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EFFICACY OF ARSENIC WATER TREATMENT SYSTEMS:

MAINTENANCE, PERFORMANCE TESTING, REGULATIONS AND PRACTICE

By

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A Dissertation Submitted to the

School of Public Health

And the

Graduate School – New Brunswick

Rutgers, The State University of New Jersey

In partial fulfillment of the requirements

For the degree of

Doctor of Philosophy

Written under the direction of

Mark Gregory Robson

and approved by

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New Brunswick, New Jersey

May, 2016

Abstract of the Dissertation

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Dissertation Director:

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Arsenic, a known human carcinogen, is naturally occurring in groundwater in New Jersey and many other states and countries. Many municipalities in the Piedmont, Highlands, and Valley and Ridge Physiographic Provinces have a high proportion of wells that exceed the New Jersey maximum contaminant level (MCL) of 5 µg/L. Hopewell Township, located in Mercer County and the Piedmont Province, has a progressive local ordinance which requires the installation of dual tank, point-of-entry treatment (POET) systems on affected wells and provided a unique study opportunity.

The purpose of this research was to determine the efficacy of existing arsenic treatment systems, if they are maintained, the behaviors and beliefs of homeowners and the risk reduction provided by treatment systems. A total of 65 homes were recruited into the study. Of the homes with dual tank POET, 92.7% of homes, regardless of age and maintenance schedule adherence, had arsenic levels under the MCL at the kitchen sink. Maintainers, homeowners who test their water yearly and replace their arsenic tanks when needed, were found to be the group with the lowest risk of arsenic exposure. This study appears to be the first to identify a potential health hazard as water treatment media was found to escape many of the systems and enter the water

supply potentially leading to acute doses of arsenic through ingestion. A potential solution of adding a post-treatment sediment filter is proposed to remedy this problem.

Based on the average concentrations of arsenic at the kitchen sink, average water consumption and the Township population, Hopewell's arsenic water treatment ordinance, requiring POET dual tank arsenic treatment reduced the incidence of excess lifetime (70-year) bladder and lung cancers from 121 (1.7 cancer cases/year) to 16 (0.2 cancer cases/year) preventing 105 lifetime cancer cases (1.5 cases/year). Because the high risk of cancer from arsenic can be mitigated with effective arsenic water treatment systems, this ordinance should be considered a model for other municipalities. An effort should also be made to increase the number of homeowners who test yearly and maintain their treatment systems.

Acknowledgements

I would like to acknowledge the following individuals who encouraged, motivated, supported and helped in my study of public health and pursuit of this degree. I am so grateful for all of you.

To my committee chair and advisor, **Dr. Robson**: You are a generous, intelligent, and kind person who does great things for students and the advancement of public health. You are a shining example of what all mentors should be. Thank you for everything. To **Dr. Jim Zhang**, my first advisor as a master's degree student at SPH: thank you for your continued support throughout the rest of my time at SPH. To **Dr. Hong**: for your advice, humor and genuine love of science, thank you for being a trusted mentor. **Dr. Meng**, thank you for your invaluable insights and suggestions, kind words and support. **Dr. Ohman-Strickland** I am grateful for your support, statistical expertise and enthusiasm about my project**. Dr. Spayd**, thank you for all the time you gave, for your attention to detail and for recommending this project. Thank you for passing on your enthusiasm and commitment to arsenic research and public health action.

Thank you to **Dr. Kari Murad** at The College of Saint Rose for introducing me to public health, inspiring me to pursue a career in it and supporting me throughout my academic journey. **Dr. Gina Prokosch-Cook** for encouraging me to pursue an undergraduate major in the sciences and for your support, thank you.

To The **Hopewell Township Health Department,** especially **Gary Guarino** and **Robert English,** you are the example of a truly great health department who cares about the health and well-being of their residents! To the **Residents of Hopewell Township** who invited me into their homes and graciously allowed me to take samples in their basements, kitchens, and toilet tanks, thank you for being so kind and welcoming! To the best "Water Sampling Team" at **NJDEP Geological and Water Survey**, Michelle Kuhn, Yelena Stroiteleva, Ryan Hupfer, Cori Kosar, Rachel Filo and Ted Pallis; and John Dooley and Larry Müller in the lab, thank you for your time and expertise. To my support system, advisors and friends at SPH**, Mrs. Margaret Mitchell, Mrs. Tina Greco, Dr. Manthan Shah, Dr. Srijata Sarkar, Dr. Cesar Rivas-Santiago, Dr. Alan Monheit and Dr. Bernadette West**. I could not have finished this without you. To **Dr. Jessica Vestel** a proof reader, constructive critic, statistics guru and friend, you've helped me though school and through this dissertation, I am so grateful to have shared this adventure with you.

To my mother and father in-law, **Pat and Diane Baldoni**, for graciously offering quiet office space to work in, encouraging words and practical advice, thank you. To my brothers and sisters-in-law, **Patrick, Lauren, Michael and Lauren Baldoni,** thank you for your encouragement.

Thank you to my grandparents, **Alice and Joseph Rockafellow**, for always seeing the best in me. Your moral and financial support have been invaluable. I have been so blessed to have you in my cheering section; it has meant the world.

To my brother, **Stephen Rockafellow**, for listening and appreciating my public health and science stories, supporting and encouraging me, thank you.

To my parents, **Peggie and Steve Rockafellow** for the many sacrifices that you have made for my education. You were my first teachers and I still continue to learn from your example. From as early as I can remember, you helped me with homework, science fair projects, studying for tests and proof reading papers. You have told me and helped me believe that I could do anything that I wanted to. You've pushed me to be a better writer and student and celebrated accomplishments with the best kind of parental enthusiasm. All of this would have been impossible without your love and support. Thank you.

Finally, to my husband, **Stephen Baldoni**, for encouraging me on a daily (and at times, hourly) basis to write one more page or analyze some more data. You've believed in me and my dream. Your love, patience and support mean everything to me. Thank you.

Dedication

To Mom and Dad, Steve and Peggie Rockafellow,

my first mentors, teachers and friends.

Table of Contents

List of Tables

List of Figures

Abbreviations

Arsenic	As
Maximum contaminant level goal	MCLG
Methylarsenate	DSMA
Micrograms	µg
Microns	µm
Oxidation reduction potential	ORP
Parts per billion	ppb
Parts per million	ppm
Point-of-Entry treatment system	POET
Private Well Testing Act	PWTA
Point-of-Use	POU

Introduction and Literature Review

Types of Arsenic

Arsenic is a naturally occurring element that is classified as a metalloid as it has characteristics of both a metal and a nonmetal. It occurs naturally in rocks and minerals and can enter air, water and soil. Arsenic in the environment is usually combined with other elements. Inorganic arsenic is combined with oxygen, hydrogen. In ground water, arsenic is usually found as As (III) or H_3AsO_3 and As (V) or H_3AsO_4. When arsenic is combined with carbon and hydrogen it is referred to as organic arsenic [1]. Organic arsenic which is found in fish, even at higher concentrations, is less harmful than inorganic arsenic. Inorganic arsenic can convert to organic arsenic once metabolized by humans, animals and plants by combining with carbon and hydrogen. Organic arsenic can also convert to inorganic arsenic if it is exposed to different elements [2].

Arsenic toxicity is dependent on its oxidation state. Arsenic can occur as As (-3), As (0), As (III) and As (V). As (-3) and As (0) are only found in strongly reducing environments. Redox potential and pH are important factors in arsenic speciation. Arsine, AsH_3, is the most toxic species. Trivalent arsenic is considered to be more harmful than pentavalent arsenic. Arsenosugars and arsenobetaine found in fish are among the least toxic arsenic compounds[3]. Though As (III) is more toxic than As (V), both are considered harmful as when As (V) is ingested by humans, it is reduced to As (III). Human metabolism of arsenic, a bio-activation process, may generate a more toxic species of arsenic than what was originally ingested [4].

In water treatment, the charge of the arsenic molecule (including whatever it is bound to) is more important than the charge or oxidation state of the arsenic element itself. Water quality parameters such as presence of iron, manganese and pH indicate which species of arsenic is present in raw water. This is of value as As (III) is much more difficult to treat than As (V) due to its neutral charge. If the water exceeds any of the following: sulfur odor, iron greater than 50 µg/L or manganese greater than 50 µg/L it is likely that a significant percentage of the arsenic should be considered to be in the As (III) species[5, 6].

Sources of Arsenic

Arsenic is a metal that is rarely found in pure form. Arsenic occurs as a major component of over 200 minerals, most commonly, arsenopyrite [3]. It is also used in industrial settings; however, it is no longer produced in the United States. All arsenic used in the U.S. is imported. Most was used as a preservative for pressure treated wood. In 2003, a phase out of arsenic treated wood was complete, however many existing structures are made with this treated wood. In the past, inorganic arsenic was used as a pesticide. Presently inorganic arsenic cannot be used. However, disodium methylarsenate (DSMA) and monosodium methylarsenate (MSMA) are still used as pesticides. Arsenic is still used in lead-acid batteries for automobiles and in semiconductors and light-emitting diodes (LED) [1].

Arsenic is found in a number of environmental media including soil, air, water and biota. Soil concentrations vary by geographic area but can range from 1 – 40 ppm with an average of 2-4 ppm. Arsenic rich geologic areas may contain higher levels. Arsenic in ground water averages 1 µg/L but has been found up to 1000 µg/L in highly contaminated areas. Groundwater is more likely to contain arsenic than surface water. Food is usually the most dominant media with high levels common in seafood, rice, mushrooms and poultry. Arsenic that is present in fish, in an organic form, is called arsenobetaine and is a less harmful form[7].

Exposure to Arsenic

Arsenic is present in the environment in air, water, soil and food [8]. Exposure to arsenic occurs primarily through ingestion and inhalation of contaminated soil, water and air. Children may be exposed to arsenic by eating soil. Occupational exposures can happen in copper or lead smelting operations and by sawing arsenic treated wood[1].

Though under debate, one article references the acute minimal lethal dose of inorganic arsenic for human beings as 70 to 200 mg or 1 mg/kg/day, which can be ingested as one dose or accumulated over many exposures[9].

Health Effects/Outcomes of Arsenic Exposure

Inorganic arsenic has been used at high concentrations as a poison since ancient times. An oral dose of 60,000 µg/L in water can result in death. This is significantly higher than doses found in groundwater. Individual doses ranging from 300 – 30,000 µg/L can lead to acute stomach issues, problems with intestines, nausea, vomiting, and diarrhea. A decreased production of red and white blood cells, fatigue, abnormal heart rhythm, blood-vessel damage and a pins and needles feeling may also result. Long term exposure causes skin changes. Skin cancer may also develop. Chronic exposure to arsenic has been reported to increase kidney, liver, bladder and lung cancer. Breathing in high levels of arsenic can result in sore throat and irritated lungs. It has also been associated with cardiovascular and neurological effects [3].

Table 1: Exposure to Arsenic and Health Outcomes

Author and Year	Main Association	Main Finding
Ashan et al., 2006 [10](Case Control)	Arsenic in drinking water and pre-malignant skin lesions	Compared with drinking water containing less than 8.1 µg/liter of arsenic, drinking water containing 8.1-864.0 µg/liter of arsenic was associated with adjusted prevalence odds ratios of skin lesions of 1.9-5.39.
Cantor and Lubin, 2007 [11] (Review)	Arsenic and internal cancer from low level exposures	Epidemiologic data from areas with very high levels of arsenic in drinking water (>150 µg/L) show a strong association between arsenic exposure and risk of several internal cancers.
Celik et al., 2008 [12] (Review)	Arsenic in drinking water and lung cancer	After reviewing 17 studies, the common thread was strong, statistically significant associations between ingesting drinking water with high concentrations of arsenic and the development of lung cancer.
Chen et al., 2011 [13] (Longitudinal Cohort)	Arsenic in drinking water and proteinuria	As was positively related to prevalence of proteinuria, a marker of renal disease.
Chen et al., 2013 [14] (Prospective Case-Cohort)	Arsenic exposure and risk of cardiovascular disease	Arsenic exposure from drinking water and the incomplete methylation capacity of arsenic are adversely associated with cardiovascular disease risk.
Dangleben et al., 2013 [15] (Review)	Arsenic immunotoxicity	After a review of literature, the data show that chronic exposure to arsenic has the potential to impair immune response which could lead to increased risk of infections and chronic diseases and cancer.
Fernandez et al., 2012 [16]	Arsenic in drinking water and bladder cancer	Arsenic exposure is related to a significant increase in bladder cancer health care and to high mortality rates (even 20 years after having controlled arsenic levels in drinking water.)
Garcia-Esquinas et al., 2013 [17]	Arsenic exposure and cancer mortality	Low to moderate exposure to inorganic arsenic was moderately associated with increased mortality for lung, prostate and pancreas cancer.
Kumasaka et al., 2013 [18]	Arsenic and iron and cancer	Researchers found an increased carcinogenicity with co-exposure to arsenic and iron.

McClintock et al., 2014 [19]	Arsenic in drinking water and hematuria	A positive association of arsenic exposure with both prevalence and incidence of dipstick hematuria was found.
Melak et al., 2014 [20]	Arsenic methylation and lung and bladder cancer in Chile	Inter-individual differences in arsenic metabolism may be an important risk factor lung cancer, and may play a role in cancer risks for people exposed to low doses.
Mink et al., 2008 [21]	"Low level" arsenic exposure in drinking water and bladder cancer	Low-level arsenic exposure (100–200 µg/L*) alone did not appear to be a significant independent risk factor for bladder cancer. More studies are needed with detailed smoking history to determine if smoking is an effect modifier. (*Note: this level is considered high in New Jersey)
Niedzwiecki et al., 2013 [22]	Methylation of blood with arsenic exposure	Arsenic exposure is positively associated with global methylation of blood cell's DNA over a wide range of drinking water arsenic concentrations.
Oberoi et al., 2014 [23]	Arsenic in food and bladder, skin and lung cancer	This study indicates foodborne arsenic exposure is the source of a significant global burden of human disease.
Steinmaus et al., 2014 [24]	High levels of early life exposure to arsenic in drinking water and bladder and lung cancer	Adjusted odds ratios in those only exposed in early life to arsenic water were between 1.00-5.24 for lung cancer, and 1.00-8.11 for bladder cancer.
Vahter, 2008 [25]	Early life exposure to arsenic	Recent studies indicate that prenatal arsenic exposure also increases the risk of adverse effects during early childhood. Prenatal exposure lead to increased mortality in young adults from both malignant and non-malignant lung disease. The involved modes of action include epigenetic effects, endocrine effects, immune suppression, neurotoxicity, and interaction with fetal development enzymes.
Wasserman et al., 2014 [26]	Associations between drinking water contaminated with As and intelligence in Maine schoolchildren	Arsenic contaminated water was significantly negatively associated with Full Scale IQ and Perceptual Reasoning, Working Memory and Verbal Comprehension scores and a decreased IQ between 5-6 points.

Arsenic in New Jersey

Arsenic exists naturally in all parts of New Jersey at varying levels. In some areas such as the Piedmont Physiographic Province, the Highlands Province and the Valley and Ridge Province, the chemical and physical properties of the underlying geology allow the arsenic to become mobile and enter groundwater[27].

Arsenic Treatment Systems

Arsenic treatment systems can be divided into two main types, point-of-entry and point-of-use. Point-of-entry treatment systems (POET) treat raw water where it enters the home. This ensures that all faucets in the home are receiving treated water. Point-of-use treatment systems are a smaller scale version and usually located under the kitchen sink. They typically treat only one tap and the remaining taps in the home supply un-treated water.

Arsenic removal technologies include both physical and chemical processes such as adsorption, ion exchange, and membrane processes. Adsorptive processes are the preferred method of treatment and include activated alumina, iron, titanium, and zirconium adsorbents. Common brand names include Adedge, Isolux, Solmetex, Layne, Metsorb and Resin Tech. Adsorptive processes have been shown to be highly effective at reducing arsenic to below the MCL[28]. *Table 2* depicts common treatment systems found in NJ and the pros and cons of these systems.

Table 2: Types of Commercially Available Arsenic Treatment Media

Type & Brand Names	Mechanism	Pros	Cons
Activated Alumina (adsorptive)	Ions in the feed water are adsorbed to the oxidized activated alumnia surface. Raw water is passed through the bed to remove the arsenic and contaminant ions are exchanged with the surface hydroxides on the alumina. [29]		Only efficient at low pH (under 6), and may require pH adjustment [2]
Ion Exchange (Resin) *Purolite*	This system uses a physical/chemical process to exchange ion between a resin bead and untreated water. These systems work by passing water through the resin bed, which is charged with chloride ions from dissolved salt. Arsenate molecules in the water replace these chloride ions on the beads. Once all the beads are full, the system can be backwashed with water that is saturated with dissolved salt. The chlorine ions in this backwash water strip the embedded arsenic molecules out of the resin and into the backwash wastewater[30]	low-cost [2]	-Other particles in water can compete with arsenic for the resin, reducing effectiveness [30] -Waste brine is high enough in arsenic to be considered hazardous waste unless discharged into a sanitary sewer[2] -If the system fails, all of the arsenic captured on the resin can be released at once leading to a high arsenic level in the treated water also known as arsenic dumping [30] -Only removes As (V) [31]
Hybrid Media (Iron-impregnated anion exchange resin) *SolmeteX; LayneGreenPro; ArsenX^{np}*	Arsenic is adsorbed onto the iron in the anion resin. Layne is an updated version of SolmeteX	Doesn't need to be backwashed due to the bead shape which prevents channel formation	Doesn't last as long due to the iron content being 50% of the bead

Reverse Osmosis	Water is forced under high pressure through membranes with small pores[32].	-Highly effective -Effective at removing inorganic metals like arsenic, iron, lead, chromium and manganese [30] -Low maintenance [30] -95% efficient	- Does not remove As (III) -They are usually designed to produce only 2 to 3 gallons per day, and are usually located near the kitchen sink [30, 32] -RO-treated water may taste bland [30] -Large POET RO systems are expensive and not practical
Granular Ferric Hydroxide (Adsorptive) *AdEDGE*		-Longest lasting media (highest capacity for arsenic removal)	-Requires backwashing to break up the media channels -Higher short-term cost
Zirconium (Adsorptive) *Isolux*			Requires 4 cartridges to be a redundant system (most install 2)
Titanium (Adsorptive) *Metsorb*		- Second longest lasting material - Slightly cheaper than longest lasting material	-Potential for titanium in the treated water - Quicker arsenic breakthrough than longest lasting material -Potential for channeling as most titanium systems are not backwashing

Hopewell Township, New Jersey

Hopewell Township is located in Mercer County, New Jersey within the Piedmont Province. It has a population of 17,304. According to Ordinance No. 16-17.3, it is required to have the water system in compliance with the NJ Safe Drinking Water Act and the Private Well Testing Act. If the system is not in compliance, a whole house point-of-entry treatment system

(POET) is required. Hopewell further requires a dual tank granular ferric adsorptive media with sampling ports for raw, between tanks and treated water. They also require maintenance testing every 6 months, but this requirement is not enforced [33].

Regulations & Guidance

In 2002, The U.S. EPA established a drinking water standard of 10 µg/L for arsenic in drinking water and a maximum contaminant level goal (MCLG) of zero. They estimated that lifetime cancer risk at 10 µg/L was as high as 6.1 in 10,000[8]. New Jersey has the most protective standard in the United States with a MCL of 5 µg/L, since 2006[34]. These standards apply to private well owners under the New Jersey Private Well Testing Act (PWTA). The PWTA requires private well owners to test well water for arsenic and other contaminants during real estate transactions and when renting a property that is supplied by a private well. Hopewell Township's ordinances are perhaps the most protective in the country, requiring a dual tank point-of-entry treatment system if arsenic is found to be above 5 µg/L in private wells.

Materials and Methods

Specific Aims

Specific Aim 1: Determine the status and maintenance of arsenic treatment systems and their impact on arsenic removal efficacy.

I. What is the status of treatment systems in Hopewell Township?

II. Does maintenance schedule adherence affect arsenic removal efficacy?

III. Is treatment media breaking though and entering the home's drinking water?

IV. Propose an ideal maintenance schedule that is protective of public health.

Specific Aim 2: Determine if the behaviors and beliefs of the well owner influence the maintenance of the system.

I. What are the characteristics (demographics) of homeowners who test their water regularly?

II. What factors lead well-owners to maintain their treatment system?

III. Is there a knowledge gap that can be addressed by a public health educational intervention?

IV. Create an informational brochure for treatment system installers to provide to home owners at the time of installation.

Specific Aim 3: Determine the arsenic exposure and risk reduction for homes with treatment systems.

I. What is the average yearly exposure to arsenic in homes with treatment systems?

II. What is the risk reduction achieved by these treatment systems? (Raw vs. treated)

III. What is the cancer risk for these individuals?

IV. Is a dual tank arsenic treatment system protective of public health?

<u>Specific Aim 4</u>: Validate the Field Methods of Estimating Arsenic Speciation.

I. Can As (III) be predicted by ORP, RDO, Iron or Manganese?

Hypotheses

H_1 Regular maintenance of arsenic treatment systems increases efficiency and lowers risk of arsenic exposure.

H_2 Arsenic treatment media is breaking through the system potentially leading to acute exposures to high levels of arsenic.

H_3 Owners who have a high level of arsenic knowledge are more likely to maintain their treatment system.

H_4 Homeowners who have high cues to action, perceived susceptibility, severity and benefits and low perceived barriers are most likely to maintain their treatment system.

Methods

Two hundred homes in Hopewell Township, NJ with arsenic treatment systems were identified in April 2014. For 100 of these homes, the type of system and installer was also identified. *Appendix A* shows the initial treatment system findings. Hopewell Township residents were contacted via mail with a postcard invitation to participate in this study. *Appendix B* shows an example of the postcard that was mailed. A follow up phone call or email was sent to schedule the home visit.

Compensation for participation was a free water test funded by the New Jersey Geological and Water Survey (NJGWS), a division of the NJ Department of Environmental Protection (NJDEP). The water test was valued at $200. In addition, homeowners were given an analysis of their water test results with recommendations. A visit to the participant's home was scheduled at their convenience. *Appendix C* details the email, answering machine and phone call scripts.

At each home, a survey was read aloud to the homeowner as they followed along on a paper copy. The homeowner's responses were recorded by the interviewer. *Appendix D* details the questions that were asked. The survey focused on behaviors and beliefs about treatment system maintenance. It also contained sections on personal health history and water consumption habits. *Appendix E* categorizes the survey questions. The survey aimed to fill in the demographic and maintenance schedule gaps left from the health department files and understand how their perception of risk affects their behavior. The homeowners were asked to hold their questions until the end of the survey to prevent potential bias.

At each home, the water was tested under stressed conditions. The homeowners were asked to turn on two cold water taps for ten minutes. If the homeowner was present during sampling, the importance of stressing the system before testing the water was explained to them. A MicroR meter was used to measure the radioactivity of each treatment tank. Homeowners were alerted if any of their treatment tanks were above 50 micro R per hour. They were advised to limit time near the tanks and keep children a safe distance away. For some homes a safe distance was established with the MicroR meter. A photograph was then taken of each system. The sample bottles from NJ Analytical Laboratory were labelled with the sampling date, home identification number and sampling location. Before sampling, the flow of water from entering the home from the well, through the system and entering the plumbing of the home was recorded.

At the raw water sampling port, a TROLL In-situ 9500 was used to measure temperature, pH, redox potential, dissolved solids and dissolved oxygen. A SmarTROLL MP Handheld Low-Flow system was attached to the In-situ to prevent water oxygenation prior to analysis. At the raw sampling port, between the treatment tanks port and kitchen sink, pool test strips were used to measure pH, hardness, chlorine, and alkalinity.

For the raw water, arsenic speciation was performed using Metalsoft Arsenic Speciation Cartridges. The cartridges are disposable and provide a portable method of determining arsenic species while in the field. Each plastic cartridge contains 2.5 g of arsenic adsorbent. The cartridges attach to a syringe and water is passed through them. The cartridges remove Arsenic (V) from the water leaving only Arsenic (III). At each home a 30 ml syringe was rinsed with raw water. 30 ml of raw water was drawn into the syringe and the speciation cartridge was attached. The first 5 ml were expelled into a waste bucket. The remaining 25 ml were expelled into a sample container at a rate of 1 ml per second. The cartridge was removed and 30 ml of raw water was drawn into the syringe. The same cartridge was re-attached and 30 ml of water was expelled at a rate of 1 ml per second into the sample container. This was repeated once more to achieve a final volume of 85 ml. Speciation cartridges were discarded after each use.

Three 120 ml water samples were taken from the raw (untreated) valve, between tanks valve and kitchen tap. An additional sample was taken if there was a reverse osmosis system installed. Water samples were sent to New Jersey Analytical Laboratory for analysis.

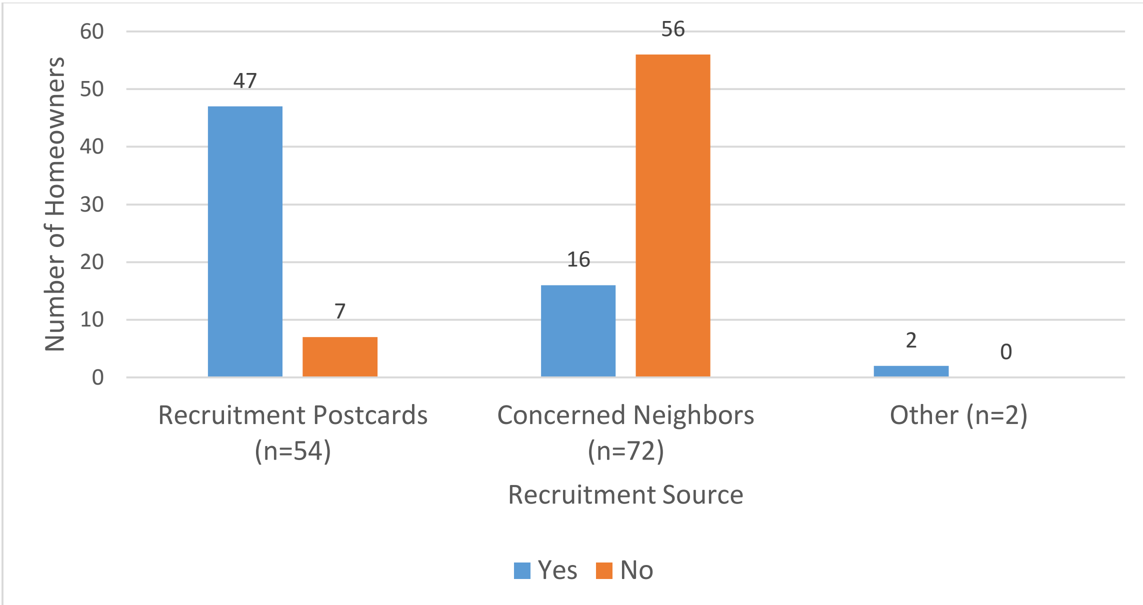
Sediment samples were taken from faucet screens and toilet tanks to determine if there was any breakthrough of the treatment media. The homeowner was asked to identify a toilet in the home that is frequently used. The water to the toilet was shut off and the toilet was flushed to remove most of the water from the tank. A turkey baster or long pipette was used to take a sample from the bottom of the toilet tank. The water was expelled into a mesh strainer with a coffee filter. The coffee filter was then placed in a Ziploc bag and labelled with the location and home identification number. A sample was also taken from faucet screens. The outer casing of the faucet was removed with duct tape covered pliers. The contents of the filter screen were tapped onto a coffee filter and placed in a labelled Ziploc bag. Sediment samples were analyzed under a microscope to determine if any arsenic treatment media is present. *Appendix F* details these procedures and necessary materials.

Chapter One: Study Population and Location

Participant Recruitment

A total of 200 post cards were mailed to Hopewell Township, NJ residents who had existing arsenic treatment systems. 54 homeowners responded to the post card or email and 47 of the 54 were recruited into the study. In addition, 72 Hopewell Township residents that heard about the study contacted us via phone or email. If they met the study eligibility criteria, they were enrolled in the study. A total of 16 additional homes were enrolled through these concerned neighbor contacts. The remaining 56 homeowners who did not meet the selection criteria were given detailed instructions on how to test their water. *Appendix G* is an example of the email response to homeowners who expressed interest in the study but did not meet the eligibility requirements. *Appendix H* shows some selected responses from homeowners who did not meet the eligibility requirements. Two additional homeowners who met the eligibility criteria were identified from other arsenic studies in Hopewell Township and participated in this study. A final total of 65 homes were enrolled in the study. *Figure 1* illustrates the recruitment sources. For the homeowners who were recruited by the postcard mailing, the blue bar represents homeowners who were reruited into the study and the orange bar represents homeowners who replied to the postcard but were not interested in participating. For homeowners that were concerned neighbors, the blue bar represents homeowners that met the eligibility requirement and were recruited into the study and the orange bars represent homeowners who did not meet the eligibility requirement.

Figure 1: Participant Recruitment Sources



Demographics

The study population was comprised of 65 homeowners living in Hopewell Township, NJ with an existing arsenic treatment system and represented 1% of the total homes in the Township. Overall, the study population was more female, more highly educated and had a higher home value than the rest of Hopewell Township. This difference may be caused by participation bias. It is also important to note that the Hopewell Township population may not represent the well-owner population in Hopewell.

Table 3 shows a comparison between the study population and Hopewell Township. The study population's median age was slightly higher than the median age of the Township. Additionally, more females (60%) than males participated in the study. Hopewell Township is a relatively affluent town with 6,526 homes and the mean tax assessed home value of $466,300. The study population had a higher mean home value of $586,888. Tax assessed home value was used as a surrogate for income. An average of 2 adults were living in the home with an average of 1.7 children.

Table 4 shows how long the average homeowner in this study had lived in the home (7 years) and how long the average homeowner intended to live in it in the future (18 years). *Figure 2* shows that most homeowners in this study (50.7%) had lived in their home for 1-5 years. It is likely that new homeowners would have arsenic treatment systems because of the Private Well Testing Act and Hopewell Township's ordinance.

Table 3: Demographics

(n=65)		Study Population	Proportion	Hopewell Township	Proportion
Age	*Mean*	48.2			
	Median	46		44.4[1]	
Gender	*Male*	26	40.0%	8509[1]	49.8%
	Female	39	60.0%	8795[1]	50.8%
Education	*High School & under*	0	0.0%		5.3%
	High School Degree	0	0.0%		12.1%
	Some College	0	0.0%		12.8%
	Associate's Degree	2	3.1%		5.2%
	Bachelor's Degree	26	40.0%		28.8%
	Graduate Degree	37	56.9%		36.4%
Home Value	*Mean*	$586,888		$466,300[2]	
	Median	$612,400			
Age of Youngest Child	*Mean*	10			
Homes with Children	*Total*	50	76.9%		
Number of Children at home	*Mean*	1.7			
Number of Adults at Home	*Mean*	2.0			

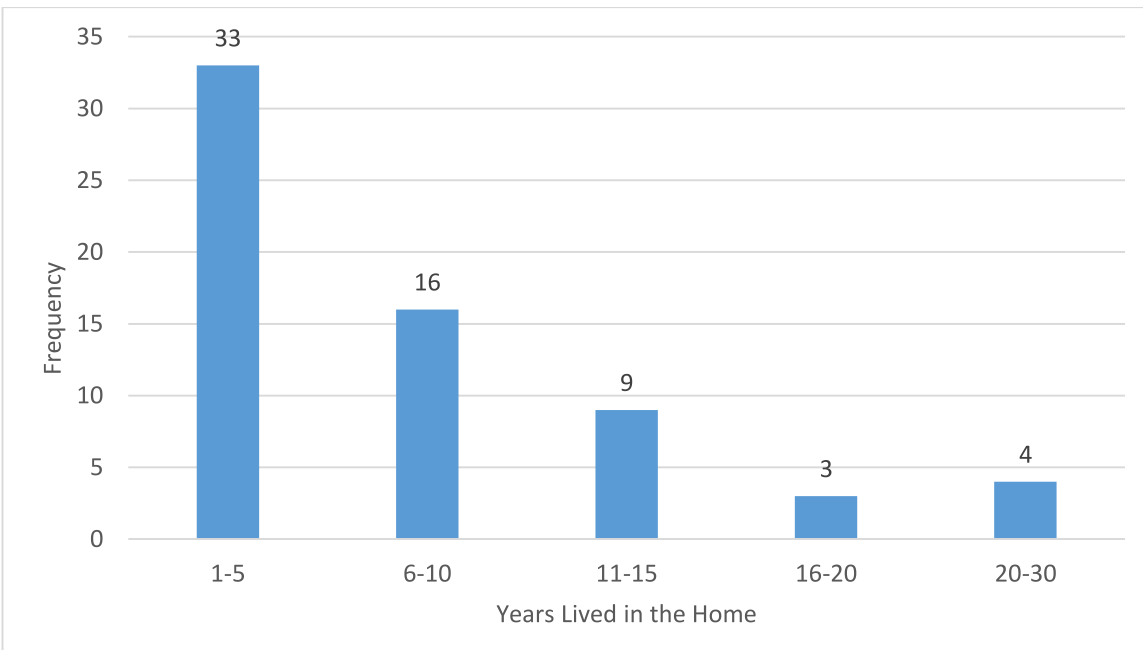
Total Homes	*Total*	65		6,526[1]	
[1]U.S. Census Bureau, 2009-2013 5-Year American Community Survey **[2] Hopewell Township Tax Assessor's Office**					

Table 4: Length of Time in Current Home (Years)

Survey Question	Mean	Stdev	Min	Max
How long have you lived in your current home? (n=65)	7	7	0	29
How long do you intend on living in your current home? (n=63)[1]	18	12	0	50

[1]One participant refused to answer. One additional participant was excluded because he was not currently living in the home (landlord of vacant home). If participant said they intend to live in the home "forever," their age was subtracted from the average American lifespan. If the participant gave a range of years, the average was recorded.

Figure 2: Years Lived in the Home



Health History

Table 5 shows the responses to the survey questions about the home owner and their family's health history. Most of the study population (95%) were non-smokers and reported that no one else in the home was a smoker (100%). Most reported no significant health issues (77%).

Of the 23% (n=15) that reported significant health issues, 7.7% (n=5) were cancers. Three of the homeowners (5%) had been pregnant in the last year.

Table 5: Health History Survey Questions (n=65)

Survey Question	Response	Total	%
“Have there been any significant health issues in your family?”	Yes	15	23.1%
	No	50	76.9%
“Have there been any cancers in your family members who live in this household?”	Yes	5	7.7%
	No	60	92.3%
“Do you Smoke?”	Yes	3	4.6%
	No	62	95.4%
“Does anyone in your household smoke?”	Yes	0	0.0%
	No	65	100.0%
“Has anyone been pregnant in the last year?”	Yes	3	4.6%
	No	62	95.4%

Sampling Locations

Figure 3 illustrates the sampling locations of this study. *Figure 4* shows the private well testing act results in 2x2 mile grids. The color of each grid represents the percentage of wells tested that exceed the MCL for arsenic. *Appendix I* contains notes, water treatment system photos, and water quality parameter data for each of the sampling locations.

Figure 3: Sampling Locations in Hopewell Township, New Jersey

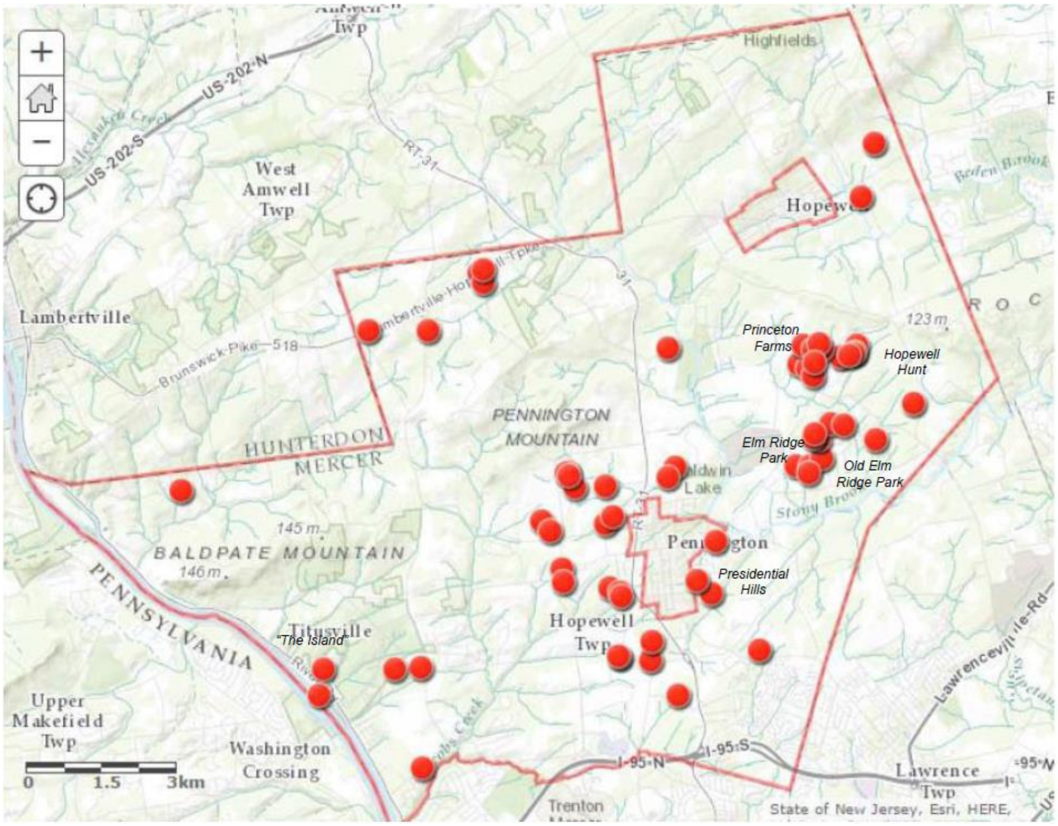
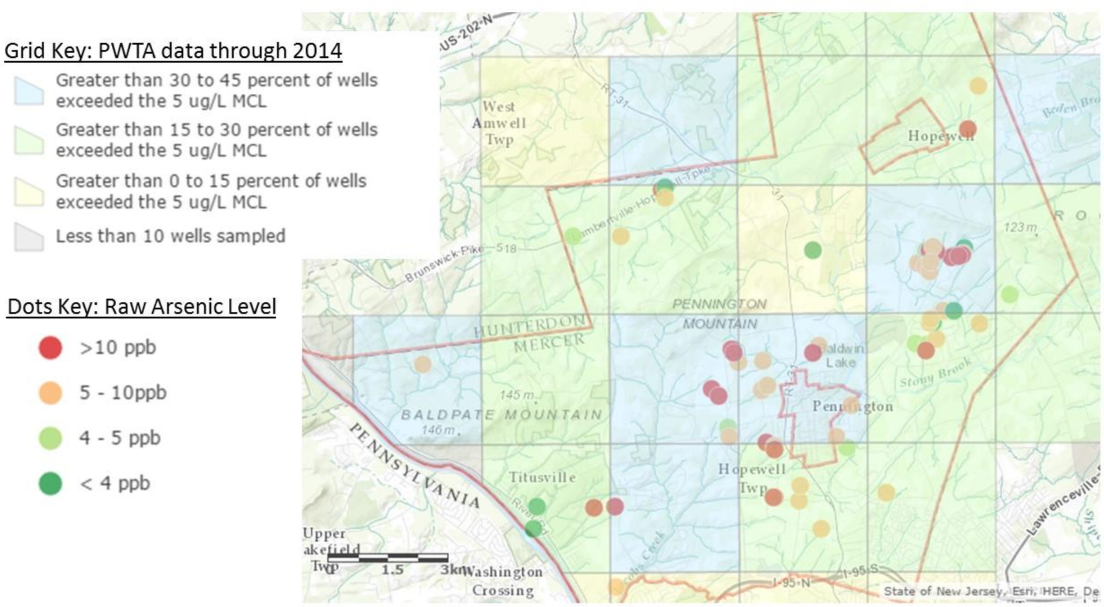


Figure 4: PWTA Exceedances and Study Population Arsenic Concentrations



Chapter Two: Arsenic Treatment Systems

Types of Treatment Systems

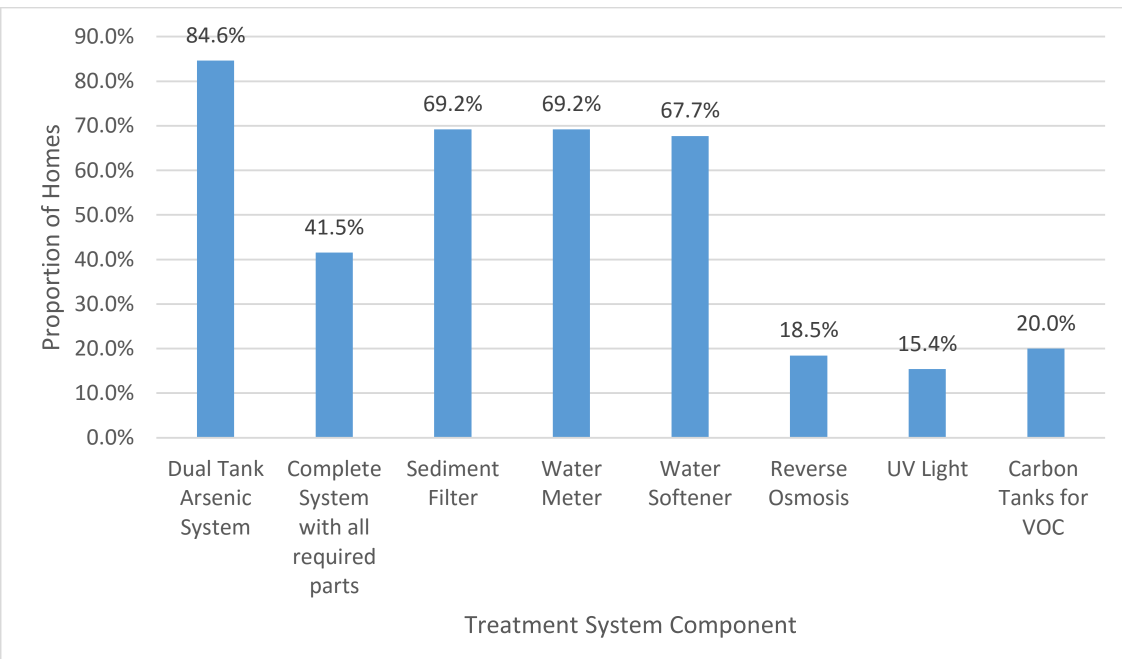
Hopewell Township's ordinance requires a dual tank arsenic system with a water meter and sediment filter. *Table 6* and *Figure 5* show what percentage of homes had each of the water treatment components. Of the 65 homes visited, 55 (84.6%) had a dual tank system and 27 of the 65 homes (41.5%) had a complete system that met the Hopewell Township ordinance. 69.2% of homes had a water meter and 69.2% of homes had a sediment filter.

Though not required by ordinance, 67.7% homes had a water softener. However, many of the homes with softeners did not have salt in the salt tank. Salt is required for the softener to function properly. 15.4% of homes had UV lights which treat water contaminated with bacteria. 20% of homes had carbon tanks, usually funded by the NJ Spill fund, to remove volatile organic chemicals from water. 18.5% of homes had a reverse osmosis treatment system which provides an added layer of protection from arsenic.

Table 6: Water Treatment System Description or Components (n=65)

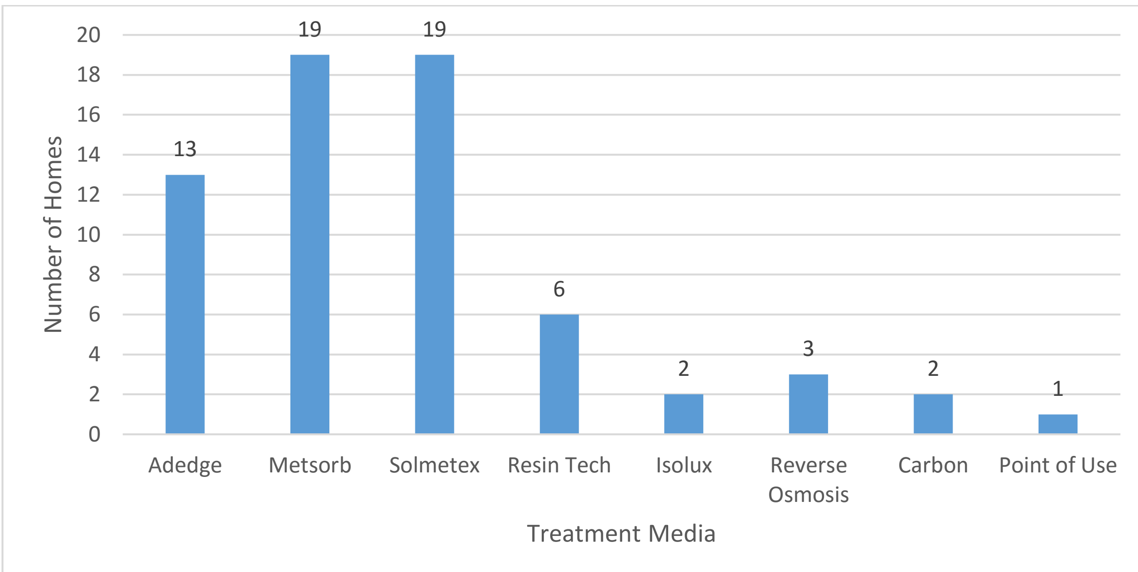
		Number	Proportion
Dual Tank Arsenic System	Yes	55	84.6%
	No	10	20.0%
Water Softener	Yes	44	67.7%
	No	21	32.3%
Reverse Osmosis	Yes	12	18.5%
	No	53	81.5%
UV Light	Yes	10	15.4%
	No	55	84.6%
Carbon Tanks for VOC	Yes	13	20.0%
	No	52	80.0%
Sediment Filter	Yes	45	69.2%
	No	20	30.8%
Water Meter	Yes	45	69.2%
	No	20	30.8%
Complete System with all required parts	Yes	27	41.5%
	No	38	58.5%

Figure 5: Overview of Treatment Systems Components (n=65)



Each treatment system contains a different type of treatment media. *Figure 6* shows how many homes had each type of media. Of the 65 homes sampled, 61 (93.8%) had whole-house treatment systems. Two of those homes had carbon tanks which they believed to be removing arsenic. Carbon is not an effective method of removing arsenic from water. The most common treatment media are Metsorb (29.2%), Solmetex (29.2%). Adedge (20%) and Resin Tech (9.2%) are the second most common media types. Four homes, 6.1%, had point-of-use treatment systems that only treat one tap.

Figure 6: Media in Arsenic Treatment Systems (n=65)



Installation, System Age and Cost

Figure 7 shows homeowner responses to treatment system history questions. It is important to note the potential for recall bias. The average treatment system was reported to be installed six years ago, in 2009. Some treatment systems were installed recently with home purchases this year. Some homeowners indicated their systems were installed as early as 1995. These early systems were carbon tanks that they believed were removing arsenic. The average homeowner reported their last arsenic test three years ago, in 2012. Some homeowners have tested their water within the past year and others have reported as early as 1998. Arsenic testing was not done in 1998 in New Jersey, therefore there may be some recall bias. A forward telescoping bias was also observed as many homeowners believed to have tested more recently than their water test results indicated.

Table 7: Treatment System Background

(n=65)	Mean	StDev	Min	Max
"When was your arsenic treatment system installed?"	2009	3.96	1995	2015
Age of the treatment system	6	3.96	0	20
"When was the last time your water has been tested for arsenic?"	2012	3.32	1998	2015
Years since last arsenic test	3	3.96	17	0

Arsenic systems may be funded by a variety of sources. *Table 8* and *Figure 7* show the funding sources from the study population. Most commonly, the previous homeowner installed the treatment system (58.5%). If the previous homeowner installed the system, it was likely part of a real estate transaction. The second most common purchaser was the current homeowner (32.3%). 3.1% of the study population reported that the cost of the system was split between the current and previous homeowner. The homeowners that reported that their system was funded by the NJ Spill Fund had carbon tanks for VOC issues.

Table 8: Purchaser of Treatment System

<table>
<tr><th colspan="2">(n=65)</th><th>Number</th><th>Proportion</th></tr>
<tr><td rowspan="6">"Who paid for your current arsenic treatment system?"</td><td>Previous homeowner</td><td>38</td><td>58.5%</td></tr>
<tr><td>Current homeowner</td><td>21</td><td>32.3%</td></tr>
<tr><td>NJ Spill Fund</td><td>1</td><td>1.5%</td></tr>
<tr><td>Split between Previous & Current Owner</td><td>2</td><td>3.1%</td></tr>
<tr><td>New Construction</td><td>1</td><td>1.5%</td></tr>
<tr><td>Other source</td><td>2</td><td>3.1%</td></tr>
</table>

Figure 7: "Who paid for your current arsenic treatment system?"

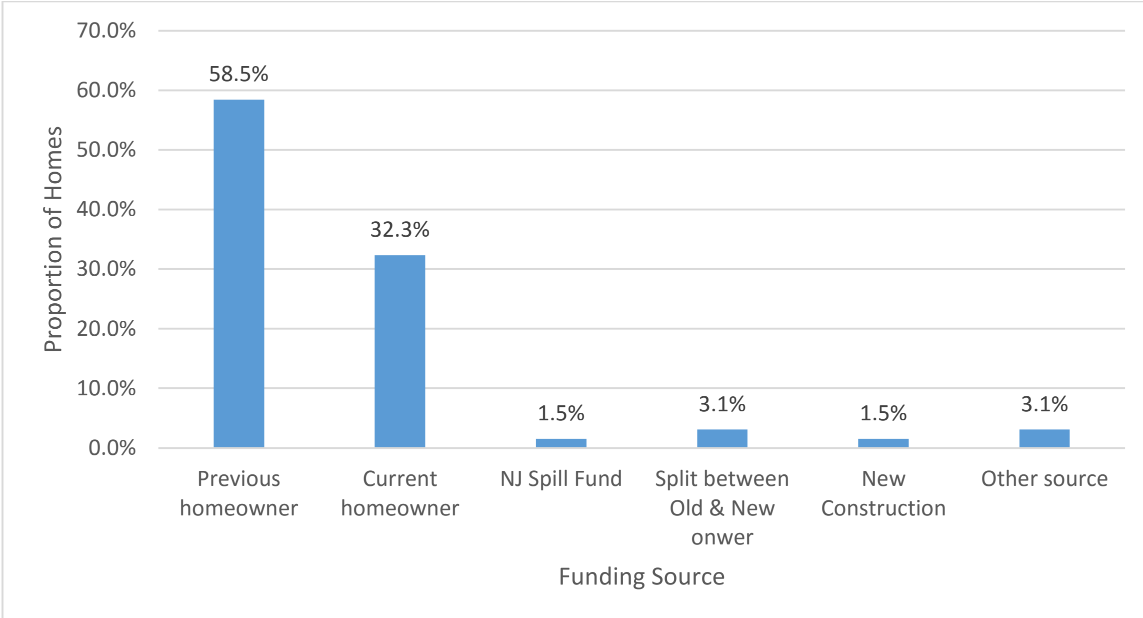
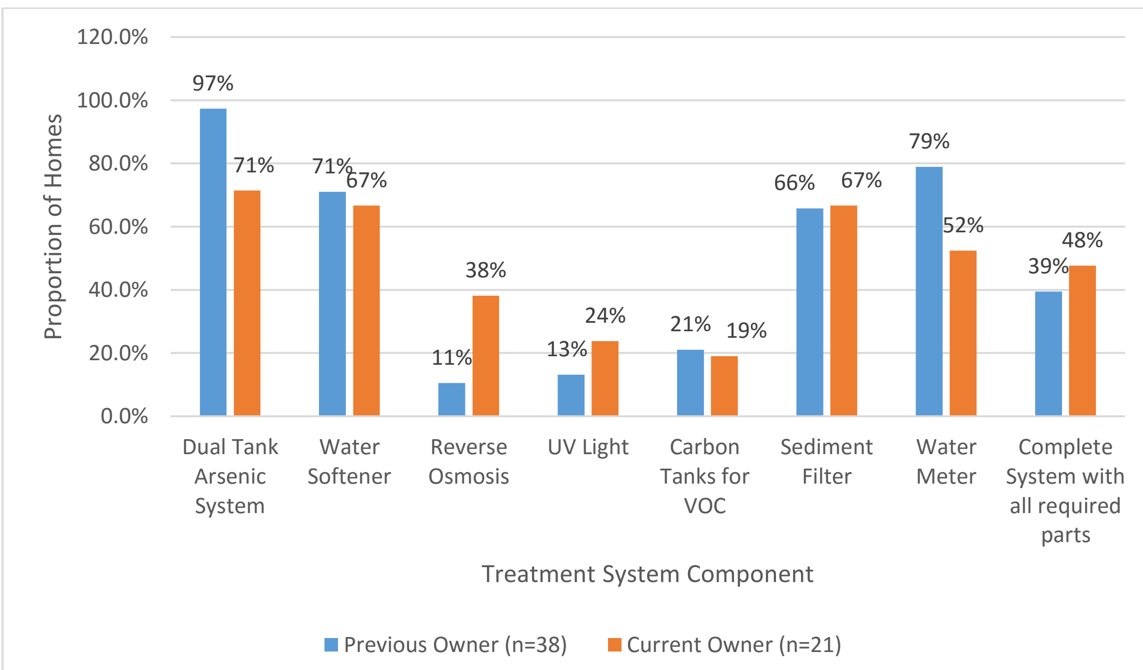


Figure 8: Treatment System Components installed by Previous vs. Current Owners

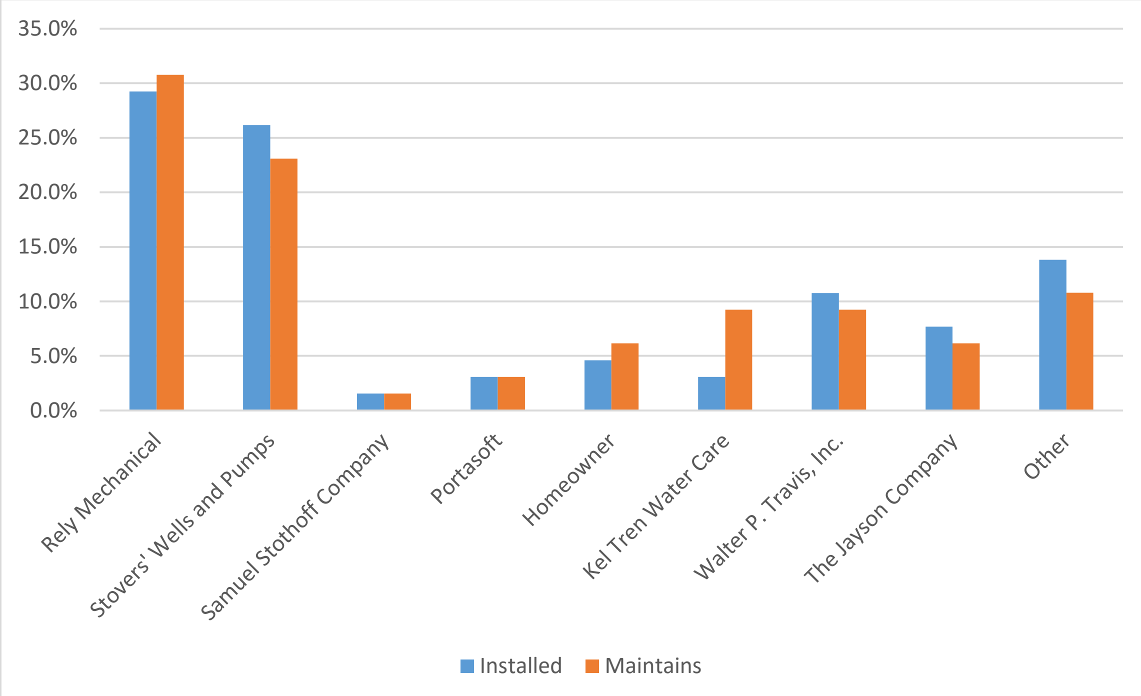


There are a number of treatment system installers and maintainers which are shown in *Table 9*. A comparison of installer and maintainer is shown in *Figure 8*. Rely Mechanical was the most common installer (29.2%) and maintainer (30.8%). Stover's Wells and Pumps was the second most common installer (26.2%) and maintainer (23.1%). Both Rely and Stover's employ methods of reminding their customers to test their water. Rely sends postcards to their customers when they are due for service. Stover's sends a box of sample bottles for the homeowners to fill with their water and send back for analysis.

