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**Hydrogeological Analysis, 66 acres, Town of Brewster property, Long Pond  
(formerly, CC Sea Camps)**

I have been asked by the Brewster Conservation Trust (BCT) to provide an analysis of the current hydrogeological status and significance of the above-referenced property. I understand the purpose is to inform the Town’s Long Pond Advisory Committee with this data as it evaluates potential uses of the property. No development proposal has been offered for evaluation; the site conditions as they are today is the focus of this report. No new research has been conducted; this is a review of existing scientific literature.

The Town of Brewster acquired this property, stretching from State Route 137 to frontage on Long Pond, in November 2021 for “habitat protection, watershed protection, open space, conservation and passive recreation, active recreation, community housing and/or general municipal purposes.” (Deed Book 34698 Page 91).

**Forest Cover, Surficial Geology, Soils, and Hydrogeology**

The property is mostly upland forest with a mix of pitch pine, white and black oak, with scattered red maples and American beech, with an understory (shrub layer) of black huckleberry, highbush blueberry, viburnum and other native Cape Cod woodland species that thrive on the sandy, low-nutrient, acidic soils. Most of the property is flat to slightly rolling until it drops steeply to Long Pond. There are two isolated freshwater wetlands at the pond shore, both grown up from prior cranberry bog activity into highbush blueberry swamp with red maples and black tupelo trees. A borrow pit, used to mine sand for the active bogs, is located adjacent to the swamps.

The retreating Wisconsin Glacier deposited the coarse sands and gravel associated with the Harwich Outwash Plain 10,000 – 12,000 years Before Present (Figure 1). The outwash plain slopes broadly from north to south across Brewster and Harwich. The land surface elevation of the parcel ranges from a high plateau of 100 feet beginning at Long Pond Road to 30 feet from at the shore of Long Pond. The outwash plains of Cape Cod are pockmarked by numerous kettleholes and channels that are now freshwater ponds or streams when they intersect the water table. The western portion of the parcel is dissected<sup>1</sup> by a north to south glacial outwash channel, which is now used as a dirt road access leading to homes on the Pond (W.H. Besse Cartway).



**Surficial Geologic Map of the Harwich Quadrangle, Massachusetts**

Compiled by  
*Excerpt* Byron D. Stone and Mary L. DiGiacomo-Cohen  
 2009 *Based on 1961 USGS data*



*Figure 1 Surficial Geologic Quadrangle*

Carver coarse sand, a name assigned by the US Natural Resources Conservation Service, dominates the upland area; this is the most common soil type found on Cape Cod. Minor areas of Swamp and Marsh and Cranberry Bog are shown in the two shades of purple on the map. The Service defines the Carver series as being “very deep, excessively drained sandy soils... saturated hydraulic conductivity is very high.”

<sup>1</sup> *A dissected plateau is a plateau area that has been severely eroded such that the relief is sharp.*

The property is located on the Monomoy Lens of the Cape Cod Aquifer, which was designated a Sole Source Aquifer in 1982 (Figure 2). Groundwater lenses can be thought of as a gentle mound of freshwater floating atop the underlying saltwater basin of the aquifer. This

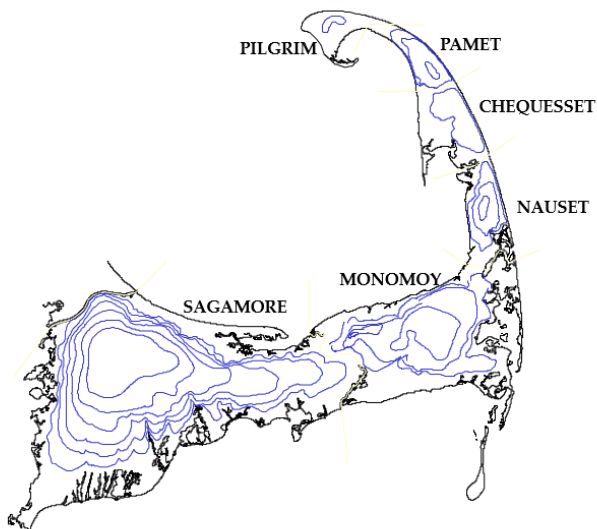


Figure 2 Cape Cod Aquifer Watertable Map

groundwater mound or “lens” (like the shape of a contact lens) is thickest in the middle of the Cape and gets thinner and thinner as it approaches the coasts. There are six separate groundwater lenses under Cape Cod. The size and elevation of the groundwater lenses is proportional to the land mass, so the Monomoy Lens, beneath the Lower Cape, is the second largest and highest next to the Sagamore Lens beneath the Upper and Mid-Cape. The Monomoy Lens at its highest elevation is about 34 feet above mean sea level and has a maximum saturated thickness of only 350 feet. The groundwater lens supports all life on Cape Cod and is extremely thin and vulnerable.

