Heavy Metals in Drinking Water and Soil on and around Hope College's Campus

Alexandra Donaldson, Ian Gorgenson, and Jarad Jaent

Part 1

A survey of the drinking water on Hope College's campus

Motivation

Water quality has been a great topic of controversy in the state of Michigan in the last decade.

Heavy metal contamination that caused the Flint Water Crisis has inspired cities all across Michigan and the country to take a closer look at the safety of their drinking water.

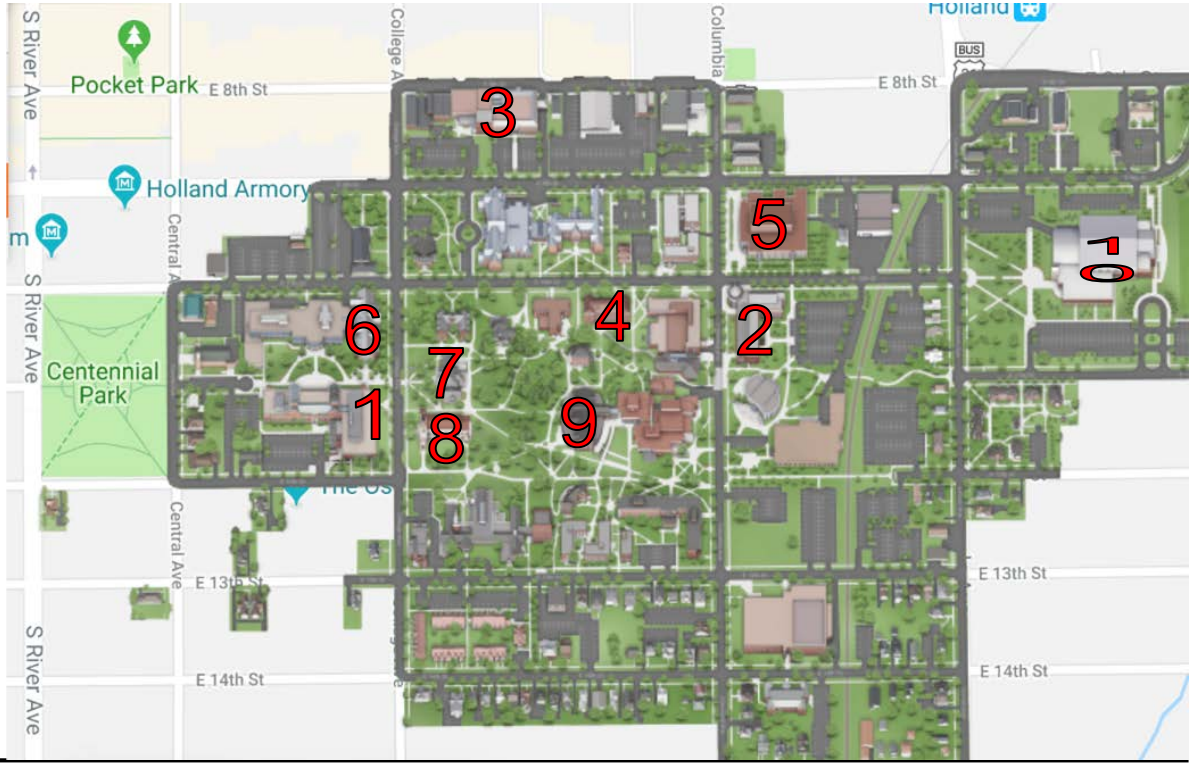
We decided to take a look at the levels of lead and copper in the drinking water here on our own campus at Hope College.

https://www.colorlines.com/articles/state-and-federal-government-still-resisting-efforts-save-flint

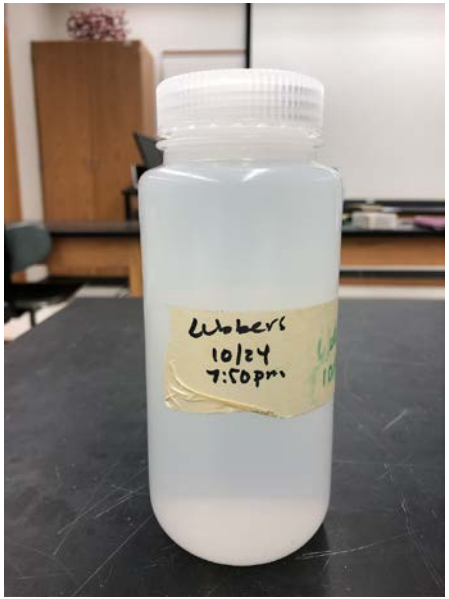
https://www.smithsonianmag.com/science-nature/chemical-study-ground-zero-house-flint-water-crisis-180962030/

Sampling Locations

1. Schaap Science Center
2. Martha Miller
3. Anderson Werkman Financial Building
4. Lubbers Hall
5. Jack Miller Music Building
6. Van Wylen Library
7. Graves Hall
8. Dimnent Chapel
9. Bultman Student Center
10. DeVos Fieldhouse



Sampling Procedure



An example of one of our water samples with a label showing location, date, and time.