Table 9: Installer and Maintainer of Arsenic Treatment Systems

(n=65)	Company	Number	Proportion
"What company installed your treatment system?"	Rely Mechanical	19	29.2%
	Stover's' Wells and Pumps	17	26.2%
	Samuel Stothoff Company	1	1.5%
	Portasoft	2	3.1%
	Pennington Water Conditioning	3	4.6%
	Kel Tren Water Care	2	3.1%
	Walter P. Travis, Inc.	7	10.8%
	The Jayson Company	5	7.7%
	Chesterfield Mechanical	1	1.5%
	Culligan Installation	1	1.5%
	Fresh Water Company	1	1.5%
	Owner Installed	3	4.6%
	Other	3	4.6%
Current Maintainer	Rely Mechanical	20	30.8%
	Stover's' Wells and Pumps	15	23.1%
	Samuel Stothoff Company	1	1.5%
	Portasoft	2	3.1%
	Aqua Pur	1	1.5%
	Kel Tren Water Care	6	9.2%
	Walter P. Travis, Inc.	6	9.2%
	The Jayson Company	4	6.2%
	Hoffman	1	1.5%
	Culligan	1	1.5%
	Fresh Water Company	1	1.5%
	Home Owner	4	6.2%
	Other	3	4.6%

Figure 9: Study Population's Use of Arsenic Treatment Installers and Maintainers (n=65)



Status of Arsenic Treatment Systems (Specific Aim 1.I)

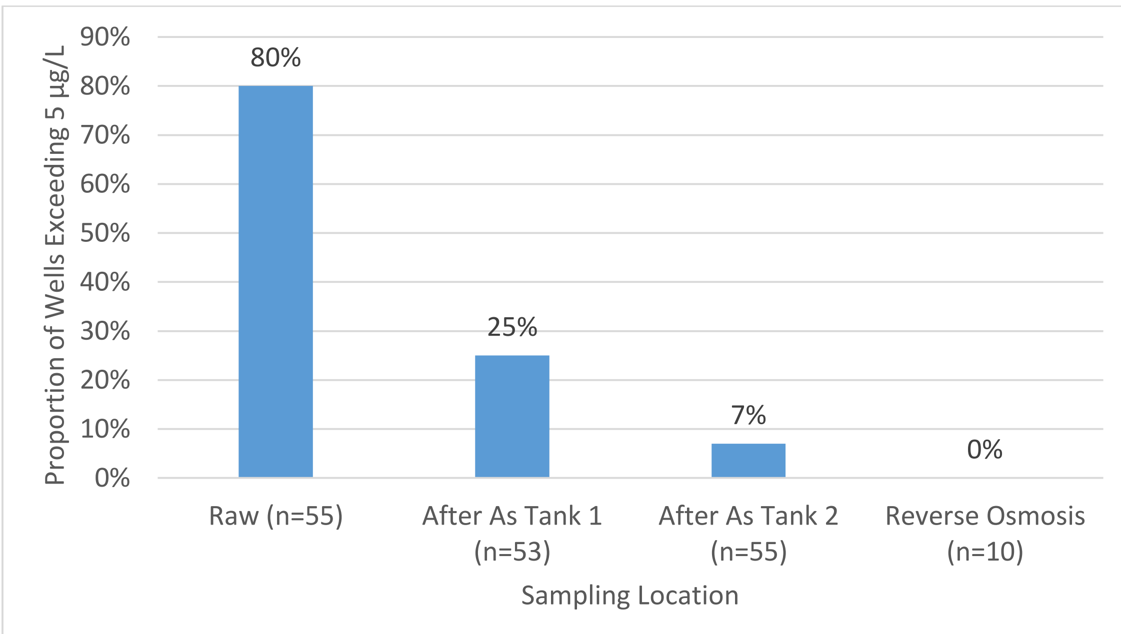
Figure 10 shows the proportion of homes with whole house treatment systems that exceed the NJ standard at each sampling location. *Table 10* shows the average, minimum and maximum arsenic concentration at each sample location. Of the 55 homes with whole house, dual tank treatment systems, 44 (80%) exceed the MCL in raw (untreated) water. The highest raw water arsenic concentration in this study population was 41.6 µg/L and lowest was 2.6 µg/L. 53 of the 55 homes had a sampling port between the two arsenic tanks. After the first arsenic tank 13 (25%) of the samples exceeded the standard. After the first arsenic tank is also referred to as “between the tanks.” The second arsenic tank adds more protection as only 4 (7%) of the

55 homes exceeded the standard. In all 10 homes with a reverse osmosis back-up system, the arsenic was non-detect.

Table 10: Arsenic Concentrations

	Raw	Between Tanks	Kitchen Sink	Reverse Osmosis
(n=)	55	53	55	10
Mean	11.29	3.65	1.08	0.05 (ND)
StDev	8.97	6.11	2.31	0.00
Min	2.60	0.05 (ND)	0.05 (ND)	0.05 (ND)
Max	41.60	38.50	12.80	0.05 (ND)

Figure 10: Proportion of Water Samples Exceeding the MCL at Each Sampling Location



Examples of Treatment Systems in Hopewell Township

Various types of arsenic treatment systems are shown in *Figures 11-13. Figure 11* shows treatment systems that meet the Hopewell Township Ordinance and are considered sufficient. *Figure 11A* shows a dual tank Metsorb system with a sediment filter and water meter. These are the minimum requirements that a system should have.

Figure 12 shows treatment systems in Hopewell Township that do not meet the township's requirements or have a problem with the system. *Figure 12A* and *D* show Isolux systems which appear to be redundant but water flows through both tanks at the same time, rendering this a single tank system. In addition, the system in *Figure 12D* also had three different types of sediment filters. Having too many sediment filters can lead to low water pressure. *Figure 12B* shows a treatment system without a sediment filter, water meter and sampling ports between the two arsenic tanks. A sampling port between the arsenic tanks is critical to the system design as it allows for testing between the tanks and indicates when maintenance is needed. *Figure 12C* shows a system with the required components, however, the sampling port faced upward and was hard to fill a sample bottle. *Figure 12E* shows a system that is missing a water meter and the backwash settings were programmed incorrectly. When a system backwashes too frequently it wastes a large amount of water. Additionally, when a backwash is programmed at an inappropriate time, e.g. during the daytime hours, the water bypasses arsenic treatment. This could mean the residents in the home would be exposed to untreated water with arsenic.

Figure 13 shows treatment systems that had a major problem or issue. *Figure 13A* shows the basement floor adjacent to an arsenic treatment system. The treatment system maintainer removed the contaminated arsenic treatment media in the home and replaced it with new media. While removing the media, some was spilled on to the floor and tracked through the basement. *Figure 13B* shows the difference in floor color from where the media was spilled (orange) and where it was not spilled (grey). The homeowner was alerted about this issue and the system maintainer was called to clean up the arsenic spill. *Figures 13C-D* show arsenic treatment media breaking through the treatment system and entering the water. This occurrence is explored in depth in Chapter 5.

Figure 11: "Good" Treatment Systems

"Good" Treatment Systems
(has all required components)

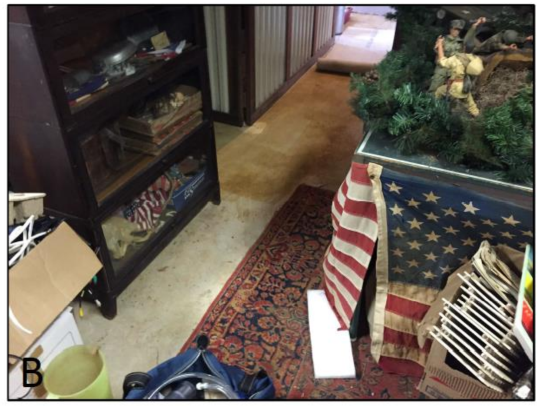
A. Rely Metsorb System B. Rely Metsorb System C. Fresh Water Adedge System
D. PWC Adedge System E. Stover's Solmetex System

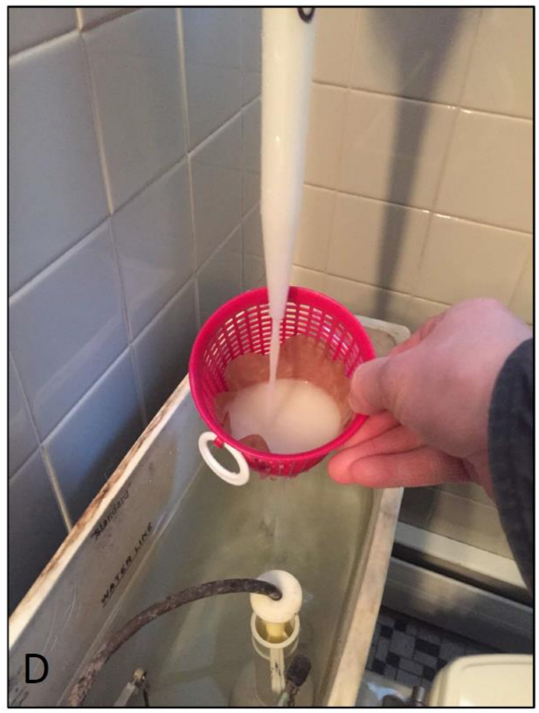
Figure 12: "Bad" Treatment Systems

"Bad" Systems
(Has something wrong)

A. *Isolux system is not redundant*
B. *Resin tech system does not have sampling ports, a sediment filter or water meter*
C. *Sampling port faces upward*
D. *Isolux system is not redundant*
E. *Adedge system missing water meter and backwashing heads were programmed improperly*

Figure 13: "Very Bad" Systems





"Very Bad" Systems
(Has something major wrong)
A & B. Media was changed in the basement by the treatment installer and tracked through the basement
C. Major resin tech media breakthrough
D. Major metsorb media breakthrough

Status of Additional Water Treatment in Home

A MicroR meter was used to measure the radioactivity of all treatment tanks. *Table 12* summarizes the measurements taken at each location. The average background level was 9.4 MicroR/hour. Arsenic tanks averaged between 13.32 and 14.33 MicroR/hour with the highest reading 60 MicroR/hour. A radioactive arsenic tank indicates the presence of uranium in the drinking water. The average softener reading was 15 MicroR/hour with the highest reading at 80 MicroR/hour. A radioactive softener indicates the presence of radium in the water. If a homeowner had a radioactive softener the importance of keeping salt in the softener tank was stressed due to the potential serious health effects from ingesting radium. The average carbon tanks were 73 MicroR/hour. The highest reading from a carbon tank was 210 MicroR/hour. Homeowners were advised to limit time near radioactive tanks and to alert their treatment system maintainer if any of the tanks are above 50 MicroR/hour.

Table 11: Treatment Tank MicroR Meter Readings (MicroR/hour)

	Background	As Tank 1	As Tank 2	Softener	Carbon 1	Carbon 2
Mean	9.40	14.33	13.32	14.95	73.23	72.86
Standard Deviation	2.69	9.65	8.56	12.62	56.53	54.07
Min	4	5	5	5	9	20
Max	18	60	56	80	210	180
Count (n=)	62	55	53	38	13	7

Chapter Three: Arsenic Treatment Media

Media Types

The three most common types of arsenic treatment media used by the study population were Adedge, Metsorb, Layne/Solmetex and Resin Tech. Each of these media use an adsorptive process to remove arsenic from the drinking water. Layne media, formerly Solmetex, is an iron impregnated anion exchange resin. Adedge is granular ferric hydroxide material. Metsorb is a titanium hydroxide material.

Media-Breakthrough (Specific Aim 1.III)

Sediment samples from toilet tanks and faucet screens were analyzed under a light microscope. *Figure 10* shows media-breakthrough frequency of each type of treatment media. Some form of media-breakthrough, either from arsenic treatment or the water softener, occurred in 72.1% of homes. Some uncertainty, represented by the blue and white bar extension, exists for Solmetex, Resin Tech and softener beads as they all have a similar appearance under the microscope. *Figure 11* shows the units of the scale in each media photo. Additional photos and descriptions of each participant's toilet tank and faucet screen analysis can be found in *Appendix J.*

Figure 14: Treatment Media-Breakthrough

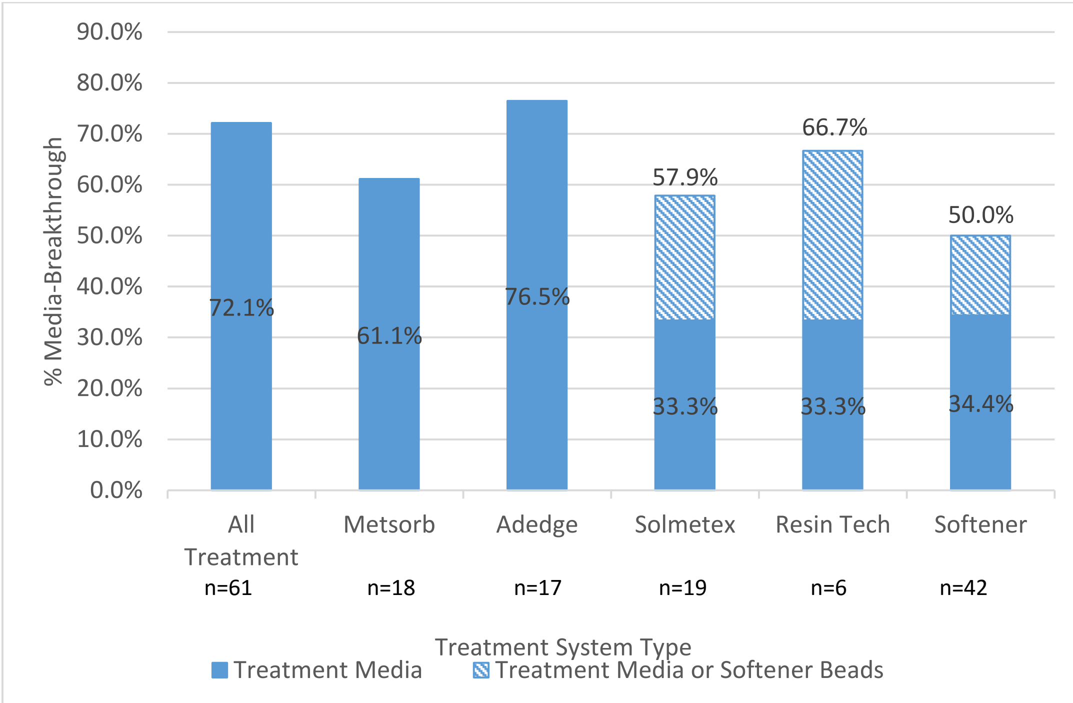
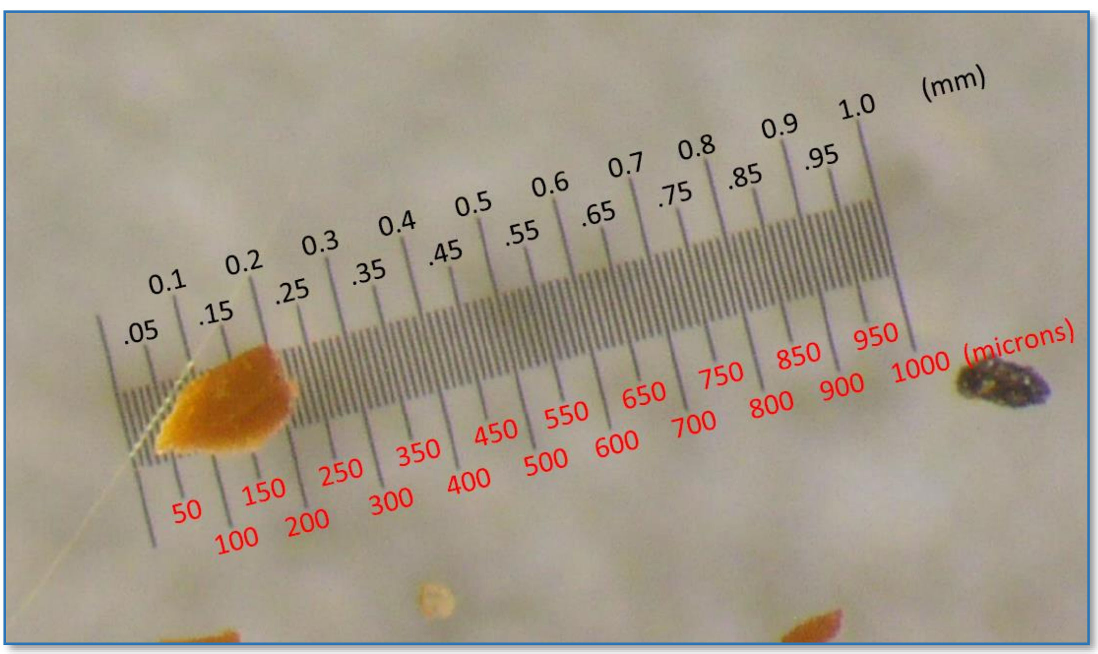


Figure 15: Scale in Microscope Photos



Adedge media-breakthrough occurred in 76.5% of homes (n=17). Under the microscope, Adedge media appeared brown and clay-like with a slight shine and often a flat side. Unused Adedge media is shown in *Figure 12A. Figure 12B* shows Adedge's brown, clay-like appearance at 64x. *Figure 12C* shows Adedge media-breakthrough from the toilet tank of house As2015-002.

Adedge media can be easily broken into very fine pieces. *Figures 12D-E* show various sizes of broken media on a scale. The sizes in *Figure 12D* range from less than 10 microns (µm) to 450 µm and 20 µm to 1000 µm in *Figure 12E. Figure 12F* shows Adedge media suspended in water at 64x. *Figure 12G* shows one of the larger Adedge media pieces which measured 2300 µm.

Metsorb media-breakthrough was second most common and occurred in in 61.1% of homes (n=18). Metsorb, under the microscope, appeared to be opaque and white and resembled popcorn. *Figure 13A* shows Metsorb media under 7.5x magnification. Metsorb pieces also had small black dots on the surface and was easily broken into many small pieces. *Figure 13B* shows a piece of media with its characteristic black dots under 64x magnification. *Figure 13D* and *13G* show Metsorb and Adedge media from toilet tanks of homes with Metsorb treatment systems that previously had Adedge treatment systems. In *Figure 13G* the size of the Metsorb pieces on the scale range from 100-150 µm.

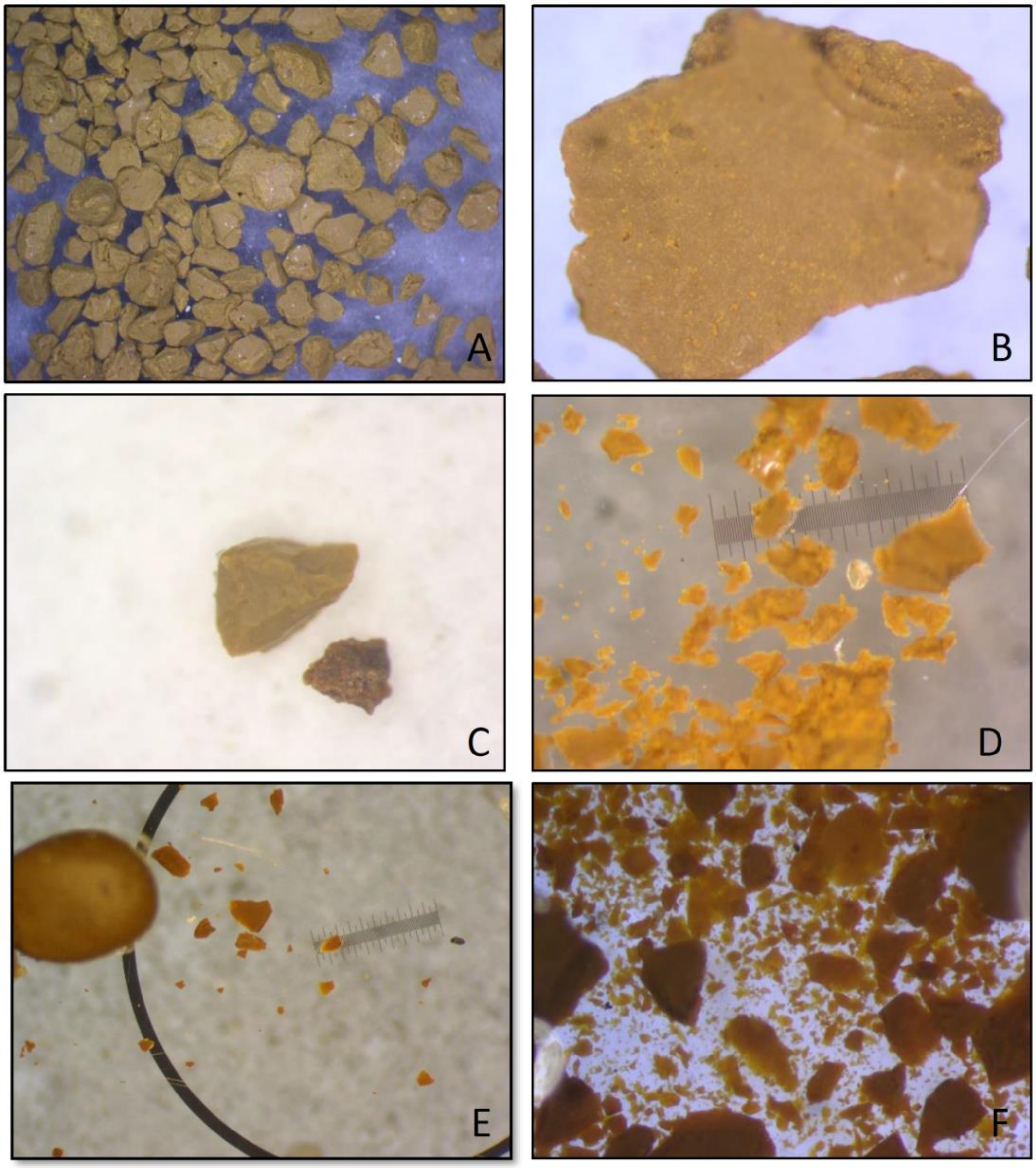
Resin Tech media-breakthrough occurred in at least 33% of homes with the treatment systems but could be as high as 66.6%. Of the 6 houses in this study with Resin Tech, 4 houses had media-breakthrough. Because of the presence of a softener in 3 of those homes, only 1 of the 6 could be analyzed for Resin Tech bead media-breakthrough. Participant As2015-004 had a Resin Tech system and no softener present. The homeowner complained of low water pressure. Upon removal of the bathroom faucet screen, treatment media was found. *Figure 14A* shows the faucet screen with media sitting on it. When the faucet was turned on, Resin Tech treatment media came out. This can be seen in *Figures 14B-C*. The treatment media and screens were analyzed under light microscopy. *Figure 15A* shows the faucet aerator with small media beads stuck along the rim. *Figure 15B* shows a 400 µm Resin Tech bead. *Figure 15C* shows a Resin Tech bead caught in the filter screen.

Solmetex and Layne media-breakthrough occurred in at least 33% of the houses but could be as high as 57.9%. *Figure 16A* shows unused Solmetex beads at 21x. The Solmetex and Layne formulation has been changed and now contains black beads. *Figure 16B* shows Solmetex beads from the toilet tank of house As2015-024. The beads range in size from 50-200 µm. *Figure 16A* shows a Solmetex bead from the toilet tank of house As2015-026. This bead is 40 µm in diameter. There were also a number of broken beads. *Figure 16D* shows a broken bead from the toilet of As2015-026.

Softeners were common in homes with treatment systems and were found to be breaking through in at least 34.4% but could be as much as 50.0% of homes. *Figure 17A* shows unused softener beads. It is interesting to note the various sizes of the beads and that some are broken even prior to use. *Figure 17B* shows softener beads from the toilet tank of As2015-017 at 64x. *Figures 17C-D* illustrate the size difference in softener beads from house As2015-020. These beads range from 50-200 µm. Broken softener beads were found in a number of samples. One broken bead is shown in *Figure 17E*. The sample from house As2015-042 contained the most softener beads of any other sample. An overview at 26x is shown in *Figure 17F*. The beads were measured and ranged in size from 200-900 µm (*Figure 17G*).

Because of the similarity in appearance between treatment media beads, the type of beads in *Figure 18* is unknown. House As2015-035 had both a softener and a Solmetex treatment system. Many broken beads were found in the samples taken from this home. *Figures 18A-B* show a broken bead from two different angles. The bead measures 500 µm in diameter. *Figure 18C* shows a broken bead. *Figures 18D-E* show various sized beads from two houses that could be softener, Resin Tech or Solmetex beads.

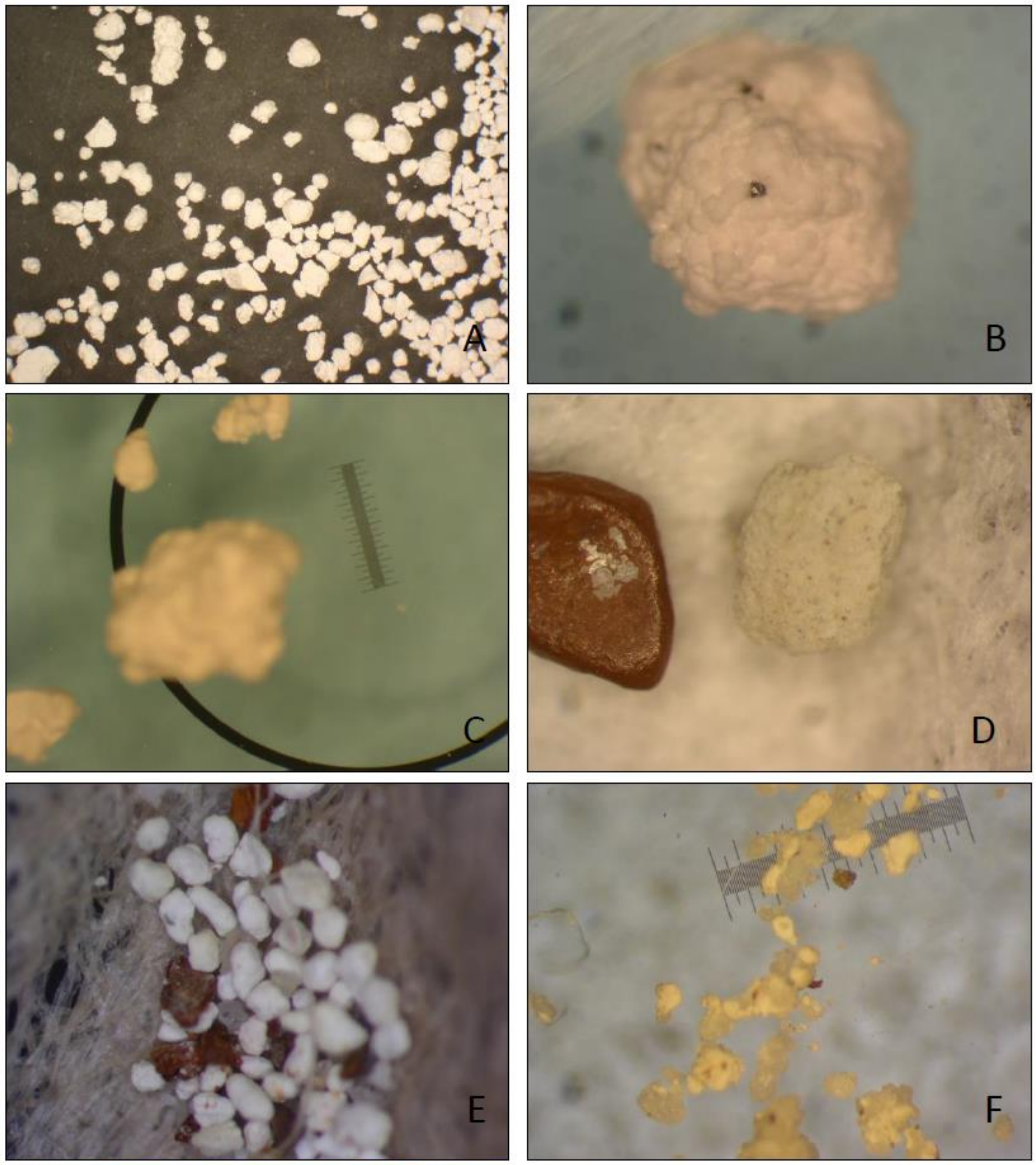
Figure 16: Adedge Media Under Light Microscopy



ADEDGE

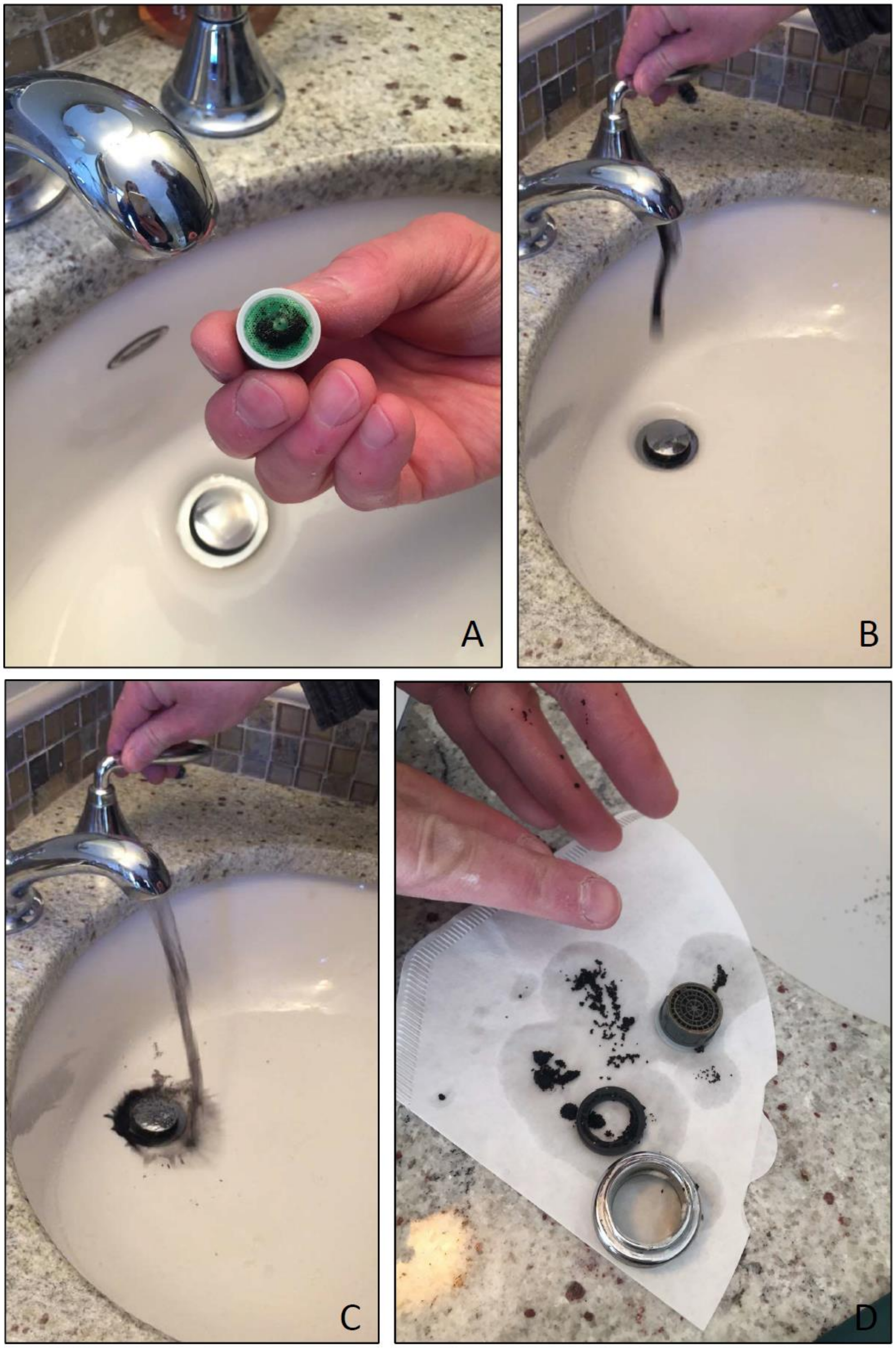
A. Unused adedge (7.5x)
B. Piece of adedge treatment media (64x)
C. Adedge treatment media found in toilet tank (As2015-002) (13x)
D. Various sizes of media on scale (size range; less than 10 µm– 450 µm (64x)
E. Various sizes of media; 20 µm - 1000 µm (32x)
F. Broken adedge suspended in water (64x)
G. Large adedge piece; 2300 µm (23x)

Figure 17: Metsorb Under Light Microscopy



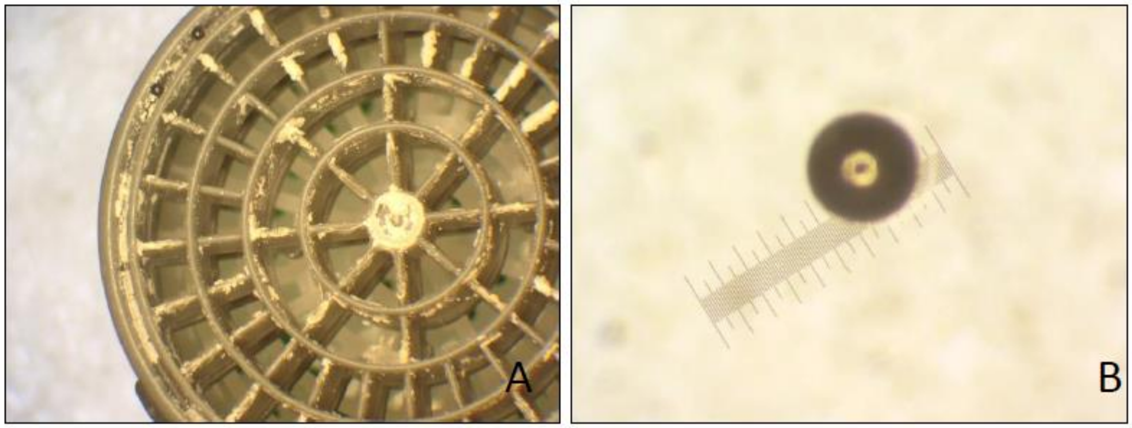
A. Unused metsorb (7.5x)
B. Unused metsorb (64x)
C. Unused metsorb; measures 1650 µm x 1.3 µm (31x)
D. Metsorb and adedge treatment media found in toilet tank As2015-011 (64x)
E. Metsorb treatment media found in toilet tank As2015-054 (64x)
F. Metsorb treatment media found in toilet tank As2015-062 (64x)
G. Metsorb and adedge treatment media found in toilet tank As2015-054; adedge on scale 100 µm and metsorb pieces on scale 100-150 µm (64x)

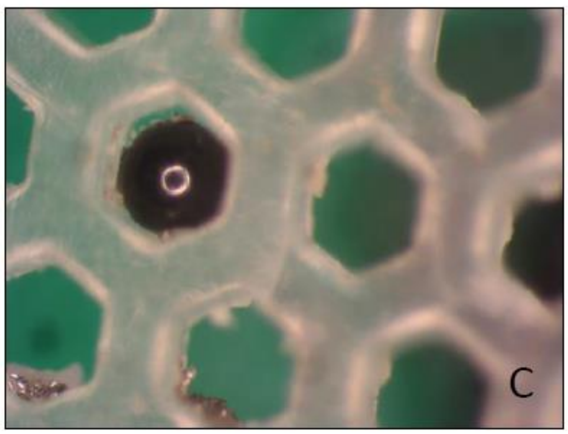
Figure 18: Resin Tech Media from Bathroom Sink Faucet



A. Resin tech beads on bathroom faucet filter screen
B–C. Resin tech beads coming out of faucet with filter screen removed
D. Resin tech beads from faucet

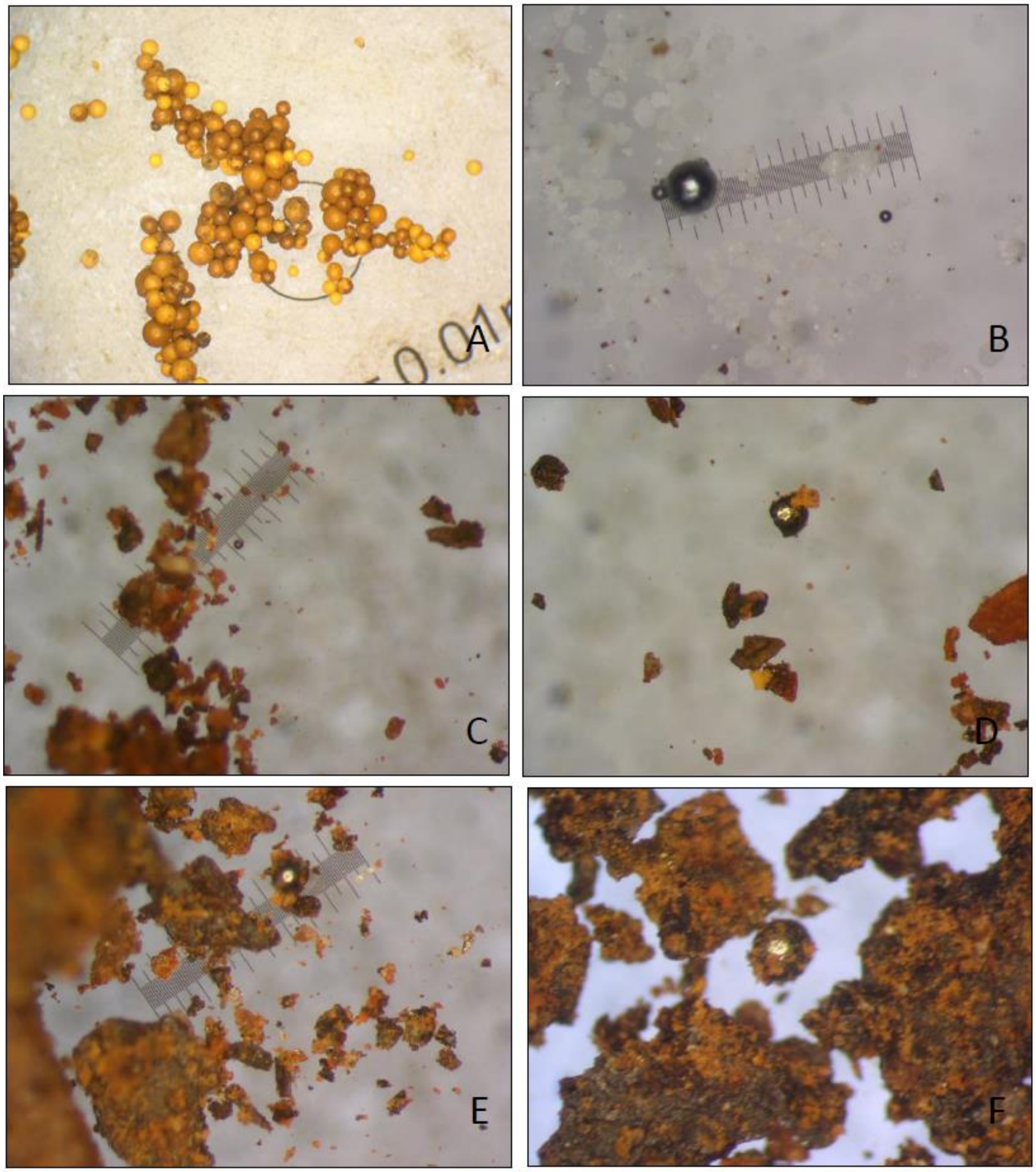
Figure 19: Resin Tech Under Light Microscopy





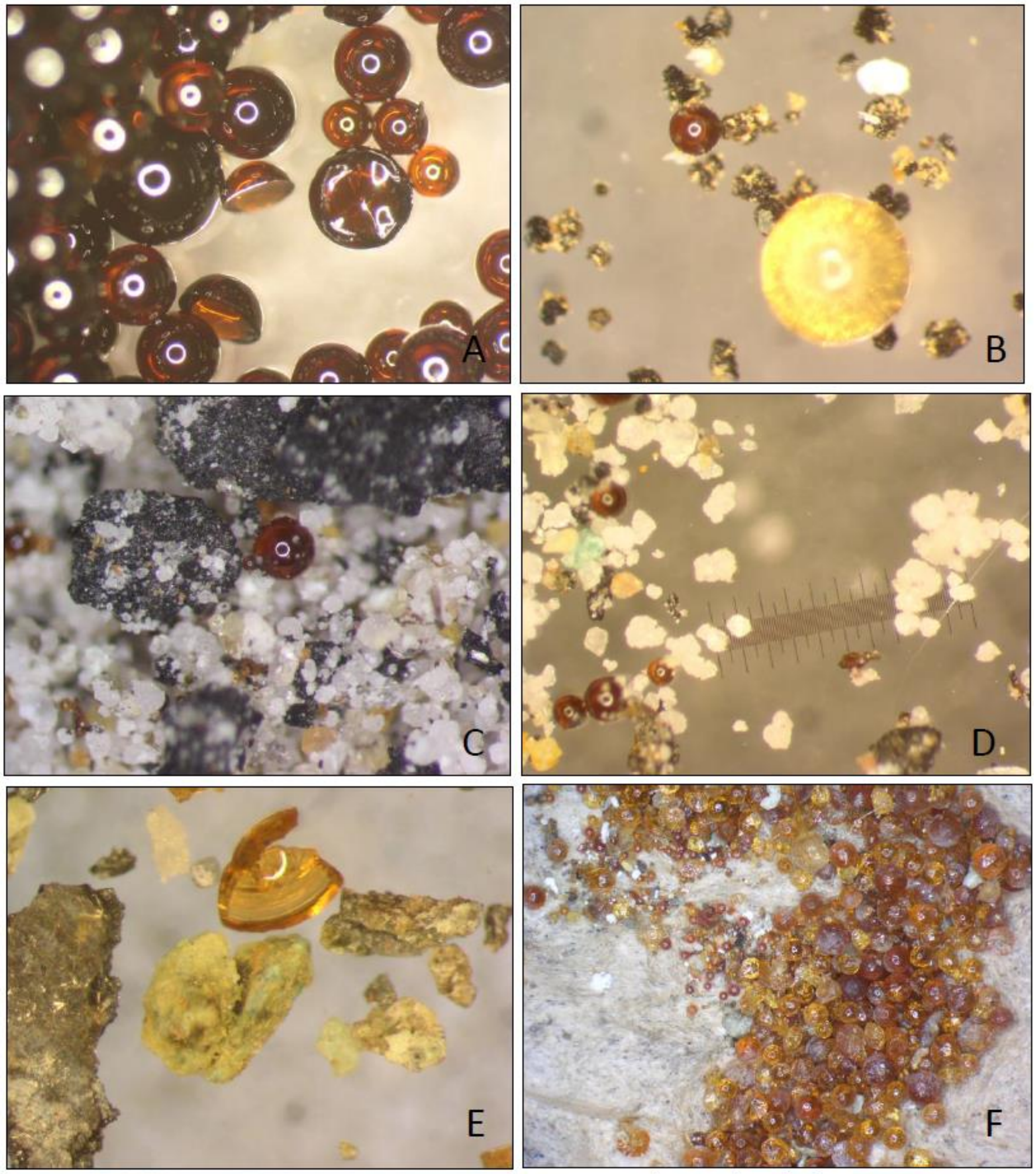
A. *Resin tech beads in faucet filter (7.5x)*
B. *Resin tech bead from faucet (As2015-004), 400 µm (64x)*
C. *Resin tech bead stuck in filter screen (64x)*

Figure 20: Solmetex Media Under Light Microscopy



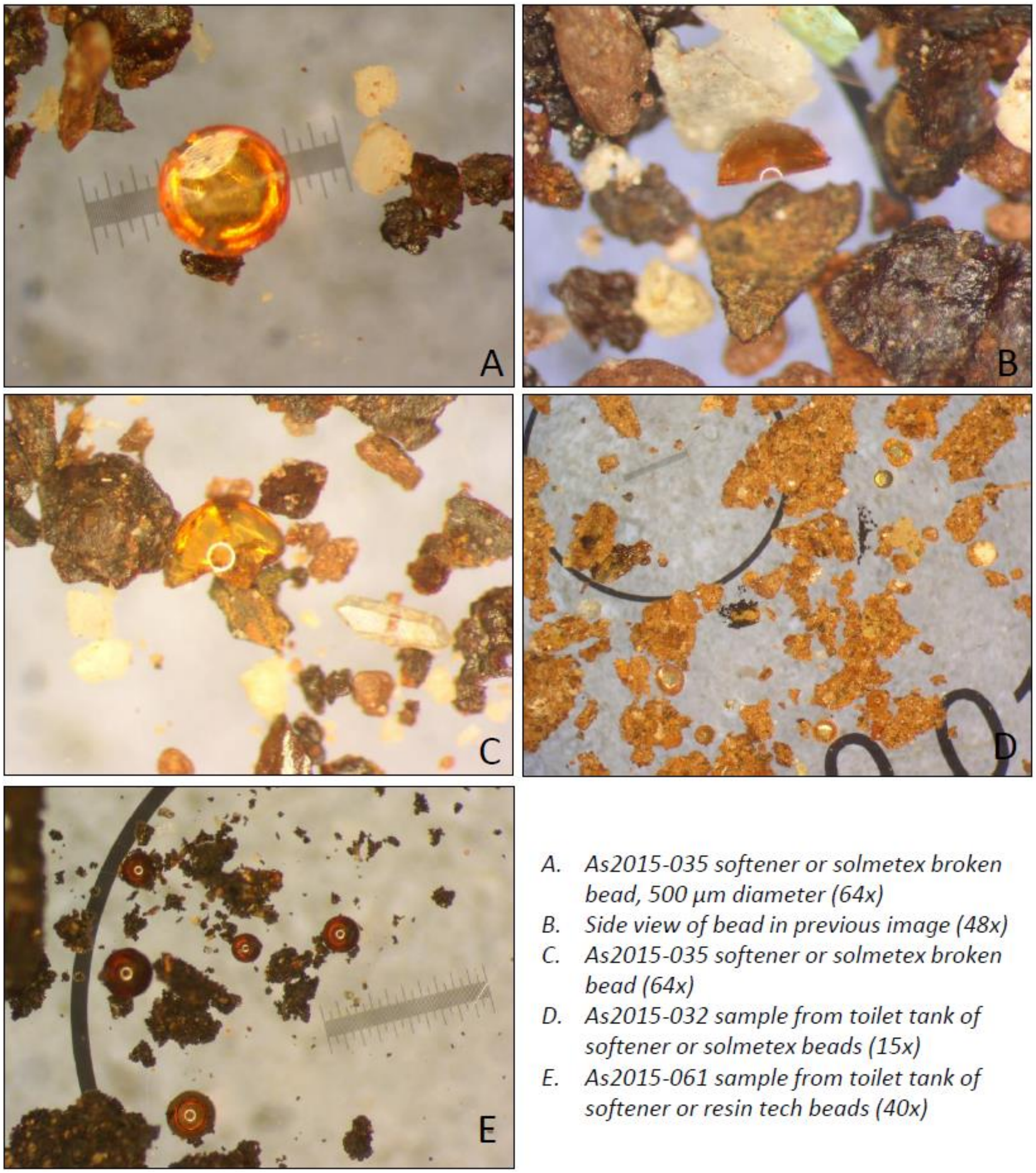
A. *Unused solmetex beads (21x)*
B. *Solmetex beads from As2015-024 toilet tank, a home without a softener, bead sizes range from 50-200 μm (64x)*
C. *Solmetex beads from As2015-026 toilet tank, a home without a softener, bead size 40 μm*
D. *Broken solmetex bead from As2015-026 toilet (64x)*
E. *Solmetex bead from As2015-040, a home without a softener, 150 μm bead (64x)*
F. *Solmetex bead from As2015-040 with rust (64x)*

Figure 21: Softener Beads Under Light Microscopy



A. Unused cation bead, shows varying sizes and broken beads (64x)
B. Softener beads from As2015-017 64x)
C. Softener beads from As2015-020, 50-200 µm (64x)
D. Softener beads from As2015-020, 70-200 µm (64x)
E. Broken softener bead from As2015-023 (64x)
F. Many softener beads from As2015-042 (26x)
G. Softener beads from As2015-042, 200-

Figure 22: Beads (Softener or Arsenic Treatment Media) Under Light Microscopy



A. As2015-035 softener or solmetex broken bead, 500 µm diameter (64x)
B. Side view of bead in previous image (48x)
C. As2015-035 softener or solmetex broken bead (64x)
D. As2015-032 sample from toilet tank of softener or solmetex beads (15x)
E. As2015-061 sample from toilet tank of softener or resin tech beads (40x)

Chapter Four: Factors that Influence Arsenic Treatment System Efficacy (Specific Aim 2)

There are a number of factors that influence arsenic treatment system efficacy. There are characteristics of the treatment system that may affect efficacy which include: point-of-use vs. point-of-entry, redundant vs. single tank systems, type of media, age of system and size of tanks. Characteristics of homeowners that may influence treatment system efficacy include age, education level, age of youngest child, level of arsenic knowledge and home value (as a surrogate for income). If homeowners are “yearly testers” or “yearly maintainers” may also have an effect on the efficacy of their treatment system. Characteristics of the well water itself may also play a role. These water characteristics include raw arsenic concentration and percent of As (III).

Health Belief Model

Psychological influences may also play a role in the efficacy of an arsenic treatment system. The constructs of the Health Belief Model were used to develop survey questions that sought to understand if and why homeowners would take action to prevent arsenic exposure. These constructs include perceived susceptibility, perceived severity, perceived benefits, perceived barrier, cues to action and self-efficacy. The basis of the Health Belief Model is that people will engage in a health protective behavior if they are susceptible to the adverse health effect, the health condition is serious, there is an action that could reduce their susceptibility, there are positive consequences of them taking action and the benefits of these actions outweigh the cost [35].

Perceived Susceptibility

Perceived susceptibility, the participant's evaluation of the chances of having a negative outcome from arsenic exposure, was assessed through survey questions. Participants were asked to quantify on a scale from 1-5 how strongly they agreed or disagreed with statements about their well water. *Table 12* shows the distribution of responses to the perceived susceptibility survey questions for all 65 participants. Participants generally agreed that households in Hopewell Township often have arsenic contaminated well water. 37% of participants disagreed that arsenic contamination was a major problem for their household while 45% agreed that it was. Most participants agreed that their well arsenic level could change over time and that the arsenic level would decrease their property value. Roughly half of the participants indicated that they were worried about their arsenic level. For those that indicated they were not worried, a common response was, "I am not worried because I have an arsenic treatment system."

Table 12: Health Belief Model Survey Questions - Perceived Susceptibility

Perceived Susceptibility Survey Questions (n=65)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Households in Hopewell Township often have arsenic contaminated well water.	0.0%	3.1%	20.0%	52.3%	24.6%
Arsenic contaminated water is a major problem for our household.	4.6%	32.3%	18.5%	27.7%	16.9%
Our well arsenic level can change over time.	0.0%	4.6%	27.7%	53.8%	13.8%
Our well arsenic level (untreated water) decreases our property value.	0.0%	29.2%	21.5%	36.9%	12.3%
I feel worried about our arsenic level.	4.6%	32.3%	13.8%	40.0%	9.2%

Perceived Severity

Perceived severity survey questions were used to determine the participants' beliefs about the seriousness of adverse health effects from arsenic exposure. Table 13 summarizes the responses to survey questions about perceived severity. 75.5% of participants agreed that arsenic exposure is a risk factor for cancer while the other 24.6% did not know. Most participants (90.8%) did not know if arsenic exposure causes strokes. Most participants (61.5%) did not know if arsenic exposure causes neurological problems and 36.9% agreed that it does. Most participants were neutral or disagreed that health effects from arsenic are seen only at high concentrations. Most participants disagreed or were neutral when asked if the health effects from arsenic were overstated.

