Achieving Safe Drinking Water Quality in Effected Towns of Cape Cod

Maia Adley

Introduction

In 1993, Cape Cod became a blip on the radar with the Massachusetts Cancer Registry because seven of the ten highest rates of cancer were in its towns. In response, Silent Springs Institute,[1] was created by the Massachusetts Breast Cancer Coalition to search for risk factors. The institute formed a research team to link environmental issues to the increase in cancer rates, creating the Cape Cod Breast Cancer Environmental Study. The Institute was named after Rachel Carson[2] , author of the book *Silent Spring* which addressed the issue of pesticides and their harmful effects, bringer attention nationally. Carson died of breast cancer only two short years after the publishing of her book. The Newton-based institute drew researchers to collaborate from Harvard, Boston University and Tufts. The use of comprehensive geographic information system (GIS) in this study introduced new techniques to the world community of public health researchers. By using GIS, they could to assess how environmental factors on Cape Cod may be linked to the increase of breast cancer rates, marking a path for future studies in environmental risk factors.

Possible Suspects for Environmental Risks

[1] 133587755319. "Our Story." *Silent Spring Institute*, silentspring.org/about-us/our-story. How and why Silent Springs Institute was created.

[2] August 13, 2015. "The Story of Silent Spring." *NRDC*, 6 Apr. 2018, www.nrdc.org/stories/story-silent-spring. The back story into the foundation of Silent Springs, Rachel Carson

Silent Spring Institute began by reviewing previous research completed in the Collaborative Breast Cancer Study and the Upper Cape Cancer Incident study, as well as looking into the data in the Massachusetts Cancer Registry from 1982-1995. Then preformed a controlled study of twenty-one thousand local Cape Cod women who had been diagnosed with breast cancer. By using geographical information system, researchers were able to chart potential exposures to pesticides and contaminated groundwater by testing the air, dust and women's urine in 120 homes. These tests were used to assess potential exposure to estrogenic compounds from the septic system runoff[3]. Additional interviews with the woman in the study helped estimate exposure to potential carcinogens.

The use of contraceptives, estrogen replacement and alcohol were the issues at the forefront when addressing breast cancer risks. It was believed that the increase in hormones given by oral contraceptives and estrogen replacement increased breast cancer, and alcohol intake was also associated with an increased estrogen level. A rise in estrogen signals causes breast cells to multiply at an abnormal rate which may lead to a mutation during the cell division causing cancer to form[4]. With this, researchers saw the importance of focusing on the study of chemicals both synthetic and natural which may mimic the role of estrogen and affect the hormonal system in women[5]. Silent Springs was able to identify potential environmental factors such as pesticides, PBDEs, PAHs, PCBs and flame retardants, potential compounds that mimic hormonal activity.

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[3] 133587755319. "Cape Cod Breast Cancer and Environment Study." *Silent Spring Institute*, silentspring.org/project/cape-cod-breast-cancer-and-environment-study.

[4] Harvard Health Publishing. "Hormones and Breast Cancer: What You Should Know." *Harvard Health*, www.health.harvard.edu/womens-health/hormones-and-breast-cancer-what-you-should-know.

[5] Mapping out a search For Environmental Causes of Breast Cancer https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1381895/pdf/pubhealthrep00045-0024.pdf

Groundwater on Cape Cod comes from a single source aquifer, which means that all the drinking water from the local wells come from the same source of water, allowing contamination of the groundwater to be widely detrimental[6]. Researchers from Boston University who are on the study for Silent Springs, Ann Aschengrau and David Ozonoff, found an association between women with breast cancer and those who live near the Massachusetts Military Reservation located on Cape Cod. These women lived close to the gun and mortar sites of the Military Reservation, areas which contain high levels of DDT. In their 1991 study, DDT was found to not have correlation with mammary tumors in animals, but was linked to cancer in the human population through three control case studies. The cape is also known for their cranberry bogs, which raised the question of pesticides leaching into the groundwater and contaminating the aquifer[7]. Silent Springs found evidence from 1948 that associated a risk of living near cranberry bogs also had a rise in breast cancer when pesticides such as DDT were sprayed. The spraying effected trees for pest control, cranberry bogs and wetlands to control mosquitos[8]. Along with cranberry bogs, the fertilizers used in the local Cape Cod golf courses also have an associated risk of contaminating the single-source aquifer.

