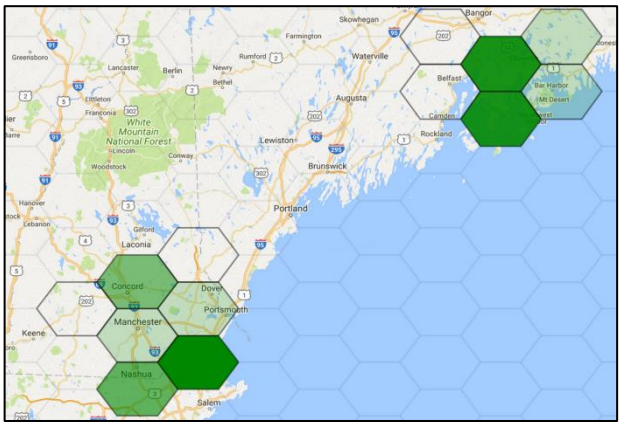
Building Collaborations to Eliminate Arsenic from Drinking Water



An evaluation of a school-community health agency collaboration project in Maine and New Hampshire

Technical report provided to the US Environmental Protection Agency

Dr. Karen Hutchins Bieluch, Dartmouth College
Dr. Bridie McGreavy, University of Maine
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Introduction

As stated in our grant application, the ultimate goal of this two-year project was to create and pilot a national model of environmental education. The objective of this model was to facilitate schools and community health agencies working together to address the public health risks of exposure to toxic contaminants in drinking water, with a particular focus on arsenic. To achieve this objective, the program devised a collaborative, extended classroom-based model of education that engaged students, teachers, and community members in well-water testing and remediation, focused on arsenic. Education coordinators from lead institutions in Maine and New Hampshire, including the Mount Desert Biological Laboratory, and Dartmouth College respectively, and community health agencies in each state collaborated with teachers to design, implement, and support the project.

The purposes of the formative, and summative evaluation for this project are to (1) describe the impact of the program on participants; (2) characterize changes in the social infrastructure within project communities, including the role of the website in shaping connections between project participants; (3) provide evaluative information to project leaders and participants to improve ongoing design and implementation; (4) identify strengths and limitations throughout the project to develop a replicable model; and (5) provide recommendations for project sustainability and broader impacts. We took a multi-pronged and mixed methods approach to evaluation to provide a holistic account of the program from diverse perspectives, including the teachers, community health partners, education coordinators, and the program administrator. Although we did not survey students directly about their experiences, we sought to include their perspectives through classroom and community meeting observations, interviews with teachers, and document analysis, which contributed to our overall understanding and evaluation of this project.

Evaluation Methods

Our evaluation approach included individual phone interviews, observations of classroom and community meetings, online teacher project journals, a pre- and post-implementation survey of teachers, and document analysis. We provide all of our research protocols, including informed consents, invitation e-mails, interview protocols, survey protocols, and related documents as Appendices. We initiated our evaluation in August 2015 and concluded with the submission of this report in July 2017. Each evaluation method was designed to provide information on five program goals: 1) overall program operations and experiences, 2) teacher and student content knowledge related to arsenic and drinking water, 3) teacher and student learning related to scientific process skills, literacy, and confidence; understanding connections between humans and nature; developing problem-solving skills in nature and society; and strengthening environmental stewardship inclinations and/or discussions (acronym SCoPSS); 4) individual and community action, such as well water testing and remediation, when necessary; and 5) individual and organization-level social network changes, such as between community health agencies and teachers.

To support an adaptive and responsive program design, we met with the program administrator, education coordinator and website designer after the first set of teacher projects were implemented in fall 2015 and winter 2016. We discussed the initial results from the teacher pre-surveys and our collective program experiences. Based on this discussion, we identified opportunities for strengthening the program, including the need to address barriers to information sharing among education coordinators and teachers because the coordinators are not in the classroom. In some cases, there was a lack of awareness among coordinators about what teachers were doing. However, we also noted that this lack of awareness was also, in some instances, an indication that teachers were picking up the program and running with it on their own. Overall, in the early months of the project, there was a need to improve project coordinator and teacher coordination. Following this feedback, participants worked to improve information sharing through increased e-mail exchanges and visits to classroom. We also recommended earlier outreach to community health partners to help strengthen their connections with the program. Finally, in this meeting, we brainstormed ways to address teacher feedback on the survey. Overall, teachers reported that they were happy with the way the project was working and seemed to have a good sense of project expectations and communication with education coordinators. Some of their needs included wanting guest speakers in the classroom, needing more information on the sampling procedure, needing assistance with GIS, data mapping and community meetings, and wanting case studies and links to groundwater movement. As a group, we identified specific strategies to increase guest lectures, clarify sampling procedures, improve mapping assistance, and provide case studies and additional case study resources.

At the end of Year I, we compiled a formative evaluation report in which we analyzed teacher pre- and post-surveys, observations of classrooms and community meetings to-date, and teacher journals. See Appendix VIII for a copy of that report. We provided that report to the education coordinators and program administrator in August 2016. Specifically, we recommended that project leaders work to ensure that the invitation to participate in the digital journaling goes out early in the program and is introduced during the face-to-face teacher meeting in order to capture their thoughts about the curriculum as it is being implemented, versus retrospectively. We also identified a need to reach out to the community health partners earlier in the project and evaluation process to promote their engagement and participation. Further, evaluators conducted a training with coordinators on participant observation methods and provided a guideline for conducting the observations to support data quality and ensure consistency in observation methods across sites; see Appendix IX for observation guidelines.

For our final report, we analyzed each data source for evidence of the five program goals listed above, specifically overall program experiences; changes in content knowledge about well-water and arsenic; scientific process skills, literacy, and confidence; understanding connections between humans and nature; developing problem-solving skills in nature and society; and strengthening environmental stewardship inclinations and/or discussions (acronym SCoPSS); community actions; and network changes. Our analysis reflects these findings.

Analysis

Science, Connections, Problem Solving, and Stewardship (SCoPSS):

Science: Although we began the grant with the goal of increasing student and teacher confidence in engaging in and teaching science, the ultimate outcomes of this project did not meet this goal. As one teacher noted, "The process of science was lost. It was more like magic." Thus, while there were several important outcomes related to the grant, students were not heavily involved in the scientific process. Instead, while students were involved in data collection, the testing kits were "ready-made," and the students were removed from the analysis process. It appears that the primary scientific skills they learned were related to science communication and data visualization.

Teachers, coordinators, and project leaders discussed the benefits of the data visualization tool and students' interest in playing with the data. However, few classes worked in depth with the data, and there were some frustrations with not knowing how to manipulate the website to work with the data. Importantly, throughout the project, the website developer and education coordinators worked to improve the data portal to meet teacher and student needs.

These findings were also demonstrated in the survey results which, overall, demonstrated limited to no change in a series of questions focused on self-efficacy in learning and doing science (Table 1).

Table 1. Pre- and post-survey questions focused on self-efficacy for learning and doing science. Participants were asked to indicate how much they agree or disagree with the series of statements, where 1=Strongly Disagree and 5=Strongly Agree. Survey questions adapted from the DEVISE Framework developed by the Cornell Lab of Ornithology.

Survey Items	Pre		Post	
	Mean (n=6)	SD	Mean (n=4)	SD
I think I'm pretty good at understanding topics about well water quality.	4.2	.408	4.3	.50
Compared to other people, I think I can quickly understand new topics about well water quality.	4.3	.516	3.8	.96
It takes me a long time to understand new topics about well water quality.	1.7	.516	1.8	.50
I feel confident in my ability to explain well water quality topics to others.	3.8	.983	4.0	.82
I know the steps necessary to teach well water quality concepts effectively.	3	.707	4.0	.82
I think I'm pretty good at following instructions for collecting well water samples and interpreting lab reports.	4.3	.516	4.5	.577
Compared to other people, I think I can effectively collect well water samples and interpret lab reports.	4	.000	4.5	.577
I feel confident about my ability to explain how to collect well water samples and interpret lab reports to others.	4	.000	4.0	.816
I am continually finding better ways to teach science.	4.5	.548	4.8	.500
I am not very effective in monitoring science experiments.	1.7	.516	1.3	.500
I am typically able to answer students' science questions.	4	.000	4.3	.500
I wonder if I have the necessary skills to teach science.	1.3	.516	1.3	.500

Connections: Overall, students seemed to strengthen their understanding of the connections between human behavior and health and environmental conditions.

