See* Dkt. No. 402, Feb. 8, 2024, Trial Tr. at 943:1-7
 4 (Thiessen) (recognizing that PBPK models have not been identified to predict maternal urinary
 5 fluoride concentrations based on drinking water exposures.). The Court rejects the EPA's
 6 argument for the following reasons.

7 i. While PBPK modeling may be useful and perhaps ideal, it is not
 8 essential to conduct a risk evaluation. The Amended TSCA does not expressly mandate use of a
 9 PBPK model, but instead affords ample discretion in the methodologies and modeling the risk
 10 assessor may employ in assessing risk. *See* 15 U.S.C. § 2625(h) (describing factors to be
 11 considered determining the methodologies or models to employ when assessing risk and omitting
 12 any reference to a PBPK model).³² And the EPA Guidelines expressly recognize that
 13 pharmacokinetic data may not always be available and instructs a risk assessor to be aware of
 14

15 the body based on physiological parameters like absorption" and is used to convert from excretion
 16 level to intake level. *See* Dkt. No. 402, Feb. 8, 2024, Trial Tr. at 943:1-7 (Thiessen).

17 ³² This section provides in full:

18 In carrying out sections 2603, 2604, and 2605 of this title, to the
 19 extent that the Administrator makes a decision based on science, the
 20 Administrator shall use scientific information, technical procedures,
 21 measures, methods, protocols, methodologies, or models, employed
 22 in a manner consistent with the best available science, and shall
 23 consider as applicable – (1) the extent to which the scientific
 24 information, technical procedures, measures, methods, protocols,
 25 methodologies, or models employed to generate the information are
 26 reasonable for and consistent with the intended use of the
 27 information; (2) the extent to which the information is relevant for
 28 the Administrator's use in making a decision about a chemical
 substance or mixture; (3) the degree of clarity and completeness
 with which the data, assumptions, methods, quality assurance, and
 analyses employed to generate the information are documented; (4)
 the extent to which the variability and uncertainty in the
 information, or in the procedures, measures, methods, protocols,
 methodologies, or models, are evaluated and characterized; and (5)
 the extent of independent verification or peer review of the
 information or of the procedures, measures, methods, protocols,
 methodologies, or models.

15 U.S.C. § 2625(h).

1 uncertainties posed by lack of such data. Specifically, the EPA Guidelines provide: “If data to be
 2 used in a risk characterization are from a route of exposure other than the expected human
 3 exposure, then pharmacokinetic data should be used, if available, to make extrapolations across
 4 routes of exposure. If such data are not available, the Agency makes certain assumptions
 5 concerning the amount of absorption likely or the applicability of the data from one route to
 6 another (U.S. EPA, 1992).” EPA Guidelines at 62. This is an implicit recognition that a risk
 7 evaluation can proceed without pharmacokinetic modeling when such data is not available. *See*
 8 *also* EPA Guidelines at 47 (“Pharmacokinetic data *may* be helpful in defining the dose-response
 9 curve, developing a more accurate basis for comparing species sensitivity (including that of
 10 humans), determining dosimetry at sites, and comparing pharmacokinetic profiles for various
 11 dosing regimens or routes of administration. The correlation of pharmacokinetic parameters and
 12 neurotoxicity data *may* be useful in determining the contribution of specific pharmacokinetic
 13 processes to the effects observed.”) (emphasis added). Dr. Barone likewise testified that the EPA
 14 has conducted risk evaluations under Amended TSCA without PBPK modeling as such models are
 15 not always available, explaining: “[w]e used PBPK models in five of the first [ten] risk
 16 evaluations. And to varying degrees . . . In some cases we actually had the ability to . . .
 17 incorporate studies that included oral exposures, inhalation exposures and dermal exposures . . . so
 18 we could look at a wider range of exposures and to do that aggregation of exposures across routes.
 19 That’s not always available to us, we don’t always have those kinds of models available to us.”
 20 Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 675:9-676:7 (Barone). *See also* Dkt. No. 401, Feb. 6,
 21 2024, Trial Tr. at 576:12-17 (Barone), 578:8-10 (Barone) (“Q. And in EPA’s 10 risk evaluations
 22 under TSCA, EPA has only departed from using the default uncertainty factor of 10 for
 23 intraspecies variability when it had an acceptable physiologically-based pharmacokinetic model
 24 for the chemical, correct? A. In the first ten that is a true statement.”). Put simply, this lack of
 25 PBPK modeling is not fatal to Plaintiffs’ proof.

26 ii. Though Plaintiffs do not present a PBPK model, Till (2018) and
 27 Malin (2023) provide real-world, observational data as to the exposure level of for the population
 28 at issue under the condition of use at issue. *See* ¶ 90. *See also* Dkt. No. 400, Feb. 5, 2024, Trial

Tr. at 678:6-21 (Barone) (describing that in assessing risk under a condition of use one endeavors to subtract the background exposure from the water intake component to understand the risk at issue, ideally through modeling, but ultimately “to the best of your ability”). And uncertainties posed by lack of modeling may be accounted for in subsequent steps of the analysis (*i.e.*, assessing overall confidence in data in the risk characterization, *see* ¶¶ 112-13 and when determining the appropriate uncertainty factor to employ when assessing the margin of exposure, *see* ¶ 101(b)). Under the present circumstances, there is sufficient data to support the exposure levels identifies notwithstanding lack of PBPK modeling.³³

iii. As stated above, Till (2018) observed an approximately 2x increase in maternal urinary fluoride levels comparing the mothers in fluoridated relative to non-fluoridated communities across three trimesters of pregnancy. *See* Trial Ex. 108, Dkt. No. 432-4 at 6-7, 8-9; Dkt. No. 432-18, Trial Ex. 122 at 5-6 (Table 2 and Fig. 1). However, Till (2018) and Malin (2023) also observed that pregnant women’s maternal urinary fluoride levels increased in *both* fluoridated and non-fluoridated areas in the third trimester of pregnancy relative to the first trimester. *See* Dkt. No. 432-4, Trial Ex. 108 at 8-9, Table 3; Dkt. No. 432-18, Trial Ex. 122, at 5-6 (Table 2 and Fig. 1). This would, at first blush, suggest that something other than fluoridated water contributed to increased maternal urinary fluoride levels in the third trimester, undermining the assumption that fluoridated water is a significant contributor to those levels. However, this observation is well accounted for. As explained previously, the increase in maternal urinary fluoride across both populations in the third trimester of pregnancy is believed to be caused by the breakdown of the maternal skeleton in later trimesters of pregnancy to facilitate the formation of the fetal bone – a process that releases fluoride. *See, e.g.*, Dkt. No. 395, Jan. 1, 2024, Trial Tr. at 121:10-20, 121:25-123:8 (Hu). This observation thus does not undermine the probative value of

³³ Though EPA does not bear the burden of proof in this context the Court does note that EPA has not explained why, if PBPK modeling is necessary to understand risk associated with water fluoridation and appropriate models are available, the EPA has not itself conducted this PBPK modeling. This is not legally relevant given the statutory framework, and does not bear on the Court’s findings. However, to the extent that the EPA determines that PBPK modeling is necessary to engage in rulemaking, it may conduct this assessment to put a finer point on risk posed by the condition of use before taking regulatory action; there is nothing preventing EPA from doing so.