Cape Cod relies on septic systems to deal with the removal of waste and wastewater. Septic systems contain a septic tank that separates the solid waste and the wastewater over time by letting the waste sink to the bottom and removal the grease and oil from the top of the water waste. The waster waste then exits the septic tank between these layers and moves to the

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[6] "Drinking Water on Cape Cod." *Cape Cod Groundwater Guardians*, www.capecodgroundwater.org/learn-more/drinking-water-supplies/.

[7] Mapping out a search For Environmental Causes of Breast Cancer
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1381895/pdf/pubhealthrep00045-0024.pdf

[8] Brody, Julia Green, et al. "Breast Cancer Risk and Historical Exposure to Pesticides from Wide-Area Applications Assessed with GIS." *Environmental Health Perspectives*, vol. 112, no. 8, 2004, pp. 889–897. *JSTOR*, www.jstor.org/stable/3435860. Accessed 29 Apr. 2020.

drainage area where it is met with pretreated water from the house's pipes and dispersed throughout the surrounding soil[9]. This wastewater can then seep not only into the groundwater aquifer but also directly into surroundings wells, due to the close proximity in the result of crowding, that the septic systems and wells are to each other. The issue with this source of water treatment is that household products such as cleaners, shampoo, and pharmaceutical medication that are flushed down the toilet or washed down the drain, are not properly treated. These household products and medications cannot be properly broken down through the simple septic system treatment due to their complex structure. The wastewater from septic systems also have a high level of nitrogen, which in turn has increased nitrate levels in the drinking water. There is minimal removal of nitrate by the natural drainage and soil process of septic systems. High nitrate levels are a sign of how developed an area is - the more crowding and over-development, the more likely a higher nitrate level will occur[10]. After years and years of this contaminated water cycling through the system, the synthetic chemicals become concentrated in the drinking water being consumed by the Cape Cod Residents. Exposure to this contaminated water for decades upon decades leads to question an association between this and the rise in breast cancer.

Findings

After reviewing the collected data, Silent Springs has confirmed the Massachusetts Cancer Registry's claim that breast cancer incidence is higher than average on Cape Cod. This issue has continued for many years even after the Cancer Registry's discovery and is not based on higher rates of diagnoses. Silent Spring Institute has drawn the conclusion that "Women who have lived longer on Cape Cod have higher breast cancer risk, after controlling for established

[9] "How Your Septic System Works." *EPA*, Environmental Protection Agency, 20 Aug. 2018, www.epa.gov/septic/how-your-septic-system-works.

[10] Cape Cod commission https://www.capecodcommission.org/our-work/208/

breast cancer risk factors and mammography use, lending support to the hypothesis that a regional factor, perhaps an environmental factor, is at work."[11] They are still working towards a concrete solution to this issue.

There is not a strong association between residual pesticide exposure applied in 1948 to the mid 1970's to the breast cancer rise, but there is still weak evidence that is suggested in other studies. Researcher Ann Aschengrau performed a study in California which did find exposure to pesticides, such as DDT, created a higher risk of breast cancer when exposed at a young age. Pesticides were prevalent in the tested households and contained high levels of DDT, Methoxychlor, Carbaryl, Ortho-Phenylphenol and Propoxyr. There was a greater risk approximately 20-80 percent higher with women who lived near the treated trees, cranberry bog and agricultural land that were sprayed exposed to pesticides, but much variation has made the data statistically insignificant.

Silent Springs has established evidence of increased wastewater infiltration from septic tanks, into the drinking water. From the Household Exposure Study, researchers found around 20 endocrine disruptors in urine alone[12], which enters the through household air and dust and cycles back through the drinking water.