Problem Solving: Problem solving was rarely discussed in the interviews. Instead, a few interviewees noted the need to have more information and resources available in future projects to help parents and community members address and remediate well water problems.

Stewardship: At the start of the grant, we sought to understand the impacts of the program on students' and teachers' environmental stewardship. As the project concludes, we are discovering an equally important, albeit different, outcome that emerged from this project. Interviewees' comments revealed that the project had a significant impact on student empowerment or agency. Teachers noted, and students provided quotes to support, that students felt empowered to help educate fellow community members about arsenic, and other elements, in drinking water. Further, students seemed to realize that they had the ability to help others test their water. The one issue that seemed to arise, especially in New Hampshire where the community health partner model was different, was that the students and teachers lacked the ability, and resources, to advise community members on remediation practices.

As part of the pre- and post-survey, we assessed changes in self-efficacy for environmental action as a proxy for problem solving. Similar to the results related to self-efficacy for learning and doing science, teachers self-reported high levels of self-efficacy for environmental action as well. Though the changes were not statistically significant, there was a notable increase in the mean score for the response to the statement "I am capable of making a positive impact on environmental quality for human health" in the post survey responses. Further, where there was a change in mean scores the change indicated a potential increase in feelings of self-efficacy for positive environmental change.

Table 2. Pre- and post-survey results focused on self-efficacy for environmental action. Participants were asked to indicate how much they agree or disagree with the series of statements, where 1=Strongly Disagree and 5=Strongly Agree. Survey questions adapted from the DEVISE Framework developed by the Cornell Lab of Ornithology.

Survey Items	Pre		Post	
	Mean (n=6)	SD	Mean (n=4)	SD
I feel confident in my ability to help educate my students and community about well water quality.	4.2	.408	4.3	.500
I am capable of making a positive impact on environmental quality for human health.	4.0	.632	4.5	.577
I am able to help take care of well water quality.	4.0	.632	4.0	.816
I believe I can contribute to solutions to well water quality problems by my actions.	4.0	.632	4.3	.500
Compared to other people, I think I can make a positive impact on well water quality.	4.0	.632	4.0	.816
I don't think I can make any difference in solving well water quality problems in my community.	1.3	.516	1.5	.577
I believe that I personally, working with others, can help solve well water quality problems.	4.3	.516	4.3	.500
It's hard for me to imagine myself helping my students learn about well water quality.	1.2	.408	1.3	.500

Teacher and student content knowledge:

An increase in teacher and student content knowledge is perhaps the most significant outcome of this project. According to the teachers and education coordinators, at the start of this project many students were unaware of where their water came from, who regulates their water, what kind of contaminates may impact their drinking water, or the adverse health effects of the contaminates. At the end of the project, students understood their water system, developed presentations describing the system and project results, and were engaging their communities in discussions about arsenic in drinking water. Teachers also learned about arsenic in the water and food system, and they noted the benefits of this improved understanding.

Exemplary Student Quotes:

- “I’ve learned that arsenic can get in the water from bedrock.”
- “I have learned that the quality of groundwater can impact your health.”
- “This project shows that people have to know about their environment in order to protect themselves.”
- “I have learned that groundwater can be contaminated, even if it has no color to it.”
- “I feel good that we are helping people figure out more about their water.”
- Student feedback on what they learned: “Which elements are common in water, Types of water sources, processing and pH levels. What arsenic is. Arsenic is a carcinogen. Arsenic is very common in certain soils. How Arsenic affects the body. E.PA. standards for levels acceptable in drinking water and how they have changed over time. That arsenic is a health problem that can be remediated if one is aware of the presence of the contaminant.”
- “Makes me want to make a positive impact.”
- “This study has taught us what to look for for future homes with your well water.”
- “In my eyes we are fortunate to be granted this money and to be spending it on something that matters in our community. Arsenic can make a huge impact on somebody's life and I'm glad we have the opportunity to prevent it if we find arsenic in people’s water.”
- “Contributing to arsenic studies in NH has broadened my interest on the subject. Our test results could result in cleaner, safer water statewide.”
- "This project shows how arsenic can get from the bedrock into the groundwater that we draw our water from, then we drink the water and it can severely harm us."
- "Humans need water to survive, but it's not always safe. That is why we are getting our water tested for arsenic.”
- "I have learned that drilled wells are usually in bedrock and that is where arsenic is found. I know that things on the surface can also affect the groundwater."
- "I learned that ground water can be contaminated naturally and not just by humans."
- "I've learned that groundwater is an important source of drinking water."
- "I have learned that the quality of groundwater affects your health."

These descriptive results are consistent with the post-survey responses where 75% (n=3) of teachers indicated “Yes” and 25% (n=1) indicated “Maybe” in response to the question: “Do you feel that the "All About Arsenic" resources increased student interest in science?”

However, it also appears that teachers had high content knowledge at the initiation of the project and that this content knowledge, as measured in the survey, did not change during the project. Comments made during teacher interviews, in the case study reports, and in the online teacher journals did indicate teacher learning.

Table 3. Pre- and post-survey results assessing content knowledge about arsenic in Maine and New Hampshire. Results demonstrate that teachers had high content knowledge about basic scientific facts and regulatory processes for arsenic at the start of the program and that this content knowledge did not change during the project.

Arsenic Content Knowledge				
	True (Pre)	**False (Pre)**	**True (Post)**	**False (Post)**
Arsenic is a naturally occurring element.	6	0	4	0
Arsenic does not typically impact human health.	0	6	1	3
Arsenic has numerous human health impacts on adults, children, and fetuses.	6	0	4	0
Children are especially resistant to the effects of arsenic.	0	6	0	4
It is uncommon for arsenic to be found in Maine and New Hampshire wells.	0	6	0	4
A representative from a State agency needs to take the water sample to test well-water.	0	6	0	4
Individuals can collect their own well-water samples and send them to a lab for testing.	6	0	0	4

All respondents (pre and post) indicated that filtration was the most effective mitigation strategy for treating arsenic in well water. All respondents (pre and post) also indicated that if their neighbor's well tested negative for arsenic that they should still test their well water.

There was a slight change in the correct responses to the identification of the United States E.P.A.'s maximum contaminant standard for arsenic in public drinking water (10 ppb), with 66% of respondent indicating the correct response on the pre-survey and 100% indicating the correct response on the post-survey. On the pre-survey, one respondent selected 100 ppb and another selected "I don't know."

There are likely multiple intersecting factors that shaped teachers already high levels of content knowledge, one of which is demonstrated in the results to the question about sources of information that teachers were already accessing prior to the initiation of the project. As shown in Table 4, teachers identified multiple and relatively diverse sources of information to support their teaching and professional development, including websites, professional conferences, and academic institutions. Importantly, multiple teachers indicated that the National Science

Teacher Association resources were a key resource, which may be an important vehicle for helping to expand this project from a pilot to a national model.

Table 4. Identified sources of information for teaching and professional development.