Walter, D.A., McCobb, T.D., Masterson, J.P., and Fielen, M.J., 2016, Potential effects of sea-level rise on the depth to saturated sediments of the Sagamore and Monomoy flow lenses on Cape Cod, Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5058, 55 p., <http://dx.doi.org/10.3133/sir20165058>.

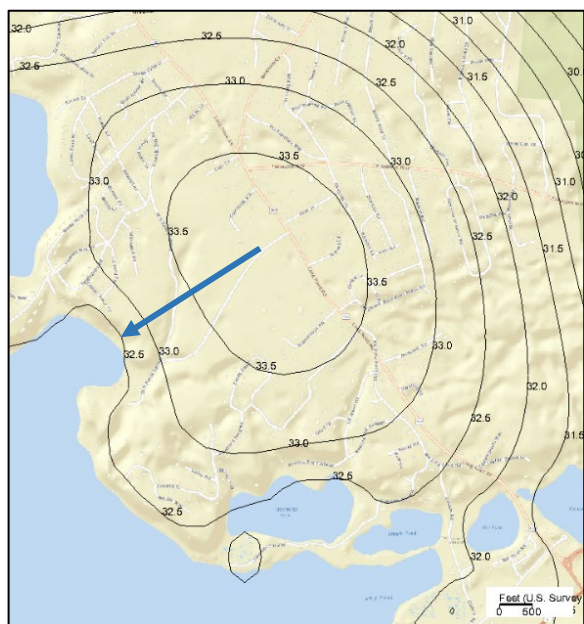


Figure 3 Water Table Map of the Parcel Area

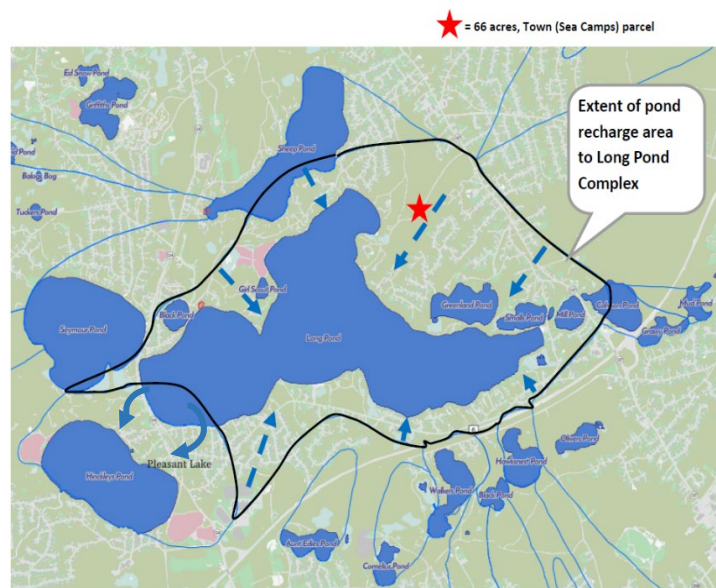
The elevation of the water table ranges from approximately 34 feet above mean sea level near Long Pond Road on the east to 31 feet, the surface water elevation of Long Pond (Figure 3). The depth to groundwater ranges from approximately 67 feet near Long Pond Road to zero at the Pond interface. The groundwater flow is generally to the southwest towards Long Pond. The high transmissivity of the glacial sands results in a fairly fast groundwater flow velocity of one foot per day. The time of travel for water flowing from the eastern border of the locus parcel to Long Pond is approximately nine years.

The rapid drainage due to the high permeability of the glacial sands ensure that the groundwater will be quickly replenished by rainfall and snowmelt. The water table and pond elevations can fluctuate as much as 6.5 feet through the year in response to climatic variations. It also means, however, that any surface or subsurface contaminants released to the ground will quickly drain through the coarse soil too, resulting in impacts to the water quality of the aquifer and its downgradient water resources. Examples of highly transmissible pollutants in glacial sands include nitrogen, volatile organic compounds, and emerging compounds of concern like, Poly and PerFluoroAlkyl Substances (PFAS). Many of these compounds derive from the release of wastewater, stormwater and managed turf associated with residential and commercial development.

