

**Project Title:** Elevated Groundwater Arsenic Concentrations In Private Wells in Central Maine

**School:** Waterville Senior High School

**Grade Level:**10-12

**Your Name:** Jon Ramgren and Justin Giroux

**Project Partners:** Dr. Juyoung K. Shim, University of Maine Augusta, was the scientist partner for this project. Justin Giroux and Jon Ramgren, the chemistry teachers at Waterville Senior High School, collaborated on the implementation of this project.

**Teacher/Scientist Partner Profile:**

Jon Ramgren has been teaching for 30 years. He has a Bachelor of Science in chemistry from North Park College and a Masters in Secondary Science Education from The Ohio State University. Over the last 10 years he has involved students in research opportunities at the Mount Desert Biological Laboratory during April vacations and summers. He coaches the Science Olympiad Team and the National Ocean Science Bowl Team. He enjoys seeing students get involved in new experiences that lead them to engage in further learning about - and exploration of - their world.

Justin Giroux has been teaching for 9 years. He has a biochemistry degree from Bates College with a focus on environmental chemistry. His undergraduate research focused on improving the efficiency of CdSe based photovoltaics. Justin is interested in bringing real life problems to his classroom to allow his students the chance to work on something meaningful to their community. To achieve this, his chemistry classes have a focus on energy and water.

**Summary:**

In the fall, Waterville High School students spent the first few weeks of the school year studying our local Messalonskee Stream that runs near the school's campus. Collecting samples done in the early fall with the idea that students could sample water at their camps before they were winterized. Obtaining samples was difficult since many of the students live on public water supplies. Obtaining a sample was worth a grade in each class. Adults in the building were able to help out students who could not find a well to sample. Students also conducted an experiment involving duckweed and arsenic concentrations ranging from 0 to 100 ppb. We purchased 7 grow light set-ups, one for each class, and duckweed. We tried different nutrient amounts, but struggled to keep the duckweed alive. Justin's class worked on producing a website publishing the results and Jon's class worked on letters to the Maine Legislature as a final project.

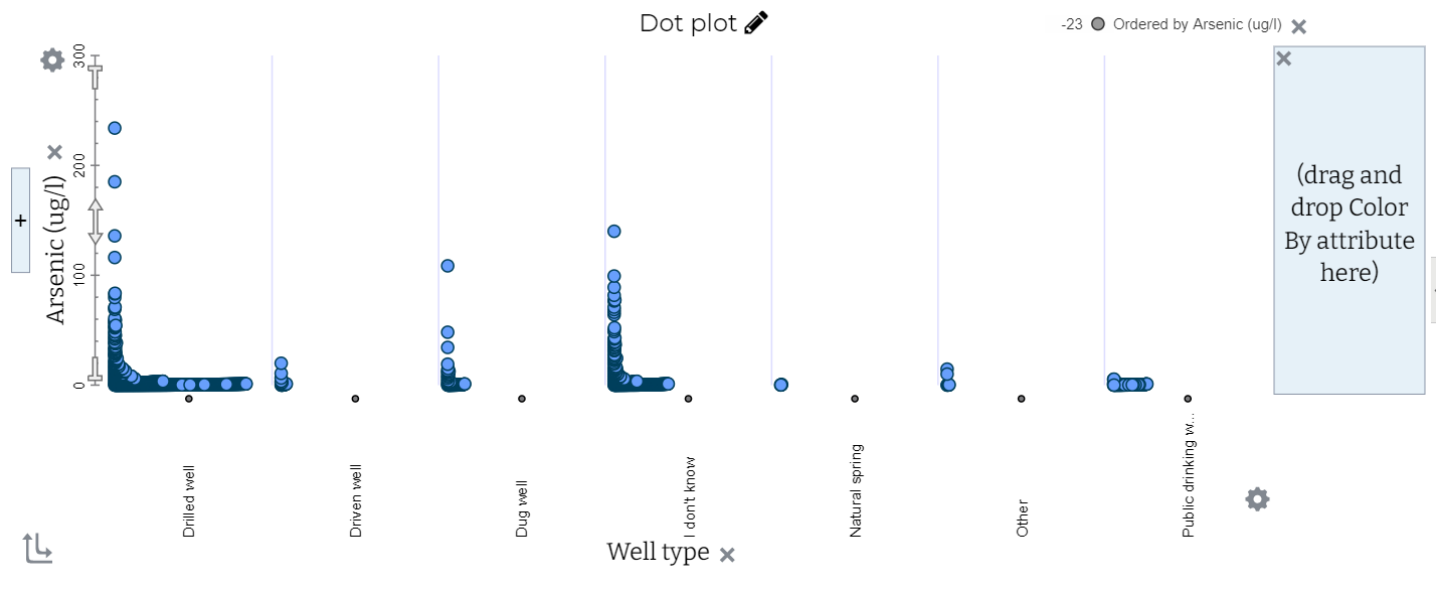
We also participated in *Crowd the Tap Maine* through the Schoodic Institute. This allowed every student to get data on the water from their house, no matter the source. Students made observations and did simple water quality testing on water from the various faucets in their homes. Data was entered into the *Crowd the Tap Maine* project on Anecdata. Jon ran out of time to work with his classes on analysing this data. Justin's class learned about types of both historic and modern pipes used in homes. His students put their data onto Anecdata. His students were able to ask questions about their individual results and their meaning, but they did not have time to make determinations about areas in town that require further study.