Sources of information		
Resource 1	**Resource 2**	**Resource 3**
Websites	Conferences	Research Institutions
New Hampshire Department of Environmental Services	Environmental Protection Agency	Center for Disease Control
MEPSP	National Science Teacher Association	Next Generation Science Standards
SEPUP (Lawrence Hall of Science) Resources owned by my school	National Science Teacher Association	Penn State University (I recently moved from PA and still have many connections to researchers there)
NASA	UCAR	Physical Science Explorations Textbook
PBS Learning Media	National Science Teacher Association, esp. Science Magazine	Colleagues & local resources such as the MDI BioLab

Individual and community action:

On the whole, community response to this project was positive. It is difficult to track the actual community impact, as we do not have data on which households have taken steps to improve their drinking water. However, as with the students, the parental and community outreach that occurred through this project improved community education about arsenic and the associated risks in their communities. On the whole, the impact appears positive and hundreds of families and community members now have up-to-date water quality information from which they can make informed decisions. 320 samples were collected and tested during this project. In addition, MDIBL formed a partnership with College of the Atlantic (COA) in Maine, and Dartmouth agreed to provide testing for their samples. COA provided an additional 77 samples. In total, 397 samples were tested and the results delivered to participants.

Perhaps one of the other great learning experiences for students was when their parents or fellow community members chose inaction over action when receiving negative test results, or when they chose not to test at all because, as one teacher reported, “they didn’t want to know.” Teachers, community health partners, and education coordinators noted students’ dismay at these responses; they could not understand why people would not act or would choose less over more information. These experiences helped students understand the diversity of opinions in their community, how to present information to diverse audiences, and how to persist in the face of opposition.

Individual and organizational network changes:
The strongest network changes appear to be within states between organizations and teachers and between states between MDIBL and Dartmouth's Toxic Metals Superfund Research Program. There was little cross-state collaboration between teachers or teachers and out-of-state organizations. However, relationships that were developed between teachers and their in-state collaborators have opened the door for future collaborations, on this or other projects, and the relationships that were developed between organizations across states was strengthened through this work. In fact, it is likely these organizations will continue to work together on other grants at some point in the future.

Although important relationships were built, there were some communication challenges. All interviewees noted there was a lack of communication among all project partners, which often led to role confusion and a feeling of being disconnected from the larger project. Teachers noted that they would have liked to have more meetings and forums for sharing ideas with other teachers, and the community health partners, education coordinators, and project leaders noted that they would have liked to have more consistent meetings throughout the project so that partners could learn about the skills each participant brought to the project, learn from each other, and share successes and failures.

Across interviewees, participants mentioned that the NH Arsenic Consortium Meeting was a valuable forum for learning about arsenic and connecting to project partners. It helped participants feel like they were part of a larger project and important interpersonal relationships were developed. People got to see and talk with collaborators. It was also a professional development opportunity for several participants.

We also saw evidence in changes in communication networks and information seeking behavior reported in the survey. Table 5 demonstrates how prior to the project, teachers were largely not accessing governmental information about environmental health issues (n=4) though two indicated that they accessed information from state agencies. During the project, all of the respondents indicated they accessed information from either the Maine Department of Environmental Protection or the New Hampshire Department of Environmental Services. Half of the respondents (n=2) also indicated that they accessed information from the Maine Center for Disease Control (CDC). These results demonstrate that in a scaled up version, programs can be designed to improve teacher access to state-based information about arsenic and related environmental health issues.

Table 5. Results for sources of information before and during the project. Note: On the pre-survey participants could only select one option and on the post survey they could select multiple. If this question were used in subsequent analyses, it would be advisable to allow participants to select multiple options in both the pre and post surveys.

Source	Pre	Post
Maine Department of Environmental Protection (ME DEP) and New Hampshire Department of Environmental Services (NH DES)	2	4
Maine Center for Disease Control (ME CDC)	0	2
I did not acquire information about well water testing before/during this project.	0	0
I did not acquire information about environmental health before/during this project.	4	0

Descriptive results for resources accessibility and information seeking

What, if any, resources in the "All About Arsenic" were useful to you?

- CDC Resources were great
  The website itself with the data map was interesting and fun to use
- video
- The data map to see distribution of Arsenic in area and other areas. The blog to find out what other teachers are doing in their classrooms on water quality.

What, if any, resources in the "All About Arsenic" were not useful to you?

- The resources listed under Teacher resources is a small list but helpful and growing.
- Finding data submitted was not working well when I visited- only got a few samples for Maine, the site was also hard to navigate

How could the resources be changed to be more useful to you?

- More local professional water quality people to connect with to help answer questions about wells and how they are made and work.
- Redesign the site to be more user friendly- it was clunky- not intuitive

Project successes

Coordinators and leaders emphasized that the two greatest successes of the project were, one, providing teachers with an opportunity to conduct hands-on, meaningful projects in their classrooms, and, two, educating students about arsenic and giving them the tools to plan and execute community engagement activities about this issue.

Teachers emphasized the action component, water testing, of the project as a key success. They discussed the importance of water testing for their community and were pleased that their students could play a key role in facilitating testing. One teacher noted that she liked splitting

the project into two years so students were not overwhelmed with testing and doing the community meeting. Most teachers also indicated that this project helped them meet state and national science standards, where 75% (n=3) of teachers selected “Yes” in response to the question “Did the "All About Arsenic" resources help you meet state or national learning standards?” and these teachers then elaborated on the ways in which this project helped them meet the standards, including naming specific standards as shown:

- This unit particularly helped me meet NGSS Science, Technology, Society and the Environment (Appendix J).
- S:LS2:11:1.6 Explain or evaluate potential bias in how evidence is interpreted in reports concerning a particular environmental factor that impacts the biology of humans.; S:LS3:11:1.2 Identify ways of detecting, and limiting or reversing environmental damage.; S:LS4:11:2.5 Explain that gene mutation in a cell can result in uncontrolled division, which is called cancer; and describe how exposure of cells to certain chemicals and radiation increase mutation, and thus the chance for cancer.; S:LS4:11:2.6 Use evidence to make and support conclusions about the ways that humans or other organisms are affected by environmental factors or heredity (e.g., pathogens, diseases, medical advances, pollution,)
- The project helped me meet standards on water quality, impact of humans on natural world, and chemistry.

Community health partners emphasized that the project leader’s selection of teachers for this project, and the motivation and focus of the teachers, were successes on this grant.

Finally, several interviewees identified that the relationships built (e.g. between MDIBL and Dartmouth and among teachers, community health partners, and MDIBL and Dartmouth) were important for future collaborations, including writing grant applications. Further, teacher professional development (i.e. funding teacher travel to present at a conference) was a key success of the project.

Project challenges

Participants identified four primary project challenges related to collaboration, process/resources, experience, and funding. Several teachers also noted the challenge of not dedicating enough time for the project and a commitment to allotting more time for the project in future years.

Collaboration: Several interviewees noted that they would have liked more opportunities to share resources, particularly among teachers; to involve community health partners in a more in-depth way, and to improve communication with teachers. The lack of in-depth involvement of community health partners seems to be related to a lack of understanding of their role and expertise by all parties, including the community health partners, and a break-down in communication among teachers and community health partners and the education coordinators. While community health partners and teachers noted that the education coordinators were the life blood of the program because they brought key participants

together and kept information flowing between participants, even the education coordinators were not always included by teachers in the scheduling process for community meetings. Coordinators and community health partners were sometimes told at the last minute about the community meetings, if at all, thus resulting in them not being able to attend all events.

Process/Resources: A couple of participants noted that the website, and particularly the data portal, was a challenge, partially because they were so excited about what it could provide but lacked the knowledge for how to use it effectively. This finding was also reflected in the Year 1 survey results. For example, one teacher noted that they wished the data portal and maps were more interactive so the students could play with the data. Yet, as one education coordinator noted, there are real concerns with the map and protecting individuals' privacy. Thus, while the map needs to be fine-grained enough to engage the students and allow them to ask specific research questions, it also needs to lack specificity to protect privacy. In general, teachers and students seemed unsure how to use the data to answer specific research questions, or how to ask specific questions of the data. Other website challenges noted included navigation, logging in, and knowing how to add to and use the journals. Another teacher noted that getting samples back from the community in a timely manner was also a challenge. Finally, one community health partner noted that the partners' and teachers' timeframes are different, and this led to some scheduling and communication challenges.