Although contaminants in the drinking water cannot be directly correlated to the increase in breast cancer among certain parts of Cape Cod, public health officials along with the Cape

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[11] 133587755319. "Findings of the Cape Cod Breast Cancer and Environment Study." *Silent Spring Institute*, silentspring.org/news/findings-cape-cod-breast-cancer-and-environment-study.

[12] https://silentspring.org/project/household-exposure-study-cape-cod. This first study to measure indoor concentrations of many endocrine disrupting chemicals found levels of PBDEs (a flame retardant) ten times higher than in European homes. Rudel, R.A., D.E. Camann, J.D. Spengler, L.R. Korn, J.G. Brody. 2003. Phthalates, alkylphenols, pesticides, polybrominated diphenyl ethers, and other endocrine-disrupting compounds in indoor air and dust. *Environmental Science & Technology,* 37(20): 4543-4553. doi:10.1021/es0264596

Cod Commission have taken it into their hands to improve Cape Cod drinking water and protect the single-source aquifer.

Action being put in place

As a result of Silent Spring's initial work, even with the conclusion of specific causes not being found, the Cape Cod Commission has taken on the role of developing the regulations and addressing the water quality of local Cape Cod towns. Contaminated wellhead sites have already been cleaned in the 1980s and 90s. The current issue is with developing towns without damage to wastewater infrastructure[13]. Over 30 years ago areas near pumping wells were designated as wellhead protection areas. These protected areas are now included in town zoning import health bylaws, thanks to water planners. This list of suitable lands for wells is periodically updated to ensure the best water quality possible. Even wells which may be inactive now can also be used in the future, proving the importance of regulating development, Current wells in Barnstable only have a twenty-foot gap between the surface and groundwater. One well in Mashpee has only 6.57 feet between surface and groundwater[14], construction of new properties will potentially digs deeper than seven feet. Wellhead protection areas are covered by regulations that limit any development around the wells which could decrease the quality of the drinking water, these wellheads are also designated in zone two of Massachusetts drinking water regulations[15]. There is a total of six zones when it comes to wellhead protection, each determined by the distance

[13] A phone interview with Tim Pasakarnis, a water resource analysis at Cape Cod Commission,

[14] "Cape Cod Groundwater Levels." *Cape Cod Groundwater Levels | Cape Cod Commission*, www.capecodcommission.org/our-work/cape-cod-groundwater-levels/.

[15] Massachusetts drinking water regulation docs.digital.mass.gov/dataset/massgis-data-massdep-wellhead-protection-areas-zone-ii-zone-i-iwpa

between surface and the groundwater in question. Each zone contains the area of the subsequent zones before them. Zone II is determined by if that well was pumped for 180 days every day without any rain what is the land surface area groundwater for that well. Zone II must contain Zone I and is the area of the aquifer which contributes the water to the wells[16]. The public health departments have embraced the need for implementing a plan for drinking water protection through regional and state actions.

To address the contamination of water quality, a vital factor in this issue is the septic tank discharge. Cape Cod Commission has also implemented a nonpoint source protection plan under Section 208 of the Clean Water Act, which was certified by Governor Charles Baker in 2015 and updated in 2018. The plan focuses on the nitrogen levels impacting the coastal waters due to waste from septic systems[17]. Because of Cape Cod's high nitrogen levels, the plan establishes a goal of five parts per million (ppm) instead of the federal goal of ten. Plan 208 of the Clean Water Act, suggests a replacement of old septic systems with new innovative septic systems which have been shown to reduce the amount of nitrogen discharge and waste matter into groundwater.

There are two different types of wells on Cape Cod: community and private wells. At peak summer season, both types of well must provide water for more than 650,000 people. Community wells serve as the source of drinking water for schools, churches, and public needs. They cover about 85% of the drinking water used and are relatively large for this reason. According to the Cape Cod Commission, the public water is drawn for filtration from around 160

[16] Bureau of Geographic Information. "310 CMR 22.00: DRINKING WATER." *Massachusetts Document Repository*, 9 Dec. 2019, docs.digital.mass.gov/dataset/massgis-data-massdep-wellhead-protection-areas-zone-ii-zone-i-iwpa.

