

## Exeter NH Region

**Project Title:** What's in your water?

**School:** Exeter High School

**Grade Level:** 9

**Teacher:** Debra Kimball

**Project Partners:** Kathrin Lawler-Dartmouth College(2016-2018), MDI Biological Laboratory, TUVA Labs, University of New Hampshire(Scott Greenwood and Kevin Gardener (2018-2019) )

**Teacher Profile:** I have been a science teacher for over 25 years. I now primarily teach physical science to 9<sup>th</sup> graders. I have a strong commitment to citizen science being active on my towns conservation commission and part of a team of volunteers for the NH DES VRAP program leading water testing on the rivers in my town. For the past 20 years I have involved students in citizen science projects.

**Summary:** Data to Action is a citizen science project involving students in the monitoring of arsenic in well water in their communities and sharing that well water data with others by informing the public on the importance of well water testing. I collaborated in 2016-2017 with 4 other teachers on the water filters and story of arsenic in well water but the 65 well water samples taken were from my classes as well as staff members of EHS. In 2018-2019 school year I was able to involve about 80 students in the water filtration and water testing project. Approximately 50 water samples were again tested. Students were able to analyze and report out of the results. A community forum was held in March of 2019, although attendance was low.

### Project Details:

In 2016-2017 all 440 freshman attended a field trip to the groundwater treatment plant in Exeter- we used grant funding to make that happen. All students got a full tour of the plant, wells, and testing lab.

- In 2016- About 300 students designed water filters to test samples of dirty water for a lab that was designed for the project. Students also explored ground water models.

**Exeter High School Explores Arsenic**

**The Big Picture**  
Students will learn about arsenic in our water and why we should test our well water, what compounds get into our groundwater, how water filters work, and how to make a water filter.

**Water Unit Ideas**  
**Engineering Challenge** - Students will make a filter system and we will test the water pre and post filtering - we can also put contaminants in the water and see how well the filters work.  
**Education piece** - Where does our drinking water come from? Why is it important to understand chemistry to have a better understanding of our well water?

**Performance tasks related to the water theme:**  
1. Groundwater model - using garden donut plastic cups students will build groundwater filter cups with mini wells (straws) - students will test for contaminants in groundwater by using different media to stop the flow of the contaminants - blue dye.  
2. Begin research on a groundwater contaminant - find 3-4 articles on your topic. Our location is the Northeast and contaminants must be common groundwater contaminants on our list.  
3. Testing the Conductivity, pH of common solutions including tap water and DI water.  
4. Water Engineering Project: Designing water filtration devices after testing the initial "dirty water" - Students tested water for conductivity, turbidity and pH.  
5. Collecting water samples and sending to

**Water Testing Unit**  
• In fall of 2016 400 Physical Science Students visit the local groundwater treatment plant to learn about how water can be treated both chemically and physically to remove arsenic, iron, manganese and bacteria.  
• In Dec. 2016 Official Water testing begins- Families of select students and staff were able to pick up a free test kit as part of a classroom-based project called "Building School and Community Collaborations to Eliminate Arsenic from Drinking Water in Maine and New Hampshire: A Model for the US". We sent out 80 kits to get water samples and collected 65 samples for analysis. All the water samples collected by staff and students sent to the Dartmouth Trace Elements Analysis (TEA) Core for analysis in one mailing.  
• In Jan. 2017 we received the water sample results. Students studied the results and created a pamphlet based on the results and other information. (See below)

**Water Filter Lab Findings**  
"Our hypothesis was in fact correct, because by having the sand at the bottom, and rocks at the top, the water came out much more clear than in trial one. We thought that by having the largest contaminant particles removed first, that the other forms of filtration would become more effective. The water went through the rock first, which would catch some of the largest particles. Then the water went to the kitty litter, which would catch up some of the water. Hopefully the dirtiest water would have stayed in the kitty litter while the rest flowed out of it. Finally the sand on the bottom was touched by water, where the fine granules caught some

**The Importance of Water Testing**  
Do you know what is in the water that you

**Private Wells**  
If you were in an appeal to the town, it's likely that you got some water from a private well. In fact, one out of the only one responsible for the development of our water. Nobody else is contributing to the one.

- In 2018- Fifty more water samples were collected from students and staff at EHS which included the following towns: Exeter, East Kingston, Stratham, Brentwood, Newfields, and Kensington, as well as several other communities in Rockingham and Stratford counties. A new water performance task and community outreach project were developed involving 75 students.

- March 2019--A community outreach presentation was planned for March 21<sup>st</sup> at the EHS library from 3-6 pm. Approximately 12 students attended the event as well as 40 more submitted projects for display.  
Only a handful of people attended even though students advertised the event on facebook and posters at town libraries and town offices.