Participants were also asked what is the highest arsenic level that they would consider safe. *Table 14* shows the responses. 30.8% of participants responded that no level of arsenic exposure is safe. 40% of the participants responded with the NJ MCL, 5 µg/L. One fifth responded between 5 and 10 µg/L, between the NJ and EPA standards. The remaining 6 participants' responses were above all standards and reflected a knowledge gap. The association between education level and response to this question was not statistically significant.

Table 13: Health Belief Model Survey Questions - Perceived Severity

Perceived Severity Survey Questions (n=65)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Arsenic exposure is a risk factor for cancer.	0.0%	0.0%	24.6%	50.8%	24.6%
Arsenic exposure causes strokes.	1.5%	4.6%	90.8%	3.1%	0.0%
Arsenic exposure causes neurological problems.	0.0%	1.5%	61.5%	27.7%	9.2%
Adverse health effects from arsenic are only seen at extremely high levels, not found in water.	13.8%	41.5%	33.8%	9.2%	1.5%
The health risks from arsenic are overstated.	15.4%	36.9%	36.9%	7.7%	3.1%

Table 14: Health Belief Model Survey Questions - Additional Perceived Severity Question

Survey Question (n=65)	Answer Choices	Number	%
What is the highest arsenic level that you would consider safe?	No level is Safe	20	30.8%
	5ppb or less	26	40.0%
	5-10 ppb	13	20.0%
	10-50 ppb	5	7.7%
	50-100 ppb	1	1.5%
	>100ppb	0	0.0%

Perceived Benefits

Perceived benefits survey questions were used to understand the participants' beliefs about the positive effects of water testing and maintain their treatment system. *Table 15* shows the responses to perceived benefits survey questions. A significant majority of participants, 75.3% agreed that reducing arsenic in their drinking water would increase the value of their home. A greater number of participants (83.1%) agreed that maintaining their treatment system would increase the value of their home. Almost all participants (98.4%) agreed that reducing arsenic in the water was protective of their family's health.

Table 15: Health Belief Model Survey Questions - Perceived Benefits

Perceived Benefits Survey Questions (n=65)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Reducing arsenic in our drinking water would increase the value of our home.	0.0%	6.2%	18.5%	53.8%	21.5%
Reducing arsenic in our drinking water is protective of my family's health.	0.0%	0.0%	1.5%	44.6%	53.8%
Maintaining my treatment system increases the value of my home.	1.5%	4.6%	10.8%	47.7%	35.4%

Perceived Barriers

The perceived barriers construct of the Health Belief Model seeks to understand the beliefs about obstacles to performing behaviors. *Table 16* highlights the responses to these questions. Participants were divided in their belief that their household is at risk for drinking arsenic contaminated water. Most participants that indicated they weren't at risk qualified their thinking by saying, "because I have a treatment system." 60% of participants agreed that it is expensive to decrease arsenic exposure. An association between the response to this question and tax assessed home value, a surrogate for income, was not statistically significant. Almost all participants acknowledged that there is a way to remove arsenic from their water.

Table 16: Health Belief Model Survey Questions - Perceived Barriers

Perceived Barriers Survey Questions (n=65)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Our household is at risk for drinking arsenic contaminated water.	4.6%	30.8%	10.8%	35.4%	18.5%
It is expensive to decrease arsenic exposure.	0.0%	18.5%	21.5%	40.0%	20.0%
There is nothing I can do to about the arsenic level in my water.	49.2%	47.7%	0.0%	1.5%	1.5%

Cues to Action

Three questions were used to determine internal and external factors that trigger water testing. *Tables 17-19* summarize participants' cues to action. 72.3% of participants indicated that some of their neighbors treat their water and 55.4% said this would prompt them to test their water. When asked if they would take action if their treated well water was found to be above 5 µg/L for arsenic, most responded that they would. Most participants (83.1%) answered that they would start or increase use of bottled water and 93.9% said they would call for service of their existing treatment system. A knowledge gap was identified as 36.9% responded they may boil water and 61.5% might use a water filtration pitcher to reduce the arsenic level. A filtration pitcher, such as a Brita, does not remove arsenic. Boiling water increases the arsenic concentration as the volume of water evaporates and the arsenic does not. This was explained to each participant at the end of the survey to prevent these behaviors in the future.

When participants were asked what would prompt them to have their water tested, almost all responded, "a change in taste, smell or appearance of water." Though this could indicate a potential problem, it is not a sufficient test for arsenic which is colorless, odorless and tasteless. A majority (83.1%) indicated a state or local requirement would prompt them to test their water. Under Hopewell Township's Ordinance No. 16-17, homeowners are required to have a service agreement which includes water tests from between arsenic tanks every six months from a New Jersey State certified laboratory. This cue to action is not supported by the testing data that show less than half of the study population has tested their water in the past year.

Table 17: Health Belief Model Survey Questions - Cues to Action

Cues to Action Survey Questions (n=65)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I believe some of my neighbors treat their well water.	1.5%	6.2%	20.0%	61.5%	10.8%

Table 18: Cues to Action Survey Question "Would you take any of the following actions if your treated well water was found to be above 5 µg/L for arsenic?"

Answer Choices (n=65)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Take no action	60.0%	38.5%	0.0%	1.5%	0.0%
Boil water before use	21.5%	41.5%	13.8%	16.9%	6.2%
Start or increase use of bottled water	3.1%	12.3%	1.5%	55.4%	27.7%
Start or increase use of filtration pitcher (e.g. Brita)	10.8%	27.7%	16.9%	35.4%	9.2%
Call for service of my existing arsenic treatment system	1.5%	4.6%	0.0%	35.4%	58.5%
Install a new whole house treatment system	15.4%	16.9%	46.2%	13.8%	7.7%
Drill another well	24.6%	49.2%	23.1%	1.5%	1.5%

Table 19: Prompts for Homeowners to Test Their Water (Cues to Action)

Survey Question (n=65)	Answer Choices	Number	%
Which of the following would prompt you to have your well water tested?	Change in taste, smell, or appearance of water	62	95.4%
	Learning that neighbors are treating their water	36	55.4%
	Results of a water test that indicate unsafe levels of contaminants	60	92.3%
	A state or local requirement for water treatment	54	83.1%
	A new baby or child in the home	37	56.9%
	Other*	4	6.2%
*Other responses: a free water test; if started noticing psychological changes or health issues; if a neighbor was spraying pesticides; selling home			

Self-Efficacy

The final construct in the Health Belief Model seeks to measure if an individual is able to perform the behavior. *Table 20* shows responses to survey questions about the ability to reduce and test for arsenic. Nearly all participants (95.4%) were committed to decreasing their family's exposure to arsenic and 87.7% knew who to contact to test and treat their water. Though 67.7% said they would remember to regularly test their water, some admitted that they might remember but not act on it. Strategies such as setting a recurring reminder in their phone or testing on an easily remembered day were suggested to participants who acknowledged they could not remember to test.

Table 20: Health Belief Model Survey Questions - Self Efficacy

Self-Efficacy Survey Questions (n=65)	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I am committed to decreasing my family's exposure to arsenic.	0.0%	0.0%	4.6%	50.8%	44.6%
I know who to contact to test and treat my water.	3.1%	7.7%	1.5%	55.4%	32.3%
I am confident that I will remember to regularly test my water.	0.0%	16.9%	15.4%	47.7%	2680.0%

Use of the Health Belief Model in Analysis

The Health Belief Model was used to formulate survey questions. *Table 21* and *Figure 23* show the average response to each question. The survey questions were grouped by construct and participants were given a score. For example, a participant with a higher perceived susceptibility score felt more at risk to drinking contaminated water, was worried, and felt it was a problem for their household. Participants with a higher perceived barriers score was more likely to see obstacles in testing their water and maintaining their treatment system. These scores were used in further analysis and the average scores are shown in *Table 22*.

Table 21: Health Belief Model Survey Questions Score

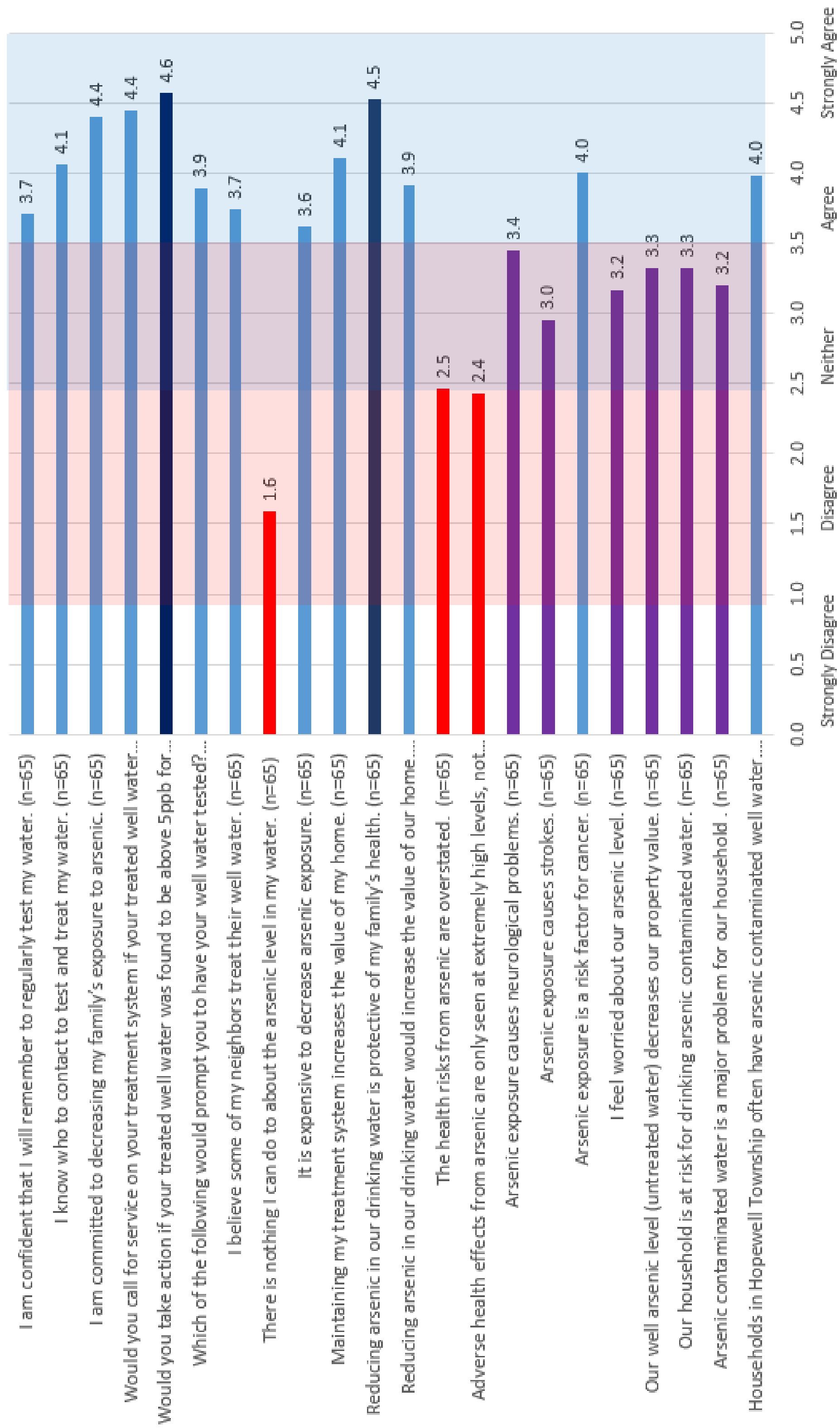
	Survey Questions (n=65)	Mean	StDev	Min	Max
Perceived Susceptibility	**Households in Hopewell Township often have arsenic contaminated well water.**	4.0	0.8	2.0	5.0
	Arsenic contaminated water is a major problem for our household.	3.2	1.2	1.0	5.0
	Our household is at risk for drinking arsenic contaminated water.	3.3	1.2	1.0	5.0
	Our well arsenic level (untreated water) decreases our property value.	3.3	1.0	2.0	5.0
	I feel worried about our arsenic level.	3.2	1.1	1.0	5.0
Perceived Severity	**Arsenic exposure is a risk factor for cancer.**	4.0	0.7	3.0	5.0
	Arsenic exposure causes strokes.	3.0	0.4	1.0	4.0
	Arsenic exposure causes neurological problems.	3.4	0.7	2.0	5.0
	Adverse health effects from arsenic are only seen at extremely high levels, not found in water.	2.4	0.9	1.0	5.0
	The health risks from arsenic are overstated.	2.5	1.0	1.0	5.0
Perceived Benefits	**Reducing arsenic in our drinking water would increase the value of our home.**	3.9	0.8	2.0	5.0
	Reducing arsenic in our drinking water is protective of my family's health.	4.5	0.5	3.0	5.0
	Maintaining my treatment system increases the value of my home.	4.1	0.9	1.0	5.0
Perceived Barriers	**It is expensive to decrease arsenic exposure.**	3.6	1.0	2.0	5.0
	There is nothing I can do to about the arsenic level in my water.	1.6	0.7	1.0	5.0
Cues to Action	**I believe some of my neighbors treat their well water.**	3.7	0.8	1.0	5.0
	Which of the following would prompt you to have your well water tested? ***Composite Score of All Choices.***	3.9	1.1	1.0	5.0
	Would you take action if your treated well water was found to be above 5 µg/L for arsenic?	4.6	0.6	2.0	5.0
	Would you call for service on your treatment system if your treated well water was found to be above 5 µg/L for arsenic?	4.4	0.8	1.0	5.0

Self-Efficacy	**I am committed to decreasing my family's exposure to arsenic.**	4.4	0.6	3.0	5.0
	I know who to contact to test and treat my water.	4.1	1.0	1.0	5.0
	I am confident that I will remember to regularly test my water.	3.7	1.0	2.0	5.0

Table 22: Average Health Behavior Model Scores and Distribution

Model Aspect	Description	Average	StDev	Min	Max
Perceived Susceptibility	One's evaluation of chances of getting a condition	3.4	0.7	2.2	4.8
Perceived Severity	One's evaluation of how serious a condition, its treatment, and its consequences would be	3.5	0.5	2.2	4.6
Perceived Benefits	One's evaluation of how well an advised action will reduce risk or moderate the impact of the condition	4.2	0.6	3.0	5.0
Perceived Barriers	One's evaluation of how difficult an advised action will be or how much it will cost, both psychologically and otherwise	2.6	0.6	1.5	4.0
Cues to Action	Events or strategies that increase one's motivation	4.1	0.5	2.6	5.0
Self-Efficacy	Confidence in one's ability to take action	4.1	0.5	2.7	5.0

Figure 23: Average Response to Health Belief Model Survey Questions



Arsenic Knowledge (Specific Aim 2.III)

Level of arsenic knowledge was gauged by responses to arsenic fact questions in the survey. An Arsenic Knowledge Score (AKS) was calculated from assigned point values to each possible response. Homeowners with a higher arsenic knowledge score were considered to have more arsenic knowledge than participants with a lower score. The highest possible AKS was +10 and lowest was -10. Participants' average score was 3.5 with a range between -2 and 9.

Table 23: Arsenic Knowledge Score Components

Survey Questions	Answer Choices	Points Awarded
Households in Hopewell Township often have arsenic contaminated well water.	Strongly Disagree	-1
	Disagree	-1
	Neither Agree nor Disagree	+0
	Agree	+1
	Strongly Agree	+1
Arsenic exposure is a risk factor for cancer.	Strongly Disagree	-2
	Disagree	-1
	Neither Agree nor Disagree	+0
	Agree	+1
	Strongly Agree	+2
Arsenic exposure causes strokes.	Strongly Disagree	-1
	Disagree	-1
	Neither Agree nor Disagree	+0
	Agree	+1
	Strongly Agree	+1
Arsenic exposure causes neurological problems.	Strongly Disagree	-1
	Disagree	-1
	Neither Agree nor Disagree	+0
	Agree	+1
	Strongly Agree	+1
Adverse health effects from arsenic are only seen at extremely high levels, not found in water.	Strongly Disagree	+1
	Disagree	+1
	Neither Agree nor Disagree	+0
	Agree	-1
	Strongly Agree	-1
What is the highest arsenic level that you would consider safe?	No level is sage	+2
	5ppb or less	+1

	5 - 10 ppb	+0
	10 - 50 ppb	-1
	50 - 100 ppb	-2
	Greater than 100 ppb	-2
Would you take any of the following actions if your treated well water was found to be above 5ppb for arsenic? (Boil water before use)	Strongly Disagree	+1
	Disagree	+1
	Neither Agree nor Disagree	+0
	Agree	-1
	Strongly Agree	-1
Would you take any of the following actions if your treated well water was found to be above 5ppb for arsenic? (Start or increase use of a filtration pitcher e.g. Brita)	Strongly Disagree	+1
	Disagree	+1
	Neither Agree nor Disagree	+0
	Agree	-1
	Strongly Agree	-1

Statistical Methods

SAS® 9.3 was used to calculate significant differences between comparison groups (e.g. yearly testers v. non-yearly testers.) Chi-squared tests were used when comparing two categorical variables (e.g. has children v. yearly tester). Logistic regression was used when comparing continuous variables and categorical variables (e.g. years in home v. yearly tester). Linear regression when comparing two continuous variables (e.g. home value and arsenic knowledge score).

Regular Water Tester Characteristics (Specific Aim 2.I-II)

For this study, a regular water tester or yearly tester was defined as having tested for arsenic within the past year and three months. The extra three months was given to account for scheduling delay (some testers used the free water test offered in this study in place of their annual water test). Of the 55 participants with dual tank arsenic treatment systems, 26 (47.2%) were yearly testers. *Table 24* compares the characteristics of homeowners that are yearly testers and homeowners that are not yearly testers. Age and tax assessed home value are significantly correlated with being a yearly tester. Yearly testers are younger and have higher tax assessed home values. Though not significant, yearly testers had more children living at home and a younger “youngest child.” *Table 25* compares the treatment systems of yearly testers and non-yearly testers. There was no significant difference in system age, media type, installer or maintainer.

Table 26 compares the well water of yearly testers and non-yearly testers. There is a significant association between raw arsenic concentration and yearly testers. The average raw arsenic level for yearly testers is 14.02 µg/L and for non-yearly testers is 8.83 µg/L. *Table 27* shows average scores to the Health Belief Model questions between yearly and non-yearly testers. Yearly testers had a significantly higher self-efficacy score than non-yearly testers. Participants with a higher self-efficacy score were more likely to say they were committed to decreasing arsenic exposure, they knew who to contact to test and treat their water and they were confident they would remember to regularly test their water.

Table 24: Characteristics of Homeowners (Yearly Testers vs. Non-Yearly Testers)

		Study Population	Yearly Testers	Non-Yearly Testers
(n=)		55	26	29
Age	Mean	47.5	44.5*	50.3
	Stdev	9.1	6.6	10.3
	Min	31	32	31
	Max	72	60	72
Education	Associate's Degree	1 (1.8%)	0 (0.0%)	1 (3.4%)
	Bachelor's Degree	24 (43.6%)	12 (46.2%)	12 (41.4%)
	Graduate Degree	30 (54.5%)	14 (53.8%)	16 (55.2%)
Home Value	Mean	581,142	650,438*	519,014
	Stdev	235,028	213,219	239,756
	Min	231,100	231,100	270,200
	Max	1,368,300	1,009,800	1,368,300
Age of Youngest Child	Mean	9.6	7.6	11.4
	Stdev	6.3	5.2	6.8
	Min	0.25	0.25	2
	Max	28	17	28
Number of Children at Home	Mean	1.7	2.0	1.4
	Stdev	1.1	1.0	1.1
	Min	0	0	0
	Max	4	4	3
Number of Adults at Home	Mean	2.1	2.0	2.1
	Stdev	0.5	0.2	0.7
	Min	1	2	1
	Max	5	3	5
Arsenic Knowledge	Mean	3.5	3.5	3.6
	Stdev	2.5	2.4	2.6
	Min	-2	-2	-1
	Max	9	8	9
Years in Home	Mean	6	6	7
	Stdev	6.1	5.4	6.8
	Min	0	0	2
	Max	29	22	29

**p<0.05 Logistic Regression*

Table 25: Characteristics of Treatment Systems (Yearly Testers vs. Non-Yearly Testers)

		Study Population	%	Yearly Testers	%	Non-Yearly Testers	%
(n=)		55	100.0%	26	47.3%	29	52.7%
Age	Mean	5.4		5.0		5.4	
	Stdev	2.6		3.4		2.6	
	Min	2		0		2	
	Max	10		13		10	
Media	Adedge	13	23.6%	7	26.9%	8	27.6%
	Metsorb	17	30.9%	9	34.6%	8	27.6%
	Solmetex	19	34.5%	8	30.8%	11	37.9%
	Resin Tech	6	10.9%	2	7.7%	4	13.8%
	Isolux	0	0.0%	0	0.0%	0	0.0%
Installer	Rely	18	32.7%	11	42.3%	7	24.1%
	Stover's	16	29.1%	6	23.1%	10	34.5%
	Stothoff	1	1.8%	1	3.8%	0	0.0%
	Portasoft	2	3.6%	1	3.8%	1	3.4%
	PWC	2	3.6%	1	3.8%	1	3.4%
	KelTren	2	3.6%	1	3.8%	1	3.4%
	Travis	6	10.9%	2	7.7%	4	13.8%
	Jayson	5	9.1%	3	11.5%	2	6.9%
	Other	3	5.5%	0	0.0%	3	10.3%
Maintainer	Rely or Stover’s	34	61.8%	18	69.2%	16	55.2%
	Other	21	38.2%	8	30.8%	13	44.8%
							No Significant Association

Table 26: Characteristics of the Well Water (Yearly Testers vs. Non-Yearly Testers)

		Study Population	Yearly Testers	Non-Yearly Testers
(n=)		55	26	29
Raw Arsenic Concentration (µg/L)	Mean	11.29	14.02*	8.83
	Stdev	8.97	11.37	5.16
	Min	2.60	2.60	4.30
	Max	41.60	41.60	29.00
Treated Water Arsenic Concentration (µg/L)	Mean	3.65	4.64	2.70
	Stdev	6.11	7.94	3.47
	Min	0.05	0.05	0.05
	Max	38.50	38.50	13.60
Kitchen Sink Arsenic Concentration (µg/L)	Mean	1.08	1.34	0.85
	Stdev	2.31	2.77	1.84
	Min	0.05	0.05	0.05
	Max	12.80	12.80	8.50
% Arsenic (III)	Mean	15.7%	17.3%	14.3%
	Stdev	24.1%	28.3%	19.9%
	Min	0.2%	0.2%	0.5%
	Max	105.7%	105.7%	90.6%
				**p<0.05 Logistic Regression*

Table 27: Psychological Characteristics (Yearly Testers vs. Non-Yearly Testers)

		Study Population	Yearly Testers	Non-Yearly Testers
(n=)		55	26	29
Perceived Susceptibility	**Mean**	**3.34**	**3.32**	**3.36**
	Stdev	0.68	0.61	0.75
	Min	2.20	2.40	2.20
	Max	4.80	4.40	4.80
Perceived Severity	**Mean**	**3.48**	**3.51**	**3.46**
	Stdev	0.50	0.42	0.57
	Min	2.20	2.80	2.20
	Max	4.60	4.40	4.60
Perceived Benefits	**Mean**	**4.23**	**4.28**	**4.18**
	Stdev	0.57	0.51	0.63
	Min	3.33	3.33	3.33
	Max	5.00	5.00	5.00
Perceived Barriers	**Mean**	**2.66**	**2.79**	**2.52**
	Stdev	0.55	0.59	0.49
	Min	1.50	2.00	1.50
	Max	4.00	4.00	3.50
Self-Efficacy	**Mean**	**4.10**	**4.26***	**3.95**
	Stdev	0.57	0.52	0.58
	Min	2.67	3.33	2.67
	Max	5.00	5.00	5.00
Cues to Action	**Mean**	**4.12**	**4.20**	**4.04**
	Stdev	0.47	0.29	0.58
	Min	2.60	3.20	2.60
	Max	5.00	4.60	5.00
				**p<0.05 Logistic Regression*

Semi-Regular Water Tester Characteristics

Semi-regular testers, participants who tested their water within the last two years were also analyzed. Of the 55 participants with dual tank POET system, 34 (61.8%) had tested their water for arsenic within the past two years. *Table 28* compares the characteristics of homeowners who tested within the past two years vs. those who have not. The association between age of participant and testing within the last two years was significant. The average age of homeowners who tested within the last year was 44.7 years and homeowners who had not tested was 52.1 years. Though not significant, homeowners who had tested within the past two years had more bachelor's and graduate degrees and higher tax assessed home values than those who did not. A significant association was seen with participants who tested within the last two years having younger and a greater number of children than those who had not tested.

Table 29 shows the characteristics of treatment systems of people who have and have not tested in the past two years. Though not statistically significant, the average system age is higher in the non-tester group. *Table 30* shows the water characteristics of testers and non-testers. Though there was no significant association between testing every two years and concentration of arsenic in the water, the arsenic concentrations for every two year testers were higher at every sampling location. *Table 31* shows average Health Belief Model scores for each group. Though not significant, every two year testers had higher scores in all categories.

Table 28: Characteristics of Homeowners (Who Have and Have Not Tested Within the Last Two Years)

		Study Population	Tested Within Past 2 Years	Not Tested in Last 2 Years
(n=)		55	34	21
Age	Mean	47.5	44.7*	52.1
	Stdev	9.1	7.5	9.8
	Min	31	31	40
	Max	72	63	72
Education	Associate's Degree	1 (1.8%)	1 (2.9%)	0 (0.0%)
	Bachelor's Degree	24 (43.6%)	15 (44.1%)	9 (42.9%)
	Graduate Degree	30 (54.5%)	18 (52.9%)	12 (57.1%)
Home Value	Mean	581,142	628,662	504,205
	Stdev	235028.4	246589.1	196874.0
	Min	231,100	231,100	270,200
	Max	1,368,300	1,368,300	1,114,400
Age of Youngest Child	Mean	9.6	7.6**	13.0
	Stdev	6.3	5.2	6.7
	Min	0.25	0.25	2.5
	Max	28	18	28
Number of Children at Home	Mean	1.7	1.9*	1.2
	Stdev	1.1	1.0	1.1
	Min	0	0	0
	Max	4	4	3
Number of Adults at Home	Mean	2.1	2.1	2.1
	Stdev	0.5	0.2	0.9
	Min	1	2	1
	Max	5	3	5
Arsenic Knowledge	Mean	3.5	3.5	3.7
	Stdev	2.5	2.5	2.5
	Min	-2	-2	-1
	Max	9	8	9
Years in Home	Mean	6	5	8
	Stdev	6.1	5.0	7.3
	Min	0	0	2
	Max	29	22	29

**p<0.05 Logistic Regression*
***p<0.01 Logistic Regression*

Table 29: Characteristics of Treatment Systems (Who Have and Have Not Tested Within the Last Two Years)

		Study Population	%	Tested Within Past 2 Years	%	Not Tested in Last 2 Years	%
(n=)		55.0	100.0%	34	61.8%	21	38.2%
Age	Mean	5.2		4.9		5.8	
	Stdev	3.0		3.3		2.4	
	Min	0		0		2	
	Max	13		13		10	
Media	Adedge	13	23.6%	9	26.5%	6	28.6%
	Metsorb	17	30.9%	11	32.4%	6	28.6%
	Solmetex	19	34.5%	11	32.4%	8	38.1%
	Resin Tech	6	10.9%	3	8.8%	3	14.3%
Installer	Rely	18	32.7%	13	38.2%	5	23.8%
	Stover's	16	29.1%	9	26.5%	7	33.3%
	Stothoff	1	1.8%	1	2.9%	0	0.0%
	Portasoft	2	3.6%	1	2.9%	1	4.8%
	PWC	2	3.6%	1	2.9%	1	4.8%
	KelTren	2	3.6%	1	2.9%	1	4.8%
	Travis	6	10.9%	3	8.8%	3	14.3%
	Jayson	5	9.1%	4	11.8%	1	4.8%
	Other	3	5.5%	1	2.9%	2	9.5%
Maintainer	Rely or Stover’s	34	61.8%	23	67.6%	11	52.4%
	Other	21	38.2%	11	32.4%	10	47.6%
							No Significant Association

Table 30: Characteristics of the Well Water (Who Have and Have Not Tested Within the Last Two Years)

		Study Population	Tested Within Past 2 Years	Not Tested in Last 2 Years
(n=)		55	34	21
Raw Arsenic Concentration (µg/L)	Mean	11.29	13.00	8.51
	Stdev	8.97	10.74	3.72
	Min	2.60	2.60	4.40
	Max	41.60	41.60	19.50
Treated Water Arsenic Concentration (µg/L)	Mean	3.65	4.13	2.81
	Stdev	6.11	7.21	3.37
	Min	0.05	0.05	0.05
	Max	38.50	38.50	13.60
Kitchen Sink Arsenic Concentration (µg/L)	Mean	1.08	1.09	1.07
	Stdev	2.31	2.46	2.11
	Min	0.05	0.05	0.05
	Max	12.80	12.80	8.50
% Arsenic (III)	Mean	15.7%	15.4%	16.2%
	Stdev	24.1%	25.3%	22.6%
	Min	0.2%	0.2%	0.5%
	Max	105.7%	105.7%	90.6%
				No Significant Association

Table 31: Psychological Characteristics of Homeowners (Who Have and Have Not Tested Within the Last Two Years)

		Study Population	Tested Within Past 2 Years	Not Tested in Last 2 Years
(n=)		55	34	21
Perceived Susceptibility	**Mean**	**3.34**	**3.39**	**3.26**
	Stdev	0.68	0.57	0.84
	Min	2.20	2.40	2.20
	Max	4.80	4.40	4.80
Perceived Severity	**Mean**	**3.48**	**3.49**	**3.47**
	Stdev	0.50	0.49	0.52
	Min	2.20	2.20	2.80
	Max	4.60	4.60	4.60
Perceived Benefits	**Mean**	**4.23**	**4.28**	**4.14**
	Stdev	0.57	0.51	0.66
	Min	3.33	3.33	3.33
	Max	5.00	5.00	5.00
Perceived Barriers	**Mean**	**2.65**	**2.69**	**2.57**
	Stdev	0.55	0.58	0.51
	Min	1.50	2.00	1.50
	Max	4.00	4.00	3.50
Self-Efficacy	**Mean**	**4.10**	**4.18**	**3.97**
	Stdev	0.57	0.50	0.65
	Min	2.67	3.33	2.67
	Max	5.00	5.00	5.00
Cues to Action	**Mean**	**4.12**	**4.18**	**4.02**
	Stdev	0.47	0.35	0.62
	Min	2.60	3.20	2.60
	Max	5.00	4.80	5.00
				No Significant Association

Water Testing After Private Well Testing Act

The Private Well Testing Act (PWTA) requires private well owners to test well water for arsenic and other contaminants during real estate transactions and when renting a property that is supplied by a private well. It was hypothesized that participants who have tested their water since required by law are in some way different than those who only tested due to the law. *Figure 24* and *Table 32* show a comparison of participants who have and have not tested their water since PWTA by the number of years lived in the home. Of people who have lived in their home between 1 and 5 years, 51.5% have not tested their water since moving in. Of homeowners who have lived in their home between 6-10 years, 25% have not tested since required by PWTA. Of participants who have lived in their home for 11-15 and 16-20 years, 33% have not tested since moving in. *Figure 25* shows the most recent arsenic test by years lived in the home.

Table 34 compares the characteristics of homeowners who have and have not tested their water since required to by PWTA. Having tested since PWTA is significantly associated with years in the home. *Table 35* compares the treatment systems of homeowners who have and have not tested since PWTA. Although there is no significant difference, homeowners who have tested since PWTA have slightly older systems. This is likely related to how long the homeowner has lived in the home and Hopewell’s requirement to install a POET after a failing PWTA arsenic test.

Table 35 compares average arsenic test results between the two groups. Homeowners who tested since required by PWTA had significantly higher raw water arsenic concentrations. *Table 36* shows the average Health Belief Model scores for homeowners who have tested and not tested since PWTA. A significant association was seen between perceived barriers score and homeowners who have tested since PWTA. This implies that the barriers identified in the survey questions were not significant enough to prevent testing.

Figure 24: Have Homeowners Tested Their Water Since Moving into The Home? (% Tested Since PWTA)

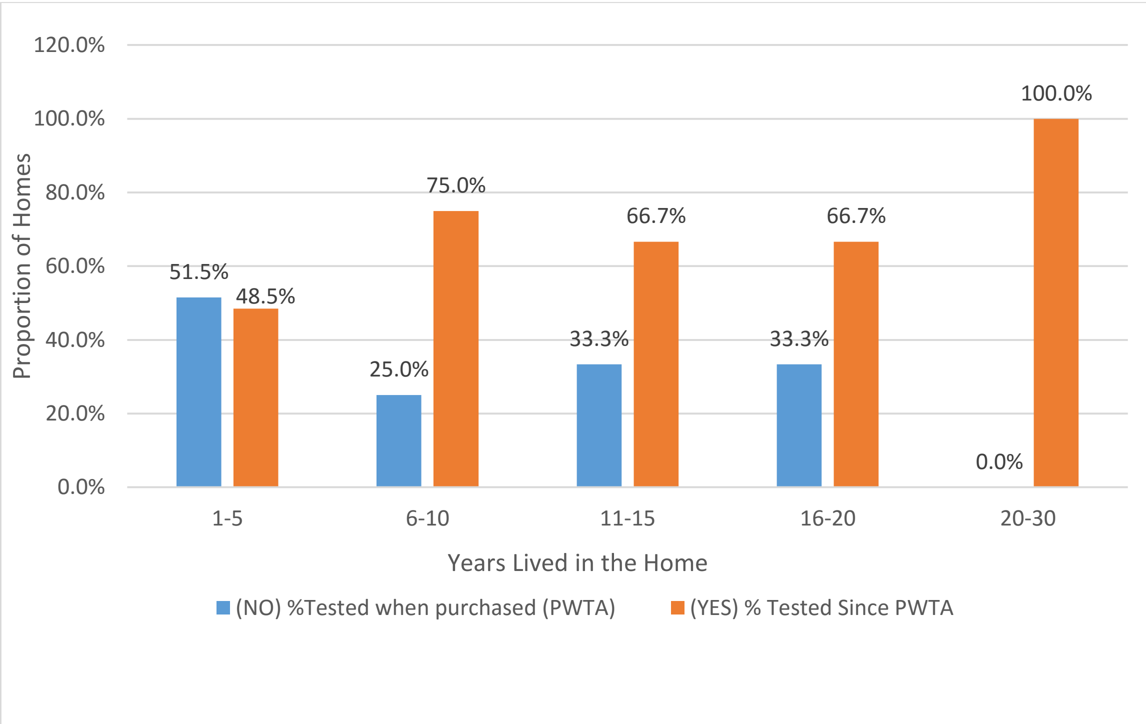


Table 32: Have Homeowners Tested Their Water Since Moving into The Home?

Years Lived in Home	NO Last tested when purchased home (PWTA)	% NO % Last tested when purchased (PWTA)	YES Tested Since PWTA	%YES % Tested Since PWTA	Total (n)
1-5	17	51.5%	16	48.5%	33
6-10	4	25.0%	12	75.0%	16
11-15	3	33.3%	6	66.7%	9
16-20	1	33.3%	2	66.7%	3
20-30	0	0.0%	4	100.0%	4

Figure 25: Most Recent Arsenic Water Test by Years Lived in Home

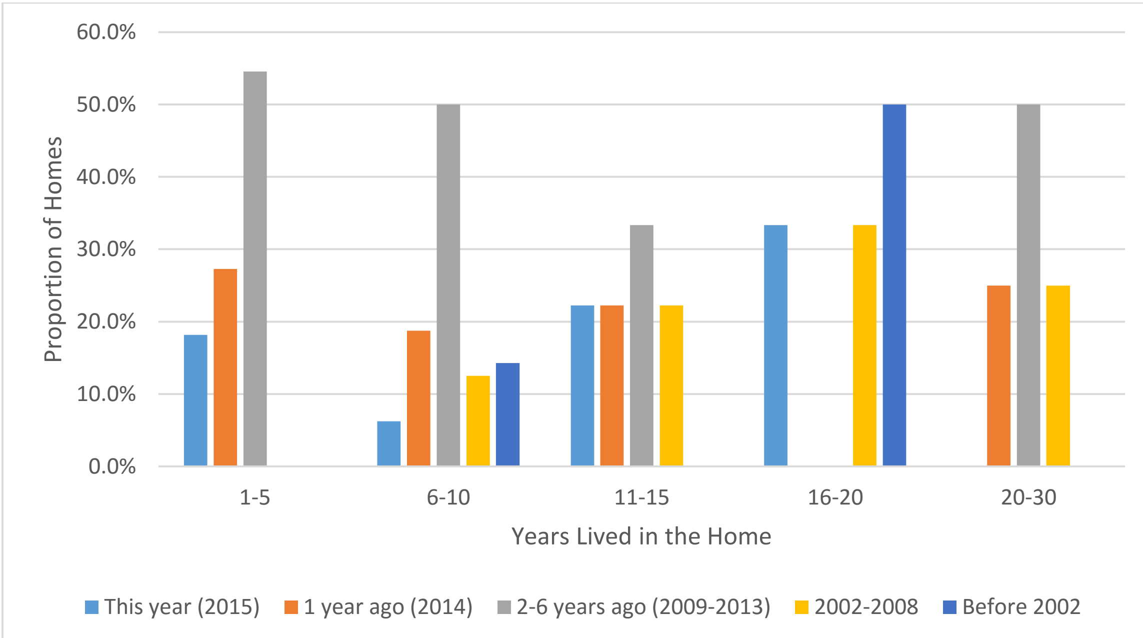


Table 33: Characteristics of Homeowners (Who Have and Have Not Tested Since PWTA)

		Study Population	Tested Since PWTA	Not Tested Since PWTA
(n=)		55	34	21
Age	Mean	47.5	49.3	44.7
	Stdev	9.1	9.8	7.2
	Min	31	32	31
	Max	72	72	63
Education	Associate's Degree	1 (1.8%)	1 (2.9%)	0 (0.0%)
	Bachelor's Degree	24 (43.6%)	15 (44.1%)	9 (42.9%)
	Graduate Degree	30 (54.5%)	18 (52.9%)	12 (57.1%)
Home Value	Mean	581,142	611,665	531,724
	Stdev	235028.4	228601.3	242423.0
	Min	231,100	270,200	231,100
	Max	1,368,300	1,114,400	1,368,300
Age of Youngest Child	Mean	9.6	9.4	9.8
	Stdev	6.3	6.7	5.9
	Min	0.25	0.25	2
	Max	28	28	23
Number of Children at Home	Mean	1.7	1.7	1.7
	Stdev	1.1	1.2	1.0
	Min	0	0	0
	Max	4	4	3
Number of Adults at Home	Mean	2.1	2.0	2.2
	Stdev	0.5	0.4	0.7
	Min	1	1	1
	Max	5	3	5
Arsenic Knowledge	Mean	3.5	3.6	3.4
	Stdev	2.5	2.5	2.5
	Min	-2	-2	-1
	Max	9	8	9
Years in Home	Mean	6	8**	3
	Stdev	6.1	6.9	2.8
	Min	0	1	0
	Max	29	29	12
				$^{**}p<0.01$ Logistic Regression

Table 34: Characteristics of Treatment Systems (Who Have and Have Not Tested Since PWTA)

		Study Population	%	Tested Since PWTA	%	Not Tested Since PWTA	%
(n=)		55.0	100.0%	34	61.8%	21	38.2%
Age	Mean	5.2		5.9		4.1	
	Stdev	3.0		3.1		2.7	
	Min	0		2		0	
	Max	13		13		9	
Media	Adedge	13	23.6%	11	32.4%	10	47.6%
	Metsorb	17	30.9%	7	20.6%	10	47.6%
	Solmetex	19	34.5%	13	38.2%	6	28.6%
	Resin Tech	6	10.9%	3	8.8%	3	14.3%
Installer	Rely	18	32.7%	8	23.5%	10	47.6%
	Stover's	16	29.1%	10	29.4%	6	28.6%
	Stothoff	1	1.8%	1	2.9%	0	0.0%
	Portasoft	2	3.6%	2	5.9%	0	0.0%
	PWC	2	3.6%	2	5.9%	0	0.0%
	KelTren	2	3.6%	1	2.9%	1	4.8%
	Travis	6	10.9%	3	8.8%	3	14.3%
	Jayson	5	9.1%	5	14.7%	0	0.0%
	Other	3	5.5%	2	5.9%	1	4.8%
Maintainer	Rely or Stover's	34	61.8%	19	55.9%	15	71.4%
	Other	21	38.2%	15	44.1%	6	28.6%
							No Significant Association

Table 35: Characteristics of the Well Water (Who Have and Have Not Tested Since PWTA)

		Study Population	Tested Since PWTA	Not Tested Since PWTA
(n=)		55	34	21
Raw Arsenic Concentration (µg/L)	Mean	11.29	13.59*	7.57
	Stdev	8.97	10.34	4.17
	Min	2.60	3.50	2.60
	Max	41.60	41.60	20.70
Treated Water Arsenic Concentration (µg/L)	Mean	3.65	4.50	2.13
	Stdev	6.11	7.20	3.02
	Min	0.05	0.05	0.05
	Max	38.50	38.50	10.90
Kitchen Sink Arsenic Concentration (µg/L)	Mean	1.08	1.23	0.84
	Stdev	2.31	2.75	1.37
	Min	0.05	0.05	0.05
	Max	12.80	12.80	5.20
% Arsenic (III)	Mean	15.7%	19.1%	10.2%
	Stdev	24.1%	27.5%	16.2%
	Min	0.2%	0.3%	0.2%
	Max	105.7%	105.7%	71.4%
				**p<0.05 Logistic Regression*

Table 36: Psychological Characteristics of Homeowners (Who Have and Have Not Tested Since PWTA)

		Study Population	Tested Since PWTA	Not Tested Since PWTA
(n=)		55	34	21
Perceived Susceptibility	**Mean**	**3.34**	**3.39**	**3.25**
	Stdev	0.68	0.67	0.72
	Min	2.20	2.40	2.20
	Max	4.80	4.80	4.80
Perceived Severity	**Mean**	**3.48**	**3.45**	**3.52**
	Stdev	0.50	0.41	0.63
	Min	2.20	2.80	2.20
	Max	4.60	4.40	4.60
Perceived Benefits	**Mean**	**4.23**	**4.26**	**4.17**
	Stdev	0.57	0.54	0.62
	Min	3.33	3.33	3.33
	Max	5.00	5.00	5.00
Perceived Barriers	**Mean**	**2.65**	**2.81****	**2.38**
	Stdev	0.55	0.52	0.50
	Min	1.50	2.00	1.50
	Max	4.00	4.00	3.00
Self-Efficacy	**Mean**	**4.10**	**4.16**	**4.00**
	Stdev	0.57	0.49	0.67
	Min	2.67	3.00	2.67
	Max	5.00	5.00	5.00
Cues to Action	**Mean**	**4.12**	**4.08**	**4.18**
	Stdev	0.47	0.41	0.56
	Min	2.60	3.20	2.60
	Max	5.00	4.60	5.00
$**p<0.01$ Logistic Regression				

Treatment System Maintainer Characteristics (Specific Aim 1.II, 2.II)

For this study, treatment system maintainers were defined as participants who were yearly testers and had taken action if necessary based on their last water test. For example, if a yearly tester had a level of 5 µg/L or higher between their arsenic tanks and subsequently had their tanks changed, they were considered a maintainer. If a yearly tester did not replace their tank when needed they were considered a non-maintainer. People who were not yearly testers were also considered non-maintainers. Maintainers comprised 36.4% of the study population.

The characteristics of maintainers and non-maintainers are compared in *Table 37*. There is a significant association between age and maintaining treatment systems. Maintainers are younger with an average age of 44 years compared to non-maintainers whose average age was 49.6 years. Though not significant, maintainers had a higher percentage of bachelor and graduate degrees, younger children, higher tax assessed home values and slightly higher arsenic knowledge than non-maintainers.

Table 38 compares the treatment systems of maintainers and non-maintainers. Having Rely Mechanical or Stover’s Wells and Pumps as their system maintainer was significantly associated with homeowners being classified as maintainers, that is, testing yearly and replacing tanks when needed. Both Rely and Stover’s offer different testing and maintenance programs which other installers and maintainers do not. 80% of maintainers identified Rely or Stover’s as their maintenance company.

Table 39 compares the arsenic concentrations at different sampling locations of maintainers and non-maintainers. Though not significant at the 0.05 level, maintainers had higher raw water arsenic levels and lower treated water (between the arsenic tanks) and kitchen sink arsenic levels than non-maintainers. There was also a significant association between self-efficacy score and maintainers. Homeowners with a higher self-efficacy score were more likely to agree that they were committed to decreasing arsenic exposure, they knew who to contact to test and treat their water and were confident they would remember to regularly test. Rely Mechanical contacts their clients as early as every 6 months to schedule a time for water testing and system service. Stover's Wells and Pumps treatment systems come with a testing contract with an outside lab. Every nine months, customers are sent sample bottles to fill and send back with their raw, treated and kitchen sink water. The program is included with the system but stipulates the homeowner must replace their arsenic worker tank when the reading between the tanks reaches 5 µg/L. A comparison of the other Health Belief Model construct scores can be found in *Table 40.*

Table 37: Characteristics of Homeowners (Maintainers vs. Non-Maintainers)

		Study Population	Maintainers	Non-Maintainers
(n=)		55	20	35
Age	Mean	47.5	44.0*	49.6
	Stdev	9.1	7.2	9.5
	Min	31	32	31
	Max	72	60	72
Education	Associate's Degree	1 (1.8%)	0 (0.0%)	1 (2.9%)
	Bachelor's Degree	24 (43.6%)	9 (45.0%)	15 (42.9%)
	Graduate Degree	30 (54.5%)	11 (55.0%)	19 (54.3%)
Home Value	Mean	581,142	620,470	558,669
	Stdev	235028.4	213466.8	246652.2
	Min	231,100	231,100	270,200
	Max	1,368,300	1,009,800	1,368,300
Age of Youngest Child	Mean	9.6	7.4	10.7
	Stdev	6.3	5.1	6.7
	Min	0.25	0.25	0.83
	Max	28	15	28
Number of Children at Home	Mean	1.7	1.9	1.5
	Stdev	1.1	1.1	1.1
	Min	0	0	0
	Max	4	4	3
Number of Adults at Home	Mean	2.1	2.1	2.1
	Stdev	0.5	0.2	0.7
	Min	1	2	1
	Max	5	3	5
Arsenic Knowledge	Mean	3.5	3.6	3.5
	Stdev	2.5	2.5	2.5
	Min	-2	-2	-1
	Max	9	8	9
Years in Home	Mean	6	6	7
	Stdev	6.1	5.4	6.6
	Min	0	0	1
	Max	29	22	29
				**p<0.05 Logistic Regression*

Table 38: Characteristics of Treatment Systems (Maintainers vs. Non-Maintainers)

		Study Population	%	Maintainers	%	Non Maintainers	%
(n=)		55.0	100.0%	20	36.4%	35	63.6%
Treatment System Age	Mean	5.2		4.4		5.8	
	Stdev	3.0		3.0		3.0	
	Min	0		0		2	
	Max	13		11		13	
Media	Adedge	13	23.6%	3	15.0%	9	25.7%
	Metsorb	17	30.9%	8	40.0%	9	25.7%
	Solmetex	19	34.5%	7	35.0%	12	34.3%
	Resin Tech	6	10.9%	2	10.0%	4	11.4%
	Isolux	0	0.0%	0	0.0%	0	0.0%
Treatment System Installer	Rely	18	32.7%	10	50.0%	8	22.9%
	Stover's	16	29.1%	5	25.0%	11	31.4%
	Stothoff	1	1.8%	1	5.0%	0	0.0%
	Portasoft	2	3.6%	0	0.0%	2	5.7%
	PWC	2	3.6%	1	5.0%	1	2.9%
	KelTren	2	3.6%	1	5.0%	1	2.9%
	Travis	6	10.9%	2	10.0%	4	11.4%
	Jayson	5	9.1%	0	0.0%	5	14.3%
	Other	3	5.5%	0	0.0%	3	8.6%
Treatment System Maintainer	Rely or Stover's	34	61.8%	16*	80.0%	18	51.4%
	Other	21	38.2%	4	20.0%	17	48.6%
							**p<.05 Logistic Regression*

Table 39: Characteristics of the Well Water (Maintainers vs. Non-Maintainers)

		Study Population	Maintainers	Non-Maintainers
(n=)		55	20	35
Raw Arsenic Concentration (µg/L)	Mean	11.29	12.34	10.69
	Stdev	8.97	9.44	8.77
	Min	2.60	2.60	3.10
	Max	41.60	38.20	41.60
Treated Water Arsenic Concentration (µg/L)	Mean	3.65	2.25	4.50
	Stdev	6.11	3.25	7.24
	Min	0.05	0.05	0.05
	Max	38.50	10.90	38.50
Kitchen Sink Arsenic Concentration (µg/L)	Mean	1.08	0.52	1.40
	Stdev	2.31	1.05	2.76
	Min	0.05	0.05	0.05
	Max	12.80	4.20	12.80
% Arsenic (III)	Mean	15.7%	20.9%	12.8%
	Stdev	24.1%	31.4%	18.5%
	Min	0.2%	0.2%	0.5%
	Max	105.7%	105.7%	90.6%
				No Significant Association

Table 40: Psychological Characteristics (Maintainers vs. Non-Maintainers)

		Study Population	Maintainers	Non-Maintainers
(n=)		55	20	35
Perceived Susceptibility	**Mean**	**3.34**	**3.39**	**3.31**
	Stdev	0.68	0.64	0.72
	Min	2.20	2.60	2.20
	Max	4.80	4.40	4.80
Perceived Severity	**Mean**	**3.48**	**3.47**	**3.49**
	Stdev	0.50	0.45	0.53
	Min	2.20	2.80	2.20
	Max	4.60	4.40	4.60
Perceived Benefits	**Mean**	**4.23**	**4.33**	**4.17**
	Stdev	0.57	0.50	0.61
	Min	3.33	3.33	3.33
	Max	5.00	5.00	5.00
Perceived Barriers	**Mean**	**2.65**	**2.73**	**2.60**
	Stdev	0.55	0.60	0.53
	Min	1.50	2.00	1.50
	Max	4.00	4.00	4.00
Self-Efficacy	**Mean**	**4.10**	**4.33***	**3.96**
	Stdev	0.57	0.48	0.57
	Min	2.67	3.33	2.67
	Max	5.00	5.00	5.00
Cues to Action	**Mean**	**4.12**	**4.18**	**4.08**
	Stdev	0.47	0.31	0.54
	Min	2.60	3.20	2.60
	Max	5.00	4.60	5.00
				**p<0.05 Logistic Regression*

Highly Effective Treatment Systems: Treated Water Arsenic Level Less than MCL

Highly effective treatment systems were defined as treatment systems that produced arsenic readings less than the MCL after the first arsenic tank. Of the 55 homes with dual tank POET systems, 74% were highly effective and under the MCL after the first treatment tank. *Table 41* compares characteristics of homeowners who have arsenic concentrations that are under the MCL after the first arsenic tank (highly effective) and systems that are over the MCL after the first treatment tank.

Table 42 compares the characteristics of highly effective vs. non-highly effective treatment systems. There is a significant association between system age and high efficacy. Treatment systems that are older are significantly more likely to be failing after the first arsenic tank.

Treatment systems that are failing after the first tank also have significantly higher raw arsenic concentrations and treated water arsenic concentrations. Raw arsenic levels could cause the life expectancy treatment systems to go down as arsenic treatment media is used up more rapidly. *Table 43* shows the average arsenic concentration at each sampling location. Though not significant, the average arsenic concentration is higher at the kitchen sink for systems failing after the first tank. The second arsenic tank is an important backup to prevent arsenic exposure at the kitchen sink. *Table 44* compares the Health Belief Model component scores of homeowners with highly effective and non-highly effective treatment systems.