1 Till (2018) and Malin (2023).

2 92. The present recommended water fluoride concentration in the United States is 0.7 mg/L
3 fluoride. NTP Monograph at 1. It follows that pregnant women living in a fluoridated community
4 in the United States are typically exposed to fluoride levels of **0.7 mg/L** fluoride, measured in
5 water fluoridation. Even more conservatively, the Till (2018) median water fluoride level of **0.56**
6 **mg/L** measured in water fluoride is also an appropriate, conservative exposure level to utilize in
7 the risk evaluation. This is because the United States and Canada (where data for Till (2018) was
8 collected) take a similar approach to water fluoridation. *See* Dkt. No. 433-4, Trial Ex. 129 at 16
9 (describing optimal water fluoride levels in Canada of 0.7 mg/L); Dkt. No. 396, Feb. 1, 2024 Trial
10 Tr. at 245:1-22 (Lanphear) (describing optimal 0.7 mg/L water fluoride standard in Canada).
11 Moreover, urinary fluoride levels in mothers from Los Angeles observed in Malin (2023) and Till
12 (2018) are highly similar. *See* Dkt. No. 432-18, Trial Ex. 122 at 1, 9.

13 93. The EPA often expresses exposure and hazard level in mg/kg/day, but this is not
14 necessary. What is vital, however, is that the exposure level and hazard level is in the same unit.
15 Dkt. No. 400, Feb. 5, 2024, Trial Tr. (Barone) at 672:22-673:4 (testifying that what matters is that
16 the “[e]xposure concentration in the denominator has to be in the same units as the hazard point of
17 departure or hazard level in the numerator[;] [t]hey have to match up”). Dr. Thiessen likewise
18 testified that “there’s no scientific reason why [the hazard and exposure levels] have to be
19 milligrams per kilogram per day. They could also be milligrams per liter in the drinking water,
20 they could also be milligrams per liter in the urine. What matters is comparison of a hazard level
21 and exposure level that are in the same units.” Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 790:18-
22 791:16 (Thiessen). Thus, the exposure and hazard level need not be expressed in mg/kg/day, but
23 the units for each must match when conducting subsequent steps of the analysis.

24 94. For the reasons stated above, and in view of the record evidence, Plaintiffs have shown by
25 a preponderance of the evidence that:

26 a. Pregnant mothers in fluoridated communities in the United States are typically
27 exposed to fluoridation of drinking water at a concentration level of **0.7 mg/L**, or conservatively,
28 **0.56 mg/L**. They have a median exposure level to fluoride of **0.8 mg/L** (measured in maternal

1 urinary fluoride), and at the 95th percentile have an exposure level to fluoride of **1.89 mg/L**
 2 (measured in maternal urinary fluoride).

3 b. To the extent that the exposure level used in this risk assessment must reflect
 4 exposure attributed solely to the condition of use of the chemical, approximately half of the
 5 maternal urinary fluoride levels discussed in Paragraph 87 are attributed to water fluoridation.

6 C. Step 3: Risk Characterization

7 a. Framework

8 95. At this step, the EPA calculates the risk presented by the chemical at issue by comparing
 9 the point of departure (*i.e.*, hazard level) with the human exposure level. *See* Dkt. No. 401, Feb. 6,
 10 2024, Trial Tr. at 705:7-706:21 (Barone). To ensure a risk is not present, the EPA utilizes a
 11 Margin of Exposure (MOE) equation that compares a safe margin from the point of departure
 12 (benchmark MOE) with the actual margin between the exposure level and point of departure
 13 (MOE). *See id.* at 707:13-708:19.

14 96. The actual MOE is calculated by discerning the ratio of the point of departure and the
 15 human exposure level, *i.e.*, the point of departure divided by the exposure level. Dkt. No. 429-7,
 16 Trial Ex. 17 at 65. The benchmark MOE (*i.e.*, the safe or requisite margin) is the product of the
 17 applicable uncertainty factors (UFs) (*i.e.*, UF x UF). *See id.* at 2-3; Dkt. No. 400, Feb. 5, 2024,
 18 Trial Tr. at 575:17-576:24 (Barone), 580:10-13 (Barone) (“Q. Now, the benchmark MOE is the
 19 product of all uncertainty factors that are found to be applicable to a given – to a given hazard,
 20 correct? A. To a given hazard, that’s correct.”), 580:24-581:19 (Barone) (“We don’t add them.
 21 We multiply – if the uncertainty factor is the default of 10 for human variability, then we use that
 22 and multiply is by any other uncertainty factors.”). For example, if there is an uncertainty factor
 23 of 10 for intraspecies variability, and an uncertainty factor of 10 for using a LOAEL as the point
 24 of departure, the benchmark MOE is 100 (10 times 10). *Id.* at 581:12-582:11. As another
 25 example, if the first uncertainty factor is 10, and the second uncertainty factor is 3, the benchmark
 26 MOE is 30 (10 times 3). *Id.*

27 97. If the actual MOE is lesser (*i.e.*, there is a smaller margin) than the benchmark MOE, then
 28 there is a risk present; if the actual MOE is greater (*i.e.*, there is a bigger margin) than the

1 benchmark MOE then a risk is presumed not to be present. *See* Dkt. No. 400, Feb. 5, 2024, Trial
2 Tr. at 583:8-13 (Barone) (explaining that if the benchmark MOE exceeds the MOE between the
3 hazard and exposure level a risk is present); Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 707:20-708:9
4 (Barone) (explaining the converse).

5 b. Key findings

6 98. A risk is present when using the BMCL of 0.28 mg/L (maternal urinary fluoride) as the
7 point of departure, and whether calculating risk using either the median or high-end exposure
8 levels; the exposure levels exceed the point of departure.

9 99. A risk is present when using the BMCL of 0.768 mg/L or even 1.536 mg/L (maternal
10 urinary fluoride) as the point of departure, whether calculating risk using either the median or
11 high-end exposure levels; the exposure levels exceed the point of departure.

12 100. Alternatively, a risk is present when utilizing the conservative 4 mg/L (water
13 fluoride) as the point of departure; the actual MOE is less than the benchmark MOE.

14 c. Underlying findings

15 (a) BMCL: 0.28 mg/L and in the alternative, 0.768 mg/L and/or 1.536
16 mg/L (maternal urinary fluoride)

17 101. The appropriate benchmark MOE to use in calculating risk for the BMCLs
18 identified by Dr. Grandjean is 10, which includes at least one UF of 10 to account for intraspecies
19 variability:

20 a. A UF of 10 is utilized as a default practice in calculating risk to account for
21 intraspecies variability, *i.e.*, the variability within the human species in reacting to chemicals.³⁴
22 *See* Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 712:12-713:22 (Barone).

23 b. Absent use of physiologically based pharmacokinetic (PBPK) modeling to account
24 for those variabilities, which could allow for the reduction of the UF from 10 down to 3, the EPA
25 applies the UF of 10 in calculating the benchmark MOE. *See id.* at 712:24-713:22; Dkt. No. 401,
26

27 ³⁴ Intraspecies variability can be compared with interspecies variability, which accounts for
28 variability between different species (*i.e.*, animals and humans) when extrapolating from
animal studies. Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 713:6-10 (Barone).

1 Feb. 6, 2024, Trial Tr. at 576:12-17 (Barone), 578:8-10 (Barone) (“Q. So the default uncertainty
2 factor that EPA uses to account for intraspecies variability and uncertainty is 10, correct? A. That
3 is the default. Q. And in EPA’s 10 risk evaluations under TSCA, EPA has only departed from
4 using the default uncertainty factor of 10 for intraspecies variability when it had an acceptable
5 physiologically-based pharmacokinetic model for the chemical, correct? A. In the first ten that is
6 a true statement.”).

