



Longview named one of the top ten prettiest towns in America by Forbes - March 29, 2012

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September 25, 2014

Sam Wardle
2440 Ocean Beach Hwy
Longview, WA 98632

Subject: Response to One Resident's Questions about "Fact Sheet: Silica"

Dear Mr. Wardle,

The following information is provided in response to your letter received August 8, 2013. For clarity, I am including the fact sheet statements cited in your letter followed by your comments in italics and my responses in bold italics. The context of your letter is repeated exactly as written in the original letter; grammatical errors have not been corrected so as not to misconstrue your comments.

BACKGROUND

The Fact Sheet was initiated by the City of Longview when the city asked "a team of health science experts to review water quality data and determine whether some of the components of Longview's drinking water might have health impacts". The document "was prepared by Intertox, Inc., a Seattle company, for the City of Longview customers...."

Unfortunately, neither the team of experts nor the data provided to them is identified. It has to be assumed by the reader that the author, Intertox, comprised the "team of experts" and silica was the "some of the components". If this is true, city staff neither drafted nor edited any of the language in the Fact Sheet so responsibility for any errors, if any, would lie with Intertox, Residents can read the Fact Sheet for themselves and decide whether, or not, it is objective.

The City initiated a rigorous Distribution System Sampling Program in August, 2013 to test our drinking water on a weekly basis for (22) analytes at (23) locations within the distribution system including the Mint Farm Regional Water Treatment Plant. Water sampling and data compilation was performed by City staff; analyte testing was performed by City staff and ALS Environmental. The City provided 7-months of this data to Intertox, Inc. for an independent health based risk assessment and invited outside discussion

between Intertox, Inc. and Confluence Engineers. To ensure specific concerns that had been raised in the community were addressed and discussed in simple terms, City staff reviewed the Fact Sheets for efficacy and grammar, but Intertox, Inc. is solely responsible for their content, accuracy and objectivity.

SCIENTIFIC CLAIMS

1. In terms of "How is silica measured", the Fact Sheet states that silica particulates, colloids, or dissolved forms in water are measured in milligrams per liter (mg/L).

The Fact Sheet fails to address what effects, if any, different forms of silica in water can have once they are introduced into drinking water. The impression is that the different forms of silica make no difference although there is no referenced source for this implied conclusion.

This statement is simply identifying the units in which silica is measured, regardless of its form. All of the silica measured in our drinking water is present in dissolved form. Including information in the Fact Sheet about other forms of silica that are not present in our water is extraneous and unnecessarily confusing to the reader.

2. Under the heading "What is the silica concentration in drinking water in Longview, the Fact Sheet states, "Data from water sampling from August 2013 to March 2014 at 23 locations in Longview show an average silica concentration of 59 mg/L. Silica concentrations ranged from 38 mg/L to 92 mg/L.

The Fact Sheet fails to compare the 23 test results against wells from other regions. In general, drinking water in Europe and America contains from 2 to 5 mg silicon/L. Food Standards Agency, "Review of Silicon Expert Group on Vitamins and Minerals", pg. 1, (2001). If the Longview samples are correct, they appear to be shockingly high.

For example, while the subject of the Fact Sheet was limited to health risks from silica in drinking water, the impression given to the reader is that Longview silica levels are normal is misleading at best. Dave Peairs, technical director, for Cal Water, authored a paper titled "Silica Over-Saturation, Precipitation, Prevention and Remediation In Hot Water Systems" (www.cal-water.com/pdf/Silica_scaling_Remediation). In his introduction Peairs states, "The greatest silica values are typically found in well water supplies, with wells in the California Central Valley being the most notorious in the United States, showing levels in the range of 20 to 60 milligrams per liter (mg L)." (emphasis added)

With apologies for transgressing from the topic of health effects but within the scope of silica concentrations, the reader is strongly urged to review a technical paper (www.gewater.com/kcpguestlsa/esedge!documents!Technical%20Papers_Cust!Americas) prepared by General Electric who had to remedy a water treatment plant that relied upon high silica feed water from wells drilled in volcanic soils. In "Reverse Osmosis in Pre Treatment of High Silica Waters", a team of engineers and scientists recount a troubling scenario that appears identical to Longview's problem with the irreversible consequences of "glassing".

