

OHA Preliminary Assessment of Health Risk from Exposure to Soils around Uroboros Glass

March 17, 2016

Based on the soil data available, the Oregon Health Authority (OHA) concludes that levels of metals in soil around Uroboros Glass are *too low to harm the health of people in the surrounding community*. The following tables and text describe OHA's process in arriving at this conclusion.

The Department of Environmental Quality (DEQ) collected 27 soil samples and two mulch samples east of the Uroboros Glass facility (2139 N Kerby Ave, Portland, OR 97227). (See [DEQ's Uroboros Soil Sampling Report](#) for sampling maps and complete data set). Sampling was limited to this area because of limited availability of soil closer to the facility. DEQ had these samples analyzed for 12 metals including specific forms of chromium called chromium +6 or hexavalent chromium. Tables 1-3 show the complete list of metals tested. DEQ collected additional samples, but OHA focused on soil samples taken at shallow depth (0-6 inches) because they represent what people in the area would likely be exposed to.

DEQ divided the 27 samples into three areas, Lillis Albina Park (10 samples), Grandma's Place Daycare (6 samples), and Albina Community Garden (11 samples). Using area average¹ concentrations, OHA assessed health risks in each area separately. In the case of Grandma's Place Daycare, there were too few samples to calculate an accurate mean, so the maximum detected level for each metal was used for screening and dose calculations. Using child-protective screening levels, a few individual sample results exceeded these levels.

Steps for analyzing data:

1. **Identification of exposure scenarios:** This involves identifying the age of people that come into contact with soil and in what ways they contact the soil. We identified two exposure scenarios for this assessment:
 - a. Children at Grandma's Place Daycare.
 - b. Lifelong residents daily exposed to the soil represented by DEQ sampling at Albina Community Gardens.
2. **Calculation of average metal concentrations for each exposure area:** OHA used EPA's ProUCL 5.0 software to calculate average (90th percentile upper confidence limit around the mean) for each metal for each of the areas. In the case of Grandma's Place Daycare there were too few samples to reliably calculate an average. In this case, we used the maximum detected level for the next step.
3. **Comparison to screening levels:** Through this step, we identify if we need to conduct a further evaluation. We compared measured levels to three [different screening levels \(Attachment 1\)](#).

¹ Upper 90th percentile confidence limit around the mean (UCL90) – Any calculation of a mean or average involves some uncertainty. The UCL90 is the measured soil level that we can say with 90 percent certainty that the actual mean does not exceed given the number of samples collected.

The section “Comparison to Screening Levels” describes how average measured metals levels for each area compared to screening levels. The screening step is also shown in Tables 1-3. When the average exceeds the Agency for Toxic Substances and Disease Registry (ATSDR) screening level (we reference this as “CDC Guidelines” in the infographics on the web) or the DEQ residential screening level (we reference this as “Oregon Guidelines” in the infographics on the web), we conducted an in-depth analysis.

- 4. In-depth analysis:** In this step, we consider the different ways that people can come into contact with contaminated soil and how much people might come into contact with.

Daycare children

Children are sensitive to exposures to contaminants and also swallow more soil than most adults. For these calculations, OHA assumed that a 10 kilogram (22 pound) child would swallow 200 milligrams (1/5 the weight of a paper clip) of soil per day, 5 days per week for 5 years at the daycare. OHA followed guidance in ATSDR’s [Public Health Assessment Guidance Manual](#) for assumptions about body weights for children and adults and for amounts of soil swallowed per day. Because cancer risk is estimated on a lifetime basis, the period of exposure is divided by the average lifespan. Following guidance from ATSDR, OHA assumed an 80 year lifespan.

Tubman Elementary School is also nearby. The exposure assumptions outlined here are also protective of Elementary School Students, if not more so, because the body weight we assumed for a daycare child is very small (smaller than an Elementary School aged child) meaning that the calculated dose per body weight will be larger for a smaller child.