7 c. A PBPK model has not been performed to assess fluoride intake in pregnant
8 women. Dkt. No. 402, Feb. 8, 2024, Trial Tr. at 943:1-16 (Thiessen); Dkt. No. 440, Feb. 13,
9 2024, Trial Tr. at 1396:17-1397:2 (Barone), 1397:20-23 (Barone) (“Q. And so in the nearly four
10 years since the first trial in this case, plaintiffs still have not performed a PBPK model to extract a
11 urinary fluoride value to an intake value, right? A. No, they haven’t.”).

12 d. Because there is no PBPK model utilized here, which would decrease uncertainty
13 and allow from a downward departure of the default UF of 10, the default UF of 10 is
14 appropriately used as the benchmark MOE in the present risk evaluation.

15 102. The median exposure level for pregnant women measured in urinary fluoride is 0.8
16 mg/L, and the 95th percentile is 1.89 mg/L. *See* ¶ 87.

17 103. The actual MOE for the BMCL of 0.28 mg/L at the median exposure level is 0.35
18 (0.28 mg/L divided by 0.8 mg/L) and 0.148 at the 95th percentile exposure level (0.28 mg/L
19 divided by 1.89 mg/L). The actual MOEs, 0.35 and 0.148, do not exceed the benchmark MOE of
20 10; thus, the MOE is below the benchmark MOE and a risk is present. *See* Dkt. No. 401, Feb. 6,
21 2024, Trial Tr. at 707:20-708:9 (Barone) (explaining that a risk is not present where the actual
22 MOE is *higher* than the benchmark MOE). Another way of looking at exposure/risk is taking the
23 BMCL and adjusting it downward for risk factors. To account for a ten-fold risk factor of human
24 variability, actual exposure should not exceed 1/10th of the BMCL of 0.28 mg/L – *i.e.*, 0.028
25 mg/L. However, the trial evidence establishes actual exposure of levels of 0.8 and 1.89 mg/L –
26 this far exceeds that safety limit of 0.028 mg/L. *See also* Dkt. No. 198-4 at 75-77 (Thiessen Decl.)
27 (providing MOE calculations).

28 104. The actual MOE for the BMCL of 0.768 mg/L at the median exposure level is 0.96

(0.768 mg/L divided by 0.8 mg/L) and 0.406 at the 95th percentile exposure level (0.768 mg/L divided by 1.89 mg/L). The actual MOEs, 0.96 and 0.406, do not exceed the benchmark MOE of 10; thus, the MOE is below the benchmark MOE and a risk is present. *See* Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 707:20-708:9 (Barone). *See also* Dkt. No. 198-4 at 75-77 (Thiessen Decl.) (providing MOE calculations). Put differently, 1/10th of this BMCL is 0.0768 mg/L (0.768 mg/L divided by 10). Both the median and upper exposure levels of fluoride found in mothers' urine exceed this amount.

105. Even using the higher 1.536 mg/L BMCL to account for omission of the OCC Cohort data, *see* ¶ 73 (discussing exclusion of OCC Cohort data in deriving 0.768 mg/L BMCL using squared model in Grandjean (2022)), a risk is present. Using this figure, the actual MOE at the median exposure level is 1.92 (1.536 mg/L divided by 0.8 mg/L) and 0.813 at the 95th percentile exposure level (1.536 mg/L divided by 1.89 mg/L). 1.92 and 0.813 do not exceed 10; thus, the actual MOE is below the benchmark MOE and a risk is present. *See* Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 707:20-708:9 (Barone). *See also* Dkt. No. 198-4 at 75-77 (Thiessen Decl.) (providing MOE calculations). Put differently, 1/10th of this BMCL is 0.1536 mg/L (1.536 mg/L divided by 10). Both the median and upper exposure levels in mothers' urine exceed this amount.

106. Even if the Court were to consider only half of the exposure level, directly attributable to water fluoridation, as opposed to other sources of fluoride (0.4 mg/L (0.8 mg/L divided by 2) (median) maternal urinary fluoride and 0.945 mg/L (1.89 mg/L divided by 2) (95th percentile) maternal urinary fluoride, a risk is still present. Both of these figures exceed the safe level using a BMCL of 0.28 mg/L (0.028 mg/L). *See* ¶ 103. And these figures also exceed the safe level considering the margin of error if the BMCL of 0.768 mg/L or 1.536 mg/L; the safe levels are 0.0768 mg/L and 0.1536 mg/L (1/10th of each BMCL), respectively. *See* ¶¶ 104-05.

(b) LOAL: 4 mg/L (water fluoride)

107. Alternatively, to the extent that the BMCLs identified previously are not appropriate points of departure, or maternal urinary fluoride is not an appropriate metric, a risk is present using a LOAL of 4 mg/L measured in water fluoride.

108. The appropriate UF applied in the benchmark MOE analysis using the LOAEL of 4

1 mg/L is 100 (10 x 10):

2 a. The UF of 10 is appropriately applied to account for intraspecies variability.

3 *See* ¶ 101.

4 b. A second UF of 10 is also appropriately applied when using a LOAEL as the point
5 of departure. Dkt. No. 440, Feb. 13, 2024, Trial Tr. at 1425:13-17 (Barone) (“Q. Right. If we
6 were using a human study and only had a LOAEL, like was the case with PCE, you would, at that
7 point, consider an additional uncertainty factor beyond the intraspecies variability uncertainty
8 factor? A. Generally, yes. Yes, we would.”).

9 c. Again, the benchmark MOE is calculated by multiplying the applicable UFs. Dkt.
10 No. 400, Feb. 5, 2024, Trial Tr. at 575:17-576:24 (Barone), 580:10-13 (Barone) (explaining that
11 the benchmark MOE is the product of applicable UFs), 580:24-581:19 (stating that “[w]e don’t
12 add them[;] [w]e multiply”).

13 109. Pregnant women in “optimally” fluoridated communities in the United States have
14 an exposure level of at least 0.7 mg/L (water fluoride). *See* ¶ 86. Or conservatively, 0.56 mg/L
15 derived from Till (2018), in the alternative. *See* ¶ 89(a).

16 110. The actual MOE for the LOAEL of 4 mg/L (water fluoride) is 5.71 (4 mg/L divided
17 by 0.7 mg/L) or 7.14 (4 mg/L divided by 0.56 mg/L).

18 111. 5.71 and/or 7.14 do not exceed 100; the actual MOE is below the benchmark MOE
19 and thus a risk is present. Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 583:8-13 (Barone) (explaining
20 that if the benchmark MOE exceeds the MOE between the hazard and exposure level a risk is
21 present). *See also* Dkt. No. 198-4 at 75-77 (Thiessen Decl.) (providing MOE calculations).
22 Again, another way of looking at this is to take the LOAEL of 4 mg/L, and divide that by the two
23 risk factors. To this end, 4 mg/L divided by 100 equals 0.04 mg/L, reflecting the tolerable
24 concentration of exposure given the risk factors. Exposure to 0.7 mg/L in United States drinking
25 water, or conservatively 0.56 mg/L (Till (2018)),³⁵ far exceeds that limit.