Table 41: Characteristics of Homeowners (Under MCL after First Treatment Tank vs. Over MCL after First Treatment Tank)

		Study Population	Over MCL at T (Failing After T1)	Under MCL at T (Passing after T1)
(n=)		54	14	40
Age	Mean	47.6	48.0	47.5
	Stdev	9.2	3.7	10.5
	Min	31	43	31
	Max	72	56	72
Education	Associate's Degree	1 (1.9%)	1 (7.1%)	0 (0.0%)
	Bachelor's Degree	23 (42.6%)	4 (28.6%)	19 (47.5%)
	Graduate Degree	30 (55.6%)	9 (64.3%)	21 (52.5%)
Home Value	Mean	586,074	649,650	563,823
	Stdev	234344.5	200754.2	243389.5
	Min	231,100	270,200	231,100
	Max	1,368,300	936,200	1,368,300
Age of Youngest Child	Mean	9.5	10.7	9.1
	Stdev	6.4	4.5	7.0
	Min	0.25	3	0.25
	Max	28	19	28
Number of Children at Home	Mean	1.6	1.8	1.6
	Stdev	1.1	1.1	1.1
	Min	0	0	0
	Max	4	3	4
Number of Adults at Home	Mean	2.1	1.9	2.1
	Stdev	0.5	0.3	0.6
	Min	1	1	1
	Max	5	2	5
Arsenic Knowledge	Mean	3.5	3.7	3.5
	Stdev	2.5	2.2	2.6
	Min	-2	0	-2
	Max	9	8	9
Years in Home	Mean	6	7	6
	Stdev	6.2	6.1	6.3
	Min	0	1	0
	Max	29	22	29
				No Significant Association

Table 42: Characteristics of Treatment Systems (Under MCL after First Treatment Tank vs. Over MCL after First Treatment Tank)

		Study Population	%	Over MCL at T (Failing After T1)	%	Under MCL at T (Passing after T1)	%
(n=)		54.0	100.0%	14	25.9%	40	74.1%
System Age	Mean	4.9		6.8*		4.7	
	Stdev	2.7		3.4		2.8	
	Min	1		2		0	
	Max	11		13		11	
Media	Adedge	13	24.1%	3	21.4%	12	30.0%
	Metsorb	16	29.6%	4	28.6%	12	30.0%
	Solmetex	19	35.2%	4	28.6%	15	37.5%
	Resin Tech	6	11.1%	3	21.4%	3	7.5%
	Isolux	0	0.0%	0	0.0%	0	0.0%
Installer	Rely	18	33.3%	4	28.6%	14	35.0%
	Stover's	16	29.6%	3	21.4%	13	32.5%
	Stothoff	1	1.9%	0	0.0%	1	2.5%
	Portasoft	2	3.7%	0	0.0%	2	5.0%
	PWC	2	3.7%	0	0.0%	2	5.0%
	KelTren	2	3.7%	1	7.1%	1	2.5%
	Travis	5	9.3%	2	14.3%	3	7.5%
	Jayson	5	9.3%	3	21.4%	2	5.0%
	Other	3	5.6%	1	7.1%	2	5.0%
Maintainer	Rely or Stover's	34	63.0%	7	50.0%	27	67.5%
	Other	20	37.0%	7	50.0%	13	32.5%

**$p<0.05$ Logistic Regression*

Table 43: Characteristics of the Well Water (Under MCL after First Treatment Tank vs. Over MCL after First Treatment Tank)

		Study Population	Over MCL at T (Failing After T1)	Under MCL at T (Passing after T1)
(n=)		54	14	40
Raw Arsenic Concentration (µg/L)	Mean	11.39	18.09*	9.05
	Stdev	9.02	11.59	6.64
	Min	2.60	3.10	2.60
	Max	41.60	41.60	38.20
Treated Water Arsenic Concentration (µg/L)	Mean	3.65	11.31*	1.17
	Stdev	6.11	8.53	1.24
	Min	0.05	5.70	0.05
	Max	38.50	38.50	4.50
Kitchen Sink Arsenic Concentration (µg/L)	Mean	1.09	2.92	0.45
	Stdev	2.34	3.40	1.39
	Min	0.05	0.05	0.05
	Max	12.80	12.80	8.50
% Arsenic (III)	Mean	15.7%	8.7%	18.2%
	Stdev	24.3%	7.7%	27.5%
	Min	0.2%	0.5%	0.2%
	Max	105.7%	24.5%	105.7%
				**p<0.05 Logistic Regression*

Table 44: Psychological Characteristics (Under MCL after First Treatment Tank vs. Over MCL after First Treatment Tank)

		Study Population	Over MCL at T (Failing After T1)	Under MCL at T (Passing after T1)
(n=)		54	14	40
Perceived Susceptibility	**Mean**	**3.34**	**3.26**	**3.37**
	Stdev	0.69	0.67	0.70
	Min	2.20	2.40	2.20
	Max	4.80	4.40	4.80
Perceived Severity	**Mean**	**3.47**	**3.51**	**3.46**
	Stdev	0.50	0.47	0.51
	Min	2.20	3.00	2.20
	Max	4.60	4.40	4.60
Perceived Benefits	**Mean**	**4.24**	**4.21**	**4.25**
	Stdev	0.57	0.61	0.56
	Min	3.33	3.33	3.33
	Max	5.00	5.00	5.00
Perceived Barriers	**Mean**	**2.66**	**2.86**	**2.59**
	Stdev	0.55	0.63	0.50
	Min	1.50	2.00	1.50
	Max	4.00	4.00	3.50
Self-Efficacy	**Mean**	**4.08**	**4.14**	**4.06**
	Stdev	0.56	0.72	0.49
	Min	2.67	2.67	3.00
	Max	5.00	5.00	5.00
Cues to Action	**Mean**	**4.11**	**4.17**	**4.09**
	Stdev	0.47	0.39	0.50
	Min	2.60	3.40	2.60
	Max	5.00	4.60	5.00
				No Significant Association

Effective Treatment Systems: Kitchen Sink Water Arsenic Level Less than MCL

In this study, effective treatment systems were defined as treatment systems that reduced the kitchen sink arsenic concentration below the MCL. Of the 55 dual tank POET systems, 92.7% had kitchen sink arsenic levels below the MCL. Because of the low number of systems failing at the kitchen sink (n=4), significant associations were difficult to achieve. The characteristics of homeowners with effective and ineffective treatment systems are shown in *Table 45*.

Table 46 shows the significant association between system age and treatment system failure at the kitchen sink. The average age of a failing system was 10 years and passing system was 4.8 years. System age was also significantly associated with treated arsenic concentration and kitchen sink arsenic concentration.

Table 47 shows the characteristics of well water in homes with passing and failing systems. Though not significant, the raw, treated and kitchen sink arsenic levels were all higher in homes with failing treatment systems. *Table 48* compares the Health Belief Model scores from these two groups.

Table 45: Characteristics of the Well Water (Under MCL at the Kitchen Sink vs. Over MCL at the Kitchen Sink)

		Study Population	Over MCL at KS (Failing)	Under MCL at KS (Passing)
(n=)		55	4	51
Age	Mean	47.5	49.8	47.4
	Stdev	9.1	4.3	9.4
	Min	31	45	31
	Max	72	55	72
Education	Associate's Degree	1	0	1
	Bachelor's Degree	24	1	23
	Graduate Degree	30	3	27
Home Value	Mean	581,142	595,225	580,037
	Stdev	235028.4	252369.1	236260.3
	Min	231,100	375,100	231,100
	Max	1,368,300	875,700	1,368,300
Age of Youngest Child	Mean	9.6	11.3	9.5
	Stdev	6.3	7.4	6.3
	Min	0.25	3	0.25
	Max	28	17	28
Number of Children at Home	Mean	1.7	1.3	1.7
	Stdev	1.1	1.0	1.1
	Min	0	0	0
	Max	4	2	4
Number of Adults at Home	Mean	2.1	1.8	2.1
	Stdev	0.5	0.5	0.5
	Min	1	1	1
	Max	5	2	5
Arsenic Knowledge	Mean	3.5	4.3	3.5
	Stdev	2.5	2.2	2.5
	Min	-2	2	-2
	Max	9	7	9
Years in Home	Mean	6	8	6
	Stdev	6.1	5.4	6.2
	Min	0	1	0
	Max	29	14	29
				No Significant Association

Table 46: Characteristics of Treatment Systems (Under MCL at the Kitchen Sink vs. Over MCL at the Kitchen Sink)

		Study Population	%	Over MCL at KS (Failing)	%	Under MCL at KS (Passing)	%
(n=)		55.0	100.0%	4	7.3%	51	92.7%
System Age	Mean	5.2		10.0*		4.8	
	Stdev	3.0		2.6		2.7	
	Min	0		7		0	
	Max	13		13		11	
Media	Adedge	13	23.6%	2	50.0%	17	33.3%
	Metsorb	17	30.9%	0	0.0%	17	33.3%
	Solmetex	19	34.5%	1	25.0%	18	35.3%
	Resin Tech	6	10.9%	1	25.0%	5	9.8%
	Isolux	0	0.0%	0	0.0%	0	0.0%
Installer	Rely	18	32.7%	0	0.0%	18	35.3%
	Stover's	16	29.1%	1	25.0%	15	29.4%
	Stothoff	1	1.8%	0	0.0%	1	2.0%
	Portasoft	2	3.6%	0	0.0%	2	3.9%
	PWC	2	3.6%	0	0.0%	2	3.9%
	KelTren	2	3.6%	0	0.0%	2	3.9%
	Travis	6	10.9%	1	25.0%	5	9.8%
	Jayson	5	9.1%	2	50.0%	3	5.9%
	Other	3	5.5%	0	0.0%	3	5.9%
Maintainer	Rely or Stover's	34	61.8%	1	25.0%	33	64.7%
	Other	21	38.2%	3	75.0%	18	35.3%
							**p<0.05 Logistic Regression*

Table 47: Characteristics of the Well Water (Under MCL at the Kitchen Sink vs. Over MCL at the Kitchen Sink)

		Study Population	Over MCL at KS (Failing)	Under MCL at KS (Passing)
(n=)		55	4	51
Raw Arsenic Concentration (µg/L)	Mean	11.29	18.08	10.75
	Stdev	8.97	13.38	8.50
	Min	2.60	5.50	2.60
	Max	41.60	31.50	41.60
Treated Water Arsenic Concentration (µg/L)	Mean	3.65	17.27	2.84
	Stdev	6.11	18.56	3.68
	Min	0.05	4.10	0.05
	Max	38.50	38.50	13.60
Kitchen Sink Arsenic Concentration (µg/L)	Mean	1.08	8.10	0.53
	Stdev	2.31	3.44	0.91
	Min	0.05	5.20	0.05
	Max	12.80	12.80	4.20
% Arsenic (III)	Mean	15.7%	19.4%	15.4%
	Stdev	24.1%	32.1%	23.7%
	Min	0.2%	0.6%	0.2%
	Max	105.7%	67.3%	105.7%
				No Significant Association

Table 48: Psychological Characteristics (Under MCL at the Kitchen Sink vs. Over MCL at the Kitchen Sink)

		Study Population	Over MCL at KS (Failing)	Under MCL at KS (Passing)
(n=)		55	4	51
Perceived Susceptibility	**Mean**	**3.34**	**3.40**	**3.33**
	Stdev	0.68	1.05	0.66
	Min	2.20	2.60	2.20
	Max	4.80	4.80	4.80
Perceived Severity	**Mean**	**3.48**	**3.85**	**3.45**
	Stdev	0.50	0.50	0.49
	Min	2.20	3.20	2.20
	Max	4.60	4.40	4.60
Perceived Benefits	**Mean**	**4.23**	**4.50**	**4.21**
	Stdev	0.57	0.58	0.57
	Min	3.33	4.00	3.33
	Max	5.00	5.00	5.00
Perceived Barriers	**Mean**	**2.65**	**3.00**	**2.62**
	Stdev	0.55	0.82	0.53
	Min	1.50	2.00	1.50
	Max	4.00	4.00	4.00
Self-Efficacy	**Mean**	**4.10**	**4.42**	**4.07**
	Stdev	0.57	0.69	0.56
	Min	2.67	3.67	2.67
	Max	5.00	5.00	5.00
Cues to Action	**Mean**	**4.12**	**4.30**	**4.10**
	Stdev	0.47	0.26	0.48
	Min	2.60	4.00	2.60
	Max	5.00	4.60	5.00
				No Significant Association

Chapter Five: Arsenic Risk Reduction with Arsenic Treatment Systems (Specific Aim 3)

Arsenic Test Results

At each participant's home, water quality parameters were measured. Iron and manganese were also tested for. The average readings and concentrations are summarized in *Table 49. Table 50* shows the average, minimum and maximum arsenic concentration at each sample location in homes with a dual tank arsenic POET system. The average raw water arsenic concentration is 11.29 µg/L. The average decreased after the first arsenic tank to 3.65 µg/L and 1.08 µg/L after the second arsenic tank. The highest concentrations measured were 41.6 µg/L in raw water, 38.5 µg/L after the first tank and 12.8 µg/L at the kitchen sink. *Appendix K* contains all water test results.

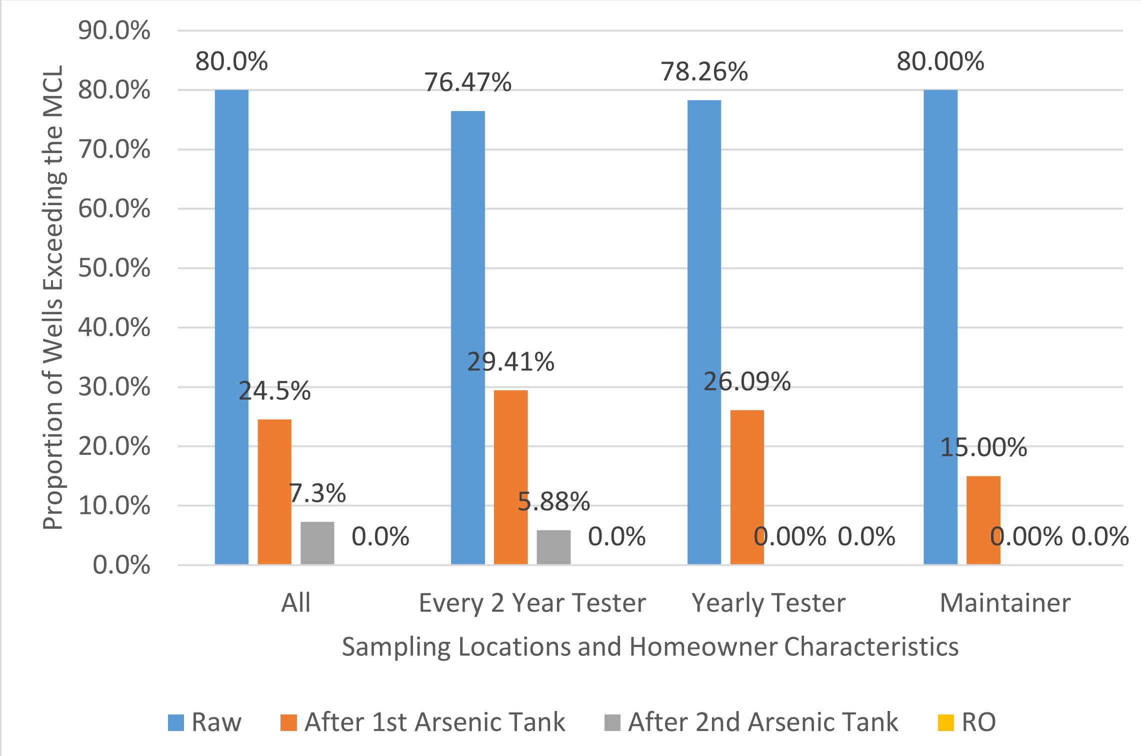
Table 49: Raw Water Quality Parameters

	pH	ORP (mV)	TDS (mg/L)	RDO	Iron (µg/L)	Manganese (µg/L)
Average	7.9	230.9	341.7	3.0	41.3	23.5
StDev	0.3	147.9	152.0	2.7	73.7	50.7
Min	7.5	-25.0	194.0	0.0	15.5	0.0
Max	8.7	460.0	917.0	11.0	410.0	233.0
(n=)	55	55	55	55	55	55

Table 50: Summary of Arsenic Results

	Raw (Well) Water					Treated	K. Sink	R.O.
	Total As (µg/L)	As (III) (µg/L)	As (V) (µg/L)	%As (III)	%As (V)	As (µg/L)	As (µg/L)	As (µg/L)
Average	11.29	1.81	9.47	15.7%	84.3%	3.65	1.08	0.05
StDev	8.97	4.82	7.90	24.1%	24.1%	6.11	2.31	0.00
Min	2.60	0.05	-0.20	0.2%	-5.7%	0.05	0.05	0.05
Max	41.60	35.10	40.70	105.7%	99.8%	38.50	12.80	0.05
(n=)	55	55	55	55	55	53	55	10

Figure 26: MCL Exceedance Reduction by Well Owner Characteristic



Exposure Assessment (Specific Aim 3.I)

In the survey, homeowners were asked to estimate their drinking water consumption per day for tap water and beverages made with tap water. The average volume of water consumed per day was 0.9 L and the average volume of beverages made with tap water was 0.7 L. Consumption of water varied greatly between 0 L and 7.1 L. The survey also collected data on length of time in the home and anticipated number of future years in the home. The volume of water consumed, arsenic concentrations and length of exposure were used to calculate past and future arsenic exposure prevented by arsenic treatment systems using *Equations 1-4* shown below. The exposure data is summarized in *Table 51*.

Table 51: Summary of Arsenic Exposure Parameters and Calculations

	Mean	StDev	Min	Max	Total	(n=)
Raw Water As Concentration (µg/L)	11.3	9.0	2.6	41.6	620.8	55
Water Consumed/ day (L)	0.9	1.1	0.0	4.7	51.8	55
Beverages Made with Water consumed/ day (L)	0.7	1.1	0.0	7.1	39.4	55
Water + Beverages Consumed per day (L)	1.7	1.5	0.0	7.1	94.1	55
Water + Beverages Consumed per year (L)	624.9	555.5	0.0	2592.4	34368.6	55
Kitchen Sink As Concentration (µg/L)	1.1	2.3	0.1	12.8	59.5	55
Years in Home	6.4	6.1	0.0	29.0	354.0	55
Years with Treatment System	4.5	2.9	0.0	12.0	250.0	55
Anticipated Future Years in Home	17.0	10.6	0.0	50.0	919.5	54
Past Arsenic Exposure Prevented (µg)	23481.6	29700.2	0.0	136101.7	1291489.6	55
Past Arsenic Exposure Prevented (mg)	23.5	29.7	0.0	136.1	1291.5	55
Future Arsenic Exposure Prevented (µg)	78652.4	97850.8	0.0	626499.8	4247227.1	54
Future Arsenic Exposure Prevented (mg)	78.7	97.9	0.0	626.5	4247.2	54
Only analyzed homeowners who had a dual tank POET; one participant refused to answer anticipated years in home						

Equation 1: Arsenic Exposure Prevented by Dual Tank Arsenic Treatment Systems

$$\left[\left(Raw\ Water\ As\ Concentration\ \left(\frac{\mu g}{L}\right) \times water\ consumed\ \left(\frac{L}{year}\right)\right) - \left(Treated\ Water\ As\ Concentration\ \left(\frac{\mu g}{L}\right) \times water\ consumed\ \left(\frac{L}{year}\right)\right)\right]$$

$$\times\ years\ in\ the\ home$$

$$=\ Arsenic\ exposure\ prevented\ by\ treatment\ system$$

$$\left[\left(RW\ As\ Conc.\left(\frac{\mu g}{L}\right) \times\ WCY\ \left(\frac{L}{year}\right)\right) - \left(TW\ As\ Conc.\left(\frac{\mu g}{L}\right) \times\ WCY\ \left(\frac{L}{year}\right)\right)\right] \times Years$$
$$= Past\ As\ Exp.Prevented$$

To calculate the arsenic exposure prevented by arsenic treatment systems, the raw arsenic concentration was multiplied by the volume of water consumed per year. The arsenic exposure was also calculated for water at the kitchen sink. Subtracting the kitchen sink arsenic from the raw water arsenic gave the exposure prevented yearly by the arsenic treatment system. An example calculation using the data from house As2015-052 is shown in *Equation 2*. The raw water concentration at this home was 9.6 µg/L and kitchen sink arsenic concentration was 0.6 µg/L. The homeowner drank 20 oz water and 120 oz coffee made with tap water daily or 4.14 L total. The homeowner lived in the home for 14 years but had a treatment system installed for the last 7 years. *Equation 2* was used to calculate the arsenic exposure prevented by the treatment system, 95.3 mg.

Equation 2: Past Exposure Prevented Sample Calculation (ID 52)

$$\left[\left(9.6\ \left(\frac{\mu g}{L}\right)\right) \times \left(1512.1\ \left(\frac{L}{year}\right)\right) - \left(0.6\ \left(\frac{\mu g}{L}\right)\right) \times \left(1512.1\ \left(\frac{L}{year}\right)\right)\right] \times 7\ Years$$
$$= 95{,}262\ \mu g = 95.3\ mg$$

Equation 3 was used to calculate future exposure prevented by the arsenic treatment system, assuming the system was effective and arsenic at the kitchen sink would remain 0 µg/L. The homeowner intended to live in his home for 10 years. Assuming his water consumption does not change, the effective arsenic treatment system will prevent him from being exposed to 145.2 mg arsenic. This calculation is shown in *Equation 4*.

Equation 3: Future Arsenic Exposure Prevented by Well-Maintained Dual Tank Arsenic Treatment Systems

$$\left[\left(Raw\ Water\ As\ Concentration\ \left(\frac{\mu g}{L}\right)\times\ water\ consumed\ \left(\frac{L}{year}\right)\right)\right.$$
$$\left.-\left(Treated\ Water\ As\ Concentration\ \left(\frac{\mu g}{L}\right)\times\ water\ consumed\ \left(\frac{L}{year}\right)\right)\right]$$
$$\times\ Anticipated\ Future\ Years\ In\ Home$$
$$=Future\ arsenic\ exposure\ prevented\ by\ treatment\ systems$$

$$\left[\left(RW\ As\ Conc.\left(\frac{\mu g}{L}\right)\times\ WCY\ \left(\frac{L}{year}\right)\right)-\left(TW\ As\ Conc.\left(\frac{\mu g}{L}\right)\times\ WCY\ \left(\frac{L}{year}\right)\right)\right]\times Years$$
$$=Future\ As\ Exp.Prevented$$

Equation 4: Future Exposure Prevented Sample Calculation (ID 52)

$$\left[\left(9.6\ \left(\frac{\mu g}{L}\right)\right)\times\left(1512.1\ \left(\frac{L}{year}\right)\right)-\ \left(0\left(\frac{\mu g}{L}\right)\right)\times\left(1512.1\ \left(\frac{L}{year}\right)\right)\right]\times 10\ Years$$
$$=145{,}162\ \mu g=145.2mg$$

Risk Reduction (Specific Aim 3.II-III)

The lifetime excess cancer risk due to arsenic exposure was estimated using lifetime average daily exposure (LADE) and the arsenic cancer slope factor (CSF). An example calculation using the average raw water concentration and average water consumption of the study population is shown in *Equation 5*.

Equation 5: Lifetime Average Daily Exposure (LADE) - Raw Water Average

$$\left(\frac{11.16\ \mu g}{L}\right)\times\left(\frac{1.71\ L}{day}\right)\times\left(\frac{1\ mg}{1000\mu g}\right)\times\left(\frac{1}{70\ kg}\right)=0.00027\left(\frac{mg}{kg*day}\right)LADE$$

The current cancer slope factor of 1.5 mg/kg-day is based on the risk of skin cancer for a population drinking high levels of arsenic in Taiwan. Some researchers have used cancer slope factors such as 3.5 mg/kg-day based on data from other arsenic caused cancers [36]. In 2010, the US EPA Integrated Risk Information System (IRIS) calculated a new cancer slope factor, 25.7 mg/kg-day, based on lung and bladder cancer for women. This increase was recommended to account for the most common arsenic caused cancers in women who are more susceptible than men [37]. This slope factor, which is currently in external review, has been used in subsequent peer reviewed research and is used in the risk calculations in this study [38]. The risk equation which multiplies the cancer slope factor and LADE is show in *Equation 6*. An example calculation for average risk from drinking raw water is shown in *Equation 7*. *Table 52* shows the exposure parameters and risk calculations for all sampling locations using average water consumption and concentrations.

Equation 6: Risk

$$Risk = Cancer\ Slope\ Factor\ \times Lifetime\ Average\ Daily\ Exposure$$

$$Risk = CSF \times LADE$$

Equation 7: Average Risk from Drinking Raw Water

$$Risk\ 0.0070 = 25.7\ (\frac{mg}{kg * day}) \times 0.00027\ (\frac{mg}{kg * day})$$

Table 52: Risk Calculation Parameters

Exposure Parameters					
Average Water Consumed per Day (L)	0.94				
Average Beverages Made with Water per day (L)	0.72				
Average Water + Beverages Per day (L)	1.71				
Total Water Consumed per year (L)	624.88				
Arsenic Cancer Slope Factor (mg/kg/day)	25.70				
Population of Hopewell Township	17,304				
	Raw	**Treated**	**Kitchen Sink**	**Achievable**	**Acceptable Risk**
Arsenic Concentration	**11.16**	**3.65**	**1.45**	**0.050**	**0.0016**
LADE	0.00027	0.000089	0.000035	0.0000012	0.000000039
CSF	25.7	25.7	25.7	25.7	25.7
Risk	0.00701	0.00229	0.000911	0.000031	0.000001
Risk	7 in 1000	2.3 in 1000	0.9 in 1000	3 in 100,000	1 in 1,000,000
Risk Applied to Hopewell's Population	121.3	39.7	15.8	0.54	0.017

Chapter Six: Water Quality Parameters (Specific Aim 4)

Arsenic is found in groundwater as Arsenic (V) and Arsenic (III). As (III) is harder to treat than As (V). Currently, commercial laboratories are unable to speciate arsenic in a quick and cost effective way. There is a need for a simple field method that allows water treatment professionals to understand the type of water they are treating. Previous studies have indicated well water in New Jersey with iron greater than 100 µg/L, manganese greater than 50 µg/L, negative oxidation reduction potential or a hydrogen sulfide odor will contain a significant percentage of As (III) [4,6.]

In this study, arsenic (III) was measured using a speciation cartridge. The concentrations of As (III) were used to validate other field methods that indicate the presence of As (III). The rule suggested in the literature (iron greater than 100 µg/L and manganese greater than 50 µg/L) gave a sensitivity of 70% (3 false negatives) and a specificity of 92.7% (4 false positives) when predicting As (III) greater than 3 µg/L. Based on *Table 53*, to reduce the number of false negatives, the rule "Iron or Manganese above 50 or RDO less than 1.0 mg/L" can be used to indicate As (III) >3 µg/L. This rule has a sensitivity of 90% (1 false negative) and a specificity of 63.64% (20 false positives). Increasing the sensitivity is a priority because of the importance of correctly diagnosing the wells with As (III). The tradeoff is that the specificity decreases. An alternative to this rule could be, "Iron or Manganese above 50 µg/L indicates As (III) greater than 3 µg/L which has a sensitivity of 80% (2 false negatives) and a specificity of 87.27% (7 false positives). In this case, less wells are incorrectly diagnosed as having As (III) but at the expense of missing an additional As (III) well. Other rules to predict the percent As (III) are shown in *Tables 54-56*.

In the interest of public health, the higher sensitivity rule should be used. This minimizes the false negatives and ensures more appropriate water treatment. Homeowners who would like confirmation of As (III) in their well prior to installing any costly pre-treatment that would convert As (III) to As (V), could do a confirmatory analysis. An arsenic speciation cartridge (as detailed in the methods section and *Appendix F*) could be used to determine the presence of As (III). A water sample could also be to a lab that has the capacity to speciate arsenic.

Table 53: Potential Rules Predicting %As (III) Above 3µg/L

Potential Rule Indicating As (III) > 3µg/L	(n=)	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Fe above 50 µg/L	65	80.00%	89.09%	57.14%	96.08%
Mn above 50 µg/L	65	60.00%	96.36%	75.00%	92.98%
RDO < 1.0 mg/L	64	60.00%	72.22%	28.57%	90.70%
Fe or Mn above 50 µg/L	65	80.00%	87.27%	53.33%	96.00%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	65	90.00%	63.64%	31.03%	97.22%
Excluding Wells with As3 < 0.5 µg/L					
Fe above 50 µg/L	41	80.00%	87.10%	66.67%	93.10%
Mn above 50 µg/L	41	60.00%	96.77%	85.71%	88.24%
RDO < 1.0 mg/L	40	60.00%	70.00%	40.00%	84.00%
Fe or Mn above 50 µg/L	41	80.00%	83.87%	61.54%	92.86%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	41	90.00%	58.06%	40.91%	94.74%
Excluding Wells with As3 < 1 µg/L					
Fe above 50 µg/L	27	80.00%	88.24%	80.00%	88.24%
Mn above 50 µg/L	27	60.00%	100.00%	100.00%	80.95%
RDO < 1.0 mg/L	26	60.00%	68.75%	54.55%	73.33%
Fe or Mn above 50 µg/L	27	80.00%	88.24%	80.00%	88.24%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	27	90.00%	58.82%	56.25%	90.91%

Table 54: Potential Rules Predicting %As (III) Above 20%

Potential Rule Indicating As (III) > 20%	(n=)	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Fe above 50 µg/L	65	53.33%	88.00%	57.14%	86.27%
Mn above 50 µg/L	65	40.00%	96.00%	75.00%	84.21%
RDO < 1.0 mg/L	64	46.67%	71.43%	33.33%	81.40%
Fe or Mn above 50 µg/L	65	53.33%	86.00%	53.33%	86.00%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	65	66.67%	62.00%	34.48%	86.11%
Excluding Wells with As3 < 0.5 µg/L					
Fe above 50 µg/L	41	53.33%	84.62%	66.67%	75.86%
Mn above 50 µg/L	41	40.00%	96.15%	85.71%	73.53%
RDO < 1.0 mg/L	40	46.67%	68.00%	46.67%	68.00%
Fe or Mn above 50 µg/L	41	53.33%	76.92%	57.14%	74.07%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	41	66.67%	53.85%	45.45%	73.68%
Excluding Wells with As3 < 1 µg/L					
Fe above 50 µg/L	27	66.67%	86.67%	80.00%	76.47%
Mn above 50 µg/L	27	42.86%	100.00%	100.00%	61.90%
RDO < 1.0 mg/L	26	42.86%	58.33%	54.55%	46.67%
Fe or Mn above 50 µg/L	27	57.14%	84.62%	80.00%	64.71%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	27	64.29%	46.15%	56.25%	54.55%

Table 55: Potential Rules Predicting %As (III) Above 30%

Potential Rule Indicating As (III) > 30%	(n=)	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Fe above 50 µg/L	65	80.00%	89.09%	57.14%	96.08%
Mn above 50 µg/L	65	60.00%	96.36%	75.00%	92.98%
RDO < 1.0 mg/L	64	60.00%	72.22%	28.57%	90.70%
Fe or Mn above 50 µg/L	65	80.00%	87.27%	53.33%	96.00%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	65	90.00%	63.64%	31.03%	97.22%
Excluding Wells with As (III) < 0.5 µg/L					
Fe above 50 µg/L	41	80.00%	87.10%	66.67%	93.10%
Mn above 50 µg/L	41	60.00%	96.77%	85.71%	88.24%
RDO < 1.0 mg/L	40	60.00%	70.00%	40.00%	84.00%
Fe or Mn above 50 µg/L	41	80.00%	80.65%	57.14%	92.59%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	41	90.00%	58.06%	40.91%	94.74%
Excluding Wells with As (III) < 1 µg/L					
Fe above 50 µg/L	27	88.89%	88.89%	80.00%	94.12%
Mn above 50 µg/L	27	66.67%	100.00%	100.00%	85.71%
RDO < 1.0 mg/L	26	55.56%	64.71%	45.45%	73.33%
Fe or Mn above 50 µg/L	27	88.89%	88.89%	80.00%	94.12%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	27	88.89%	55.56%	50.00%	90.91%

Table 56: Potential Rules Predicting %As (III) Above 40%

Potential Rule Indicating As (III) > 40%	(n=)	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Fe above 50 µg/L	65	100.00%	86.44%	42.86%	100.00%
Mn above 50 µg/L	65	83.33%	94.92%	62.50%	98.25%
RDO < 1.0 mg/L	64	66.67%	70.69%	19.05%	95.35%
Fe or Mn above 50 µg/L	65	100.00%	84.75%	40.00%	100.00%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	65	100.00%	61.02%	20.69%	100.00%
Excluding Wells with As (III) < 0.5 µg/L					
Fe above 50 µg/L	41	100.00%	82.86%	50.00%	100.00%
Mn above 50 µg/L	41	83.33%	94.29%	71.43%	97.06%
RDO < 1.0 mg/L	40	66.67%	67.65%	26.67%	92.00%
Fe or Mn above 50 µg/L	41	100.00%	77.14%	42.86%	100.00%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	41	100.00%	54.29%	27.27%	100.00%
Excluding Wells with As (III) < 1 µg/L					
Fe above 50 µg/L	27	100.00%	80.95%	60.00%	100.00%
Mn above 50 µg/L	27	83.33%	95.24%	83.33%	95.24%
RDO < 1.0 mg/L	26	66.67%	65.00%	36.36%	86.67%
Fe or Mn above 50 µg/L	27	100.00%	80.95%	60.00%	100.00%
Fe or Mn above 50µg/L or RDO < 1.0 mg/L	27	100.00%	52.38%	37.50%	100.00%

There is a significant correlation between As (III)% and iron. This relationship is shown in *Figure 27*. Iron above 50 µg/L is the best predictor of wells with As (III) at 40% and above with a sensitivity of 100% and specificity of 86.44% (*Table 56*). There is also a significant correlation between As (III)% and manganese. The relationship between these two variables is shown in *Figure 28*. Manganese above 50 µg/L can predict As (III)% above 20-40% with a high specificity (*Tables 54-56*).

There was no significant relationship between rapid dissolved oxygen or oxidation reduction potential and As (III)% (*Figure 29-30*.) There also was no correlation observed between pH and As (III)% (*Figure 31*), however, pH is an important water quality parameter. Most treatment systems work best when the pH is between 3.5 and 7.5.

Figure 27: Relationship Between Iron and %As (III)

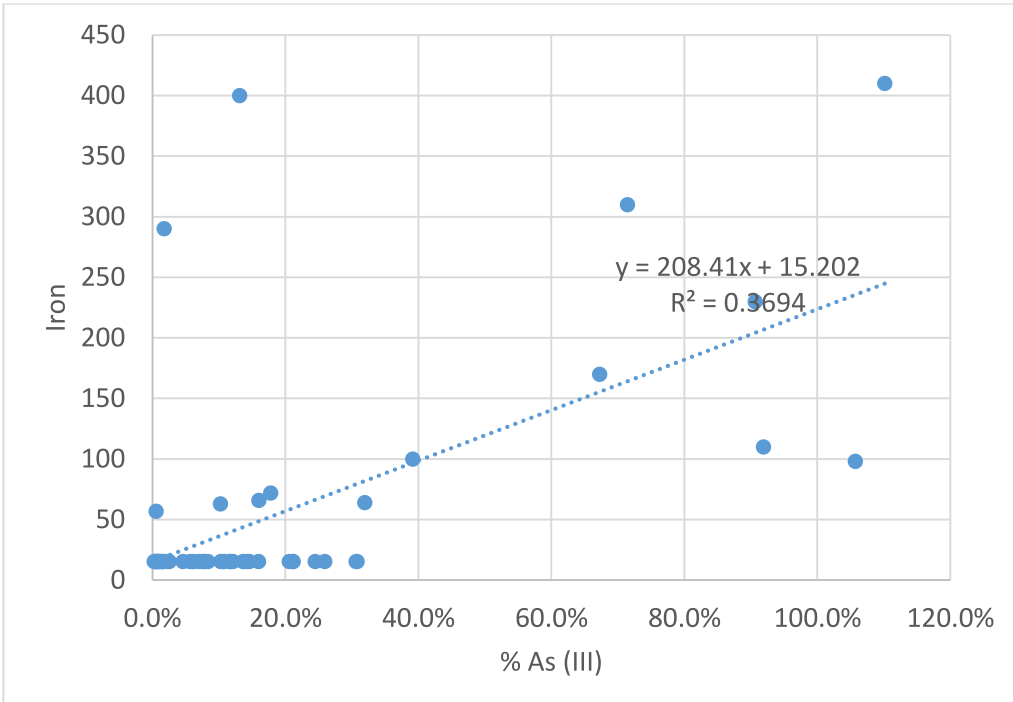


Figure 28: Relationship Between Manganese and %As (III)

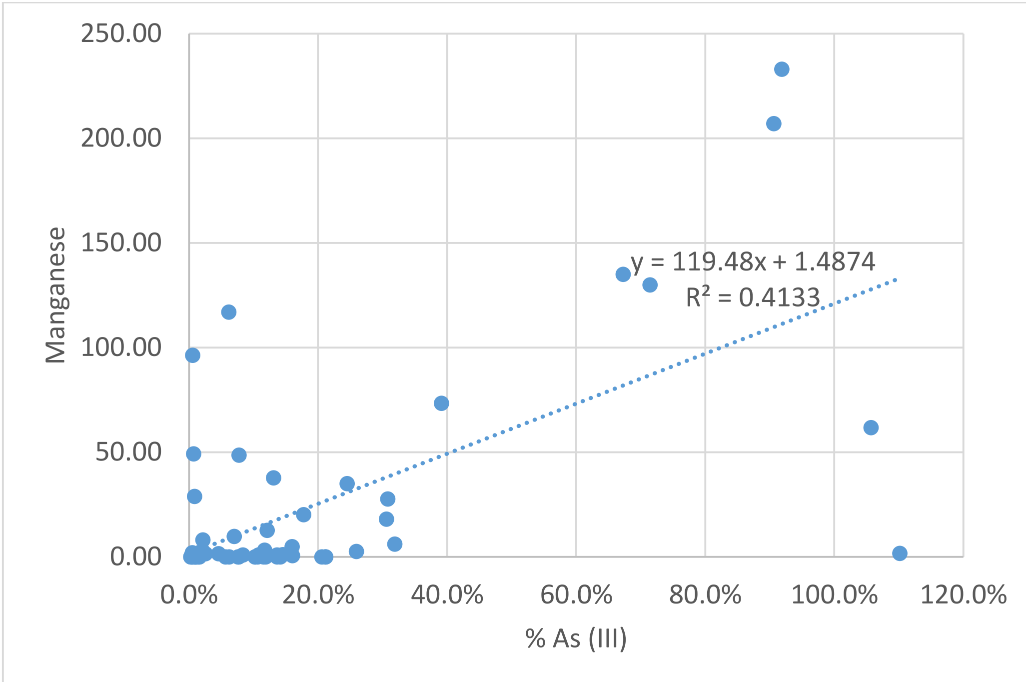


Figure 29: Relationship Between Dissolved Oxygen and %As (III)

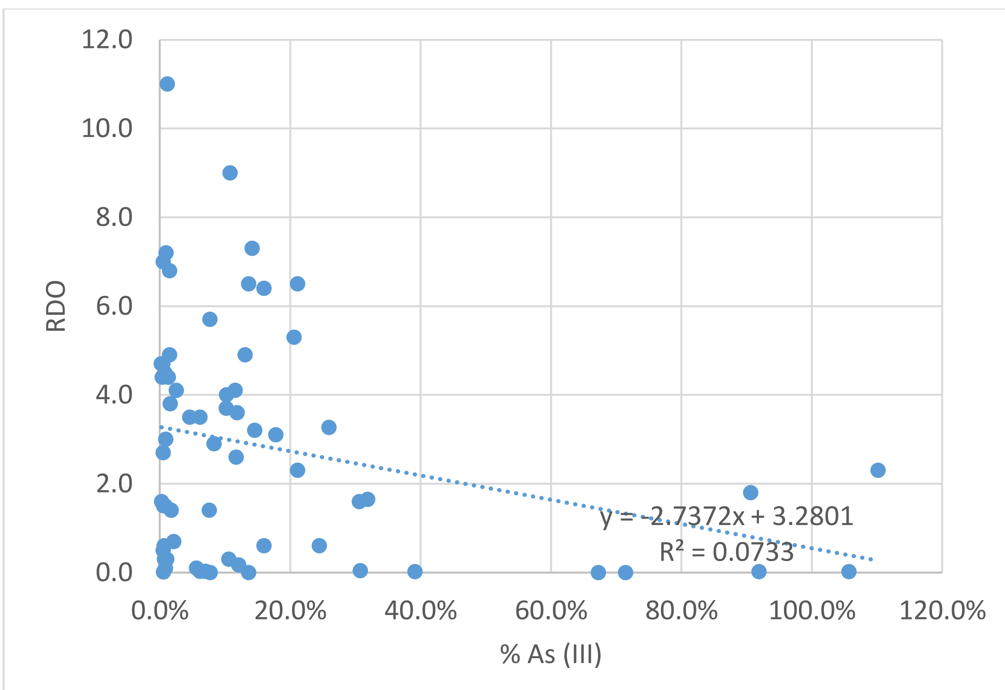


Figure 30: Relationship Between Oxidation Reduction Potential and %As (III)

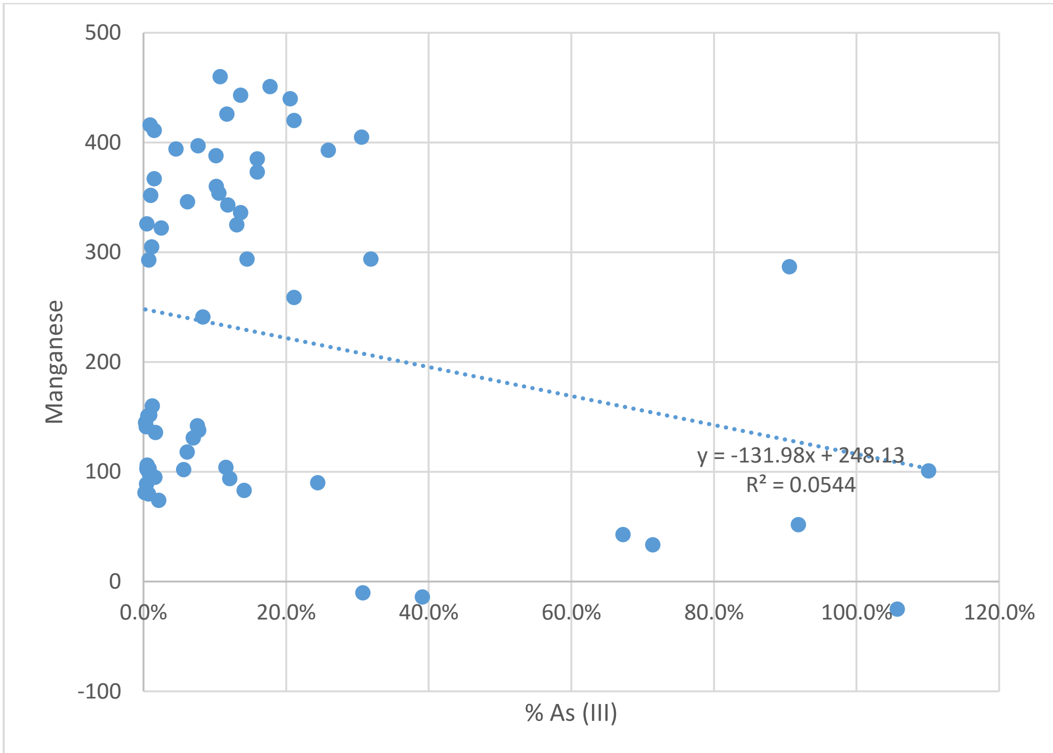
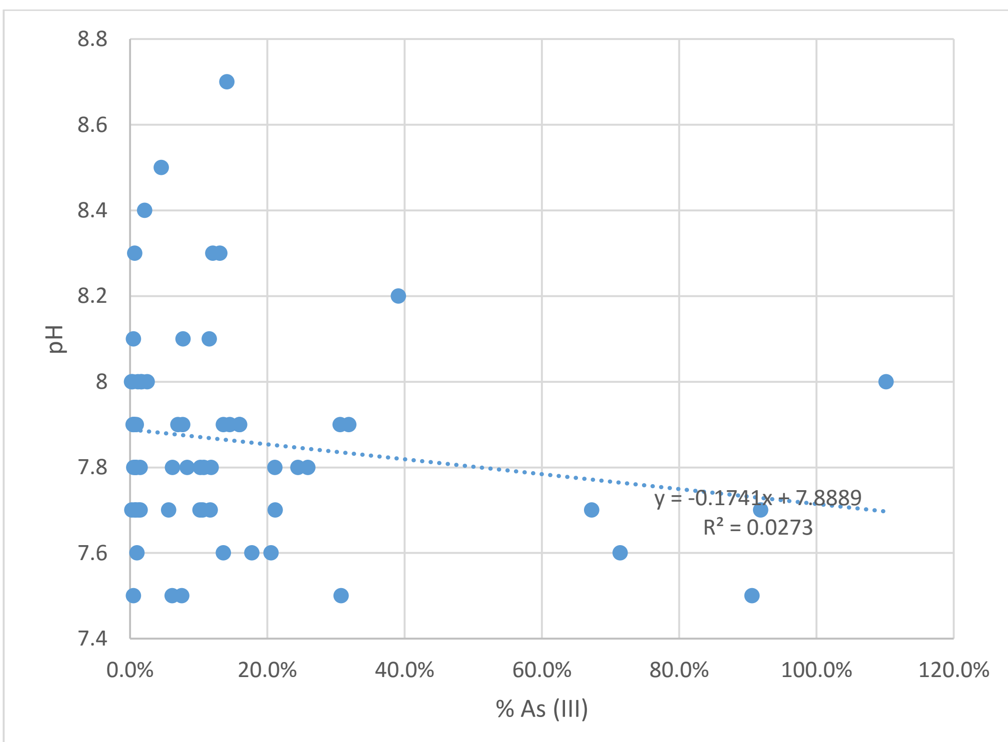


Figure 31: Relationship Between pH and %As (III)



Discussion

Participant Recruitment

Of the 200 homes identified from Hopewell Township Health Department's data base, 54 replied to the postcard or email and 47 (27%) were recruited into the study. An unexpected response occurred from friends and neighbors of the 47 recruited individuals as they posted about the study on social media sites and online neighborhood pages, and shared in person with friends and neighbors. Because of this social networking, an additional 72 homeowners reached out and asked to be included in the study. This suggests there is value in word-of-mouth information dissemination and a potential intervention avenue exists in neighborhood social media sites. Future research and outreach may need to look at alternative and non-traditional participant recruitment methods.

All participants were notified by email of their water test results. Each participant received a detailed explanation of their water and treatment system. As a public health action, the participants were told what specific steps they should take to ensure arsenic-free drinking water. Links to helpful websites as well as interest free water treatment financing information was also provided. *Appendix L* contains a sample results letter sent to homeowners. As a public health action for homeowners that did not meet the eligibility requirements for this study, a detailed email was sent to instruct them how to test their water. The study staff also offered to help interpret their results when they received them back from the lab. The response to this was positive and many homeowners indicated their intent to follow-up.

Arsenic Treatment Systems: Status and Maintenance Proposal

Status of Treatment Systems in Hopewell Township

Of the 65 homes recruited into the study, 55 (84.6%) had a dual tank point-of-entry arsenic treatment system. Even with the Hopewell ordinance and a post installation inspection, only 27 of the 65 homes (41.5%) had a complete system without any missing parts. Most commonly missing were sediment filters and water meters which were present in 69.2% of the homes. Some homes were missing a sampling tap between the arsenic tanks which prevents the homeowner from knowing when to change the tanks.

It is unclear what specifically caused these systems to have missing parts. Based on anecdotal evidence from homeowners, it is likely due to a combination of problems. These may include, the previous homeowner tasked with installing a system during their home sale and treatment installers and homeowners unaware of the existence or purpose of current regulations. 58.3% of homeowners reported that their arsenic system was installed by the previous homeowner. *Figure 8* shows that a complete system with all required parts was installed 39.5% of the time for previous homeowners and 47.6% of the time for current homeowners. Often, the buyer of the home did not have input into the type of system installed. To remedy this, real estate lawyers can stress the importance of the buyer choosing an appropriate system and making sure all required components are installed. Treatment system installers should have a treatment system guidance that includes a checklist of required components. As a final check, inspectors should carefully verify that the system meets the ordinance requirements.

Irrespective of the problems with many of the systems meeting the strict ordinance requirements, there is still a significant reduction in arsenic concentrations due to the regulation and presence of the systems. In the 55 homes with dual tank POET systems, 80% exceeded the MCL in the raw water. The raw water concentrations ranged from 2.6 – 41.6 µg/L with an average concentration of 11.29 µg/L. The proportion of homes exceeding the standard dropped significantly after the first arsenic treatment tank to 24.5%. Hopewell's unique ordinance which requires a safety tank dropped the proportion of homes exceeding the standard at the kitchen sink down to 7.3%. The average concentration at the kitchen sink was 1.08 µg/L and ranged between non-detect and 12.80 µg/L. This is a highly effective ordinance with a significant reduction in arsenic exposure. Because of the success in reducing exposure in Hopewell Township, adopting a similar ordinance in towns with arsenic contamination would further promote and protect public health.

Arsenic Treatment Systems: Factors that Affect Testing and Maintenance

In this study, treatment system maintainers were defined as homeowners who were yearly testers and had replaced their arsenic tanks if needed based on their last water test. It was hypothesized that regular maintenance of arsenic treatment systems increases efficacy and lowers risk of arsenic exposure. For maintainers, the proportion of homes that exceeded the MCL for arsenic dropped from 80% in raw water to 15% after the first arsenic tank and 0% after the second arsenic tank, at the kitchen sink. The results indicate that being a maintainer is the most protective health and results in the lowest likelihood of arsenic exposure at the kitchen sink. The constructs of the Health Belief Model appeared to influence maintenance behavior. Homeowners who have high cues to action, perceived susceptibility, severity and benefits and low perceived barriers are most likely to maintain their treatment system.

It was hypothesized that owners who have a high level of arsenic knowledge are more likely to maintain their treatment system. Based on the arsenic knowledge assessment in this study, there was only a slight increase in arsenic knowledge score for maintainers when compared to non-maintainers. This implies that arsenic knowledge alone is not enough for homeowners to maintain their system and that other factors influence this behavior.

Rely Mechanical and Stover's Wells and Pumps were the two most commonly used treatment system maintainers reported by the study population. There was a statistically significant association between being a Stover's or Rely customer and being a maintainer. It is likely that this association is significant because Rely and Stover's offer testing and maintenance programs. These programs did have some limitations. Because many previous homeowners installed the treatment systems, the testing company was not notified of the new homeowner's name. This lead to the new homeowner being unaware of the program and never receiving the testing kit. Addressing the testing kit to "Current Resident" may help make the new homeowners aware of the program and increase the likelihood of participation. As a public health action, in homes that were eligible, the study staff contacted the testing program and alerted them of the new owner's name.

Though not enforced, a maintenance contract is required by Hopewell Township Health Department. Because a testing and maintenance contract is beneficial to both homeowners and businesses, other treatment system maintainers should be made aware of this option. It would also be beneficial for the testing company to allow other homeowners to purchase a contract.

Of the 55 participants with POET systems, 47.2% were classified as yearly testers. Yearly testers were younger and had a higher tax assessed home value than non-yearly testers. This association was significant. There was also a significant association between yearly tester and raw arsenic level. Yearly testers had a significantly higher self-efficacy score and were more likely to say they were committed to decreasing arsenic exposure, they knew who to contact to test and treat their water and more confident that they would remember to regularly test their water. Though not significant, yearly testers had a slightly higher perceived severity, perceived benefits and cues to action scores. For yearly testers, the proportion of homes that exceeded the MCL for arsenic dropped from 78.2% in raw water to 26.1% after the first arsenic tank and 0% after the second arsenic tank, at the kitchen sink.

Semi-regular water testers, homeowners who had tested in the past two years were also compared to homeowners whose last arsenic test was over two years ago. A statistically significant association was observed between having tested in the past two years and age and having younger and a greater number of children. Though not significant, semi-regular testers had higher scores in each of the Health Belief Model constructs. For every 2 year testers, the proportion of homes that exceeded the MCL for arsenic dropped from 76.5% in raw water to 29.4% after the first arsenic tank and 5.9% after the second arsenic tank, at the kitchen sink. These results indicate that yearly testing is more protective of health than testing every two years.

Arsenic Treatment Media-Breakthrough: Proposed Solution

It was hypothesized that arsenic treatment media is breaking through the arsenic system potentially leading to acute exposures to high levels of arsenic. After analyzing samples from each participant’s toilet tank and faucet screen, it was determined that some kind of treatment media-breakthrough is occurring in 72.1% of all homes sampled. The most common treatment media-breakthrough was Adedge (76.5% of homes sampled). The second most common media-breakthrough was Metsorb, which was observed in 61.1% of homes. Because Solmetex and Resin Tech treatment media were indistinguishable from softener beads under the microscope, some uncertainty exists for these media-breakthrough calculations. Solmetex was measured with certainty to have media-breakthrough in at least 33.3% of homes (homes without softeners) but could be as high as 57.9%. Resin Tech had media-breakthrough in at least 33.3% of homes but could be as high as 50%. Because these treatment media have a high affinity for arsenic, we can guess that ingesting treatment media would deliver an acute dose of arsenic in a human. The exact capacity of these beads is unknown and beyond the scope of this project. Future research is needed to determine the concentration of arsenic and the toxicokinetics (absorption, distribution, metabolism and excretion) of the arsenic laced media in humans. In the interim, to protect the health of treatment system owners, a 5-micron sediment filter should be installed after the arsenic tanks. Future studies should examine if this filter is small enough to remove the smallest media fragments. A potential limitation of this study is that the collection method (in a coffee filter) and analysis (through a 64x light microscope) did not allow for the smallest pieces of media to be measured. Additional studies could measure the smallest size that each type of media could break down into to ensure the post-treatment sediment filter is small enough to catch them.

Arsenic Exposure and Cancer Risk Reduction from Dual Tank Point-of-Entry Arsenic Treatment Systems

Based on arsenic concentrations and average water consumption, the arsenic exposure and risk reduction for homes with treatment systems was calculated. The average homeowner drank 624.9 L of water and beverages made with tap water per year. The average exposure to arsenic prevented by dual tank POET systems was 23,481.6 µg or 23.5 mg. Assuming that all homeowners maintain their systems and how long they intend to live in their current home, an estimated 78.7 mg future arsenic exposure will be prevented. It is important to note that these calculations are for only one person in the home. Homes in this study had an average of 3.8 residents and ranged between 1 and 6. This results in an underestimation of the protection the arsenic treatment systems are providing.

