State of the Waters: Cape Cod

2022 Cape Cod Water Health Report and Action Plan

Association to Preserve Cape Cod
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1. Introduction

The **State of the Waters: Cape Cod** is an annual assessment of the Cape's water quality, designed to help you understand the water quality problems that we face and the actions that are needed to address these problems. The Association to Preserve Cape Cod (APCC) launched this project in 2019 in order to answer the question: "How healthy are Cape Cod's waters?" The State of the Waters: Cape Cod website is the place to find out about the Cape's water quality and what can be done to address water pollution and achieve clean water.

This is a multi-year project in which an annual water health report is provided each year assessing the most recent available water quality data up to and including the previous year (e.g., this report assesses available water quality data up to and including 2021). To prepare annual assessments and reports, APCC collected existing data on water quality on Cape Cod in order to assess the health of Cape Cod's waters. APCC evaluated surface water quality in coastal waters (saltwater) and freshwater ponds and lakes using scoring methods to assess water quality. Scores were assigned into two grade levels for water quality to distinguish between degraded surface waters with **unacceptable** water quality where immediate action is needed to restore water quality vs. surface waters with **acceptable** quality where ongoing protection is needed to avoid a decline in quality. The results are summarized in this annual water health report. The quality of public drinking water supplies was assessed on an **Excellent/Good/Poor** scale. To guide public action, APCC prepared a Water Action Plan that contains recommendations for changes in policies, actions, and regulations to improve and protect our waters.

2. About APCC

The Association to Preserve Cape Cod (APCC) is a 501(c)3 environmental non-profit organization founded in 1968 to promote policies and programs that foster preservation of Cape Cod's natural resources. APCC is a Cape-wide organization with members representing all 15 towns on the Cape. Our goals include protection of water and wetlands; preservation of open space; promotion of responsible, planned growth; and the achievement of an environmental ethic. To achieve these goals, we provide technical assistance, outreach, advocacy, science-based policies and partnership-building. APCC has established itself as the Cape's environmental

leader, earning a reputation for effective policies and actions to protect our precious natural resources (APCC.org).

APCC is well-positioned to provide this Cape-wide assessment of our water quality. Since our inception in 1968, APCC has worked with numerous partners to protect and improve the Cape's water resources and aquatic habitat through policy, science, and education. APCC's successes include:

- Designation of Cape Cod's groundwater as a sole source aquifer to protect our drinking water;
- Designation of the ocean waters around Cape Cod as state ocean sanctuaries;
- Designation of Stellwagen Bank as a National Marine Sanctuary;
- Passage of the Cape Cod Land Bank Act to preserve open space;
- Creation of the Cape Cod Water Protection Collaborative to address water pollution due to wastewater;
- Passage of the Cape Cod Commission Act to create a regional planning agency and promote regional planning;
- Designation of the ocean waters surrounding Cape Cod as a No Discharge Area for boat sewage;
- Coordination of Congressional authorization and funding of the Cape Cod Water Resources Restoration Project, a 10-year Cape-wide restoration program to restore impaired salt marsh and fish runs and shellfish beds;
- Assistance to towns on efforts to restore salt marsh and fish runs and remediate stormwater runoff throughout the Cape;
- Coordination of a regional stormwater partnership;
- Establishment of programs to monitor salt marsh, herring runs and harmful cyanobacteria blooms;
- Evaluation of the effect of future sea level rise on the Cape's aquifer; and
- Passage of legislation creating and funding the Cape and Islands Water Protection Fund.

3. Why This Project is Needed

APCC recognized that while the Cape's waters are well-studied and pollution issues are well-documented, this wealth of information on water quality is usually buried in reports, studies and websites and is not readily available in one place. More importantly, the data are often not translated into clear, easily understood results. Too often, reports that contain gold nuggets of information are mired in complex terminology understood, and seen, only by experts.

4. Goals

APCC's State of the Waters: Cape Cod report is designed to plainly and clearly inform the public about the conditions of our waters. APCC collects water quality data from credible sources and translates the data into clear, easily understood terms in order to identify water quality problems that need to be addressed. Our goals are to: 1) Help people to understand the health of our waters

and the need to protect and improve water quality; 2) Identify the actions needed to protect and improve water quality; and 3) Motivate public action to achieve clean water.

5. Products

APCC has produced the following products for the State of the Waters, available through the State of the Waters website at https://capecodwaters.org:

- Interactive maps of water quality scores and grades for coastal embayments, ponds, and drinking water supplies;
- Information on how water quality data were evaluated, scored and graded;
- Annual Water Health Reports summarizing findings;
- Water Action Plan containing recommendations for actions to protect and improve water quality;
- Atlas of Water Restoration Needs and Solutions;
- Frequently Asked Questions (FAQs); and
- References and sources of information.

6. Partners and Collaboration

Collaboration with partners is an essential feature of the State of the Waters: Cape Cod, as the project involves a gathering and summation of water quality data from many organizations. Partners also provide advice, support, funding, information, and networking.

Advisory Committee: To help advise this project at its inception, APCC convened an Advisory Committee composed of experts in Cape Cod's water pollution issues, water monitoring, drinking water, aquatic ecosystems, fisheries, natural resource management and municipal management. Members represent local, regional and state agencies, environmental nonprofit organizations, and partnerships. Advisory Committee members provide advice, guidance, and data used in this project. Members of the Advisory Committee are listed below:

- Rachel Jakuba, Ph.D., Science Director, Buzzards Bay Coalition
- Erin Perry, Deputy Director, Cape Cod Commission
- Tim Pasakarnis, Ph.D., Water Resources Analyst, Cape Cod Commission
- Richard Delaney, President, Center for Coastal Studies
- Amy Costa, Ph.D., Director of Cape Cod Bay Monitoring Program, Center for Coastal Studies
- Robert Duncanson, Ph.D., Director, Department of Natural Resources, Town of Chatham
- Jane Crowley, Director, Department of Health and Environment, Town of Eastham
- Ivan Valiela, Ph.D., Distinguished Scientist, Ecosystems Center, Marine Biological Laboratory
- Javier Lloret, Ph.D., Research Scientist, Ecosystems Center, Marine Biological Laboratory
- Andrew Marks, Supervisor, Mashpee Water District
- Pam DiBona, Executive Director, Massachusetts Bays National Estuary Partnership
- Prassede Vella, Staff Scientist, Massachusetts Bays National Estuary Partnership

- Todd Callaghan, Coastal and Marine Scientist, Massachusetts Office of Coastal Zone Management
- Brad Chase, Diadromous Fisheries Project Leader, Massachusetts Division of Marine Fisheries
- Brian Howes, Ph.D., Chancellor Professor, School for Marine and Atmospheric Sciences and Technology (SMAST), University of Massachusetts at Dartmouth
- Ed Eichner, TMDL Solutions
- Jordan Mora, Research Technician, Waquoit Bay National Estuarine Research Reserve (now with APCC)
- R. Max Holmes, Ph.D., Deputy Director and Senior Scientist, Woods Hole Research Center (now President and CEO, Woodwell Climate Research Center)

Sources of data: APCC relies upon water quality data collected by other organizations (see Sources of Water Quality Data, below).

Funding: APCC received startup funding for this project from a number of sources. They include the Massachusetts Environmental Trust (MET), an important supporter of environmental projects and funded by the sale of environmental license plates through the Registry of Motor Vehicles. Over the years, additional funding was provided by a U.S. Environmental Protection Agency Southeast New England Coastal Watershed Restoration Program (SNEP) grant to the Cape Cod Commission, the Friendship Fund, and the Cape Cod Five Foundation. APCC dues and donations now fund the annual updates.

7. Why We Need Clean Water

Clean water is central to the health of the Cape's natural ecosystems. Our coastal waters, estuaries and embayments support valuable shellfish such as oysters and clams, as well as important finfish such as winter flounder and striped bass. Waterbirds, migrating waterfowl, raptors and wildlife feed on fish, shellfish and aquatic plants. Freshwater ponds and streams support numerous fish and wildlife species, including important diadromous species such as river herring and American eels, which live in both fresh water and the ocean. The Cape's ecosystems and food webs depend upon clean water.

Clean water is also important for our economy. The Cape's economy is a "blue economy" where our residents, visitors and businesses rely upon clean water and healthy natural resources. The economic benefits of clean water and healthy ecosystems are demonstrated by the fact that coastal tourism and commercial and recreational fishing and shellfishing and their supporting industries bring in more than $1 billion to the local economy. For example, in 2018, tourists visiting Cape Cod spent $1.32 billion that supported 10,844 tourism-related jobs and $357.7 million in wages, and generated $133 million in state and local taxes (Cape Cod Chamber of Commerce).

Commercial and recreational fishing and shellfishing also bring in additional millions of dollars each year. From 2000 – 2004, the average annual value of commercial and recreational shellfishing was $11.4 million. In 2009 alone the value of commercial fishing was $19 million, while the value of commercial fishing for species that eat river herring was over $37 million (NRCS, Cape Cod Water Resources Restoration Project: Why It Matters to Massachusetts

Economy). In 2018, the economic value of Cape Cod's commercial fisheries totaled over $73.6 million, accounting for over 11 percent of the economic value of the Commonwealth's commercial fisheries ("Port by Port: Profiles and Analysis of the Massachusetts Commercial Fishery"). These numbers do not include the economic contribution from water-focused organizations such as oceanographic institutions and businesses, non-governmental organizations, educational institutions and laboratories that employ people and provide services and products.

Finally, clean drinking water is critically important for human health. The water we drink comes from Cape Cod's sole-source aquifer, a vast underground natural reservoir of groundwater. Federal, state and local laws are designed to protect a sole-source aquifer from pollution. However, as we discuss below, our groundwater, ponds, lakes, estuaries and embayments are all interconnected.

8. Waters of the Cape

Cape Cod enjoys a wealth of water resources. These include salt water and freshwater resources. Each major resource is summarized below. More information can be obtained at the Cape Cod Commission's website on water resources.

Coastal waters (saltwater) surround most of the Cape, creating over 559 miles of coastline bordering the Atlantic Ocean, Nantucket Sound, Vineyard Sound, Buzzards Bay and Cape Cod Bay. This long coastline contains 53 distinct saltwater **embayments**, places where there is a recess or indentation in the coastline that forms a bay bordering the ocean. Estuaries are places where rivers meet the sea. Estuaries typically contain a range of wetlands, including freshwater, brackish and tidal wetlands (aka salt marshes) and tidal channels. On Cape Cod, rivers, streams and groundwater flow into estuaries and embayments that border the ocean.

Freshwater ponds and lakes: Few people know that the Cape is the land of nearly a thousand lakes. At least 890 freshwater ponds and lakes cover nearly 11,000 acres, and individual ponds and lakes range in area from less than one acre to 735 acres and include 171 "great ponds" of 10 acres or greater in size (https://www.capecodcommission.org/our-work/ponds-and-lakes/). Because the Cape's ponds and lakes are fed by groundwater, they are often referred to as "windows on our aquifer." The sandy soils of the Cape allow groundwater to flow into and out of ponds. For this reason, pollution of ponds will likely also pollute groundwater and vice versa.

Groundwater: Groundwater is the lifeblood of the Cape. Rain and melting snow quickly soak into our sandy soils where it collects to form a huge underground reservoir of groundwater that lies beneath most of the Cape. Water seeks the lowest elevation, so groundwater continues to move, seeking sea level, flowing into and out of ponds, feeding streams and flowing towards the coast, finding sea level when it enters our estuaries and embayments.

Groundwater is also the sole source of our **drinking water**. In 1982, the U.S. Environmental Protection Agency designated Cape Cod's groundwater as a sole-source aquifer for drinking water under the federal Clean Water Act and Safe Drinking Water Act. All of the Cape's drinking water comes from this sole-source aquifer, which is protected by local, regional, state

and federal regulations. Nearly all of the Cape's public water supplies are from groundwater wells, with one exception being Long Pond in Falmouth, which is itself groundwater-fed.

Watersheds connect our waters: Nearly all of the Cape's waters are connected by watersheds that collect water and discharge it into the ocean. Watersheds are the land areas that collect rain and snow, which drains into ponds, lakes, streams and groundwater, which in turn discharge into estuaries, embayments and the ocean. Cape Cod has a total of 101 watersheds that discharge to the ocean. Of these, 53 discharge to embayments, which are susceptible to nitrogen pollution, and the remainder discharge directly to the ocean. Through the Section 208 Water Quality Management Plan for Cape Cod, the Cape Cod Commission has created a regional blueprint for protecting and improving water quality and tracks progress in implementation.

9. Water Pollution

Most of the Cape's coastal embayments and many freshwater ponds and lakes are suffering from water pollution, based on years of studies and reports on water quality and water pollution. These studies and reports indicate that the Cape's waters suffer from pollution due to the following pollutants and pollution sources.

Nutrient pollution: Excess nutrients (nitrogen in coastal waters and phosphorus in fresh water) have caused severe eutrophication and severe ecological damage. **Eutrophication** refers to the harmful effects of excess nutrients on an aquatic ecosystem, resulting in increased growth of phytoplankton and depletion of oxygen. Excess nutrients in water stimulates the growth of phytoplankton (microscopic algae), which depletes the water of oxygen. Oxygen depletion leads to fish kills and impacts on shellfish and other aquatic life. Excess phytoplankton also causes water to become cloudy, reducing the amount of light in the water column, which impacts the growth of other beneficial aquatic plants such as eelgrass. When algae die, their remains settle to the bottom and decompose, causing more oxygen depletion and releasing nutrients back into the water, feeding the nutrient cycle. Also, the buildup of decaying organic matter on the bottom of ponds, lakes and embayments often results in thick muck that is unhealthy for shellfish, fish and other aquatic organisms.

Many of the Cape's estuaries and embayments are suffering from eutrophication caused by excess nitrogen, as demonstrated by the Massachusetts Estuaries Project and by the Section 208 Water Quality Management Plan for Cape Cod.

Ponds and lakes are also suffering from eutrophication caused by excess nutrients, in particular phosphorus (Cape Cod Commission, Ponds and Lakes).

On Cape Cod, excess nutrients originate largely from human sources and activities. Excess nitrogen comes from poorly treated wastewater (e.g., Title 5 septic systems) as well as fertilizers used on lawns, gardens, golf courses and farms. Some nitrogen also falls out from the atmosphere in precipitation, and this atmospheric nitrogen largely originates from burning fossil fuels. Excess phosphorus also comes from septic systems that discharge phosphorus into groundwater that enters ponds and lakes, as well as fertilizers used on lawns, gardens, golf courses and farms that is carried into ponds and lakes in stormwater runoff.

Harmful bacteria include bacteria that originate from fecal wastes (humans and/or animals). Examples of fecal bacteria are *Escherichia coli (E. coli)* and enteric bacteria. Fecal bacteria can cause illness in both humans and animals. On Cape Cod, most fecal bacteria contamination originates from domestic animals and wildlife. Failed septic systems (including flooded septic systems) are another source of bacteria. Bacteria are carried into water by stormwater runoff. State and federal water quality standards limit the amounts of fecal bacteria that can be present in waters where swimming and shellfishing are conducted. Swimming beach water quality is monitored by Barnstable County**.** The Massachusetts Division of Marine Fisheries monitors water quality in shellfish beds and limits shellfishing to waters that meet a stringent water quality standard for fecal bacteria.

Harmful algal and cyanobacteria blooms include toxic red tides in coastal waters and toxic cyanobacteria blooms in freshwater ponds and lakes. In coastal waters, red tide is the common name for several species of toxic phytoplankton, including toxic dinoflagellates. Shellfish that ingest such toxic phytoplankton become toxic themselves, posing a threat to humans who eat contaminated shellfish and impacting the shellfishing industry. In freshwater, harmful cyanobacteria that produce toxins thrive in nutrient-rich and warm waters. APCC's Cyanobacteria Monitoring Program has documented cyanobacteria blooms in dozens of ponds throughout the Cape and we anticipate that this will be an increasing problem as nutrient pollution continues and the climate warms. This year is the third year that APCC has incorporated cyanobacteria monitoring data into our grading system for freshwater ponds as another indicator of nutrient pollution.

Mercury pollution occurs in waters throughout the Northeast. As of July 2022, the Massachusetts Department of Public Health listed 32 ponds and lakes on Cape Cod with fish consumption advisories that warn people (i.e., children under 12, pregnant women, nursing mothers, women of childbearing age, and the general public) to limit or avoid eating fish from that lake due to mercury pollution (MA DPH Fish Consumption Advisories). Mercury pollution is caused by fallout of mercury from the atmosphere, which originates from coal-burning fuel plant emissions. Incineration of medical wastes and municipal wastes also contributes mercury to the atmosphere. Our assessment does not address mercury pollution, but the State of the Waters; Cape Cod website provides information on mercury pollution and state fish consumption advisories for freshwater lakes and ponds on Cape Cod.

Emerging contaminants and pharmaceutical compounds have been found both in groundwater and surface water throughout Cape Cod. This group of pollutants contains a wide variety of compounds, including endocrine-disrupting compounds, pharmaceutical drugs (including antibiotics), insect repellant, flame retardant, fluorinated compounds and PFAS (per- and polyfluoroacetate substances). The Silent Spring Institute has been monitoring the Cape's waters' emerging contaminants. The Center for Coastal Studies and Silent Spring Institute also found pharmaceutical compounds in Cape Cod Bay and in groundwater near septic systems, pointing to septic systems as the source of these pharmaceutical compounds.