26
27 ³⁵ The condition of use at issue in this suit is fluoridation of water at 0.7 mg/L. However, it is
28 useful to consider the risk posed with the lesser exposure level of 0.56 mg/L given the findings of
Till (2018). There, subjects in Canada – which has the same optimal level of water fluoridation as
the United States – had a median community water fluoride level of 0.56 mg/L. It follows that

1 D. Step 4: Risk Determination2 a. Framework

3 112. Once the risk has been identified, in the last step of the risk evaluation process the
4 assessor determines if that risk is an *unreasonable* one. Dkt. No. 401, Feb. 6, 2024, Trial Tr. at
5 735:11-19 (Barone).

6 113. In making the determination of whether the risk is unreasonable, the assessor
7 considers several factors including: (1) severity of the hazard; (2) exposure-related considerations
8 (*e.g.*, duration, magnitude, or frequency of the exposure, and size of the affected population); (3)
9 other characteristics of the population that is exposed, including the susceptibility of
10 subpopulations; (4) confidence in the information used to inform the hazard and exposure values;
11 and relatedly, the (5) overall strength of the evidence and uncertainties and assumptions included
12 throughout the risk assessment. *See* Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 735:11-736:19
13 (Barone); Dkt No. 437-1, Trial Ex. 96, at 500 (PCE Risk Evaluation); Dkt. No. 437-3, Trial Ex.
14 98 at 271 (1,4-Dioxane Risk Evaluation).

15 b. Key finding

16 114. Based on the aforementioned factors, and in view of the record evidence, the risk at
17 issue – reduced IQ in children posed by water fluoridation at 0.7 mg/L – is an unreasonable risk.

18 c. Underlying findings

19 115. Given the seriousness of reduced IQ, and the ample support in the record that the
20 United States population is at risk of experiencing IQ decrements of over four IQ points, the
21 **severity** of the hazard at issue (reduced IQ in children, *see* Section III.A.1.), weighs in favor of
22 finding the risk at issue unreasonable:

23 a. The EPA has recognized that cognitive deficits including reduced IQ are critical
24 chronic health effects, as exemplified by its in its risk evaluation of PCE under the Amended
25 TSCA which identified cognitive deficits as the hazard warranting regulatory action. Dkt. No.

26
27
28 some communities in the United States may have similar median water fluoridation levels. Thus,
it is worth considering if a risk is present at this lower level of exposure, to understand the risk of
setting an optimal fluoridation level of 0.7 mg/L as is the standard in the United States.

400, Feb. 5, 2024, Trial Tr. at 597:9-13 (Barone). Moreover, according to the EPA’s Clean Air Science Advisory Commission, in the context of its analysis of lead: “[a] population loss of 1-2 IQ points is highly significant from a public health perspective.” Dkt. No. 430-1, Trial Ex. 42 at 67000. To this end, a 1-to-2 point loss in IQ was the hazard that supported the identification of lead as a substance posing an unreasonable risk. *Id.* See also Dkt. No. 433-4, Trial Ex. 129 at 27 (recognizing that one study found that a reduction of one IQ point “has been shown to be associated with reduced educational attainment, employment status, productivity, and earned wages, reflecting substantial public health concerns”).

b. In risk assessments, the EPA evaluates not only the hazard presented at median exposures levels, but considered the hazard posed to the 95th percentile (*i.e.*, high exposure populations). Dkt. No. 430-1, Trial Ex. 42 at 67000. And the EPA considers impact upon smaller, susceptible subpopulations in assessing the risk at issue. See Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 587:7-18 (Barone) (testifying that the EPA considered impact on small, susceptible subgroup of population in regulating lead).

c. As Dr. Grandjean explained, women in the 95th percentile exposure level to fluoride exceed the BMCL for a 1-point loss in IQ by over a factor of four. See Dkt. No. 397, Feb. 2, 2024, Trial Tr. at 358:2-18 (Grandjean). Indeed, when considering high-end exposure levels, relative to Dr. Grandjean’s BMCL identifying the dosage at which a 1-point IQ decrement is expected, fluoride presents a risk of a decrease in IQ ranging from 2.86 to 6.75 IQ points.³⁶

116. **Exposure-related considerations** (*e.g.*, duration, magnitude, or frequency of the exposure, and size of the affected population) weighs heavily toward finding the risk at issue unreasonable; the exposure is continuous, and nearly all Americans are affected.

³⁶ According to Dr. Grandjean’s analysis, an increase of 0.28 mg/L of fluoride exposure (measured in maternal urinary fluoride) is associated with a 1-point IQ loss in the mother’s offspring (boys and girls). See Dkt. No. 432-15, Trial Ex. 119 (Grandjean (2023)) at 1-2, 9. Pregnant mothers in fluoridated communities in the United States have a median and 95th percentile exposure level to fluoride of 0.8 mg/L and 1.89 mg/L, respectively (measured in maternal urinary fluoride). See ¶¶ 86-88; Trial Ex. 122, Dkt. No. 432-18 at, Trial Ex. 122 at 9. Thus, fluoride presents a hazard of reduced IQ ranging from approximately 2.86 points at the median intake level, ((0.8 mg/L (median exposure level) divided by 0.28 mg/L (dosage at which 1 IQ point decrease is observed)), *i.e.*, 2.857) to 6.75 points at the 95th percentile ((1.89 mg/L (95th percentile exposure level) divided by 0.28 mg/L (dosage at which 1 IQ point decrease is observed)), *i.e.*, 6.75).

117. The size of the affected population is vast. Approximately 200 million Americans have fluoride intentionally added to their drinking water at a concentration of 0.7 mg/L. *See* Dkt. No. 421 at 206-07 (undisputed). Other Americans are indirectly exposed to fluoridated water through consumption of commercial beverages and food manufactured with fluoridated water (*i.e.*, the “halo effect”). *See, e.g.*, Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 799:7:800:13 (Thiessen) (describing the “halo effect” of water fluoridation); Dkt. No. 396, Feb. 1, 2024, Trial Tr. at 212:7-23 (Lanphear) (similar). *See also* Dkt. No. 432-4, Trial Ex. 108 at 6-7 (describing the “diffusion or halo effect” . . . “which refers to the extension of fluoridation to residents of nonfluoridated communities as a result of foods and beverages that are commercially processed in fluoridated areas and consumed in nonfluoridated communities”) (citing Griffin et al. 2001; Ripa 1993). Approximately two million pregnant women, and over 300,000 exclusively formula-fed babies are exposed to fluoridated water. Dkt. No. 421 at 209-210. *See also* Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 815:6-816:23 (Thiessen). The number of pregnant women and formula-fed babies alone who are exposed to water fluoridation each year exceeds entire populations exposed to conditions of use for which EPA has found unreasonable risk; the EPA has found risks unreasonable where the population impacted was less than 500 people. *See* Dkt. No. 400, Feb. 5, 2024, Trial Tr. at 588:11-15 (Barone) (testifying that under TSCA the EPA had made unreasonable risk determinations for conditions of use that involve less than 500 people, and that “many are less than 500 people”). *See also* Dkt. No. 421 at 209-210 (EPA agreeing that “the exposed population for the condition of use of community water fluoridation exceeds the exposed populations of the first ten risk evaluations under Amended TSCA”).

a. Individuals are exposed to fluoride through water intake every day; the parties do not dispute that frequency of exposure for most people is several times daily (*i.e.*, through drinking tap water). Dkt. No. 421 at 207 (undisputed).

b. And the duration of exposure to fluoridated water is continuous with its effects long-lasting. *See* Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 813:18-20 (Thiessen) (describing that exposure to community water fluoridation is intended to be lifelong). To this end, fluoride remains in the body through years; for several years after cessation of fluoride exposure a woman

1 is likely to release fluoride into blood due to skeletal breakdown. Dkt. No. 397, Jan. 31, 2024,
2 Trial Tr. at 370:6-371:12 (Grandjean); Dkt. No. 402, Feb. 8, 2024, Trial Tr. at 932:16-20
3 (Thiessen).