The lifetime excess cancer risk due to arsenic exposure was estimated using lifetime average daily exposure (LADE) and the IRIS proposed arsenic cancer slope factor (CSF). The cancer risk from arsenic from drinking water without a treatment system was estimated to be 7 in 1000. The cancer risk drops to 2.3 in 1000 with the addition of one arsenic tank and again to 0.9 in 1000 with two arsenic tanks. Based on the technology and testing available, a risk of 3 in 100,000 is achievable. All of these risks are relatively high when compared to the public health acceptable risk of 1 in 1,000,000. To achieve this risk, the arsenic concentration would need to be reduced to 1.6 parts-per-trillion (ppt). When applying these risks to the Hopewell Township population of 17,304, 121.3 excess lifetime bladder and lung cancer cases would be caused by drinking untreated (raw) water, 39.7 from having only one arsenic tank, 15.8 from two arsenic tanks and less than 1 from having a functioning POET with non-detect arsenic levels at the kitchen sink. Hopewell Township's ordinance requiring two arsenic tanks has the potential to prevent 105-121 excess cancer cases. Because the risk of cancer from arsenic is so high and reduction is achievable, in the interest of public health, this ordinance should be adopted by more towns in New Jersey.

Where could public health interventions be targeted?

To improve the health of residents, multi-pronged public health interventions should target different aspects of water treatment. Because many homeowners get their water treatment advice from their system installers and maintainers, these professionals should be trained in appropriate water treatment system design. This could take the form of a licensing or certification exam or course. Having As (III) in the water is a major issue that treatment system installers need to be equipped to handle. Installers can be taught to diagnose the water based on the presence of iron and manganese and how to proceed if As (III) is detected. Because As (III) is not removed by some treatment systems and shortens the life-expectancy of others, installers should be educated on pre-treatment methods. Current studies at New Jersey Geological and Water Survey are looking into the best pre-treatment for the conversion of As (III) to As (V).

Many participants in this study expressed that they do not know who to turn to for water treatment advice and facts. Treatment installers should hang an informational brochure (*Appendix M*) on the treatment system for homeowners to refer to if they have questions. This brochure includes frequently asked questions that were developed in collaboration with the NJ Geological and Water Survey and Columbia University. The issue of remembering to test was common among participants. Potential solutions include setting a recurring event in their cell phone, testing yearly on a memorable day or participating in a maintenance program that sends yearly reminders. A common problem for homeowners is not knowing where to take a water sample. To remedy this, treatment system installers could be trained to attach labels (as shown in *Appendix M*) to each sampling port and treatment tank.

When purchasing a home, buyers should insist on choosing their own water treatment system. Many participants in this study successfully negotiated money off the selling price to pay for a quality water treatment system. This would reduce the risk of sellers installing a cheaper and lower quality system.

Strengths and Limitations

This study has a number of limitations. A participation bias may exist as the study participants who were recruited through the postcard and through word of mouth may, in some way, different than those who did not respond to the recruitment postcard and emails. Some of the homeowners interviewed were not the water treatment decision makers. Their views, especially in the Health Belief Model constructs, could differ from the water treatment decision maker. The population in this study is extremely well-educated with almost the entire study population having a bachelor's or advanced graduate degree. This may limit the generalizability to the rest of the New Jersey population. This study relied on the recall of participants to determine their daily exposure to arsenic. An effort was made to reduce the under or over estimation of water consumption by showing them a 20 oz glass.

There are a number of strengths that made this a unique study opportunity. Hopewell Township is the only town in the United States with an ordinance that requires a dual tank point-of-entry arsenic treatment system for homes that exceeded the NJ MCL on a PWTA water test. Because this requirement has been in place for a number of years, the unique opportunity to understand the status of the treatment systems a few years after installation arose. Because of this ordinance, a generous sample size of 65, all within the same town was possible.

Conclusion

The purpose of this study was to determine the status of existing arsenic treatment systems and how maintenance affects their efficacy. Of the 55 homes with dual tank arsenic treatment systems only four homes exceeded the MCL at the kitchen sink. In other words, 92.7% of homes with treatment systems, regardless of age and maintenance schedule adherence had acceptable arsenic levels under the current New Jersey standard. This speaks to the efficacy of the Hopewell Township ordinance in promoting public health and reducing the risk of contaminated drinking water.

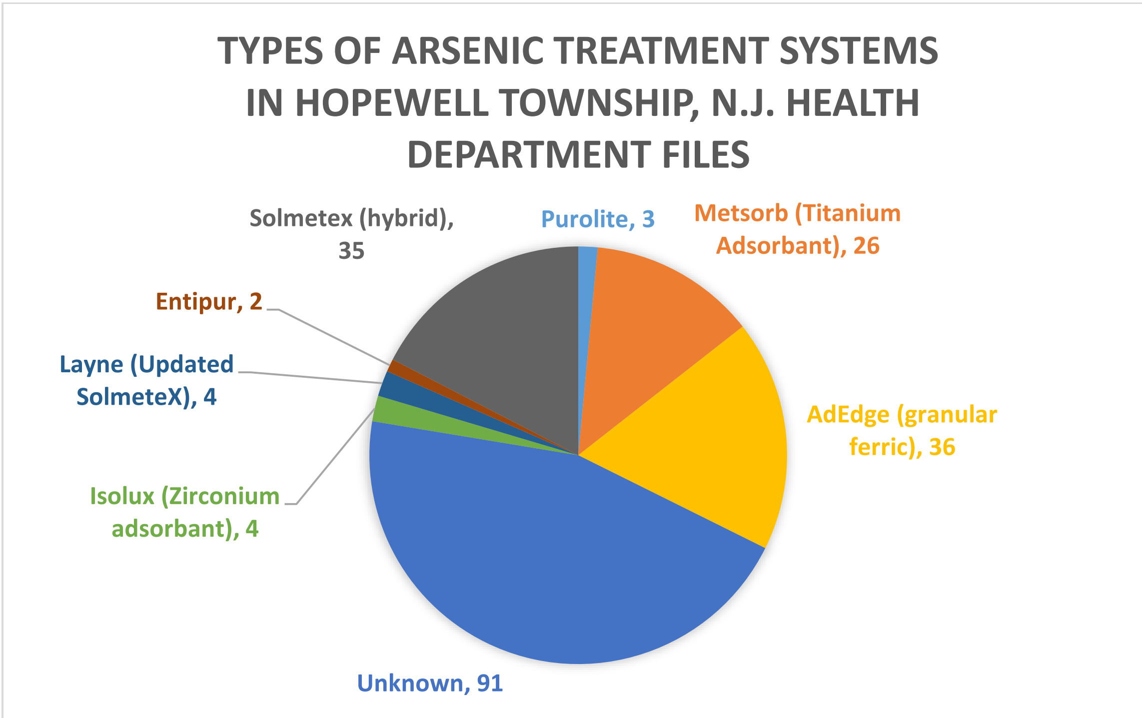
Though extremely effective, there is room for improvement. This study identified a potential health hazard as arsenic treatment media is breaking through the system and entering the home's water supply. This could potentially lead to acute doses of arsenic. A solution was proposed in this text, to install a 5-micron post-treatment sediment filter. It is imperative that further research is done to ensure this solution mitigates the problem completely.

This study also sought to identify the behaviors and beliefs of homeowners regarding testing and treating their water. Maintainers, homeowners who test their water yearly and replace their arsenic tanks when needed were found to be the group with the lowest risk of arsenic exposure. These homeowners had high cues to action, perceived susceptibility, severity and benefits and low perceived barriers. They were also younger, had a higher tax assessed home values and were more likely to be a customer of an installer with a testing or maintenance program. These findings may point to the value of having a maintenance contract and a knowledgeable treatment installer.

Additionally, this study aimed to determine the risk reduction provided by treatment systems. Hopewell Township's ordinance is estimated to prevent 105 excess bladder and lung cancers due to the arsenic exposure reduction of whole house, dual tank arsenic treatment systems. Based on the average water consumption and arsenic concentrations at the kitchen sink, the lifetime risk of bladder and lung cancer from exposure to arsenic was estimated to be 0.9 in 1000. It is reasonable to set a goal of 3 in 100,000 by achieving non-detect levels of arsenic at every home's kitchen sink. This goal can be achieved through appropriately disseminating this information to homeowners and treatment system installers. Because the risk of cancer from arsenic is so high without treatment and risk reduction is achievable, in the interest of public health, this ordinance should be adopted by more towns in New Jersey and an effort should be made to increase the number of homeowners who test yearly and maintain their treatment systems.

Appendices

Appendix A: Arsenic Treatment Systems Found in Hopewell, N.J.



Appendix B: Postcard Mailed to Hopewell Residents

RUTGERS
School of Public Health

Are you a homeowner in Hopewell Township, New Jersey with an arsenic treatment system?

If so, you may be eligible to participate in a research study.

RUTGERS APPROVED
THE STATE UNIVERSITY
IRB ID: Pro20140000535
Approval Date: 12/31/2014
Expiration Date: 12/30/2015

over

We are looking to talk with homeowners who have arsenic treatment systems about their thoughts and experiences with maintaining the system. If eligible, you will be asked to participate in a 20 minute survey and 40 minute well water test. This study is being led by Megan Rockafellow, MPH, PhD student at Rutgers. **<u>Participants will receive a free well test for their time.</u>**

For more information and to sign up, email us your name and phone number to: **megrock@sph.rutgers.edu** . You will receive a follow up phone call from our study staff within the next few weeks. Thank you in advance for your participation!

RUTGERS
School of Public Health

<u>Megan F. Rockafellow, MPH, PhD(c)</u>
Rutgers SPH, 3rd Floor
683 Hoes Lane West
Piscataway, New Jersey 08854
Phone: 845-926-7792

PLEASE
PLACE
STAMP
HERE

RUTGERS APPROVED
THE STATE UNIVERSITY OF NEW JERSEY
IRB ID: Pro20140000535
Approval Date: 12/31/2014
Expiration Date: 12/30/2015

Appendix C: Phone, Email and Answering Machine Scripts

Sample Email

Hello, my name is Megan Rockafellow and I am a doctoral student at Rutgers School of Public Health. I am partnering with New Jersey Geological and Water Survey and Hopewell Township Health Department to research arsenic in Hopewell Township and would like to invite you to participate.

By participating in this study you will receive a free water test. Participation in this research includes taking a survey about your behavior and beliefs toward arsenic and a general health history which will take approximately 15-20 minutes. If you agree to participate, we can set up a day and time that is convenient for you for a home visit. Individual test results will be kept confidential and shared only with you. Additionally, we may make recommendations to you based on your water test results in order to protect your family's health.

Feel free to contact me by phone or email or Hopewell Township Health Department if you should have any questions. Looking forward to hearing back from you.

Kind Regards, Megan Rockafellow

Sample Phone Script

Hello, my name is Megan Rockafellow and I am a PhD student at Rutgers School of Public Health.

I am partnering with NJ Geological and Water Survey and Hopewell Township Health Department to research arsenic in Hopewell Township and would like to invite you to participate in the study.

I identified that your household has an arsenic treatment system and would like to offer you a free water test. I'd like to schedule a home visit to test your water and complete a short survey. Would there be a day and time convenient for you?

Sample Answering Machine Script

Hello, my name is Megan Rockafellow and I am a PhD student at Rutgers School of Public Health.

I am conducting a research study on arsenic in well water and would like to invite you to participate and receive a free water test. Please call me at 845-926-7792 or email megrock@rutgers.edu to schedule a day that works for you. Thank you.

Appendix D: Survey

HOPEWELL TOWNSHIP WATER TESTING SURVEY

Informed Consent

Thank you for your participation in our survey which seeks to understand the attitudes, behaviors and beliefs of Hopewell Township residents toward arsenic and well water testing.

This survey should take about 20 minutes to complete.

Your participation is voluntary and individual answers will be kept confidential. If you feel uncomfortable answering any questions you may skip them.

If you have concerns or questions about this study, please contact Megan Rockafellow at megrock@sph.rutgers.edu, Robert English at Hopewell Township Health Department or Steve Spayd at New Jersey Geological Survey.

Thank you for your participation.

I am at least 21 years of age, have read and understand the explanation provided to me and voluntarily agree to participate in this study.

Printed Name ________________________________

Signature _______________________________ Date __________________________________

RUTGERS
School of Public Health

Interviewer Note: Please indicate the participant's response by filling in the blanks or marking the appropriate box.

Demographics

1. In what year were you born? ___________
2. What is your gender
    - ☐ Male
    - ☐ Female
    - ☐ Prefer not to respond
3. What is the highest level of formal education that you have completed?
    - ☐ Some high school
    - ☐ High School
    - ☐ Some College
    - ☐ Associates (2 year degree)
    - ☐ Bachelor's degree (4 year degree)
    - ☐ Some graduate school
    - ☐ Graduate degree
    - ☐ Prefer not to respond
4. How many ADULTS (aged 21 years or older, including yourself) currently live in your home? _________
5. How many CHILDREN/YOUTH (aged 20 years or younger) currently live in your home? _________
6. Has anyone in the home been pregnant in the last year? ________________
7. If there are children in your home what is the age of the youngest child? ___________
8. Do you smoke?
    - ☐ Yes
    - ☐ No
    - ☐ Prefer not to respond
9. Does anyone in your household smoke?
    - ☐ Yes If yes, who? ______________
    - ☐ No
    - ☐ Prefer not to respond
10. What year did you move into your current home? ______________
11. Which of the following best describes your residence:
    - ☐ I own
    - ☐ I rent
    - ☐ Vacation or seasonal home (How many months per year ________________)
    - ☐ Business only
    - ☐ Prefer not to respond

Health History

12. Have there been any significant health issues in your family?
    ____
13. Have there been any cancers in your family members who live in this household?
    ____
    Type
    ____

Exposure Assessment

14. What year did you move to this house? ____________________
15. How long do you intend on living in your current home? __________________
16. How often do you use your home tap water for drinking water?
    - ☐ Always
    - ☐ Sometimes
    - ☐ Rarely
    - ☐ Never
17. About how much water do you consume per day from your home tap (oz)
    ____

18. How often do you use your tap water for cooking?
    - ☐ Daily
    - ☐ A few times per week
    - ☐ Occasionally
    - ☐ Never
19. How often do you consume beverages made with tap water (e.g. coffee, iced tea, lemonade)?

    [Interviewer note: Based on the response given, ask participant to estimate the amount]

    - ☐ Daily
        - ➢Estimate how many cups (8 oz) you drink daily ___________
    - ☐ A few times per week
        - ➢Estimate how many cups (8 oz) you drink daily ___________
    - ☐ Occasionally
        - ➢Estimate how many cups (8 oz) you drink in a month ___________
    - ☐ Never

Thoughts about Well Water

20. Please tell us how much you agree or disagree with the following statements about your well water. For each statement please indicate whether you strongly disagree, disagree, neither agree nor disagree, agree or strongly agree.

Interviewer Note: Please circle the participant's response.

	Strongly Disagree	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
Households in Hopewell Township often have arsenic contaminated well water.	1	2	3	4	5
Arsenic contaminated water is a major problem for our household.	1	2	3	4	5
Our well arsenic level can change over time.	1	2	3	4	5
Our well arsenic level (untreated water) decreases our property value.	1	2	3	4	5
I feel worried about our arsenic level.	1	2	3	4	5
Arsenic exposure is a risk factor for cancer.	1	2	3	4	5
Arsenic exposure causes strokes.	1	2	3	4	5
Arsenic exposure causes neurological problems.	1	2	3	4	5
Adverse health effects from arsenic are only seen at extremely high levels, not found in water.	1	2	3	4	5
The health risks from arsenic are overstated.	1	2	3	4	5
Reducing arsenic in our drinking water would increase the value of our home.	1	2	3	4	5
Reducing arsenic in our drinking water is protective of my family's health.	1	2	3	4	5
Maintaining my treatment system increases the value of my home.	1	2	3	4	5
Our household is at risk for drinking arsenic contaminated water.	1	2	3	4	5
It is expensive to decrease arsenic exposure.	1	2	3	4	5
There is nothing I can do to about the arsenic level in my water.	1	2	3	4	5

I believe some of my neighbors treat their well water.	1	2	3	4	5
I am committed to decreasing my family's exposure to arsenic.	1	2	3	4	5
I know who to contact to test and treat my water.	1	2	3	4	5
I am confident that I will remember to regularly test my water.	1	2	3	4	5

Arsenic Knowledge

21. What is the highest arsenic level that you would consider safe?
    - ☐ No level is safe
    - ☐ 5 ppb or less
    - ☐ 5 - 10 ppb
    - ☐ 10 and 50 ppb
    - ☐ 50 and 100 ppb
    - ☐ Greater than 100 ppb

*ppb = parts per billion

Your actions and preferences

22. When was your treatment system installed?
    ____
23. Who paid for your current arsenic treatment system?
    - ☐ Previous homeowner
    - ☐ Current homeowner
    - ☐ NJ Spill fund
    - ☐ Other source _____________________________
24. How often do you have your well water tested?
    ____
25. Where do you usually test your water? (Check all that apply)
    - ☐ Kitchen Sink
    - ☐ Raw Water
    - ☐ Between the Arsenic Tanks
    - ☐ Other ______________
26. When was the last time your water has been tested for arsenic?
    ____
27. Do you have the test results available?
    ____
28. Which of the following would prompt you to have your well water tested? (Check all that apply)
    - ☐ Change in taste, smell, or appearance of water
    - ☐ Learning that neighbors are treating their water
    - ☐ Results of a water test that indicate unsafe levels of contaminants

- ☐ A state or local requirement for water treatment
- ☐ A new baby or child in the home
- ☐ Other

29. **Would you take any of the following actions if your treated well water was found to be above 5ppb for arsenic?** For each statement please indicate whether you strongly disagree, disagree, neither agree nor disagree, agree or strongly agree.

Interviewer Note: Please circle the participant's response.

I would:

	Strongly Disagree	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
Take no action	1	2	3	4	5
Boil water before use	1	2	3	4	5
Start or increase use of bottled water	1	2	3	4	5
Start or increase use of filtration pitcher (e.g. Brita)	1	2	3	4	5
Call for service of my existing arsenic treatment system	1	2	3	4	5
Install a new whole house treatment system	1	2	3	4	5
Drill another well	1	2	3	4	5

Appendix E: Categorization of Survey Questions

Categorization of Survey Questions

Demographics	• In what year were you born? • What is your gender • What is the highest level of formal education that you have completed? • How many ADULTS (aged 21 years or older, including yourself) currently live in your home? • How many CHILDREN/YOUTH (aged 20 years or younger) currently live in your home? • If there are children in your home what is the age of the youngest child? • Which of the following best describes your residence
Health History	• Do you smoke? • Does anyone in your household smoke? • Has anyone in the home been pregnant in the last year? • Have there been any significant health issues in your family? • Have there been any cancers in your family members who live in this household?
Exposure Assessment	• What year did you move to this house? • How long do you intend on living in your current home? • How often do you use your home tap water for drinking water? • About how much water do you consume per day from your home tap (oz) • How often do you use your tap water for cooking? • How often do you consume beverages made with tap water (e.g. coffee, iced tea, lemonade) [Interviewer note: Based on the response given, ask participant to estimate the amount]
Treatment System History	• When was your arsenic treatment system installed? • What company installed your treatment system? • Who paid for your current arsenic treatment system? • How often do you have your well water tested? • Where do you usually test your water? (Check all that apply) • When was the last time your water has been tested for arsenic? • Do you have the test results available?
Health Belief Model	
Perceived Susceptibility	• Households in Hopewell Township often have arsenic contaminated well water. • Arsenic contaminated water is a major problem for our household

One's evaluation of chances of getting a condition	• Our well arsenic level can change over time. • Our well arsenic level (untreated water) decreases our property value. • I feel worried about our arsenic level.
Perceived Severity **One's evaluation of how serious a condition, its treatment, and its consequences would be**	• Arsenic exposure is a risk factor for cancer. • Arsenic exposure causes strokes (internal validity?) • Arsenic exposure neurological problems. • Adverse health effects from arsenic are only seen at extremely high levels, not found in water (validity?) • The health risks from arsenic are overstated. • What is the highest arsenic level that you would consider safe?
Perceived Benefits **One's evaluation of how well an advised action will reduce risk or moderate the impact of the condition**	• Reducing arsenic in our drinking water would increase the value of our home. • Reducing arsenic in our drinking water is protective of my family's health. • Maintaining my treatment system increases the value of my home.
Perceived Barriers **One's evaluation of how difficult an advised action will be or how much it will cost, both psychologically and otherwise**	• Our household is at risk for drinking arsenic contaminated water. • It is expensive to decrease arsenic exposure. • There is nothing I can do to about the arsenic level in my water.
Cues to Action **Events or strategies that increase one's motivation**	• I believe some of my neighbors treat their well water. • Which of the following would prompt you to have your well water tested? (Check all that apply) • Would you take any of the following actions if your treated well water was found to be above 5ppb for arsenic?
Self-efficacy **Confidence in one's ability to take action**	• I am committed to decreasing my family's exposure to arsenic. • I know who to contact to test and treat my water. • I am confident that I will remember to regularly test my water.

Appendix F: Protocol for Home Visits

Protocol for Home Visits

<u>Materials</u>

1. (3-4) empty water sample bottles from NJ Analytical Laboratories
2. Paper towels
3. Sharpie Marker
4. In Situ 9500 probe
5. 5-gallon bucket
6. Small 20 oz cup
7. Pool test strips
8. Sample Ziploc bag
9. Kimwipes
10. Pliers with rubber nose
11. Coffee filters
12. Turkey Baster
13. Arsenic speciation cartridge
14. MicroR Meter
15. Camera
16. Flashlight

<u>Methods</u>

1. Read the survey questions aloud as the homeowner follows along on a paper copy of the survey. Record the answers on a separate survey. Hold all questions until the end of the survey to prevent bias
2. Turn two cold water taps on and run the water for 10 minutes
3. During this time set up the sample instruments
4. Take MicroR readings of each of the tanks
5. Take a photograph of the treatment system
6. Water Tests:
    a. <u>Raw Water</u>
        i. In-situ 9500: record temperature, pH, redox potential, dissolved solids and dissolved oxygen
        ii. Pool test strips: record pH, hardness, chlorine, and alkalinity
        iii. Label and fill sample bottle
        iv. Perform arsenic speciation
            1. Rinse out a 30 ml syringe
            2. Draw 30 ml of raw water into the syringe and attach the speciation cartridge
            3. Expel the first 5ml into a waste bucket
            4. Expel the remaining 25ml into a sample container at a rate of 1ml per second
            5. Remove the cartridge and draw 30 ml of raw water, attach cartridge and expel 30 ml of water at a rate of 1ml per second into the sample container. Repeat once more.
            6. Discard speciation cartridge after use

b. <u>Middle Sampling Port</u>
    i. Pool test strips: record pH, hardness, chlorine, and alkalinity
    ii. Label and fill sample bottle
c. <u>Kitchen Tap</u>
    i. Pool test strips: record pH, hardness, chlorine, and alkalinity
    ii. Label and fill sample bottle
d. <u>Reverse Osmosis (if applicable)</u>
    i. Pool test strips: record pH, hardness, chlorine, and alkalinity
    ii. Label and fill sample bottle

7. Sample Collections:
    a. Toilet Tank
        i. Shut off water to the toilet
        ii. Flush toilet to remove water from the tank
        iii. Remove any excess water with turkey baster or pipette
        iv. Expel water into a coffee filter to collect the particles
        v. Place coffee filter in a Ziploc bag and label bag with home identification number
        vi. Let the filter dry
        vii. Analyze particles under light microscopy
    b. Faucet Screen
        i. Remove outer casing using duct tape covered pliers
        ii. Scrape off filter screen into a coffee filter and place the filter in a Ziploc bag
        iii. Label the bag with the home identification number
        iv. Let the filter dry
        v. Analyze under light microscopy

Data Sheet for Home Visits

House Identification Number:			Date:	
		Raw Water	Between Tanks	Kitchen Tap
Field Probe (In-Situ 9500)	Temp			
	pH			
	ORP			
	Dis. Solids			
	Dis. Oxygen			
Pool Test Strips	pH			
	Hardness			
	Chlorine			
	Alkalinity			
Lab	Arsenic			
	Arsenic Species			
	Iron*			
	Manganese*			
				**If funding allows*

Appendix G: Email Response for Homeowners Who Do Not Meet Inclusion Criteria

Thanks again for your interest in the study. Because you do not have an arsenic water treatment system, my protocol does not allow me to include you in the current study. I still strongly encourage you to have your water tested for arsenic which is the most commonly found well water contaminant in the Hopewell Township area.

I cannot recommend any specific water testing labs, but you may consider NJ Analytical which is close by on Scotch Road. If you call them, you can ask for just an arsenic test. You don't have to purchase the packages listed on their website. If you ask them to come to your house to test the water, it will be around $140. If you go yourself to pick up the bottle, fill it and bring it back, you will save money and it only costs around $40.

I’m available to help interpret your water test results and to provide water treatment advice. Feel free to email me when you get your arsenic water test results and I'll try to help in any way that I can. Below are some additional links to help you out.

Best Regards, Megan Rockafellow

NJ Analytical Lab: https://www.njal.com/Residential-Water-Testing/Order-Water-Test.aspx

New Jersey Arsenic Awareness: http://njarsenic.superfund.ciesin.columbia.edu/

http://www.nj.gov/dep/pwta/Arsenic_Treatment.pdf

Appendix H: Selected Responses from Neighbors

- 2/16/15: We live on [removed] and have a private well. One of our neighbors told us you were providing free Arsenic testing. Can we participate in program?
- 4/3/15: Good Afternoon—I heard about your Rutgers study on arsenic treatment systems from a neighbor in our Hopewell Township, per her posting below on our neighborhood website. We would be interested to be one of your 100 participants. Please let me know about the details. You can email me back at this [removed], or you can call me in the evenings at home at [removed]. Thanks very much, and I will look forward to hearing from you. Fwd: Wanted to spread the word about Rutgers University School of Public Health conducting a study about arsenic treatment systems in Hopewell Township homes. Megan Rockafellow, PhD Candidate and her Professor were at our house this week. The meeting was very informative, educational and there is a free water test involved. Also the arsenic test they run is a bit more comprehensive then the standard well water test. The whole process took about 1 hour, but I ask a ton of questions. Our family has nothing to personally gain from the study. I just wanted to spread the news. She needs 100 participants for the study. She currently has about 46 enrolled. If you have any questions you can contact her
- 4/3/15: Megan, My name is [name] One of our neighbors, [name], posted a note about the study that you are conducting. I'd be very interested in participating. We have a water filtration system, but I do not believe that it filters for arsenic. I've been intending since we moved into our house in July to get a system installed, but I just haven't gotten educated sufficiently. I don't know is this is a deal breaker or not. Please let me know if you have an interest in connecting to discuss. Also, [name] described the time at her house as being very informative because she asked a lot of questions. I was thinking

that we could always gather a number of our neighbors together at the same time, so that you didn't have to repeat the education process. If that would be helpful, I'm happy to have you use our house for that purpose. I live in [removed]. Thanks, [name]

- 4/3/15: Hi --I live in [removed] in Hopewell Township. Recently, a neighbor of mine posted an announcement about your study on our neighborhood website. I would be very interested in participating in your study. We live at [removed]. Please feel free to contact me via email (best) or phone [removed]. I teach during the day, but I would be more than happy to meet with you in the evening or on a weekend.
- 4/3/15: Dear Megan: This I something that interests me. I have lived in [identifying information removed] for 12 years and, of course, have a well. Please let me know if you would be interested in having me participate. [identifying information removed] If you are interested, please contact me via email at this address. Thanks – and best of luck with the Doctorate!
- 4/4/15: Hi Megan, We live in Hopewell Township and recently learned of the arsenic study from our neighbor [name]. We would be interested in participating if you still need volunteers. We do not have an arsenic treatment system if that is one of the prerequisites. Our well water has never been tested for arsenic. Thank you.
- 4/5/15: Hi Ms. Rockafellow. [name] spread the word (in our Nextdoor network) about your research into arsenic treatment systems in Hopewell Township homes. If you are still seeking participants, we are willing to contribute, although we do not currently have an arsenic treatment system in place. Regards, [name]
- 5/16/15: Hi, If you still have openings, we would love to participate in your water study. We live on [removed] Rd in the township near the high school. Thank-you, [name]

- 5/16/15: Hi Megan, If you still need additional homes in Hopewell Township to test for arsenic, you are free to test ours. We live at [identifying information removed] Let me know!
- 5/16/15: Hi Megan, You were at my neighbors' house [name removed] last Thursday. I was not available to talk to you then as I had to pick a child up from school, but [name] told me that you still need more houses to test. [identifying information removed]. Thank you. [name]
- 5/16/15: Hi meg, I would be very interested in being part of your arsenic research project. We have a farm sand have been herbicide pesticide free for years. Also have a 4-year-old living with us so should be aware of this. Contact me.
- 5/16/15: Megan, I just read [name]’s post on Facebook re: your research on arsenic. We recently moved out of Hopewell Borough to the Township and just learned that our neighbors (across the street) have arsenic in their water, but we do not. Since learning of this (and having 2 small children) I am very concerned about our water. I would absolutely love to have you come to our house to test our water and I hope you can teach me about our well water and more. Please let me know your availability.
- 5/18/15: Hi Megan, I got your contact info from [name]'s Facebook post. We live in Hopewell and have an arsenic treatment system in our basement to help mitigate arsenic in our well water. I would love to be part of your study and learn more about our water/system. We are especially concerned since we are in need of replacing one of the tanks and would love to be more informed before proceeding with such a costly replacement. Looking forward to hearing from you! Best, [name]

- 5/18/15: Hi Meg, My wife forwarded to me a Facebook posting by [name]. We would be happy to participate in your study of arsenic in groundwater. We had our well tested when we first bought the house in 1998 and arsenic was detected at 3 micrograms per liter (if memory serves). I've not tested it since. [identifying information removed] knowing the importance and difficulty of collecting good data, we'd be glad to participate fully in your study. Best regards [name]
- 5/18/15: Hello, A fellow Hopewell Township resident mentioned that you are performing research and testing well water in Hopewell Township. I live in Hopewell Township and would be happy to participate and help in any way I can. Please let me know if you are interested. Thanks! [name]

Appendix I: Home Visit Notes

As2015-001 - Thursday, 1/29/2015 (Megan, Steve S.)

- **Metsorb media** was replaced on 1/2/2015 by [Treatment Installer], he charged $1108.
- Original installation of this system was in **2008**, paid for by current homeowner.
- Problems: missing a sediment filter and sampling tap between tanks
- Homeowner said arsenic system was approved by Hopewell Township Health Dept.
- Homeowner would like if water tests were required yearly, similar to Hopewell Township's dog licenses.
- Wants a contract with a water company, same as his HVAC unit, that they just come out and check everything every year
- Had an arsenic test in 2008 but waited until 2015 to replace tank, because [Treatment Installer] told him the tank should last 5 years.
- Last water test in 2008 shows Arsenic at 6.3 µg/L, gross alpha 3.05 pCi/L (standard is 5)
- Breaking through already, after tank was changed less than a month ago? What was tank changed to?

As2015-001 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	1/29/14	7.9	+294	292	3.2	0	140	200
Between Tanks	1/29/14	NT				NT	NT	NT
Kitchen Sink	1/29/14					0	140	180

As2015-001 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic 3** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	1/29/14	**5.5**	**0.8** **14.5%**	**4.7** **85.5%**	1.0	ND
Between Tanks	1/29/14					
Kitchen Sink	1/29/14	0.7				

As2015-001 Treatment System	
Date Installed	12/11/2008, tank changed on 1/2/15

Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Metsorb
Additional Water Treatment Present	None
Missing components that are required by Hopewell Township	sampling tap between tanks, water meter, sediment filter

Photo of System

Meter Reading	no meter

As2015-001 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
9/4/2008		5.1			
11/13/2008				6.3	
1/2/15	Tank changed				
1/29/15		5.5	NT	0.7	

As2015-002 - Thursday 1/29/3015 (Megan, Steve S.)

- Original installation was in 2007, paid for by previous homeowner.
- **Adedge, 2 tanks E33P, AD33 media, 2 cubic feet each**
- Service contract with [Treatment Installer], they come every year and test the water and chlorinate well for $400
- Very concerned with tap water, even though she has a good system, drinks poland spring water.
- Meter reading 270,830 gallons post arsenic system

- Last service was 6/4/2011 (overdue 3.5 years)
- Not likely to have arsenic breakthrough because she has large arsenic tanks
- Meter Readings: (home uses about 36,110 gallons per year)
    - Meter installed 6-5-2007
    - 4-13-2010: 90,750
    - 4-26-2011: 126,630
    - 1-29-2015: 270,830

As2015-002 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	1/29/15	8.3	325	294	4.9	0	120	50
Between Tanks	1/29/15					0	120	50
Kitchen Sink	1/29/15					0	150	50

As2015-002 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	1/29/15	**14.5**	**1.9** **13.1%**	**12.6** **86.9%**	37.7	400
Between Tanks	1/29/15	1.3				
Kitchen Sink	1/29/15	ND				

As2015-002 Arsenic Treatment System	
Date Installed	6/2007
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	AdEdge E33P
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	NA

Photo of System

Meter Reading	270,830 gallons

As2015-002 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
1/2/2007		24.4			
6/22/2007			ND		
1/4/2008			21.2		
1/11/2008			ND		
4/13/2010	90,750		0.8		
4/25/2011	126,630		ND		
1/29/2015	270,830	14.5	1.3	ND	

<u>As2015-003, Friday, 1/30/2015 (Megan, Steve S.)</u>

- [Treatment Installer] installed **Layne RT** system with "S1, S2, S3" sampling ports in basement
- System was installed in 2013, paid for by previous homeowner.
- Water softener was present but not functioning.
- Confusing plumbing work in basement

- Has not tested water since he moved in a year and a half ago.
- Is setting up a reminder on his iphone to test once per year.
- Did not know he had service contract, Steve helped him contact the installer and he now has one for 2 years.
- Radioactivity
    - Water Softener - 10
    - Arsenic Unit - 14
    - Background - 10

As2015-003 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	1/30/15	7.8	346	234	3.5	0	120	150
Between Tanks	1/30/15					0	120	150
Kitchen Sink	1/30/15					0	120	175

As2015-003 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	1/30/15	**9.7**	**0.6** **6.2%**	**9.1** **93.8%**	ND	ND
Between Tanks	1/30/15	ND				
Kitchen Sink	1/30/15	ND				

As2015-003 Arsenic Treatment System	
Date Installed	6/2013
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	Water softener, not plugged in
Missing components that are required by Hopewell Township	

Meter Reading	97,600

As2015-003 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)
6/3/13		9.5			
7/3/13			ND treated		
1/30/15		9.7	ND	ND	

As2015-004, Friday, 1/30/2015 (Megan, Steve S.)

- House came with NJ State VOC – nearby contamination, but because of the house sale, it is now his responsibility
- TCE contamination, highest level was 68.6 µg/L in 2013 (ND treated)
- Wife is worried about the arsenic system so they have been drinking poland spring water only.
- Remembers to change UV light because it beeps
- Charcoal tanks were radioactive (advised homeowner not to spend too much time by the tanks)
    - Background - 13 (micro R/hour)
    - Carbon Tank #1 - 70
    - Carbon Tank #2 - 40
    - Arsenic Tank #1 - 12
    - Arsenic Tank #2 - 12
- [Treatment Installer] installed As tanks with **Resin Tech** media from DWC in 2013.
- The tanks were shut off when we arrived. Homeowner knew this, he called Hopewell Health department for a recommendation of a service tech. Whoever came to look at them said they were off and would call him back with what to do.
- We can guess that the tanks were running when they were originally installed (posttest was ND for As) but were shut off at some later point. The UV system was installed later; this may be when the arsenic tanks were shut off.
- UV system has a sediment filter pre system and post As tanks.
- Steve turned the tanks back on.
- Participant said he had low water pressure in taps, especially bathroom faucets.
- Downstairs half bath did not have a lot of media in the toilet tank.
- Faucet screens were removed from the sinks and were loaded with arsenic treatment media.
- Media had been backed up into the faucet and when we turned the water on it flushed out.
- Homeowner was extremely concerned, is replacing all faucet screens and sending me the old ones for analysis. (Need to determine size of holes and if the media gets through.)

- Upstairs bathroom sinks were loaded with arsenic treatment media. When we cleaned them out the water pressure was normal again.
- Homeowner was thankful we came, said it was very helpful for him.
- Major Problem: Resin Tech media is coming out of the tanks and entering the home, with potential for the residents to consume large doses of arsenic.
- Meter reading 66,990, but we don't think the arsenic tanks were on the whole time.

As2015-004 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	1/30/15	7.8	360	268	4.0	0	150	200
Between Tanks	1/30/15					0	180	200
Kitchen Sink	1/30/15					0	150	160

As2015-004 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)
Raw Water	1/30/15	**7.8**	**0.8 10.3%**	**7.0 89.7%**	ND	ND
Between Tanks	1/30/15	ND				
Kitchen Sink	1/30/15	ND				

As2015-004 Arsenic Treatment System	
Date Installed	9/2013
Number of Tanks and Size	(2) 1 cubic ft tanks?
Media in Tanks	Resin Tec
Additional Water Treatment Present	Carbon tanks for VOC and UV light
Missing components that are required by Hopewell Township	Arsenic tanks were bypassed

Photo of System	
	
Meter Reading	66,999

As2015-004 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
9/3/13		8.8			
9/11/13				ND	
1/30/15	66,999	7.8	ND	ND	

<u>As2015-005, Wednesday, February 4, 2015 (Megan, Steve S.)</u>

- Regular water testers (every 6 months-year)
- Radioactivity
  - Background - 6 (micro R/hour)
  - Softener - 8
  - As tank #1 - 10
  - As Tank #2 - 10
- Radon remediation system
- Meter reading 250,310
- Water Treatment systems: As, Reverse osmosis, softener
- Homeowners are very worried about the water; husband would like to bring in Poland Spring water because he doesn't trust the water.
- **Metsorb media**, (2) 2 cubic ft tanks installed in December 2011

As2015-005 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/4/15	7.7	426	304	2.6	0	130	170
Between Tanks	2/4/15					0	140	200
Kitchen Sink	2/4/15					0	200	0
Reverse Osmosis	2/4/15					0	50	0

As2015-005 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Titanium** (µg/L)
Raw Water	2/4/15	**25.6**			3.1	ND	3.4
Between Tanks	2/4/15	10.9					
Kitchen Sink	2/4/15	1.4					9.8
Reverse Osmosis	2/4/15	ND					ND

As2015-005 Arsenic Treatment System	
Date Installed	12/23/2011
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	Metsorb
Additional Water Treatment Present	Softener, reverse osmosis
Missing components that are required by Hopewell Township	NA, all required components are present
Photo of System	

Meter Reading	250,310

As2015-005 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
12/8/11		35.9			
1/4/12				ND	
1/22/15	247,450		2.9		
2/4/15	250,310	25.6	10.9	1.4	ND

<u>As2015-006, Wednesday, February 4, 2015 (Megan, Steve S.)</u>

- Regular tester (tests every 6 months)
- Has been the only owner of this home, new construction in 1993. She had her water tested and put in a remediation system (not part of real estate transfer law)
- Radioactivity
  - Background - 14 (micro R/hour)
  - Softener - 14
  - As tank #1 - 14
  - As Tank #2 - 14
- Meter reading 212,270
- Water Treatment systems: As, Reverse osmosis, softener
- System History $9359 in parts and labor alone, not including testing

  - 2004 purchased (2) 1 cubic ft tanks Adedge Media and RO from [Treatment Installer]. $2394
  - 2009 purchased (2) 2 cubic ft tanks of Bayoxide Adedge media $3875
  - June 2011 purchased (2) 2 cubic ft tanks of Metsorb [Treatment Installer] $3090
- Home owner had her raw water tested in May 2011 for the following:
  - Boron 123
  - Iron ND
  - Pb ND
  - Manganese 1.7 µg/L
  - Vanadium 16.5
  - Nitrate 1.7 mg/L
  - Phosphate .04
  - Silica 20 mg/L

As2015-006 Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/4/15	8.5	394	240	3.5	0	150	150
Between Tanks	2/4/15					0	150	150
Kitchen Sink	2/4/15					0	150	0
Reverse Osmosis (if applicable)	2/4/15					0	30	0

As2015-006 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/4/15	**24**	1.1 4.6%	22.9 95.4%	1.5	ND
Between Tanks	2/4/15	5.7				
Kitchen Sink	2/4/15	ND				
Reverse Osmosis	2/4/15	ND				

As2015-006 Arsenic Treatment System	
Date Installed	6/2004
Number of Tanks and Size	Current: Installed June 2011 (2) 2 cubic ft tanks with Metsorb media. Past: 2004 Adedge Media (2) 1 cubic ft tanks; 2009 (2) 2 cubic ft tanks with Adedge Bayoxide
Media in Tanks	Metsorb
Additional Water Treatment Present	Reverse osmosis and softener
Missing components that are required by Hopewell Township	No missing components
Photo of System 	
Meter Reading	212,270

As2015-006 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
2003		30.8			
9/5/2008				5.1	
12/22/2009				17.6	

2/7/2011			12.4		
5/4/2011		23			
10/2013			1.1		
4/2014			1.5		
9/26/2014			1.4		
2/4/2015		24	5.7	ND	ND

Big jump from September's readings. Accurate for Metsorb, did they not stress test or is it within the margin of error?

As2015-007, Thursday, February 5, 2015 (Megan, Steve S.)

- Sends in his own samples to Prescott
- Homeowner reports that he only tests in between the tanks, but lab results show he tests raw, treated and kitchen. He may think between the tanks because all 3 sampling ports are located between the two arsenic tanks.
- Additional Data in folder for softened water with in-situ
- [Treatment Installer] installed **Layne/Solmetex** in 2012 (new construction)
    - changed a tank in March 2014
- Radioactivity
    - Background - <10 (micro R/hour)
    - As tank #1 - 15
    - As Tank #2 - 13
    - Softener - 13
- Meter reading 443,000
- Control says 22 gallons per minute (should be around 3 gallons per minute)
- Didn't have enough salt in his softener
- Complained of glassware not getting clean

As2015-007 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/5/15	7.8	430	331	9	0	200	190
Between Tanks	2/5/15					0	200	25
Kitchen Sink	2/5/15					0	200	25

As2015-007 Laboratory Analysis

Sample Location	Sample Date	Total Arsenic (µg/L)	Arsenic (III) (µg/L)	Arsenic (V) (µg/L)	Manganese (µg/L)	Iron (µg/L)
Raw Water	2/5/15	10.2	1.1 10.8%	9.1 89.2%	0.8	ND
Between Tanks	2/5/15	ND				
Kitchen Sink	2/5/15	ND				
Reverse Osmosis	ND					

As2015-007 Arsenic Treatment System	
Date Installed	2012
Number of Tanks and Size	(2) 1 cubic ft tanks; Tank changed in March 2014
Media in Tanks	Solmetex
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	NA
Photo of System	
Meter Reading	443,000

As2015-007 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
8/27/2012		9.1			
9/11/2012			ND treated		
8/8/2014		11	ND	ND	
2/5/2015		10.2	ND	ND	

As2015-008, Thursday, February 5, 2015 (Megan, Steve S., Michelle K.)

- Hasn't tested water since free tests ran out, doesn't have any previous test results
- Has [Treatment Installer] come and "service" the treatment tanks but states that they don't test the water
- Homeowner dumps bottle of chlorine into the chlorine tank and adds water
- Sulfur smell to the raw water, may have As3
- Planning on moving in a year
- [Treatment Installer] installed Layne/Solmetex(?) in 2005
- He added chlorine and carbon tanks because they didn't like the smell and taste of their water
- Water Treatment: Chlorine, Carbon, 2 arsenic tanks, softener
- Radioactivity
  - Background - <10 (micro R/hour)
  - Softener - 14
  - Carbon Tank - 40
  - As tank #1 - <10
  - As Tank #2 - <10
- Meter reading 354,894 (which doesn't make sense for a 9-year-old system)

As2015-008 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/5/15	7.5	287	398	1.8	0	180	190
Between Tanks	2/5/15					0	180	0
Kitchen Sink	2/5/15					0	200	0

As2015-008 Laboratory Analysis

Sample Location	Sample Date	Total Arsenic (µg/L)	Arsenic (III) (µg/L)	Arsenic (V) (µg/L)	Manganese (µg/L)	Iron (µg/L)
Raw Water	2/5/15	**6.4**	5.8 90.6%	0.6 0.6%	207	230
Between Tanks	2/5/15	1.6				
Kitchen Sink	2/5/15	1.7				

As2015-008 Arsenic Treatment System	
Date Installed	2005
Number of Tanks and Size	(2) 1 cubic ft arsenic tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	Chlorinator, carbon tank, softener
Missing components that are required by Hopewell Township	NA
Photo of System	
Meter Reading	354,894 (seems low for 10 years of water usage)

As2015-008 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)
2/7/2006		6			

3/22/2006				1 (treated)	
2/5/2015		6.4	1.6	1.7	

They have iron, manganese and sulfur smell and mostly As3.

As2015-009, Thursday, February 5, 2015 (Megan, Steve S., Michelle K.)

- [Treatment Installer] installed **AdEdge-Advantedge** (2) 2 cubic ft tanks
- Taps aerated the water, not a good Dis.Oxygen reading
- Water Treatment: UV light, As tanks, softener
- Remembers to change UV light because it beeps
- Radioactivity
    - Background - <8
    - As tank #1 - <8
- Softener at the other end of basement, in fitness room closet (Softener is not working)
- No meter present (new construction, inspected)

As2015-009 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/5/15	8.0	305	219	11 – aerated faucet	0	100	180
Between Tanks	2/5/15					0	100	180
Kitchen Sink	2/5/15					0	120	190

As2015-009 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/5/15	4.3	**0.05 1.2%**	**4.25 98.8%**	ND	ND
Between Tanks	2/5/15	2.0				
Kitchen Sink	2/5/15	ND				

As2015-009 Arsenic Treatment System

Date Installed	2009 arsenic tanks; 2013 UV light
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	AdEdge Advantedge
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	Water meter
Photo of System 	
Meter Reading	No meter

As2015-009 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading (gallons)**	**Raw Water (µg/L)**	**Between Tanks (µg/L)**	**Kitchen Sink (µg/L)**	**Reverse Osmosis (µg/L)**
5/7/2009		6.1			
12/12/2012		4.66 (holding tank)			
2/11/2013				3.8 treated	
2/5/2015		4.3	2.0	ND	

<u>As2015-010, Thursday, February 5, 2015 (Megan, Steve S., Michelle K.)</u>

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks, no sediment filter, no meter
- Radioactivity
    - Background - 7 (micro R/hour)
    - As tank #1 - 7

  - As Tank #2 - 10
- Analytical Lab in PA was doing water tests from 2003 until recently
  - They reported a raw water reading of 298 µg/L? Could have wrong decimal place and supposed to be 29.8 µg/L
  - No other raw water tests
- Is now using lab in NJ
- As of November 2014, 4.6 µg/L at kitchen sink, 23 between tanks.
  - Advised to replace at least one tank, to get drinking water to ND
- [Water Treatment Company] advised the homeowner, in 2011, not to change the tanks until the sample between the tanks reaches 30ppb. (The first tank may never reach 30 µg/L if the raw water is only 29). Based on this advice and the MCL, homeowner thought he was being proactive.
- Homeowner is a regular tester, every 6 months, was confident that his water was safe to drink
- Homeowner doesn't believe that the labs stress test his system
- We told him that we would tell him our results within a month, then make a recommendation. Results could be worse because we stress tested the system.
- System set to backwash every other day.

As2015-010 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/5/15	7.95	322	253	4.1	0	150	180
Between Tanks	2/5/15					0	150	180
Kitchen Sink	2/5/15					0	120	180

As2015-010 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/5/15	**27.6**	**0.7** **2.5%**	**26.9** **97.4%**	1.50	ND
Between Tanks	2/5/15	**38.5**				
Kitchen Sink	2/5/15	**12.8**				

As2015-010 Arsenic Treatment System

Date Installed	6/19/2003
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	AR59-Arsenic removal
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	No sediment filter or water meter
Meter Reading	NA

As2015-010 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
5/21/2003				<5	
6/21/2007		29.8			
12/11/2013			21	3.0	
5/22/2014			21	3.6	
11/18/2014			23	4.6	
2/5/2015		27.6	38.5	12.8	

As2015-011, Friday, February 6, 2015 (Megan, Steve S.)

- 1st POET installed by [Treatment Installer], passed home inspection
- 2nd POET installed by [Treatment Installer] $10,000 financed through a New Jersey program
  - 2 Large Carbon Tanks (TCE 2.16 in raw)
  - (2) 2 cubic foot Arsenic tanks - **Metsorb**
  - Water softener
  - Reverse osmosis system
- Radioactivity
  - Background - 12 (micro R/hour)
  - Carbon Tank #1 - 140
  - Carbon Tank #2 - 20
  - As tank #1 - 15
  - As Tank #2 - 14
  - Softener - 14
- VOCs in water, 2 very large carbon tanks (unsure why they are so big)
- Meter reading 134,620

As2015-011 Field Equipment Results								
Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	2/6/15	7.9	397	278	5.7	0	170	190
Between Tanks	2/6/15					0	200	190
Kitchen Sink	2/6/15					0	180	0
Reverse Osmosis	2/6/15					0	80	0

As2015-011 Laboratory Analysis						
Sample Location	Sample Date	Total Arsenic (µg/L)	Arsenic (III) (µg/L)	Arsenic (V) (µg/L)	Manganese (µg/L)	Iron (µg/L)
Raw Water	2/6/15	**6.5**	**0.5** **7.7%**	**6** **92.3%**	1.0	ND
Between Tanks	2/6/15	0.6				
Kitchen Sink	2/6/15	ND				
Reverse Osmosis (if applicable)	2/6/15	ND				

As2015-011 Arsenic Treatment System	
Date Installed	9/20/11
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	Metsorb
Additional Water Treatment Present	Carbon tanks, UV light, Reverse osmosis
Missing components that are required by Hopewell Township	NA
Photo of System	

Meter Reading	134,620

As2015-011 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)
8/3/2007		11.9			
10/11/2007				2 treated	
2/17/2010				8.3	
3/28/2011				5.6	
4/2014			ND treated		
2/6/2015		6.5	0.6	ND	ND

As2015-012, Friday, February 6, 2015 (Megan, Steve S.)

- POET installed by homeowner, engineer. Replaced one of the tanks in April 2014. Wife reported that the water was orange for a while because he filled “too many rocks in the bottom”. They backwashed until the water was clear.
  - Sediment filter
  - (2) 1 cubic ft arsenic tanks
- Radioactivity
  - Background - 12 (micro R/hour)
  - As tank #1 - 13
  - As Tank #2 - 12
- No meter, tests every 3-4 years

As2015-012 Field Equipment Results								
Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)

Raw Water	2/6/15	7.9	405	384	1.6	0	180	190
Between Tanks	2/6/15					0	180	190
Kitchen Sink	2/6/15					0	130	190

As2015-012 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)
Raw Water	2/6/15	**4.9**	**1.5** **30.6%**	**3.4** **69.4%**	18	ND
Between Tanks	2/6/15	0.7				
Kitchen Sink	2/6/15	0.5				

As2015-012 Arsenic Treatment System	
Date Installed	4/2011
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Adedge
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	Water meter
Photo of System	

Meter Reading	NA

As2015-012 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
7/15/2002		7.9			
5/1/2006		8.7			
2/6/2015		4.9	0.7	0.5	

<u>As2015-013, Wednesday, February 11, 2015 (Megan, Steve S., Cori)</u>

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in May 2007, no sediment filter, no meter, set to backwash every other day (Steve changed backwash settings)
- Pressure tank in small part of basement, accessed by a ladder
- Home has a radon remediation system
- Homeowner reports a sulfur smell, only when she's been away and runs the hot water for a long period of time.
- Radioactivity
    - Background - 10(micro R/hour)
    - As tank #1 - 25
    - As Tank #2 - 22
    - **Carbon Tank - 210**
- Home owner reports [Treatment Installer] comes 1x/year to "replace carbon filter"

As2015-013 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/11/15	7.7	354	314	0.30	0	200	150
Between Tanks	2/11/15					0	190	150
Kitchen Sink	2/11/15					0	200	150

As2015-013 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/11/15	**6.6**	**0.7** **10.6%**	**5.9** **89.4%**	ND	ND
Between Tanks	2/11/15	3.4				
Kitchen Sink	2/11/15	0.5				

As2015-013 Arsenic Treatment System	
Date Installed	5/18/2007
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Unknown
Additional Water Treatment Present	Carbon tanks
Missing components that are required by Hopewell Township	Missing sediment filter and water meter
Photo of System	

Meter Reading	No meter

As2015-013 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
6/15/2004		5.8			
3/9/2007		6.4			
4/24/2007				1.1 treated	
5/9/2008		6.4		ND treated	
6/21/2013		6.4		ND treated	
2/11/2015		6.6	3.4	0.5	

<u>As2015-014, Wednesday, February 11, 2015 (Megan, Steve S., Cori)</u>

- [Treatment Installer] installed (2) 2 cubic ft tanks with **Metsorb** media
- Radioactivity
  - Background - 10 (micro R/hour)
  - As tank #1 - 12
  - As Tank #2 - 13 (cinder blocks)
- No sediment filter
- Meter reads 24,140 (since 2013)

As2015-014 Field Equipment Results

Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	2/11/15	7.7	367	433	6.8	0	100	200
Between Tanks	2/11/15					0	140	200
Kitchen Sink	2/11/15					0	100	200

As2015-014 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)
Raw Water	2/11/15	**3.3**	**0.5** **1.5%**	**3.25** **98.5%**	ND	ND
Between Tanks	2/11/15	ND				
Kitchen Sink	2/11/15	0.9				

As2015-014 Arsenic Treatment System	
Date Installed	4/2013
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	Metsorb
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	No sediment filter
Photo of System	

Meter Reading	24,140

As2015-014 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
3/4/2013		9.1			
4/25/2013				ND treated	
2/11/2015	24,140	3.3	ND	0.9	

As2015-015, Thursday, February 12, 2015 (Megan, Steve S., Cori)

- (4) Carbon tanks and (2) additional sediment filters present but currently bypassed.
    - part of pennington dry cleaner VOC issue
    - do not look like Jayson tanks, they are tan not blue
- [Treatment Installer] installed (2) 1 cubic ft arsenic tanks, sediment filter, meter on control (doesn't seem accurate).
- **Solmetex** media
- Homeowner was given [Treatment Installer] test kit from 2011, has not used it yet.
- Homeowner is eager to understand who to call to treat her water.
- Called [Treatment Installer] and they are sending the homeowner a new test kit with updated address.
- Radioactivity - Carbon tanks read background level (no water is running through them).
- Homeowner will wait for our results before calling for service.
- Arsenic tanks appear to have media spilled on the outside
- Meter reading - 524,206 gallons
- Blinking light on the arsenic tanks control box - don’t know what it means
- We did not get a faucet screen sample because the faucets did not have screens

As2015-015 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/12/15	7.7	420	267	6.5	0	120	150
Between Tanks	2/12/15					0	120	170
Kitchen Sink	2/12/15					0	140	180

As2015-015 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/12/15	**10.4**	**2.2** **21.2%**	**8.2** **78.8%**	ND	ND
Between Tanks	2/12/15	10.9				
Kitchen Sink	2/15/15	1.2				

As2015-015 Arsenic Treatment System	
Date Installed	2006
Number of Tanks and Size	(2) 1 cubic ft arsenic tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	4 carbon tanks but they are bypassed
Missing components that are required by Hopewell Township	
Photo of System	

Meter Reading	524,206

As2015-015 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
4/21/2006		18			
5/11/2006				ND	
8/27/2013				ND	
2/12/2015		10.4	10.9	1.9	

<u>As2015-016, Thursday, February 5, 2015 (Megan, Steve S., Cori)</u>

- Well drilled in 1974, in the garage
- Pump present in basement for the septic system
- [Treatment Installer] installed **Adedge** (2) 1 cubic foot arsenic tanks, with sediment filter and meter in 2006
- No other water treatment present.
- Radon remediation system for home
- Radioactivity
  - Background - <15 (micro R/hour)
  - As tank #1 - 14
  - As Tank #2 - 14
- Faucet screens looked like they had harness minerals

As2015-016 Field Equipment Results

Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	2/12/15	7.6	440	291	5.3	0	180	200
Between Tanks	2/12/15					0	200	200
Kitchen Sink	2/12/15					0	170	200

As2015-016 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)
Raw Water	2/15/15	**6.8**	**1.4** **20.6%**	**5.4** **79.4%**	ND	ND
Between Tanks	2/15/15	1.6				
Kitchen Sink	2/15/15	ND				

As2015-016 Your Arsenic Treatment System	
Date Installed	7/5/2006
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Adedge
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	Water meter
Photo of System	

As2015-016 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)
5/24/2006		8.3			
1/21/2010				<0.5	
2/12/2015		6.8	1.6	ND	

As2015-017, Thursday, February 5, 2015 (Megan, Steve S., Cori)

- Radioactivity
  - Background - 10 (micro R/hour)
  - As tank #1 - 60
  - As Tank #2 - 40
  - Softener - 32
- No salt in the softener, softener not working
  - Softener is being used to catch radium in the water
  - Family is likely drinking radium
  - Explained the severity of the problem
  - Steve put 2 bags of salt in the system
- Homeowner reports high iron in water
- Well is in known well restriction area
- File states gross alpha 195.7 in 2010, 179 in 2012 and treated 2.55

- [Treatment Installer] gave an estimate on 3/6/15 for a new treatment system. It includes a mixed bed anion cation tank to remove gross alpha and a redundant arsenic system. RO at the kitchen sink as a backup. Est $6,138

2nd Visit: As2015-017, Monday, March 23, 2015 (Megan, Steve S.)