30-Year resident

For 30-year residents, OHA assumed an 80 kilogram (176 pound) adult would swallow 200 milligrams (1/5 the weight of a paper clip) of soil per day every day for 30 years, while gardening and consuming vegetables grown in the soil. ATSDR’s guidance suggests that adults consume 100 milligrams of soil per day, but because this is a community garden, OHA assumed that gardening adults may swallow more soil per day than the average adult referenced in ATSDR guidance.

Comparison to Screening Levels

It is important to note that levels of arsenic in Oregon soils are often naturally higher than DEQ’s residential screening level for arsenic. Results for most metals, including arsenic, were below expected background levels for the Portland Basin. Overall, cadmium levels were not above expected background levels except at Grandma’s Place Daycare where the maximum detected value was above Portland Basin expected levels. Cadmium levels were below DEQ and ATSDR screening levels in all areas. See Tables 1-3 for details.

Screening level comparison for Lillis Albina Park

In Lillis Albina Park, the average² soil levels of arsenic and chromium +6 were higher than DEQ's residential screening levels, and none of the metals were measured at levels higher than ATSDR screening levels. Because arsenic and chromium +6 were higher than the DEQ residential screening levels we conducted an in-depth analysis, included in the next section. Levels of cadmium and all other metals tested were below DEQ and ATSDR screening levels.

Screening levels comparison for Grandma's Place Day Care

At Grandma's Place Day Care, the maximum³ soil levels of arsenic and chromium +6 levels were higher than DEQ's Residential Screening Levels, and none of the metals were measured at levels higher than ATSDR screening levels. Because arsenic and chromium +6 were higher than the DEQ residential screening levels we conducted an in-depth analysis, included in the next section. Levels of cadmium and all other metals tested were below DEQ and ATSDR screening levels.

Screening level comparison for Albina Community Gardens

At the Albina Community Garden, the average² soil levels of arsenic and chromium +6 were higher than DEQ's Residential Screening Levels, and no metals were present at levels higher than ATSDR screening levels. Because arsenic and chromium +6 were higher than the DEQ residential screening levels we conducted an in-depth analysis, included in the next section. Levels of cadmium and all other metals tested were below DEQ and ATSDR screening levels.

In-depth analysis for all three sampling areas by contaminant

In-depth analysis includes estimating a dose for the populations most at risk for experiencing harm to health. A dose is the amount of contaminant that gets into a human body.

OHA did not consider every possible exposure scenario. The more comprehensive public health assessment that OHA will complete later in 2016 will include a more complete list of exposure scenarios. In this preliminary and initial analysis, OHA selected scenarios that would include the "worst case but plausible" exposure risks to the most sensitive populations. OHA chose young children as the population for Grandma's Place Day Care center and 30-year residents gardening and eating garden grown food at the Albina Community Garden.

Arsenic

OHA calculated estimated child-specific arsenic doses at Grandma's Place Day Care center based on the maximum⁴ arsenic levels detected in that location. The maximum arsenic levels that were higher than DEQ's residential screening levels. Scientific studies indicate that less than 10 percent of total arsenic in ingested soil actually gets absorbed into the body (this is known as "bioavailability"). EPA typically assumes 60 percent bioavailability when calculating arsenic doses from soil, and this is the assumption

² Upper 90th percentile confidence limit around the mean (UCL90) – Any calculation of a mean or average involves some uncertainty. The UCL90 is the measured soil level that we can say with 90 percent certainty that the actual mean does not exceed given the number of samples collected.

³ Because there were too few samples collected at Grandma's Place Day Care to calculate a reliable average, OHA used the maximum detected value for each metal.

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OHA used here⁵. For these calculations, OHA used assumptions mentioned in Step 4 of the Steps for Analyzing Data listed above (See Attachment 2 for calculation details). Given these assumptions, OHA estimated excess risk of lung and bladder cancers to children at Grandma's Place Day Care center from arsenic exposure at 20 in 1 million over an 80 year lifespan. For a 30-year resident, OHA used the average arsenic concentration at Albina Community Garden because people grow food in this soil and consume the vegetables. OHA estimated excess lung and bladder cancer risk for a 30-year resident at 10 in 1 million over an 80 year lifespan. These are very low cancer risks that are indistinguishable from background cancer risk.