4 118. The **susceptibility** of exposed populations weighs heavily toward finding the risk at
5 issue unreasonable. It is undisputed that large numbers of susceptible individuals are being
6 exposed each year to fluoride through fluoridation, namely, approximately two million **pregnant**
7 **women**, and over 300,000 exclusively formula-fed **babies**. Dkt. No. 421 at 209-210. *See also*
8 Dkt. No. 401, Feb. 6, 2024, Trial Tr. at 815:6-816:23 (Thiessen).

9 119. The scientific literature in the record provides a high level of certainty that a hazard
10 is present; fluoride is associated with reduced IQ. There are uncertainties presented by the
11 underlying data regarding the appropriate point of departure and exposure level to utilize in this
12 risk evaluation. But those uncertainties do not undermine the finding of an unreasonable risk; in
13 every scenario utilizing any of the various possible points of departures, exposure levels and
14 metrics, a risk is present in view of the applicable uncertainty factors that apply:

15 a. Regarding the point of departure, as discussed above, there is some uncertainty
16 regarding the appropriate point of departure to utilize. Specifically, there is lack of certainty
17 regarding the model fit to be utilized in the BMD modeling analysis, which determines the BMCL
18 to utilize as a point of departure. *See* ¶ 72 (discussing use of linear vs. squared model to derive
19 BMCL). However, under either scenario (whether using a linear or squared model), there is an
20 insufficient safety margin between the exposure level and hazard level; a risk is present. *See* ¶¶
21 102-106. Even assuming BMD modeling cannot be used for the data set and using a highly
22 conservative LOAEL of 4 mg/L, a risk remains present by a substantial margin. *See* ¶¶ 107-111.
23 Accordingly, the uncertainty regarding the point of departure (hazard level) is ultimately not
24 consequential to the conclusion herein. The EPA has deemed a risk unreasonable even where it
25 lacked high confidence in the hazard data. *See* Dkt. No. 421 at 211 (undisputed).

26 b. Regarding the exposure level, there is uncertainty presented by the fact that a
27 PBPK model was not utilized to determine the precise amount of fluoride reflected in pregnant
28 women's maternal urinary fluoride levels that derives from fluoridated water. *See* ¶ 91(b).

1 Uncertainty due to lack of modeling is offset by the fact that it is appropriate to view risk
 2 presented by water fluoridation in context of its additive effects on aggregate exposure, which is
 3 best reflected by real world maternal urinary fluoride levels. *See* ¶¶ 89-90. And this is
 4 particularly true where, as here, water fluoridation is known to be a significant contributor to
 5 maternal urinary fluoride levels, and indeed functions roughly as a 2x multiplier to those levels.
 6 *See id.* Further, here, there is real-world observational data showing what the maternal urinary
 7 fluoride levels of women that live in communities with fluoridation levels comparable to that of
 8 the United States; this data makes the PBPK model less critical to the analysis. *See* ¶¶ 89-91. The
 9 uncertainty from the lack of PBPK model weighs against finding the risk unreasonable, but not
 10 strongly so due to these mitigating circumstances. Moreover, when utilizing the conservative
 11 LOAEL as a point of departure, that metric is derived from water fluoride intake, and does not
 12 present the same uncertainty posed by using maternal urinary fluoride levels as the metric of
 13 hazard and exposure. Finally, the EPA has deemed a risk unreasonable even where it lacked high
 14 confidence in the exposure data. *See* Dkt. No. 421 at 211 (undisputed).

15 c. There is significant *certainty* in the data set regarding the association between
 16 fluoride and reduced IQ. Namely, there is a robust body of evidence finding a statistically
 17 significant adverse association between fluoride and IQ. A large majority of the 72
 18 epidemiological studies assessed by the NTP Monograph observed this relationship including all
 19 but one of the 19 high-quality studies, *see* ¶¶ 34-36, and literature published after the NTP
 20 Monograph cutoff date observed the same relationship, *see* ¶ 37 – and countervailing evidence, for
 21 various reasons described previously, are of little impact on this repeated, and consistently
 22 observed association between fluoride and reduced IQ, *see* ¶ 39. Moreover, complete consistency
 23 amongst studies is not expected. *See* Dkt. No. 414, Feb. 9, 20240, Trial Tr. at 1172:23-1173:6
 24 (Savitz). Notably, notwithstanding inherent difficulties in observing this association at lower
 25 exposure levels, studies assessing such levels still observed a statistically significant relationship
 26 between fluoride and reduced IQ. *See* ¶¶ 42-44. Again, to put the breadth of evidence supporting
 27 this finding in perspective, the EPA has identified a LOAEL based upon far less in other contexts.
 28 For instance, in the EPA’s risk evaluation of Methylene, conducted pursuant to Amended TSCA,

1 the EPA used a LOAEL for developmental neurotoxicity, derived from the analysis of *one study*
 2 *conducted upon mouse pups* (Fredriksson et al., 1992). *See* Methylene Risk Evaluation at 262.
 3 Compare this with 6 (water fluoride) and 9 (urinary fluoride), high-quality, epidemiological
 4 studies of human populations underling the 4 mg/L LOAEL underlying the POD here. Dkt. No.
 5 431-2, Trial Ex. 68 at 39, 41 (eTable 4). The scientific literature in the record provides a high
 6 level of certainty that a hazard is present; fluoride is associated with reduced IQ. The qualitative
 7 evidence is superior.

8 120. In sum, the first three factors weigh toward finding the risk unreasonable. Namely,
 9 the severity of the hazard weighs toward finding the risk unreasonable. The exposure-related
 10 considerations and exposure of susceptible populations weighs *strongly* toward finding the risk
 11 unreasonable; millions of susceptible individuals are exposed to fluoride and the exposure is
 12 frequent and long-lasting. The two final factors, confidence in hazard data and overall strength of
 13 the evidence and uncertainties, are largely neutral. Because the first three factors weigh strongly
 14 toward finding the risk unreasonable and the last two are largely neutral, the totality of the factors
 15 establish that the risk is unreasonable under the Amended TSCA. The Court thus finds that the
 16 Plaintiffs have established by a preponderance of the evidence that the risk at issue is
 17 **unreasonable.**

18 **IV. CONCLUSIONS OF LAW**

19 121. Plaintiffs have proven, by a preponderance of the evidence, that water fluoridation
 20 at the level of 0.7 mg/L – the prescribed optimal level of fluoridation in the United States –
 21 presents an “unreasonable risk of injury to health or the environment, without consideration of
 22 costs or other non-risk factors, including an unreasonable risk to a potentially exposed or
 23 susceptible subpopulation under the conditions of use.” 15 U.S.C. § 2620(b)(4)(B)(ii).

24 122. The Court thus orders the Administrator to initiate rulemaking pursuant to
 25 Subsection 6(a) of TSCA. *See id.* §§ 2605(a), 2620(a).

26 123. The Court defers ruling as to whether Plaintiffs are entitled to recovery of their
 27 costs of suit and attorneys and expert witness fees. Parties are ordered to submit a proposed
 28 supplemental briefing schedule regarding costs and fees within two weeks of the date of this order.