The silica levels in our water are high; it would not have been necessary to publish a fact sheet otherwise. But the Fact Sheet does not cite any references to indicate or imply what levels of silica are considered "normal" so it is unclear how you concluded the Fact Sheet to be misleading. Data regarding silica concentrations is not available on the USGS website and most water systems do not report silica levels, but we have conducted some research to compare the City of Longview with other drinking water systems and sources in the Pacific Northwest.

City of Everett, WA: 4 mg/L (2013)

City of Kelso, WA: 19.5 mg/L (2014)

City of Vancouver, WA: 56 mg/L (1993)

Nob Hill Water, Yakima WA: 73.4 mg/L (2008)

Cowlitz River, River Mile 5.4: 24 mg/L (2009)

At the end of the same paragraph, the Fact Sheet states, "Some bottled waters contain up to 92 mg/L silica."

To insert the bottled water comparison is questionable. It would help if these presumed mineral bottled waters were named. Do customers drink those bottled waters in the same amount as Longview customers drink tap water? Are these bottled waters used for cooking? Is this mineral water exposed to chlorine?

The reference to bottled water is appropriate because customers opposed to our water have stated emphatically that they now resort to bottled water for drinking, cooking, brushing teeth, watering animals, etc. with the belief that bottled water is better for their health when, in fact, the silica levels may be higher in certain bottled waters.

Fiji bottled water contains 99 mg/L of silica (FIJI Water Company Bottled Water Quality Report, Report Date: June 2014, Sampling Period: January, 2014, Reference Report #420033). Additional information is available at <http://www.fijiwater.com/faqs/>.

The silica levels reported for Longview are post-chlorination and exist as dissolved, reactive silica. Your letter implies some negative reaction due to exposure of silica to chlorine – what is the basis for this? Please provide a reference suggesting possible reactions with chlorine.

Silicon can react with chlorine to produce silicon tetrachloride. This reaction can occur when silica is in the presence of carbon but only at temperatures above 1000° F.
<http://pubs.acs.org/doi/abs/10.1021/ie00101a011?journalCode=iecred>

3. Admittedly, our government does not publish recommend daily allowances for silica in drinking water, but the Fact Sheet states, "The Food Standards Agency of Great Britain derived a safe upper level for daily consumption of silica over a lifetime of 25 mg per kilogram (kg) body weight per day (equivalent to about 1500 mg/day for an average adult)."

The source for these statistics is found at footnote 4 of the Fact Sheet, "Food Standards Agency, 2003, Upper Levels for Vitamins and Minerals. Expert Group on Vitamins and Minerals, from <http://cot.food.gov.uk/pdfs/vitmin2003.pdf>." While no page number is given in the footnote, the relevant portion of the agency's report relating to silica begins on page 306. The statistics cited are found on page 312 and are taken from a study Takasawa et al. did 25 years ago on rats. The very important point the Fact Sheet misses is that the report dealt with safe levels of supplemental vitamins and minerals sold to people and not dietary silica ingested through food and drinking water. Additionally, it appears that Takasawa concluded that for supplemental purposes, the upper limit is 700 mg. per day for an "average person" and not 1500 mg. per day as the Fact Sheet states.

The Takizawa study (misspelled as Takasawa in your letter) was a dietary feeding study in mice and rats. The Food Standards Agency used the study to derive a Safe Upper Level for Daily Consumption over a lifetime. While it's true the purpose of the document was to derive safe levels for dietary supplements, the calculation is the same to determine safe levels for other exposures (i.e., food or water). In other words, the calculation used to derive the Safe Upper Level derived by FSA is that same as would be used by the EPA to establish an oral reference dose. <http://www.epa.gov/iris/rfd.htm>

Support for this argument is found In an article published by the University of Hawaii in it's technical magazine for sports and fitness professionals, NutritionA TC .. The authors, under the heading "How much is too much?": reported the same conclusion on the safe upper limits for silicon, namely, 700 mg/day with a note that high intake of silicon can possibly lead to kidney stones. They relied on the same article cited in the Fact Sheet. <http://www.nutritionatc.hawaii.edu/IUL.htm>. How could Intertox make such mistakes by not recognizing the upper level at 700 mg/day and then only as a measure for supplements and not normal dietary intake?