- Revisited radioactivity in water
- Family is concerned about showering in water, has been showering with bottled water and at a friend's house
- Steve explained uranium, radon, radium and half lives
- See photos of tank media levels, appears broken?
- Homeowner wants to understand their water and took notes
- Treatment installer told homeowner that radon is expensive to remediate
- Installed backwash line to under the house, not septic tank
- Radon fan sounds like it is bubbling with water
- Took samples for gross alpha, arsenic, uranium and radon

As2015-017 Field Equipment Results

Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	2/12/15	7.6	+451	318	3.1	0	130	180
Between Tanks	2/12/15					0	170	180
Kitchen Sink	2/12/15					0	200	190

As2015-017 Field Equipment Results (2nd Visit)

Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	3/23/15	7.7	141	318	2.5			
Between Tanks	3/23/15							
Kitchen Sink	3/23/15							

As2015-017 Laboratory Analysis (1st Visit)

Sample Location	Sample Date	Total Arsenic (µg/L)	Arsenic (III) (µg/L)	Arsenic (V) (µg/L)	Manganese (µg/L)	Iron (µg/L)	Uranium

Raw Water	2/12/15	**4.5**	**0.8** **17.8%**	**3.7** **82.2%**	20.2	72	5.4
Between Tanks	2/12/15	ND					1.1
Kitchen Sink	2/12/15	ND					ND

As2015-017 Laboratory Analysis (RETEST)						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Uranium**	**Gross Alpha pCi/L**	**Radon pCi/L**	
Raw Water	3/23/15			358 initial 523 final	8223.7 9130.1	
Between Tanks	3/23/15			330 initial 427 final		
Kitchen Sink	3/23/15			4.62 initial	10015.4 10350.1	

As2015-017 Arsenic Treatment System	
Date Installed	2012
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	AdEdge
Additional Water Treatment Present	Softener (no salt present in softener, not working)
Missing components that are required by Hopewell Township	All present No salt in the salt tank.
Photo of System	

Meter Reading	Didn't take reading.

As2015-017 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)
6/17/2010		5.3			
7/19/2010		5.3		ND	
10/23/2012				4.6	
1/30/2015		4.3		ND	
2/12/2015		4.5	ND	ND	

As2015-017 Treatment System History (Previous Gross Alpha Results)					
Date of Test	Meter Reading	Raw Water	Between Tanks	Kitchen Sink	Reverse Osmosis
7/19/2010				2.55 treated	
10/23/2012				179 (initial) 224.2 (final)	
1/30/2015		242.2 (48h) 330.6 (48h)		180.3 (48h) 294.7 (72h)	

3/23/2015		358 initial 523 final	330 initial 427 final	4.62 initial	

As2015-017 Treatment System History (Previous Uranium Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
1/30/2015		5.5			
2/12/2015		5.4	1.1	ND	
3/23/2015					

<u>As2015-018, Thursday, February 19, 2015 (Megan, Steve S., Michelle)</u>

- Homeowner said he no longer wanted a POET system and was looking into a POU system. I told him that if he was planning on moving in 5 years, the cost effective thing to do would be to fix the POET system and get the benefit of it too. Hopewell will not let him sell his house without a POET. He agreed to consider it.
- [Treatment Installer] installed (2) 2 cubic foot arsenic tanks in 2012 - **Metsorb.**
- Radioactivity
  - Background - 12 (micro R/hour)
  - As tank #1 - 17
  - As Tank #2 - 13
- Softener has salt, but was not softening water
- Meter reading: 201,682

As2015-018 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/19/15	7.9	294	359	1.65	0	160	200
Between Tanks								
Kitchen Sink	2/19/15	7.4				0	200	150-200

As2015-018 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Titanium** (µg/L)

Raw Water	2/19/15	**16.3**	**5.2** **31.9%**	**11.1** **68.1%**	6.0	64	2.6
Between Tanks							
Kitchen Sink	2/19/15	18.6					2.4

As2015-018 Arsenic Treatment System	
Date Installed	2012
Number of Tanks and Size	(2) 2 cubic ft tanks (very big for size of home
Media in Tanks	Metsorb
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	NA

Photo of System

Meter Reading	201,682

As2015-018 Treatment System History (Previous Arsenic Test Results)

Date of Test	Meter Reading (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)
12/5/2014				21.5	
12/22/2011		8.8			
1/17/2012				ND	
2/19/2015		16.3		18.6	

<u>As2015-019, Thursday, February 19, 2015 (Megan, Steve S., Michelle)</u>

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2006 - **Solmetex**
    - Red alarm was blinking
- Flow of water is from well to softener to sediment filter then arsenic tanks
- Top control meter reading 586,726.0
- Homeowners have the testing program but noted that it is contingent on replacing the tanks when they are notified to do so.
- Homeowners have tested their water using a “Quick Rapid Arsenic Test Kit” $20+shipping for 2 tests
    - Steve warned that this test creates toxic arsene gas
    - Homeowners don’t trust the [Treatment Installer] tests because they are sent by the company
- Homeowners are regular testers with excellent records of their system. They seem to replace their tank very frequently, “every 14 months” but think they have changed them 3x
- They drink bottled water only and are afraid to drink their water.
- Homeowners report sulfur smell, I confirmed
- Their outside taps are treated water because they water their vegetable garden
- Comprehensive record keeping of their system
- It is likely that the kitchen sink level has arsenic now.
- Jet pump in basement, shallow water table
- Radioactivity
    - Background - 8 (micro R/hour)
    - As tank #1 - 11
    - As Tank #2 - 11
    - Softener- 8-9

As2015-019 Field Equipment Results								
Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	2/19/15	7.7	+43	211	0.00	0	200	150

Between Tanks	2/19/15					0	200	150
Kitchen Sink	2/19/15					0	150	150

As2015-019 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/19/15	**5.5**	**3.7** **67.2%**	**1.8** **32.7%**	135	170
Between Tanks	2/19/15	4.1				
Kitchen Sink	2/19/15	8.5				

As2015-019 Arsenic Treatment System	
Date Installed	2/19/15
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	Softener (precedes sediment filter and As tanks)
Missing components that are required by Hopewell Township	NA
Photo of System	

Meter Reading	586,762

As2015-019 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Notes**
6/19/2006		6.2			
7/21/2006				ND treated	
3/29/2007	44,988	5.5	ND	ND	
3/17/2008	127,667	4.5	3.0	ND	*Tank likely changed here?*
10/13/2009	264,799	5	2	ND	*Tank likely changed here?*
4/21/2011	388,605	4	ND	ND	
2/8/2012		7	5	ND	This is the last time homeowner tested

2/19/2015	586,726	5.5	4.1	8.5	

As2015-020, Friday, February 20, 2015 (Megan, Steve S., Ted)

- [Treatment Installer] installed (2) 2 cubic foot arsenic tanks in the Summer of 2012 - **Metsorb**
    - Homeowners were advised to remove the carbon tanks from the basement, no longer needed them. [Treatment Installer] removed them and added a softener.
- Meter 108,550
- Homeowner is changing his own sediment filters but they aren't small enough, 50 microns
- Wife reports toilets are hard to clean, black and white stuff in toilet tank.
    - Daughter's toilet had white chunky and chalky material in toilet tank
- Radioactivity
    - Background - 6 (micro R/hour)
    - Softener - 5
    - As tank #1 - 6
    - As Tank #2 - 6

As2015-020 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/20/15	7.6	352	435	0.3	0	150	200
Between Tanks	2/20/15					0	150	200
Kitchen Sink	2/20/15					0	150	0

As2015-020 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/20/15	**4.8**	**0.05** **1%**	**4.75** **99%**	ND	ND
Between Tanks	2/20/15	1.3				
Kitchen Sink	2/20/15	ND				

As2015-020 Arsenic Treatment System	
Date Installed	4/11/2013
Number of Tanks and Size	(2) 1.5 cubic ft tanks
Media in Tanks	Metsorb
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	NA

Photo of System

Meter Reading	108,550

As2015-020 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
9/26/2012		5.5			
10/17/2012				ND treated	
2/20/2015	108,550	4.8	1.3	ND	

<u>As2015-021, Friday, February 20, 2015 (Megan, Steve S., Ted)</u>

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in March 2013 - **Metsorb**
- Control says 47,210 gallons (does not seem accurate)
- Has never tested the water, we instructed how to.
- Found carbon media in the back of the toilet tank
- Radioactivity
  - Background - 7 (micro R/hour)
  - Carbon tank 1 - 70
  - Carbon tank 2 - 70
  - As tank #1 - 9
  - As Tank #2 - 9
- Home Value: $417,900

As2015-021 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/20/15	7.7	388	302	3.17	0	120	200
Between Tanks	2/20/15					0	180	200
Kitchen Sink	2/20/15					0	180	200

As2015-021 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/20/15	**4.9**	**0.5** **10.2%**	**4.4** **89.8%**	0.5	63
Between Tanks	2/20/15	0.7				
Kitchen Sink	2/20/15	ND				

As2015-021 Arsenic Treatment System	
Date Installed	3/11/13
Number of Tanks and Size	(2) 1 cubic ft Metsorb tanks Appear to be bigger like 1.5 or 2
Media in Tanks	Metsorb

<table>
<tr><td>Additional Water Treatment Present</td><td>(2) Carbon tanks</td></tr>
<tr><td>Missing components that are required by Hopewell Township</td><td>NA</td></tr>
<tr><td colspan="2">Photo of System
</td></tr>
<tr><td>Meter Reading</td><td>47,210 doesn’t seem to be accurate</td></tr>
</table>

As2015-021 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
2/18/2013		5.9			
3/17/2013		6.0		0.1 treated	
2/20/2015	47,210	4.9	0.7	ND	

<u>As2015-022, Friday, February 20, 2015 (Megan, Steve S., Ted)</u>

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks - **AdEdge**, tanks were later changed to Metsorb and (2) 2 cubic ft tanks by [Treatment Installer] in 2013
- 525,020 gallons
- Radioactivity
  - Background - 7(micro R/hour)
  - Filter - 9
  - As tank #1 - 10
  - As Tank #2 - 10
  - Softener -7

As2015-022 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/20/15	7.8	393	221	3.27	0	200	200
Between Tanks	2/20/15					0	180	150
Kitchen Sink	2/20/15					0	180	0

As2015-022 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/20/15	**21.6**	**5.6** **29.5%**	**16** **74.1%**	2.5	ND
Between Tanks	2/20/15	1.4				
Kitchen Sink	2/20/15	ND				

As2015-022 Arsenic Treatment System	
Date Installed	10/30/13
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	Metsorb
Additional Water Treatment Present	Water softener
Missing components that are required by Hopewell Township	NA
Photo of System	

Meter Reading	525,020

As2015-022 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
4/8/2005		23.9			
10/25/2005		6.9 (says raw but doesn't make sense)			
4/6/2007		25.3			
4/20/2007				ND treated	
10/30/2013	441,650			ND treated	
2/20/15	525,020	21.6	1.4	ND	

As2015-023, Saturday, February 21, 2015 (Megan, Steve S.)

- [Treatment Installer] installed (2) Isolux filters in 2006 - water flows through the system simultaneously so it is not a redundant arsenic system with a safety tank.
- Water flows from the well to sediment filter, 2 isolux tanks simultaneously, sediment filter #2, softener
- Homeowner changed sediment filters while we were there and gave us the 2nd sediment filter to examine for isolux media

- Seller and buyer split cost for arsenic system, chose it together.
- [Treatment Installer] replaced 2 cartridges for $818
- meter reads 462,182 since 2006
- Pressure switch is set from 45-75 psi, pump kicks on after 8 seconds and off after 22 seconds with only 2 gallons of water flowing through
- Radioactivity
  - Background - 9(micro R/hour)
  - As tank #1 - 8
  - As Tank #2 - 12
  - Softener - 14 - softener needs salt

As2015-023 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/21/15	7.9	385	245	0.6	0	200	200
Between Tanks	NA							
Kitchen Sink	2/21/15					0	180	180

As2015-023 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/21/15	**9.4**	**1.5** **16%**	**7.9** **84%**	4.8	ND
Between Tanks						
Kitchen Sink	2/21/15	ND				

As2015-023 Arsenic Treatment System	
Date Installed	2006
Number of Tanks and Size	2 cartridges (not a redundant system)
Media in Tanks	Isolux
Additional Water Treatment Present	Softener

Missing components that are required by Hopewell Township	2 more cartridges or a different arsenic treatment tank with a sampling port in between (to make it a redundant arsenic system); Water meter
Photo of System 	
Meter Reading	

As2015-023 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
2/7/2006		10.3			
3/15/06				ND treated	
9/30/2009				ND treated	
2/21/15		9.4		ND treated	

<u>As2015-024, Wednesday, February 25, 2015 (Megan, Steve S., Cori)</u>

- Prefers to go by EPA standards 10µg/L. Thinks the last question of the survey was leading.
- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2007 - **Solmetex**

- Meter reading: 437,952
- No test results available; owner thinks the raw water is 7µg/L
- Has no intention to test water or maintain the system.
- Radioactivity
  - Background - 8 (micro R/hour)
  - As tank #1 - 19 <- possibly catching uranium
  - As Tank #2 - 10

As2015-024 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/25/15	7.9	373	194	6.4	0	100	150
Between Tanks	2/25/15					0	110	180
Kitchen Sink	2/25/15					0	110	180

As2015-024 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/25/15	**7.5**	**1.2** **16%**	**6.3** **84%**	0.5	66
Between Tanks	2/25/15	3.3				
Kitchen Sink	2/25/15	ND				

As2015-024 Arsenic Treatment System	
Date Installed	2/22/07
Number of Tanks and Size	(2) 1 cubic ft arsenic tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	NA

Photo of System	
	
Meter Reading	437,952

As2015-024 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
1/10/2006	Missing result				
3/20/2007				ND treated	
2/22/2015		7.5	3.3	ND treated	

As2015-025, Wednesday, February 25, 2015 (Megan, Steve S., Cori)

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2008 - **Layne?**
- Previous homeowners were not happy installing it because they lost a coat closet. Told the homeowner that the system cost $10,000.
- Arsenic system, UV, softener (has salt in tank)
- Radioactivity
    - Background - 8(micro R/hour)
    - As tank #1 - 11
    - As Tank #2 - 11
    - Softener -11

As2015-025 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/25/15	7.78	343	297	3.6	0	120	170
Between Tanks	2/25/15					0	120	170
Kitchen Sink	2/25/15					0	120	0

As2015-025 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/25/15	**5.9**	**0.7** **11.9%**	**5.2** **88.1%**	ND	ND
Between Tanks	2/25/15	1.7				
Kitchen Sink	2/25/15	1.0				

As2015-025 Arsenic Treatment System	
Date Installed	5/16/2008
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Unknown
Additional Water Treatment Present	Softener + UV
Missing components that are required by Hopewell Township	Water meter
Photo of System	

Meter Reading	NA

As2015-025 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
4/7/08		7.1			
4/22/08		6.2			
5/27/08				ND treated	
2/25/15		5.9	1.7	1.0	

As2015-026, Wednesday, February 25, 2015 (Megan, Steve S., Cori)

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2011 - **Solmetex**
- (2) Carbon tanks and a UV light present.
- Sediment filter before carbon tank and before arsenic tank but not present before the UV system.
- Radioactivity
  - Background - 8(micro R/hour)
  - Background downstairs - 18
  - Carbon Tank 1- 130
  - Carbon Tank 2 - 180
  - As tank #1 - 50
  - As Tank #2 - 32
- Toilet tank was covered in dark sediment
- Home Value: $1,114,400

As2015-026 Field Equipment Results

Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	2/25/15	7.6	336	218	6.5	0	120	150
Between Tanks	2/25/15					0	120	170
Kitchen Sink	2/25/15					0	130	150

As2015-026 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/25/15	**4.4**	**0.6** **13.6%**	**3.8** **86.4%**	0.8	ND
Between Tanks	2/25/15	2.5				
Kitchen Sink	2/25/15	ND				

As2015-026 Arsenic Treatment System	
Date Installed	2011
Number of Tanks and Size	(2) 1 cubic foot arsenic tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	(2) carbon tanks and a UV light present
Missing components that are required by Hopewell Township	Sediment filter before carbon tank and before arsenic tank but not present before the UV system.

Photo of System	

As2015-026 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading	Raw Water	Between Tanks	Kitchen Sink	Reverse Osmosis
2004		6.0			
2/25/15		4.4	2.5	ND	

<u>As2015-027, Thursday, February 26, 2015 (Megan, Michelle)</u>

- [Treatment Installer] installed water softener (no salt in tank), 2 carbon tanks for VOCs (homeowner doesn’t know why), 2 (1 cubic ft) **Solmetex**
- Meter reading was 169.5x1000
- Has sampling program
- Home owner adds "Iron Out" to softener tank when he adds salt
- Reports that when salt is low, water becomes carbonated and salty
- Radioactivity
    - Background: 9
    - Carbon tank 1: 57
    - Carbon tank 2: 30
    - Arsenic tank 1: 20
    - Arsenic tank 2: 56
    - Softener: 18
- Has re-bedded the carbon tanks 2x. He does both tanks at the same (not worker and safety tank)

As2015-027 Field Equipment Results

Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	2/26/15	7.7	293	296	4.5	0	200	200
Between Tanks	2/26/15					0	200	50
Kitchen Sink	2/26/15					0	150	50

As2015-027 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/26/15	**6.4**	**0.05 0.8%**	**6.35 99.2%**	0.7	ND
Between Tanks	2/26/15	1.3				
Kitchen Sink	2/26/15	ND				

As2015-027 Arsenic Treatment System	
Date Installed	2009
Number of Tanks and Size	2 (1 cubic ft)
Media in Tanks	Solmetex
Additional Water Treatment Present	2 carbon tanks for VOCs; softener
Missing components that are required by Hopewell Township	Sediment filters are bypassed
Photo of System	

Meter Reading	169,500

As2015-027 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)
3/31/2009		5.3			
2/26/15		6.4	1.3	ND	

As2015-028, Thursday, February 26, 2015 (Megan, Michelle)

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in January 2012 - **Solmetex**
- Sediment filter made out of rope? (Home owner wants to know if he should get a big blue filter instead) It needs to be changed
- Home owner reports that something gets clogged in the softener tank and he manually removes it.
- Prescott sends sample bottles every 9 months and homeowner tests every year.
- In-Situ readings were taken from S1, access to raw water port was limited and kept shutting off. Raw water samples were taken from raw water port.
- Radioactivity
    - Background - 13(micro R/hour)
    - Softener - 15
    - As tank #1 - 17
    - As Tank #2 – 16
- Control meter says 75,620 gallons
- Probe readings very similar to what Steve has on file from 2012

As2015-028 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/26/15	7.5	326	453	2.7	0	200	200
Between Tanks	2/26/15					0	200	200
Kitchen Sink	2/26/15					0	200	200

As2015-028 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/26/15	9.7	0.05 0.5%	9.95 99.5%	0.9	ND
Between Tanks	2/26/15	ND				
Kitchen Sink	2/26/15	ND				

As2015-028 Your Arsenic Treatment System	
Date Installed	January 2012
Number of Tanks and Size	(2) 1 cubic foot arsenic tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	
Photo of System	

Meter Reading	75,620

As2015-028 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
5/30/08		6			
12/15/11		38.8			
1/16/12				ND treated	
11/29/12	18,620	36.4	ND	ND	
11/24/14	69,000	24	ND	ND	
2/26/15	75,620	9.7	ND	ND	

<u>As2015-029, Friday, February 27, 2015 (Megan, Steve S., Sara F.)</u>

- Meter reading 53,338 gallons
- Raw water was orange- arsenic reading may be skewed because of iron present
- NJ Analytical charged $135 for just arsenic test with a 4-day rush
- Got a quote from [Treatment Installer] for $6952.80 for 2 (2 cubic ft) tanks.
- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2011 – **Resin Tech** cost: $3900
- Water has not been tested since tanks were installed

- Toilet tanks and faucet screens had small black pieces in them but could be coming up from the well.
- Homeowner doesn't trust the people who test and install systems
- 4/15/12 Gross Alpha 4.82 pCi/L, Iron 0.182 mg/L and Manganese <0.030 mg/L
- Radioactivity
    - Background - 8(micro R/hour)
    - As tank #1 - 8
    - As Tank #2 - 8

As2015-029 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	2/27/15	7.8	259	266	2.3	0	120	180
Between Tanks	2/27/15					0	120	180
Kitchen Sink	2/27/15					0	140	180

As2015-029 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	2/27/15	**7.1**	**1.5**	**5.6**	ND	ND
Between Tanks	2/27/15	2.4				
Kitchen Sink	2/27/15	4.3				

As2015-029 Arsenic Treatment System	
Date Installed	5/24/2012
Number of Tanks and Size	(2) 1 cubic foot arsenic tanks in 2011
Media in Tanks	Resin Tech, backwashing heads
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	NA

Photo of System	
	
Meter Reading	53,338

As2015-029 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
4/15/09				5.48	
4/29/09				5	
4/2012				6.1	
5/14/12				6.0	
5/24/12				6.1	
2/27/15	53,338	7.1	2.4	4.3	

<u>As2015-030, Friday, March 6, 2015 (Megan, Michelle)</u>

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2013 - **Layne**
- Radioactivity
  - Background - 7(micro R/hour)
  - As tank #1 - 12
  - As Tank #2 - 11
- Radon remediation in basement

- Control on arsenic tank says 41,220 gallons
- Neighbors sump pump drains next to homeowner's well, snow was melted - bacteria problem in their well
- Suggested she call [Treatment Installer] and get the free sample boxes
- No sediment filter before UV light
- Rope sediment filter before As tanks

As2015-030 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	3/6/15	7.9	416	257	7.2	0	160	200
Between Tanks	3/6/15					0	160	200
Kitchen Sink	3/6/15					0	160	200

As2015-030 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	3/6/15	**5.3**	**0.05** **0.9%**	**5.25** **99.1%**	ND	ND
Between Tanks	3/6/15	ND				
Kitchen Sink	3/6/15	ND				

As2015-030 Arsenic Treatment System	
Date Installed	10/2/13
Number of Tanks and Size	(2) 1 cubic foot arsenic tanks
Media in Tanks	Layne Solmetex
Additional Water Treatment Present	UV
Missing components that are required by Hopewell Township	Sediment filter before UV light

Photo of System

Meter Reading	41,220

As2015-030 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
5/23/13		5.7			
7/3/13				0.8 treated	
3/6/15	41,220	5.3	ND	ND	

<u>As2015-031, Friday, March 6, 2015 (Megan, Michelle)</u>

- [Treatment Installer] installed (1) 2-3 cubic foot carbon tank in 1999 for TCE contamination and arsenic removal. $778+$160 install + Tax
- No water meter, no sediment filter, no sampling port
- Homeowner has not tested water and believes arsenic levels are low and TCE levels are low but he didn't want to take a chance
- When he moved in in 1999, the realtor told him not to install any treatment because no one would want to buy his home, the tanks would scare them away.
- Radioactivity
    - Background -8 (micro R/hour)
    - Softener - 11

  - Carbon tank - 38
- There was barely any salt in the salt tank. Suggested that the homeowner fill the salt tank. He said no, seeing water was fine. Tested the water for hardness - 200 raw and 50 at kitchen sink.

As2015-031 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	3/6/12	7.8	411	324	4.9	0	140	180
Between Tanks								
Kitchen Sink	3/6/12					0	180	50

As2015-031 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water		**3.3**	**0.05** **1.5%**	**3.25** **98.5%**	0.9	ND
Between Tanks						
Kitchen Sink		4.3				

As2015-031 CARBON for Arsenic Removal Treatment System	
Date Installed	1999
Number of Tanks and Size	(1) 2 cubic ft carbon tank
Media in Tanks	Carbon
Additional Water Treatment Present	Softener, UV light
Missing components that are required by Hopewell Township	No sediment filter, no sediment filter before UV, no meter, no redundant arsenic system
Photo of System	

Meter Reading	NA

As2015-031 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (μg/L)	**Between Tanks** (μg/L)	**Kitchen Sink** (μg/L)	**Reverse Osmosis** (μg/L)
3/6/12		3.3	NT	4.3	

As2015-032, Monday, March 9, 2015 (Megan, Ted)

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks on 7/28/2008- file says **Solmetex, tanks say PuroLite**
    - Very nice info tag hanging from system that has date installed, and what each sampling port is.
    - Tanks were labelled
    - No sediment filter
    - No water meter
    - No easy access to raw water, tap labelled untreated was softened water
    - Softener had adequate salt
- Radioactivity
    - Background - 8 (micro R/hour)
    - Softener - 15
    - As tank #1 - 10
    - As Tank #2 - 8

As 2015-032 Field Equipment Results

Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	3/9/15	7.9	+443	237.7	6.0 (cup)	0	220	200
Between Tanks	3/9/15					0	220	0
Kitchen Sink	3/9/15					0	180	0

As 2015-032 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)
Raw Water	3/9/15	**8.8**	**1.2 13.6%**	**7.6 86.4%**	ND	ND
Between Tanks	3/9/15	8.1				
Kitchen Sink	3/9/15	ND				

As 2015-032 Arsenic Treatment System	
Date Installed	7/28/08
Number of Tanks and Size	(2) 1 cubit ft tanks
Media in Tanks	Purolite
Additional Water Treatment Present	Water softener, has enough salt
Missing components that are required by Hopewell Township	No water meter, no sediment filter
Photo of System	

Meter Reading	No meter.

As2015-032 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
3/9/15	NA	8.8	8.1	ND	

<u>As2015-033, Thursday, March 12, 2015 (Megan, Steve S., Cori)</u>

- NJ Spill Fund installed 2 carbon tanks before the homeowner bought the house
- No water meter
- No arsenic tanks
- Pre and post carbon tank sediment filter
- Selling home, closing on May 1, found out they need to install an arsenic system
- Radioactivity (initial)
    - Background -6 (micro R/hour)
    - Carbon tank #1 - 33
    - Carbon tank #2 - 33
- Radioactivity (after 1/2 hour water running)
    - Background - 6 (micro R/hour)
    - Carbon tank #1 - 33
    - Carbon tank #2 - 37

As2015-033 Field Equipment Results

Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	3/12/15	7.8	152	260	3.0	0	120	200
Between Carbon Tanks	3/12/15					0	130	200
Kitchen Sink	3/12/15					0	130	200

As2015-033 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	3/15/15	**5.5**	**0.05** **0.9%**	**5.45** **99.1%**	ND	ND
Between Tanks	3/12/15	9				
Kitchen Sink	3/12/15	8.7				

As2015-033 Treatment System (Carbon Tanks only)	
Date Installed	Unknown
Number of Tanks and Size	(2) 1.5 cubic ft carbon tanks
Media in Tanks	Carbon
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	Arsenic tanks
Photo of System	

Meter Reading	No meter

As2015-033 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)
5/3/05		6.8			
3/12/15		5.5	9	8.7	

As2015-034, Thursday, February 12, 2015 (Megan, Cori)

- Health department files said PWC installed on 12/16/2004
- Tanks say [Treatment Installer] installed (2) 2 cubic foot arsenic tanks, no date
- Reverse Osmosis system present, installer told them it was cleaner than bottled water.
- Radioactivity
  - Background – 8 (micro R/hour)
  - As tank #1 - 8
  - As Tank #2 - 7
  - Softener – 8
- [Lab] told them not to worry about the arsenic level.

As2015-034 Field Equipment Results								
Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	3/12/15	7.9	131	230	0.03	0	100	170

Between Tanks	3/12/15					0	120	0
Kitchen Sink	3/12/15					0	150	0
Reverse Osmosis	3/12/15					0	20	0

As2015-034 Laboratory Analysis

Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	3/15/15	**31.5**	**2.2** **7.0%**	**29.3** **93.0%**	9.7	ND
Between Tanks	3/12/15	9.2				
Kitchen Sink	3/12/15	5.9				
Reverse Osmosis (if applicable)	3/12/15	ND				

As2015-034 Arsenic Treatment System

Date Installed	Unknown
Number of Tanks and Size	(2) 2 cubic foot tanks
Media in Tanks	Adedge
Additional Water Treatment Present	Softener and reverse osmosis
Missing components that are required by Hopewell Township	No water meter
Photo of System	

As2015-034 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading	Raw Water	Between Tanks	Kitchen Sink	Reverse Osmosis
5/17/04	NA	30.3			
7/14/13	NA			2.8	
7/24/13	NA			31	
12/12/14	NA	29.3	2.5	29.8	
3/12/15	NA	31.5	9.2	5.9	ND

As2015-035, Thursday, March 12, 2015 (Megan, Cori)

- Does not drink the water, everyone drinks Deer Park Bottled
- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks on 9/7/2012 – **Solmetex**
- No salt in softener, told homeowner that she should keep salt in the tank because her gross alpha is 6.2. The softener will remove radium and the arsenic tanks will remove uranium. Homeowner was very happy to learn this information.
- Control on arsenic tanks says 120,000 gallons total
- Radioactivity
    - Background -9 (micro R/hour)
    - As tank #1 - 11
    - As Tank #2 - 10
    - Softener -11

As2015-035 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)

Raw Water	3/12/15	7.5	142	323	1.41	0	240	200
Between Tanks	3/12/15					0	240	200
Kitchen Sink	3/12/15					0	240	200

As2015-035 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	3/12/15	**6.6**	**0.5** **7.6%**	**6.1** **92.4%**	ND	ND
Between Tanks	3/12/15	ND				
Kitchen Sink	3/12/15	ND				

As2015-035 Arsenic Treatment System	
Date Installed	9/7/12
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	NA
Photo of System	

Meter Reading	120,000

As2015-035 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
4/19/12	NA	5.2			
6/3/12				ND treated	
8/5/04		3.5			
3/12/15	120,000	6.6	ND	ND	

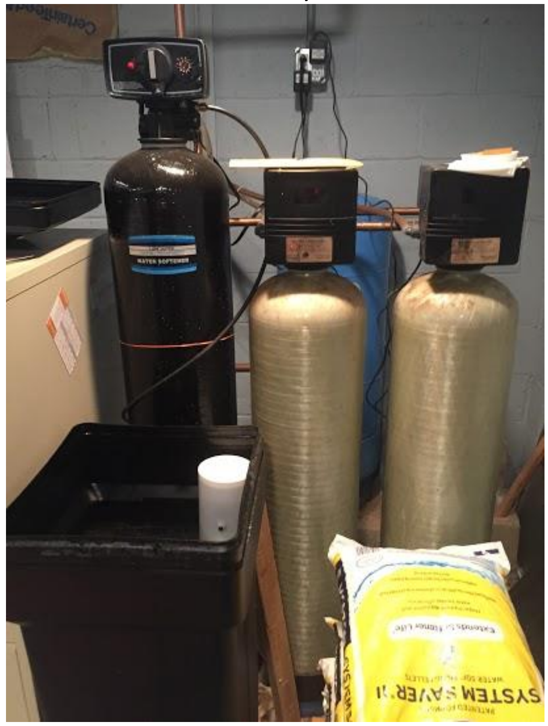
<u>As2015-036, Friday, March 13, 2015 (Megan, Cori)</u>

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in September 2008 – **Resin Tech**
- Homeowner installed the softener himself
- Possible Resin Tech beads in the toilet tank sample
- Missing water meter, Missing tap between arsenic tanks, missing sediment filter
- Radioactivity
    - Background - 8(micro R/hour)
    - As tank #1 - 15
    - As Tank #2 - 9
    - Softener - 9

As2015-036 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	3/13/15	7.9	151	410	0.60	0	600	200
Between Tanks	NT 3/13/15	NT				NT	NT	NT
Kitchen Sink	3/13/15					0	100	0

As2015-036 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	3/13/15	**7.7**	**0.05 0.6%**	**7.65 99.4%**	0.6	ND
Between Tanks	3/13/15	NT				
Kitchen Sink	3/13/15	5.2				
Reverse Osmosis (if applicable)						
NJ Drinking Water Standard		5.0	5.0	5.0	50.0	300

As2015-036 Arsenic Treatment System	
Date Installed	9/19/2008
Number of Tanks and Size	(2) 1 1/2 cubic foot tanks
Media in Tanks	Resin Tech
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	No water meter, no tap between tanks, no sediment filter

Photo of System	
	
Meter Reading	NA

As2015-036 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
8/11/08		7.8			
3/13/15		7.7	NT	5.2	

As2015-037, Friday, March 13, 2015 (Megan, Cori)

- 1 tank was installed initially by the owner and it didn't work. They called [Treatment Installer] and they installed the 2 tanks.
- Participate in the sampling program from [Treatment Installer] but don't understand what S1, S2 and S3 are
- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 6-24-11 – **Solmetex**
- Concerned about the arsenic, doesn't drink her water.
- Radioactivity
  - Background -10 (micro R/hour)
  - As tank #1 - 12
  - As Tank #2 - 14
  - Softener -14

As2015-037 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	3/13/15	7.7	145	339	1.64	0	240	200
Between Tanks	3/13/15					0	240	0
Kitchen Sink	3/13/15					0	240	0

As2015-037 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)
Raw Water	3/13/15	**16.7**	**0.05** **0.3%**	**16.65** **99.7%**	ND	ND
Between Tanks	3/13/15	ND				
Kitchen Sink	3/13/15	ND				

As2015-037 Arsenic Treatment System	
Date Installed	6/2011
Number of Tanks and Size	(2) 1 cubic ft arsenic tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	All present
Photo of System	

As2015-037 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
11/23/10		17.1			
3/13/15		16.7	ND	ND	

<u>As2015-038, Thursday, March 5, 2015 (Megan, Steve S.)</u>

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in June 2006 – **Resin Tech**
- Toilet tank: completely black, Steve said could be manganese
- Faucet Screen: clean except for a few black spots, took photos
- Salt tank has salt and is working
- Missing sediment filter and water meter
- Homeowner doesn't test her water
- Radioactivity
    - Background - 10(micro R/hour)
    - Softener –15
    - As tank #1 - 18
    - As Tank #2 - 15

As2015-038 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	3/19/15	7.5	118	724	0.03	0	120	600

Between Tanks	3/19/15					0	130	0
Kitchen Sink	3/19/15					0	140	0

As2015-038 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	3/19/15	**8.1**	**0.5** **6.2%**	**7.6** **93.8%**	117	ND
Between Tanks	3/19/15	5.9				
Kitchen Sink	3/19/15	2.9				

As2015-038 Arsenic Treatment System	
Date Installed	6/1/2006
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Resin Tech
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	Water meter, sediment filter
Photo of System	

Meter Reading	No meter

As2015-038 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
5/4/2010	NA	6.3			
6/5/2010	NA			ND treated	
3/19/2015		8.1	5.9	2.9	

As2015-039, Thursday, March 19, 2015 (Megan, Steve S.)

- Did initial PWTA testing and thought she retested but only did bacteria test in Nov 2011
- Doesn't drink the water because she doesn't like the taste of it – drinks Poland spring instead
- Cooks with the water
- No salt in salt tank, salt tank beeping, told homeowner she should keep salt in the tank in case of gross alpha contamination
- Previous owners installed system and [Treatment Installer] never sent the testing boxes
- Control on tanks says 783,000 gallons
- Helped homeowner change sediment filter which was completely black and stained the container
- Moving soon, hope to sell within 6 months
- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in August 2011 – **Solmetex**
- Also have a softener and a carbon tank

- Toilet tank: took sample
- Radioactivity
  - Background - 8(micro R/hour)
  - Softener – 80
  - As tank #1 - 14
  - As Tank #2 - 12

As2015-039 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	3/19/15	7.7	102	473	0.14	0	140	200
Between Tanks	3/19/15					0	100	300
Kitchen Sink	3/19/15					0	140	300

As2015-039 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	3/19/15	**19.5**	**1.1** **5.6%**	**18.4** **94.4%**	ND	ND
Between Tanks	3/19/15	ND				
Kitchen Sink	3/19/15	ND				

As2015-039 Arsenic Treatment System	
Date Installed	8/2011
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	Softener and possibly carbon filter
Missing components that are required by Hopewell Township	NA

Photo of System

Meter Reading	783,000

As2015-039 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
6/2011		9.5			
3/19/2015	783,000	19.5	ND	ND	

<u>As2015-040, Friday, March 27, 2015 (Megan, Steve S.)</u>

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in August 2009 – **Solmetex**
- 2 carbon tanks
- Under the sink filter “Franke FRX2” takes out iron
- Toilet tank: took sample, looks like rust
- Faucet Screen: hardness minerals, no sample
- Carbon filter set to backwash every 3 days
- Huge pressure tank
- Radon remediation system present
- [Treatment Installer] didn’t leave a wrench for homeowner to change sediment filter
- Meter on control says 10,390 gallons and current flow 11 gallons per minute. This doesn’t seem accurate if they’ve had the system since 2009
- Previous test results show Iron and Manganese ND
- 2009 Gross alpha 3.41 pCi/L

- Carbon tetrachloride 0.3 µg/L
- Took extra samples
    - RTS1 is s1 tap to compare raw to S1
    - 040KSP- kitchen sink pure tap after the Franke filter
- Radioactivity
    - Background (finished part of basement)– 10 (micro R/hour)
    - Background (unfinished part of basement) – 14
    - Carbon tank 1 - 70
    - Carbon tank 2 - 80
    - As tank #1 - 14
    - As Tank #2 – 20 (shine from other tank)

As2015-040 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	3/27/15	7.9	89	263	4.7	0	200	150
Tap "S1"	3/27/15					0	150	150
Between Tanks	3/27/15					0	120	200
Kitchen Sink	3/27/15					0	120	200

As2015-040 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	3/27/15	**10.8**	**0.05** **0.5%**	**10.75** **99.5%**	ND	ND
Raw S1 Tap	3/27/15	9.1				
Between Tanks	3/27/15	1				
Kitchen Sink	3/27/15	ND				
"Pure" Tap Franke	3/27/15	ND				

As2015-040 Arsenic Treatment System	
Date Installed	7/31/2009
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	2 Carbon tanks
Missing components that are required by Hopewell Township	NA
Photo of System 	
Meter Reading	10,390 gal (doesn't seem to be accurate)

As2015-040 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (μg/L)	**Between Tanks** (μg/L)	**Kitchen Sink** (μg/L)	**Reverse Osmosis** (μg/L)
4/21/09				7	
3/27/15	10,390	10.8	1	ND	ND

As2015-041, Friday, March 27, 2015 (Megan, Steve S.)

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2010 – **Adedge**

- Toilet tank: very clean – took a sample
- Faucet Screen: clean
- Wasn't sure if he had arsenic tanks, only knew that he had tanks in his basement and that the 2nd previous owner installed them. File from Hopewell health department confirms 2 carbon tanks and 2 arsenic tanks. Also 2 sediment filters, pre and post carbon tanks.
- Steve showed homeowner how to change a sediment filter. Homeowner was happy when his water pressure went back up.
- Radioactivity
    - Background – 7 (micro R/hour)
    - Carbon 1- 70
    - Carbon 2- 90
    - As tank #1 - 10
    - As Tank #2 - 8

As2015-041 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	3/27/15	8.0	81.1	237	4.96	0	180	200
Between Tanks	3/27/15					0	180	200
Kitchen Sink	3/27/15					0	120	200

As2015-041 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	3/27/15	**20.7**	**20.65 99.8%**	**0.05 0.2%**	ND	ND
Between Tanks	3/27/15	1.4				
Kitchen Sink	3/27/15	ND				

As2015-041 Arsenic Treatment System	
Date Installed	March 2010

Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Adedge
Additional Water Treatment Present	2 carbon tanks; 2 sediment filters
Missing components that are required by Hopewell Township	NA
Photo of System 	
Meter Reading	245,417

As2015-041 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading	Raw Water	Between Tanks	Kitchen Sink	Reverse Osmosis
2010		17			
3/27/15	245,417	20.7	1.4	ND	

As2015-042, Thursday, March 5, 2015 (Megan, Steve S., Cori)

- [Treatment Installer] installed (2) 2 cubic foot arsenic tanks in Jan-Feb 2014 – **Metsorb**
- Media in the tanks was flowing back and forth after pump kicked on. Steve thinks they may have installed it as an up flow system.

- Homeowners had a good attorney and lawyer who suggested that they get the money from the previous owner and choose their own arsenic system.
- Softener has salt and salt bags next to it
- Water has manganese
- Toilet tank: Looks like it has beads. Possibly cation beads from the softener.
- Faucet Screen: pretty clean.
- Radioactivity
    - Background - 10 (micro R/hour)
    - Softener12
    - As tank #1 - 12
    - As Tank #2 - 11
    - Carbon Sediment filter – 60 (explained this to homeowner)

As2015-042 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	3/27/15	7.5	10.1	342	0.04	0	40	200
Between Tanks	3/27/15					0	240	0
Kitchen Sink	3/27/15					0	240	0

As2015-042 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Titanium** (µg/L)
Raw Water	3/27/15	**2.6**	**0.8 30.8%**	**1.8 69.2%**	27.6	ND	41.8
Between Tanks	3/27/15	1.2					1.3
Kitchen Sink	3/27/15	2.2					ND

As2015-042 Arsenic Treatment System	
Date Installed	Jan-Feb 2014
Number of Tanks and Size	(2) 2 cubic ft tanks

Media in Tanks	Metsorb possibly upflow
Additional Water Treatment Present	Softener, 2 sediment filters (one carbon)
Missing components that are required by Hopewell Township	NA

Photo of System

As2015-042 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (μg/L)	**Between Tanks** (μg/L)	**Kitchen Sink** (μg/L)	**Reverse Osmosis** (μg/L)
12/6/13		8.6			
11/1/13				4.2 treated	
10/4/13				5.1	
3/27/15		2.6	1.2	2.2	

As2015-043, Wednesday, April 1, 2015 (Megan, Steve S.)

- [Treatment Installer] installed (2) 2 cubic foot arsenic tanks in 2012 – **Metsorb**
- Meter reading 135,520
- Toilet tank: sample taken
- Faucet Screen: pretty clean

- Currently has a 30 micron sediment filter, recommend that he uses a 5 micron
- Softener – Culligan maintained by [Treatment Installer]
    - Goes through one bag of salt per week
    - Water is very hard
    - Softener has salt, backwashed while we were there – is set to backwash every other day
    - Softener is after the arsenic tanks
- Radioactivity --- Explained to homeowner that sediment filter is radioactive
    - Background – 7 (micro R/hour)
    - Carbon Sediment filter- 60
    - As tank #1 - 9
    - As Tank #2 - 9
    - Softener –9

As2015-043 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/1/15	7.8	90	726	0.6	0	100	600
Between Tanks	4/1/15					0	100	600
Kitchen Sink	4/1/15					0	120	0

As2015-043 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Boron**
Raw Water	4/1/15	**29**	**7.1 24.5%**	**21.9 75.5%**	35	ND	**1040**
Between Tanks	4/1/15	5.7					
Kitchen Sink	4/1/15	0.7					

As2015-043 Arsenic Treatment System	
Date Installed	March 2012
Number of Tanks and Size	(2) 2 cubic ft tanks

Media in Tanks	Metsorb
Additional Water Treatment Present	Softener; Sediment filter with carbon cartridges
Missing components that are required by Hopewell Township	NA

Photo of System

Meter Reading	135,520

As2015-043 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
2/21/12		17.6			
8/9/13			2.3	0.9	
4/1/15	135,520	29	5.7	0.7	

As2015-044, Thursday, April 2, 2015 (Megan, Steve S.)

- Home well is an artesian well with an overflow pond; Barn well was drilled in 1995 and homeowner thinks it has gross alpha
- No water meter; no sediment filter
- [Treatment Installer] installed (2) 2 cubic foot arsenic tanks in 2004 – **Adedge** told him that it would last 10 years.

    - [Treatment Installer] replaced a tank in March 2015, seems to have left a trail of arsenic from the tanks to the bilco doors (photos taken). Home owner called [Treatment Installer] and they are sending someone to clean it up
- Toilet tank: Sample taken
- Radioactivity
    - Background - 5(micro R/hour)
    - Softener –7
    - As tank #1 - 7
    - As Tank #2 - 6

As2015-044 Field Equipment Results (HOME)								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/2/15	7.7	51.8	917	0.02	0	100	600
Between Tanks	4/2/15					0	110	25
Kitchen Sink	4/2/15					0	100	25

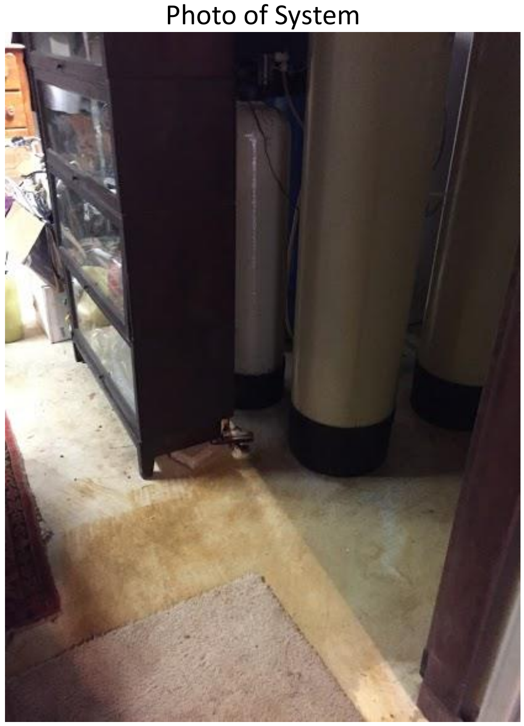
As2015-044 Field Equipment Results (BARN)								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/2/15	7.9	94.8	306	0.04			

As2015-044 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Boron** (µg/L)
Barn Water	4/2/15	**33.8**					
Raw Water	4/2/15	**38.2**	**35.1 91.9%**	**3.1 8.1%**	233	110	458
Between Tanks	4/2/15	ND					
Kitchen Sink	4/2/15	ND					

Reverse Osmosis	4/2/15	ND					

As2015-044 Arsenic Treatment System	
Date Installed	2004
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	Adedge
Additional Water Treatment Present	Softener, RO at kitchen sink
Missing components that are required by Hopewell Township	Sediment filter and water meter

Photo of System



As2015-044 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading**	**Raw Water**	**Between Tanks**	**Kitchen Sink**	**Reverse Osmosis**
2/5/04		42.4			
2/27/08		71.2	ND	ND	

4/2/15		38.2	ND	ND	ND

As2015-045, Thursday, April 2, 2015 (Megan, Steve S.)

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks 2/24/2007 – **Adedge**
- [Treatment Installer]changed the control box and added a better sediment filter
- We reprogrammed the backwashing settings. Buttons on the second control were installed incorrectly.
- Toilet tank: sandy appearance sample taken.
- Faucet Screen: faucet screen fell down the drain and was replaced with a new screen
- 11/20/2006 Gross alpha 8.0 initial; 4.0 final
- Radioactivity
  - Background - 11(micro R/hour)
  - Sediment filter- 15
  - As tank #1 - 12
  - As Tank #2 - 12

As2015-045 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/2/15	7.7	103	250	1.47	0	160	200
Between Tanks	4/2/15					0	200	200
Kitchen Sink	4/2/15					0	180	200

As2015-045 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Titanium** (µg/L)
Raw Water	4/2/15	**6.1**	**0.05 0.8%**	**6.05 99.2%**	ND	67.4	67.4
Between Tanks	4/2/15	ND					
Kitchen Sink	4/2/15	ND					58

As2015-045 Arsenic Treatment System

Date Installed	2/24/2007
Number of Tanks and Size	(2) 1 cubic ft
Media in Tanks	Adedge
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	Water meter

Photo of System

As2015-045 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
11/20/06		10.1			
9/20/07				ND	
10/19/07		9.3		ND	
6/28/13				ND	
4/2/15		6.1	ND	ND	

As2015-046, Friday, April 3, 2015 (Megan, Steve S.)

- [Treatment Installer] installed (2) 2 cubic foot arsenic tanks in 2013 – **Metsorb & RO** non backwashing
- Toilet tank: sample taken
- Homeowner reports water is red sometimes
- No sediment filter
- Uses "resin cleaning solution" dumps in softener tank "res-care" ([Treatment Installer] recommended he do this, they service the softener) Steve suggested Iron-out salt in the green bag
- Paid $4380
- Meter reading is 17 gallons (though all 4 family members showered). He reset the beeping meter this morning. He thinks it said 50,000 gallons before he reset it. It's unclear why it was beeping.
- Did a 3 gallon test and the meter appears to be working
- Septic issues, homes on this street have mound septics
- Radioactivity
    - Background - 4(micro R/hour)
    - As tank #1 - 5
    - As Tank #2 - 5
    - Softener –5
    - RO - 7

As2015-046 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/3/15	7.9	102	579	0.01	0	180	300
Between Tanks	4/3/15					0	180	300
Kitchen Sink	4/3/15					0	180	0
Reverse Osmosis	4/3/15	7.1	112	60.6	0.01	0	50	0

As2015-046 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Titanium** (µg/L)
Raw Water	4/3/15	**8.9**	**0.05** **0.6%**	**8.85** **99.4%**	96.3	57	91.1

Between Tanks	4/3/15	ND					
Kitchen Sink	4/3/15	ND					3.9
Reverse Osmosis	4/3/15	ND					

As2015-046 Arsenic Treatment System	
Date Installed	10/2/2013
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	Metsorb
Additional Water Treatment Present	Softener and RO
Missing components that are required by Hopewell Township	Sediment filter

Photo of System

Meter Reading	17 gallons

As2015-046 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
4/3/15	17 gallons (was reset)	8.9	ND	ND	ND

As2015-047, Friday, April 10, 2015 (Megan, Steve S.)