PFAS (per- and polyfluoroacetate substances) are manmade chemicals used widely in diverse items (e.g., fireproof clothing, non-stick pans, stain-and-waterproof fabrics, fire-fighting foam, dental floss, cleaning products, paints, electronics manufacturing and other industries and

household products). PFAS are long-lasting compounds that have been found worldwide in humans, wildlife, water, soil and the air. PFAS have been found in Cape Cod water supplies, groundwater, and ponds (in 2022, six of the 32 ponds which had fish consumption advisories due to mercury also had fish consumption advisories due to PFAS). PFAS compounds have been linked to human health impacts such as developmental disorders, immune system disorders, thyroid hormone disruption and cancer. Information on PFAS is provided in APCC's PFAS Primer. New state regulations limiting PFAS6 in drinking water came into effect in 2021 and were applied in our drinking water grades for this report.

10. How We Graded Water Quality

To help people understand where water quality is acceptable vs. unacceptable, APCC has created this State of the Waters: Cape Cod project and website to collect existing information on water quality and translate it into easily understood terms by grading water quality. This website is a key means of collecting and distributing information to the public. Our intent is to guide public policy and investment in restoration and protection efforts.

Using existing data, APCC grades the following water resources:

- **Coastal waters in embayments and estuaries**;
- **Freshwater ponds and lakes**; and
- **Public water supplies for drinking water** (i.e., drinking water after it is treated by the public water supplier and before it is distributed to consumers).

APCC uses three grading systems, one system for grading coastal waters, a second system for grading freshwater ponds and lakes, and a third system for grading public water supplies that provide drinking water. Each of the grading systems scores water quality parameters. The scores are then translated into grades. APCC uses grading systems that meet the following criteria:

- Are scientifically sound;
- Have been used before to evaluate water quality;
- Use key water quality parameters to evaluate water quality problems;
- Allow for annual updating using the most recent available data;
- Are easily understood and can be replicated by others (e.g., it does not require complex methods, modeling or software); and
- Evaluates the most pressing water quality problems.

In order to provide the most up-to-date assessment feasible, each year the grades are updated on a moving basis by dropping older data and adding newer available data through the previous year. The grading systems are explained below.

10.1. Grading Coastal Waters: Buzzards Bay Eutrophic Index

APCC uses an existing method of grading the severity of nitrogen pollution of coastal waters. The method is called the Buzzards Bay Eutrophic Index (aka "Bay Health Index"), developed in 1992 by the Buzzards Bay National Estuary Program. The Eutrophic Index was based on an earlier method developed by Hillsborough County, Florida, to evaluate coastal water quality.

The Buzzards Bay Eutrophic Index (EI) was developed to help the Buzzards Bay Coalition (BBC) evaluate citizen water quality monitoring data for Buzzards Bay embayments and to help rank each embayment with respect to its relative health for the purpose of prioritizing remedial management measures (i.e., Bay Health). The goal was to evaluate nitrogen loading inputs and to provide accurate and reliable water quality data for most of the major embayments around Buzzards Bay to assist environmental managers to:

- Establish baseline water quality;
- Characterize and identify sources of pollution;
- Document long-term environmental trends in water quality;
- Evaluate the relative success of cleanup efforts;
- Facilitate implementation of management efforts in the CCMP; and
- Evaluate the appropriateness of the Buzzards Bay Project's recommended nitrogen limits.

In addition to the BBC, the Eutrophic Index has also been used by the Center for Coastal Studies, the Pleasant Bay Alliance, and the town of Chatham to evaluate nitrogen pollution in Buzzards Bay, Cape Cod Bay and coastal waters around the Cape, Pleasant Bay, and Chatham. The Eutrophic Index is considered by practitioners to be a well-tested method.

The Eutrophic Index scores parameters that measure the degree of eutrophication are: dissolved oxygen saturation, water clarity (measured using either Secchi disk or a turbidity meter), chlorophyll, dissolved inorganic nitrogen (DIN), and total organic nitrogen (TON). Water quality data for these parameters is used to calculate a numerical score that indicates the degree of eutrophication. To translate scores into an assessment of water quality, the BBC uses three categories to "grade" scores: scores of 65 to 100 indicate Good water quality; scores between 35 and 65 indicated Fair water quality; and scores below 35 indicate Poor water quality.

Following the BBC's method, APCC calculates numerical Eutrophic Index scores for water quality from stations in coastal embayments and coastal waters around Cape Cod. However, APCC "grades" the numerical scores for water quality from individual stations in a manner that differs from the BBC. APCC assigns scores to two grading categories based on whether they indicate acceptable water quality or unacceptable water quality. The two grading categories are chosen to indicate the type of action needed to protect or restore water quality.

Grading coastal water quality at coastal stations:

EI scores greater than 65 (> 65) are graded as: "Acceptable: requires ongoing protection."

EI scores of 65 or below (≤ 65) are graded as: "Unacceptable: requires immediate restoration."

Waters that are graded as "**Acceptable: requires ongoing protection**" are waters that are healthy and free of excess nutrients. These waters need ongoing protection to remain healthy and free of pollution.

Waters that are graded as "**Unacceptable: requires immediate restoration**" are waters that are suffering from excess nutrients. These waters need immediate restoration in order to improve water quality.

Grading water quality in coastal embayments:

APCC has taken the additional step of **identifying embayments where at least one monitoring station had Unacceptable water quality and graded these embayments as "Unacceptable: requires immediate restoration." Embayments where all monitoring stations had Acceptable water quality were graded as "Acceptable: requires ongoing protection."** This approach to grading embayments provides a clear summary of which embayments have portions with poor water quality that require restoration vs. embayments with good water quality that require protection.

10.2 Grading Ponds and Lakes

Method 1: Carlson Trophic Index

To grade water quality in freshwater ponds and lakes, APCC uses two methods. The first method is the Carlson Trophic Index (CTI) which evaluates the trophic state of the water body in terms of three important parameters for fresh water quality: total phosphorus, chlorophyll, and water transparency. The **Carlson Trophic Index** was developed in 1996 to assess the trophic state of a freshwater pond or lake, where trophic state refers to the ecological response (algal biomass) to nutrients (Carlson, 1977). Since then, it has been widely used for evaluating freshwater ponds and lakes. The Carlson Trophic Index is analogous to the Buzzards Bay Eutrophic Index in that it evaluates the degree of eutrophication in fresh water.

The Carlson Trophic Index uses a numerical scoring system to evaluate pond trophic status. Using the Carlson Trophic Index, a **eutrophic to hypereutrophic** pond with high nutrient concentrations would be characterized by high concentrations of algae, algal scums, poor water clarity due to dense algae, low to no dissolved oxygen, and CTI scores between 50 and 100. At the opposite end of the spectrum, an **oligotrophic** pond with low nutrient concentrations would be characterized by clear, well-oxygenated water, healthy aquatic plants, little to no algal growth, and CTI scores between 0 and 40. A **mesotrophic** pond with intermediate nutrient concentrations would be characterized by moderately clear water, intermediate amounts of aquatic plants and algae, low dissolved oxygen during the summer, and CTI scores between 40 and 50.

APCC uses a grading system that assigns the following grades to Carlson Trophic Index (CTI) scores:

CTI scores of less than 50 (< 50) are graded as: "Acceptable: requires ongoing protection."

CTI scores of 50 or above (≥ 50) are graded as: "Unacceptable: requires immediate restoration."

Ponds that are graded as "**Acceptable: requires ongoing protection**" are ponds that are healthy and free of excess nutrients. These ponds need ongoing protection to remain healthy and free of pollution.

Ponds that are graded as "**Unacceptable: requires immediate restoration**" are ponds that are suffering from excess nutrients. These ponds need immediate restoration in order to improve water quality.

Data quality for CTI scoring: Many datasets for pond water quality for Cape Cod ponds are older, i.e., at least five years old or more. Using older data to grade ponds would cause grades to reflect conditions that existed at the time when water samples were collected and analyzed. Conditions in ponds may have changed since such older data were collected. In order to provide an evaluation of recent pond conditions, this project screens out older data on a moving basis each year. For 2022 grading of ponds, APCC screened out pond data older than 2017 and required at least three years of data from 2017 on, as well as data for all three CTI parameters (chlorophyll, total phosphorus, and Secchi disk depth). Application of these stringent data quality requirements for grading resulted this year in only 68 ponds with sufficient water quality data to enable grading using the Carlson Trophic Index. As the Cape has 890 ponds, this points out the severe shortage of recent Cape-wide pond monitoring data to inform pond management and protection measures.

Method 2: Using Cyanobacteria Monitoring Data

Since 2018, APCC has been monitoring cyanobacteria and cyanobacteria blooms in over 100 freshwater ponds on Cape Cod. Cyanobacteria blooms occur when there are sufficient nutrients to stimulate growth of these photosynthetic bacteria. Warmth and sunlight are other factors that stimulate cyanobacteria growth, but in the absence of nutrients or when nutrient concentrations are very low, cyanobacteria growth is generally minimal. Cyanobacteria blooms therefore represent another indicator of nutrient enrichment in freshwater ponds.

APCC's Cyanobacteria Monitoring Program uses an EPA-approved protocol developed by EPA for the Cyanobacteria Monitoring Collaborative and refinements added under the guidance of Dr. James Haney (emeritus professor, University of New Hampshire) and Nancy Leland of Lim-tex, Inc. (Leland and Haney, 2018; Leland, Haney, Conte, Malkus-Benjamin and Horseley, 2019). The EPA protocol utilizes a combination of field observations, microscopy and fluorometry to analyze samples from freshwater lakes and ponds for cyanobacteria. Data collected includes photographs and field observations, microscopy to identify composition and dominance of cyanobacteria genera, and concentrations of phycocyanin and chlorophyll pigments indicative of the biomass of cyanobacteria vs. biomass of other algae and phytoplankton, respectively. By monitoring biweekly from May to October, APCC tracks changes in cyanobacterial composition, dominance and abundance throughout the season. At this sampling frequency, it is often possible to forecast when cyanobacteria blooms may be about to form or when cyanobacteria concentrations may lead to cyanobacteria toxin concentrations approaching harmful levels. APCC then increases the frequency of testing to inform town officials to be aware of potential threats and to plan for proactive management actions to protect public safety. To learn more, visit APCC's Cyanobacteria Monitoring Program.

The scarcity of recent pond water quality data led APCC in 2020 to adopt a second method of grading ponds using cyanobacteria monitoring data to provide an additional measure of pond health. The use of cyanobacteria data helps to fill the gap in freshwater pond data by providing a different measure of trophic status. APCC's cyanobacteria grading system utilizes our three-tiered risk warning system for assigning monitored cyanobacteria concentrations into "Low," "Moderate" and "High" risk tiers, which describe potential risks in terms of exposure to children, pets, exposure during recreational activities, toxin concentrations, and presence of visible cyanobacteria blooms. To grade ponds using cyanobacteria risk tiers, the tiers are assigned into "Acceptable" or "Unacceptable" grades according to the risk definitions. The previous year's monitoring results are used. The highest risk tier that is documented in a pond in a monitoring season is used to assign a grade.

Cyanobacteria risk tiers and grading system used this year:

This year, APCC revised our risk tier definitions for the 2022 Cyanobacteria Monitoring Program. The revisions in risk definitions reflect input from local and state public health officials and scientists, incorporation of state limits for cyanobacteria toxin in recreational waters, and a new regional capability for cyanobacteria toxin testing at the Barnstable County water quality lab. The 2022 risk tiers are given below.

Acceptable ("Low" risk): No concerning cyanobacteria results at the time and place of sampling. To the best of APCC's knowledge and based on our monitoring results, regular recreational usage of the pond is safe with respect to cyanobacteria and toxins. Map color is blue. Formerly the Low Warning Tier.

Potential for Concern ("Moderate" risk): Monitoring results or the presence of cyanobacteria scum at the time and place of sampling indicate a potential for increased risk for exposure to cyanobacteria toxins approaching, but below, state standards. Conditions do not yet warrant the posting of a recreational human health advisory according to guidelines from the Massachusetts Department of Public Health (MDPH). While these conditions pose low health risks to adults, risks are higher for children or pets based on lower body mass, particularly if contaminated water is incidentally ingested. Children may inadvertently consume pond water while swimming and pet exposure can result from drinking or ingesting pond water or from grooming after swimming. Map color is yellow. Map color yellow with crosshatching indicates a municipal pet advisory has been issued. Formerly the Moderate Warning Tier.

Use Restriction Warranted ("High" risk): Monitoring results at the time and place of sampling indicate the pond is unsafe for recreation by humans and pets based on one or more of the following criteria: 1) presence of microcystin at or above state standards (8 ppb microcystin) as described in MDPH guidance, 2) presence of significant cyanobacteria scum layers according to MDPH guidance, 3) a municipal health agent issues a closure for any other reason related to cyanobacteria. Recreational risk to adults is moderate following exposure. Recreational risks are especially high for children and pets following exposure through accidental ingestion of contaminated water. Children may inadvertently consume pond water while swimming and pet exposure can result from ingestion or directly drinking pond water or from grooming after swimming. Due to lower body masses, children and pets are more susceptible to cyanobacteria

risks than adults. Map color is red. Map color red with crosshatching indicates a municipal advisory has been issued. Formerly the High Warning Tier.

The 2022 cyanobacteria grading system for 2021 cyanobacteria data is given below:

Cyanobacteria levels in the "Low" and "Moderate" risk tiers were graded as: "Acceptable: ongoing protection is needed"; and

Cyanobacteria levels in the "High" risk tier were graded as "Unacceptable: requires immediate restoration."

Combined Pond Grading System

As in previous years, APCC's combined pond grading system utilizes available Carlson Trophic Index grades and cyanobacteria grades, as follows:

1) Carlson Trophic Index scores and grades for ponds were calculated for ponds where water quality data from 2017 on was available, and where at least three years of data were available for all three CTI parameters (chlorophyll, total phosphorus, and Secchi disk depth).
2) Cyanobacteria monitoring data from 2021 were used to grade ponds using APCC's revised cyanobacteria risk tiers and grading system described above:
    a. Ponds with cyanobacteria levels in the "High" risk tier were graded as "Unacceptable: requires immediate restoration";
    b. Ponds with cyanobacteria levels in the "Low" and "Moderate" risk tiers were graded as "Acceptable: requires ongoing protection."
    c.
3) **If a pond had both Carlson Trophic Index grades and Cyanobacteria grades**:
    a. The pond was graded as **"Acceptable: requires ongoing protection" only if both grades were Acceptable**;
    b. The pond was graded as **"Unacceptable: requires immediate restoration" if at least one of the grades was Unacceptable**.
4) **If a pond had only one grade (i.e., Carlson Trophic Index grade or Cyanobacteria grade), that grade was used as the sole determinant of the overall pond grade.**

10.3. Grading Public Water Supplies of Drinking Water

The grading system for drinking water is based on a modification of a method developed by the Natural Resources Defense Council (NRDC) to grade drinking water. The NRDC grading system evaluates three areas of drinking water: water quality and compliance, source water protection, and right-to-know compliance. APCC evaluates water quality and compliance of public water supplies after treatment and before distribution to consumers, the so-called "finished water." This represents the underlying quality of the public water supply before it is distributed to customers, not the quality of the water as it comes out of the tap, which can be affected by pipes and plumbing in the distribution system and in homes and businesses. APCC evaluates public water supplies in this manner because underlying water quality represents the

first line of defense in ensuring safe drinking water supplies and because many water protection measures are aimed at protecting source water quality.

To grade Cape Cod public water supplies, APCC uses publicly available Consumer Confidence Reports (CCRs) for the previous year to determine if water quality met existing state and federal drinking water standards (i.e., Maximum Contaminant Levels, or MCLs).

In the 2019 and 2020 State of the Waters report, APCC applied a two-level grading system based on whether public water supplies met all existing state and federal drinking water standards were met in the previous year. If a public water supply met all existing state and federal drinking water standards, it was graded as "Excellent"; if not, it was graded as "Poor." In the 2019 and 2020 reports, all public water suppliers met all existing state and federal drinking water standards. Resulting grades were all "Excellent."

In 2021, the grading system was revised to a three-level grading system: "Excellent," "Good," and "Poor." The change was based on the need to report on varying degrees of potential risk posed by violations, e.g., ranging from one or two violations of the total coliform standard followed by compliance, to several violations of two drinking water standards occurring at different locations on different dates requiring issuance of a boil-water order representing a high potential risk level. APCC felt it was important to distinguish the different levels of potential risk. The 2021 three-level grading system was as follows: "Excellent": Public water supply met all existing state and federal health and reporting standards (unchanged); "Good": Public water supply had one or more exceedances of the total coliform MCL and/or no more than one violation of an existing state and/or federal standard that posed a risk to public health and that violation was neither chronic nor repeated; and "Poor": Public water supply had two or more violations of an existing state and/or federal standard that posed a risk to public health or a violation that was repeated or persisted through more than one sampling round.

Grading system used this year (2022)

The major change in drinking water regulation since last year's report involved the new state drinking water standard for PFAS6 that went into effect in April 2021 (MassDEP PFAS Drinking Water Regulation Quick Reference Guide). PFAS refers to per- and polyfluoroalkyl substances, a family of manmade chemicals used in industry and consumer products worldwide since the 1950s to manufacture stain-resistant, water-resistant, and non-stick products. Thousands of PFAS compounds are known. PFAS6 refers to the sum of six per- and polyfluoroalkyl substances. The new PFAS6 standard is 20 parts per trillion (ppt) based on the average of the monthly samples over a quarter. If any one sampling location is in violation, then the PWS is in violation. If any sample result would cause the quarterly average to exceed the PFAS6 MCL, the PWS is immediately in violation and begins compliance actions.