1 Defendant shall respond two weeks thereafter. The Court will take the matter under submission
2 unless it orders a hearing.

3
4 The Clerk of Court is directed to enter judgment in Plaintiffs' favor.

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6 **IT IS SO ORDERED.**

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8 Dated: September 24, 2024

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11 EDWARD M. CHEN
12 United States District Judge
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United States District Court
Northern District of California



Cochrane Database of Systematic Reviews

Water fluoridation for the prevention of dental caries (Review)

Iheozor-Ejiofor Z, Walsh T, Lewis SR, Riley P, Boyers D, Clarkson JE, Worthington HV, Glenny AM, O'Malley L

Iheozor-Ejiofor Z, Walsh T, Lewis SR, Riley P, Boyers D, Clarkson JE, Worthington HV, Glenny A-M, O'Malley L.
Water fluoridation for the prevention of dental caries.
Cochrane Database of Systematic Reviews 2024, Issue 10. Art. No.: CD010856.
DOI: [pd.pdd2up4N1p818.\(\)dpd81N.0](https://doi.org/10.1002/14651406.CD010856).

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Water fluoridation for the prevention of dental caries (Review)

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WILEY

[Intervention Review]**Water fluoridation for the prevention of dental caries**

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Editorial group: Cochrane Oral Health Group.

Publication status and date: New search for studies and content updated (conclusions changed), published in Issue 10, 2024.

Citation: Iheozor-Ejiofor Z, Walsh T, Lewis SR, Riley P, Boyers D, Clarkson JE, Worthington HV, Glenn A-M, O'Malley L. Water fluoridation for the prevention of dental caries. *Cochrane Database of Systematic Reviews* 2024, Issue 10. Art. No.: CD010856. DOI: [pdd2up4N1p818.1](https://doi.org/10.1002/pdd2up4N1p818.1) [dpd81N.1](https://doi.org/10.1002/dpd81N.1).

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ABSTRACT**Background**

Dental caries is a major public health problem in most industrialised countries, affecting 60% to 90% of school children. Community water fluoridation (CWF) is currently practised in about 25 countries; health authorities consider it to be a key strategy for preventing dental caries. CWF is of interest to health professionals, policymakers and the public. This is an update of a Cochrane review first published in 2015, focusing on contemporary evidence about the effects of CWF on dental caries.

Objectives

To evaluate the effects of initiation or cessation of CWF programmes for the prevention of dental caries.

To evaluate the association of water fluoridation (artificial or natural) with dental fluorosis.

Search methods

We searched CENTRAL, MEDLINE, Embase and four other databases up to 16 August 2023. We also searched two clinical trials registers and conducted backward citation searches.

Selection criteria

We included populations of all ages.

For our first objective (effects of initiation or cessation of CWF programmes on dental caries), we included prospective controlled studies comparing populations receiving fluoridated water with those receiving non-fluoridated or naturally low-fluoridated water. To evaluate change in caries status, studies measured caries both within three years of a change in fluoridation status and at the end of study follow-up.

For our second objective (association of water fluoridation with dental fluorosis), we included any study design, with concurrent control, comparing populations exposed to different water fluoride concentrations. In this update, we did not search for or include new evidence for this objective.

Data collection and analysis

We used standard methodological procedures expected by Cochrane.

For our first objective, we included the following outcomes as change from baseline: decayed, missing or filled teeth ('dmft' for primary and 'DMFT' for permanent teeth); decayed, missing or filled tooth surfaces ('dmfs' for primary and 'DMFS' for permanent teeth); proportion of

Water fluoridation for the prevention of dental caries (Review)**1**

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caries-free participants for both primary and permanent dentition; adverse events. We stratified the results of the meta-analyses according to whether data were collected before or after the widespread use of fluoride toothpaste in 1975.

For our second objective, we included dental fluorosis (of aesthetic concern, or any level of fluorosis), and any other adverse events reported by the included studies.

Main results

We included 157 studies. All used non-randomised designs. Given the inherent risks of bias in these designs, particularly related to management of confounding factors and blinding of outcome assessors, we downgraded the certainty of all evidence for these risks. We downgraded some evidence for imprecision, inconsistency or both. Evidence from older studies may not be applicable to contemporary societies, and we downgraded older evidence for indirectness.

Water fluoridation initiation (21 studies)

Based on contemporary evidence (after 1975), the initiation of CWF may lead to a slightly greater change in dmft over time (mean difference (MD) 0.24, 95% confidence interval (CI) -0.03 to 0.52; $P = 0.09$; 2 studies, 2908 children; low-certainty evidence). This equates to a difference in dmft of approximately one-quarter of a tooth in favour of CWF; this effect estimate includes the possibility of benefit and no benefit. Contemporary evidence (after 1975) was also available for change in DMFT (4 studies, 2856 children) and change in DMFS (1 study, 343 children); we were very uncertain of these findings.

CWF may lead to a slightly greater change over time in the proportion of caries-free children with primary dentition (MD -0.04, 95% CI -0.09 to 0.01; $P = 0.12$; 2 studies, 2908 children), and permanent dentition (MD -0.03, 95% CI -0.07 to 0.01; $P = 0.14$; 2 studies, 2348 children). These low-certainty findings (a 4 percentage point difference and 3 percentage point difference for primary and permanent dentition, respectively) favoured CWF. These effect estimates include the possibility of benefit and no benefit. No contemporary data were available for adverse effects.

Because of very low-certainty evidence, we were unsure of the size of effects of CWF when using older evidence (from 1975 or earlier) on all outcomes: change in dmft (5 studies, 5709 children), change in DMFT (3 studies, 5623 children), change in proportion of caries-free children with primary dentition (5 studies, 6278 children) or permanent dentition (4 studies, 6219 children), or adverse effects (2 studies, 7800 children).

Only one study, conducted after 1975, reported disparities according to socioeconomic status, with no evidence that deprivation influenced the relationship between water exposure and caries status.

Water fluoridation cessation (1 study)

Because of very low-certainty evidence, we could not determine if the cessation of CWF affected DMFS (1 study conducted after 1975; 2994 children). Data were not available for other review outcomes for this comparison.

Association of water fluoridation with dental fluorosis (135 studies)

The previous version of this review found low-certainty evidence that fluoridated water may be associated with dental fluorosis. With a fluoride level of 0.7 parts per million (ppm), approximately 12% of participants had fluorosis of aesthetic concern (95% CI 8% to 17%; 40 studies, 59,630 participants), and approximately 40% had fluorosis of any level (95% CI 35% to 44%; 90 studies, 180,530 participants). Because of very low-certainty evidence, we were unsure of other adverse effects (including skeletal fluorosis, bone fractures and skeletal maturity; 5 studies, incomplete participant numbers).

Authors' conclusions

Contemporary studies indicate that initiation of CWF may lead to a slightly greater reduction in dmft and may lead to a slightly greater increase in the proportion of caries-free children, but with smaller effect sizes than pre-1975 studies. There is insufficient evidence to determine the effect of cessation of CWF on caries and whether water fluoridation results in a change in disparities in caries according to socioeconomic status. We found no eligible studies that report caries outcomes in adults.

The implementation or cessation of CWF requires careful consideration of this current evidence, in the broader context of a population's oral health, diet and consumption of tap water, movement or migration, and the availability and uptake of other caries-prevention strategies. Acceptability, cost-effectiveness and feasibility of the implementation and monitoring of a CWF programme should also be taken into account.