## Long Pond

With 715 acres of surface water, Long Pond is the largest lake on Cape Cod. It is considered a Coastal Plain Pond, which are shallow, highly acidic, low nutrient groundwater ponds in sandy glacial outwash, typically with no outlet or inlets. They are characterized as having distinct herbaceous pond shore communities, with rare plants such as Plymouth gentian, inhabiting the narrow beach margin. Long Pond has a mean depth of 29 feet and a maximum depth of 70 feet; it holds more than 20,000 acre-feet of water.

Groundwater interactions for most kettlehole ponds on Cape Cod consist of groundwater flow into one side of the pond and groundwater discharge back into the aquifer on the downgradient side. But with its central location straddling Brewster and Harwich, Long Pond is unique in having recharge from almost all sides (Figure 4). The reason for this characteristic lies in the pond being situated between higher lands that contain several groundwater highs that collectively define the top of the Monomoy Lens. At 31 feet, the surface of Long Pond is higher above sea level than any other pond east of Bass River. Long Pond drains into the Herring River system through small surface flow outlets and groundwater to the southwest (Figure 4). The total flow of water through Long Pond is estimated at 5,700 acre-feet per year, suggesting a total volume turnover of three to four years.<sup>2</sup>



Source: Cape Cod Commission Pond and Lakes Atlas, 2022 update, <https://ccccommission.maps.arcgis.com/apps/insant/sidebar/index.html?>

Figure 4 Long Pond Recharge Area showing Groundwater Flow and Discharge into the Herring River System (Hinckley's Pond)

<sup>2</sup> Management Study of Long Pond, ENSER Intn'l, 2001

According to watershed delineations based on groundwater flow models provided by the US Geological Survey (USGS), all of the 66-acre property (our study area) is within the recharge area (upgradient) Long Pond. Absent any artificial influences (such as the Town's pumping wells to the east, discussed later), every drop of water that falls on the 66 acres that drains into the aquifer below will end up in Long Pond (Figure 4). The release of contaminants from land use within the recharge area is a primary factor affecting the quality of water in the Pond (owing to the sandy, well-drained glacial soils). Surface runoff of storm water and or pond surface pollutants (waterfowl, boats) are secondary considerations.

With almost all of the Long Pond shoreline developed residentially and most of the recharge area similarly built out, the 66-acre property is the largest undeveloped parcel in the pond's watershed and, in conjunction with the adjoining 41-acre Robinson parcel purchased by the Town in 2018, can contribute significantly to the pond's water quality, particularly in the northeast cove on which they are situated.

### **Pond Water Quality Concerns**

Despite its size and depth, Long Pond has been unfortunately highlighted for a long time (since 2004) as an "impaired" water body by the US Environmental Protection Agency.<sup>3</sup> It is one of twenty Cape ponds that have a combination of low dissolved oxygen, excessive nutrients, organic enrichment, a presence of metals, noxious aquatic species and high turbidity. An application of alum in the pond in 2007 to bind the phosphorus causing algal blooms has not produced a marked measure of success. Low oxygen levels in the water column continue to be a problem. Additional development in the Long Pond recharge area could exacerbate these issues in one of the most widely-used recreational ponds on Cape Cod.

### **Town Water Supply**

As noted above, the entire Long Pond property is within the natural recharge area of Long Pond, absent any other influence. But there is a big influence: the pumping of the Town's #1 and #2 Wells off Route 137. All things being equal, drinking water supply wells are best located where the aquifer is thickest to have a greater quantity of water to draw from. Pumping induces groundwater to flow to a well by drawing down the water table. Pumping of the Town's wells are shown through the Zone II analysis to distort the natural aquifer flow to the pond to the wells. More than half (38 of 66 acres) of the Long Pond property is included in the Zone II<sup>4</sup> to the Town's main wellfield (Figure 5). About half of the Town water supply comes from this wellfield, active since the first two wells were installed in the 1970s. During the summer season, when the population of Brewster surges and irrigation increases demand for

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<sup>3</sup> <https://www.epa.gov/tmdl/overview-listing-impaired-waters-under-cwa-section-303d>.