Because all metals were measured at levels well below screening levels for health effects other than cancer, OHA did not calculate doses or risks for health effects other than cancer.

Considering all of this information, OHA concludes that soil concentrations of arsenic are too low to harm the health of children at the daycare center or local 30-year residents using the community garden.

Chromium +6

In order to calculate dose and cancer risk for daycare children who may come into contact with chromium +6, OHA used the maximum measured level of chromium +6 at Grandma's Place Day Care (0.56 mg/kg). For 30-year residents, OHA used the average chromium +6 concentration for the Albina Community Garden (0.77 mg/kg). For children exposed to chromium +6 at the daycare center, OHA calculated an estimated excess cancer risk of 0.2 in 1 million over an 80 year lifespan. For 30-year residents, OHA calculated an estimated excess cancer risk at 0.4 in 1 million. These are very low cancer risks that would not be detectable over baseline cancer rates.

Combined cancer risk

For daycare children and 30-year residents OHA added the estimated cancer risks for arsenic and chromium +6. The combined excess cancer risk, over an 80-year lifespan, was 20 in 1 million for daycare children, and 10 in 1 million for 30-year residents. Even combined, these cancer risks would cause no detectable increase in cancer rates over baseline.

Note that estimated cancer risks are always presented to 1 significant digit to avoid implying a degree of precision that does not exist. However, all digits are used in all calculations. This rounding is the reason that the combined risk isn't 20.2, a straight sum of 20 for arsenic and 0.2 for chromium +6.

Conclusions

Overall, OHA concludes that exposure to the levels of metals in soils around Uroboros Glass are too low to harm the health of the community, including children at Grandma's Place Day Care center and 30-year residents using the Albina Community Garden. This conclusion is based on 27 surface soil samples collected by DEQ.

⁵ Email communication from EPA reviewers.

When additional soil data become available and DEQ verifies its reliability, OHA will evaluate it for public health significance.

Soil in individual yards and gardens is typically different from the soil in public spaces. See OHA's guidance on self-collected soil data (insert hyperlink) for information about how to understand the results of any yard or garden soil testing you may have had done independently. [Healthy Soils: Information about testing your yard or garden.](#)

**Table 1. Lillis
Albina Park**

METAL	Average* measured (mg/kg)	Portland Basin Background Estimate (mg/kg)	DEQ Residential Screening Levels (mg/kg)	ATSDR [£] Screening Levels (mg/kg)	Greater than Background?	Greater than DEQ Residential Screening Levels?	Greater than ATSDR Screening Levels?
Arsenic	5.85	8.8	0.43	15	NO	YES	NO
Cadmium	0.392	0.63	78	5	NO	NO	NO
Chromium (total)	15.57	76	120,000	75,000	NO	NO	NO
Chromium +6	0.976	NA	0.3	45	NA	YES	NO
Cobalt	14.03	33	23	500	NO	NO	NO
Lead	71.6	79	400	NA	NO	NO	NO
Nickel	19.25	47	1,500	1,000	NO	NO	NO
Selenium	0.484	0.71	390	250	NO	NO	NO
Mercury	0.0406	0.23	23	15	NO	NO	NO
Iron	24914	36100	55,000	NA	NO	NO	NA
Manganese	614.6	1800	1,800	2,500	NO	NO	NO
Aluminum	9179	52300	77,000	50,000	NO	NO	NO
Boron	3.4	8	NA	10,000	No	NA	NO

*Upper 90th confidence limit around the mean, ¥Highest detection used instead of average because there were too few detections to calculate an average, £Agency for Toxic Substances and Disease Registry screening levels are a mixture of Environmental Media Evaluation Guideline (EMEGs) and Reference Dose Media Evaluation Guidelines (RMEGs) for children with a preference, when available, for chronic EMEGs, followed by child RMEGs, followed by intermediate child EMEGs. See table 1 for more details about which ATSDR screening levels were used for each metal.