- Part of an arsenic study from 15 years ago. Dr. Meng (Stevens Institute of Technology) installed a titanium point-of-use system. Homeowner is using the original hardware and now replaces the cartridges with something he found online
- Homeowner is considering installing a POET because of Hopewell Twp's requirement
- Took a sample from the hot tub "HT"
- Filter was last changed in 10/2/13
- Post-treatment sediment filter present
- Cartridges – Doulton A5 Imperial arsenic reduction cartridge $128
- Toilet tank: no sample taken
- Faucet Screen: no sample taken
- Homeowner has a letter stating he is in the area for a VOC issue, but never detected any VOCs
- Radioactivity
    - Background -8 (micro R/hour)
    - Basement - 9
    - Carbon Filter - 12
    - As cartridge - 11

As2015-047 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/10/15	8.0	141	289	4.4	0	120	160
Between Tanks	4/10/15							
Kitchen Sink	4/10/15					0	100	160
Hot Tub	4/10/15	6.0	764	639	6.7			

As2015-047 Laboratory Analysis

Sample Location	Sample Date	Total Arsenic (µg/L)	Arsenic (III) (µg/L)	Arsenic (V) (µg/L)	Manganese (µg/L)	Iron (µg/L)	Titanium (µg/L)
Raw Water	4/10/15	**12.7**	**0.05** **0.4%**	**12.65** **99.6%**	0.8	ND	41.8
Between Tanks	4/10/15						
Kitchen Sink	4/10/15	ND					54.8
Hot Tub	4/10/15						

As2015-047 Arsenic Treatment System	
Date Installed	2000
Number of Tanks and Size	POU
Media in Tanks	Cartridge from Doulton
Additional Water Treatment Present	Sediment filter
Missing components that are required by Hopewell Township	Water meter, dual tank POET

Photo of System

As2015-047 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
10/30/2001		18			
12/21/2001		20 As 100iron			
10/29/2004		21		0.4	
6/13/2005				ND	
11/15/2005				ND	
7/19/2007				ND	
4/10/15		12.7		ND	

As2015-048, Friday, April 10, 2015 (Megan, Steve S.)

- [Treatment Installer] installed a POE **Reverse Osmosis** system
- Toilet tank: did not sample
- Faucet Screen: did not sample
- UV light without a sediment filter
- Radioactivity
    - Background - 8(micro R/hour)
    - Softener - 11
    - Carbon on RO – 10 & 12
    - Cinder block 12

As2015-048 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/10/15	7.8	241	342	2.9	0	180	200
Between Tanks	4/10/15							
Kitchen Sink (after softener)	4/10/15					0	180	50
Reverse Osmosis	4/10/15					0	40	0

As2015-048 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)	**Titanium** (μg/L)
Raw Water	4/10/15	**0.6**	**0.05 8.3%**	**0.55 91.7%**	0.8	15.5	73.3
Between Tanks							
Kitchen Sink							
Reverse Osmosis	4/10/15	ND					

As2015-048 Arsenic Treatment System	
Date Installed	2002 & filters changed 6 months ago
Number of Tanks and Size	Reverse osmosis
Media in Tanks	NA
Additional Water Treatment Present	Softener, UV light
Missing components that are required by Hopewell Township	Redundant POET arsenic system, water meter, sediment filter
Photo of System	

Meter Reading	No meter

As2015-048 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (μg/L)	**Between Tanks** (μg/L)	**Kitchen Sink** (μg/L)	**Reverse Osmosis** (μg/L)
4/10/15		0.6			ND

<u>As2015-049, Friday, April 10, 2015 (Megan, Steve)</u>

- [Treatment Installer] installed (2) Isolux tanks (both worker tanks, not redundant)– **Isolux**
    - Last serviced in 2014, 125K gallons ago, per husband
- Toilet tank: had white and black sediment, took a sample
- Faucet Screen: didn't have anything
- Homeowner reports very bad water pressure. If she takes a shower and someone flushes a toilet the water in the shower turns off for 30 seconds.
- Well is 600 feet deep. They replaced the well pump 3 years ago and were charged $15,000
- Has a water softener but it is not working because there is no salt in the tank. Wife thinks they have never put salt in the tank
- Homeowner has taken her own sample in a water bottle and mailed it to treatment company in Flemington.
- Meter reading: 622,865
- 3 different sediment filters
    - "Ag tank" a 14x65 tank with unknown media. Autotrol backwashing head was not plugged in and therefore not backwashing

  - "Harmsco Industrial Filters" Industrial size sediment filter – unknown what kind of filter is inside
  - 3rd sediment filter looks like 2 rope filters stacked on top of each other
- Radioactivity
  - Background - 8(micro R/hour)
  - Ag tank -12
  - Softener - 9

As2015-049 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/10/15	8.0	136	275	1.4	0	120	170
Between Tanks								
Kitchen Sink	4/10/15					0	120	170

As2015-049 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	4/10/15	**2.9**	**0.05** **1.7%**	**2.85** **98.3%**	2.2	290
Between Tanks		NT				
Kitchen Sink	4/10/15	ND				

As2015-049 Arsenic Treatment System	
Date Installed	Existing when they moved in
Number of Tanks and Size	(2) isolux filters, not redundant
Media in Tanks	Isolux
Additional Water Treatment Present	3 different sediment filters Softener

Missing components that are required by Hopewell Township	Redundant arsenic tank

Photo of System

Meter Reading	622,865

As2015-049 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading	Raw Water	Between Tanks	Kitchen Sink	Reverse Osmosis
4/10/15	622,865	2.9	NT	ND	

As2015-050, Thursday, April 16, 2015 (Megan, Steve S.)

- Previous owners installed the system. Hasn't been looked at since install 2.5 years ago.
- They've been using bottled water since they moved in and do not trust the water.
- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2012 – **Metsorb**
- Toilet tank: Took sample, a lot of sediment in the downstairs toilet, pasty grey (removed this toilet before we came)
- Faucet Screen:
- Meter reading: 87,060
- [Treatment Installer] doesn't send them postcards
- Black/grey chunks in washing machine when they first moved in. Grey chunks clogging bathroom sink
- No softener but thinks water is really hard
- No sediment filter
- Radon treatment present for air
- Previous test results show no iron or manganese, gross alpha initial 15.4 and final 8.69
- Radioactivity
  - Background - 11(micro R/hour)
  - As tank #1 - 15

- As Tank #2 - 13

As2015-050 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/16/15	8.1	103	225	7.0	0	120	150
Between Tanks	4/16/15					0	120	150
Kitchen Sink	4/16/15					0	120	150

As2015-050 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Titanium** (µg/L)
Raw Water	4/16/15	**9.8**	**0.05** **0.5%**	**9.75** **99.5%**	ND	ND	33.8
Between Tanks	4/16/15	0.5					
Kitchen Sink	4/16/15	ND					37.3

As2015-050 Arsenic Treatment System	
Date Installed	10/25/12
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Metsorb
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	Sediment filter
Meter Reading	87,600

As2015-050 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
10/23/12		16.9		1.2	
4/16/15	87,600	9.8	ND	ND	

As2015-051, Friday, April 17, 2015 (Megan, Steve S., Yelena)

- Large softener and UV light installed on 7/7/14
- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks – **Solmetex**
- Well supplies this home and 2 others + barn
- Softener does not contain enough salt
- Very happy to learn about NJ financing for new arsenic system
- Homeowner thinks the tanks were just "switched" by the pump guy. She will email me his name and any test results
- Toilet tank: sample taken
- Faucet Screen: no sample taken
- Reverse osmosis system is a Culligan water tower. It doesn't seem to work as well as other brands. Homeowner just replaced all cartridges. R.O. light is on tap and it's green. Homeowner changed it when it turned orange.
- Radioactivity
    - Background - 14(micro R/hour)
    - Softener –24
    - As tank #1 - 16
    - As Tank #2 - 14

As2015-051 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/17/15	8.0	95	355	3.8	0	100	200
Between Tanks	4/17/15					0	100	50
Kitchen Sink	4/17/15					0	160	50
Reverse Osmosis	4/17/15					0	100	0

As2015-051 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)	**Titanium** (μg/L)
Raw Water	4/17/15	**3.1**	**0.05 1.6%**	**3.05 98.4%**	ND	ND	77.2
Between Tanks	4/17/15	8					
Kitchen Sink	4/17/15	2.9					**2.1**
Reverse Osmosis	4/17/15	ND					

As2015-051 Arsenic Treatment System	
Date Installed	Unknown
Number of Tanks and Size	(2) 1 cubic ft tanks, not adequate for the number of houses it serves
Media in Tanks	Solmetex
Additional Water Treatment Present	Softener, UV light (no sediment filter)
Missing components that are required by Hopewell Township	Sediment filter
Photo of System	

Meter Reading	690,997

As2015-051 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
12/13/06		5.6			
4/11/11		5.5			
4/17/13				<0.5	
4/27/13				<0.5	
4/17/15		3.1	8	2.9	ND

As2015-052, Friday, April 17, 2015 (Megan, Steve S., Yelena)

- Showed homeowner how to test her water, from between the arsenic tanks.
- Reset Ag filter and arsenic tank backwashing days to be less frequent (As tanks were set to backwash every 2 days)
- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks 5-7 years ago – **Adedge**
- Toilet tank: sample taken
- Faucet Screen: no sample
- Has a really small sediment filter, surprised the water pressure isn't bad
- Radioactivity
    - Background - 6(micro R/hour)
    - Mini sediment filter – 8

- Filter Ag - 9
- As tank #1 - 6
- As Tank #2 - 7
- Softener –8

As2015-052 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/17/15	7.9	106	285	0.49	0	120	200
Between Tanks	4/17/15					0	120	200
Kitchen Sink	4/17/15					0	120	0

As2015-052 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)	**Titanium** (μg/L)
Raw Water	4/17/15	**9.6**	**0.05 0.5%**	**9.55 99.5%**	2	ND	77.5
Between Tanks	4/17/15	**8.3**					
Kitchen Sink	4/17/15	0.6					**5.8**

As2015-052 Arsenic Treatment System	
Date Installed	5-7 years ago
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Adedge
Additional Water Treatment Present	Small sediment filter, ag filter, softener
Missing components that are required by Hopewell Township	Water meter
Photo of System	

Meter Reading	NA

As2015-052 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)
1/31/2007				ND	
8/5/2010				3.1	
2/28/2011			7.9		
1/6/2012				1.2	
11/26/2012				1.8	
10/15/13				2.7	
4/17/15		9.6	8.3	0.6	

<u>As2015-053, Tuesday, April 21, 2015 (Megan, Steve S.)</u>

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2006-2008 time – **Solmetex**
- Toilet tank: took sample
- Faucet Screen: did not take sample
- Has a UV system and pays [Treatment Installer]$480/year to change the light bulb, possibly add salt and “service” system
- Gets [Treatment Installer] test kit in the mail and doesn’t want to test herself
- No sediment filter before the UV light

- Thinks her raw arsenic is 5 µg/L, tested originally because of VOC issue
- Neighbor referred and plans to refer friends in Titusville
- Meter – 330,500 green light on control
- Very concerned about water but does not have any previous test results
- Radioactivity
  - Background - 8(micro R/hour)
  - As tank #1 - 13
  - As Tank #2 - 13
  - Softener –26 has salt

As2015-053 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/21/15	7.8	98	392	0.09	0	120	200
Between Tanks	4/21/15					0	180	200
Kitchen Sink	4/21/15					0	180	0

As2015-053 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Titanium**
Raw Water	4/21/15	**5.9**	**0.05 0.8%**	**5.85 99.2%**	28.9	ND	103
Between Tanks	4/21/15	ND					
Kitchen Sink	4/21/15	ND					

As2015-053 Arsenic Treatment System	
Date Installed	2006-2008
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	UV light, water softener

<table>
<tr><td>Missing components that are required by Hopewell Township</td><td>NA</td></tr>
<tr><td colspan="2">Photo of System
</td></tr>
<tr><td>Meter Reading</td><td>330,500 (water conservers)</td></tr>
</table>

<u>As2015-054, Thursday, April 23, 2015 (Megan, Steve S.)</u>

- [Treatment Installer] installed (2) 2 cubic foot arsenic tanks in 2014 - **Metsorb**
- Toilet tank: clean, recently replaced
- Faucet Screen: clean
- Homeowner reports that [Treatment Installer] installed a backwashing system. [Treatment Installer] told him it was too small for the size of his house and needed to install a bigger, passive system. They told him the backwashing system was too problematic. [Treatment Installer] said the Metsorb tanks would last 7-9 years. They had arsenic breakthrough after a year-2 so [Treatment Installer] put in a buffer system last year, 2014.
- Called [Treatment Installer] to make sure the tanks should not be on all the way, tank number one was half on.
- In 2012 the well pump was replaced. Homeowner thinks the well was 110ft deep
- Meter Reading: 188,089 gallons
- Sulfur smell
- Likely Arsenic (III)
- Homeowner paid [Treatment Installer] $3800 for Metsorb tanks and $1000 for mixed bed material. Was told he was getting the mixed bed material “at cost”
- Radioactivity
    - Background – 9 (micro R/hour)
    - As tank #1 - 10
    - As Tank #2 - 9
    - Softener –10 has salt

As2015-054 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/23/15		25.0	308	0.02	0	200	200
Between Tanks	4/23/15					0	120	150
Kitchen Sink	4/23/15					0	120	0

As2015-054 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Titanium** (µg/L)
Raw Water	4/23/15	**3.5**	**3.7** **105.7%**	**-0.2** **-5.7%**	61.7	98	42.3
Between Tanks	4/23/15	4.5					
Kitchen Sink	4/23/15	ND					**4.6**

As2015-054 Arsenic Treatment System	
Date Installed	2008 Adedge, 2013 Metsorb
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	Metsorb
Additional Water Treatment Present	Softener, UV light
Missing components that are required by Hopewell Township	NA
Photo of System	

Meter Reading	188,089

As2015-054 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Notes**
2/4/2008		6.9			
8/22/2008			ND		
2/18/2009	27,720		ND		
9/12/2009	66,120		ND		
4/29/2011	188,795		1.8		Tanks changed to Metsorb here?
1/24/2012			ND		
11/5/2012			1.3		
9/17/13			1.5		
7/31/2014				ND	Tanks changed to mixed bed here?

4/23/15	188,089	3.5		ND	

As2015-055, Thursday, April 23, 2015 (Megan, Steve S.)

- [Treatment Installer] installed a reverse osmosis system in 2003
- Toilet tank: sample taken
- Faucet Screen: no sample taken
- Meter Reading: no meter
- Had bad experiences with water treatment salesmen, too many different options and opinions, no one agreed, didn't know who to trust
- Thinks she has 8 µg/L arsenic
- Has salt in the softener and the water level is really high
- Radioactivity
  - Background - 8(micro R/hour)
  - Softener – 9

As2015-055 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/23/15	8.0	101	255	2.3	0	180	150
Kitchen Sink (after softener)	4/23/15					0	180	0
Reverse Osmosis	4/23/15					0	40	0

As2015-055 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Titanium** (µg/L)
Raw Water	4/23/15	**13.8**	**15.2** **110.1%**	**-1.4** **-10.1%**	1.6	410	52.5
Kitchen Sink	4/23/15	ND					
Reverse Osmosis	4/23/15	ND					

As2015-055 Arsenic Treatment System	
Date Installed	2003
Number of Tanks and Size	
Media in Tanks	Reverse osmosis system only
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	Meter, sediment filter, whole house -dual tank arsenic treatment system
Photo of System 	
Meter Reading	No meter

<u>As2015-056, Thursday, April 23, 2015 (Megan, Steve S.)</u>

- Believes that the water table raised when adjacent neighborhood went it because her sump pump is constantly working
- Softener has salt, she fills her own salt tank
- [Treatment Installer] told her to change tanks at 700,000 gallons, which seems like a good estimate based on her levels
- [Treatment Installer]installed (2) 1 cubic foot arsenic tanks in 2006 – **Adedge** with backwashing heads $2800 (she got many quotes)

- In 1997 – 1.9 trans – 1,2 dichloroethene
- 6/30/1999 cis 1-2 dichloroethylene ----- 1.2 µg/L
- Toilet tank: looked clean, took samples
- Changes her own reverse osmosis filters, last changed in Oct 2014
- Meter Reading: 187,229 (6 years)
- Radioactivity
    - Background -12 (micro R/hour)
    - Softener – 12
    - As tank #1 - 14
    - As Tank #2 - 14

As2015-056 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/23/15	7.8	104	435	1.5	0	120	300
Between Tanks	4/23/15					0	180	0
Kitchen Sink	4/23/15					0	120	0
Reverse Osmosis	4/23/15					0	40	0

As2015-056 Laboratory Analysis							
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)	**Titanium** (µg/L)
Raw Water	4/23/15	**8.5**	**0.05 0.6%**	**8.45 99.4%**	ND	ND	105
Between Tanks	4/23/15	ND					
Kitchen Sink	4/23/15	ND					**5.5**
Reverse Osmosis	4/23/15	ND					

As2015-056 Arsenic Treatment System

Date Installed	2008
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Adedge
Additional Water Treatment Present	Water softener, R.O.
Missing components that are required by Hopewell Township	NA
Photo of System	
Meter Reading	187,229 /6 years

As2015-056 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (μg/L)	**Between Tanks** (μg/L)	**Kitchen Sink** (μg/L)	**Reverse Osmosis** (μg/L)
8/13/02		2.2			
8/13/07		8.9			
12/20/07				ND	
4/23/15	187,229	8.5	ND	ND	ND

<u>As2015-057, Thursday, April 30, 2015 (Megan, Steve S.)</u>

- Gross alpha note from Health Department
- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2006 – **Resin Tech (but looks like Metsorb)**
- Toilet tank: downstairs was clean but upstairs was completely black/dark sediment
- Home has a radon remediation system
- Not enough salt in the softener
- No sediment filter
- Faucet Screen:
- Meter Reading:199,860
- 11/12/13 manganese 6.5, As ND, Iron ND, gross alpha initial 6.7, final 14.96 (possible radium 224 due to number going up
- Their lawyer made the seller put money in an account and they couldn't get it back until the system passed 3 years of water tests.
- Radioactivity
  - Background -15 (micro R/hour)
  - Softener –20
  - As tank #1 - 23
  - As Tank #2 - 16

As2015-057 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	4/30/15	8.3	94	252	0.2	0	180	150
Between Tanks	4/30/15					0	180	0
Kitchen Sink	4/30/15					0	180	0

As2015-057 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	4/30/15	15.7	1.9 (12.1%)	13.8 (87.9%)	12.6	ND
Between Tanks	4/30/15	10.5				

Kitchen Sink	4/30/15	4.2				

As2015-057 Arsenic Treatment System	
Date Installed	10/30/13
Number of Tanks and Size	(2) 1.5 cubic ft tanks
Media in Tanks	Resin Tech (appears to be Metsorb though)
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	
Photo of System 	
Meter Reading	119,860

As2015-057 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
10/10/16		16			
11/12/13				ND	

2/5/14				ND	

As2015-058, Thursday, May 14, 2015 (Megan, Yelena)

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2012 – **Metsorb**
- Toilet tank: took sample but looked clean
- Faucet Screen:
- Meter Reading: 85,035
- No sediment filter
- Radioactivity
  - Background - 12(micro R/hour)
  - As tank #1 - 14
  - 0As Tank #2 - 14

As2015-058 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	5/14/15	8.1	104	269	4.05	0	180	200
Between Tanks	5/14/15					0	120	200
Kitchen Sink	5/14/15					0	180	200

As2015-058 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	5/14/15	9.5	1.1 (11.6%)	8.4 (88.4%)	ND	ND
Between Tanks	5/14/15	3.1				
Kitchen Sink	5/14/15	1				

As2015-058 Arsenic Treatment System	
Date Installed	2012
Number of Tanks and Size	(2) 1 cubic ft tanks

Media in Tanks	Metsorb
Additional Water Treatment Present	NA
Missing components that are required by Hopewell Township	Sediment filter
Photo of System 	
Meter Reading	85,035

As2015-058 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
9/19/12		9.86			
10/11/12				ND treated	

<u>As2015-059, Thursday, May 14, 2015 (Megan, Steve S.)</u>

- House was previously connected to the same well as neighbor
- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2010 – **Solmetex**
- Says they test every 2 years but don't have results.
- Toilet tank: sample taken
- Faucet Screen: couldn't get the faucet screen off
- Meter Reading: 301,500 since 2010

- Radioactivity
    - Background -8 (micro R/hour)
    - As tank #1 - 13
    - As Tank #2 - 8

As2015-059 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	5/14/15	8.7	83.3	332	7.3 (air in pump?)	0	200	180
Between Tanks	5/14/15					0	200	180
Kitchen Sink	5/15/15					0	200	180

As2015-059 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	5/14/15	10.6	1.5 (14.2%)	9.1 (85.8%)	ND	ND
Between Tanks	5/14/15	13.6				
Kitchen Sink	5/14/15	32.5				

As2015-059 Arsenic Treatment System	
Date Installed	2010
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Solmetex
Additional Water Treatment Present	
Missing components that are required by Hopewell Township	
Photo of System	

Meter Reading	301,500

As2015-059 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
3/12/2010		14.4			

As2015-060, Thursday, May 21, 2015 (Megan, Steve S., Yelena)

- Strong sulfur smell in water
- Husband installed (1) 2 cubic foot arsenic tank in June 2012 – filled one tank with 2 tanks worth of Metsorb and left the second tank empty.
- Toilet tank: blue, took a sample
- Faucet Screen: no sample taken
- Think they have Arsenic (III) based on readings and sulfur smell
- Meter Reading: 283,210
- Radioactivity
    - Background - 12(micro R/hour)
    - Softener –12
    - As tank #1 - 10

As2015-060 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	5/21/15	8.2	13.6	290	0.02	0	160	250

Kitchen Sink	5/21/15					0	200	0

As2015-060 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic 3** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	5/21/15	9.2	3.6 (39.1%)	5.6 (60.9%)	73.4	100
Between Tanks	5/21/15	NT				
Kitchen Sink	5/21/15	7.4				

As2015-060 Arsenic Treatment System	
Date Installed	June 2012
Number of Tanks and Size	(1) 2 cubic ft tank
Media in Tanks	Metsorb
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	2nd arsenic tank

Photo of System

Meter Reading	283,210

As2015-061, Wednesday, May 27, 2015 (Megan, Steve S., Rachel)

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks 5/17/13 – **Resin Tech**
- Code on backwash heads: As#1 HR318, As#2 HR484
- Recommend that homeowner tests gross alpha yearly
- 4/22/15 0.12 mg/ml manganese or 120 µg/L
- 4/22/15 gross alpha initial 22.08 pCi/L final 20.74 pCi/L
- Toilet tank: sample taken
- Faucet Screen: no sample
- Meter Reading: 82,756
- Radioactivity
    - Background - 8(micro R/hour)
    - Softener – 15
    - As tank #1 - 16
    - As Tank #2 - 13

As2015-061 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	5/27/15	8.34	80.4	230	0.3	0	180	200
Between Tanks	5/27/15					0	180	200
Kitchen Sink	5/27/15					0	150	0

As2015-061 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	5/27/15	7.0	0.05 (0.7%)	6.95 (99.3%)	49.2	ND
Between Tanks	5/27/15	2.4				
Kitchen Sink	5/27/15	ND				

As2015-061 Arsenic Treatment System	
Date Installed	5/17/13

Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Resin Tech
Additional Water Treatment Present	Softener
Missing components that are required by Hopewell Township	Sediment filter
Photo of System	
Meter Reading	82,756

As2015-061 Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)
4/22/13				7.3	
6/4/13				ND	
5/27/15	82,756	7	2.4	ND	

As2015-062, Wednesday, May 27, 2015 (Megan, Steve S., Rachel)

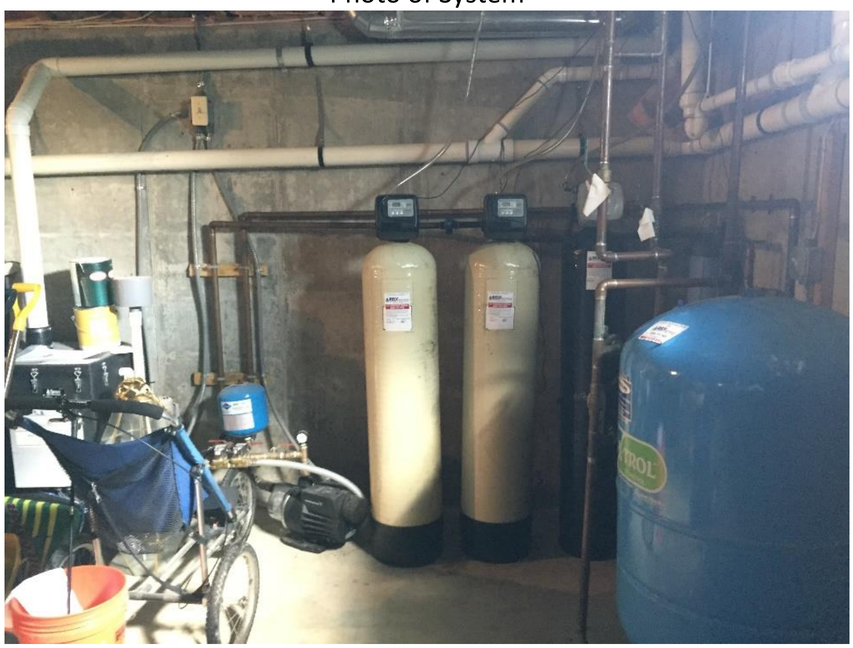
- [Treatment Installer] installed (2) 2 cubic foot arsenic tanks in 2009-10 – **Adedge**
- Toilet tank: sample taken
- Faucet Screen: no sample

- Homeowner said [Treatment Installer] came in $3000 higher than previous time changed out tanks
- [Treatment Installer] told her to wait until safety is filled and he will replace with his system
- Bubbler installed by [Treatment Installer] in 2006
- Radioactivity
  - Background -8 (micro R/hour)
  - Softener – 10
  - As tank #1 - 8
  - As Tank #2 - 8

As2015-062 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)
Raw Water	5/27/15	7.8	74	247	0.7	0	130	220
Between Tanks	5/27/15					0	140	0
Kitchen Sink	5/27/15					0	140	0
Reverse Osmosis	5/27/15					0	60	0

As2015-062 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)
Raw Water	5/27/15	41.6	0.9 (2.2%)	40.7 (97.8%)	8	ND
Between Tanks	5/27/15	11.7				
Kitchen Sink	5/27/15	2.1				
Reverse Osmosis	5/27/15	ND				

As2015-062 Arsenic Treatment System

Date Installed	2009-10
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	Adedge
Additional Water Treatment Present	Bubbler (not on), Softener, RO
Missing components that are required by Hopewell Township	Water meter
Photo of System 	
Meter Reading	No water meter

As2015-063, Tuesday, August 25, 2015 (Megan, Steve S., Ryan)

- Homeowner installed Home Depot Reverse Osmosis
- Meter Reading: no meter present
- Radioactivity
  - Background -7 (micro R/hour)
  - Sediment filter – 8
  - Pressure tank - 7

As2015-063 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP** (mv)	**TDS** (mg/L)	**DO** (mg/L)	**Chlorine** (mg/L)	**Alkalinity** (mg/L)	**Hardness** (mg/L)

Raw Water	8/25/15	7.7	160	326	4.4	0	200	250
Kitchen Sink	8/25/15					0	180	180
Reverse Osmosis	8/25/15	7.4	171	13				

As2015-063 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (μg/L)	**Arsenic (III)** (μg/L)	**Arsenic (V)** (μg/L)	**Manganese** (μg/L)	**Iron** (μg/L)
Raw Water	8/25/15	3.9	0%	100%	ND	ND
Kitchen Sink	8/25/15	4.0				
Reverse Osmosis	8/25/15	ND				

As2015-063 Arsenic Treatment System	
Date Installed	8/25/15
Number of Tanks and Size	R.O.
Media in Tanks	
Additional Water Treatment Present	NA, just sediment filter
Missing components that are required by Hopewell Township	Dual tank arsenic treatment system, water meter
Photo of System	

Meter Reading	No meter

As2015-064, Thursday, March 5, 2015 (Megan, Steve S.)

- [Treatment Installer] installed (2) 1 cubic foot arsenic tanks in 2010 – **Metsorb (backwashing)**
- Toilet tank: took sample, orange
- Meter Reading: 214,300
- Pressure tank is in the hatch outside the house, second pressure tank is after the treatment system. Called [Treatment Installer] to look at the system and wants to use them in the future. Wants instructions how to test her water and what to test for. Recommend she tests for gross alpha, arsenic
- PWTA results from 2010 show arsenic at 11.8 µg/L, manganese at 260 µg/L (over the limit of 50 µg/L and close to health advisory of 300 µg/L), gross alpha initial 81.7 and final 87.1 pCi/L
- Radioactivity
    - Background – 12 (micro R/hour)
    - Sediment filter - 14
    - As tank #1 - 38
    - As Tank #2 - 26
    - Softener –18
    - Softener 2 - 15

As2015-064 Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP (mv)**	**TDS (mg/L)**	**DO (mg/L)**	**Chlorine (mg/L)**	**Alkalinity (mg/L)**	**Hardness (mg/L)**
Raw Water	8/25/15	8.1	138	365	-0.00	0	120	250

Between Tanks	8/25/15					0	120	200
T2	8/25/15					0	180	200
Kitchen Sink	8/25/15					0	0	60

As2015-064 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	8/25/15	14.2	7.7%	92.3%	48.6	ND
Between Tanks	8/25/15	1.4				
T2	8/25/15	ND				
Kitchen Sink	8/25/15	ND				

As2015-064 Arsenic Treatment System	
Date Installed	2010
Number of Tanks and Size	(2) 1 cubic ft tanks
Media in Tanks	Adedge
Additional Water Treatment Present	2 softeners (anion, cation); Sediment filter
Missing components that are required by Hopewell Township	NA
Photo of System	

Meter Reading	214,300

As2015-064 Treatment System History (Previous Arsenic Test Results)					
Date of Test	**Meter Reading** (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
11/10/2010		11.8			

<u>As2015-065, Thursday, March 5, 2015 (Megan, Steve S.)</u>

- [Treatment Installer] installed (2) 2 cubic foot arsenic tanks in 2015 – **Metsorb**
- Meter Reading: 49,010
- [Treatment Installer] installed anion/cation
- Had [Treatment Installer] sampling program at previous house and liked their method of testing and maintenance
- Participated in Columbia research study – when homeowner tested his water for the study he didn't know what sample ports to test from
- Homeowner worried about sodium and radon levels in water
- Sample ports were unlabeled
- Radioactivity
    - Background -9 (micro R/hour)
    - Cation -10
    - Anion –
    - As tank #1 - 8
    - As Tank #2 - 8

As2015-065 Field Equipment Results

Sample Location	Sample Date	pH	ORP (mv)	TDS (mg/L)	DO (mg/L)	Chlorine (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)
Raw Water	9/3/15	7.6	34	822	0.0	0	Over 240	200
After Anion/Cation	9/3/15					0	80	0
Between As Tanks	9/3/15					0	60	0
Kitchen Sink	9/3/15					0	60	0

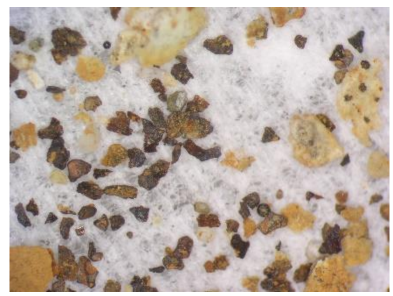
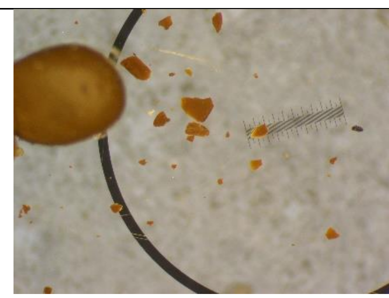
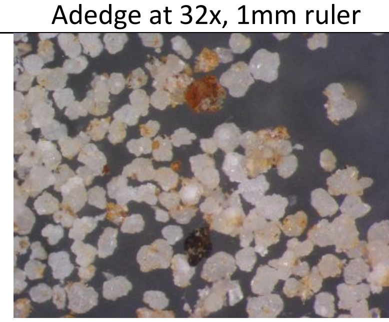
As2015-065 Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic** (µg/L)	**Arsenic (III)** (µg/L)	**Arsenic (V)** (µg/L)	**Manganese** (µg/L)	**Iron** (µg/L)
Raw Water	9/3/15	4.9	71.4%	28.6%	130	310
After Anion/Cation	9/3/15	3.5				
Between Tanks	9/3/15	0.5				
Kitchen Sink	9/3/15	ND				

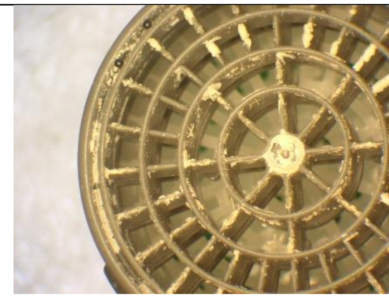
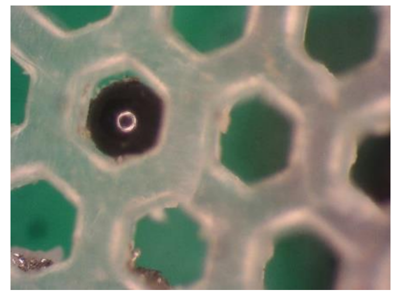
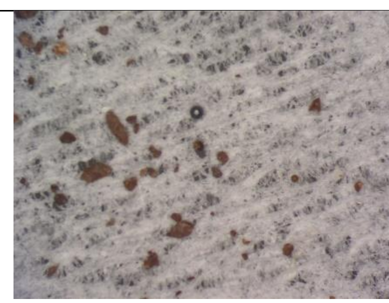
As2015-065 Arsenic Treatment System	
Date Installed	2015
Number of Tanks and Size	(2) 2 cubic ft tanks
Media in Tanks	Metsorb
Additional Water Treatment Present	Anion/cation
Missing components that are required by Hopewell Township	Sediment filter
Photo of System	

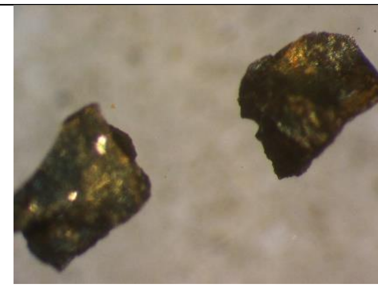
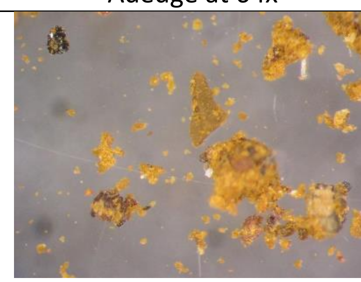
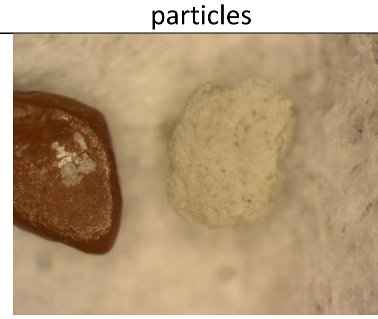
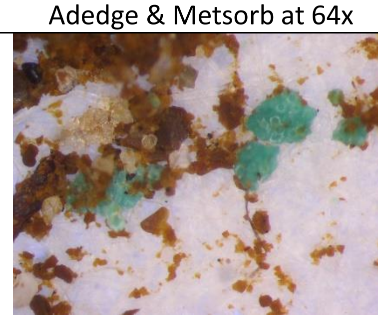
Meter Reading	49,010

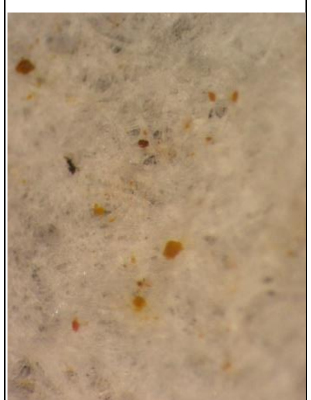
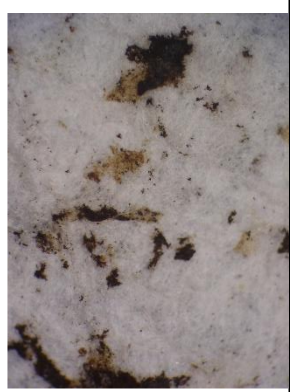
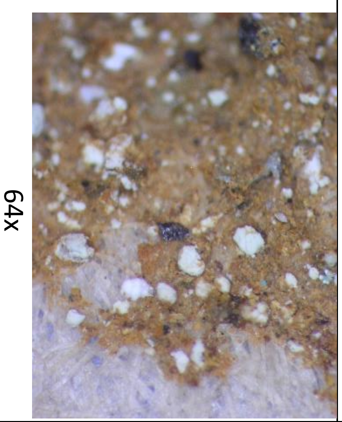
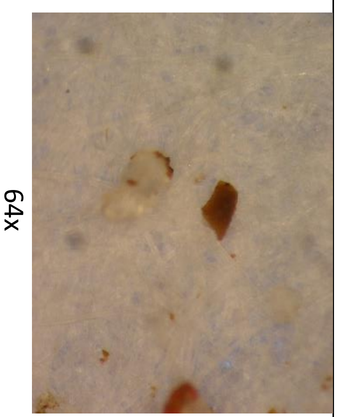
As2015-065 Treatment System History (Previous Arsenic Test Results)					
	Meter Reading (gallons)	**Raw Water** (µg/L)	**Between Tanks** (µg/L)	**Kitchen Sink** (µg/L)	**Reverse Osmosis** (µg/L)
11/4/14		7.47			
7/17/15				<0.1	
9/3/15	49,010	4.9	0.5	ND	

Appendix J: Toilet Tank and Faucet Screen Analysis

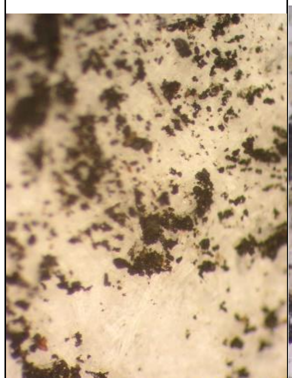
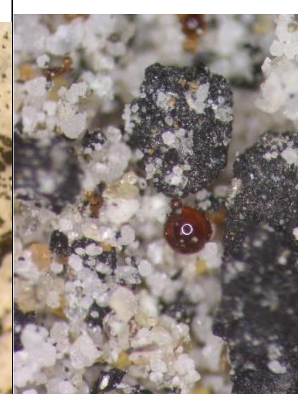
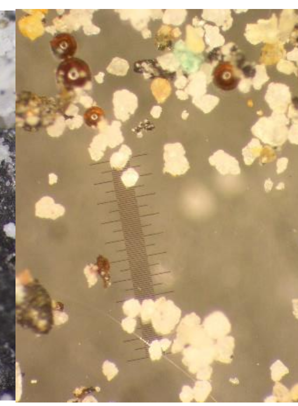
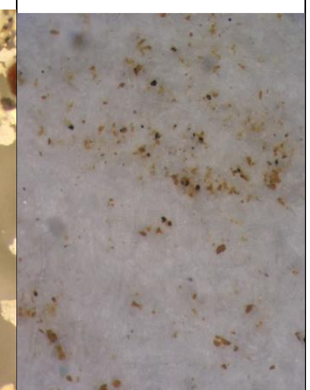
House ID	Location	Type of Treatment in home	Media found?	Likely Source	Notes	Photo
As2015-001	Toilet	Metsorb	Yes	Resin Tech or Metsorb	Notes say the homeowner had Metsorb. Saw 6 **black beads** in the toilet tank. This could mean Resin Tech (they don't have a softener). Some white particles that could be Metsorb. Other rocks: orange, black and white. White pieces were slightly translucent (not opaque like Metsorb)	
As2015-002	Toilet	Adedge	Yes	Adedge	Toilet sediment is brown, appears like clay that has been cut in half and slightly shiny or metallic. Beads were not seen.	 Adedge at 32x, 1mm ruler
As2015-003	Toilet	Layne RT Had a Softener	No		Looks like sand. Tan and orange irregular shaped, slightly translucent	 64x

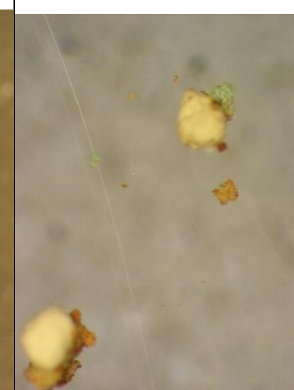
As2015-004	Sink Screen	Resin Tech Carbon	Yes	Resin Tech	Black beads came out of the upstairs bathroom faucet. Also black beads stuck in the faucet filter and around the rim of the filter.	 7.5x bottom of faucet screen  64x Resin bead in filter screen
As2015-005	Sink	Metsorb Softener	No		No particles in filter	
	Toile		No			
As2015-006	Faucet	Softener Metsorb	No			
As2015-007	Toilet	Solmetex Softener	Yes	Solmetex or Softener	Beads appear to be brown and black. House has Solmetex and a softener.	 30x black & brown beads
As2015-008	Toilet	Softener Carbon	No		Gold flecks, John says chrome off pipes or aluminum foil. Did not see any beads	

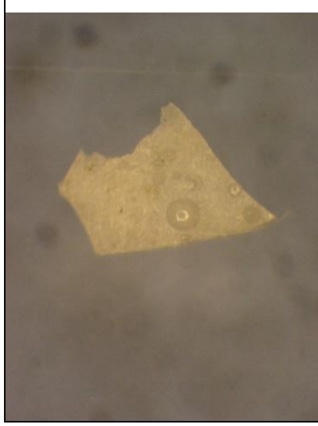
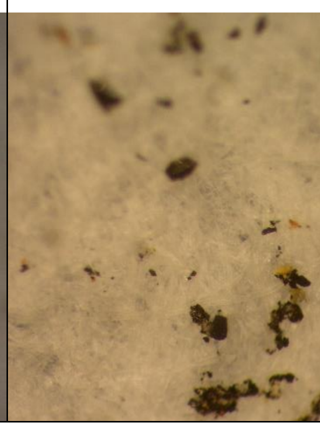
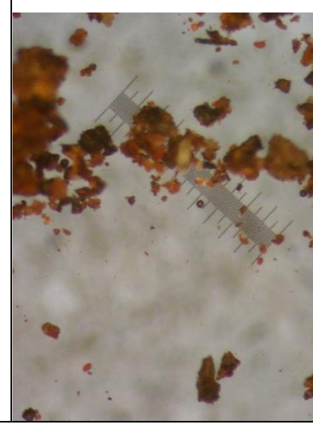
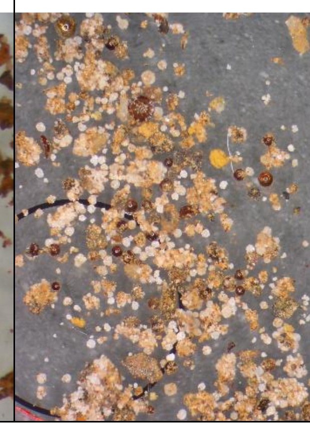
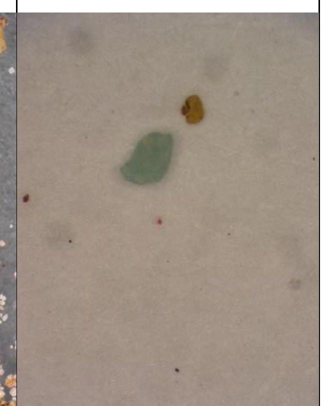
	Sink		No		Black, Shiny/metallic rocks	 64x
As2015-009	Toilet	Adedge Softener	Yes	Adedge	Adedge- dull, slightly metallic brown cut clay appearance	 Adedge at 64x
As2015-010	Toilet	Adedge	Yes	Adedge	Adedge and rust	 64x Adedge in center, rust particles
As2015-011	Sink	Carbon Softener	Yes	Metsorb, Beads	Adedge and Metsorb and Softener	 Adedge & Metsorb at 64x
As2015-012	Toilet	Adedge	Yes	Adedge	Adedge, tan clay, green, black shiny particles	 64x Adedge

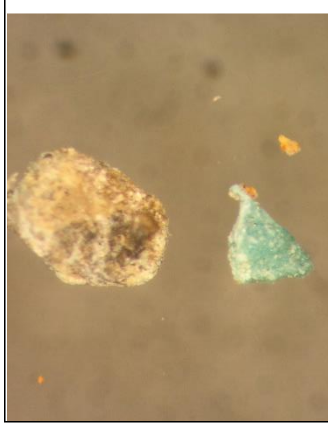
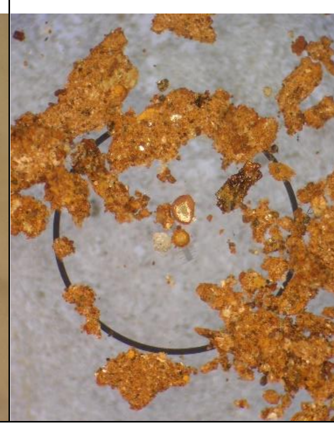
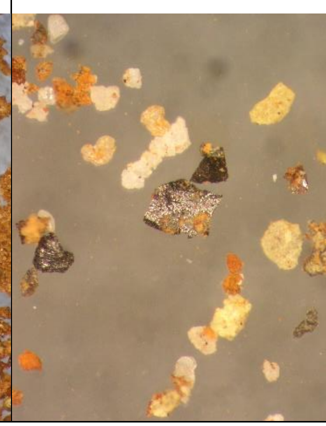
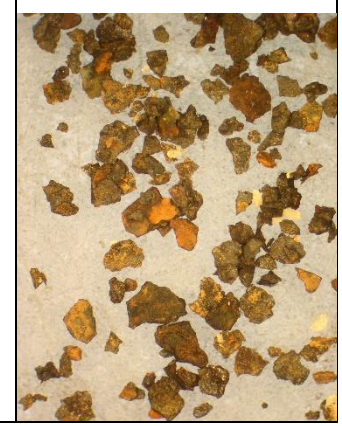
As2015-016	As2015-015	As2015-014		As2015-013
Toilet	Toilet	Sink	Toilet	Toilet
Adedge	Carbon (p) Solmetex	Metsorb		Adedge Carbon Tank
Yes	No	No	Yes	Yes
Adedge			Metsorb	Adedge
Adedge	Looks like mud, black irregular specks.		Metsorb pieces, rust	Adedge, rust
	40x 		64x 	64x 

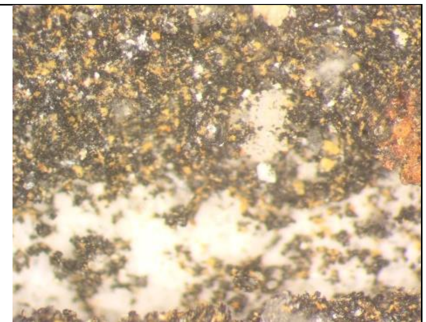
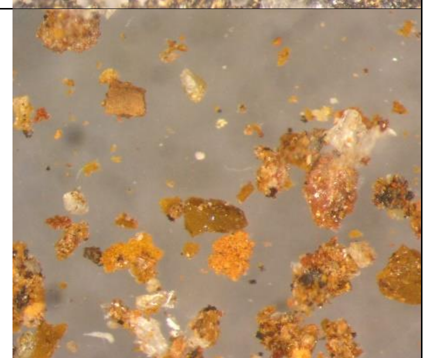
As2015-019	As2015-018	As2015-017	As2015-017	
Toilet	Toilet	Sink	Toilet	Sink
Solmetex Softener	Metsorb Softener	Softener Adedge		
No	Yes	Yes	Yes	Yes
	Metsorb	Beads	Adedge	Adedge
Clumps of black dirt with yellow specks. Also a white crystal substance on the brown coffee filter	No beads, white pieces, rust, Metsorb, black specks, possibly quartz	Softener bead, no Adedge	Cation beads, rust colored particles. Some pieces of Adedge and rust.	Rust, Adedge
				 Adedge found in sink

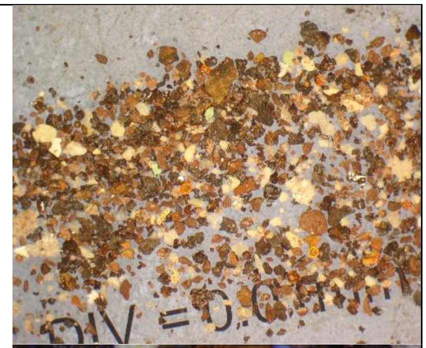
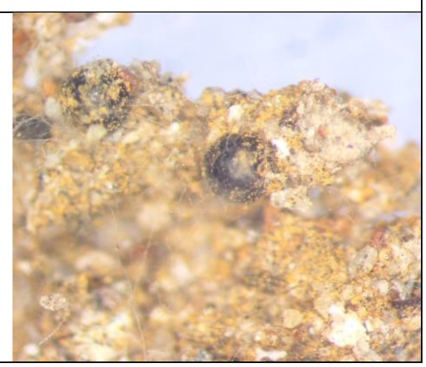
As2015-021	As2015-020		
Toilet	Toilet		Sink
Metsorb Carbon	Metsorb Softener		
No	Yes		No
	Beads and Metsorb		
Appears to be manganese	Beads, white translucent particles, white opaque likely Metsorb, one of the smallest softener beads that I’ve seen		Tiny pieces of brown and black, possibly some rust
			

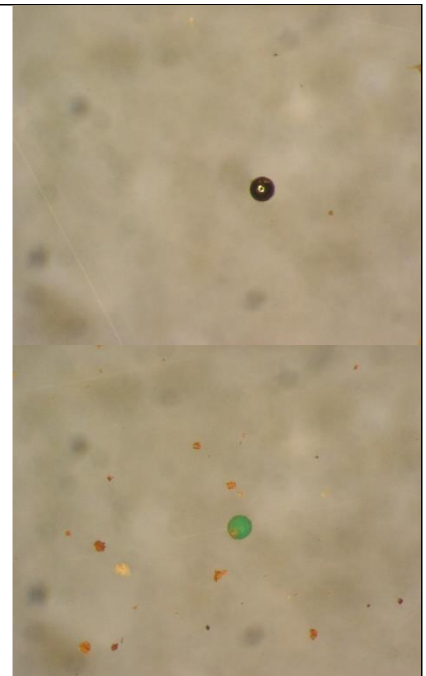
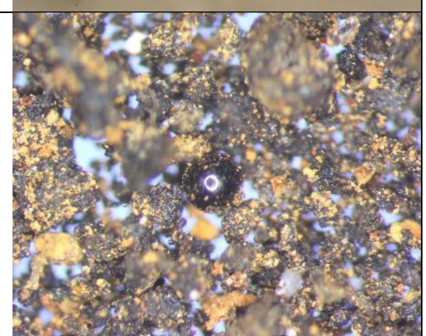
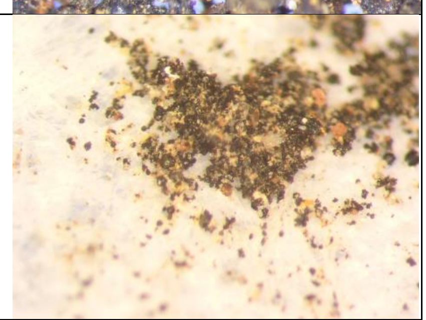
As2015-024	As2015-023		As2015-022
Toilet	Toilet	Sink	Toilet
Solmetex	Isolux Softener		Adedge (p?) Metsorb
Yes	Yes	?	Yes
Solmetex	Softener beads		Beads, Adedge
Home does not have a softener. Has black beads, must be Solmetex as no other water treatment is present. Quartz, secondary copper, mica. Small white crystals don't effervesce when acid	Beads	White particles, black rocks and white powder	Softener beads, Adedge, rust, white clumps that look like Metsorb
			 

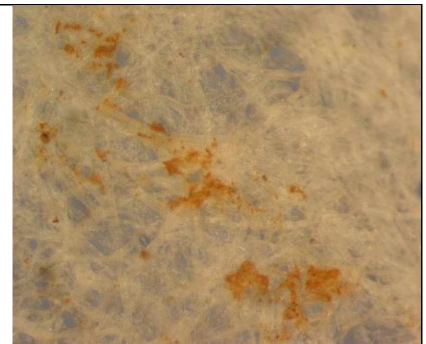
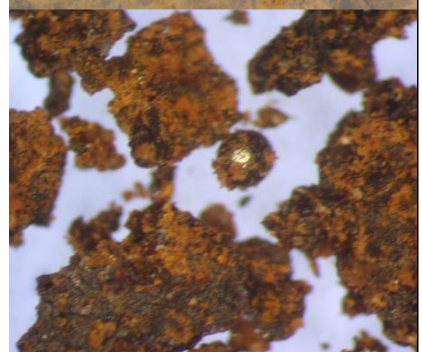
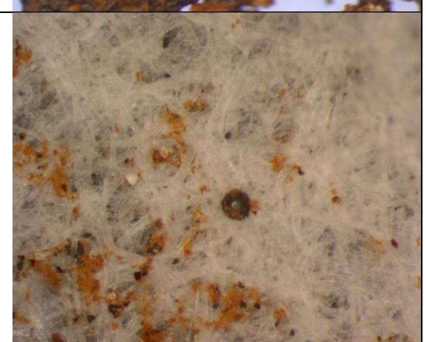
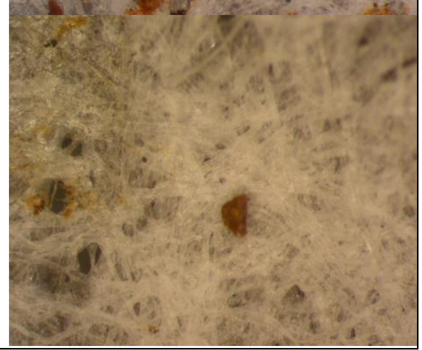
As2015-028	As2015-027	As2015-026		As2015-025	
Toilet	Toilet	Sink	Toilet	Toilet	Sink
Solmetex Softener	Solmetex Carbon	Solmetex Carbon		Softener Layne?	
? see photo	No	No	Yes	Yes	No
			Solmetex	Beads	
White, round pieces stuck in a rock?	Black, irregular, metallic		Black beads present. No softener in the home, beads must be Solmetex.	Brown beads, broken beads, hollow beads	Green and tan pieces, quartz- white and translucent
					

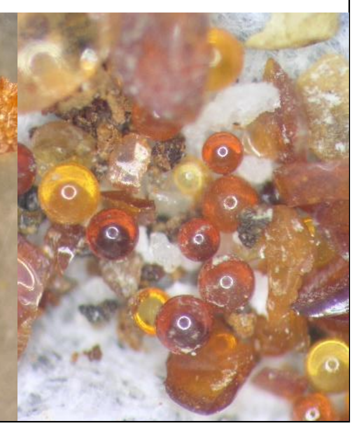
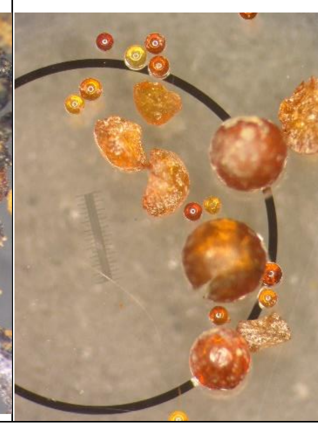
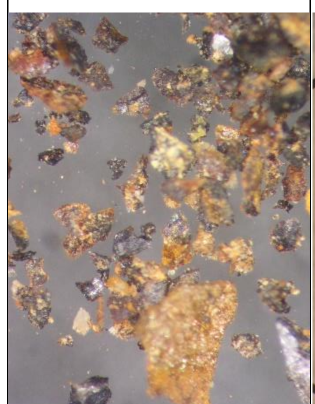
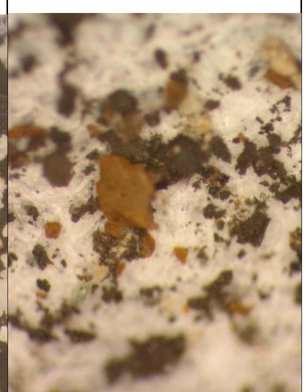
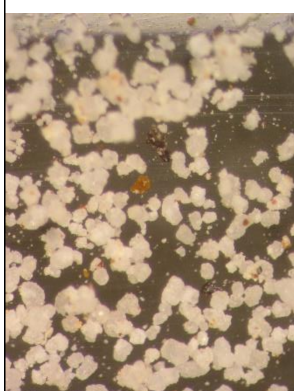
As2015-033	As2015-032	As2015-031	As2015-030	As2015-029	
Bathroom sink	Toilet	Toilet	Toilet	Sink	Toilet
Carbon	Softener Solmetex	Carbon Softener	Layne UV	Resin Tech	
No	Yes	Yes	No	No	No
	Beads	Bead, possibly carbon			
Green and white rocks, white flat rocks	Yellow, orange beads, some covered in rust	Black fibrous shiny/metallic, flat edge shiny, clear bead, white orange, brown and black pieces	Rust only		Rust and grey colored rocks
					

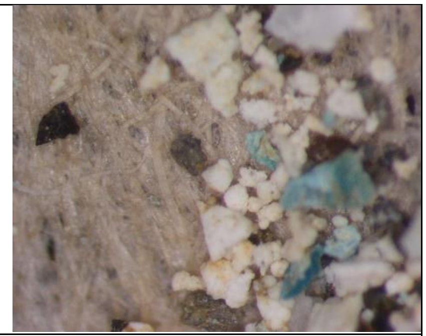
	Upstairs Toilet		Yes	Carbon (?)	Fine black particles, one black bead on coffee filter, orange particles. Black bead is unexplained unless they previously had a bead treatment system installed.	
As2015-034	Toilet	Adedge Solmetex	Yes	Adedge	Rust, adedge	
As2015-034	Sink	Adedge Solmetex	Yes	Bead, Adedge	Beads, adedge	

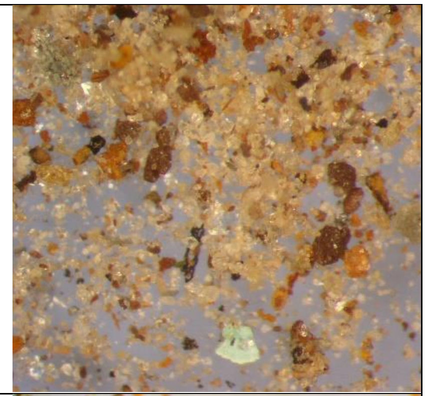
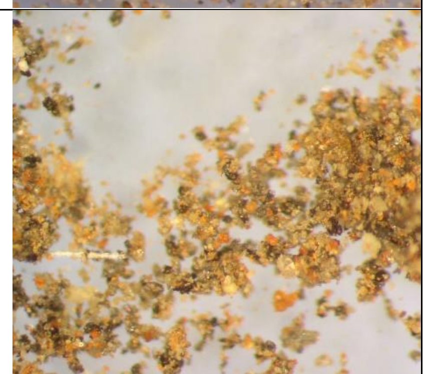
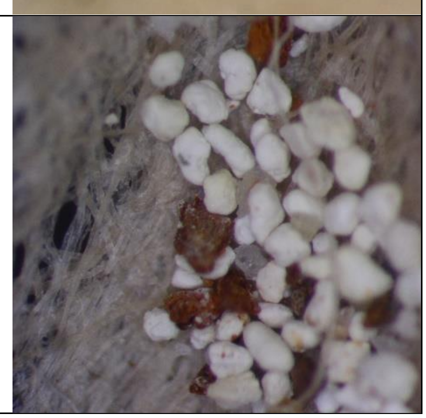
As2015-035	Toilet	Softener Solmetex	Yes	Softener or Solmetex	Brown beads, black bead, broken beads	 
	Sink		No			
As2015-036	Toilet	Resin Tech Softener	Yes	Black beads, clear beads	Likely softener beads and resin tech beads.	

