

Municipal Vulnerability Preparedness Program Action Grant Case Study

Municipality: Plymouth

Project Title: Subterranean Resilience: Predicting, Assessing and Mitigating Saltwater Intrusion

Award Year: FY 22/23

Grant Award: \$304,915

Match: \$169,127.25

Match Source: Predominantly from 7 partners and their members' personal participation.

One or Two Year Project: Two-year

Municipal Department Leading Project: Planning Department

Project Website URL: <https://pinebarrensalliance.org/massachusetts-vulnerability-preparedness-mvp/>

Community Overview:

- Plymouth is a coastal community in Southeastern Massachusetts with approximately 65,000 full-time residents.
- Plymouth has two areas designated as environmental justice communities: one based on income, the other on the presence of a minority population of just over 38%.
- Plymouth is world-famous as the site of the Mayflower's landing and the subsequent effect of the Mayflower Compact on the establishment of representative democracy in North America, and therefore Plymouth is a popular tourist destination.
- Relative to climate concerns, the town is dependent upon a large sole source aquifer and features 450 ponds and 35 miles of coastline.

Project Description and Goals:

- Research on saltwater intrusion focused on the coastal areas of town but the project was also concerned with the effects of climate change and sea level rise on the community's sole-source aquifer, and the siting of municipal wells. A town-wide educational program addressing climate change and water-quality issues was initiated.
- Sea level rise and its effect on salinity levels was the critical factor reviewed by the project.
- Our basic mission was to assess the effects of climate change and sea level rise on the town's vulnerability to saltwater intrusion.
- Our project met its climate/resiliency goals:
 - Nature-based solutions for the effects of sea level rise on freshwater were outlined.
 - New, innovative models for assessing saltwater intrusion that will benefit all Massachusetts coastal communities, were developed.
 - Scientific results should have direct impact on future plans for securing access to municipal water (siting new town wells).
 - Community organizations directly involved in both the scientific and community outreach aspects of the project: The Town of Plymouth, Southeastern Massachusetts Pine Barrens Alliance, Living Observatory, Wildlands Trust, The League of Women Voters of the Plymouth Area, Plymouth Open Space Committee, Herring Pond Wampanoag Tribe, Indigenous Resources Collaborative, Plymouth Water Conservation Committee, Old Colony Planning Council, U-Mass Amherst School of Earth and Sustainability.

Results and Deliverables:

- An analysis of the current state of saltwater intrusion in Plymouth showed limited increases in subsurface salinity in the aquifer along the coast. At the larger aquifer scale sources of salinity were localized to specific land uses, such as road salting and septic return flows.
 - Three potential areas of saltwater intrusion due to sea level rise, water use increase and terrestrial climate changes showed limited onshore movement of saltwater.
 - The three potential areas of the largest changes experienced 3-4 times the increase in salinity, based on 6 feet of sea level rise.
- Based on the modeling results the following mitigation strategies were recommended:
 - Develop a data dashboard to post salinity observations of town water supply wells on an annual basis.
 - Fund an airborne electromagnetic geophysical survey of coastal areas (to test models and more accurately image extent of saltwater intrusion).
 - Install early-warning system (3 nested piezometers) utilizing real-time pressure and salinity monitoring.
 - Establish salinity data base for town surface and groundwaters.
 - Optimize future freshwater well placement determinations with data provided.

Deliverables and/or web links:

- **Southeastern Massachusetts Pine Barrens Alliance (SEMPBA) Website:**

UMass-Amherst School of Earth and Sustainability MVP project reports, Dr. David Boutt, PhD, Principal Investigator:

- *Future water demand for Plymouth Public Water System through 2100*, by Alexander Kirshen and David F. Boutt, Ph.D., University of Massachusetts Amherst. (https://pinebarrensalliance.org/wp-content/uploads/2023/07/Task-9-PlymouthFutureWaterDemand_Memo.06302023.pdf)
 - *Salt-Water Intrusion Vulnerability Assessment in Plymouth, MA —Compounding effects of Sea-Level Rise on Water Quality and Aquifer Sustainability*, by Alexander Kirshen, David Boutt, Daniel Corkran, Brendan Moran, & Rachel King. (https://pinebarrensalliance.org/wp-content/uploads/2023/07/Task-9-Boutt_MVP_FY23.Report.pdf).
- **Southeastern Massachusetts Pine Barrens Alliance (SEMPBA) Youtube Channel**
 - *Salt-Water Intrusion Vulnerability Assessment in Plymouth, MA—Compounding Effects of Sea-Level Rise*. (<https://www.youtube.com/watch?v=g7-7jgbc-mu&t=117s>)
 - *The Potential of Saltwater Intrusion into Plymouth's Groundwater*. Dr. David Boutt, UMass Amherst. (<https://www.youtube.com/watch?v=fEn0lpNI8yw&t=1116s>)
 - **Living Observatory OneWater Website:** <https://onewater.livingobservatory.org>.
 - **League of Women Voters of the Plymouth Area Website:** <https://www.plymouthlww.org/sustainability/>.