PLAIN LANGUAGE SUMMARY

Does adding fluoride to water supplies prevent tooth decay?

Key messages

Water fluoridation for the prevention of dental caries (Review)

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- Adding fluoride to water supplies may lead to slightly less tooth decay in children's baby teeth.
- It may also lead to slightly more children being free of tooth decay.
- The benefits of fluoride in water supplies may be smaller than they were before the widespread addition of fluoride to toothpaste.

Tooth decay and the use of fluoride

Tooth decay is a worldwide problem affecting most adults and children. Untreated decay may cause pain and lead to teeth having to be removed.

Fluoride is a mineral which occurs naturally in water at different concentrations. It prevents tooth decay. Since 1975, fluoride has been an ingredient in most toothpastes. It is available in some mouth-rinses, and dentists use treatments that contain fluoride. It is possible to add fluoride to the local water supply. In this case, everyone in a community will have access to fluoride.

If young children swallow too much fluoride while their permanent teeth are forming, marks may develop on those teeth – this is called dental fluorosis. This can be very mild, with barely noticeable white lines or streaks. Rarely, some fluorosis is more noticeable, and people can dislike how their teeth look.

What did we want to find out?

We wanted to find out if water with added fluoride in the local water supply is better than water without added fluoride at:

- reducing the number of teeth, or tooth surfaces, with signs of decay;
- increasing the number of people who have no tooth decay.

We also wanted to find out about unwanted effects.

What did we do?

We searched for studies comparing communities that had fluoride added to their water supplies with communities that had no additional fluoride in their water.

The last time we published this Cochrane review, we also searched for studies that reported dental fluorosis and the concentration of fluoride in the water. Because the association of fluoridated water with dental fluorosis is widely accepted, we did not update the evidence on this occasion.

What did we find?

We found 21 studies that assessed the effects of adding fluoride to a water supply. We also found one study that assessed the effects of stopping artificially-added fluoride in a water supply. Studies only measured tooth decay in children.

In the last version of the review – not updated on this occasion – we found 135 studies that assessed the association of fluoridated water with dental fluorosis.

Main results

Studies conducted after 1975 showed that adding fluoride to water may lead to slightly less tooth decay in children's baby teeth. We could not be sure whether adding fluoride to water reduced tooth decay in children's permanent teeth or decay on the surfaces of permanent teeth.

Adding fluoride to water may slightly increase the number of children who have no tooth decay in either their baby teeth or permanent teeth. However, these results also included the possibility of little or no difference in tooth decay.

Studies conducted in 1975 or earlier showed a clear and important effect on prevention of tooth decay in children. However, due to the increased availability of fluoride in toothpaste since 1975, it is unlikely that we will see this effect in all populations today.

We were unsure whether there were any effects on tooth decay when fluoride is removed from a water supply.

We were unsure if fluoride reduces differences in tooth decay between richer and poorer people.

In the last version of the review, we found that adding fluoride to water supplies increases the number of people with dental fluorosis. If water contains 0.7 mg/L of fluoride, about 12% of people may have dental fluorosis that causes them to be bothered about how their teeth look, and about 40% of people may have dental fluorosis of any level. We were unsure whether fluoride in water leads to other unwanted effects.

What are the limitations of the evidence?

Our confidence in the evidence is limited because this review included studies in which communities were deliberately selected to have changes to fluoride levels in the water supply. Although a common study approach for this topic, it can mean that there are differences between communities that might affect the results. In addition, the findings in some studies were different from others, and some results included the possibility of benefit and no benefit.

Older studies were conducted before the widespread use of fluoride toothpaste and other improvements in tooth decay prevention. This meant we could not tell if these results were applicable to current times. However, they may still be relevant to countries in which tooth decay is very high and people don't have easy access to fluoride toothpaste and other prevention strategies.

How current is this evidence?

For the effects of water fluoridation on tooth decay, this review updates our previous review and the evidence is current to August 2023.

For the association of fluoridated water with dental fluorosis, the review evidence is current to February 2015.

Abstract for MGRAPH-08

NTP Monograph on the State of the Science Concerning Fluoride Exposure and Neurodevelopment and Cognition: A Systematic Review

Report Date: August 2024

Background

Fluoride is a common exposure in our environment that comes from a variety of sources and is widely promoted for its dental and overall oral health benefits. Contributions to an individual's total exposure come primarily from fluoride in drinking water, food, beverages and dental products. A 2006 evaluation by the National Research Council (NRC) found support for an association between consumption of high levels of naturally occurring fluoride in drinking water and adverse neurological effects in humans and recommended further investigation. The evidence reviewed at that time was from dental and skeletal fluorosis-endemic regions of China. Since the NRC evaluation, the number and location of studies examining cognitive and neurobehavioral effects of fluoride in humans have grown considerably, including several recent North American prospective cohort studies evaluating prenatal fluoride exposure.

In 2016, the National Toxicology Program (NTP) published a systematic review of the evidence from experimental animal studies on the effects of fluoride on learning and memory. That systematic review found a low-to-moderate level of evidence that deficits in learning and memory occur in non-human mammals exposed to fluoride.

Objective

To conduct a systematic review of the human, experimental animal, and mechanistic literature to evaluate the extent and quality of the evidence linking fluoride exposure to neurodevelopmental and cognitive effects in humans.

Method

A systematic review protocol was developed and utilized following the standardized OHAT systematic review approach for conducting literature-based health assessments. This monograph presents the current state of evidence associating fluoride exposure with cognitive or neurodevelopmental health effects and incorporated predefined assessments of study quality and confidence levels. Benefits of fluoride with respect to oral health are not addressed in this monograph.

Results

The bodies of experimental animal studies and human mechanistic evidence do not provide clarity on the association between fluoride exposure and cognitive or neurodevelopmental human health effects. Human mechanistic studies were too heterogeneous and limited in number to make any determination on biological plausibility.

This systematic review identified studies that assessed the association between estimated fluoride exposure and cognitive or neurodevelopmental effects in both adults and children, which were evaluated separately. The most common exposure assessment measures were drinking water concentrations and estimates of total fluoride exposure, as reflected in biomarkers such as urinary fluoride. In adults, only two high-quality cross-sectional studies

examining cognitive effects were available. The literature in children was more extensive and was separated into studies assessing intelligence quotient (IQ) and studies assessing other cognitive or neurodevelopmental outcomes. Eight of nine high-quality studies examining other cognitive or neurodevelopmental outcomes reported associations with estimated fluoride exposure. Seventy-two studies assessed the association between fluoride exposure and IQ in children. Nineteen of those studies were considered to be high quality; of these, 18 reported an inverse association between estimated fluoride exposure and IQ in children. The 18 studies, which include 3 prospective cohort studies and 15 cross-sectional studies, were conducted in 5 different countries. Forty-six of the 53 low-quality studies in children also found evidence of an inverse association between estimated fluoride exposure and IQ in children.

Discussion

Existing animal studies provide little insight into the question of whether fluoride exposure affects IQ. In addition, studies that evaluated fluoride exposure and mechanistic data in humans were too heterogeneous and limited in number to make any determination on biological plausibility. The body of evidence from studies in adults is also limited and provides low confidence that fluoride exposure is associated with adverse effects on adult cognition. There is, however, a large body of evidence on associations between fluoride exposure and IQ in children. There is also some evidence that fluoride exposure is associated with other neurodevelopmental and cognitive effects in children; although, because of the heterogeneity of the outcomes, there is low confidence in the literature for these other effects. This review finds, with moderate confidence, that higher estimated fluoride exposures (e.g., as in approximations of exposure such as drinking water fluoride concentrations that exceed the World Health Organization Guidelines for Drinking-water Quality of 1.5 mg/L of fluoride) are consistently associated with lower IQ in children. More studies are needed to fully understand the potential for lower fluoride exposure to affect children's IQ.