[17] "Section 208 Area Wide Water Quality Management Plan." *Section 208 Area Wide Water Quality Management Plan | Cape Cod Commission*, www.capecodcommission.org/our-work/208/.

gravel packed supply wells and only one surface reservoir. These wells go through many safety checks and testing to ensure high water quality. Private wells, on the other hand, are much smaller than community wells and are only used for about 15% of the drinking water[18]. These types of wells are most prominent in outer cape communities and are usually in close proximity to the owner's house. Such private water sources are the point of risk to contamination by being shallow and are often close to septic systems. These are the water sources that are of concerned for increased breast cancer rates. Water testing on these wells, since they are privately owned, are done by the users of the wells. County public health departments such as Barnstable County Department of Health[19] and Environment allows owners to send in water samples for the cost of $45 to be tested[20].

With these tests the Silent Springs Institute and the Cape Cod Commission found traces of pharmaceuticals and personal care products (PPCP) in private wells. Although water quality has improved in the past 15 years the nitrate level has slightly gone up. Plan 208 funding has been given to Cape Cod County Department of Health environment to help reduce levels of nitrate and increase the drinking water qualities and each county. Including the Barnstable County Department of Health and Environment, there is the division of Massachusetts alternative septic system test center which is used to test the effectiveness of septic systems. This

[18] "Drinking Water on Cape Cod." *Cape Cod Groundwater Guardians*, www.capecodgroundwater.org/learn-more/drinking-water-supplies/.

[19] "Residential Water Testing." *Barnstable County Department of Health and Environment*, www.barnstablecountyhealth.org/programs-and-services/water-quality-laboratory/residential-water-testing.

[20] "Residential Water Testing." *Barnstable County Department of Health and Environment*, www.barnstablecountyhealth.org/programs-and-services/water-quality-laboratory/residential-water-testing.

center is currently being used to test the usefulness of a soil-based septic system that may be able to process effluent containing pharmaceutical and other synthetic chemicals[21].

Future plans and Recommendations

The issue of the financial implications of this plan is at the forefront of the implementation. In addition to the idea of using compostable toilets the Commission has introduced the potential of using urine diversions in houses to help the diversion of waste into the water. Silent Spring Institute urges the vitality of continuing research on the cause and risk factors of the rising breast cancer in Cape Cod. They are currently looking into PFAS in the drinking water and a correlation between children and their immune strength due to PFAS while drinking possibly contaminated water[22].

A big issue with this topic is the lack of education on the issue amongst the Cape. Teaching children, schools and residents about properly testing drinking water is vital for prevention against the possibility of breast cancer. A lot of the information about this issue has to be found online, and it is not easy to get a clear answer on the current issues and regulations on the topic. Counties should be more open to their residents about the quality of the drinking water.

Creating a mandatory and sustainable plan across all counties of Cape Cod in unity, will help progress and sustain the drinking water quality in the future. Implementing mandatory testing of septic tanks and the effluent from the septic systems when they are in close proximity to a well, should be the jumping off point. Testing should also be free in these cases, having to pay a fee may drive residents away and forgo the lab test. Addressing the already contaminated

[21] "Section 208 Area Wide Water Quality Management Plan." *Section 208 Area Wide Water Quality Management Plan | Cape Cod Commission*, www.capecodcommission.org/our-work/208

[22] PFAS-Reach , Silent Springs Institute's current research on Cape Cod's Drinking water.

water is an important factor to moving forward. Hyannis has started construction on their $12 million Maher Water Filtration Plant[23], a system which removes synthetic chemicals by carbon filtration, oxidized with peroxide and ultra violet let and removes iron and manganese by greensand filtration. The plant is scheduled to be done by the fall of 2021, but until then, education on synthetic chemicals in homes and how-to safety remove these risk factors is needed.

[23] Gregory, Jon W. Barnstable, Massachusetts. https://town.barnstable.ma.us/Departments/watersupply/Barnstable%20Maher%20Filtration%20Plant%20Final%20Pilot%20Test%20Report_%20trans%20no.%20X277113_1-18-18.pdf

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