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Water Analysis: *Safe Drinking Water in Sunbury and Milton*
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INTRODUCTION

Water is an essential component of life and is used in a myriad of activities. Consequently, water quality has important implications for humans and specifically human health. “The Safe Drinking Water Act (SDWA) defines ‘contaminant’ as any physical, chemical, biological or radiological substance or matter in water…The presence of contaminants does not necessarily indicate that the water poses a health risk” (water.epa.gov). Accordingly, the Pennsylvania Department of Health has identified various potentially harmful water contaminants and safe limits of these contaminants in drinking water. High concentrations of some contaminants are known to increase risk for certain cancers. In order to minimize the concentration of contaminants in drinking water, water is filtered before consumption. It is therefore important to determine whether the water is being filtered well enough to meet the national standards for safe drinking water; if the water contaminants are not being filtered correctly, they could be a cause of some of the cancers listed in the Pennsylvania Department of Health’s “Analysis of Cancer Incidence in Pennsylvania Counties.” [1]

The motivation of this research was to determine whether or not contaminants were present at dangerous levels in water collected from locations in Northumberland County, Pennsylvania. In order to assess water safety, both river water and purified water samples were obtained and analyzed. Finally, national standards for safe drinking water were used to determine the safety of collected water samples.

METHODS

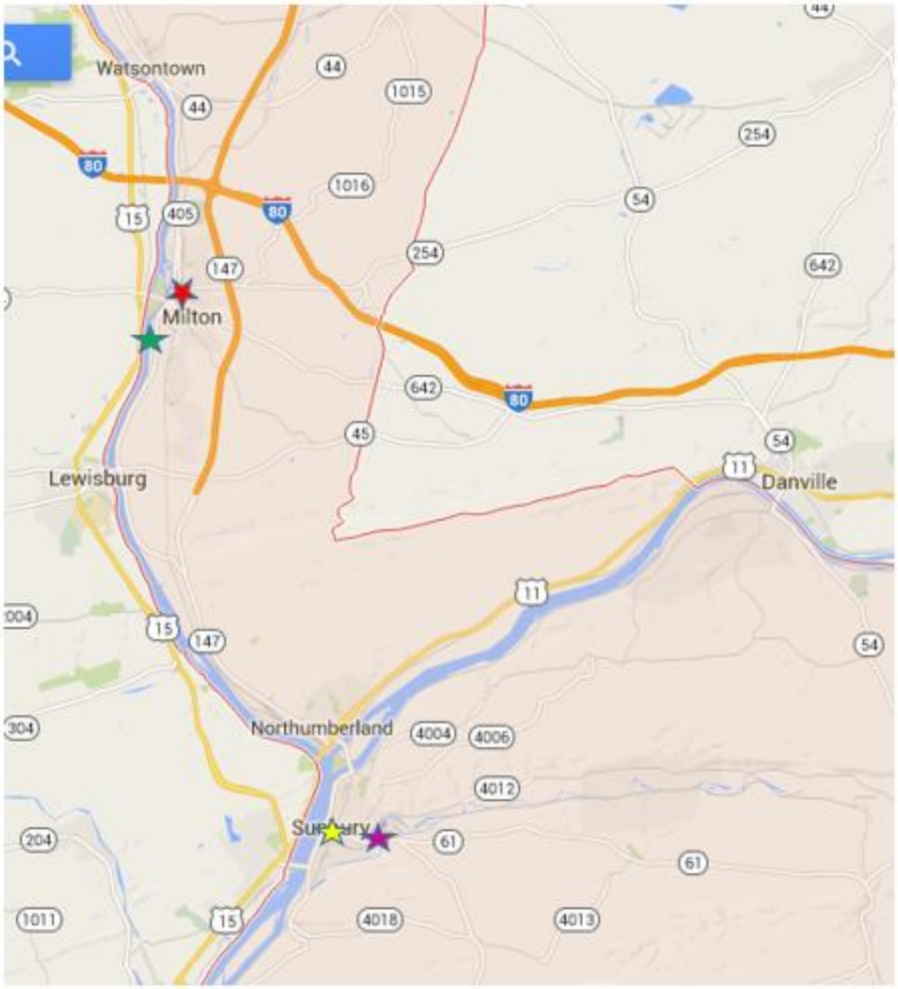
The first step in carrying out an analysis of water quality in Pennsylvania communities was choosing locations from which to collect water. Because we were interested in a possible