Here and elsewhere, it appears you are confusing "silicon" with "silica". One must multiply mg/L of silicon (Si) by two to get mg/L of silica (SiO₂). Our data is reported as silica (SiO₂). The 1500 mg/day safe upper level for daily consumption over a lifetime refers to silica (SiO₂), which is equivalent to 700 mg/day of silicon (Si). The information provided in the fact sheet is correct.

In addition, the article you reference stating the Safe Upper Limit for Silicon is 700 mg/day contains a footnote which states "These are intended to be levels of daily intake of nutrients in dietary supplements that potentially susceptible individuals could take daily on a life-long basis without medical supervision in reasonable safety... SULs and Guidance Levels tend to be conservative and it is possible that, for some vitamins and minerals, greater amounts could be consumed for short periods without risk to health."

In the table under "Selected Potential Effects of Excess Intake" it states "Low toxicity; possibility of kidney stones". No reference is given. The wording of the table suggests that kidney stones could be a possible adverse effect at levels ABOVE 700 mg/day silicon (equal to 1500 mg/day silica).

In 2002, The American Journal of Clinical Nutrition reported on an lengthy English study on the dietary intake and absorption of silicon. The study concluded that the mean silicon dietary intake levels for men were between approximately 20 to 50 mg/d depending on sex and age. <http://ajcn.nutrition.org/content/75/5/887>. At a more pedestrian website, Fine Waters which appears to be an industry promotional site for bottled waters, we read under silica, {{Most adults need between twenty and thirty milligrams of silica daily If bottled waters contain any silica, it's usually less than 20 mg/l, and the higher levels in waters such as Fiji and Antipodes are well below 100 mg/l." http://www.finewaters.com/Minera/_Water!Uncatergorized

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If the city's statements in the Fact Sheet as to intake are incorrect, it is difficult to imagine how a company of Intertox's reputation could make or pass on such mistakes. While doubtful, the Fact Sheet may have accurately presented the Takasawa study, but at a minimum some clarification or explanation appears to be needed.

The paragraph on daily allowances ends with the comparison of one glass of Longview tap water with a level of 22 mg/L versus the silica levels of certain foods and admits that one glass would be equivalent to a certain number of servings of different foods.

The table provided in the Fact Sheet reveals that for every glass of water with the silica /eve/listed, a person would have to eat approximately 3 servings of dried fruit or 4 cups of cereal. Any cursory reading of scientific studies on dietary silica leads to the immediate conclusion that a normal diet anticipates a far higher intake of silica from food rather than drinking water. What studies support the inverse silica intake ratio that the Fact Sheet sublimely implicates for Longview users?

In most cases, intake of silica from food is likely higher than that from water. At the average silica level measured in our water (59 mg/L), a person who drinks a typical amount of water per day (2 liters/day) will get 118 mg/day of silica from drinking water. If a person consumed the maximum concentration ever measured in our water every day (92 mg/L), which is highly unlikely day after day, the amount from drinking water would be 184 mg/day silica. This is far below the safe intake level from the FSA of 1500 mg/day silica. Even if a person is exposed to silica in food from cereals, dried fruits, vegetables and other sources, the total daily intake is unlikely to add up to this value. Mean daily silicon intakes from diet were reported at 30-33 mg/day for men and 24-25 mg/day for women (equivalent to about 64-70 mg/day silica for men and 51-53 mg/day silica for women). (Jugdaohsingh et al. 2002 <http://ajcn.nutrition.org/content/75/5/887.long>)

Any substance can produce an adverse health effect at a sufficient level of exposure. For example, at high levels of exposure to magnesium trisilicate (historically used as an antacid,) infrequent development of kidney stones has been reported. However, this is a different form of silica (Mg₂O₈Si₃) and is insoluble in water. Substantial data have

reported no adverse health effects from daily exposure to soluble silica in water and food (FSA). Refer to the following publications for more information:

<http://www.ncbi.nlm.nih.gov/pubmed/6088815>

<http://www.ncbi.nlm.nih.gov/pubmed/8394600>

http://lib.njutc.edu.cn/yaodian/ep/EP501E/16_monographs/18_monographs_1-p/magnesium_trisilicate/0403e.pdf.