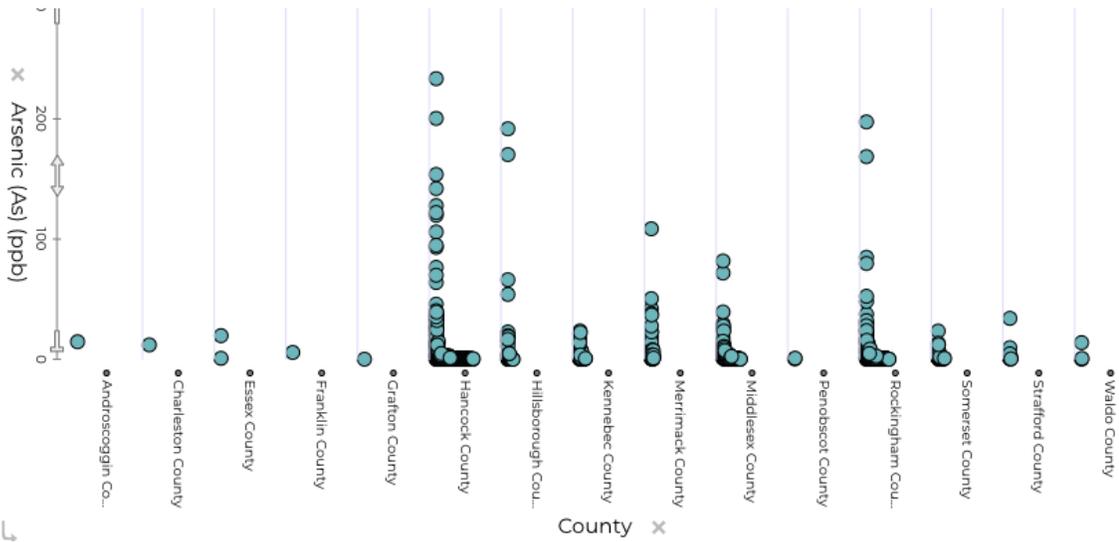
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| <p><b>What?</b></p> <p>This is a well water awareness event, informing you on the contaminants in well water, good or bad, along with why you should test your well water</p> <p><b>Where?</b></p> <p>The Exeter High School library, on March 21st 2019, from 3 to 5 PM</p> <p><b>If you can make it.</b></p> | <p style="text-align: center;"><b>Come to the Exeter High School library on Thursday, the 21st</b></p> <p style="text-align: right;"><small>Jack</small></p> <p><b>Why should you test your well water?</b></p> <p>–Contaminants can occur in your well water, and those like arsenic, can cause negative health issues.</p> <p>The graph to the right shows that arsenic is most common in New Hampshire drilled wells, something a lot of people have. If not treated, these can cause health effects such as cancer.</p>  |
|  | <p><b>Why should you come this Thursday?</b></p> <p>If you can, you should attend this event to learn more about</p>  |

### 2018-2019--Water performance task:

- [What can students explore? Choose one of the 3 options for project](#)
- 1.Students explore the production, purpose, and mechanical issues of a water filtration system, investigating the bests ones for common NH contaminants such as arsenic and or designing their own water filters.
- 2.Students explore which contaminants typically occur in NH well water, why they are a concern, how they might be removed via filtration, and how to share this knowledge with the public.
- 3.Students analyze local well water data available via TUVA database and try to find out if levels of certain contaminants/elements are affect by another factor.
- [Choose three I Can statements for your project](#)
- I can design and conduct a short research project to investigate the types of water filters that best address the contaminants in Southeast NH.
- I can create a water filter prototype that is based on real world research from a range of reliable resources.
- I can evaluate well water data and reach sound conclusions based on the data provided
- I can analyze and make predictions from raw data sets by creating valid graphs
- I can make a convincing case for the community to do water tests
- I can interpret and evaluate information from many sources to develop a complete picture of the Southeast portion of NH well water data.
- I can test my water filter and identify specific design weaknesses
- I can interpret and evaluate information from multiple sources to better analyze groundwater contaminants

About 80 students conducted water tests to see if their filter designed would purify the dirty water samples (iron or copper filings, coffee grounds, silt, and or NaCl or acetic acid, food coloring). There were 4 different types of dirty water- some proved too difficult to clean up with our materials. Twenty five students went on to explore the water filter design option in more depth and engineered many designs. .At least 50 percent of all students analyzed the water data using the TUVA labs site for arsenic data. We received technical help from Scott Greenwood and Kevin Gardener of UNH. Kevin Gardener was also able to interview a few students on their final projects at our community event in March. We had planned for an April Tuva data analysis presentation and tutorial for students but our schedules were too full.