For grading this year, APCC used the three-level grading system but clarified the definitions as follows:

Excellent: In 2021, finish water met all existing state and federal health and reporting standards.

<u>Good</u>: In 2021, finish water had one or more exceedances of the Total Coliform MCL and/or no more than one violation of an existing state or federal standard that posed a risk to public health and that violation was neither chronic nor repeated.

<u>Poor</u>: In 2021, finish water had violations of two or more existing state and/or federal standards that posed a risk to public health or a violation that was repeated or persisted through more than one sampling round.

In addition, APCC identified PWSs that had detectable PFAS6 but met the state standard with an asterisk (*).

11. Sources of Data and Data Quality

Cape Cod is fortunate to have many environmental organizations and agencies that have monitored water quality for many years. Over the years, hundreds of citizen scientists, local, state and federal government agencies, scientists, environmental organizations, consulting firms, and APCC interns and volunteers have collected water samples for different water quality monitoring programs. With the assistance of our Advisory Committee and partners, our sources of water quality data that met our criteria (see below) included the following organizations and agencies listed below. It is important to note that these organizations and agencies followed quality assurance protocols for sampling and analysis.

<u>Regional data sources. These sources provided</u> data covering multiple embayments or large areas of the Cape. Sources of coastal data are also shown in Figure 1.

- Association to Preserve Cape Cod: 202<u>1</u> cyanobacteria monitoring data for freshwater ponds located in the towns of Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown, Sandwich, Truro, Wellfleet, and Yarmouth;
- Partners who assisted APCC with cyanobacteria sample collection included: Brewster Ponds Coalition, Falmouth Water Stewards, Friends of Chatham Waterways, Friends of Long Pond Marstons Mills, Orleans Ponds Coalition, Oyster Pond Environmental Trust, the towns listed above, and other organizations and individuals.
- Barnstable Clean Water Coalition: coastal water quality data for stations located in the Three Bays embayment and pond water quality data;
- Buzzards Bay Coalition: Eutrophic Index scores for coastal stations and embayments located in Buzzards Bay along the coasts of Falmouth and Bourne;
- Center for Coastal Studies: coastal water quality data for stations located in embayments on Cape Cod Bay, Nantucket Sound and Vineyard Sound;
- Cape Cod Commission: coastal and pond water quality data collected by and for the Cape Cod Regional Water Quality Database, a project to collect and make publicly available all water quality monitoring data for the Cape. The project was funded by the EPA Southeast New England Coastal Watershed Restoration Program (EPA SNEP);
- Cape Cod Commission and University of Massachusetts at Dartmouth, School of Marine and Atmospheric Science and Technology (SMAST): Pond and Lake Stewards (PALS)

data for pond water quality (note: most of the pond data provided by towns and organizations listed below was provided by PALS and SMAST for the towns and organizations);
- Pleasant Bay Alliance: coastal Eutrophic Index scores for stations located in Pleasant Bay;
- Waquoit Bay National Estuarine Research Reserve (WBNERR): coastal water quality data for stations located in Waquoit Bay.

Municipal data sources:

- Town of Barnstable: coastal and pond water quality data;
- Town of Brewster: pond water quality data for one pond;
- Town of Chatham: coastal Eutrophic Index scores for coastal stations in Chatham and Pleasant Bay;
- Town of Eastham: coastal and pond water quality data;
- Town of Harwich: coastal and pond water quality data;
- Town of Mashpee: coastal and pond water quality data;
- Town of Orleans: coastal and pond water quality data.

Data quality

In order to evaluate recent water quality conditions, APCC applies data quality standards that include using the most recent and complete data available. Data quality requirements for grading water quality data are summarized below. Data sets are posted on this State of the Waters: Cape Cod website under Resources.

Coastal water quality data: For this 2022 report, APCC collected the most recent available coastal water quality data up to and through 2021 from the data sources listed above. Our criteria for grading coastal water quality data included at least five years of data from 2017 on (e.g., 2017, 2018, 2019, 2020, and 2021). There were two exceptions: Harwich coastal water quality data where data from 2016, 2017, 2018, 2019, and 2021 were used for grading monitoring in 2020 was suspended due to the COVID-19 pandemic; and WBNERR where data for 2016-2020 were utilized as 2021 data were not available.

Freshwater pond and lake water quality data: Since 2000, the Cape Cod Ponds and Lakes Stewardship Program (PALS) has worked with volunteers and organizations who monitor many ponds across the Cape. The PALS program was developed by the Cape Cod Commission, APCC and SMAST, in coordination with organizations and towns that monitor water quality on an annual snapshot basis. Other pond associations and organizations have gathered a considerable amount of data with their member volunteers. For this 2022 report, APCC collected pond water quality data from the sources listed above. Our criteria for grading pond water quality data included at least three years of data from 2017 on, and data for all three Carlson Trophic Index parameters (chlorophyll, transparency, and total phosphorus).

Cyanobacteria data for ponds and lakes: For this 2022 report, APCC utilized 2021 cyanobacteria monitoring data collected by APCC's Cyanobacteria Monitoring Program. Cyanobacteria monitoring data were collected according to an EPA-approved Quality Assurance Projecdt Plan for cyanobacteria monitoring.

Drinking water and public water supplies: For this 2022 report, APCC collected each town's public-right-to-know reports for 2021 monitoring results, also known as the Consumer Confidence Reports (CCRs) for drinking water. CCRs are posted on each town's website. Links to the CCRs are provided under Resources, in the popups on the interactive viewer, and in our Public Water Supplies grading sheet. APCC used the CCRs to grade water quality and compliance with existing drinking water regulations. In some cases APCC contacted water superintendents for additional information.

12. Results

Our 2022 grades for coastal embayments and stations, freshwater ponds and lakes, and public water supplies are provided as maps (**Figures 2-5**) and summarized in tables (**Tables 1-7**). **Tables 1, 4, and 6** summarize grades from 2019 through 2022 for for coastal waters, ponds, and public water supplies, respectively. Detailed scores and grades for coastal embayments and stations are provided in **Tables 8 to 16**. Our findings are described below.

12.1 Coastal embayments and coastal stations

Coastal embayments:

- The number and percentage of Unacceptable embayments increased to 43 this year, representing 90% of graded embayments. Last year in our 2021 report, 41 embayments or 87% were Unacceptable. In our 2020 report, 38 embayments or 79% were Unacceptable. In our 2019 report, 32 embayments or 68% were Unacceptable (Table 1). Over the past four years of the State of the Waters reporting, the number of Unacceptable embayments has steadily increased.
- The number and percentage of Acceptable embayments decreased to five this year, represending 10% of graded embayments. Last year in our 2021 report, six or 13% of graded embayments were Acceptable. In our 2020 report, 10 of 48 embayments or 21% were Acceptable. In our 2019 report, 15 of 47 embayments or 32% were Acceptable (Table 1). Over the past four years of the State of the Waters reporting, the number of Acceptable embayments has steadily decreased.
- There were 48 embayments graded this year, compared to 47 embayments graded in 2021, 48 in 2020, and 47 in 2019 (Table 1).
- The new Unacceptable embayment this year is the Pamet River on Cape Cod Bay. (Figure 2 and Table 2).
- As in 2021, all embayments on Nantucket Sound were Unacceptable, all embayments in Buzzards Bay were Unacceptable with the exception of Quissett Harbor, and Pleasant Bay and Nauset Estuary were Unacceptable.
- Cape Cod Bay continued to have the largest number of Acceptable grades (three) but the Pamet River embayment became Unacceptable.
- There were no embayments that improved from Unacceptable to Acceptable (Tables 1, 2).

Coastal stations:

- Coastal stations had similar numbers and percentages of Unacceptable stations compared to previous years, with over two-thirds of stations graded as Unacceptable. There were 131 Unacceptable coastal stations, representing 69% of graded stations. In our 2021 report there were 133 Unacceptable stations or 68% of graded stations. In our 2020 report there were 106 Unacceptable stations or 70% of graded stations. In our 2019 report there were 98 Unacceptable stations or 64% of graded stations (Tables 1, 3).
- There were similar numbers and percentages of Acceptable stations compared to previous years, with the percentage of Acceptable stations less than one-third of graded stations. There were 60 Acceptable coastal stations, representing 31% of graded stations. In our 2021 report there were 64 Acceptable stations or 32% of Acceptable stations. In our 2020 report there were 46 Acceptable stations or 30% of graded stations. In our 2019 report there were 54 Acceptable stations or 36% of graded stations (Tables 1, 3).
- There were 191 coastal stations graded this year, reflecting a slight decrease from 2021 when there were 197 coastal stations graded. However, the numbers of coastal stations graded this year and last year were greater than the numbers of coastal stations graded in 2019 and 2020 when there were 152 coastal stations with sufficient data to grade (Tables 1, 3).

12.2 Ponds

- This year, 151 ponds had sufficient water quality data and/or cyanobacteria data to enable grading, representing an increase over the number of ponds with sufficient data from previous years (i.e., 109 ponds in 2021, 93 in 2020, and 149 in 2019, Tables 4 and 5). However, 151 ponds represents only 17% of the Cape's 890 freshwater ponds, indicating that there is an ongoing shortage of recent data for grading most of the Cape's ponds.
- Over one-third of all graded ponds were Unacceptable, i.e., there were 59 Unacceptable ponds or 39% of all graded ponds. In our 2021 report last year there were 38 Unacceptable ponds representing 35% of graded ponds. In our 2020 report there were 39 Unacceptable ponds or 42% of all graded ponds. In 2019 there were 58 Unacceptable ponds or 39% of all graded ponds (Tables 4, 5).
- Nearly two-thirds of graded ponds were Acceptable, i.e., there were 92 Acceptable ponds representing 61% of graded ponds. Last year, there were 71 Acceptable ponds or 65% of Acceptable ponds. In 2020, there were 54 Acceptable ponds representing 58% of graded ponds. In 2019, there were 91 Acceptable ponds or 61% of graded ponds (Tables 4, 5).
- Sixty-eight ponds had sufficient water quality data to grade them using the Carlson Trophic Index, compared to only 36 ponds last year. Of these ponds, 37 or 54% were Acceptable and 31 or 46% were Unacceptable (Tables 4, 5).
- One hundred and twenty-eight ponds were graded using 2021 cyanobacteria monitoring data. Of these, 93 ponds (72%) were Acceptable and 36 ponds (28%) were Unacceptable (Tables 4, 5). The use of cyanobacteria data enabled an additional 83 ponds to be graded.
- Only 46 ponds had both Carlson Trophic Index and Cyanobacteria grades. Of these ponds with dual grades, 23 ponds had Acceptable grades, and 15 ponds had Unacceptable grades (Tables 4, 5).
- The percentages of Acceptable vs. Unacceptable grades for ponds graded using either the Carlson Trophic Index or cyanobacteria were as follows: 54% of ponds with CTI grades

were Acceptable compared to 72% of ponds with cyanobacteria grades of Acceptable. Likewise, 46% of ponds with CTI grades were Unacceptable compared to 28% of ponds with cyanobacteria grades of Unacceptable (Tables 4, 5). More data are needed to determine whether the differences are incidental or reflect a more fundamental difference.

- Towns with sufficient pond water quality data to enable grading using the Carlson Trophic Index included: Barnstable (33 ponds); Orleans (12 ponds); Eastham (9 ponds); Harwich (8 ponds); Mashpee (5 ponds); and Brewster (1 pond).
- Towns with 2021 cyanobacteria monitoring data for ponds included: Barnstable (27 ponds); Bourne (2 ponds); Brewster (22 ponds); Chatham (5 ponds); Dennis (4 ponds); Eastham (7 ponds); Falmouth (16 ponds); Harwich (9 ponds); Mashpee (5 ponds); Orleans (4 ponds); Provincetown (2 ponds); Sandwich (7 ponds); Truro (2 ponds); Wellfleet (8 ponds); and Yarmouth (10 ponds).

12.3. Public Water Supplies

Grades for public water supplies are summarized below and described in Tables 6 and 7 and Figure 4.

- A total of 20 public water supplies were graded for the quality of their finish water. Sixteen public water supplies on the Cape had "Excellent" water quality, meaning that they met all state and federal drinking water standards: Barnstable COMM, Barnstable Fire District, Cotuit Water Department, Hyannis Water System, Bourne Water District, North Sagamore Water District, Town of Brewster Water Department, Town of Chatham Department of Public Works Water Division, Town of Dennis Water District, Town of Eastham Water Department, Town of Falmouth Water Department, Town of Harwich Water Department, Mashpee Water District, Town of Orleans Water Department, Town of Provincetown Water Department, and Town of Sandwich Water District (Tables 6, 7).
- However, of the 16 public water suppliers with "Excellent" grades, 10 had detectable levels of PFAS6 but met the new state standard for PFAS6 that became effective in 2021. The ten PWSs were: Barnstable COMM, Barnstable Fire District, Cotuit Water Department, Hyannis Water System, Bourne Water District, Town of Chatham DPW Water Division, Town of Dennis Water District, Town of Falmouth Water Department, Mashpee Water District, and Town of Sandwich Water District.
- Two PWSs were graded as having "Good" water quality, based on their detection of total coliform bacteria in finish water: Buzzards Bay Water District, and Town of Wellfleet Municipal Water System (Tables 6, 7). The presence of total coliform bacteria is used as an indicator that harmful enteric bacteria (e.g., E. coli) may be present. Both PWSs followed up with appropriate response measures and did not detect E. coli.
- Two PWSs were graded as "Poor" due to violations of two or more drinking water standards and several violations at different locations: Otis Air National Guard (Total Coliform and E. coli requiring issuance of a boil water order), and the Town of Yarmouth Water Department (Enterococci, and PFAS6). See Tables 6, 7.

For more information on PFAS, see APCC's PFAS Primer .

12.4. Discussion

This is the fourth annual report on the State of the Waters: Cape Cod, which provides an assessment of water quality in coastal embayments, freshwater ponds, and public water supplies using the most recent available data. Collectively these annual reports show that the Cape's coastal waters and freshwater ponds continue to suffer from eutrophication due to excess nutrients, primarily from septic systems (Figure 6). In contrast, public water supplies generally were "Excellent" or "Good" but the two "Poor" exceptions indicate that E. coli bacteria or PFAS6 contamination of finish water occurred, which threatens public health. This report also covers the first year (2021) in which new state regulations limiting PFAS6 concentrations in drinking water came into effect. While PFAS6 was detected in 11 of the 20 public water supply systems that serve Cape Cod, 10 of these met the new DEP drinking water regulations for PFAS6. The widespread detection of PFAS6 in public water supplies calls for ongoing monitoring as well as planning and implementation of effective treatment methods.

Coastal embayments and stations

This year, the majority of Cape Cod's coastal embayments (90%) were Unacceptable, an increase from previous years. Over the past four years of State of the Waters reporting, the number of Unacceptable embayments has steadily increased. Conversely, the number of Acceptable embayments has steadily decreased over the past four years, reaching a low of 10% of embayments this year. As in previous years, over two-thirds of the Cape's 191 coastal stations had Unacceptable water quality, and less than one-third had Acceptable water quality, similar to results from previous years. These results show that coastal eutrophication in embayments continues and is expanding.

A number of towns have made significant steps toward managing nutrients by approving construction of modern wastewater treatment projects. While embayment water quality has yet to improve as a result, as these projects are implemented over the next few years the region should begin to see lower nutrient loadings that should be reflected in improving water quality in selected embayments.

Ponds

This year, over one-third of the 151 ponds graded were Unacceptable and nearly two-thirds of ponds graded were Acceptable. Despite the increase in the number of ponds with sufficient data to enable grading, these percentages are similar to percentages in previous years. Also, despite the increase in the number of ponds with sufficient data,-there is still a drastic shortage of recent pond data, as 151 ponds represents only 17% of the Cape's 890 freshwater ponds and lakes.

As APCC's monitoring has expanded, much has been learned about the scope of the impairment of ponds. While lacking a sufficiently robust and lengthy data record upon which to base trend analyses, it appears that based on recent data, approximately one-third of graded ponds achieve Unacceptable status in any given year, and that there is considerable variability from year to year in which ponds trigger that designation. While the conditions representing impairment exist in many ponds, perhaps a majority of ponds Cape-wide, the actual confluence of events that drive

poor water quality conditions in any given pond in a particular year remain hard to predict given the lack of detailed and multi-year data.

A comprehensive review and assessment of overall pond health is also hampered by data quality issues. To grade water quality, APCC uses the Carlson Trophic Index, an index of water quality that describes the trophic status of a water body based on total phosphorus, chlorophyll and transparency; i.e., it is a measure of phytoplankton productivity due to nutrient loading where phytoplankton include algae and cyanobacteria). Many pond data are older, e.g., five years old or more. Using older data to grade ponds would cause grades to reflect conditions that existed at the time when water samples were collected and analyzed. Conditions in ponds may have changed since these older data were collected. This year, APCC screened out pond data older than 2017 and ponds with less than three years of data collected. Using these more stringent requirements for grading resulted in only 68 ponds having sufficient water quality data to enable grading using the Carlson Trophic Index. This points out the severe shortage of more recent Cape-wide pond monitoring data to inform pond management and protection measures.