Experience: A few interviewees noted that some participants lacked knowledge of how to work with students and teachers, and this lack of experience led to some challenges with relaying complex information to students and understanding how to fit into a teacher's classroom plans. Interestingly, while a couple of interviewees noted that they did not think their community health partner had much experience interacting with schools, both community health partners interviewed for this project explained that they, or their organization, had experience working with schools on other projects. Thus, the perceived lack of experience may have been related to a lack of experience with the topic area instead of with K-12 schools generally.

Funding: Finally, one community health partner noted that the small amount of funding restricted her/his involvement with the project. This project represented a small portion of an individual's worktime. Even if s/he wanted to be more involved, because community health partners are primarily grant funded, s/he could dedicate limited time to the project.

These challenges are also observed in the post-survey responses that evaluated the project organization and communication (Table 6).

Table 6. Results from pre and post survey where participants were asked to indicate how much they agree or disagree with the series of statements that evaluated project organization, communication, and use of the All About Arsenic website, where 1=Strongly Disagree and 5=Strongly Agree.

Survey Items	Pre		Post	
	Mean (n=6)	SD	Mean (n=4)	SD
I feel like I know what was expected of me for this grant.	3.7	.516	4.3	.500
I feel like I know what I needed to do in my classroom to achieve the goals of the grant.	3.8	.408	3.8	.957
I did not receive adequate information from the education coordinators to plan my curriculum for this grant.	2.0	.632	2.0	.816
I knew how to reach my community health partner.	3.5	1.225	4.3	.500
I am not familiar with the “All About Arsenic” website.	1.5	.548	1.3	.500
I have visited the “All About Arsenic” website.	4.1	.408	4.8	.500
I have used resources on the “All About Arsenic” website to help plan my curriculum.	3.7	1.033	4.5	.577
I felt supported by the education coordinators.	4.3	.516	4.5	.577
The "All About Arsenic" curriculum was easy to implement.	N/A	N/A	3.8	1.258

Overall program operations and experiences:

At the outset of the project, participants indicated the following expectations, which became important points of focus on the ongoing project development and have guided our subsequent recommendations here:

What are you most excited about in engaging in this project?

- Authentic science- educating students and the public about the dangers of arsenic
- That is a real life project with student centered input.
- I am excited that my students can learn about a real problem in our community and do something towards a solution.
- Having my students collect and analyze real data that has an impact on their daily lives
- Learning about arsenic levels in this area and education the getting our community to

be aware about arsenic and well water testing
- Helping students learn about their water sources and communicating results to the public.

What are you most anxious about in engaging in this project?

- I'm concerned about not getting enough samples back
- Knowing what mapping tool will be used and if I will have the time to have students understand how to use it.
- I am most anxious about coordinating the return of the samples to be tested and refusal of families to participate.
- Making mistakes in collecting/labeling the water samples
- That the tests kits we give out come back and students did collect the samples properly
- Coordinating a community gathering and making the topic interesting and engaging to my students.

Valued the Project Focus: Across the board, participants valued the hands-on, community-engaged work on this project. As one teacher noted, this project gave students the opportunity to be the experts, and they took this challenge seriously. Four key classroom-related outcomes include: 1) Content knowledge gain of arsenic, well water contamination and remediation, and the associated health risks. 2) Student empowerment for civic engagement to take action to help protect their families and communities. 3) Student professionalization in terms of learning to communicate science, work in teams, and develop public presentations. 4) Water testing and results. Students and their families were provided the information they needed to know if remediation was necessary. This project facilitated testing by putting the tests in the hands of the participants, by providing an easy return system, and by funding the test.

Simplify Testing: The program lead and education coordinators all noted that they would simplify the testing in the next iteration of this project. Instead of testing for 14 parameters, they would focus on arsenic only. This simplifies the process and reduces the need for project participants to be experts on all parameters. If the testing were to include parameters other than arsenic, they suggest working more closely with the state environmental protection agency or drinking water programs for project support.

Increase Meetings and Sharing: Almost all interviewees noted that they wished there were more opportunities to get to know fellow project partners and to share experiences. The initial project meeting held in Maine and the NH Arsenic Consortium Conference in NH were excellent forums for learning about the project, meeting colleagues, and developing content expertise. However, the initial meeting was not replicated in NH, and it was held only once, in September 2015, the first year of the grant in Maine. The NH Arsenic Consortium Conference was in early spring 2016. Thus, while there were some early efforts to connect people, the meetings were not consistent and did not occur in year 2 of the grant. The community health partners in particular felt disconnected and expressed during interviews that meetings could have helped them understand their role on the project and strengthen trust with teachers. Teachers felt like

they could have learned from others and would have benefitted from sharing lessons and strategies. Education coordinators felt that more meetings could have improved their project oversight, helped maintain consistency across the curriculum, and prevented the classes from sharing some misinformation with the community.

Summative Recommendations

1) Continue to integrate the project into the curriculum so that it has the potential to become part of an ongoing lesson plan for teachers and students. Integration also helps students connect this particular lesson/issue with other types of issues, such as surface water testing. Several teachers coordinated with English/Language Arts teachers in their schools so that students were reading a book, "Flush," by Carl Hiaasen which focuses on water contamination and human behavior, at the same time as they were learning about arsenic in well water in their science classes. This interdisciplinary approach seemed to work well for these teachers and students.

2) Student empowerment and community engagement was another highlight from this project. Students took ownership over community education and took their work seriously. One group even designed a skit to perform during their community meeting. While groups took different approaches to engaging community (i.e. community housed meeting at the school, reaching out at voting polls, conducting a skit, etc), they helped educate fellow community members about the importance of testing their well water. Further, the students learned valuable profession skills, including civic engagement, science communication, and public presentations. To improve the public engagement, teachers, community health partners, and education coordinators should work early in the process to schedule and plan the meeting. Ultimately, at least in Year 1, one of the experts should review student work to make sure that the facts are accurate, especially if the students are sharing their results with community members. As one coordinator noted, the student got the big facts right, but there were some smaller details that were inaccurate. In Maine, one of the community health partners was able to provide remediation advice, and potentially funding support to communities. This was an important component of the Maine outreach activities, and New Hampshire would benefit from implementing a similar model.

3) Provide additional instruction on conducting data analysis and asking research questions of the data. Although students were exposed to some aspects of the scientific process, learning how to do science was not a primary focus. Including additional instruction on the scientific process and connecting students with practicing scientists would strengthen the scientific literacy outcomes of the program. Further, consult with teachers before building the database to verify that the data storage program (e.g. Excel) aligns with the programs available to students.

4) Simplify testing parameters in the future.

5) Meet early and at least two to three times annually to help ensure people understand the project and their roles on the project, to help others learn about collaborators' expertise and what they bring to the project, to share ideas and resources, and to provide project oversight. An early meeting in each state is critical for getting the project off on the right foot and to help people connect before teachers are planning their lessons. Although people like face-to-face meetings, there should always be remote access opportunities, such as Zoom or WebEx, Skype, and conference calls. One teacher noted that, if teachers continue to keep journals, the journals should be accessible by other teachers so they may share ideas. It seems that the teachers primarily used the journals to document process and lesson plans, and these are certainly valuable resources for other educators.

6) Funding needs to be increased, and there needs to be long-term funding for teachers to continue this work post-project. Interviewees recognized that project participants were often donating time through in-kind investments and that the compensation through the project was not sufficient to cover all expenses. The true cost of a project such as this is closer to $500,000. Specific areas that need additional funding include evaluation and long-term investments in water testing to ensure that teachers can continue the project past project completion. While teachers were interested in this work and thought it was valuable, it is unlikely they can continue with this specific project without further funding.