National Toxicology Program (NTP). 2024. NTP monograph on the state of the science concerning fluoride exposure and neurodevelopment and cognition: a systematic review. Research Triangle Park, NC: National Toxicology Program. NTP Monograph 08. <https://doi.org/10.22427/NTP-MGRAPH-8>

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7 October 2024

Ref: H2024052572



Tēnā koe 

Thank you for your email of 27 September 2024 to the Director-General of Health, Dr Diana Sarfati, regarding a United States court judgment relating to community water fluoridation. The Director-General has asked that I respond to you directly.

The Director-General is aware of the recent decision of the US District Court for the Northern District of California.

As was required by the New Zealand High Court, the Director-General is undertaking a Bill of Rights analysis of the 2022 directions to fluoridate to ensure that section 11 of the New Zealand Bill of Rights Act 1990 is considered. The directions to fluoridate remain in place in accordance with High Court rulings.

As was outlined in my previous response to you, the World Health Organization and other international and national health and scientific experts endorse water fluoridation as a safe and effective public health measure for preventing dental decay. A 2014 report conducted by Royal Society Te Apārangi, jointly with the Office of the Prime Minister's Chief Science Advisor, concluded that there are no adverse health effects of any significance from fluoridation at the level used in New Zealand. In June 2021, the Office of the Prime Minister's Chief Science Advisor released an evidence update confirming this conclusion. These reviews are publicly available at:
www.pmcasa.ac.nz/topics/fluoridation-an-update-on-evidence/

Nāku noa, nā



Jane Chambers
Group Manager Public Health Policy and Regulation
Public Health Agency | Te Pou Hauora Tūmatanui

**IN THE HIGH COURT OF NEW ZEALAND
WELLINGTON REGISTRY**

**I TE KŌTI MATUA O AOTEAROA
TE WHANGANUI-A-TARA ROHE**

**CIV-2023-485-330
[2024] NZHC 1717**

UNDER	the Judicial Review Procedure Act 2016 and Part 30 of the High Court Rules
IN THE MATTER	of an application for judicial review of directions made by the Director-General of Health under section 116E(1) of the Health Act 1956
BETWEEN	NEW HEALTH NEW ZEALAND INCORPORATED Applicant
AND	DIRECTOR-GENERAL OF HEALTH First Respondent ATTORNEY-GENERAL Second Respondent

Hearing:	Teleconference on 26 June 2024 at 10 am
Counsel:	L M Hansen and C F J Reid for Applicant J N E Varuhas and R E R Gavey for First and Second Respondents
Judgment:	26 June 2024

JUDGMENT OF RADICH J

[1] In my judgment on relief in this proceeding of 16 February 2024, I made an order under s 17(3) of the Judicial Review Procedure Act 2016 directing the Director-General to reconsider and determine the decision described in [1] of my first decision in the proceeding.¹

¹ *New Health New Zealand Inc v Director-General of Health* [2024] NZHC 196 at [31].

[2] In [33] of that decision, I observed that, in accordance with s 17(6) of the Judicial Review Procedure Act, the decision to be reconsidered continues to have effect. In that paragraph I went on to say:

It is not in my view an appropriate case for an interim order to be made and, for the reasons given, I do not see additional relief under s 16 of the Judicial Review Procedure Act as being warranted.

[3] Despite those findings, on 4 June 2024, the applicant sought, in a memorandum, interim orders under s 15(3) of the Judicial Review Procedure Act to prevent the first respondent taking any further action in relation to the directions to the 14 local authorities to fluoridate that are in question. Interim orders were sought, also, declaring that the first respondent not to instigate or continue any proceedings in connection with any matter to which the application relates pending completion of the reconsideration I had directed.

[4] Following the respondents' response to that memorandum, the applicant adjusted its position and filed, instead, an 'interlocutory application for recall of judgment and further interim orders' on 18 June 2024. That application seeks orders:

- (a) That my judgment on relief of 16 February 2024 be recalled.
- (b) That paragraph [33] of that decision be amended to reserve leave to the applicant to apply for further directions and/or interim orders.
- (c) That consequential on (b), the reconsideration process on the part of the first respondent be timetabled.
- (d) By way of declaration, that the first respondent ought not to institute any proceedings in connection with any council that does not comply with any direction unless and until the first respondent has undertaken a reconsideration and determined that a direction is a reasonable limit on the right to refuse medical treatment.

[5] At this morning's teleconference on the applicant's application, timetabling directions were made for a hearing of the application on 9 August 2024.²

[6] In the meantime, the applicant seeks an interim declaration in the nature of that described in [4(d)] above pending further consideration of the issue at the 9 August hearing. That application is opposed by the respondents. In support of the application for what is essentially an interim declaration under s 15(3) of the Judicial Review Procedure Act, Ms Hansen said that it would be wrong in principle for the Director-General to take action against a council until the reconsideration process had been carried out. She said that, if the Director-General was not constrained, a risk of predetermination in the reconsideration process would arise.

[7] In circumstances in which a failure to comply with a direction of the Director-General to fluoridate is a statutory offence, giving rise to a fine of up to \$200,000, it is said that the position should effectively be held at least until the 9 August hearing.³

[8] Mr Varuhas, for the respondents, opposed the application on the basis that it is at odds with my previous decisions, that the first respondent is actively complying with the orders that have been made, that the first respondent's directions remain valid in the meantime⁴ and that there is no indication that the Director-General would take enforcement action in relation to the directions.

[9] At the conclusion of this morning's teleconference, I said that I would not be making the interim declarations sought.

[10] The starting point is that, in [33] of my 16 February 2024 decision, having considered the position, I concluded that it was not appropriate in this case for an interim order to be made. The applicant seeks, through the recall application, to have that conclusion altered. That application is yet to be considered but at this stage I do not see a basis to make such a material change to the decision on relief.

² Those directions are the subject of a separate minute.

³ Reference was made, by way of example, to the Waitaki District Council which, it is said, has a 28 June deadline to comply with the Director-General's directions.

⁴ Reference having been made by both parties to the decision of La Hood J in *Fluoride Action Network (NZ) Inc v Hastings District Council* [2024] NZHC 1313

[11] Moreover, as has been said for the respondents, there has been no indication that the Director-General would take enforcement action and the Director-General has not taken any such action. Mr Varuhas put it on the basis that at this stage the Director-General is taking an educative approach. Any decision on enforcement action would need to be informed by the Solicitor-General's guidelines. In the event that enforcement action was threatened, then the most appropriate course would be for any council affected to seek interim orders.

[12] Accordingly, I do not at this stage see a sufficient position on the part of the applicants that needs to be preserved. In addition, I do not see the applicant's case on the interim declaration sought to be sufficiently strong and, moreover, I do not see the balance of convenience or the overall justice of the current position to favour the applicant.

[13] Whether there is a basis for the 16 February 2024 decision to be recalled so that a form of interim order or declaration could be made will be the subject of the hearing on 9 August 2024.

Radich J

Solicitors:
Maxwell Law, Wellington for Plaintiff
Crown Law, Wellington for First and Second Defendants