Analysis of water samples from Newark, NJ collected by Jose Pagliery from Univision

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September 23, 2019

One of the striking features of the water-lead crisis in Newark has been the lack of data. To shed some light on the performance of the household filters provided by the city to residents during summer 2019, we teamed up with journalist Jose Pagliery from Spanish-language TV station Univision. On August 30, 2019, Univision announced that households served by the Pequannock reservoir that received city-issued filters could have their water tested for lead (Pb), both tap water entering the filter (hereon referred to as input) and treated water coming out of their filter (output). On September 6, 2019, Univision distributed and received the sampling vials at a live, televised event. This note focuses on the 76 pairs input and output water samples that were returned to Jose Pagliery by volunteer households. No addresses or any other household information were provided to us. We followed well-established methods (see below) that minimize the risk of erroneous results to prepare the sample vials and subsequently analyze the water samples for Pb.

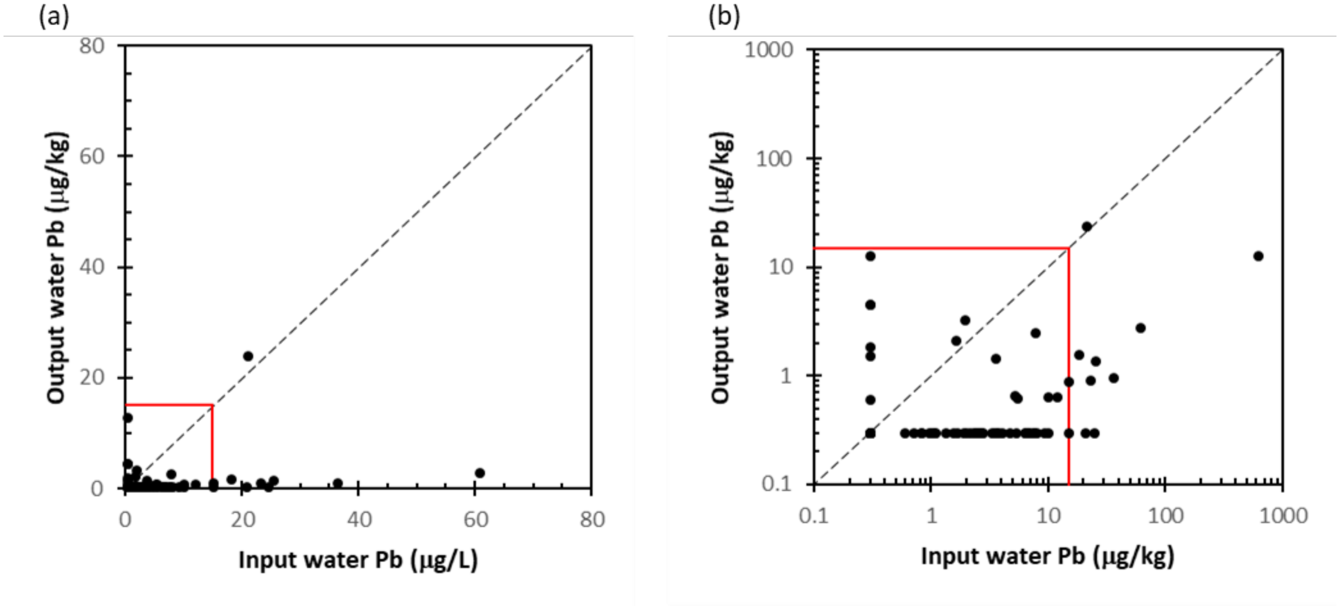

Figure 1. Comparison of Pb concentrations in input and output water for 76 city-provided filters on (a) a linear scale, excluding the one sample with 630 µg/kg in the input water and, (b) a logarithmic scale in order to show concentrations for all samples. The black dashed line indicates equal concentrations of Pb in the in- and output. The red lines indicate the 15 µg/kg EPA threshold for Pb in drinking water.

Our analyses show that Pb concentrations exceeded 15 µg/kg (also referred to as part per billion or ppb), the US Environmental Protection Agency's threshold for Pb in drinking water, in 11 out of the 76 input samples, including one sample with an extremely high level of 630 µg/kg, and in 1 of the 76 output samples which contained 24 µg/kg. The average Pb content of all 76 input and output samples was 14±8 µg/kg (±standard error of the mean) and 1.2±0.4 µg/kg for all 76 output samples. Our data therefore indicate that, for these 76 volunteer households, the city-provided filters lowered the Pb content of their water by more than a factor of ten. This conclusion is not affected when excluding the household with 630 µg/kg Pb in the input water, which is not the one with more than 15 µg/kg in the output (see table).

The Pb content of input water was actually higher than for the output for 9 out of 76 filters (see Figure 1). This suggests that water with sporadically higher Pb concentrations may have reached the filters in the past. Previous studies conducted in other cities have clearly shown that Pb concentrations in tap water can be highly variable, and occasionally dominated by particulate Pb rather than dissolved Pb (Masters et al. 2016a, b). We do not know to what extent the Pb content of input water was already lowered when these samples were collected by recently introduced improvements in corrosion control, the addition of phosphate to the water in particular. For this reason, and because the number of filters with a high Pb input in this data set is relatively small, it is difficult to extrapolate our findings to estimate the overall proportion of failing filters in the city before better corrosion control was introduced.

In spite of these uncertainties, our main conclusion remains that the delivery of filters by the city of Newark was a measure that significantly lowered exposure to Pb from drinking tap water during summer 2019. At the same time, the failure of 1 out of 11 filters receiving input that is high in Pb suggests that the output from a considerable number of filters distributed by the city may have contained >15 μg/kg Pb.