   Additional funding would also help engage a larger number of schools in each state. Teachers suggested that conducting a regional project may be interesting because it may garner county-level support and also generate healthy competition and innovation among proximate schools. Students expressed interest in how their results compared to proximate schools. Collaborations – and some competition – among schools could incentivize participation and help the project gain traction in local communities. It may also help the students ask bigger questions of the data from a regional perspective and, potentially, develop some innovative and local solutions.

7) Provide and fund networking and professional development opportunities, such as the NH Arsenic Consortium Conference. Numerous interviewees noted that the conference helped them connect with project partners and learn about arsenic and its health impacts.

8) Ensure that website resources and communication forums be set before the outreach with teachers begins, if a central website is going to be used. Although developing a website at the start of a grant takes considerable time, it may be worth waiting to engage teachers, at least in curriculum discussions, until the website is complete. Teachers are likely to use the website initially for ideas and may not return to the website if it is not immediately useful.

9) Select a lead organization to oversee the project. This project benefited from one lead organization, MDIBL, organizing, collecting and coordinating the project and data. This lead organization was particularly helpful when dealing with privacy issues and complaints related to the data. Teachers never knew the results from specific wells; therefore, all questions related to the tests could be directed to MDIBL. The lead organization may also play a key role in explaining project goals and helping ensure consistency among partners.

10) Provide more training for students on how to communicate with the public. Projects could bring in resources from local universities and colleges with expertise in science and public communication to help the students.

11) Consider involving some well water testing companies in the project, or at least provide information to homeowners to help them understand why (e.g. differences in instructions on how long to run your water before testing) there may be differences between tests from different organizations (e.g. a well water testing company and Dartmouth College) and even between years. There was one citizen and related well water testing company who were upset with the project, and the homeowner was worried because his/her test results in this project were different from that of the well water company.

Appendices

Appendix I: Informed Consent Forms for Phone Interviews, Participant Observation, and Digital Journals
Appendix II: Interview Protocol with Program Coordinators and Leaders
Appendix III: Interview Protocol for Teachers
Appendix IV: Interview Protocol Community Health Partners
Appendix IV: Pre-survey for Teachers
Appendix V: Post-survey for Teachers

Appendix I

INFORMED CONSENT
Phone Interviews

Note: This was adapted for use with project leaders, teachers, and community partners depending on role. Example questions and other details would reflect these changes.

You are invited to participate in a program evaluation study led by researchers from Dartmouth College (Dartmouth) and the University of Maine (UMaine). The program evaluation study will assess outcomes of the education initiative, "Building School and Community Collaborations to Eliminate Arsenic from Drinking Water in Maine and New Hampshire: A Model for the US." As a member of this initiative, we are seeking your input, feedback, and evaluation of program outcomes and effectiveness. Participation in this study is voluntary.

This study is being conducted by Dr. Karen H. Bieluch, Practice-based Learning Specialist, Dartmouth College, and Dr. Bridie McGreavy, Assistant Professor of Environmental Communication, University of Maine. The study is funded by the US Environmental Protection Agency.

What will you be asked to do?
If you decide to participate in the study, you will be asked to participate in a phone interview. The interview will take approximately one hour depending on the topics you would like to discuss. You will be asked a series of questions related to the development of new relationships through the project, your collaboration with the project team, and your experiences developing and implementing the classroom curriculum and hosting the community meeting. Information we ask you may include questions such as, "In what ways did you work with teachers and other members of the project team?" and "What do you perceive as the greatest strengths of this collaborative model among teachers, community health partners, and MDIBL?"

You will be asked permission to be either digitally recorded to ensure we capture the full details of the conversation, or that we may take detailed notes during the interview. If we digitally record our conversation, we will later transcribe the recording.

Confidentiality
The information you provide will be treated as professional confidences. No information, which might directly identify you, will be presented in any research reports or communications. Your name will not be associated with the interview data. Pseudonyms will be assigned to each participant. The handwritten key associating the pseudonym with the participants' real names will be kept in the locked offices of the project researchers and will be destroyed after seven years. In some reports, such as our technical report, we will list the names of the schools and the community organizations associated with the project.

All electronically recorded notes taken during and after the interview, as well as the digital audio recordings, will be typed and downloaded and kept on password-protected computers of project researchers, and physical notes from the interviews will be kept in investigators' locked

offices at Dartmouth and UMaine. Audio recordings will be deleted from the recording device after being downloaded to the password-protected computer, which will occur within a week of the interview. Data will be retained indefinitely for the purpose of future research or until data analysis is complete.

Benefits
Although there may be no direct personal benefits of participation to you, we anticipate that the benefits of this study to you and others will be 1) improved knowledge of drinking water contamination, testing, and mitigation, 2) new lesson plans to be implemented in your program, and 3) a strengthened understanding of how to design environmental research projects for student, teacher, and community benefit and the outcomes of such projects. If achieved, these outcomes may help improve environmental health and environmental health literacy.

Risks
Except for your time, there are no foreseeable risks to you in participating in this study.

Voluntary
Participation is voluntary, and you may skip any questions you do not wish to answer. If you choose to take part in the study, you may stop at any time or request that the researcher turn off the recorder during periods of time in the discussion.

Contact information
If you have any questions, comments, or concerns about the study, please contact:

Karen Hutchins Bieluch, I.PhD
Practice-based Learning Specialist
Dartmouth College
Environmental Studies Program
6182 Steele Hall
Hanover, NH 03755
(603) 568-6076
karen.h.bieluch@dartmouth.edu

Bridie McGreavy, PhD
Assistant Professor
University of Maine
Department of Communication & Journalism
5724 Dunn Hall
Orono, ME 04469
(207) 581-1943
bridie.mcgreavy@maine.edu

If you have questions about your rights as a research participant, please contact:

Gayle Jones
Assistant to the University of Maine's Protection of Human Subjects Review Board
University of Maine
(207) 581-1498
gayle.jones@umit.maine.edu.

Appendix II

Interview Protocol – Program Coordinators and Leaders

During the interview, we want to learn about your experiences with the arsenic monitoring and mitigation environmental education project and your work with project collaborators.

General Questions:

1. Will you tell us a bit about yourself and your role on the project?

2. Thinking about the arsenic monitoring project, how much experience have you had with arsenic monitoring before starting this project?

    a. How about with coordinating projects like this with schools?

3. Who did you work with on this project, whether in the schools, fellow coordinators and/or in the community? How did you work with them – e.g. frequency of communication, interactions in the classroom, etc?
    a. Have you noticed any changes in the network or types of things teachers or partners are asking you about at this point, compared to when the project started?

4. During the project, what have been your greatest resources for helping teachers develop their curriculum, if you played that role?

5. Thinking about the teachers, what do you see as the major learning/classroom outcomes for them?

6. Thinking about the students, what do you see as the major learning outcomes for them? How about any of the following:
    a. Scientific method
    b. Motivations for environmental stewardship
    c. Understanding connections between humans and environment, what some call systems thinking
    d. Problem solving

7. In what ways, if any, have you observed the community benefitting from this project? Have there been any disadvantages with their involvement?

8. What do you view as some of the greatest successes with the project? What were some challenges?

9. If you were to run/coordinate this sort of project again, what are some of the things you would keep the same?

10. If you were to run/coordinate this sort of project again, what are some of the things you would change?

11. *Follow-up only if website is not discussed for prior questions:* In what ways, if any, do you use the All About Arsenic website for your work? Do you use the website to connect with other teachers and/or community health partners?

12. Thinking about working across states, what are some of the key challenges and benefits of collaborating across state lines?

13. Project leader (Jane): If other states were considering doing similar work, what kind of organizational infrastructure would you say promotes or inhibits this work, based on your experience with this project? For example, what personnel, facilities, resources are necessary?