To help fill the gap in freshwater pond data, APCC utilized the results of our cyanobacteria monitoring program. Since 2018, APCC has been monitoring cyanobacteria and cyanobacteria blooms in dozens of freshwater ponds on Cape Cod. Cyanobacteria blooms occur when there are sufficient nutrients to stimulate growth of these photosynthetic bacteria. Warmth and sunlight are other factors that stimulate cyanobacteria growth, but in the absence of nutrients or when nutrient concentrations are very low, cyanobacteria growth is minimal. Cyanobacteria blooms represent another way to assess phytoplankton productivity due to nutrient enrichment in freshwater ponds and is complementary to the use of the Carlson Trophic Index. Of the 68 ponds with sufficient water quality data to be graded using the Carlson Trophic Index, 46% were Unacceptable. Of the 129 ponds graded using cyanobacteria tiers, 28% were Unacceptable. The differences in percentages of Unacceptable grades between the two grading systems likely reflects the fact that they represent two different ways to measure eutrophication: The Carlson Trophic Index measures overall phytoplankton productivity while the cyanobacteria grade measures cyanobacteria productivity where cyanobacteria represent a component of phytoplankton populations.

Public Water Supplies

The majority of public water supplies (16 of 20) met all existing state and federal drinking water quality standards and were graded as “Excellent.” Several exceptions indicate that bacterial contamination can occur and can threaten public health. The need to issue a boil-water order to protect public health from E. coli resulted in a grade of “Poor” for one public water system (Otis Air National Guard). The town of Wellfleet’s public water system, which was graded “Poor” last year for the same reason, was graded as “Good” this year, as it had improved. Strict adherence to prevention of pollution, monitoring, follow-up actions, treatment, maintenance, and public awareness should address such bacterial issues and protect public health.

This report also covers the first year (2021) in which new state regulations limiting PFAS6 concentrations in drinking water to 20 parts per trillion (ppt) became effective. While PFAS6 was detected in 11 of the 20 public water supply systems, 10 of these systems met the new

PFAS6 standard. The exception was Yarmouth where PFAS6 exceeded the state limit, resulting in a grade of "Poor" for that system. The widespread detection of PFAS6 in public water supplies calls for ongoing monitoring as well as planning and implementation of effective treatment methods.

Other water quality issues of concern

- Consumer tap water quality was not evaluated and would require testing of the water coming out of consumers' taps as well as monitoring data from water distribution systems. Water quality coming out of the tap will be affected by the age and type of pipes in the distribution system and in consumers' homes and businesses.
- Private wells were not addressed in this project. APCC strongly recommends that private well owners have their water tested and, if needed, treated.
- Drinking water consumers and regulators alike need to consider that there may be other unregulated contaminants affecting drinking water quality. These include:
    - Emerging contaminants in surface water and/or groundwater:
        - Endocrine-disrupting compounds and pharmaceuticals from inadequately treated wastewater;
        - Microplastics from wastewater, stormwater runoff and atmospheric fallout;
        - Cyanobacteria (aka blue-green algae) in freshwater ponds produce toxins that are harmful to humans and animals if ingested. Public surface water supplies can become contaminated by cyanotoxins, and public water suppliers elsewhere are taking precautions to guard against cyanotoxins in drinking water. This issue is of limited scope on Cape Cod, as only Falmouth utilizes a surface water source for a portion of its public drinking water. APCC has been monitoring cyanobacteria since 2018 and has incorporated cyanobacteria into our pond grading system since 2019.
- Harmful bacteria in coastal waters and freshwater ponds, lakes and streams include fecal coliform bacteria and enteric bacteria that are indicators of human and/or wildlife fecal matter. Bacteria can impact swimming beach water quality and water quality in shellfish beds. Beach water quality and shellfish bed water quality are monitored by Barnstable County and the state, respectively.
- Mercury contamination of surface water continues to be of concern, based on the fact that this year 32 ponds and lakes on the Cape have fish consumption advisories due to high levels of mercury. Last year there were 29 ponds with fish consumption advisories, and the year before 24 ponds. Towns with ponds with fish consumption advisories this year included Barnstable, Bourne, Brewster, Falmouth, Mashpee, Sandwich, Truro, and Wellfleet. Mercury originates from atmospheric fallout of mercury emissions from coal-burning power plants. For more information, visit **MA Fish Consumption Advisories**
- Six ponds also had fish consumption advisories due to PFAS. Towns with such ponds included Bourne, Falmouth, and Mashpee.
- Climate change impacts for the Northeast are predicted to include warmer air and water temperatures year-round; more precipitation; more intense storms; longer and warmer growing seasons coupled with shorter and warmer winters; shifts in populations of fish, wildlife and invertebrates; rising sea level; changes in groundwater elevations; more

flooding; and changes in dynamic landforms such as those found on the Cape (e.g., dunes, beaches, floodplains). Many of these climate change predictions will impact water quality and exacerbate the harmful effects of existing pollutants.

12.5. Filling the gaps: recommendations for monitoring

Monitoring is crucially important to understand current conditions and for tracking progress in improving and protecting water quality. Based on our findings, APCC provides the following recommendations for monitoring:

- Coastal embayments need ongoing monitoring to collect up-to-date information on water quality in order to assess whether wastewater management measures and protection measures are working and to determine when success has been achieved.
- Monitoring of five more coastal embayments is needed: Chase Garden Creek in Yarmouth, Red River in Chatham and Harwich, Hatches Harbor in Provincetown, Great Sippewissett Marsh in Falmouth, and Salt Pond in Falmouth. These embayments are listed in the 208 Water Quality Plan as coastal embayments receiving nutrients from their watersheds.
- Pond monitoring should be expanded to many more ponds and lakes throughout the Cape, particularly those where there are swimming beaches, public access, and/or sensitive resources (e.g., diadromous fish, rare species, wildlife). In 2022, the Cape Cod Commission received funding for a 208-scale study of ponds across the region called the Cape Cod Freshwater Initiative. The initiative will enable the Cape Cod Commission and its partners to undertake a comprehensive assessment of the quality of the Cape's freshwater resources in order to establish a regional plan for restoring and protecting the Cape's ponds and lakes.
- Cyanobacteria monitoring of ponds should be expanded as it provides a useful measure of eutrophication and a complement to water quality monitoring.
- The PALS program is useful as a "screening tool" to identify ponds where more in-depth monitoring and assessment is needed to determine causes, extent and severity of problems. However, pond monitoring should be conducted more frequently than the once-a-year snapshot that is typically provided by the PALS program.
- Newer, more recent pond data should be utilized to assess pond conditions and inform restoration and protection efforts.
- Monitoring of pond water quality and cyanobacteria blooms should be conducted hand-in-hand so that water quality data can be used to help predict where serious cyanobacteria blooms may occur, and vice versa.
- Public water suppliers should expand their monitoring of PFAS, emerging contaminants and cyanobacteria to help safeguard public health.

13. State of the Waters Action Plan

The most common threats to our water quality are:

- Nutrient pollution from septic system wastewater (**Figure 6**) and from fertilizers;

- Stormwater runoff containing roadside pollutants, including nutrients and harmful bacteria;
- Contaminants of emerging concern such as pharmaceuticals, personal care products, PFAS, industrial chemicals, and microplastics;
- Mercury contamination of freshwater ponds and lakes.

Action is needed now, especially on the municipal level. Moving forward immediately on water quality restoration efforts that produce measurable results must be the first priority. Securing and using both the new (short term rental tax and Cape and Islands Water Protection Fund) and traditional (State Revolving Fund and local debt) funding sources, now supercharged by recent landmark federal appropriations legislation, to pay for water quality restoration and for monitoring water resources is critical. The towns of Cape Cod must lead the effort on protecting and improving water quality. State agencies must be a partner in this process. Enhanced municipal, regional and state regulatory standards that increase protections of water resources are crucial. The Cape and Islands Water Protection Fund awarded $98 million to eight Cape towns to support water quality projects through 2022, making the promise of critical financial assistance a reality. Towns realize there is now a 25% subsidy of capital costs and should accelerate their construction plans, especially with additional subsidy available for water quality projects due to recently approved federal legislation. The next few years represent a generational opportunity for the Cape to draw on unprecedented availability of federal funds to leverage water quality improvement on a very cost-effective basis.

Great progress has been made on developing the necessary understanding, scope and nature of estuarine water quality problems as well as the realistic and cost-effective management options. Development of the Cape Cod Commission's 208-water quality report was the turning point that enabled recent progress on implementation to begin. The 208 report identified, but did not address, the need for an equivalent level of assessment of the water quality of the ponds of Cape Cod. The expanded monitoring APCC has undertaken the last few years underscores and makes plain the need for a Cape-wide assessment of, and strategy for the restoration of, freshwater pond water quality. In 2022, Barnstable County answered APCC's call by creating funding for the Cape Cod Freshwater Initiative which will enable the Cape Cod Commission and its partners to undertake an analysis of available monitoring data to assess the health of the Cape's freshwater lakes and ponds. The initiative will help establish a regional plan for improving the quality of the Cape's freshwater resources.

Of course, public involvement is essential. Residents should support municipal investments in local water quality improvement projects. The participation of citizen groups and individuals are necessary to achieving local and regional water quality improvement goals. Be aware of your role in the health of Cape Cod's water resources. Individual actions by homeowners and businesses—both by the actions you take on your property and by making sure your voice is heard in the local decision-making process—can make a difference in the protection of Cape Cod's water resources.

Because the quality of groundwater directly affects the quality of the Cape's coastal embayments, ponds and drinking water, many of the following recommendations in this action plan focus on groundwater protection and crosscut all three resource areas studied in the State of

the Waters: Cape Cod report. Action at the municipal level is most impactful and this plan emphasizes municipal actions and the importance of residents in forcing action at the town level.

13.1. Recommended Actions for Coastal Embayments

- For Municipalities:
    - Comprehensive Wastewater Management Planning:
        - Towns with plans that are consistent with the Cape Cod 208 Plan must begin to implement their long-term strategy for managing wastewater and improving water quality in the town's watersheds.
        - Towns without a plan must make the development and adoption of a plan a municipal priority.
        - Towns whose plans include shared estuary watersheds should adopt intermunicipal agreements that establish nitrogen responsibility and cooperative wastewater management strategies. Obtaining a state-issued Watershed Permit will provide additional accountability and enforceability.
    - Dedicate at least 50 percent of short-term rental tax revenue to infrastructure investments that include wastewater infrastructure and use the revenue to fund appropriate programs.
    - Develop financing plans that take full advantage of zero percent loans from the State Revolving Fund (SRF), the principal forgiveness offered by the Cape and Islands Water Protection Fund and new federal funds for Covid recovery and for infrastructure investment.
    - Expand monitoring of embayment restoration efforts to assess the effectiveness of management measures. Results should be used for adaptive management and course correction if needed.
    - Adopt local zoning bylaws and planning policies that encourage and facilitate future growth at greater densities in strategic locations where wastewater infrastructure can support additional development. Adopt local zoning bylaws, regulations and policies that direct growth away from sensitive watershed areas that do not have supportive wastewater infrastructure.
    - Prioritize water resources protection in municipal regulatory review. Establish consistency across town boards and commissions regarding municipal bylaws and regulations relating to water resource protection. For example, local planning boards, boards of health and conservation commissions should adopt the same regulations for requiring advanced denitrifying septic systems for development and redevelopment in nitrogen-sensitive watersheds.
    - Explore viable, alternative wastewater treatment strategies to augment municipal investments in wastewater infrastructure.
    - Stormwater planning and treatment:
        - Complete and implement stormwater plans (i.e., mapping, stormwater pollution prevention plan, bylaws, elimination of illicit discharges, prioritizing stormwater projects, funding maintenance) and include all roads that drain to wetlands and waters. Address both nutrients and bacteria.

        - Invest in stormwater remediation efforts in every road project going forward. Prioritize projects with the greatest water quality benefit. Adopt stormwater best management practices that include low impact development techniques.
        - Use the revised 208 Technologies Matrix that now includes stormwater Best Management Practices (BMPs) and their removal efficiencies for pollutants (including nutrients, bacteria and solids) to select BMPs for projects.
    - Maintain adequate natural vegetated buffer zones around roads and parking lots near water bodies to capture stormwater runoff.
    - Eliminate fertilizer and pesticide use on municipal properties. Establish fertilizer and pesticide reduction outreach programs for residents and businesses, including a call for residents to eliminate fertilizer use.
    - Support ecological restoration programs and projects that will improve water quality and habitat.
    - Incorporate climate change into pond monitoring, planning and protection.

- <u>For Homeowners/Business Owners:</u>
    - Organize locally and demand action by town officials to protect and restore coastal embayments.
    - At town meetings and the ballot box, support municipal investments in wastewater infrastructure and the use of viable, alternative wastewater treatment strategies to augment the development of wastewater infrastructure.
    - Don't dump contaminants down house drains. Household chemicals, paints, thinners, solvents, pharmaceuticals and other hazardous materials can leach into groundwater and pollute water bodies. Properly dispose of hazardous waste during designated collection days at local transfer stations.
    - Eliminate the use of fertilizers and pesticides on your property. Reduce, or better yet, eliminate turf grass lawns and replace with native plantings, and where lawn is needed, make it a Cape Cod lawn.
    - Encourage your town, local school and golf courses to reduce or eliminate fertilizer and pesticide use.
    - For coastal waterfront properties, establish protective buffers of native vegetation at least 100 feet deep along shorelines to reduce the potential for stormwater runoff.
    - Work to achieve zero stormwater runoff from your property. Direct roof runoff from downspouts away from paved areas. Install rain gardens to capture runoff, and rain barrels to harvest water for landscape use. Maximize permeable areas and native plantings that help absorb stormwater and prevent water runoff to roadways.
    - Work with your neighborhood association to address stormwater problems and ensure proper maintenance of stormwater controls on private roads, especially where stormwater directly discharges into embayments.
    - Help your town properly maintain stormwater systems and report problems, remove debris and litter around storm drains. Never dump oil or other contaminants down storm drains.

  - Encourage your town to use pervious surfaces where feasible, and allow roadside vegetation to grow instead of mowing, so it can filter stormwater pollutants.
  - Be a responsible boater. Never dump trash or debris overboard. Discharge of any boat sewage, whether treated or not, is prohibited by federal and state law in coastal waters; use designated pump out facilities.
  - If using an on-site septic system, maintain it properly by having it pumped regularly—every three years is recommended. Consider an advanced wastewater treatment system to treat nutrients.

- For State Government:
  - Adopt the Department of Environmental Protection's proposed updates to regulations governing septic systems and which also encourage municipalities to adopt watershed permits that provide an actionable plan for restoring impaired marine embayments.
  - Utilize and support watershed permitting for municipalities that promotes and addresses alternative technologies for wastewater treatment, requires sewering if alternatives do not work, and that also assures enforceability.
  - Prioritize investments in stormwater control for state roads that improve water quality by removing nutrients as well as bacteria when allocating funding for state road infrastructure projects.
  - Provide timely reporting on the state's list of impaired waters.
  - Support monitoring of harmful algal blooms (HABs) in both marine and freshwater environments and address causes of HABs using ecologically safe methods.
  - Provide additional state funding to the county and municipalities for water quality improvement projects and for monitoring programs.
  - Support ecological restoration programs and projects that will improve water quality and habitat.

- For Regional Government:
  - Expand investment of resources to focus on regional water quality efforts.
  - Invest in monitoring and regional data collection and the dissemination of collected data.
  - Provide evaluation of efficacy of alternative Title 5 systems.
  - Help focus municipal efforts on water quality restoration on the potential benefits of acting regionally and learning from best practices from across the region.
  - Aggressively promote availability of variable rate (0%-4%) County loans for sewer connections and septic upgrades.
  - Discourage further development in areas not currently or planned to be serviced by sewer.
  - Support ecological restoration programs and projects that will improve water quality and habitat.

13.2 Recommended Actions for Ponds

- For Municipalities:
  - Make protection of ponds and restoration of pond water quality a priority. Initiate detailed assessments of water quality for every pond, including promoting and

supporting citizen water quality monitoring projects for ponds, including monitoring for cyanobacteria blooms.
- Actively participate in the development, adoption and implementation of the Cape Cod Freshwater Initiative to protect and restore the Cape's lakes and ponds.
- Accelerate nutrient management, including sewering, of pond watersheds to improve pond water quality.
- Establish, in partnership with APCC or individually, a cyanobacteria monitoring program and companion public notice protocol that ensures the public is advised of the presence of cyanobacteria blooms and provided with real-time guidance on the need to restrict contact with ponds with high cyano levels.
- Eliminate fertilizer and pesticide use on municipal properties. Establish fertilizer and pesticide reduction outreach programs for residents and businesses, including a call for residents to eliminate fertilizer use.
- Adopt local bylaws and regulations that increase protections of ponds. Require placement of septic systems at least 300 feet back from the edge of a pond when located on the up-gradient side of groundwater flow toward a pond. Develop homeowner financial assistance programs for upgrading septic systems to comply with updated pond-front septic regulations.
- Invest in stormwater remediation efforts around ponds. Adopt stormwater best management practices that include low impact development (LID) techniques. Conduct routine street sweeping and catch basin cleaning to help prevent sediments and contaminants from reaching water bodies through stormwater. Maintain up-to-date GIS mapping and ground-truthing of storm drain locations. Maintain adequate natural vegetated buffer zones around roads and parking lots near ponds to capture stormwater. Conduct the comprehensive stormwater management and implementation described above in the section for coastal embayments.
- Establish consistency across town boards and commissions regarding municipal regulations and bylaws relating to water resource protection. For example, local planning boards, boards of health and conservation commissions should adopt consistent language for septic system technologies and siting in proximity to ponds.
- Weigh the pros and cons of pond management options such as alum treatment, macrophyte (vegetation) removal, or dredging to improve a pond's water quality. Each pond is unique, therefore methods to address water quality issues should be carefully considered.
- Invest in open space acquisitions of pond-front property as well as property within pond watersheds.
- Adopt site plan review standards that take topography into account. Require appropriate setbacks from water bodies and minimize impervious surfaces.
- Incorporate climate change into pond monitoring, planning and protection.
- Support ecological restoration programs and projects that will improve water quality and habitat.
- Sponsor pond education and stewardship programs.