Methods: Three trays of 100 20 mL scintillation vials with PolySeal caps each were handed over to Jose Pagliery on September 5, 2019. Pairs of vials were labeled “In” and “Out” along with a sequential numbers 001-150 on the vial cap and on the side of the vial itself with a permanent marker. The scintillation vials and caps had previously been acid-leached in 10% hydrochloric acid, right-side up one night, and upside down the next night, and then rinsed 3 times with high-purity (Milli-Q) water. Two trays containing a total of 184 vials were returned on September 10, 2019 and acidified to 1% with high-purity Optima hydrochloric acid. At the same time, a subset of 6 vials previously cleaned by the same procedure were filled with Milli-Q water and acidified like a sample. At least 24 hours after acidification, an aliquot of each sample and blank was diluted in a germanium spike solution for analysis on a Thermo Element2 inductively-coupled mass spectrometer according to the method of Cheng et al. 2004. Along with samples and blanks, reference water samples 1640A and 1643F from the National Institute of Standards and Technology were each analyzed 8 times. Measured Pb concentration of 12.5±0.2 μg/kg (±1 standard deviation) and 19.2±0.1 μg/kg were only slightly higher than certified values of 12.00±0.04 μg/kg and 18.3±0.08 μg/kg for NIST 1640A and 1643F, respectively. Concentrations of Pb for the 6 blanks analyzed 12 times averaged 0.2±0.2 μg/kg, from which a detection limit of 0.6 μg/kg was calculated by multiplying the standard deviation of the blank by 3. Sample results were not blank-corrected and all Pb concentrations measured in the samples below 0.6 μg/kg were set to 0.3 μg/kg, i.e. half the detection limit.

References

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Results provided by Tyler Ellis and Alexander van Geen, Lamont-Doherty Earth Observatory of Columbia University. September, 19 2019

Newark Pb Filters

Pb detection limit = 0.6 ppb

Pb detection limit determined from 3 x standard deviation of the method blank. Concentrations below 0.6 ppb were replaced with half the detection limit, i.e. 0.3 ppb.

filter-type	sample	return	lead_result_in (ppb)	lead_result_out (ppb)
city	1	y	0.3	not analyzed yet
city	2	y	7.8	2.5
city	3	y	15.1	0.9
private	4	y	5.7	0.3
no filter	5	y	0.3	0.8
city	6	y	1.9	3.2
city	7	y	60.8	2.7
city	8	y	3.4	0.3
city	9	y	12.0	0.6
city	10	y	0.3	4.4
city	11	y	9.3	0.3
city	12	y	36.5	1.0
city	13	y	0.3	0.3
city	14	y	0.3	1.8
private	15	y	0.3	0.3
city	16	no	sample not received	sample not received
city	17	y	2.6	0.3
city	18	y	0.3	12.8
city	19	y	1.9	0.3
private	20	y	0.3	0.3
city	21	y	0.3	0.3
city	22	y	0.3	0.3
city	23	y	21.1	23.9
city	24	y	24.6	0.3
city	25	y	0.3	0.3
city	26	no	sample not received	sample not received
city	27	y	2.4	0.3
city	28	y	0.3	0.3
city	29	y	6.4	0.3
city	30	y	6.7	0.3
city	31	y	15.1	0.3
city	32	y	3.8	0.3
city	33	y	1.6	2.1
city	34	y	1.3	0.3
city	35	y	0.3	0.3
city	36	y	622.8	12.8
city	37	y	0.3	4.5
city	38	y	23.2	0.9
city	39	y	0.8	0.3

city	40	y	0.6	0.3
private	41	y	0.3	1.0
city	42	y	6.4	0.3
city	43	y	6.5	0.3
city	44	y	7.6	0.3
city	45	y	10.0	0.6
private	46	y	10.1	0.3
city	47	y	7.7	0.3
city	48	y	3.6	1.4
city	49	y	0.3	0.3
city	50	y	2.3	0.3
city	51	y	5.4	0.3
city	52	y	1.0	0.3
private	53	y	0.3	0.3
city	54	y	1.7	0.3
city	55	y	18.2	1.6
city	56	y	0.3	1.5
city	57	y	1.1	0.3
city	58	y	4.7	0.3
city	59	y	2.4	0.3
city	60	y	0.3	0.3
no filter	61	y	0.3	sample not received
private	62	y	5.0	0.3
no filter	63	y	2.1	sample not received
city	64	y	2.2	0.3
no filter	65	y	0.3	0.3
city	66	y	6.7	0.3
city	67	y	0.8	0.3
city	68	y	0.3	sample not received
city	69	y	7.1	0.3
city	70	y	0.3	0.3
city	71	y	3.4	0.3
city	72	y	5.2	0.7
city	73	y	5.5	0.6
city	74	y	0.3	0.3
city	75	y	0.3	0.3
private	76	y	0.6	0.3
city	77	y	0.7	0.3
no filter	78	y	3.5	3.2
city	79	y	0.3	0.6
city	80	y	25.5	1.4
city	81	y	20.8	0.3
city	82	y	2.6	0.3
city	83	y	2.8	0.3
city	84	y	2.7	0.3
city	85	y	4.0	0.3
city	86	y	10.2	0.3
city	87	y	1.6	0.3
no filter	88	y	1.8	sample not received

city	89	y	2.0	0.3
city	90	no	sample not received	sample not received
city	91	y	1.1	0.3
city	92	y	1.0	0.3
city	93	y	3.7	0.3
private	94	y	0.6	0.3
city	95	y	8.0	0.3
city	96	y	2.5	0.3
private	97	y	0.3	0.3