- **MVP Winter Webinar: Community-Based Problem Solving** – January 18, 2023, featuring the Town of Plymouth project Subterranean Resilience (<https://www.youtube.com/watch?v=ud2vbrfdq4g>).
- **Plymouth SWI Taskforce** - <https://www.facebook.com/PlymouthSWIT/>.

Lessons Learned:

- The interconnectivity of water-related issues—and the public’s broad support for pro-active measures to ensure the abundance and quality of water —was a pleasant revelation. Though our project was focused on the technical end, the public’s willingness to participate was an encouraging sign.
- An important lesson, applicable to many Massachusetts communities, is the importance and likely lack of relevant water quality data. We were surprised to discover that the data we thought that well-installers should collect, and municipalities compile, were either unavailable, or in a form (hand-written cards) that were difficult to utilize.
- The project also drove home the reality that Massachusetts communities with a high percentage of septic systems have reached a tipping point in terms of those systems—and other contributors such as fertilizers—effect on groundwater. In Plymouth that issue is exacerbated by the presence of 450 ponds, most of which are encircled by residences.
- If others wish to apply the scientific lessons of this project to their community, a first step would be to consult the paper by Kirshen, Boutt, Corkran, et al, “Saltwater Intrusion Vulnerability Assessment in Plymouth, MA – Compounding Effects of Sea Level Rise on Water Quality and Aquifer Sustainability.”
- The Southeastern Massachusetts Pine Barrens Alliance is available to discuss the challenges and opportunities of a community-driven project, in keeping with the goals of MVP 2.0.

Partners and Other Support:

Our project engaged a dozen community organizations (non-profit environmental organizations, indigenous groups, and others) in almost every aspect of our endeavor.

- Southeastern Massachusetts Pine Barrens Alliance was responsible for the creation and submission of the grant application itself, the management of the grant once approved, the promotion of the project’s varied elements and partners during its two years, and over a dozen organizational meetings including a culminating event that included Mass ‘Climate Chief’ Melissa Hoffer, Boston Globe Climate Writer David Abel, and Project Scientist Dr. David Boutt of UMass-Amherst.
- UMass-Amherst School of Earth & Sustainability Professor David Boutt’s team led the saltwater intrusion assessment team.
- The Living Observatory established OneWater, a data-driven website that chronicled the MVP project’s efforts and will continue to serve as a depository for all water-related environmental projects in the region going forward.
- The League of Women Voters of the Plymouth Area produced “Read Up A Storm,” a community-wide discussion of climate-related issues centered around concern for our sole-source aquifer.
- The Indigenous Resources Collaborative produced several indigenous/water related activities including the event, ‘The Way of Wampum.’

- The Herring Pond Wampanoag Tribe produced several heritage walks highlighting the indigenous approach to natural resources.
- The Savery Pond Conservancy and the Six Ponds Improvement Association led the Saltwater Intrusion Taskforce: volunteers who solicited homeowners to allow their wells to be tested and began the compilation of laboratory equipment that will establish a 'community water testing station' that will offer free water tests to community residents.
- The Plymouth Water Conservation Commission produced a report on the potential of water conservation measures.
- Sustainable Plymouth, the Plymouth Open Space Committee, the Old Colony Planning Council offered advice, match hours (hikes, meetings, well sampling etc.) and promotion throughout the project's 2-year tenure.

Project Photos Attached:

- MVP Plymouth Herring Pond Wampanoag Tribe Water Testing Event Flyer
- MVP Plymouth Event Flyer
- MVP Plymouth League of Women Voters Plymouth Area 'Read Up A Storm' photo.
- MVP Plymouth Herring Fest Hydrology Demo
- MVP Plymouth SWI Overdrawing
- MVP Plymouth Well Sampling Training