- For Homeowners/Business Owners:

- Organize locally, and demand action by town officials to restore and protect ponds.
- At town meeting and the ballot box, support municipal investments to restore and protect pond water quality.
- Support the adoption of local bylaws and regulations that increase protections of ponds.
- Upgrade your septic system so that it is at least 300 feet back from the edge of a pond when located on the upgradient side of groundwater flow toward a pond.
- Eliminate the use of fertilizers and pesticides on your property.
- Reduce, or better yet, eliminate turf grass lawns and replace with native plantings and where lawn is needed, make it a Cape Cod lawn.
- Encourage your town, local schools and golf courses to reduce or eliminate fertilizer and pesticide use.
- Don't dump contaminants down house drains. Household chemicals, paints, thinners, solvents, pharmaceuticals and other hazardous materials can leach into groundwater and pollute water bodies. Properly dispose of hazardous waste during designated collection days at local transfer stations.
- Work to achieve zero stormwater runoff from your property. Direct roof runoff from downspouts away from paved areas. Install rain gardens or rain barrels to collect water. Maximize permeable areas and native plantings that help absorb stormwater and prevent water runoff to roads.
- Establish protective vegetative buffers of native vegetation at least 100 feet wide along pond shorelines to reduce the potential for stormwater runoff to a pond.
- Support town and local land trust open space acquisitions of property with pond frontage or within pond watersheds.
- Help organize and participate in citizen water quality monitoring projects for area ponds, including monitoring for cyanobacteria blooms.
- For homeowners, become active in your local pond association, or if there isn't one for your pond, start one.
- Work with your neighborhood association to address stormwater problems and ensure proper maintenance of stormwater controls on private roads, especially where stormwater directly discharges into ponds.
- Help your town properly maintain stormwater systems and report problems, remove debris and litter around storm drains. Never dump oil or other contaminants down storm drains.
- Encourage your town to use more pervious surfaces in place of pavement and to allow roadside vegetation to grow instead of mowing it so it can filter pollutants from stormwater.
- Pick up after pets and deposit waste in the trash. Pet waste can introduce harmful bacteria and other pathogens into ponds.
- Do not wash cars on paved driveways or parking lots, which allows oil, fuel and soap to make their way into ponds.
- Be a responsible boater. Never dump trash or debris overboard.
- Attend education workshops to learn more about pond issues and how you and your community can protect ponds.

  - If using an on-site septic system, maintain it properly by having it pumped regularly—every three years is recommended. Consider an advanced wastewater treatment system to treat nutrients.

- For State Government:
  - Increase funding to municipalities and nonprofits for pond restoration, management and monitoring initiatives. Increase funding to state agencies—e.g., the Department of Conservation and Recreation—for management of ponds under state control.
  - Develop better protocols for monitoring of, and responding quickly to, toxic cyanobacteria (blue-green algae) blooms that could impact public health and ecosystems. Work with municipalities and environmental nonprofits to develop standardized monitoring and reporting programs.
  - Establish Total Daily Maximum Loads (TMDL) for phosphorus for high priority Cape Cod ponds.
  - Support ecological restoration programs and projects that will improve water quality and habitat.
  - Provide timely reporting on the state's list of impaired waters.
  - Incorporate climate change into pond monitoring, planning and protection.

- For Regional Government:
  - Continue support for the newly established Cape Cod Freshwater Initiative, which includes a comprehensive focus on pond water quality similar to the county's focus on the nutrient problem in Cape Cod embayments.
  - Support ecological restoration programs and projects that will improve water quality and habitat.
  - Incorporate climate change into pond monitoring, planning and protection.

13.3 Recommended Actions for Drinking Water Supplies

- For Municipalities:
  - Make protection of water supply sources a municipal priority, with special consideration to climate change impacts (e.g., extended periods of drought).
  - Adopt local bylaws and regulations that increase protection of public water supplies, such as natural resource protection zoning, restriction of uses that involve hazardous materials storage or use, standards for construction projects, and waste disposal procedures.
  - Acquire permanently protected open space in public water supply areas to protect water quality.
  - In addition to new state regulations requiring testing for per- and polyfluoroalkyl substances (PFAS), expand public water supply sampling to include testing for unregulated contaminants of emerging concern that are more likely to be present in the region.
  - Conduct or update the town's source water assessment and protection (SWAP) plan to rate the susceptibility of public drinking water supplies compared to the collected inventory of likely contamination threats, such as gas stations, landfills

and other uses. Make the assessment available to the public on the town's website. Adopt measures to address specific risks with the water supply area.
    - Promote water conservation and limited outdoor watering to protect source water.
    - Encourage and promote homeowners and businesses to use native species in landscaping and to reduce or eliminate lawns to reduce use of fertilizers, pesticides and water. Do the same for municipal properties such as offices, public parks, schools and other landscaped areas.
    - Improve water supply infrastructure to ensure high water quality delivery standards for homeowners and businesses.
    - Identify and address stormwater runoff sources that could carry contaminants to drinking water supplies.
    - Develop, update and implement contingency planning strategies that address water supply contamination or emergency service interruptions.
    - Adopt public education programs to increase awareness of threats to drinking water sources, encourage source water protection, and build support for local water protection initiatives. Inform businesses and households that are located within a water supply protection area.
    - Incorporate climate change into the town's water resource planning and protection.

- <u>For Homeowners/Business Owners:</u>
    - Organize locally and demand action by town officials to protect water supplies.
    - At town meeting and at the ballot box, support investments to improve water supply protection.
    - Support the adoption of local regulations that increase protection of water supplies, such as natural resource protection zoning, restriction of uses that involve the storage or use of hazardous materials, and other protective measures.
    - Support town and local land trust efforts to acquire permanently protected open space in public water supply areas.
    - Know where your town's water supply protection areas are located. If your home or business is located within a water supply protection area, avoid activities in and around your home or business that could pollute the groundwater beneath it. Even a small spill of a hazardous substance (see the list below) can cause major contamination of groundwater.
    - Don't dump hazardous substances down the drain. Household chemicals, paints, thinners, solvents, pharmaceuticals and other hazardous materials can leach into groundwater and drinking water supplies. Properly dispose of hazardous waste during designated collection days at local transfer stations.
    - Work to achieve zero stormwater runoff from your property. Direct roof runoff from downspouts away from paved areas. Install rain gardens to capture stormwater, and rain barrels to collect water. Maximize permeable areas and native plantings that help absorb stormwater and prevent water runoff to roads.
    - Eliminate the use of fertilizers and pesticides. Reduce, or better yet, eliminate turf grass lawns. Encourage your town, local school and golf courses to reduce or eliminate fertilizer and pesticide use.

  - Conserve water usage inside and outside your house or business. For example, avoid watering the lawn during summertime drought conditions. Plant drought tolerant native species and reduce your need for irrigation.
  - If using a private well, conduct regular testing, including testing for contaminants of emerging concern that are more likely to occur in the region.
  - Maintain your on-site septic systems properly by having it pumped regularly—every three years is recommended. Consider an advanced wastewater treatment system to treat nutrients.

- For State Government:
  - Adopt more protective standards to address unregulated contaminants and contaminants of emerging concern.
  - Expand the number of per- and polyfluoroalkyl substances (PFAS) regulated by the state that public water suppliers are required to monitor.
  - Incorporate climate change into water resource planning and protection. Pass legislation to establish a state drought management plan to protect water supplies.

- For Regional Government:
  - Maintain, and where possible, improve, rigorous protections of drinking water supply areas within the Cape Cod Commission's regulatory review jurisdiction.
  - Clean up municipal drinking water supplies in locations where county-controlled activities are responsible for contaminating groundwater.
  - Incorporate climate change into water resource planning and protection.

14. Success Stories

Despite the challenges and the need for much greater action in every town, there have been some successes in addressing nutrient pollution. These successes include the following:

- Passage of state legislation in 2018 that established the Cape Cod and Islands Water Protection Fund to provide a non-property tax-based source of funds to help Cape Cod and the Islands pay for necessary wastewater infrastructure and water quality remediation efforts. Through 2022, this fund has provided $98 million to eight towns to assist them with wastewater management and to provide dollar for dollar property tax relief to residents of Barnstable County.
- Barnstable County's alternative septic system testing center has been testing efficacy of different alternative septic systems and has identified several as being potentially useful;
- Sewer expansion projects in Chatham and in Falmouth;
- Alternative wastewater treatment methods are being tested or utilized in towns, including permeable reactive barriers in Falmouth and Orleans and shellfish aquaculture projects in Falmouth, Barnstable, Mashpee, Yarmouth, Dennis, Orleans and Wellfleet;
- Partnering agreements between towns to share public wastewater treatment facilities (e.g., Harwich and Chatham), including first-ever sewers installed in Harwich;
- Groundbreaking in 2020 for the Orleans wastewater treatment facility and collection system, with sewer construction in downtown Orleans continuing throughout 2022;
- The state's first Watershed Permit for four towns in the Pleasant Bay watershed, designed to facilitate a coordinated effort by the towns of Brewster, Chatham, Harwich and

Orleans and the Pleasant Bay Alliance to control nutrient pollution in Pleasant Bay (see Pleasant Bay Watershed Permit);

- Intermunicipal agreement between Mashpee, Sandwich and Barnstable for nitrogen load sharing for the cleanup of Popponesset Bay;
- Pond restoration success stories have been compiled by the Cape Cod Commission. Success stories for freshwater ponds are fewer because ponds have not received the attention that coastal embayments have received; and
- Additional water quality improvement success stories can be found on the Cape Cod Commission's website.

Finally, ecological restoration projects provide benefits for water quality as well as ecological benefits for fish and wildlife habitat. Several restoration projects that are planned, underway or completed include: Parkers River tidal restoration, Herring River tidal restoration, Childs River freshwater wetland restoration, Coonamessett River restoration, Sesuit Creek salt marsh restoration, Three Bays stormwater remediation project, Stony Brook salt marsh and fish passage restoration, and others. APCC's Restoration Coordination Center is assisting with many of these projects and provides Cape Cod communities with assistance in planning and implementing successful restoration projects. For more information on restoration projects on Cape Cod, visit APCC's website.

15. References and Resources

Cape Cod's water resources: Cape Cod Commission website on Water Resources. Visit: https://www.capecodcommission.org/our-work/topic/water-resources/

Economic value of the blue economy:

Cape Cod Chamber of Commerce website on economic value of Cape Cod's tourism industry. Visit: http://www.whycapecod.org/stats.html

Massachusetts Division of Marine Fisheries, Urban Harbors Institute, and Cape Cod Commercial Fishermen's Alliance, 2021. Port by Port: Profiles and Analysis of the Massachusetts Commercial Fishery. Posted at: https://www.mass.gov/doc/port-by-port-profiles-and-analysis-of-the-massachusetts-commercial-fishery/download. Hyperlink: "Port by Port: Profiles and Analysis of the Massachusetts Commercial Fishery"

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Definitions:

Embayments: https://www.yourdictionary.com/embayment
Estuaries: NOAA https://oceanservice.noaa.gov/facts/estuary.html.

Watersheds: Cape Cod Commission watershed reports. Posted at https://www.capecodcommission.org/our-work/208-plan-implementation/#WatershedReports. Click on an individual watershed to get the report for that watershed.

Nutrient pollution:

Cape Cod Commission. 2015. Cape Cod Areawide 208 Water Quality Management Plan. Posted at: https://www.capecodcommission.org/our-work/208.

Massachusetts Estuaries Project. See state website at: https://www.mass.gov/guides/the-massachusetts-estuaries-project-and-reports

Massachusetts Estuaries Project, University of Massachusetts at Dartmouth, School of Marine and Atmospheric Science and Technology (SMAST) website at: http://www.smast.umassd.edu/Coastal/research/estuaries/estuaries.html.

Cape Cod Commission, Ponds and Lakes website at: https://www.capecodcommission.org/our-work/ponds-and-lakes/.

Beach water quality monitoring: Barnstable County webpage on bathing beach water quality at https://www.barnstablecountyhealth.org/health-topics/recreational-water-quality

Shellfish water quality monitoring: Massachusetts Division of Marine Fisheries webpage on shellfish sanitation and management, at: https://www.mass.gov/shellfish-sanitation-and-management

Cyanobacteria monitoring:

Association to Preserve Cape Cod, Cyanobacteria monitoring program webpage at: https://apcc.org/our-work/science/community-science/cyanobacteria/

Leland, N.J., J.F. Haney, K. Conte, K. Malkus-Benjamin and B. Horsley. 2019. Evaluation of size structure in freshwater cyanobacteria populations: methods to quantify risk associated with changes in biomass and Microcystin concentrations. Journal of Water Research and Protection, 2019, 11, 810-829. Hyperlink: Leland, Haney, Conte, Malkus-Benjamin and Horseley, 2019

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Leland, N.J. and Haney, J.F., 2018. Alternative Methods for Analysis of Cyanobacterial Populations in Drinking Water Supplies: Fluorometric and Toxicological Applications Using Phycocyanin. Journal of Water Resource and Protection, 10, 740-761. Hyperlink: Leland and Haney, 2018

U.S. Environmental Protection Agency (EPA). 2017, updated 2021. Cyanobacteria Monitoring Collaborative Program (CMC). 2017. Quality Assurance Program Plan (QAPP) for the Cyanobacteria Monitoring Collaborative Program. Rev: 0, April 26, 2017: Posted at: https://cyanos.org/wp-content/uploads/2017/04/cmc_qapp_final.pdf . Hyperlink: CMC 2017

Mercury in ponds and lakes: https://www.mass.gov/info-details/eating-fish-safely-in-massachusetts

Emerging contaminants and pharmaceutical compounds in Cape Cod's waters:

Silent Spring Institute website at https://silentspring.org/news/contaminants-pervasive-cape-cods-drinking-water-supply/faqs-emerging-contaminants-cape-cod).

Center for Coastal Studies webpage on pharmaceuticals in marine waters, at: -program/monitoring-projects/contaminants-of-emerging-concern/pharmaceuticals-in-the-waters-of-cape-cod-bay-and-nantucket-sound/).

PFAS:

EPA website on PFAS, at: https://www.epa.gov/pfas

Massachusetts website on PFAS, at: https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas.

MassDEP PFAS Drinking Water Regulation Quick Reference Guide

PFAS Primer on APCC's State of the Waters: Cape Cod website.

Buzzards Bay Eutrophic Index for evaluating coastal eutrophication:

Costa, J. E., B. L. Howes, A. Giblin, and I. Valiela. 1992. Monitoring Nitrogen and indicators of nitrogen to support management action in Buzzards Bay, p. 497-529. In McKenzie et al.(eds) Ecological Indicators, Elsevier, London.

Buzzards Bay National Estuary Program webpage on the Buzzards Bay Eutrophic Index, at http://buzzardsbay.org/technical-data/status-trends/citizen-wq-monitoring/eutroindex/

Gunn, E., D.S. Janik and J.E. Costa. 1994. Quality Assurance Project Plan (QAPP) for the Buzzards Bay Project. https://buzzardsbay.org/download/qappcitz1994.pdf.)

Buzzards Bay Coalition website on Bay Health Index, at: https://www.savebuzzardsbay.org/bay-health/.

Center for Coastal Studies website on water quality monitoring program, at: https://coastalstudies.org/cape-cod-bay-monitoring-program/.

Carlson Trophic Index for evaluating freshwater ponds and lakes:

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Pond water quality: Cape Cod Commission, Freshwater Initiative website at: https://www.capecodcommission.org/our-work/cape-cod-freshwater-initiative/

Note: In the following figures and tables, 2022 refers to this updated report, not the year(s) in which water quality was monitored.