- Students created basic graphs and infographics on the importance of understanding arsenic levels in well water.



## WHY YOU SHOULD TEST YOUR WATER A MESSAGE BROUGHT TO YOU BY NOAH JOHNSON

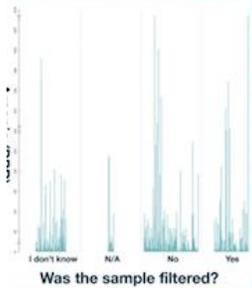
If your water comes from a private well, then you are responsible for your own water. If you are not sure of what is in your water, then it is necessary you get a water test. Why? Many reasons. The main being the amount of Arsenic in your water.

### ARSENIC

Arsenic is an element that is found in nature, man-made products, and in some pesticides. Lower levels of arsenic can be found in water, and in the air. It can be found in two different compounds: inorganic and organic. When in an inorganic compound, it is more likely to be cancer-causing. An inorganic compound is any compound that does not include carbon.



People consume the largest amounts of arsenic in food. According to the Virginia Department of Public Health, the average person consumes about 100 micrograms of arsenic each day. But, that doesn't mean there can't be large amounts of arsenic in your water.



So now you know what arsenic is, here is why you should test your water before, it is cancer causing when in an inorganic form. But this isn't all, arsenic can also cause health problems like gastrointestinal illness, reproductive problems, and skin lesions. That is called arsenic poisoning. This is most commonly caused by contaminated groundwater. The most at risk for arsenic poisoning from water are children, pregnant women, and the elderly. The symptoms include swollen skin, abdominal pain, nausea and vomiting, diarrhea, abnormal heart rate, and fatigue. This can all be prevented if you take a water test to see if your arsenic levels are under control. Public health officials advise by law to have less than 10 ppb (parts per billion) of arsenic in your water, but some believe any arsenic at all is bad, so they test their arsenic levels under 1 ppb.

The graph above shows the differences in arsenic levels depending on whether or not the water sample was filtered.

### OKAY, SO HOW CAN I TEST MY WATER? WHAT FILTER DO I GET?

- We had planned on graduate students from UNH helping EHS students with the TUVAs. They did make an instructional video for us but we simply ran out of time to coordinate and follow through on our ideas.

**Supplies purchased:** Charcoal for filtration, filters, pH, and conductivity probes, water pitcher filter, as well as water test kits and other water testing supplies.

### **What did students learn?**

Students learned about the importance of water testing and understanding how various elements in our water affected our health. Students were surprised to learn about how little of arsenic could have serious health effects. Many encouraged their parents to install better filters and some had their grandparents getting water tests. Students also learned the value of face to face communication with the public. Students had to present their findings to other students and then a few presented to the public at our event. Student learn about how water filters work and how important a water filter is. They also realized that filtered water is what many bottled water companies sell—they wanted to test the various bottled water samples but I did not think we were allowed to do that. I thought it was a good idea.

### **What did you learn?**

- I would rethink how to do a community event- folks just don't turn out for a water event on a Thursday afternoon or evening- it needs to be part of a bigger event. If I did this again I would get volunteers to man a table at one or two of our winter farmers markets.
- I would begin the project earlier and have distinct stage of the water analysis project. I would allow more time to learn TUV A and have perhaps UNH grad students work with our students on this piece. I also realized it might be best to scale back this project so that the most important pieces get done- we focused so much time on investigating and building filters, as well as how they worked that we really did not spend enough time on the data analysis as I would have liked.
- However, I did use this project as a model for Student Centered Learning (there is even an exemplar on the NGSX science project ideas site of how to design a water filtration and community project). I learned that when I let students choose which way they wanted to explore this topic they really got invested in this project since it was their own. Student created amazing filter designs, did good research and created google sites that informed the public. In the end more folks in the community really do know about arsenic in their water and what that means for health. We created awareness around the Arsenic and You website.
- What would you do differently? I would weave the essentials of this project into our curriculum on chemistry and data analysis so that will was not a separate project at the end of chemistry but an evolving thread that wove all of what we learned on chemistry together. I would focus on what ppb really meant as well as explore TUV A data sets sooner. I would also begin this project sooner in the year- say in October. I would also work more closely with my teaching partners, and the UNH mentors that involved data analysis for all students.

**Conclusion:** I have a strong commitment to citizen science for both myself (long time member of my town's Conservation Commission) and my students (UNH Albedo study and Harvard Forests Hemlock Wooley adelgid project). The All About Arsenic project fits into this citizen science piece by involving students in the monitoring of water quality in their own homes and getting out the message of how important it is to test and understand how arsenic affects human health. New Hampshire is looking at lowering the MDL of arsenic to 5 ppb from 10 ppb- this will create a new talking point for the importance of water testing in for every NH well.

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