14. What, if any, suggestions do you have for other states considering doing this work?

15. What steps do you think are needed to continue the work started through this project?

16. Is there anything I didn't ask that you'd like to add or discuss?

Appendix III

Interview Protocol - Teachers

During the interview, we want to learn about your experiences with the arsenic monitoring and mitigation environmental education project and your work with project collaborators.

General Questions:

1. Will you tell us a bit about yourself and the subject areas that you teach?

2. Thinking about the arsenic monitoring project, how much experience have you had with arsenic monitoring before starting this project?

3. Who did you work with on this project, whether in this school, coordinators and/or in the community? How did you work with them?

4. During the project, what have been your greatest resources for curriculum development and/or implementation?

5. What were some of the successes with the project? What were some challenges?

6. Thinking about yourself, what do you see as your own learning outcomes?

7. Thinking about your students, what do you see as the major learning outcomes for them? How about any of the following:
   a. Scientific method
   b. Motivations for environmental stewardship
   c. Understanding connections between humans and environment, what some call systems thinking
   d. Problem solving

8. In what ways, if any, have you observed the community benefitting from this project? Have there been any disadvantages with their involvement?

9. In what ways, if any, do you use the All About Arsenic website for your work? Do you use the website to connect with other teachers and/or community health partners?

10. What steps do you think are needed to continue the work started through this project?

11. What, if any, suggestions do you have to improve the project?

12. Is there anything I didn't ask that you'd like to add or discuss?

Appendix IV

Interview Protocol – Community Health Partners

During the interview, we want to learn about your experiences with the arsenic monitoring and mitigation environmental education project and your work with project collaborators.

General Questions:

1. Will you tell us a bit about yourself and your role on the project?

2. Thinking about the arsenic monitoring project, how much experience have you had with arsenic monitoring before starting this project?

    a. How about with coordinating projects like this with schools?

3. Who did you work with on this project, whether in the schools, fellow coordinators and/or in the community? How did you work with them – e.g. frequency of communication, interactions in the classroom, etc?
    a. Have you noticed any changes in the network or types of things teachers or partners are asking you about at this point, compared to when the project started?

4. During the project, what have been your greatest resources for helping teachers develop their curriculum, if you played that role?

5. Thinking about the teachers, what do you see as the major learning/classroom outcomes for them?

6. Thinking about the students, what do you see as the major learning outcomes for them? How about any of the following:
    a. Scientific method
    b. Motivations for environmental stewardship
    c. Understanding connections between humans and environment, what some call systems thinking
    d. Problem solving

7. In what ways, if any, have you observed the community benefitting from this project? Have there been any disadvantages with their involvement?

8. What do you view as some of the greatest successes with the project? What were some challenges?

9. If your agency were to initiate this sort of partnership in the future, what are some of the things you would keep the same?

10. If your agency were to initiate this sort of partnership in the future, what are some of the things you would change?

11. *Follow-up only if website is not discussed for prior questions:* In what ways, if any, do you use the All About Arsenic website for your work? Do you use the website to connect with other teachers and/or MDIBL?

12. What, if any, suggestions do you have for other agencies considering doing this work/partnering with schools?

13. What steps do you think are needed to continue the work started through this project?

14. Is there anything I didn't ask that you'd like to add or discuss?

Appendix V

Invitation to Teachers to Participate in Participant Observation

You are invited to participate in a program evaluation study led by researchers from Dartmouth College (Dartmouth) and the University of Maine (UMaine). The program evaluation study will assess outcomes of the education initiative, "Building School and Community Collaborations to Eliminate Arsenic from Drinking Water in Maine and New Hampshire: A Model for the US." As a member of this initiative, we are seeking your input, feedback, and evaluation of program outcomes and effectiveness. We are conducting observations of program activities and participants over the course of the project to better understand the range of activities involved with the project and individual's participation in those activities.

We're conducting participant observation as part of our evaluation process, meaning that we will We are conducting observations of program activities and participants over the course of the project to better understand the range of activities involved with the project and individual's participation in those activities. For this research, participant observation will include one to two years of observation at project meetings, in the classroom, and at community meetings. Children under the age of 18 may be observed as part of this study for research purposes. However, they will only be observed as part of the study because their behaviors may help us understand adult interactions with the program.

Participation in this study is voluntary, and I am inviting you to participate in it. If you're potentially interested in taking part in the study, please see the attached informed consent form, which explains your rights as a participant, the benefits and risks to participating, and how the data will be used and confidentiality.

Do you have any questions about the study or consent form? Are you willing to participate by being observed in meetings, the classroom, and/or community meetings?
If you have any questions about the evaluation process now or in the future, please contact the evaluators. They may be reached at the following: Bridie McGreavy, bridie.mcgreavy@maine.edu or (207) 581-1943, and Karen Bieluch, karen.h.bieluch@dartmouth.edu or (603) 646-9895.

Pre-Project Survey Invitation

Hello [Participant name]

Program evaluators, Dr. Bridie McGreavy, University of Maine, and Dr. Karen Bieluch, Dartmouth College, are inviting you to complete a survey about your experience with the EPA EE Grant titled the "All About Arsenic Project." This is an initial survey that we're asking you to complete prior to implementing your classroom lessons related to this project, or as close to the start of that work as possible. You'll also be asked to complete a follow-up survey later in this project that will help us understand the project's influence and ways we can better support your work. Your participation and answers are greatly appreciated. The data you provide will help accomplish the goals and objectives of the research project and will be used to help educators in other states throughout the US implement similar projects.

The survey will take approximately 20 minutes to complete. To learn more about the study and to respond to the anonymous survey, visit:

https://umaine.qualtrics.com//SE/?SID=SV_8GrPPq4jxkoFEq1

You will be asked a series of questions related to your knowledge of and confidence in facilitating environmental research projects (e.g. groundwater testing for arsenic), your environmental stewardship, and your research knowledge. Findings from this survey may be used in- and out-of-state to design and improve well-water monitoring and mitigation programs.

If you have any questions, please contact Karen Bieluch at karen.h.bieluch@dartmouth.edu or (603) 646-9895, or Bridie McGreavy at bridie.mcgreavy@maine.edu or (207) 581-1943.

Thank you for your time and participation.

Bridie and Karen

Post-Project Survey Invitation

Dear [participant name],Program evaluators, Dr. Bridie McGreavy, University of Maine, and Dr. Karen Bieluch, Dartmouth College, are inviting you to complete a survey about your experience with the All About Arsenic Project funded by the US EPA. This is a follow-up survey that we are asking you to complete after implementing your classroom lessons related to this project, and after your community meeting. Please complete the survey even if you plan to implement the curriculum again in the fall.

This follow-up survey asks many similar questions as the first survey and is intended to help us understand the project's influence and considerations for implementing similar programs in the future. Your participation and answers are greatly appreciated. The data you provide will help accomplish the goals and objectives of the research project and will be used to help educators in other states throughout the US implement similar projects.

The survey will take approximately 20 minutes to complete. To learn more about the study and to respond to the anonymous survey, visit:

https://umaine.qualtrics.com/SE/?SID=SV_6gltraZPhe5Ck4d

You will be asked a series of questions related to your knowledge of and confidence in facilitating environmental research projects (e.g. groundwater testing for arsenic), your environmental stewardship, and your research knowledge. Findings from this survey may be used in- and out-of-state to design and improve well-water monitoring and mitigation programs.

If you have any questions, please contact Karen Bieluch at karen.h.bieluch@dartmouth.edu or (603) 646-9895, or Bridie McGreavy at bridie.mcgreavy@maine.edu or (207) 581-1943.

Thank you for your time and participation. We hope you have a wonderful summer!