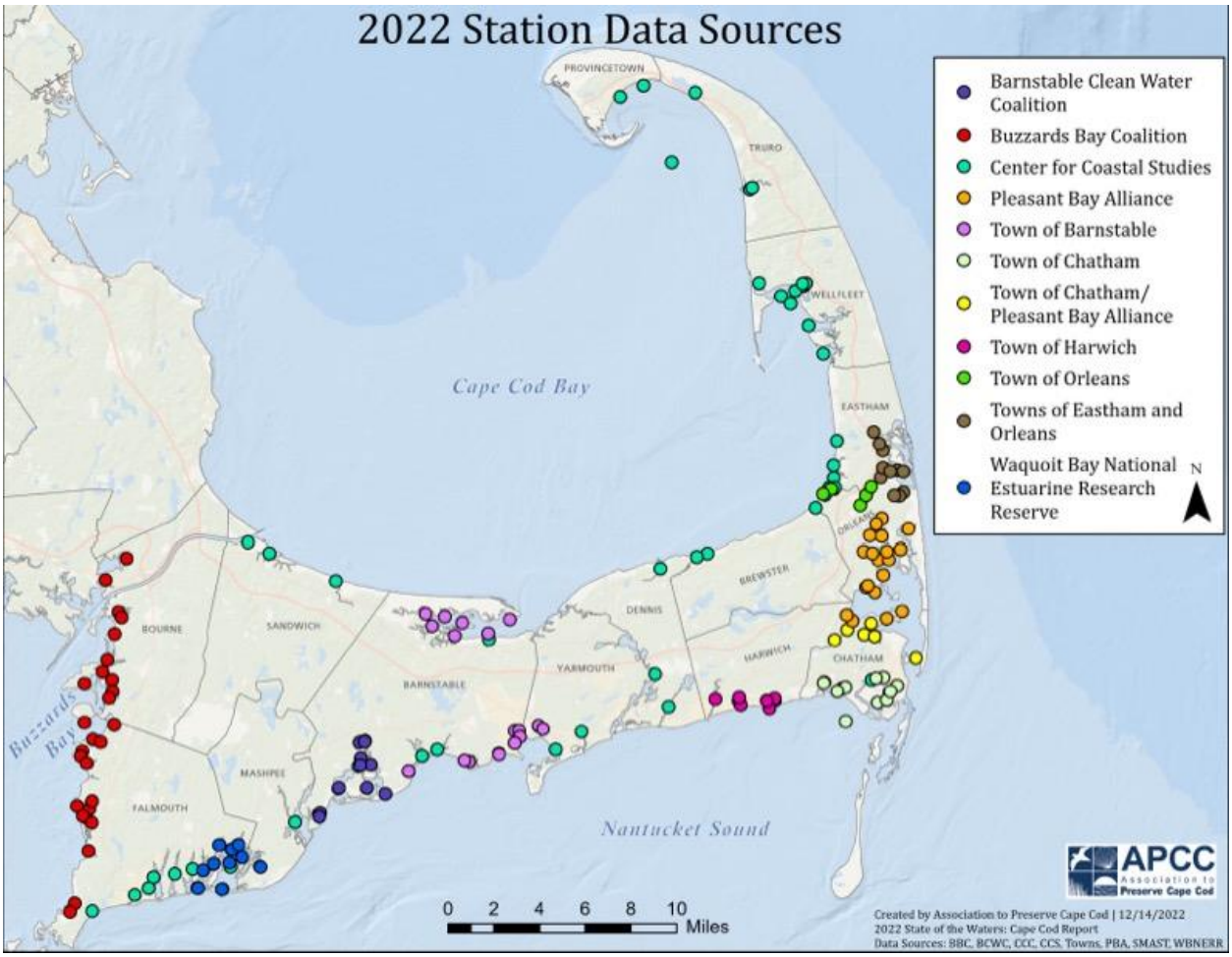

Figure 1. 2022 Map of Data Sources for Coastal Water Quality Data.

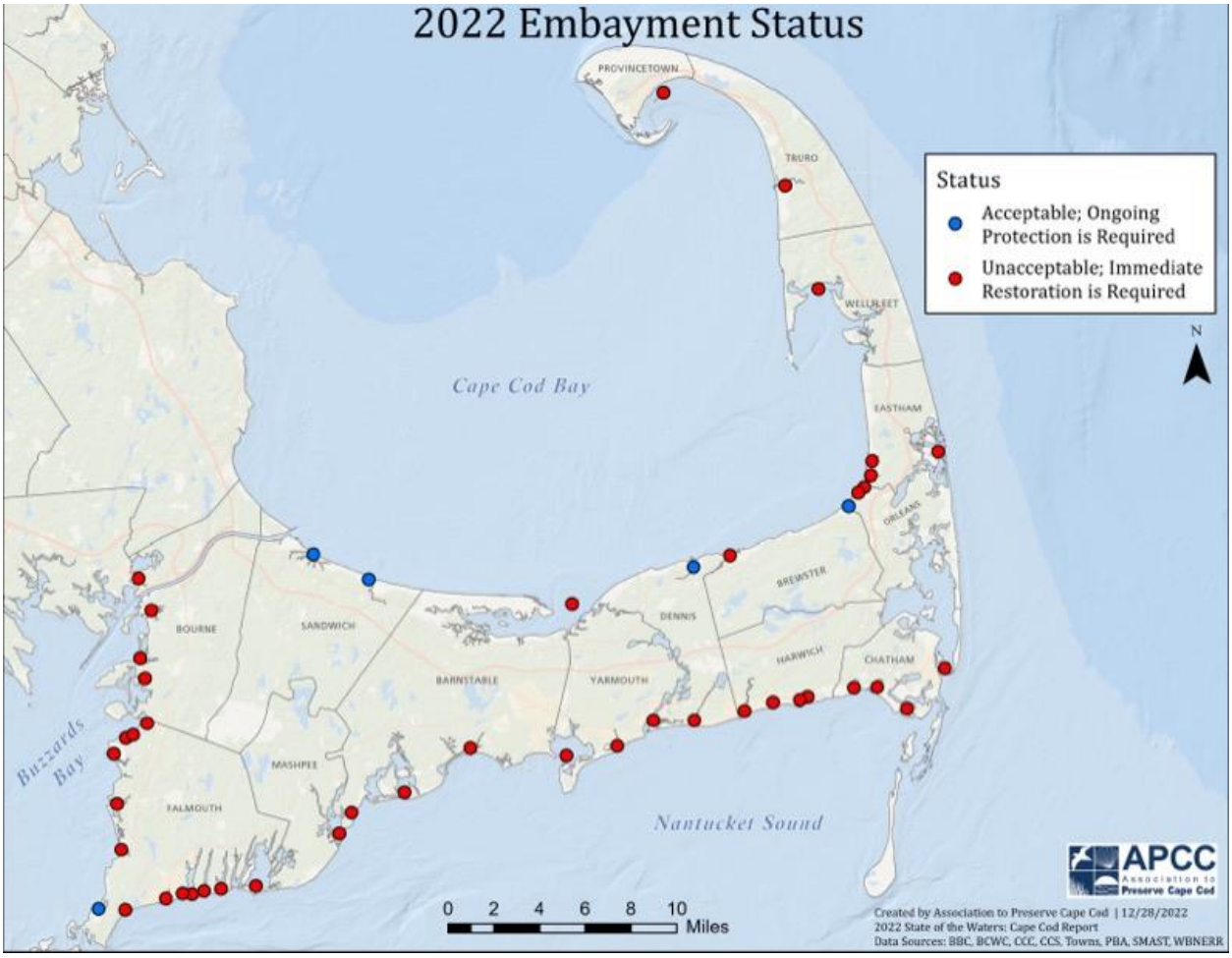

Figure 2. 2022 Map of Water Quality Grades for Coastal Embayments. Water quality grades for individual stations in embayments were reviewed. If there was at least one station in the embayment with Unacceptable water quality, the embayment received a grade of Unacceptable: requires immediate restoration. If all stations in an embayment had Acceptable water quality, the embayment received a grade of Acceptable: requires ongoing protection.

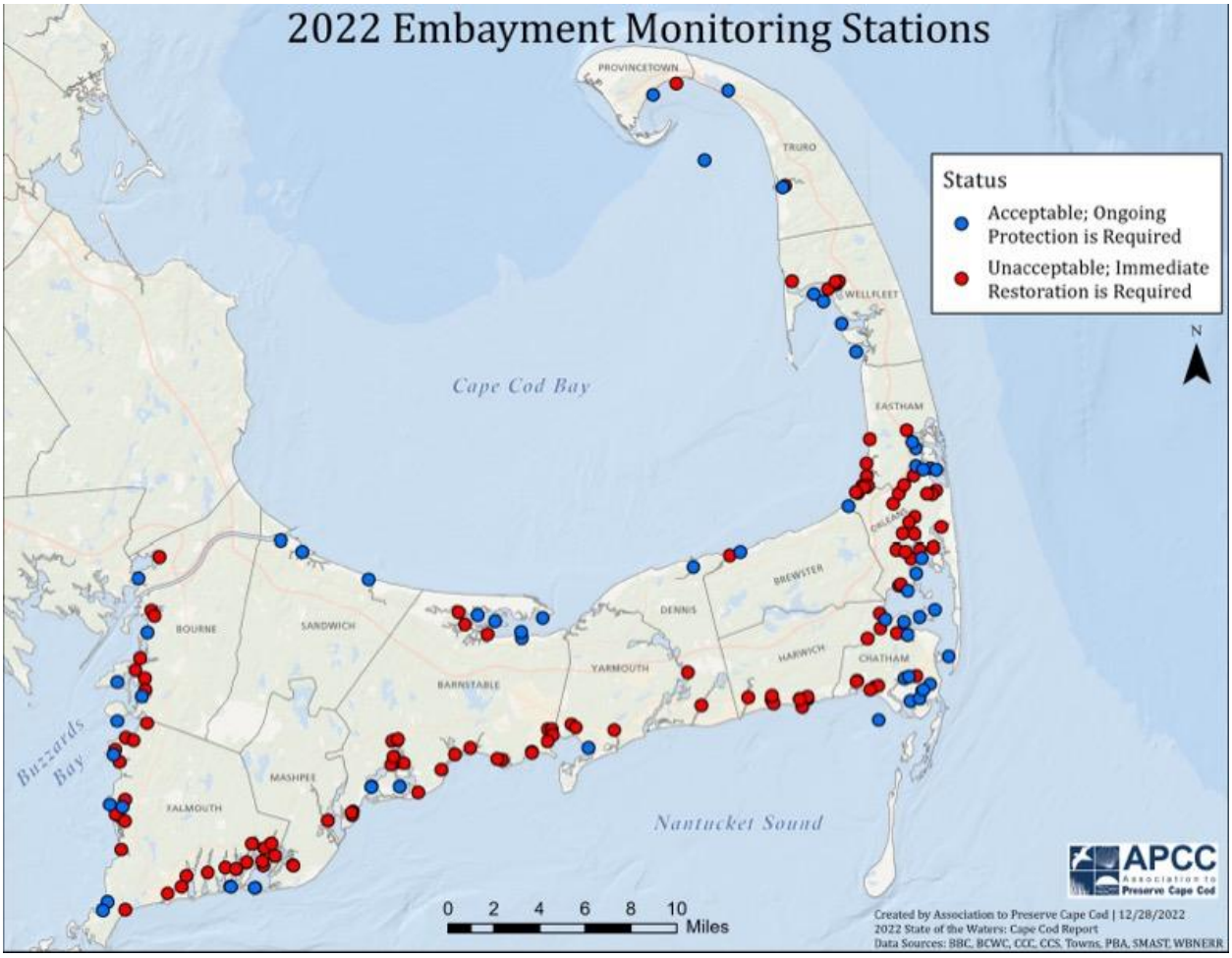

Figure 3. 2022 Map of Water Quality Grades for Coastal Embayment Stations. Water quality data for individual stations were scored using the Buzzards Bay Eutrophication Index and scores were converted into grades as described in Section 10.

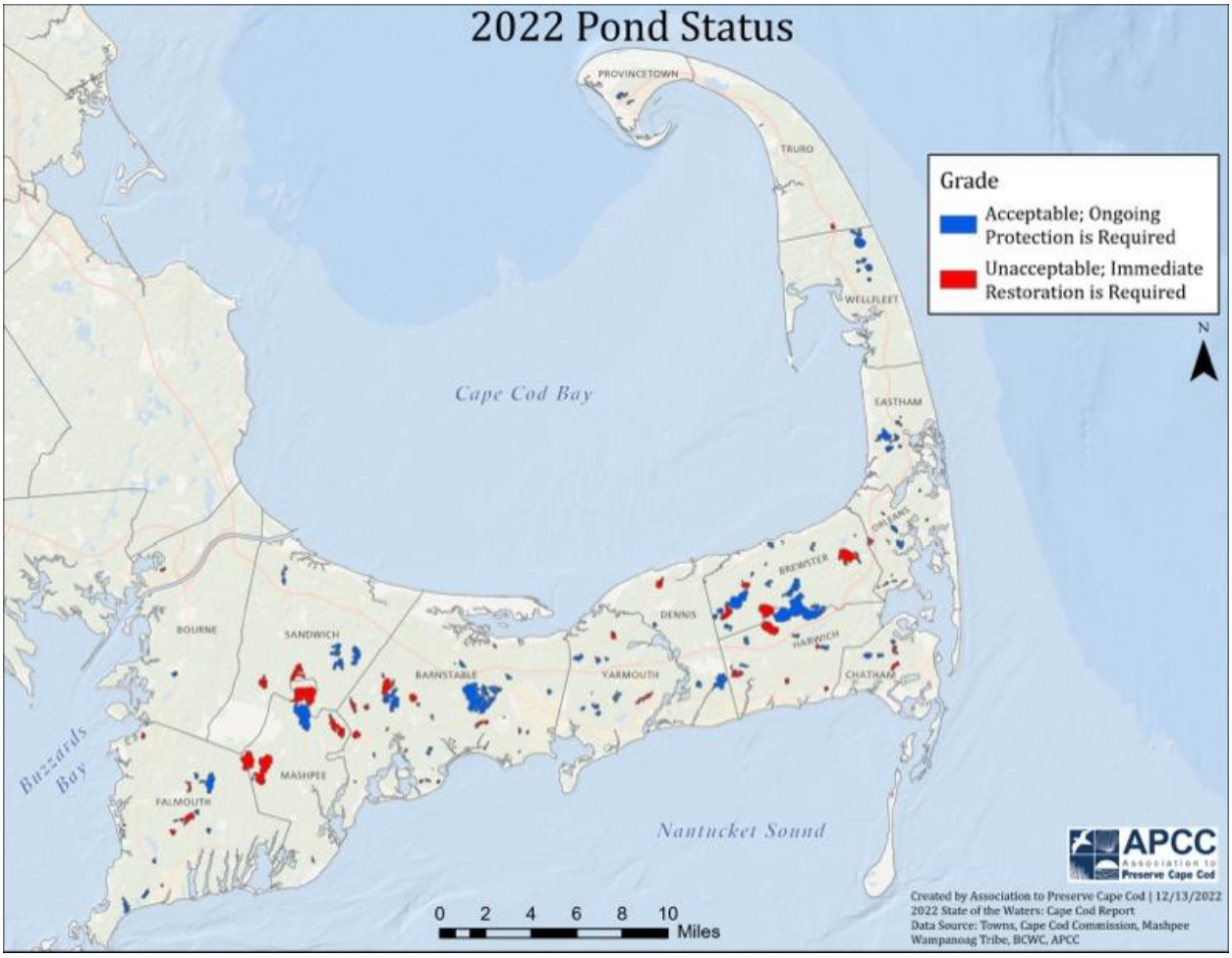

Figure 4. 2022 Map of Water Quality Grades for Ponds and Lakes. Ponds were graded using the Carlson Trophic Index and/or cyanobacteria data.

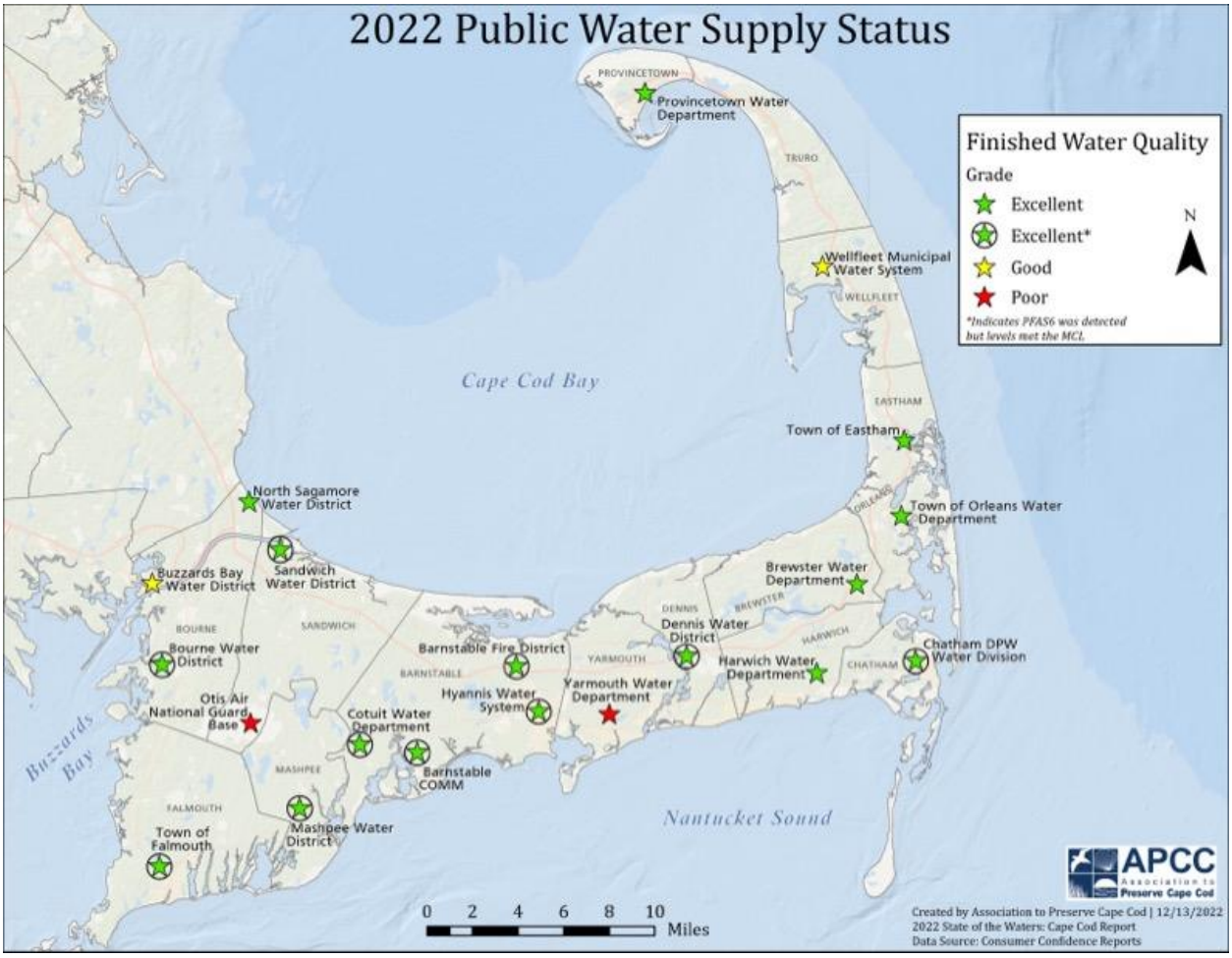

Figure 5. 2022 Map of Grades for Public Water Supplies of Drinking Water. Consumer Confidence Reports from 2021 were used to grade water quality in public water supplies prior to distribution to consumers.