NA = no value available, or no comparison possible because no screening level value available

Table 2.
Grandma's
Place Day Care

METAL	Average* measured (mg/kg)	Portland Basin Background Estimate (mg/kg)	DEQ Residential Screening Level (mg/kg)	ATSDR [£] Screening Level (mg/kg)	Greater than Background?	Greater than DEQ Residential Screening Level?	Greater than ATSDR Screening Level?
Arsenic	5.71 [¥]	8.8	0.43	15	NO	YES	NO
Cadmium	1.07 [¥]	0.63	78	5	YES	NO	NO
Chromium (total)	15.7 [¥]	76	120000	75000	NO	NO	NO
Chromium +6	0.56 [¥]	NA	0.3	45	NA	YES	NO
Cobalt	14.1 [¥]	33	23	500	NO	NO	NO
Lead	105 [¥]	79	400	NA	NO	NO	NO
Nickel	14.8 [¥]	47	1500	1000	NO	NO	NO
Selenium	0.6 [¥]	0.71	390	250	NO	NO	NO
Mercury	0.04 [¥]	0.23	23	15	NO	NO	NO
Iron	26100 [¥]	36100	55000	NA	NO	NO	NA
Manganese	655 [¥]	1800	1800	2500	NO	NO	NO
Aluminum	8400 [¥]	53300	77000	50000	NO	NO	NO
Boron	5.6	8	NA	10,000	NO	NA	NO

*Upper 90th confidence limit around the mean, ¥Highest detection used instead of average because there were too few detections to calculate an average, £Agency for Toxic Substances and Disease Registry screening levels are a mixture of Environmental Media Evaluation Guideline (EMEGs) and Reference Dose Media Evaluation Guidelines (RMEGs) for children with a preference, when available, for chronic EMEGs, followed by child RMEGs, followed by intermediate child EMEGs. See table 1 for more details about which ATSDR screening levels were used for each metal.

NA = no value available, or no comparison possible because no screening level value available

**Table 3.
Albina
Community
Garden**

METAL	Average* measured (mg/kg)	Portland Basin Background Estimate (mg/kg)	DEQ Residential Screening Level (mg/kg)	ATSDR [£] Screening Level (mg/kg)	Greater than Background?	Greater than DEQ Residential Screening Level?	Greater than ATSDR Screening Level?
Arsenic	4.20	8.8	0.43	15	NO	YES	NO
Cadmium	0.33	0.63	78	5	NO	NO	NO
Chromium (total)	55.70	76	120000	75000	NO	NO	NO
Chromium +6	0.77	NA	0.3	45	NA	YES	NO
Cobalt	13.12	33	23	500	NO	NO	NO
Lead	43.08	79	400	NA	NO	NO	NO
Nickel	14.18	47	1500	1000	NO	NO	NO
Selenium	0.42	0.71	390	250	NO	NO	NO
Mercury	0.04	0.23	23	15	NO	NO	NO
Iron	22059	36100	55000	NA	NO	NO	NA
Manganese	818.30	1800	1800	2500	NO	NO	NO
Aluminum	8712	53300	77000	50000	NO	NO	NO
Boron	5.1	8	NA	10,000	NO	NA	NO

*Upper 90th confidence limit around the mean, ¥Highest detection used instead of average because there were too few detections to calculate an average, £Agency for Toxic Substances and Disease Registry screening levels are a mixture of Environmental Media Evaluation Guideline (EMEGs) and Reference Dose Media Evaluation Guidelines (RMEGs) for children with a preference, when available, for chronic EMEGs, followed by child RMEGs, followed by intermediate child EMEGs. See table 1 for more details about which ATSDR screening levels were used for each metal.

NA = no value available, or no comparison possible because no screening level value available

Attachment 1: Soil Screening Levels

Health risks were evaluated by comparing soil sample results against accepted screening levels. Data was evaluated for three areas: the Grandma's Place Day Care, Lillis Albina Park, and the Albina Community Garden

Three screening levels were used for each contaminant.