Bridie and Karen

Appendix VIII

EPA EE Grant Evaluation Summary: August 1, 2015-August 1, 2016

A. Overall Program Evaluation Observations:

The first year of the grant focused on coordinating plans and program goals among collaborators in each state, figuring out program logistics, onboarding teachers, developing the website, and, for most teachers, implementing a curriculum and community workshop focused on arsenic in private well water. While MDIBL had pre-established relationships with the schools and community health partners at the start of the grant, the New Hampshire education coordinator needed to establish a relationship with new schools and a new community health partner in Year One. The collaboration between the program educators and the teachers seems to be effective and met teacher needs. Community health partners have attended classrooms and events as well, providing expertise and resources. The type of involvement of community health partners seems to vary by state.

The *All About Arsenic* website is a great tool for mapping water sample results, and for providing resources and connections with other educators. However, getting teachers to use the website and website resources, including the digital journal and blog, seems to be challenging. A few people use the resources and participate in the blog and journal, but use is not consistent across participants.

Because each teacher is implementing a slightly different curriculum having a standard measure for effectiveness across classrooms is more difficult. The lack of one single curriculum also created quite a few questions for education coordinators in the beginning of the project. Close communication through conference calls and informal phone calls and emails between educators and program leaders between states seemed critical for getting the project off on the right track and for learning across the differences in approaches. The benefits of not having a specific curriculum for teachers to implement seem to be: 1) an ability for teachers to adapt the project to fit their classroom, students, and professional interests; 2) an ability for teachers to be responsive to community needs and context; and 3) flexibility to adapt to the different community health partners by state. The disadvantages of not having a specific curriculum for teachers to implement seem to be: 1) students and communities are getting exposed to different information about arsenic in well water by community; 2) increased confusion at the start of the program coordinating program and curriculum expectations across states; and 3) challenges with developing evaluation instruments that can accurately measure program outcomes because of these nuances with implementation.

Overall, in this first year of the project, participants seem to be meeting their objectives of providing arsenic education programs across states and developing an innovative model for community health monitoring. Project leaders as well as educators and teachers are reporting positive classroom and community outcomes. In Year Two, we will be conducting formal interviews with educators, program leaders, teachers and community partners to better

understand student learning, community engagement, and program coordination outcomes, as well as to ascertain recommendations for program successes and modifications that may be implementable in other states in the United States. We will also continue to survey and observe teachers who are implementing the curriculum for the first or second time.

B. Evaluation Measures

1. Participant-Observation:
    a. Initial Maine teachers, community partners, and project leaders orientation meeting, September, 2015; participated via phone.
    b. NH Arsenic Consortium Annual Meeting at DES in Concord, NH, March 2016; attended one session and ate lunch with the teachers and program leaders
    c. Education Coordinators conducted participant observations in ME and NH classrooms and wrote up their observations. Evaluators held a training session with the education coordinators and program leader on conducting participant-observation. Notes from the training meeting, along with a guiding framework for their observations and an article on conducting participant-observation, were shared with the coordinators and project leader.

2. Pre- and Post-Survey: The survey included four validated scales produced by the Cornell Lab of Ornithology. The scales included the: *Self-Efficacy for Science Instrument, Motivation for Science Instrument, Nature Relatedness Instrument,* and *Self Efficacy for Environmental Action Instrument.* We also included several content-specific questions related to Arsenic to measure changes in content knowledge, and questions about program management, communication, resources, and social networks. The same questions were asked in the post-survey, although questions related to program management, resources, and social networks were altered and additional questions related to program recommendations and intention to continue the program in the future were added.
    a. Pre-survey: The survey was conducted online in Qualtrics. Participants received the first invitation to participate in the online survey from early to mid-February, prior to the teachers implementing their first lessons as part of the program. A reminder email was sent to all teachers in the middle of March, reminding them of the survey. Five out of seven teachers completed the survey, or 71.4%.
    b. Post-survey: The post-survey was conducted online in Qualtrics. The majority of the questions on the survey were the same as presented in the pre-survey, with the exception of a set of questions related to program management, successes, and recommendations. Participants received the first invitation to participate in the online survey in late June. A reminder email was sent to all teachers in early August. Three of the six teachers who implemented the curriculum during the 2016 school year completed the survey, or 50%.

3. Teacher Digital Journals: One method we implemented for tracking teacher observations, especially of student learning, are the teacher digital journals. Each teacher can set-up an account on the *All About Arsenic* website where they can blog, access program resources, and participate in the teacher digital journals. In late March, after some teachers had already started their curriculum, we invited teachers to participate in the digital journals. The journals are only visible to program managers and evaluators. The teachers were provided via email a set of guiding questions to respond to, and those same questions were included online in the teacher journal webpage. In early May, we reminded teachers about participating in the digital journals. Three of the six teachers who implemented curriculum this year participated in the journals

4. Teacher, Education Coordinator, and Program Leader Interviews: We conducted an informal interview about the program in March during a training session on participant observation conducted with the education coordinators and program leader. The individual, formal interviews with project participations are in-process. Data from these interviews will be analyzed for key take-aways that need to be shared with the management team prior to teachers implementing their curriculum in the 2016-2017 school year. A detailed analysis of the interviews will be written up later this year.

C. Program Findings and Outcomes:

Teacher Surveys:

Pre-Survey Key Results: Survey findings indicate that, overall, participants (n=5) had high levels of self-efficacy for learning science and conducting scientific activities, specifically related to well water testing, and for addressing environmental concerns. Further, participants reported high levels of internal and external motivations for doing scientific activities and interest in the natural world. Overall, content knowledge was also strong. Results also indicate that teachers are happy with the way the project is working, seem to have a good sense of project expectations, and have good communication with education coordinators. Some of their reported project needs included wanting guest speakers in the classroom, needing additional guidance on the sampling procedure, needing assistance with GIS and mapping and community meetings, and wanting case studies and links to groundwater movement.

Finally, responses to open-ended questions revealed that the respondents were most excited about the project because it allowed them to engage their students in a “real life” project about a problem faced in the course of daily life. Two of four respondents indicated they had some anxiety about properly collecting the samples.

Post-Survey Key Results:

We have not yet compared pre- and post-results by participant. However, results seems consistent with pre-survey results, suggesting there was not a change in teacher confidence, self-efficacy and motivation through the project. However, respondents did indicate that

they felt the project helped increase student interest in science, and it also helped the teachers meet national science standard requirements.

Teacher Digital Journals:

Example Student Reflections from Teacher Journals:

- “This study has taught us what to look for in future homes with your well water” and “Being a part of the arsenic study has made me more aware of water pollutants.”
- “I can help inform other people about the risks of having arsenic in their water and how to manage it."
- “This project shows how arsenic can get from the bedrock into the groundwater that we draw our water from, then we drink the water and it can severely harm us."
- "I learned that groundwater is a valuable resource that can be easily contaminated by things like arsenic, sewage and other things."
- "I have learned that groundwater has lots of stuff in it even though there's no color to it. Some of those things are not good.

Example Teacher Observations of Curriculum Implementation and Student Learning from Teacher Journals

- Teachers were able to bring in national news, such as the water quality problems in Flint Michigan, to connect the classroom project to broader issues.
- One teacher reported that none of the students in her class seemed to know that individuals with private wells were responsible for testing their own water. A great lesson learn through this project!
- In one classroom, students coordinated with and presented to the Board of Selectmen about their work. They developed an informational table for Old Home Day in their municipality, and they will be at the voting booths this November, 2016 with informational brochures and water testing kits for the community.
- One teacher noted that students were making hypotheses about the data, specifically about trends in results and the relationship to wells located in new developments where families shared wells. The teacher was impressed to see this level of scientific thinking.
- Data collection- they don’t even realize they are using the scientific method!