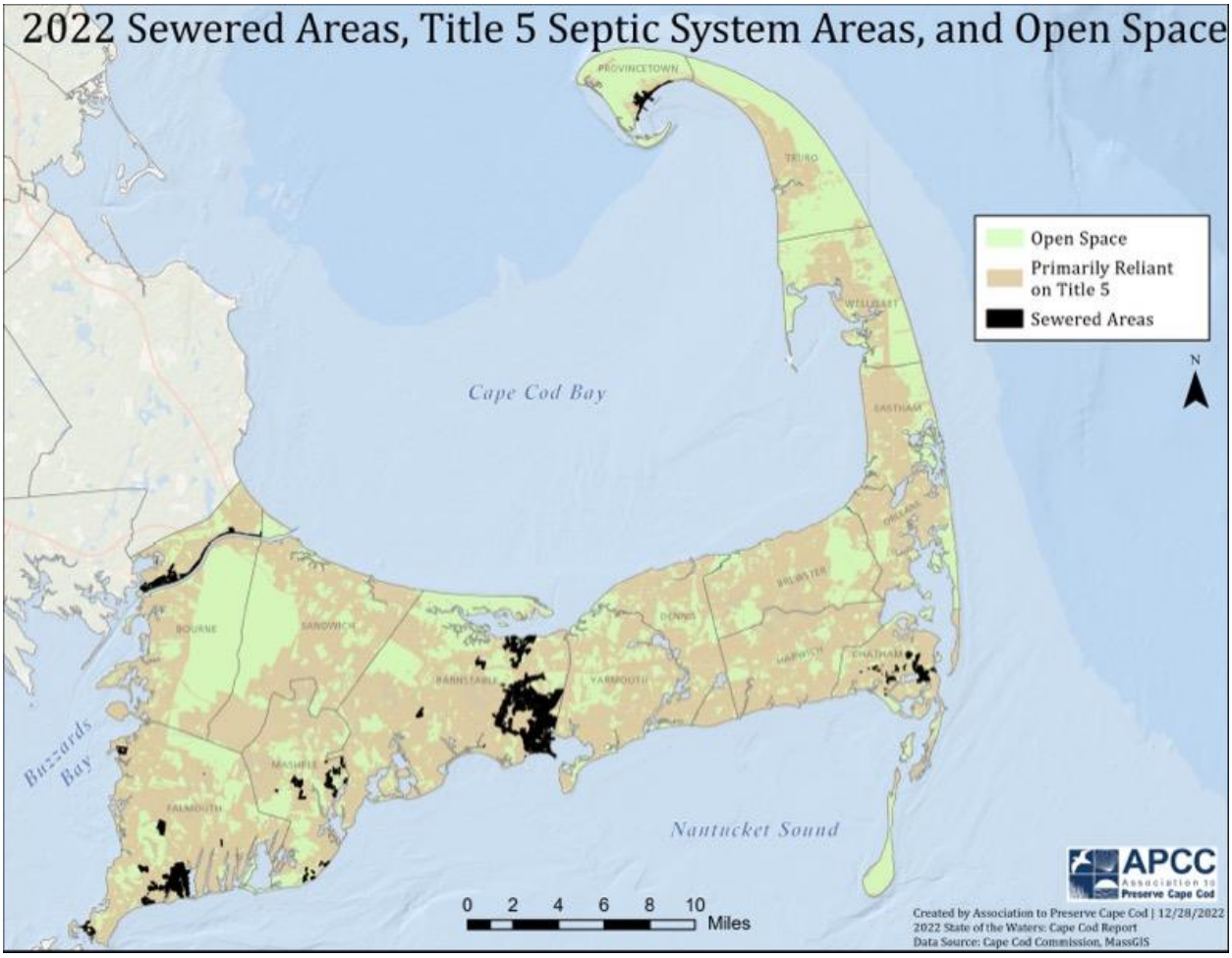

Figure 6. Map of Areas Served by Title 5 Septic Systems and Publicly-Owned Wastewater Treatment Facilities and Open Space.

Table 1. Summary of 2019, 2020, 2021 and 2022 State of the Waters Grades for Coastal Embayments and Stations.

State of the Waters: Cape Cod: 2022 12/20/22
Summary of Grades for Coastal Embaymens and Stations for 2019, 2020, 2021, and 2022

Note: 2019, 2020, 2021 and 2022 refer to the year in which the State of the Waters report was issued.

COASTAL EMBAYMENTS AND STATIONS	**2019 Grades**		**2020 Grades**		**2021 Grades**			**2022 Grades**	
	No.	% of graded embayments	No.	% of graded embayments	No.	% of graded embayments		No.	% of graded embayments
Embayments									
Acceptable:	15	32%	10	21%	6	13%		5	10%
Unacceptable:	32	68%	38	79%	41	87%		43	90%
No Data:	5		4		4			5	
Total graded Embayments:	**47**		**48**		**47**			**48**	
Total:	52		52		51			53	
Embayment Stations	No.	% of graded stations	No.	%	No.	% of graded stations	Change from 2020	No.	% of graded stations
Acceptable:	54	36%	46	30%	64	32%	18	60	31%
Unacceptable	98	64%	106	70%	133	68%	27	131	69%
Total graded Stations:	**152**		**152**		**197**		**45**	**191**	

Station grades:
Station grades were based on a 5-year moving average of Eutrophic Index scores as follows:
2022 grades used 2017-2021 data, with some exceptions (e.g., Harwich, Waquoit Bay) where data in this date range were not available due to COVID or other reasons.
2021 grades used 2016-2020 data, with some exceptions (e.g., Harwich) where data in this date range were not available.
2020 grades used 2015-2019 data, with some exceptions where data in this date range were not available.
2019 grades largely utilized station data from 2013-2017, with some exceptions made to use older data for stations not recently monitored.

Embayment grades:
An embayment was graded as Acceptable only if all graded stations in that embayment were Acceptable.
An embayment was graded as Unacceptable if one or more graded stations in that embayment were Unacceptable.

Table 2. 2022 Coastal Embayment Grades. A coastal embayment was graded as Acceptable if all stations in the embayment were Acceptable; if at least one station was Unacceptable, the embayment was graded as Unacceptable.

2022 State of the Waters: Cape Cod
Status of Coastal Embayments

Embayment	Source	2022 Embayment Status
Allen Harbor	Town of Harwich	Unacceptable; Immediate Restoration is Required
Barnstable Harbor	Town of Barnstable	Unacceptable; Immediate Restoration is Required
Bass River	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Boat Meadow River	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Bournes Pond	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Buttermilk Bay	Buzzards Bay Coalition	Unacceptable; Immediate Restoration is Required
Centerville River	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Falmouth Inner Harbor	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Fiddlers Cove	Buzzards Bay Coalition	Unacceptable; Immediate Restoration is Required
Great Pond	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Green Pond	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Herring River (EA)	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Herring River (HA)	Town of Harwich	Unacceptable; Immediate Restoration is Required
Lewis Bay	Town of Barnstable	Unacceptable; Immediate Restoration is Required
Little Namskaket Creek	Town of Orleans	Unacceptable; Immediate Restoration is Required
Little Pond	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Little Sippewissett Marsh	Buzzards Bay Coalition	Unacceptable; Immediate Restoration is Required
Megansett Harbor	Buzzards Bay Coalition	Unacceptable; Immediate Restoration is Required
Namskaket Creek	Center for Coastal Studies	Acceptable; Ongoing Protection is Required
Nauset Marsh	Town of Orleans	Unacceptable; Immediate Restoration is Required
Oyster Pond (FA)	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Pamet Harbor	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Parkers River (YA)	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Phinneys Harbor, Eel Pond	Buzzards Bay Coalition	Unacceptable; Immediate Restoration is Required
Pleasant Bay	Town of Chatham/Pleasant Bay Alliance	Unacceptable; Immediate Restoration is Required
Pocasset Harbor	Buzzards Bay Coalition	Unacceptable; Immediate Restoration is Required
Pocasset River	Buzzards Bay Coalition	Unacceptable; Immediate Restoration is Required
Popponesset Bay	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Provincetown Harbor	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Quissett Harbor	Buzzards Bay Coalition	Acceptable; Ongoing Protection is Required
Quivett Creek	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Rands Harbor	Buzzards Bay Coalition	Unacceptable; Immediate Restoration is Required
Rock Harbor	Town of Orleans	Unacceptable; Immediate Restoration is Required
Rushy Marsh Pond	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Sandwich Harbor	Center for Coastal Studies	Acceptable; Ongoing Protection is Required
Saquetucket Harbor	Town of Harwich	Unacceptable; Immediate Restoration is Required
Scorton Harbor	Center for Coastal Studies	Acceptable; Ongoing Protection is Required
Sesuit Harbor	Center for Coastal Studies	Acceptable; Ongoing Protection is Required
Stage Harbor	Town of Chatham	Unacceptable; Immediate Restoration is Required
Sulfur Springs/Bucks Creek	Town of Chatham	Unacceptable; Immediate Restoration is Required
Swan Pond River	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
Taylor's Pond/Mill Creek	Town of Chatham	Unacceptable; Immediate Restoration is Required
Three Bays	Barnstable Clean Water Coalition	Unacceptable; Immediate Restoration is Required
Waquoit Bay	Waquoit Bay National Estuarine Research Reserve	Unacceptable; Immediate Restoration is Required
Wellfleet Harbor	Center for Coastal Studies	Unacceptable; Immediate Restoration is Required
West Falmouth Harbor	Buzzards Bay Coalition	Unacceptable; Immediate Restoration is Required
Wild Harbor	Buzzards Bay Coalition	Unacceptable; Immediate Restoration is Required
Wychmere Harbor	Town of Harwich	Unacceptable; Immediate Restoration is Required

208 Embayments with no data:
Chase Garden Creek (YA)
Great Sippewissett Creek (FA)
Hatches Harbor (PR)
Red River (CH)
Salt Pond (FA)

Summary:	Unacceptable:	43
	Acceptable:	5
	Total number of embayments with grades:	**48**
	Number of embayments with no data	5
	Total number of embayments:	53

Note: 208 Plan has 53 embayments

Table 3. 2022 Coastal Station Grades.