- **DEQ's estimate of the background level for the Portland Basin.** This comparison provides context for what we would expect to find in soil anywhere in the Portland area. For more information: <http://www.deq.state.or.us/lq/pubs/docs/cu/FSbackgroundmetals.pdf>
- **DEQ's Residential Screening Level.** These screening numbers establish soil cleanup levels based on proposed reuse for contaminated sites. Residential reuse requires the most stringent cleanup as it assumes children and families will live on the property. For more information: <http://www.epa.gov/risk/regional-screening-levels-rsls-users-guide-november-2015>
- **ATSDR Screening Level.** Environmental Media Evaluation Guides [EMEGs] and Reference Dose Media Evaluation Guides [RMEGs] from the Agency for Toxic Substances and Disease Registry (ATSDR), which is a part of the Centers for Disease Control and Prevention (CDC). These screening levels are calculated to assess human health risks. For more information: ATSDR's website (section 3 of [Appendix F](#) of ATSDR's Public Health Assessment Guidance Manual)

The toxicity-based screening levels from both DEQ and ATSDR were added to give more perspective for both cancer and non-cancer risks. When the screening level numbers vary widely, it is because the level of a substance that causes a non-cancer health effect may be much higher than the amount that would pose a cancer risk. Depending on the metal in question, non-cancer health effects could include kidney damage for cadmium, skin problems or nerve damage for arsenic, and learning deficits for lead.

The screening levels established by DEQ assume that a 33 pound child will consume 200 milligrams (about 1/5th the weight of a paper clip) of the contaminated soil per day for a year or more and that it will all be absorbed into their body. ATSDR uses the same assumptions except that the child is 22 pounds instead of 33 pounds. These assumptions are designed to protect health, because metals in swallowed soil are absorbed at much lower rates (often as low as 1% or less), especially when soil is mixed with organic matter. These assumptions are also very protective of adults because an adult is larger and so would have a smaller dose than a child if the same amount were swallowed.

In summary, substances measured at levels below screening levels are not expected to harm health for children or adults. Substances measured at levels above screening levels require further evaluation before making a conclusion on how health could be affected.

Metal	DEQ Portland Basin Background¹	DEQ Residential Screening Levels²	ATSDR Screening Levels³
Aluminum	52,300 ^b	77,000 ^a	50,000
Arsenic	8.8	0.43	15
Cadmium	0.63	78	5
Total Chromium ^e	76	120,000	75,000
Chromium +6	NA	0.3	45
Cobalt	33 ^c	23 ^a	500
Iron	36,100 ^b	55,000 ^a	NA
Lead	79	400	NA
Manganese	1,800	1,800	2,500
Mercury	0.23	23	15
Nickel	47	1,500	1,000
Selenium	0.71	390 ^a	250
Boron	8 ^d	NA	10,000

1- Source DEQ background metals fact sheet,

<http://www.deq.state.or.us/lq/pubs/docs/cu/FSbackgroundmetals.pdf>

2 - Residential Levels are DEQ soil screening levels, where available, or EPA regional screening levels (RSLs) When no DEQ residential level is published.

3 - Agency for Toxic Substances and Disease Registry (ATSDR) Screening Levels. ATSDR levels are environmental media evaluation guides (EMEGs), or reference dose media evaluation guides (RMEGs).

a - Residential levels for these metals are the US EPA Regional Screening Levels (RSLs) for residential use.

b - Background levels shown are from Washington Department of Ecology Pub. No. 94-115

c - No background estimate for cobalt has been published by DEQ. Level shown is average of Willamette Valley soil from DEQ database.

d- Background estimate from Toxicological Profile for Boron, US ATSDR, November 2010.

e- Background level is based on total chromium. Screening Levels are based on trivalent chromium.

NA - Not Available - No estimate of background soil concentration or screening levels are available for these metals and agencies.