<sup>4</sup> "A Zone II is the area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (i.e., 180 days of pumping at approved yield with no recharge from precipitation). Any contamination of groundwater in a Zone II could impact drinking water quality at the public well drawing water from that area. ***Land acquisition in the Zone II areas to public drinking water wells is a pro-active approach to protecting drinking water quality.*** [emphasis added]" p. 43, Brewster Open Space and Recreation Plan, April 2021 draft."

water, this entire Zone II area of South Brewster contributes groundwater to the drinking water supply of the town.

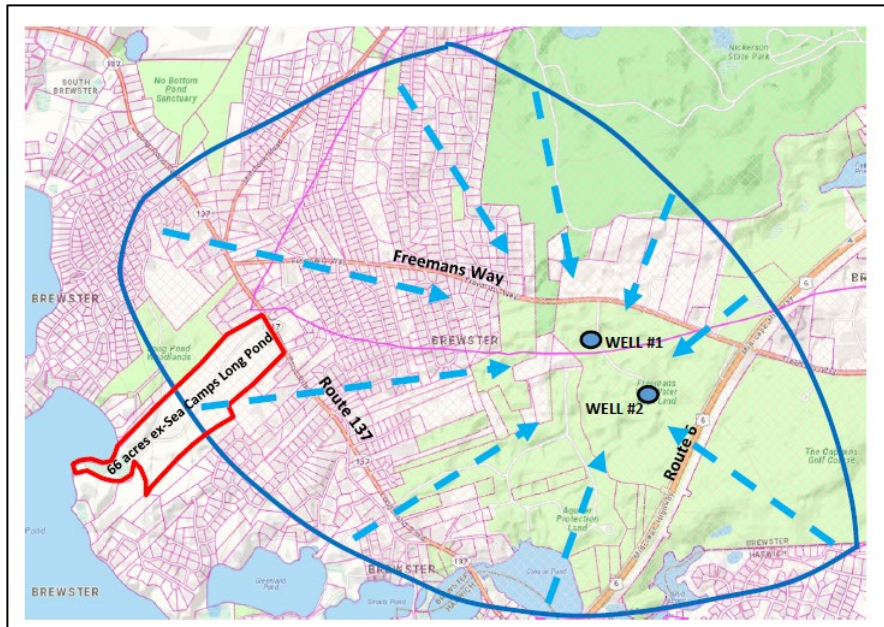


Figure 5 Zone II to the Freeman Way Public Supply Wells

### Future Water Supply

Because the 66-acre parcel was acquired for unspecified uses by the Town, it might be considered as a possible source of future drinking water supply – a site for a new town well or two. The Massachusetts DEP-Water Supply Program requires that the water supplier (in this case, the Brewster Water Department) own or control a minimum of 400 feet in all directions from the well head. As seen in Figure 6, the width of the Long Pond parcel, even by itself is greater than 800 feet, providing multiple options for siting new wells. Because the Town owns the adjoining 41-acre ex-Robinson parcel for conservation, some of the 800-foot diameter protection circles could intrude onto that parcel, though any well would need to be sited on the 66 acres.