**Project Details:**

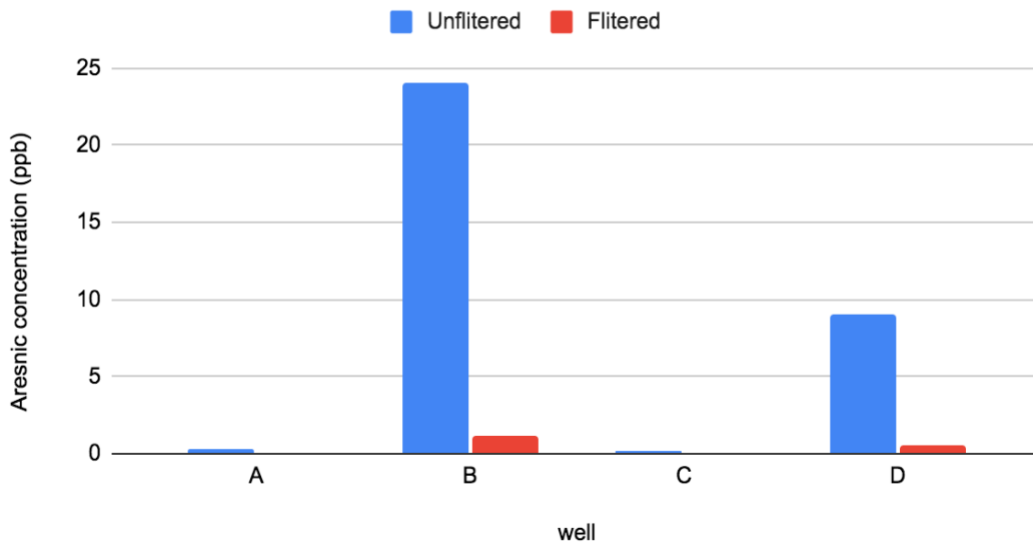
- How many students were in the class that was involved in this project? Justin had 31 students work on this project. Jon had 39 students.

- Detail specific curricular items such as questions, articles, books, YouTube videos, and labs. It's helpful if you provide links.
  - "The Quest for a Clean Drink" <https://www.acs.org/content/dam/acsorg/education/resources/highschool/chemmatters/gcquest-for-a-clean-drink.pdf>
  - "The Flint Water Crisis: What's Really Going On?" <https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/pastissues/2016-2017/december-2016/flint-water-crisis.html>
  - Maine Geological Survey Bedrock Geology Maps <https://www.maine.gov/dacf/mgs/pubs/online/bedrock/state.htm>
  - "How Much Arsenic is in Rice" <https://www.youtube.com/watch?v=9XK66S50oas>
  - Tuva Video tutorials <https://tuvalabs.com/resources/videos/>
  - Tuva pre-made data sets and activities [https://tuvalabs.com/content/?show=all&view=block&type=datasets&order\\_by=-last\\_modified](https://tuvalabs.com/content/?show=all&view=block&type=datasets&order_by=-last_modified)
  - "Assessment of Arsenic Concentrations in Domestic Well Water, by Town, in Maine, 2005–09" <https://pubs.usgs.gov/sir/2010/5199/>
  - Questions for "All About Arsenic - Data to Action: A Secondary School-Based...", <http://www.allaboutarsenic.org/>
  - Jon and Justin used Tuva activities to teach students how to use the program. Jon also put the data from the class penny density lab into Tuva and had students make graphs of the data. Justin used Tuva with his periodic table unit. Students also made various graphs of the Arsenic Data Set.
  - Essential question: What conditions cause the water quality of Messalonskee Stream to change?
  - Essential question: How widespread is the PFOA contamination in Central Maine?
  - Essential question: How widespread is arsenic in Maine's well water?
  - Essential question: Is lead in pipes an issue today in Waterville, ME?
- Did you:
  - Collaborate with any other teachers in your school? *See above*
  - Go on any field trips? Why and where? *Only to the local stream.*
  - Conduct any experiments? What kinds of questions did students ask? *We used duckweeds as model organisms to ask the question How does arsenic concentration change duckweed growth?*
  - Use your stipend to purchase anything for your classroom? If so, what, and how did you use it? *Several Vernier water quality probes, materials for student duckweed.*
  - Invite any guests to visit your classroom? *No*
- How did you use Tuva, both for the arsenic data and for other datasets? Students used the periodic table dataset as the introduction to Tuva. Once the arsenic data was produced students used Tuva to explore the dataset to explore associations between the different attributes. Students then begin to understand that not all data is significant and work must be done to determine what is and what is not significant.
- How did you plan your community outreach?
  - What did the students do?
    - Justin's students worked on a website
    - Jon's students wrote letters to the legislature.

- What was the impact?
  - Justin’s students ran out of time to get the website published
  - Jon’s students decided not to mail in their letters.
- Include any data analyses your students did.



### Effectiveness of Zero Water Filter at Reducing Aresenic in Well Water



#### Discussion:

- What did students learn? It’s great to include quotes if you have them.
  - “Arsenic contaminated water it could cause public health issue”
  - “Although not all filters work, Zero Water Filters have shown that they are very effective at reducing arsenic in wells.”
- What did you learn?
  - This year we learned a lot more about the local PFOA issue as it ties into our drinking water theme. We also learned a good deal about lead in pipes. This is the second year now that we’ve

found that some filters specifically marketed for arsenic do not filter out arsenic effectively, but Zero Water has done so consistently.

- What would you do differently?
  - We have a lot of content and real world initiatives that we try to cover in our classes. We would like to work on making it all more seamless going forward.

**Conclusion:** The arsenic project was well received by students. We did find several families have high levels of arsenic in their well water. We found the percent of wells tested with elevated arsenic was similar this year to last year's results. We were able to teach about what things can be done if there is a high level of arsenic in a given water supply. Making water quality the central theme of our chemical class has been helpful at engaging students. We will continue to work at refining curriculum and activities to improve student outcomes.

**References:**

<https://csi-maine.org/crowd-the-tap-maine/>

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