Attachment 2. Dose and Risk Calculation

This attachment describes the formulas, methods, and assumptions used to calculate estimated doses and risk for arsenic and chromium +6 for children at Grandma's Place Day Care and 30 year residents using Albina Community Gardens. For soil samples, the upper 90th percent confidence limit (UCL90) around the average concentration was used to calculate dose (Tables 1-3). This is protective of human health because uncertainty about the true mean is added to the concentration. People will likely be exposed to lower concentrations of arsenic and chromium +6.

Doses were calculated as follows:

$$\text{Dose} = \frac{C \times IR \times C1 \times BAF \times EF \times ED}{AT \times BW}$$

Risk was calculated as:

$$\text{Cancer Risk} = \text{Dose} \times \text{CSF}$$

Where⁶:

C = Concentration of chemical measured in soil (chemical specific)

IR = Intake rate of soil

C1 = Conversion factor 1

BAF = Bioavailability Factor (chemical specific)

EF = Exposure frequency

ED = Exposure duration

AT = Averaging time

BW = Body weight

CSF = Cancer slope factor (chemical specific)

AT = averaging time for cancer effects over an 80 year lifetime multiplied by 365 days per year. The rationale is that cancer is the result of multiple defects/mutation in genetic material accumulated over an entire lifetime. Therefore, the averaging time is representative of an entire statistical lifetime (80 years) for agents that cause cancer.⁷

⁶See Table 2-1 for more details about terms in the formula and the values used for each with their rationale.

⁷ ATSDR Public Health Assessment Guidance Manual, accessible online at <http://www.atsdr.cdc.gov/hac/PHAManual/toc.html>

Table 2-1. Exposure Factors for Dose Calculations

Term	Description	Child at daycare	Adult 30-year resident	Units	Notes
C	Concentration	Arsenic: 5.71 Chromium +6: 0.56	Arsenic: 4.2 Chromium +6: 0.77	mg/kg	Chemical and location specific from Tables 1-3. UCL90
IR	Intake rate for soil/tailings ingestion	200	200	mg/day	ATSDR Guidance [Public Health Assessment Guidance Manual] assumed higher adult consumption rate than average assuming gardening scenario
C1	Conversion Factor 1	0.000001	0.000001	kg/mg	Converts kilograms of soil to milligrams of soil
BAF	Oral bioavailability factor	Arsenic: 0.6 Chromium +6: 1	Arsenic: 0.6 Chromium +6: 1	No units	Chemical specific
EF	Exposure frequency for ingestion of soil	260	365	days/year	Assumed 5 days per week for daycare children and 7 days per week for 30-year resident
ED	Exposure Duration	5	30	years	
BW	Body weight	10	80	kg	ATSDR guidance for adults [[Public Health Assessment Guidance Manual]; Conservative assumption for very young children
AT _c	Averaging time for cancer health effects	29200	29200	days	80 year lifetime x 365 days
CSF	Cancer Slope Factor	Arsenic: 5.7 Chromium +6: 0.5	Arsenic: 5.7 Chromium +6: 0.5	Mg/kg-day ⁻¹	EPA

Abbreviations: ATSDR – Agency for Toxic Substances and Disease Registry; EPA – Environmental Protection Agency; mg – milligrams; kg – kilograms; w/ – with

Table 2-2. Dose and risk calculation results (cancer) for arsenic and chromium +6

Exposed Group	Chemical	Dose (mg/kg-day)	Excess cancer risk (rounded to 1 significant digit)	Health Hazard?
Child at daycare	Arsenic	3.1×10^{-6}	2×10^{-5} (20 in 1 million)	No
	Chromium +6	5.0×10^{-7}	2×10^{-7} (0.2 in 1 million)	No
	Combined cancer risk		2×10^{-5} (20 in 1 million)	No
Adult 30-year resident	Arsenic	2.4×10^{-6}	1×10^{-5} (10 in 1 million)	No
	Chromium +6	7.2×10^{-7}	4×10^{-7} (0.4 in 1 million)	No
	Combined cancer risk		1×10^{-5} (10 in 1 million)	No