Samples were collected at approximately 8:00 AM and 8:00 PM from the same drinking fountain.

We collected samples in 500 mL nalgene bottles from various sites around campus.

Once collected, samples were stored in a refrigerator until they were ready to be analyzed.

Testing Procedure

In order to determine the presence of lead and copper in the drinking water samples, they had to be analyzed through Atomic Absorption Spectroscopy.

The Atomic Absorption (AA) would first be able to tell us if lead and copper were present with a preliminary test.

If they were present, further analysis would be performed.

http://triadscientific.com/?site=preowned&item=5563&menu=7788

Results

Location	Date Sampled	Presence of Heavy Metal
Science Center 2nd Floor	11/8	ND
Martha Miller	11/8	ND
Jack Miller	11/8	ND
Library	11/8	ND
BSC	11/8	ND
Anderson Werkman	10/24	ND
Lubbers	10/24	ND
Dimnent Chapel	10/24	ND
Graves	10/24	ND
DeVos	10/24	ND

After completing preliminary tests with the AA, lead and copper were not found in any of our 20 samples.

Discussion

Since there was a lack of lead and copper in the drinking water samples from campus, we can rest assured that these elements do not present a risk to consumption of water on Hope College's campus.

Part 2

Leachable heavy metals in soils on and near Hope College's campus due to corrosion at the Western Seminary Library

Motivation

The library at the Western Theological Seminary was having problems with corrosion which prompted them to tear down and rebuild.

We wanted to see how the corrosion impacted the soil and potentially groundwater in the surrounding area.

Sampling Location

Two native soil samples were collected from the construction site. One from the front and one from the back, marked with the yellow stars.

Preparation Procedure

The soil samples were stored in a cold room until the extraction and digestion period (followed EPA Toxicity Characteristic Leaching Procedure).

We found the pH after reaction with HCl of the samples to identify which extraction fluid would be used for the remainder of the analysis.

After determining the correct extraction fluid, 100 g of the soil sample were placed in the fluid, and shaken overnight to promote leaching of heavy metals from the soil into the fluid.

After being shaken overnight, the soil was separated from the fluid, and 100 mL of the fluid was digested down to 50 mL and then analyzed.

An image of the shaking machine used to agitate our samples and promote leaching

Analysis

After the samples were digested, a preliminary run through the AA helped determine which heavy metals were present.

Preliminary tests with the AA indicated presence of Zn, Cu, Pb, Mg, Mn, Ni, and Fe.

However, we chose to determine the exact levels of Pb, Cu, and Fe in the sample. We believed these would indicate the presence of corrosion and would be most impactful on overall health.

Results

Cu Concentrations (ppm)	
F1	1.7416
F2	1.6854
F3	1.5449
B1	1.8258
B2	1.8258
B3	1.8258

Pb Concentrations (ppm)	
F1	0.5946
F2	0.6486
F3	0.5946
B1	0.7027
B2	0.7027
B3	0.7027

Fe Concentrations (ppm)	
F1	1.0377
F2	1.1006
F3	1.0377
B1	1.9497
B2	1.8239
B3	1.8239

F1, F2, & F3 represent three trials from the samples taken from the front of the construction site.
B1, B2, & B3 represent three trials from the samples taken from the back of the construction site.

MCL for Soil

Copper:	Lead:	Iron:
250 ppm	400ppm	192,000 ppm

MCL for Drinking Water

Copper:	Lead:	Iron:
1.3 ppm	0 ppm	0.3 ppm

Note: MCL = Maximum Contaminant Level

Discussion

Our soil samples did not exceed maximum contaminant levels for soil of any of the three heavy metals that were tested for. But, the very presence of copper could cause cascading problems in an ecosystem.

Some water-soluble copper compounds do enter groundwater. Copper that enters groundwater eventually collects in the sediments of lakes, rivers, and estuaries.

The heavy metal concentrations were higher in the sample taken from the back of the site, where more construction and movement of heavy machinery was likely to occur.

Conclusion

Lead and copper were not found in the drinking water, they were found in the soil samples.

Although there were detectable levels of Pb, Cu, and Fe in the soil, these levels were low enough to be tolerable in respect to EPA soil standards.

As long as the correct water treatment processes are in place to treat any consumable groundwater that could interact with this soil, these heavy metals should not pose a problem

Future Work

Because we do not have a control sample of soil, we cannot definitively say if the heavy metals originated from the corrosion in the building.

A further step would to be repeat this same process with a soil sample from a neutral location.

Sources

http://waterquality.cce.cornell.edu/publications/CCEWQ-06-IronManganese.pdf

https://www.epa.gov/dwreginfo/lead-and-copper-rule

https://www.epa.gov/sites/production/files/2015-12/documents/1311.pdf

https://www.atsdr.cdc.gov/toxprofiles/tp132-c1.pdf

https://www.epa.gov/sites/production/files/2014-10/documents/final-updated-wmaps-2014-0630-soil-team1.pdf

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Questions?