Evaluation Changes for Future Programs:

1. Make sure the digital journal invitation goes out early in the program and is introduced during the face-to-face teacher meeting in order to capture their thoughts about the curriculum as it is being implemented, versus retrospectively.
2. Reach out to the community health partners earlier in the evaluation process

Appendix X

Memorandum of Understanding Sample

MEMORANDUM OF UNDERSTANDING
BETWEEN
Jane Disney, Charles Fidler, Duncan Bailey, Anna Farrell, Mark Borsuk, and Kathrin Lawlor,
COLLABORATORS
AND
Karen Hutchins Bieluch and Bridie McGreavy, EVALUATORS

This MEMORANDUM OF UNDERSTANDING is hereby made and entered into by and between Jane Disney, Anna Farrell, Charles Fidler and Duncan Bailey of the MDI Biological Laboratory and Mark Borsuk and Kathrin Lawlor of Dartmouth College hereinafter referred to as COLLABORATORS and Karen Hutchins Bieluch of Dartmouth College and Bridie McGreavy of the University of Maine, hereinafter referred to as EVALUATORS.

(1) PURPOSE:

The purpose of this MOU is to establish a framework of cooperation between the COLLABORATORS and the EVALUATORS. This framework supports the development of an evaluation program associated with the Environmental Protection Agency (EPA)-funded project entitled: "Building School and Community Collaborations to Eliminate Arsenic from Drinking Water in Maine and New Hampshire: A Model for the US." The project evaluation intends to support the overarching project goal, which is to create and pilot a national model of environmental education that facilitates schools and community organizations working together to address the public health risks of exposure to toxic contaminants in drinking water.

(2) EVALUATORS SHALL:

a. Design and analyze teacher surveys
b. Identify questions for surveys based on: the literature, project goals related to social networks, changes in process and scientific knowledge, teacher motivations for involvement, and teacher perceptions of student achievement and knowledge changes
c. Develop and submit application for IRB approval through the University of Maine
d. Solicit feedback from COLLABORATORS on all survey instruments
e. Train COLLABORATORS to assist with and analyze interviews and conduct participant observations in the classroom, at school-based meetings, and at community meetings
f. Conduct content analysis of project documents, focusing on the interviews and case studies
g. Work with COLLABORATORS to conduct key informant interviews in year 1 with a selection of CHPs, teachers, program administrators, and faculty mentors to identify year 1 networks among project partners

h. Work with COLLABORATORS to analyze key informant interviews
i. Track website statistics, identify added resources, and conduct initial content analysis on blog and email communication
j. Work with project collaborators to track: 1) ME CDC and project partner data sharing; 2) reported well water testing requests in schools and in the surrounding school communities; and 3) attendance at community meetings and attendees' reported intention to or actual testing of their well water
k. Provide a formative technical report with descriptive statistics from pre-surveys; findings from content analysis of interviews and project documents; and website analysis
l. Conduct project-by-project and/or state-by-state project comparisons
m. Develop summative assessment for entire project and present information to project partners at a team meeting and on the website

(3) COLLABORATORS SHALL:

a. Work with EVALUATORS on the development of pre- and post-survey instruments
b. Implement all surveys with teachers and provide data from surveys to EVALUATORS
c. Conduct participant observations in classroom settings
d. Assist with key informant interviews and analysis of those interviews
e. Help EVALUATORS gather the necessary documents to conduct program review, such as case studies, classroom exercises, and well-water testing data
f. Participate in EVALUATOR-led training to learn about conducting and analyzing interviews and participant-observation

IT IS MUTUALLY UNDERSTOOD AND AGREED BY AND BETWEEN THE PARTIES THAT:

(4) MODIFICATION. Modifications to this agreement shall be made by mutual consent of the parties, by the issuance of a written modification, signed and dated by authorized officials, prior to any changes being performed.

(5) PARTICIPATION IN SIMILAR ACTIVITIES. This agreement in no way restricts EVALUATORS or COLLABORATORS from participating in similar activities with other public or private agencies, organizations, and individuals.

(6) TERMINATION. Either party, upon thirty (30) days written notice, may terminate the agreement in whole, or in part, at any time before the date of expiration.

(7) PRINCIPAL CONTACTS. The principal contacts for this instrument are:

COLLABORATORS:

Jane Disney, Ph.D.
Senior Staff Scientist
Co-Director, Office of Education
Director of the Community Health and Envirnmental Testing Lab
MDI Biological Laboratory
159 Old Bar Harbor RD
PO Box 35
Salisbury Cove, ME 04672

Charles Fidler, Ph.D.
Director, Office of Education
MDI Biological Laboratory
159 Old Bar Harbor RD
PO Box 35
Salisbury Cove, ME 04672

Duncan Bailey
Systems Developer for the Community Health and Environmental Testing Lab
MDI Biological Laboratory
159 Old Bar Harbor RD
PO Box 35
Salisbury Cove, ME 04672

Anna Farrell
Education Coordinator
MDI Biological Laboratory
159 Old Bar Harbor RD
PO Box 35
Salisbury Cove, ME 04672

Mark Borsuk, Ph.D.
Associate Professor of Engineering
Thayer School of Engineering
Dartmouth College
14 Engineering Drive
Hanover, NH 03755

Kathrin Lawlor
Community Engagement Coordinator
Toxic Metals Superfund Research Program
Dartmouth College
Vail Room 505
Hanover, NH 03755

EVALUATORS

Karen Hutchins Bieluch, Ph.D.
Practice-based Learning Specialist
Dartmouth College
6182 Steele Hall
Hanover, NH 03755

Bridie McGreavy, Ph.D.
Assistant Professor of Environmental Communication
5724 Dunn Hall
University of Maine, Orono, ME 04469

(8) NON-FUND OBLIGATING DOCUMENT. This agreement is neither a fiscal nor a funds obligation document. Any endeavor or transfer of anything of value involving reimbursement or contribution of funds between the parties to this agreement will be handled in accordance with applicable laws, regulations, and procedures. Such endeavors will be outlined in separate agreements that shall be made in writing by representatives of the parties and shall be independently authorized by appropriate statutory authority. This agreement does not provide such authority. Each party shall be fiscally responsible for their own portion of work performed under the MOU.

(9) HUMAN SUBJECTS COMPLIANCE. The parties agree to abide by all applicable Federal and State laws/regulations addressing the ethical conduct of research with human subjects.

All Parties shall be responsible for:

a. Completing the CITI Training and receiving certification for the ethical conduct of research with human subjects. This certification is required to be included on the Institutional Review Board (IRB) application.

b. Abiding by the requirements for informed consent and maintaining confidentiality as outlined in the IRB application.

(10) CONFLICT OF INTEREST. This agreement is subject to the provisions of A.R.S 38-511 and EVALUATORS may cancel this agreement if any person significantly involved in negotiating, drafting, securing or obtaining this agreement for or on behalf of EVALUATORS becomes an employee or a consultant to any other party with reference to the subject matter of this agreement while this agreement or any extension thereof is in effect.

(11) COMPLIANCE. The parties agree to be bound by applicable state and federal rules governing Equal Employment Opportunity, Non-Discrimination and Immigration

(12) COMMENCEMENT/EXPIRATION DATE. This agreement is executed as of the date of last signature and is effective through December 2017 at which time it will expire unless extended.

(13) LIABILITIES. It is understood that neither party to this Memorandum of Understanding is the agent of the other and neither is liable for the wrongful acts or negligence of the other. Each party shall be responsible for its negligent acts or omissions and those of its officers, employees, agents or students (if applicable), howsoever caused, to the extent allowed by their respective state laws.

IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the last written date below.

FOR: **COLLABORATORS**

Signature:_____ Date: _____

Signature:_____ Date: _____

Signature:_____ Date: _____

Signature:_____ Date: _____

Signature:_____ Date: _____

Signature:_____ Date: _____

FOR: **EVALUATORS**

Signature:_____ Date: _____

Signature:_____ Date: _____