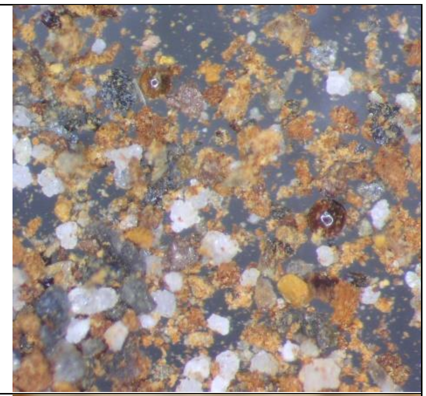
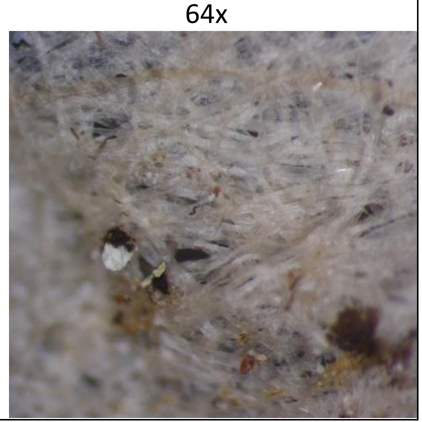
As2015-037	Toilet	Solmetex Softener	Yes	Softener or Solmetex	Brown and black beads, one green bead	
As2015-038	Toilet	ResinTech Softener	Yes	Softener or Resin Tech	Black beads, rust colored rocks	
As2015-039	Toilet	Softener Solmetex	Yes	Softener or Solmetex	Black beads, white granules	

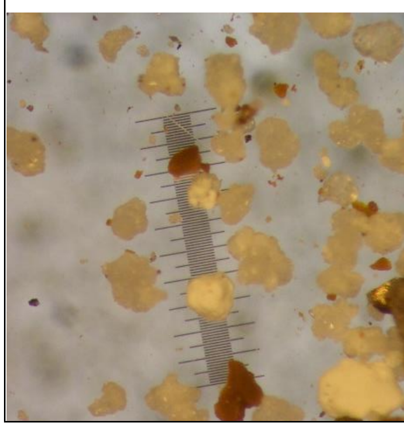
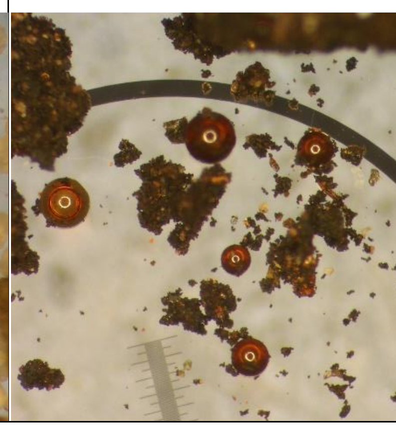
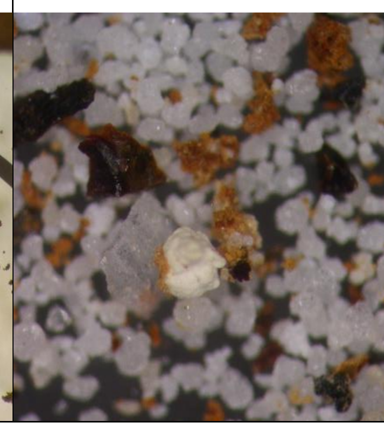
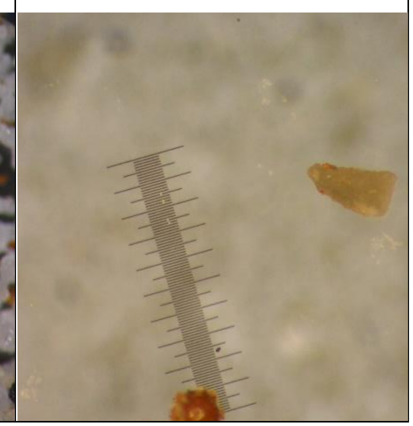
As2015-040	Toilet	Carbon Solmetex	Yes	Solmetex	Beads present, rust. Metallic rocks with rust	 
As2015-041	Toilet	Carbon Adedge	Yes	Adedge + carbon	Round shiny black piece, adedge, charcoal, rust	 

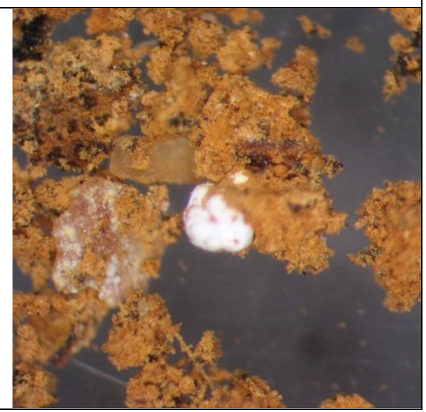
As2015-042	Toilet	Metsorb Softener	Yes	Softener beads	Looks like cation beads, many broken beads	 
As2015-043	Toilet	Metsorb Carbon	No		White pieces looked too sharp and granular to me metsorb	
As2015-044	Sink	Adedge Softener	No		Fibrous copper pieces, one green	
	Toilet		Yes	Adedge	Rust and adedge	
As2015-045	Toilet	Adedge	Yes	Adedge	A lot of quartz and adedge media	

As2015-046	Sink	Metsorb RO	Yes	Metsorb	White opaque clumps with small black dots, some have orange rust spots	
	Toilet		No			
As2015-047	No	As POU				
As2015-048	No	Softener RO				
As2015-049	Toilet	Isolux Softener	Yes	Softener	Beads (cation?), black bead	
As2015-050	Sink	Metsorb	No		Secondary copper mineral, green minerals, rust	 Double check this, it looks like it could be metsorb
	Toilet		No		No media	

As2015-051	Toilet	Softener Solmetex	No		Brown, black and red sand	
As2015-052	Toilet	Adedge Ag Filter	No		Doesn't look like adedge, looks more like pieces of rust	
As2015-053	Toilet	Solmetex Softener	Yes	Softener or Solmetex	Clear beads	
As2015-054	Toilet	Metsorb Softener	Yes	Metsorb	Clumps of white, appears to be metsorb, did not see any beads	

As2015-055	Toilet	Softener RO	Yes	Softener beads	Orange and brown beads, orange rocks, black metallic flat rocks	
As2015-056	Toilet	Softener Adedge	Yes	Adedge	Adedge seen in sample	 64x Adedge
	Faucet		No			
As2015-057	Toilet	Resin Tech	No		Rust colored particles and rocks	
As2015-058	Toilet	Metsorb	Yes	Metsorb	White particles that appear to be metsorb	64x 

As2015-062	As2015-061	As2015-060	As2015-059
Toilet	Toilet	Toilet	Toilet
Softener Adedge	Resin Tech Softener	Softener Metsorb	Solmetex
Yes	Yes	Yes	Yes
Adedge, beads, pos. Metsorb	Resin Tech or Softener	Metsor	Solmetex
White and brown pieces, metsorb possibly, adedge, beads	Broken red bead, brown beads	Bright white, not translucent pieces that are likely metsorb	Brown beads, brown clumps of irregular shapes and sizes
			

As2015-063	No	R.O. only				
As2015-064	Toilet	Metsorb Anion	Yes	Beads	Broken beads, clean and brown beads	

Appendix K: Water Test Results

Lab Results for Raw Water

House #	pH	ORP	TDS	RDO	Iron	Manganese
1	7.9	294	292	3.2	15.5	1.00
2	8.3	325	294	4.9	400	37.70
3	7.8	346	234	3.5	15.5	0.01
4	7.8	360	268	4.0	15.5	0.01
5	7.7	426	304	2.6	15.5	3.10
6	8.5	394	240	3.5	15.5	1.50
7	7.8	460	331	9.0	15.5	0.80
8	7.5	287	398	1.8	230	207.00
9	8	305	219	11.0	15.5	0.01
10	8	322	253	4.1	15.5	1.50
11	7.9	397	278	5.7	15.5	0.01
12	7.9	405	384	1.6	15.5	18.00
13	7.7	354	314	0.3	15.5	0.01
14	7.7	367	433	6.8	15.5	0.01
15	7.7	420	267	6.5	15.5	0.01
16	7.6	440	291	5.3	15.5	0.01
17	7.6	451	318	3.1	72	20.20
18	7.9	294	359	1.7	64	6.00
19	7.7	43	211	0.0	170	135.00
20	7.6	352	435	0.3	15.5	0.01
21	7.7	388	302	3.7	63	0.01
22	7.8	393	221	3.3	15.5	2.50
23	7.9	385	245	0.6	15.5	4.80
24	7.9	373	194	6.4	66	0.50
25	7.8	343	297	3.6	15.5	0.01
26	7.6	336	218	6.5	15.5	0.80
27	7.7	293	296	4.5	15.5	0.7
28	7.5	326	453	2.7	15.5	0.9
29	7.8	259	226	2.3	15.5	0.01
30	7.9	416	257	7.2	15.5	0.01
31	7.8	411	324	4.9	15.5	0.9
32	7.9	443	238	6.0[1]	15.5	0.01
33	7.8	152	260	3	15.5	0.01
34	7.9	131	230	0.03	15.5	9.7
35	7.5	142	323	1.4	15.5	0.01
36	7.9	151	410	0.6	15.5	0.6

37	7.7	145	339	1.6	15.5	0.01
38	7.5	118	724	0.03	15.5	117
39	7.7	102	473	0.1	15.5	0.01
40	7.9	89	263	4.7	15.5	0.01
41	8	81.1	237	4.7	15.5	0.01
42	7.5	-10.1	342	0.04	15.5	27.6
43	7.8	90	726	0.6	15.5	35
44	7.7	51.8	917	0.02	110	233
45	7.7	103	250	1.5	15.5	0.01
46	7.9	102	579	0.01	57	96.3
47	8	141	289	4.4	15.5	0.8
48	7.8	241	342	2.9	15.5	0.8
49	8	136	275	1.4	290	2.2
50	8.1	103	225	7	15.5	0.01
51	8	95	355	3.8	15.5	0.01
52	7.9	106	285	0.5	15.5	2
53	7.8	98	392	0.1	15.5	28.9
54	8.1	-25	308	0.02	98	61.7
55	8	101	225	2.3	410	1.6
56	7.8	104	435	1.5	15.5	0.01
57	8.3	94	252	0.17	15.5	12.6
58	8.1	104	269	4.1	15.5	0.01
59	8.7	83	332	7.3	15.5	0.01
60	8.2	-14	290	0.02	100	73.4
61	8.3	80	230	0.3	15.5	49.2
62	8.4	74	246	0.7	15.5	8
63	7.7	160	356	4.4	15.5	0.01
64	8.1	138	365	0	15.5	48.6
65	7.6	33.6	822	0	310	130
[1]Aerated faucet caused a large RDO Half the MDL was used in place of "non-detect"						

Arsenic Lab Data

	Raw (Well) Water					Treated	Kitchen Sink	R.O.
House #	**Total As**	**As (III)**	**As (V)**	**%As (III)**	**% As (V)**	**Total As**	**Total As**	**Total As**
1	5.5	0.8	4.7	14.5%	85.5%	NT	0.70	
2	14.5	1.9	12.6	13.1%	86.9%	1.30	0.05	

3	9.7	0.6	9.1	6.2%	93.8%	0.05	0.05	
4	7.8	0.8	7	10.3%	89.7%	0.05	0.05	
5	25.6	3	22.6	11.7%	88.3%	10.90	1.40	0.05
6	24	1.1	22.9	4.6%	95.4%	5.70	0.05	0.05
7	10.2	1.1	9.1	10.8%	89.2%	0.05	0.05	
8	6.4	5.8	0.6	90.6%	9.4%	1.60	1.70	
9	4.3	0.05	4.25	1.2%	98.8%	2.00	0.05	
10	27.6	0.7	26.9	2.5%	97.5%	38.50	12.80	
11	6.5	0.5	6	7.7%	92.3%	0.60	0.05	0.05
12	4.9	1.5	3.4	30.6%	69.4%	0.70	0.50	
13	6.6	0.7	5.9	10.6%	89.4%	3.40	0.50	
14	3.3	0.05	3.25	1.5%	98.5%	0.05	0.90	
15	10.4	2.2	8.2	21.2%	78.8%	10.90	1.20	
16	6.8	1.4	5.4	20.6%	79.4%	1.60	0.05	
17	4.5	0.8	3.7	17.8%	82.2%	0.05	0.05	
18	16.3	5.2	11.1	31.9%	68.1%	NT	18.60	
19	5.5	3.7	1.8	67.3%	32.7%	4.10	8.50	
20	4.8	0.05	4.75	1.0%	99.0%	1.30	0.05	
21	4.9	0.5	4.4	10.2%	89.8%	0.70	0.05	
22	21.6	5.6	16	25.9%	74.1%	1.40	0.05	
23	9.4	1.5	7.9	16.0%	84.0%	NT	0.05	
24	7.5	1.2	6.3	16.0%	84.0%	3.30	0.05	
25	5.9	0.7	5.2	11.9%	88.1%	1.70	1.00	
26	4.4	0.6	3.8	13.6%	86.4%	2.50	0.05	
27	6.4	0.05	6.35	0.8%	99.2%	1.3	0.05	
28	9.7	0.05	9.65	0.5%	99.5%	0.05	0.05	
29	7.1	1.5	5.6	21.1%	78.9%	2.4	0.05	
30	5.3	0.05	5.25	0.9%	99.1%	0.05	0.05	
31	3.3	0.05	3.25	1.5%	98.5%	NT	4.3	
32	8.8	1.2	7.6	13.6%	86.4%	8.1	0.05	
33	5.5	0.05	5.45	0.9%	99.1%	9	8.7	
34	31.5	2.2	29.3	7.0%	93.0%	9.2	5.9	0.05
35	6.6	0.5	6.1	7.6%	92.4%	0.05	0.05	
36	7.7	0.05	7.65	0.6%	99.4%	NT	5.2	
37	16.7	0.05	16.65	0.3%	99.7%	0.05	0.05	
38	8.1	0.5	7.6	6.2%	93.8%	5.9	2.9	
39	19.5	1.1	18.4	5.6%	94.4%	0.05	0.05	
40	10.8	0.05	10.75	0.5%	99.5%	1	0.05	0.05
41	20.7	0.05	20.65	0.2%	99.8%	1.4	0.05	
42	2.6	0.8	1.8	30.8%	69.2%	1.2	2.2	

43	29	7.1	21.9	24.5%	75.5%	5.7	0.7	
44	38.2	35.1	3.1	91.9%	8.1%	0.05	0.05	0.05
45	6.1	0.05	6.05	0.8%	99.2%	0.05	0.05	
46	8.9	0.05	8.85	0.6%	99.4%	0.05	0.05	0.05
47	12.7	0.05	12.65	0.4%	99.6%	NT	0.05	
48	0.6	0.05	0.55	8.3%	91.7%	NT	NT	0.05
49	2.9	0.05	2.85	1.7%	98.3%	NT	0.05	
50	9.8	0.05	9.75	0.5%	99.5%	0.5	0.05	
51	3.1	0.05	3.05	1.6%	98.4%	8	2.9	0.05
52	9.6	0.05	9.55	0.5%	99.5%	8.3	0.6	
53	5.9	0.05	5.85	0.8%	99.2%	0.05	0.05	
54	3.5	3.7	-0.2	105.7%	-5.7%	4.5	0.05	
55	13.8	15.2	-1.4	110.1%	-10.1%	NT	0.05	0.05
56	8.5	0.05	8.45	0.6%	99.4%	0.05	0.05	0.05
57	15.7	1.9	13.8	12.1%	87.9%	10.5	4.2	
58	9.5	1.1	8.4	11.6%	88.4%	3.1	1	
59	10.6	1.5	9.1	14.2%	85.8%	13.6	0.9	
60	9.2	3.6	5.6	39.1%	60.9%	NT	7.4	
61	7	0.05	6.95	0.7%	99.3%	2.4	0.05	
62	41.6	0.9	40.7	2.2%	97.8%	11.7	2.1	0.05
63	3.9	0.05	3.85	1.3%	98.7%	NT	4.0	0.05
64	14.2	1.1	13.1	7.7%	92.3%	1.4	0.05	
65	4.9	3.5	1.4	71.4%	28.6%	0.5	0.05	
NT: Not Tested								

Appendix L: Example Results Letter Sent to Homeowners

RUTGERS
School of Public Health

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[Date]

Dear [Homeowner],

Thank you for allowing us to collect water samples from your home as part of our study of arsenic well water treatment in New Jersey. We tested the water with our field equipment and also sent samples for laboratory analyses. The results are shown in the tables below. The data suggest that your treatment system needs maintenance. The arsenic level at the kitchen sink is ## µg/L and the reading between the arsenic tanks is ## µg/L. When the reading between the arsenic tanks reaches 5 µg/L, you should move the safety tank to the worker tank position and get a new safety tank.

You should also continue to test your water yearly. Remember to "stress" the system by running two cold water taps for 10 minutes before taking samples. It's also a good idea to write the meter reading down. You can use the table that I started at the bottom of this email to keep a "system history."

Field Equipment Results								
Sample Location	**Sample Date**	**pH**	**ORP (mv)**	**TDS (mg/L)**	**DO (mg/L)**	**Chlorine (mg/L)**	**Alkalinity (mg/L)**	**Hardness (mg/L)**
Raw Water								
Between Tanks								
Kitchen Sink								
Drinking Water Standard		6.5-8.5		500				
Abbreviation Guide: ND =Non-detect mg/L = milligrams per liter µg/L = micrograms per liter ORP= oxidation reduction potential TDS= total dissolved solids DO= dissolved oxygen								

Laboratory Analysis						
Sample Location	**Sample Date**	**Total Arsenic (µg/L)**	**Arsenic (III)**	**Arsenic (V)**	**Manganese (µg/L)**	**Iron (µg/L)**
Raw Water						
Between Tanks						
Kitchen Sink						
NJ Drinking Water Standard		5.0			50	300

Your Arsenic Treatment System	
Date Installed	
Installer	
Maintained by	
Number of Tanks and Size	
Media in Tanks	
Additional Water Treatment Present	
Missing components that are required by Hopewell Township	

Radioactivity (Micro R/ Hour)	
Background	
Softener	
Arsenic Tank 1	
Arsenic Tank 2	

Your Treatment System History (Previous Arsenic Test Results)					
Date of Test	Meter Reading (gallons)	Raw Water (µg/L)	Between Tanks (µg/L)	Kitchen Sink (µg/L)	Reverse Osmosis (µg/L)

Recommendations	
General Maintenance Recommendations	• Test yearly for arsenic between the arsenic tanks. (You may find it helpful to create a yearly recurring reminder on your cell phone or calendar. You also may find it helpful to associate water testing with a specific day (i.e. President's Day) • Keep a high level of salt in your softener tank. As a general rule, the salt should be above the water line.
Specific Recommendations	• Install a sediment filter after your arsenic tanks • Install a sediment filter before your arsenic tanks • Install a water meter

	• Replace your arsenic worker tank. Have your system maintainer move your safety tank to the worker tank position and purchase a new safety tank.

Arsenic is a toxic element that is known to increase the risk of adverse health effects in people who drink water containing it. Arsenic is a known human carcinogen that causes cancer of the skin, bladder, lung, kidney, and liver. It also causes increased risk of cardiovascular disease, peripheral neuropathy, skin hyperpigmentation and keratoses, and diabetes. The major exposure pathway for arsenic in residential well water is drinking and cooking with the untreated water. There may also be exposure from other uses of water in the home through bathing, showering, and brushing teeth. Arsenic requires special treatment considerations. Maintenance and yearly testing is critical. Please refer to the enclosed Information Circular on Arsenic Water Treatment for Residential Wells in New Jersey.

Water treatment financing is available from the New Jersey Housing and Mortgage Finance Agency (800-654-6873) to owners of single family residences whose source of drinking water comes from a private well that violates the state's Primary Drinking Water Standards, including arsenic. Loan proceeds can be used to pay for adequate and appropriate water treatment technology. Information on this program is enclosed.

If you have any questions concerning your water sample results, water treatment, or re-testing, please email me at megrock@sph.rutgers.edu.

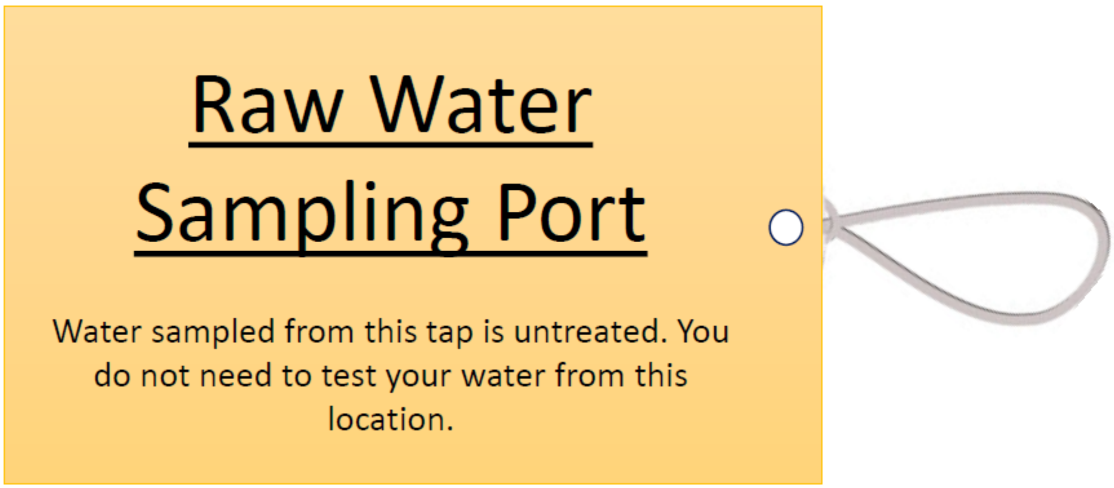
Sincerely,

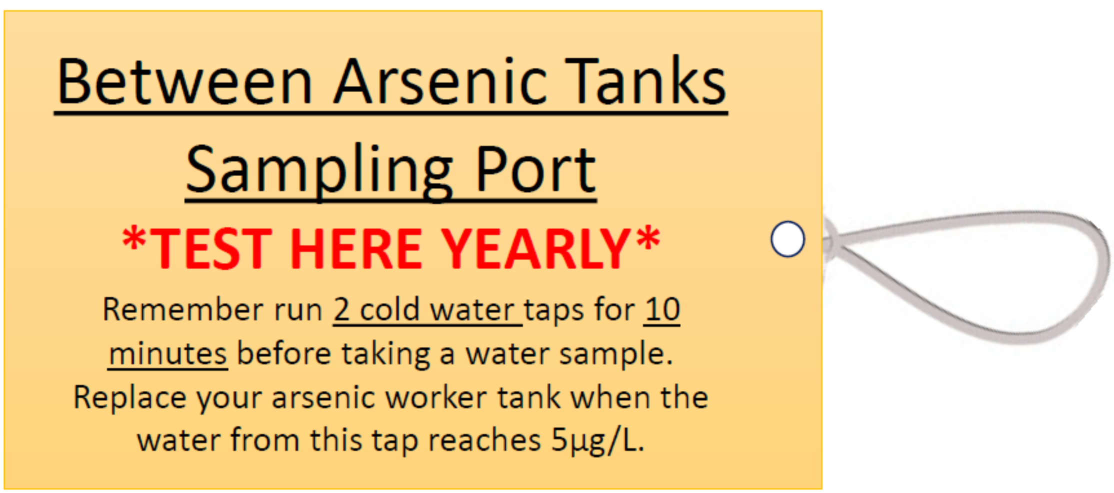
Megan Rockafellow Baldoni, MPH

Enclosure: Arsenic Water Treatment for Residential Wells in New Jersey
NJHMFA Potable Water Loan Program

Appendix M: Proposed Public Health Interventions

Sampling Port Tags





Treatment Tank Stickers

ARSENIC TREATMENT

Installed by: _______________

Phone:_________________

Media: _________________

Date: ___________________

CARBON TANK

Installed by: _______________

Phone:_________________

Date: ___________________

SOFTENER SALT TANK

KEEP A HIGH LEVEL OF SALT IN THIS TANK AT ALL TIMES.

THE SALT SHOULD BE ABOVE THE WATER LINE.

WATER SOFTENER

Installed by: _______________

Phone:_________________

Date: ___________________

PRESSURE TANK

Installed by: _______________

Phone:_________________

Date: ___________________

CHLORINE TANK

Installed by: _______________

Phone:_________________

Date: ___________________

Frequently Asked Questions (FAQs)

Draft prepared by:
Steven Spayd, NJDEP, NJ Geological and Water Survey
Stuart Braman, Columbia University, Lamont Doherty Geological Observatory
Megan Rockafellow-Baldoni, Rutgers University School of Public Health

Selecting an Arsenic Treatment System

1. Do I really need an arsenic water treatment system?

- Yes, if arsenic has been detected in your well water above the New Jersey Safe Drinking Water Standard of 5 micrograms per liter (mcg/L).
- Arsenic is a toxic element. It is known that people who drink water containing elevated levels of arsenic have an increased risk of a wide array of adverse health effects.
- Arsenic is a known human carcinogen via ingestion (drinking or eating) at elevated levels found in well water. Chronic exposure to high levels of arsenic is associated with a range of serious health problems including skin lesions, skin cancer, lung cancer, liver cancer, and bladder cancer.
- Arsenic exposure has also been associated with increased risk of cardiovascular disorders, neuropathy, and diabetes. Studies show a negative effect of arsenic from drinking water on children's IQ.
- When you sell your home, you will be required to test for arsenic and share the results with the buyer of your home. If the arsenic level is above the New Jersey arsenic standard of 5 mcg/L, a treatment system will be needed.
- Even though the standard for arsenic is 5 mcg/L in New Jersey, the US Environmental Protection Agency has set a maximum contaminant level goal of 0 mcg/L in drinking water.

2. What does it mean that the maximum contaminant level goal for arsenic is 0 mcg/L in drinking water?

The maximum contaminant level goal (MCLG) is defined by EPA as the level at which no known or anticipated adverse effects on the health of persons occur and which allows an adequate margin of safety. Because arsenic is a known human carcinogen via drinking water, the USEPA has determined that the maximum contaminant level goal is to have zero exposure to arsenic from your water.

3. <u>What are my arsenic water treatment system choices?</u>

- The preferred system is a whole-house treatment which is often called "Point-of-Entry" (POE) because it treats all water in the home near the point where the water enters the home.
- The other type of treatment is single tap treatment which is often called "Point-of-Use" (POU) because the treatment unit is usually near the single tap that is treated.

4. <u>In the case of a home sale, who should choose what arsenic treatment system to install?</u>

In the case of a home sale, the <u>buyer of the home</u> should always choose the type of water treatment system and who will install it. This is important so the person living with the system will know what they have, how to monitor and maintain it, who to call for service and of course the buyer is the one who will be drinking the water.

5. <u>What are the advantages and disadvantages of Whole House or Point of Entry (POE) systems?</u>

POE Advantages:

- All water in the house is treated
- Can drink water safely from any tap
- Arsenic-free shower and bath water
- Can easily size system to maintain water flows the same as before the treatment system was installed

POE Disadvantages:

- Installation cost
- Maintenance cost

6. <u>Why is the whole-house point-of-entry (POE) system strongly recommended in New Jersey?</u>

- The POE system is the most protective of you and your family's health.
- All water in the house is treated so any tap in the home can be used safely for drinking water.
- Water for bathing, showering, brushing teeth, and laundry will also be arsenic-free.
- A New Jersey study found that whole-house arsenic water treatment provided more effective exposure reduction than point-of-use treatment. See this link for an abstract of the study: <u>http://www.sciencedirect.com/science/article/pii/S004896971400881X</u>

7. ***Some vendors offer a one tank point-of-entry system. What are the advantages and disadvantages of choosing a one tank system instead of the more common two tank system?***

One tank POE system disadvantages:

- With no back-up tank homeowners are at risk of drinking water with unhealthy levels of arsenic during the period after the arsenic begins to break through the treatment media and before the next testing.
- More expensive over the long term

One tank POE system advantages:

- Cheaper in the short term

8. Why is the two-tank POE system significantly better than a one-tank POE system?

- A one tank POE system is cheaper in the short term, but with no back-up tank, homeowners are at risk of drinking water with unhealthy levels of arsenic during the period after the arsenic begins to break through and before the next testing.
- The water goes through the first tank and then through the second tank. We call the first tank the "worker tank" because it does the most work removing arsenic. When the worker tank is new, it will remove all the arsenic, but after about one year (depending on the arsenic level and how much water is used), some arsenic will start to break through the worker tank. When this occurs, the second tank will catch the arsenic, and this is why well the second tank the "safety tank".
- Without the safety tank, you would be exposed to the arsenic getting through the worker tank. With only a one-tank system, you will not know you are being exposed to arsenic until the next water test is obtained.
- A properly installed and maintained two-tank POE system will reduce your arsenic exposure to zero, which is the EPA maximum contaminant level goal for arsenic. A one-tank POE system cannot meet this goal.
- A two-tank POE system is also more economical over the life of the system. With one tank, you will need to change the tank as soon as the concentration gets near 5 mcg/L. Otherwise, you will be exposed to arsenic above the standard. However, with a two-tank POE system, you can safely conduct once per year sampling, and not need to replace the worker tank until the concentration after the worker tank exceeds 5 mcg/L. Even if the concentration after the worker tank goes up to 10 or 20 mcg/L, the safety tank will remove all of the arsenic before it reaches your taps in the home.

9. <u>How much space is required for a two-tank POE arsenic water treatment system?</u>

- The typical two-tank POE arsenic water treatment system is 4-5 feet tall and requires a floor area of about 2 feet by 3 feet.
- Most homeowners find space for these systems in their basement near the well pump.

10. **<u>Are there any disadvantages of the point-of-entry(POE) system compared to the point-of-use system</u>?**

- The POE system has a higher initial cost but the NJ Housing and Mortgage Finance Agency offers no interest loans through its Potable Water Program to cover the cost of installation.
- The POE system requires approximately 6 square feet of floor space in the basement, though it takes up no space under the kitchen sink.

11. <u>What are the advantages and disadvantages of the point-of-use (POU) system?</u>

POU advantages:

- Installation cost is less for POU than for POE, when POU is used for a single tap
- Maintenance cost is less for POU than for POE, when POU is used for a single tap

POU disadvantages:

- Water from untreated taps still contains unhealthy levels of arsenic.
- Once the under the sink storage reservoir is depleted the flow volume will be affected.
- Some POU systems only remove Arsenic 5 (Reverse Osmosis).
- POU systems do not have a safety tank so users will be exposed to arsenic contamination after the capacity is reached and before testing indicates the need for a replacement
- With a POU system, you will still be bathing, showering and filling up swimming pools or hot tubs with arsenic contaminated water.
- One study showed that in homes with a single tap arsenic POU water treatment system, it is not uncommon for people to occasionally drink from untreated taps, and when they do, arsenic levels increase in their urine.
- If POU treatment at the kitchen sink is used, the kitchen tap should be the only source of water used for drinking or cooking. If water may be used for drinking in other rooms of the home (e.g., at a bathroom sink), either a POU unit should be installed at each potential drinking water tap in the home, or a POE whole-house treatment system should be used.

- When the cost of multiple POU treatment systems is considered, it often becomes more economical to install a whole-house POE system.
- Some local health departments require whole-house POE arsenic water treatment to ensure the health of current and future homeowners.

12. <u>What water treatment options are NOT effective at removing any arsenic?</u>

- The following treatments are not effective for removing arsenic:
    - Boiling water (this will increase the arsenic concentration)
    - Ultraviolet (UV) light
    - Cation exchange (commonly called a water softener)
    - Granular activated carbon (GAC)
    - Aeration
    - Magnetic Water Conditioners
    - Anion Exchange (only removes Arsenic 5)
    - Reverse Osmosis (only removes Arsenic 5)
    - Water Filtration Pitchers (Brita etc.)
    - Water Filtration from the Refrigerator

<u>13. What water treatment options are only effective at removing arsenic 5?</u>

- ***Reverse Osmosis***
    - Reverse osmosis is not effective at removing Arsenic 3. There is no simple and affordable test commercially available to determine which arsenic species is present so the species of arsenic present is usually unknown.
    - Reverse osmosis can, however, be an effective backup in combination with a whole-house POE arsenic removal system.
- ***Anion Exchange Systems***
    - Anion exchange systems are not effective at removing Arsenic 3. There is no simple and affordable test commercially available to determine which arsenic species is present so the species of arsenic present is usually unknown.
    - In addition, the anion exchange system requires regular maintenance that involves purchasing water softener salt to keep the brine tank filled. If the salt level is not maintained, the system will not remove any arsenic and will dump the removed arsenic into the home's water at a very elevated concentration.

- Finally, when an anion exchange system runs through a regeneration cycle, all of the arsenic captured by the system will be flushed out of the tank and discharged somewhere, usually to the home's septic system
- Anion exchange can, however, be effective addressing pH issues when they occur in combination with a whole-house POE arsenic removal system.

14. <u>Can I test to determine which arsenic species I have in my water (arsenic 3 or arsenic 5)?</u>

There is no simple and affordable test commercially available to determine which arsenic species is present.

15. <u>Are there any important differences between media that are offered by different treatment providers to filter out arsenic?</u>

It's important to realize that if you choose a cheaper media, it may have a lower capacity. This means you may need to replace the tanks more often.

16. <u>Why is it essential to have a post-treatment sediment filter?</u>

A 5-micron size post-treatment sediment filter is essential to prevent any particles of treatment media, which may be highly enriched in arsenic or other contaminants, from getting into your drinking water supply.

<u>17. Are pre-treatment sediment filters required in an arsenic treatment system?</u>

18. <u>What would the recommended arsenic treatment system include?</u>

An effective treatment system would have the following components:

1. Two whole-house arsenic treatment tanks with a high capacity arsenic treatment media installed in series.
2. A sampling port between the two arsenic tanks
3. A sediment filter before the arsenic tanks (depending on whether other water treatment elements are in place)
4. A sediment filter after the arsenic tanks
5. A water meter

An effective system also needs to be maintained. To qualify as a well maintained system, a water test must be conducted yearly from the sampling port between the two tanks. If the arsenic between the tanks is 5 mcg/L or above, the worker tank should be removed and replaced with the safety tank and a new safety tank should be installed.

Using and Maintaining Your Arsenic Treatment System

19. How do I know that the arsenic levels are safe once I have installed a system?

- Test the treated water one or two weeks after the installation is complete. This is very important. Even the best water treatment professionals can make a mistake and your system may not be working due to an error. We have seen homes with the wrong media in the tanks (pH adjustment media instead of arsenic treatment media). We also have seen a good installation not remove any arsenic for an entire year because of incorrect settings on the bypass valves. Hence the importance of the initial after-installation test.
- After the initial testing shows the system is working, you should test the water at the kitchen sink and between the worker and safety tanks (on a POE system) once every year.

20. What are the options for testing my water once the arsenic treatment system is installed?

- A list of labs capable of testing arsenic by the most sensitive analytical methods are listed on our "Testing Options" Page
- A full list of NJDEP approved labs can be found by clicking this link.
- Some water treatment professionals will provide annual testing as part of their service. Obtaining a service contract from them will take the worry away from you and protect your family's health.
- You can pick up the appropriate bottles from a convenient lab, collect the water samples yourself and deliver them to the lab. A more convenient option and more expensive option is to schedule someone from the lab to come out and collect the samples.
- If arsenic is your only water quality problem, test for arsenic every year along with nitrates and total coliform which can change from year to year. You don't need to purchase the full PWTA package every year, but testing for all PWTA contaminants once every five years is a good idea.

21. Should the water be run for a certain length of time when collecting samples to test my water?

- Yes, the treatment system needs to be stressed to be sure it works when multiple taps are on at the same time.
- To test whole-house POE systems, you should run two cold water taps full blast for at least 10 minutes before collecting the sample between the tanks or at the kitchen sink.
- The reason for stressing the system is that all treatment systems require contact time between the water and the treatment media to remove all the arsenic. The more taps that are on at the same time in the home, the faster the water goes through the tanks and this shortens the contact time. You want to make sure the system is removing the arsenic during high water use times in your home (for example, two showers at one time, or a shower and the dishwasher or washing machine on at the same time).

22. How often should I test my water quality after I have installed a treatment system (and after I've done a post-installation test?

- You should test the water coming out of the tap annually.
- With a two tank point-of-entry system you should also test the water between the two tanks, yearly.

23. How can I remember to test my treated water once per year?

- You can add a yearly recurring event to your calendar to remind you that it is time to test your water.
- You can pick a day of the year – maybe a Holiday and always schedule your water test for that day each year. One person picked Valentine's Day for their water test reminder-day saying, "my love for my family reminds me to make sure they are not being exposed to arsenic".

24. I heard that pH could be a problem. Do you ever need to adjust the pH for the system to work well?

- It is much harder for arsenic treatment systems to remove arsenic when the pH of the water is greater than 8.5 and the life of the media is greatly reduced.
- In New Jersey wells with arsenic and a pH greater than 8.5, a pH adjustment tank should be included in their system. This can be accomplished by installing an anion-exchange system before the arsenic tanks. The anion exchange system will reduce the pH about 1 point. The anion exchange system may also remove some arsenic which will also help increase the life expectancy of the media

- Well water with arsenic and pH greater than 9.5 is a more difficult situation that will require the attention and recommendation of your water treatment professional. Injection of ascorbic acid into the water before it goes into the arsenic tanks is one example for dealing with very high pH water.

25. <u>Are there any other signs of media needing replacement or treatment system failure besides testing results?</u>

Unfortunately, the only way to tell if your system is working is by a water test. Because arsenic is colorless, odorless and tasteless you would not be able to tell if it is breaking through the treatment system by looking at or tasting or smelling your water.

26. <u>Are there any other maintenance requirements besides regular testing and media replacement when test results indicate the filter is no longer working?</u>

- All treatment systems require pre-treatment sediment filters to be changed on a regular basis The timing of sediment filter changes depends on the specific characteristics of your well and water. If the water pressure in the home gradually drops, the first place to look is a clogged sediment filter.
- The post-treatment sediment filters will probably only need to be changed once per year.

27. <u>Is there waste from the treatment system that I'll need to dispose of safely?</u>

- Your treatment system installer should take care of the proper disposal of used treatment media.
- Used arsenic tanks should be tightly closed and disposed of.
- Treatment installers should never re-bed (empty the used media and replace with new media) treatment tanks in your home.
- Used media should not be touched with bare hands.

Informational Brochure

(front cover and inside cover)

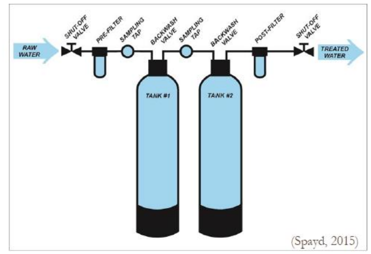
well aware

A Guide to Maintaining your

ARSENIC

Treatment System

RUTGERS
School of Public Health



(Spayd, 2015)

TREATMENT SYSTEM INSTALLATION CHECKLIST

- (2) Arsenic Treatment Tanks
- Water Meter
- Pre-treatment Sediment Filter
- Post-treatment Sediment Filter
- Sampling Port in between the arsenic tanks
- Reverse Osmosis (optional backup)

2

Pg. 3 & 4

YOUR ARSENIC SYSTEM

Date Installed: ______________________________

Installer: ______________________________

Maintained by: ______________________________

Phone Number: ______________________________

Make sure your installer labels your middle sampling port. This makes it easy to find where to collect your yearly water test sample.

Type of Arsenic System:

Size of tanks: ______________________________

Media in Tanks ______________________________

Water Meter Reading at time of Installation _____ gallons.

YOUR WATER

Arsenic ______ppb Iron ________ Manganese _____

Date: ______________________________

Test Yearly on this date: ____________

Keep a summary of your results in this booklet.

Helpful Hint: Set a repeating event in your phone calendar or choose a memorable day like a holiday

3

FREQUENTLY ASKED QUESTIONS

Why is the whole-house point-of-entry (POE) system strongly recommended in New Jersey?

- The POE system is the most protective of you and your family's health. All water in the house is treated so any tap in the home can be used safely for drinking water.
- Water for bathing, showering, brushing teeth, and laundry will also be arsenic-free.
- A New Jersey study found that whole-house arsenic water treatment provided more effective exposure reduction than point-of-use treatment.
- See this link for an abstract of the study: http://www.sciencedirect.com/science/article/pii/S004896971400881X

Why is the two-tank POE system significantly better than a one-tank POE system?

- A one tank POE system is cheaper in the short term, but with no backup tank, homeowners are at risk of drinking water with unhealthy levels of arsenic during the period after the arsenic begins to break through and before the next testing.
- The water goes through the first tank and then through the second tank. We call the first tank the "worker tank" because it does the most work removing arsenic. When the worker tank is new, it will remove all the arsenic, but after about one year (depending on the arsenic level and how much water is used), some arsenic will start to break through the worker tank. When this occurs, the second tank will catch the arsenic, and this is why well the second tank the "safety tank".
- Without the safety tank, you would be exposed to the arsenic getting through the worker tank. With only a one-tank system, you will not know you are being exposed to arsenic until the next water test is obtained.
- A properly installed and maintained two-tank POE system will reduce your arsenic exposure to zero, which is the goal for arsenic. A one-tank POE system cannot meet this goal.
- A two-tank POE system is also more economical over the life of the system. With one tank, you will need to change the tank as soon as the concentration gets near 5 µg/L. Otherwise, you will be exposed to arsenic above the standard. However, with a two-tank POE system, you can safely conduct once per year sampling, and not need to replace the worker tank until the concentration after the worker tank exceeds 5 µg/L. Even if the concentration after the worker tank goes up to 10 or 20 µg/L, the safety tank will remove all of the arsenic before it reaches your taps in the home.

4

Pg. 5 & 6

What water treatment options are NOT effective at removing arsenic?

The following treatments are not effective for removing arsenic:

- Boiling water (this will increase the arsenic concentration)
- Ultraviolet (UV) light
- Cation exchange (commonly called a water softener)
- Granular activated carbon (GAC)
- Aeration
- Magnetic Water Conditioners
- Anion Exchange (only removes Arsenic 5)
- Reverse Osmosis (only removes Arsenic 5)
- Water Filtration Pitchers (Brita etc.)
- Water Filtration from the Refrigerator

Will a reverse osmosis system work for arsenic removal?

Reverse osmosis is not effective in removing all arsenic species. When arsenic is tested, the results are expressed as "total arsenic". Of this total arsenic, there are generally two types (species) of arsenic that are found in well water in New Jersey, arsenate (Arsenic 5) and arsenite (Arsenic 3). Reverse osmosis is not effective at removing Arsenic 3. Reverse osmosis is, however, an effective backup after a whole-house POE arsenic removal system.

Can I test for the arsenic species in my water?

There is no simple and affordable test commercially available to determine which arsenic species is present. However, a rule of thumb has been developed for determining the presence of Arsenic 3 in New Jersey. A significant percentage of the arsenic should be considered to be in the Arsenic 3 species if a well with an arsenic MCL exceedance has any of the following: sulfur odor, iron greater than 50 µg/L (0.05 mg/L), manganese greater than 50 µg/L (0.05 mg/L), or a dissolved oxygen concentration less than 1 mg/L. If any of these conditions are present, reverse osmosis or anion exchange should not be the selected option for arsenic removal.

Are there any important differences between media that are offered by different treatment providers to filter out arsenic?

It's important to realize that if you choose a cheaper media, it may have a lower capacity. This means you may need to replace the tanks more often.

5

Why is it essential to have a post-treatment sediment filter?

A 5-micron size post-treatment sediment filter is essential to prevent any particles of treatment media, which may be highly enriched in arsenic or other contaminants, from getting into your drinking water supply.

How do I know that the arsenic levels are safe once I have installed a system?

- Test the treated water one or two weeks after the installation is complete. This is very important. Even the best water treatment professionals can make a mistake and your system may not be working due to an error. We have seen homes with the wrong media in the tanks (pH adjustment media instead of arsenic treatment media). We also have seen a good installation not remove any arsenic for an entire year because of incorrect settings on the bypass valves. Hence the importance of the initial after-installation test.
- After the initial testing shows the system is working, you should test the water at the kitchen sink and between the worker and safety tanks (on a POE system) once every year.

What are the options for testing my water once the arsenic treatment system is installed?

- A list of labs capable of testing arsenic by the most sensitive analytical methods are listed on this website: tinyurl.com/arsenichelp on the "Testing Options" Page
- Some water treatment professionals will provide annual testing as part of their service. Obtaining a service contract from them will take the worry away from you and protect your family's health.
- You can pick up the appropriate bottles from a convenient lab, collect the water samples yourself and deliver them to the lab. A more convenient option may be to schedule someone from the lab to come out and collect the samples.
- If arsenic is your only water quality problem, just test for arsenic every year. You don't need to purchase the full PWTA package every year, but testing for all PWTA contaminants once every five years is a good idea.

Should the water be run for a certain length of time when collecting samples to test my water?

- Yes, the treatment system needs to be stressed to be sure it works when multiple taps are on at the same time.
- To test whole-house POE systems, you should run two cold water taps full blast for at least 10 minutes before collecting the sample

6

Pg. 7 & 8

between the tanks or at the kitchen sink.

- The reason for stressing the system is that all treatment systems require contact time between the water and the treatment media to remove all the arsenic. The more taps that are on at the same time in the home, the faster the water goes through the tanks and this shortens the contact time. You want to make sure the system is removing the arsenic during high water use times in your home (for example, two showers at one time, or a shower and the dishwasher or washing machine on at the same time).

How often should I test my water quality after I have installed a treatment system?

- You should test the water coming out of the tap annually.
- With a two tank point-of-entry system you should also test the water between the two tanks, yearly.

How can I remember to test my treated water once per year?

- We recommend that you add a yearly recurring event to your calendar to remind you that it is time to test your water.
- We recommend that you pick a day of the year – maybe a Holiday and always schedule your water test for that day each year. One person picked Valentine's Day for their water test reminder-day saying, "my love for my family reminds me to make sure they are not being exposed to arsenic".

I heard that pH could be a problem. Do you ever need to adjust the pH for the system to work well?

- It is much harder for arsenic treatment systems to remove arsenic when the pH of the water is greater than 8.5 and the life of the media is greatly reduced.
- In New Jersey wells with arsenic and a pH greater than 8.5, a pH adjustment tank should be included in their system. This can be accomplished by installing an anion-exchange system before the arsenic tanks. The anion exchange system will reduce the pH about 1 point. The anion exchange system may also remove some arsenic which will also help increase the life expectancy of the media
- Well water with arsenic and pH greater than 9.5 is a more difficult situation that will require the attention and recommendation of your water treatment professional. Injection of ascorbic acid into the water before it goes into the arsenic tanks is one example for dealing with very high pH water.

7

Are there any other signs of media needing replacement or treatment system failure besides testing results?

Unfortunately, the only way to tell if your system is working is by a water test. Because arsenic is colorless, odorless and tasteless you would not be able to tell if it is breaking through by looking at or tasting your water.

Are there any other maintenance requirements besides regular testing and media replacement when test results indicate the filter is no longer working?

- All treatment systems require pre-treatment sediment filters to be changed on a regular basis The timing of sediment filter changes depends on the specific characteristics of your well and water. If the water pressure in the home gradually drops, the first place to look is a clogged sediment filter.
- The post-treatment sediment filters will probably only need to be changed once per year.

Is there waste from the treatment system that I'll need to dispose of safely?

Your treatment system installer should take care of the proper disposal of used treatment media.

Used arsenic tanks should be tightly closed and disposed of.

Treatment installers should never re-bed (empty the used media and replace with new media) treatment tanks in your home.

Used media should not be touched with bare hands.

8

Pg. 9 & 10

ARSENIC TEST RESULTS

Helpful Hint: Replace your arsenic worker tank when the reading between the tanks reaches 5(µg/L) or 5ppb.

Date	Meter Reading	Between the Arsenic Tanks	Kitchen Sink	Reverse Osmosis
	(Gallons)	(µg/L) or PPB	(µg/L) or PPB	(µg/L) or PPB

Date	Meter Reading	Between the Arsenic Tanks	Kitchen Sink	Reverse Osmosis
	(Gallons)	(µg/L) or PPB	(µg/L) or PPB	(µg/L) or PPB

10

Inside Back Cover and Back Cover

Date	Meter Reading	Between the Arsenic Tanks	Kitchen Sink	Reverse Osmosis
	(Gallons)	(µg/L) or PPB	(µg/L) or PPB	(µg/L) or PPB

11

12

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