[1] http://www.portal.state.pa.us/portal/server.pt?open=514&objID=596023&mode=2

relationship between water quality and health we consulted Pennsylvania health records before choosing sampling locations. State health records indicated an increased rate of lung cancer in Northumberland County and we decided to investigate water contamination as a possible cause. Furthermore, the Pennsylvania Department of Health's 2007-2011 Analysis of Cancer Index lists exposure to arsenic as a possible cause of lung cancer. Therefore, the first location within Northumberland that we chose, Sunbury, was located downstream of farms, as agricultural runoff has been known to contain arsenic (ADSTR[2]). Other possible causes of lung cancer listed by the New York Department of Health include workplace exposure to "beryllium, cadmium, vinyl chloride, nickel compounds, chromium compounds, coal products, tars and soot, chloromethyl ethers and diesel exhaust." Accordingly, we chose to take samples from Milton, Pennsylvania, because Milton is known for its "building of railroad cars [and] manufacture of iron and steel" (miltonhistory.org). For both locations, sources of unpurified drinking water and filtered drinking water were obtained. These locations consisted of the Little Shamokin Creek (a main source of Sunbury's drinking water), tap water the Northumberland County Court Administration government building in Sunbury, the Susquehanna River (a main source Milton's drinking water) and tap water from the Borough of Milton's Police Department[3] (Figure 1).

[2] http://www.atsdr.cdc.gov/csem/csem.asp?csem=1&po=6

[3] Sources of Sunbury's drinking water were found at http://www.cityofsunbury.com/Pages/Municipal%20Authority/WaterDepartment.aspx
Sources of Milton's drinking water were found at http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-59532/White%20Deer%20RS4490023001.pdf



Milton Police Department Susquehanna River

Northumberland County Court Administration Little Shamokin Creek

Figure 1: Map of Water Collection Sites

Once at the locations, water samples were collected in glass bottles to avoid any potential chemical leaching into the samples from the bottles themselves. Additionally, headspace in the bottles was limited to prevent exposure of the samples to oxygen, since air might oxidize the elements within the samples. A sample of at least one liter was taken from each location. The four samples were then brought back to the lab where they were refrigerated before analytical testing began. The first chemical analysis was for arsenic. This was carried out using an arsenic testing kit (Figures 2 & 3).

Figure 2: Arsenic Testing Kit and Setup

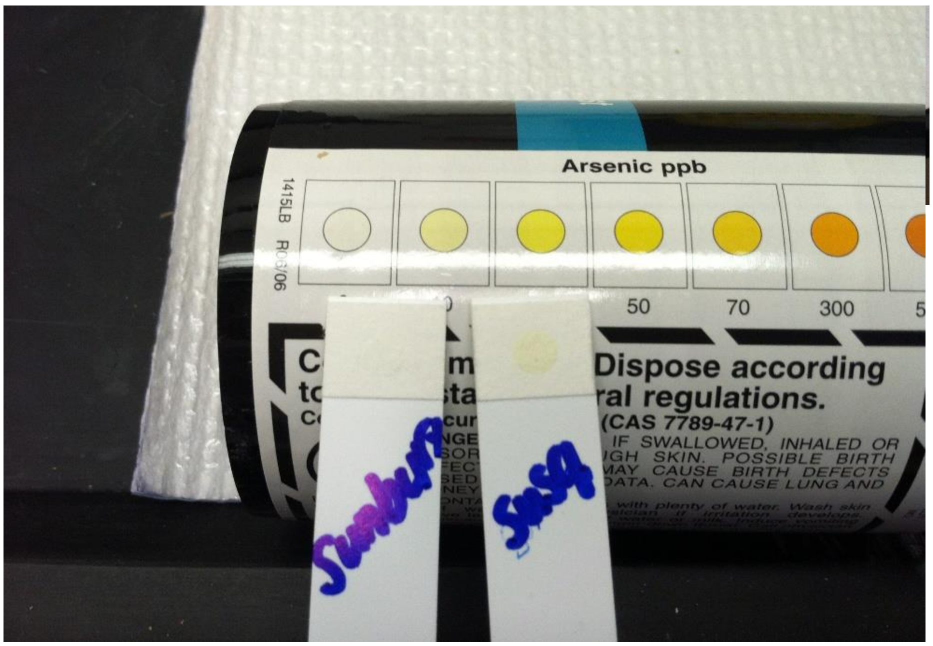


Figure 3: Comparison of testing strip shade to shades of known arsenic concentrations

The next set of analyses were done to quantify the concentrations of various anions in the samples. This was done using IC, ion chromatography. After both the arsenic and anion testing procedures were completed, contaminant concentrations were compared to EPA Drinking Standards to determine the quality of the water samples and whether or not they are safe for drinking.

RESULTS AND DISCUSSION

All four water samples collected were tested for arsenic, fluorine, chlorine, sulfates, nitrates and phosphates.