4. The final paragraphs of the Fact Sheet state essentially that there are no ill affects from the intake of silica and that there are no side affects reported. Additionally it is safe for infants.

*Studies on animals which have been deliberately deprived of all silicon confirms that silicon is essential to bone growth and tissue connectivity. "Deficiencies of silicon have not been observed in man." Food Standards Agency, "Review of Silicon": Expert Group on Vitamins and Minerals, pg. 4, (2001). As to the absorption of silicon by the body, the key is directly linked to how soluble the silica is with dissolved silicon in water the most absorbable. *ibid.*,p.5*

According to the publisher, The National Academy of Sciences presented an "authoritative series on ... dietary reference intakes": and the academy said it best at page 502, when the authors summarized, "At present such data do[es] not exist for .. silicon" to establish a recommended daily allowance. National Research Council, "Dietary Reference Intakes for ... Silicon ... ": National Academies Press (2001). Consequently, it may be irresponsible for the Fact Sheet to claim no ill affects. The possibility of kidney stones has already been pointed out.

If such a basic question has not been authoritatively answered, what about the more complicated issues? For example what happens, if anything, to colloidal silica when the water has been chlorinated resulting in a higher ph? What is the health affects, if any, of drinking water where the colloidal silica has polymerized in the supply lines? Nobody apparently knows the answers to these questions and yet opinions are plentiful including the administration of such high levels of silicon to infants and the young.

The target pH of our water system is 7.7. Silica solubility and speciation are largely independent of pH below a pH of 9. Based on analysis performed by the City, our consultants, and the EPA laboratory, there is no indication that colloidal silica is present in the water. Water samples used to analyze the forms of silica were taken across the distribution system after contact time in the water mains.

No known data on adverse effects from oral or dermal exposure to silica are available - for any population.

CONCLUSION

There must be many other questions that this brief paper has not asked. But the silica levels in our water already affect our fellow citizens quality of life, particularly, in their faith in

their city leaders. But the relevant inquiry in this paper is limited to, "Is the Fact Sheet accurate? If not, what is going to be done about it?"

I sincerely hope for Longview water users, I am proven to be mistaken.

I hope this letter helps correct your misunderstandings about the form of silica present in our water, potential impacts of chlorination, and mischaracterization of the level of silica in our water as "shockingly high". Your confusion about the unit conversion between silicon and silica suggests the information presented in the various documents cited in your letter is not comparable.

Longview's water contains dissolved silica, which does not react with chlorine under our system conditions. While silica levels in Longview's water may be high, some bottled waters and public water systems contain silica at levels exceeding ours.

The data presented in the Silica Fact Sheet is factually correct.

If you have any additional questions regarding the fact sheets or the information provided in this letter, feel free to contact me at 360.442.5206 or amy.blain@ci.longview.wa.us.

Best regards,



Amy Blain, P.E.
Civil Engineer

cc: Longview City Council
Bob Gregory, City Manager
David Campbell, Assistant City Manager

ONE RESIDENT'S QUESTIONS ABOUT "FACT SHEET: SILICA"

INTRODUCTION

The purpose of this paper is to review the statements made in the Fact Sheet found on Longview's website which was prepared for the ostensible purpose of informing water customers about the silica (silicon dioxide) levels in their drinking water. This outline will examine statements made in each paragraph followed in *italics* by issues or questions with respect to those claims. Any misunderstanding or misinterpretation on my part is made out of ignorance with the hope that city staff will clarify and correct my error.

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At the end of the same paragraph, the Fact Sheet states, "Some bottled waters contain up to 92 mg/L silica."

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Support for this argument is found In an article published by the University of Hawaii in it's technical magazine for sports and fitness professionals, NutritionATC,. The authors, under the heading "How much is too much?", reported the same conclusion on the safe upper limits for silicon, namely, 700 mg/day with a note that high intake of silicon can possibly lead to kidney stones. They relied on the same article cited in the Fact Sheet. <http://www.nutritionatc.hawaii.edu/UL.htm>. How could Intertox make such mistakes by not recognizing the upper level at 700 mg/day and then only as a measure for supplements and not normal dietary intake?

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Respectfully,

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