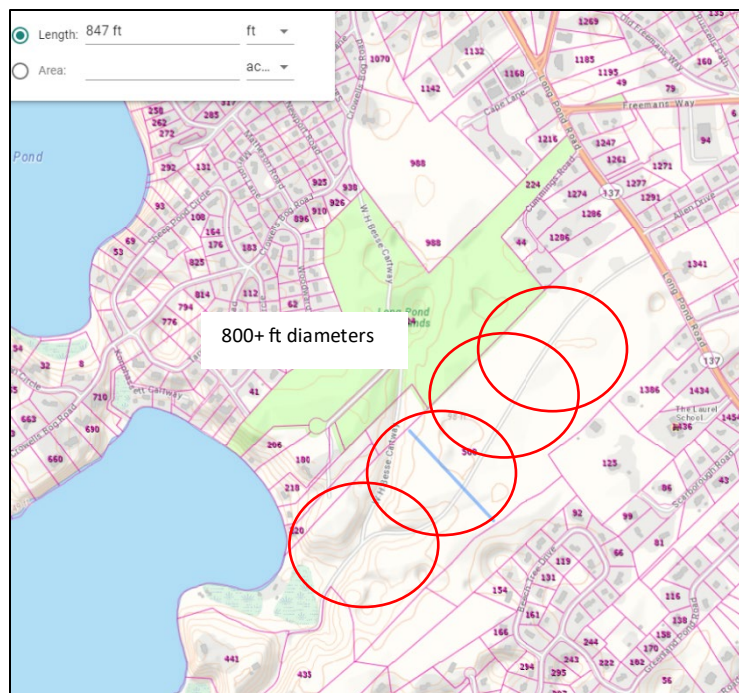


Figure 6 Potential Water Supply Well Suitability Siting

In 1999, the Cape Cod Commission, with technical support from the USGS, identified only five percent (5%) of the Cape's land mass that could support new public supply wells, based on size, aquifer characteristics and land use. There were 35 tracts or assemblages of undeveloped parcels in Brewster that qualified as suitable for accommodating new wells, based on this analysis, including the 100+ acre tract at Long Pond.<sup>5</sup> The Cape Cod Commission's Regional Policy Plan recognizes this parcel as a potential Future Water Supply Site that has more stringent protection standards than a Wellhead Protection Area.

The Brewster Water Department would need to conduct exploratory well drilling and test the quantity, flow and chemistry of the groundwater in this tract to determine actual usefulness for a new water supply here. One advantage for water supply development is the thickness of the ground water lens here. With the scarcity of natural tracts large enough to accommodate new wellfields, this option should not be ignored. The rate of residential and commercial development since the plan was prepared in 1999 has removed many of the other tracts from potential consideration.

### Protection of Water Quality

Brewster Town Meeting voters have made a concerted effort over many years to focus its land purchases in these Zone II areas to protect the natural filter offered by the forest cover on protected land-- the cheapest, most efficient way to prevent aquifer degradation. This preventive strategy is in stark contrast to other Towns that have had to provide a multi-million-dollar treatment process and/or sewers after finding contamination from inappropriate land use activities. The Brewster Water Department has received regional awards for its excellent quality drinking water.

In 2008 the Town nominated its Zone II areas (about 4000+ acres) as a District of Critical Planning Concern (DCPC), which was approved by the voters and codified with the Cape Cod Commission and Barnstable County. Development within the DCPC is supposed to hew to

<sup>5</sup> Cape Cod Commission, *Priority Land Aquifer Assessment Program, Water Supply Development Potential of Priority Property Tracts Based on Existing Conditions -- Town of Brewster*, June 1999

zoning overlay regulations<sup>6</sup> to reduce density, while providing flexible subdivision layout patterns. The purpose of the District is to “protect water resources and preserve the open space of Brewster.” The DCPC adoption signaled another step Brewster has taken to ensure top quality of its drinking water supply, in addition to aggressive land purchases in Zone II.

The 38 acres of the Long Pond property that are within the DCPC/Zone II should be considered important to aquifer protection to the Town’s main wellfield. All of Brewster is currently unsewered, so every development employs subsurface disposal systems for its untreated sewage and wastewater. As noted above, the highly transmissible soil associated with the glacial coarse sands and gravel of this site provides the potential for contaminants from development like nitrogen, phosphorous, metals, volatile organic compounds, and emerging compounds of concern to reach the Town wells off Route 137.

### **Summary**

My review of the 66-acre parcel indicates that it is a pivotal piece in the water quality protection strategy of the Town. Consideration of potential future uses of the property should prioritize the environmental benefits derived from keeping the land in its natural wooded state. All of the parcel is important for water quality protection, either for recharging the waters in Long Pond or in the Town’s main wellfield. A future potential wellfield on the property is not out of the realm of possibility if the land remains undeveloped.

*Thomas C. Cambareri is a Water Resources Specialist and Hydrogeologist. He has 40 years of experience in Cape Cod water resources issues and is engaged in providing expert reviews and opinions, data collection in field, groundwater modeling and water quality analysis for several clients. He managed the Water Resources Office of the Cape Cod Commission for 30 years and provided guidance to the 15 towns on Cape Cod on water resource planning and regulatory protection. He and his staff reviewed all Development of Regional Impact projects on the Cape for their water quality considerations. Mr. Cambareri has also served on the Massachusetts Water Resources Commission since 2007, appointed by Governor Romney to guide water resource planning in the state. He has an M.S. in Geology with a focus on hydrogeology from UMass-Amherst (1986). He is a Certified Ground Water Professional (#360) and a Mass. Licensed Site Cleanup Professional (# 3778).*

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<sup>6</sup> Article XIII Natural Resource Protection Design, Brewster Zoning Bylaws, <https://ecode360.com/14371915>