Arsenic:

Arsenic is an inorganic chemical. When present in high concentrations arsenic poses risks to human health. On the EPA's website skin damage, circulatory problems and increased risk of cancer are listed as possible effects of exposure to arsenic. Some common sources include "erosion of natural deposits; runoff from orchards; runoff from glass & electronics production wastes" (water.epa.gov). The limit for arsenic in drinking water is 0.010 mg/L and the public health goal is 0 mg/L. In the samples analyzed arsenic was found in low, safe concentrations. Tap water samples from Milton and Sunbury contained .005-.010 mg/L. Unpurified water from the Susquehanna River contained .010-.020 mg/L and unpurified water from the Little Shamokin Creek contained less than .010 mg/L.

Fluoride:

Fluoride has in many counties been purposefully added to drinking water. In small amounts, fluoride offers health benefits, such as prevention against dental ailments. However, exposure to large amounts of fluoride can have detrimental effects on human health. For example, "fluoride concentrations above 1.5 ppm in drinking water cause dental fluorosis and much higher concentration skeletal fluorosis" (Kumar & Puri 2012). The EPA defines concentrations of 4 mg/L the maximum amount of fluorine which can exist in drinking water safely. In all four samples that we gathered from Northumberland County, fluorine was absent.

Chloride:

Unlike some of the other contaminants tested for, chloride is listed under National Secondary Drinking Water Regulations (NSDWRs or secondary standards). The limit for chloride is defined as 250 mg/L. However, secondary standards are non-enforceable because high concentrations of listed chemicals “may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water,” but are not known to be a risk to human health. Sources of chloride include "rocks contain chlorides, agricultural run-off, waste water from industries, oil well wastes, and effluent waste water from waste water treatment plants" (water.epa.gov). All samples tested were below the 250 mg/L limit and between 11.76 mg/L and 27.31 mg/L. The highest concentration of chloride was found in the sample of tap water from Sunbury.

Sulfates:

As with chloride, sulfates are listed as secondary standards with a limit of 250 mg/L. Commonly, the source of sulfate in water is natural erosion from rock. The Minnesota Department of Health acknowledges that high concentrations of sulfate can cause diarrhea and dehydration. All samples collected were found to have concentrations below the safe limits. The concentrations ranged from 10.40 mg/L to 23.71 mg/L, with the highest concentration observed in the sample of water from the Susquehanna River.

Nitrates:

Water contamination by nitrates is possible by various means. Common sources of nitrates include "agriculture fertilizers, decayed vegetable water, domestic effluent, sewage disposal industrial discharges, leachable from refuse dumps, atmospheric and atmospheric precipitation" (Kumar & Puri 2012). Excess levels of nitrates in drinking water are reason for concern for health reasons. Kumar and Puri (2012) suggest that nitrates may cause hemoglobin to be reduced to methemoglobin preventing oxygen transport within the body and resulting in a condition known as methemoglobinemia. Accordingly, the limit for nitrate measured as nitrogen in drinking water is 10 mg/L. All samples that we tested were under this limit with the highest concentration found to be 3.11 mg/L (water from Little Shamokin Creek). Tap water from Milton had the lowest concentration of nitrate, 0.43 mg/L.

Phosphates:

Three forms of phosphate, orthophosphate, met-pho sulfate, and organically bound phosphate, can be found in sewage, detergents and organic pesticides. Research has shown that unless in high concentrations, phosphates are not harmful to humans or animals. The EPA website states “a person would have to drink 10 to 15 liters of water to equal the amount of phosphates in just one can of soda.” However, extremely high levels phosphate have been linked to human digestive issues (Kumar & Puri 2012). Very low concentrations of phosphates (measured as phosphorous) were found in three of the water samples. Tap water from Milton contained 0.39 mg/L and tap water from Sunbury contained 0.49 mg/L. Little Shamokin Creek water contained 0.01 mg/L and phosphates were absent from Susquehanna River water.

CONCLUSION

Ultimately, water samples collected at all four locations within Northumberland County prove safe for consumption. Both arsenic and the various anion contaminants tested for were found at levels considered harmless for human health. No trends in concentrations of the contaminants were found among sources. Therefore, this study suggests that water contamination is an unlikely cause for the observed pattern of lung cancer incidence in Northumberland County, Pennsylvania. This research did have some limitations, however. First off, the sample size of this study was small, as only one bottle of water was taken from one location at each of the four sources. Furthermore, collection methods were rather rudimentary and time in between collection and water analysis (within a week of collection) may have influenced data. Additionally, exact sampling locations were not documented, as a GPS was not used. As a result, the water samples were taken from locations deemed by researcher judgement to be within intended location boundaries. Lastly, the quantification of arsenic concentrations was limited, as visual comparison, not chemical methods, were used to determine the concentrations. Evidently, use of more thorough collection methods and scientific protocol for testing may improve the accuracy of results. Much more research is needed to confidently conclude that drinking water from the four sampled locations pose no health risks.

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