1

2022 State of the Waters: Cape Cod
Status of Coastal Stations and Embayments

ObjectID_1	Station	Site_Name	Embayment	Source	Station Score 2022	Score 2021	APCC Station Status 2022	No. Years	Years Covered	2022 Embayment Status
1	North Prince's Cove	Site 3	Three Bays	BCWC	**38.35**	39.5	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
2	Warren's Cove	Site 4	Three Bays	BCWC	**34.93**	35.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
3	North N. Bay	Site 5	Three Bays	BCWC	**36.94**	37.4	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
4	South N. Bay	Site 6	Three Bays	BCWC	**51.32**	49.6	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
5	South West Bay	Site 9	Three Bays	BCWC	**70.20**	67.9	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
6	South West Bay	Site 10	Three Bays	BCWC	**58.56**	58.1	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
7	South Cotuit Bay	Site 13	Three Bays	BCWC	**52.22**	55	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
8	Cotuit Sentinel	Site 18	Three Bays	BCWC	**49.59**	49.2	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
9	Rushy Marsh	Site RM3	Rushy Marsh Pond	BCWC	**37.95**	33.5	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
10	Rushy Marsh	Site RM4	Rushy Marsh Pond	BCWC	**39.45**	34.6	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
11	BB4	Buttermilk Bay	Buttermilk Bay	BBC	**69.00**	65.7	**Acceptable; Ongoing Protection is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
12	not listed in lat-long-location is	Little Buttermilk Bay	Buttermilk Bay	BBC	**61.00**	57.6	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
13	FC1N	Fiddlers Cove	Fiddlers Cove	BBC	**61.00**	60.5	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
14	LSM1	Little Sippewisset Marsh	Little Sippewissett Marsh	BBC	**63.00**	62	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
15	MG4	Megansett Harbor	Megansett Harbor	BBC	**83.00**	83.4	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
16	SQ1N	Squeteague Harbor	Megansett Harbor	BBC	**58.00**	56.7	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
17	EP3	Back River	Phinneys Harbor, Eel Pond & I	BBC	**57.00**	56	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
18	EP2	Eel Pond, Bourne	Phinneys Harbor, Eel Pond & I	BBC	**40.00**	38.4	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
19	PH2	Phinneys Harbor	Phinneys Harbor, Eel Pond & I	BBC	**69.00**	69.6	**Acceptable; Ongoing Protection is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
20	HC2	Hen Cove	Pocasset Harbor	BBC	**57.00**	59.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
21	PC1	Pocasset Harbor Inner	Pocasset Harbor	BBC	**50.00**	49.7	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
22	PC3	Pocasset Harbor Outer	Pocasset Harbor	BBC	**76.00**	72.5	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
23	RB4	Red Brook Harbor Inner	Pocasset Harbor	BBC	**63.00**	63.9	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
24	RB2	Red Brook Harbor Outer	Pocasset Harbor	BBC	**76.00**	77.2	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
25	PR3	Pocasset River	Pocasset River	BBC	**51.00**	52.5	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
26	QH2	Quissett Harbor Inner	Quissett Harbor	BBC	**89.00**	87.1	**Acceptable; Ongoing Protection is Required**	5	2017-2021	Acceptable; Ongoing Protection is Required
27	QH1	Quissett Harbor Outer	Quissett Harbor	BBC	**91.00**	89.8	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
28	RH1	Rands Harbor	Rands Harbor	BBC	**39.00**	35.7	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
29	MAC1	Mashapaquit Creek	West Falmouth Harbor	BBC		2.5				
30	WF4N	West Falmouth Harbor Head	West Falmouth Harbor	BBC	**65.00**	52.5	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
31	WF9N	West Falmouth Harbor Outer	West Falmouth Harbor	BBC	**74.00**	74.2	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
32	WF1N	West Falmouth Harbor Town Dock	West Falmouth Harbor	BBC	**66.00**	61.9	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
33	WF5N	West Falmouth Mid-Harbor	West Falmouth Harbor	BBC	**65.00**	64.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
34	WF8	West Falmouth Oyster Pond	West Falmouth Harbor	BBC	**32.00**	33.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
35	WF2	West Falmouth Snug Harbor	West Falmouth Harbor	BBC	**25.00**	24.1	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
36	not listed in document that con	Potters Hole Pond	Wild Harbor	BBC		57.6				
37	WH1N	Wild Harbor Inner	Wild Harbor	BBC	**57.00**	57	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
38	WH3	Wild Harbor Outer	Wild Harbor	BBC	**83.00**	82.5	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
39	WH2	Wild Harbor River	Wild Harbor	BBC	**63.00**	64.6	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
40	524	HAR-4	Allen Harbor	CCS	**42.65**	43.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
41	131	Millway Beach	Barnstable Harbor	CCS	**74.08**	74.7	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
42	505	BR-7	Bass River	CCS	**54.09**	39.4	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
43	11.5	Boat Meadow	Boat Meadow River	CCS	**53.77**	53.1	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
44	21.5	First Encounter	Herring River (EA)	CCS	**45.76**	46.7	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
45	500	B3	Bournes Pond	CCS	**44.94**	45.4	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
46	1	5N	Provincetown Harbor	CCS	**99.09**	99.1	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
47	2	5S	Cape Cod Bay	CCS		99.4				
48	3	6M	Cape Cod Bay	CCS		100				
49	4	6S	Cape Cod Bay	CCS		100				
50	5	7S	Cape Cod Bay	CCS		100				
51	6	8M	Cape Cod Bay	CCS		99.6				
52	8	9S	Cape Cod Bay	CCS		99.9				
53	15	Canal	Cape Cod Bay	CCS	**81.97**	82.9	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
54	502	BCT-1	Centerville River	CCS	**30.53**	29	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
55	503	BCT-2	Centerville River	CCS	**37.33**	36.9	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
56	518	FHx	Falmouth Inner Harbor	CCS	**43.01**	42.9	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
57	521	GT-5	Great Pond	CCS	**44.01**	42.2	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
58	520	G4	Green Pond	CCS	**42.27**	43.9	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
59	129	Cole Road Brook	Herring River (EA)	CCS	**64.94**	64.9	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
60	501	BC-14 (Halls Creek)	Lewis Bay	CCS	**48.40**	44	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
61	504	BHY-3	Lewis Bay	CCS	**66.02**	66.6	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
62	542	Stewarts Creek	Lewis Bay	CCS	**33.60**	32	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
63	107	Little Namskaket	Little Namskaket Creek	CCS	**61.10**	63.4	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
64	568	LP-2	Little Pond	CCS	**35.49**	33.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
65	108	Namskaket (inner)	Namskaket Creek	CCS	**78.08**	79.7	**Acceptable; Ongoing Protection is Required**	5	2017-2021	Acceptable; Ongoing Protection is Required
66	52	NTKS_10	Nantucket Sound	CCS		91.5				
67	53	NTKS_13	Nantucket Sound	CCS		94.9				
68	54	NTKS_16	Nantucket Sound	CCS		96				
69	60	NTKS_14	Nantucket Sound	CCS		97.6				
70	534	OP-3	Oyster Pond (FA)	CCS	**63.42**	57.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
71	25	Inner Pamet Harbor	Pamet Harbor	CCS	**74.72**	76.6	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
72	117	Pamet River	Pamet Harbor	CCS	**56.97**		**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
73	536	PR-2	Parkers River (YA)	CCS	**45.19**	44.4	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
74	535	PBh	Popponesset Bay	CCS	**59.15**	58.2	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
75	23	Holiday Inn	Provincetown Harbor	CCS	**59.02**	64.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
76	30	MacMillan	Provincetown Harbor	CCS	**91.92**	92.1	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
77	110	Paines Creek	Paines Creek	CCS	**79.46**	76.5	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
78	128	Quivet Marsh	Quivet Creek	CCS	**34.67**	34.7	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
79	26.5	Inner Rock Harbor	Rock Harbor	CCS	**30.62**	30.7	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
80	39.5	Rock Harbor	Rock Harbor	CCS	**56.58**	55.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
81	304	RH-bend	Rock Harbor	CCS	**35.26**	33.9	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
82	538	RM-2	Rushy Marsh Pond	CCS	**39.04**	37	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
83	101	Boardwalk	Sandwich Harbor	CCS	**87.93**	85.3	**Acceptable; Ongoing Protection is Required**	5	2017-2021	Acceptable; Ongoing Protection is Required
84	522	HAR-2	Saquetucket Harbor	CCS	**46.22**	44.7	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
85	114	Scorton	Scorton Harbor	CCS	**84.37**	82.1	**Acceptable; Ongoing Protection is Required**	5	2017-2021	Acceptable; Ongoing Protection is Required
86	27	Inner Sesuit Harbor	Sesuit Harbor	CCS	**79.79**	79.5	**Acceptable; Ongoing Protection is Required**	5	2017-2021	Acceptable; Ongoing Protection is Required
87	507	CM-1A	Stage Harbor	CCS	**75.23**	74.5	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
88	508	CM-5A	Stage Harbor	CCS	**70.85**	69.9	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
89	509	CM-8	Sulfur Springs/Bucks Creek	CCS	**57.76**	42.2	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
90	543	SWP-2	Swan Pond River	CCS	**47.77**	48.6	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
91	506	CM-10	Taylor's Pond/Mill Creek	CCS	**53.75**	39.4	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
92	510	Cotuit Bay	Three Bays	CCS	**70.28**	70.3	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
93	532	Narrows	Three Bays	CCS	**55.95**	56.2	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
94	533	North Bay	Three Bays	CCS	**47.99**	48.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
95	551	Warrens Cove	Three Bays	CCS	**38.62**	38.9	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
96	553	West Bay	Three Bays	CCS	**77.12**	78.2	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
97	119	Pilgrim Lake East	Provincetown Harbor	CCS	**76.74**	76.7	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
98	511	Site 7 - CR-2	Waquoit Bay	CCS	**22.60**	22.6	**Unacceptable; Immediate Restoration is Required**	5	2016-2020	
99	517	Site 8 - ER-2	Waquoit Bay	CCS	**47.50**	47.5	**Unacceptable; Immediate Restoration is Required**	5	2016-2020	
100	526	Site 3 - HPu	Waquoit Bay	CCS	**51.20**	51.2	**Unacceptable; Immediate Restoration is Required**	5	2016-2020	
101	527	Site 4 - JHP	Waquoit Bay	CCS	**48.40**	48.4	**Unacceptable; Immediate Restoration is Required**	5	2016-2020	
102	537	Site 5 - QRm	Waquoit Bay	CCS	**36.70**	36.7	**Unacceptable; Immediate Restoration is Required**	5	2016-2020	
103	552	Site 10 - WBu/Metoxit	Waquoit Bay	CCS	**64.50**	64.5	**Unacceptable; Immediate Restoration is Required**	5	2016-2020	
104	564	Site 1 - Seapit	Waquoit Bay	CCS	**46.50**	46.5	**Unacceptable; Immediate Restoration is Required**	5	2016-2020	
105	565	Site 2 - WB north	Waquoit Bay	CCS	**54.10**	54.1	**Unacceptable; Immediate Restoration is Required**	5	2016-2020	
106	566	Site 9 - WB south	Waquoit Bay	CCS	**81.10**	81.1	**Acceptable; Ongoing Protection is Required**	5	2016-2020	
107	567	Site 6 - Menauhant	Waquoit Bay	CCS	**76.30**	76.3	**Acceptable; Ongoing Protection is Required**	5	2016-2020	
108	10	Blackfish Creek	Wellfleet Harbor	CCS	**70.80**	69.9	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
109	22	Great Island Channel	Wellfleet Harbor	CCS	**70.34**	70.4	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
110	28	Inner Wellfleet Harbor	Wellfleet Harbor	CCS	**52.09**	50.1	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	Unacceptable; Immediate Restoration is Required
111	42	Sunken Meadow	Wellfleet Harbor	CCS	**84.30**	84.3	**Acceptable; Ongoing Protection is Required**	5	2017-2021	
112	43	Wellfleet Harbor	Wellfleet Harbor	CCS	**59.24**	56.5	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
113	105	Herring River, Wellfleet	Wellfleet Harbor	CCS	**23.10**		**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
114	138	WH-5	Wellfleet Harbor	CCS	**65.69**		**Acceptable; Ongoing Protection is Required**	5	2017-2021	
115	202	Channel	Wellfleet Harbor	CCS	**38.99**		**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
116	205	Transect 2	Wellfleet Harbor	CCS	**43.32**		**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
117	212	DB-pipe, Mayo Creek	Wellfleet Harbor	CCS	**17.83**		**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
118	523	HAR-3	Wychmere Harbor	CCS	**48.47**	47.4	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	

Summary-Embayments and Stations-SOTW2022 copy.xlsx

Table 4. Summary of 2019, 2020, 2021, and 2022 State of the Waters Grades for Ponds.

State of the Waters: Cape Cod: 2022 12/20/22
Summary of Pond Grades for 2019, 2020, 2021, and 2022

PONDS	2019 Grades		2020 Grades		2021 Grades			2022 Grades		
Final grades based on CTI and cyanobacteria grades	No.	%	No.	%	No.	% of all 109 graded ponds		No.	% of all 151 graded ponds	
Acceptable:	91	61%	54	58%	71	65%		92	61%	
Unacceptable:	58	39%	39	42%	38	35%		59	39%	
Total graded Ponds:	**149**		**93**		**109**			**151**		
Ponds with enough water quality data to calculate Carlson Trophic Index (CTI) grades					No.	% of ponds w/CTI grades	% of all 109 graded ponds	No.	% of ponds w/CTI grades	% of all 151 graded ponds
Acceptable:					24	67%	22%	37	54%	25%
Unacceptable:					12	33%	11%	31	46%	21%
Total with CTI grades:	149		29		36		33%	68		45%
Ponds with Cyanobacteria data that enabled grading	NA				No.	% of ponds w/Cyano grades	% of all 109 graded ponds	No.	% of ponds w/Cyano grades	% of all 151 graded ponds
Acceptable:					52	60%	48%	93	72%	62%
Unacceptable:					35	40%	32%	36	28%	24%
Total with Cyano grades:			81		87		80%	129		85%
Ponds with both CTI and Cyano grades:					No.	% of ponds w/both grades	% of all 109 graded ponds	No.	% of ponds w/both grades	% of all 151 graded ponds
Ponds with both CTI and Cyano grades:	NA		17		14	100%	13%	46		30%
Both CTI and Cyano were Acceptable:					6	43%	6%	23	50%	15%
Either CTI or Cyano was Unacceptable:					8	57%	7%	15	33%	10%
Where CTI and Cyano grades differed, the Final Unacceptable grade was due to Cyano being Unacceptable:					7	50%	6%	6	13%	4%
Where CTI and Cyano grades differed, the Final Unacceptable grade was due to CTI being Unacceptable:					4	29%	4%	9	20%	6%
Both CTI and Cyano were Unacceptable:					3	21%	3%	7	15%	5%

The larger number of ponds graded in the 2019 report reflects a wide range of years of water quality data used for grading (e.g.,the oldest data were from 2003 and the most recent data were from 2017. From the 2020 report on, data quality requirements for water quality data used for Carlson Trophic Index scoring were tightened : at least 3 years of data from a given year which moves up each year. Examples: in the 2020 report, water quality data used for Carlson Trophic Index scoring and grading required at least 3 years of data from 2015 on.
In 2021, water quality data used for Carlson Trophic Index scoring and grading required at least 3 years of data from 2016 on.
In 2022, water quality data used for Carlson Trophic Index scoring and grading required at least 3 years of data from 2017 on.

Table 5. 2022 Pond Grades. Pond water quality data were provided by towns and organizations, SMAST and the Cape Cod Commission. Cyanobacteria data were provided by APCC.

State of the Waters: Cape Cod, 2022 Rev.11/22/22
Pond Status based on Carlson Trophic Index status and Cyanobacteria status
New ponds this year are in red

CCC_GIS_ITown_Data_Sou	Pond_name	Highest Cyano Map Status in 2021	Cyano_Status_2021 data	Carlson Trophic Index TSI_AVG_2022 score	Years_Covered	Carlson trophic Index (CTI) Status, 2022	Final Status, 2022
Barnstable	Aunt Betty's			48.7	2017-2020	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-617 Barnstable	Bearse	Low	Acceptable; ongoing protection required	46.3	2018-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-802 Barnstable	Bog			58.0	2017-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-694 Barnstable	Crocker Pond (form	High	Unacceptable; immediate restoration required	59.1	2018-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-878 Barnstable	Crystal Lake	Low	Acceptable; ongoing protection required	45.1	2017-2019, 2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
Barnstable	Dunns			68.2	2018-2019,2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-815 Barnstable	Eagle	Low	Acceptable; ongoing protection required	40.3	2017-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-748 Barnstable	Fawcett	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
BA-510 Barnstable	Garrett	Low	Acceptable; ongoing protection required	47.2	2017-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-606 Barnstable	Gooseberry	Low	Acceptable; ongoing protection required	40.5	2018-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-668 Barnstable	Hamblin	Low	Acceptable; ongoing protection required	38.2	2017, 2019-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-565 Barnstable	Hathaway	Low	Acceptable; ongoing protection required	37.6	2017-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-511 Barnstable	Hinkley	Low	Acceptable; ongoing protection required	63.2	2017, 2019-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; Immediate Restoration is Required**
BA-807 Barnstable	Joshua	Low	Acceptable; ongoing protection required	34.6	2017-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-795 Barnstable	Lake Elizabeth	Low	Acceptable; ongoing protection required	50.8	2017-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-881 Barnstable	Lewis (Cotuit)	Low	Acceptable; ongoing protection required	59.6	2017-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
Barnstable	Little Parker			81.3	2018-2019,2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-737 Barnstable	Long Pond Centerv	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
BA-675 Barnstable	Long Pond Marstor	High	Unacceptable; immediate restoration required	44.7	2018-2021	Acceptable; Ongoing Protection is Required	**Unacceptable; immediate restoration required**
BA-759 Barnstable	Lovells	High	Unacceptable; immediate restoration required	49.3	2017-2021	Acceptable; Ongoing Protection is Required	**Unacceptable; immediate restoration required**
Barnstable	Lumbert Mill			56.6	2017-2020	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
Barnstable	Mary Dunn			47.9	2017-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-797 Barnstable	Micah	Low	Acceptable; ongoing protection required	38.4	2017-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-640 Barnstable	Middle	Low	Acceptable; ongoing protection required	42.6	2017-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-746 Barnstable	Mill			57.9	2017-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-584 Barnstable	Mystic	Low	Acceptable; ongoing protection required	53.9	2017-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-874 Barnstable	Neck	Moderate	Acceptable; ongoing protection required	42.2	2017-2019, 2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-395 Barnstable	Night Heron Pond						
BA-523 Barnstable	No Bottom	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
BA-816 Barnstable	North						
BA-875 Barnstable	Parker Pond	High	Unacceptable; immediate restoration required	63.5	2017-2019, 2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-731 Barnstable	Pattys						
Barnstable	Red Lily Pond			49.2	2018-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-691 Barnstable	Round	Low	Acceptable; ongoing protection required	54.4	2017-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-806 Barnstable	Schoolhouse	High	Unacceptable; immediate restoration required	58.0	2017-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-626 Barnstable	Shallow	Low	Acceptable; ongoing protection required	44.9	2017-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
BA-664 Barnstable	Shubael	High	Unacceptable; immediate restoration required	40.3	2017-2021	Acceptable; Ongoing Protection is Required	**Unacceptable; immediate restoration required**
BA-789 Barnstable	Simmons						
BA-564 Barnstable	Stoney			58.0	2017, 2019-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
BA-605 Barnstable	Wequaquet	Low	Acceptable; ongoing protection required	42.0	2017-2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
Bourne	Picture Lake	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Bourne	Queen Sewell Pond	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
Brewster	Bakers Pond (same	High	Unacceptable; immediate restoration required	33.4	2017-2018, 2020	Acceptable; Ongoing Protection is Required	**Unacceptable; immediate restoration required**
Brewster	Blueberry Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Brewster	Bound Brook Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Brewster	Greenland Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Brewster	Owl Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Brewster	Pine Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Brewster	Slough Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Brewster	Smith Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
BR-1028 Brewster	Cliff Pond	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
BR-179 Brewster	Cobbs	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
BR-357 Brewster	Elbow	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
BR-248 Brewster	Griffiths Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
BR-192 Brewster	Little Cliff Pond	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
BR-279 Brewster	Long Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
BR-245 Brewster	Lower Mill	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
BR-177 Brewster	Myricks Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
BR-205 Brewster	Schoolhouse Pond (	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
HA-306 Brewster	Seymour Pond	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
BR-240 Brewster	Sheep Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
BR-314 Brewster	Smalls Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
BR-272 Brewster	Upper Mill Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
BR-313 Brewster	Walkers Pond	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
CH-458 Chatham	Goose Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
CH-428 Chatham	Lovers Lake	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
CH-463 Chatham	Schoolhouse Pond (	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
CH-396 Chatham	Stillwater Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
CH-516 Chatham	White Pond	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
DE-347 Dennis	Clay						
DE-355 Dennis	Flax Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
DE-236 Dennis	Scargo Lake	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
HA-414 Dennis	Whites						
Dennis	Swan Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Dennis	Fresh Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
EA-96 Eastham	Depot Pond	Low	Acceptable; ongoing protection required	46.7	2017-2019, 2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
Eastham	Bridge Pond	Low	Acceptable; ongoing protection required	50.3	2017-2019, 2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
Eastham	Great Pond	Low	Acceptable; ongoing protection required	49.6	2017-2019, 2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
Eastham	Herring Pond	Low	Acceptable; ongoing protection required	48.7	2017-2019, 2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
Eastham	Jemima Pond	Low	Acceptable; ongoing protection required	48.4	2017-2019, 2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
Eastham	Minister's Pond	Low	Acceptable; ongoing protection required	53.6	2017-2019, 2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
Eastham	Muddy Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Eastham	Little Depot Pond			64.9	2017-2019, 2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
Eastham	Moll			60.3	2017-2019, 2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
Eastham	Schoolhouse			54.3	2017-2019, 2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
Falmouth	Ashumet Pond	High	Unacceptable; immediate restoration required	52.9	2017-2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
Falmouth	Coonamessett Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Falmouth	Grews Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Falmouth	Round Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Falmouth	Mill Pond (FA)	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Falmouth	Siders Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
Falmouth	Deer Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
FA-761 Falmouth	Cedar Lake	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
FA-884 Falmouth	Crooked Pond	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
FA-857 Falmouth	Deep Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
FA-937 Falmouth	Flax Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
FA-933 Falmouth	Fresh Pond	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
FA-918 Falmouth	Jenkins Pond	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
FA-938 Falmouth	Mares Pond	High	Unacceptable; immediate restoration required				**Unacceptable; immediate restoration required**
FA-995 Falmouth	Nyes Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
FA-1005 Falmouth	Oyster Pond	Low	Acceptable; ongoing protection required				**Acceptable; ongoing protection required**
HA-376 Harwich	Aunt Edies Pond	Low	Acceptable; ongoing protection required	49.4	2017-2019, 2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
HA-420 Harwich	Bucks Pond	Low	Acceptable; ongoing protection required	41.2	2017-2019, 2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
HA-579 Harwich	Grass			57.4	2017-2019	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
HA-353 Harwich	Hinckley's Pond	Low	Acceptable; ongoing protection required	51.9	2017-2019, 2021	Unacceptable; Immediate Restoration is Required	**Unacceptable; immediate restoration required**
HA-416 Harwich	Joseph's Pond	High	Unacceptable; immediate restoration required	39.5	2017-2019, 2021	Acceptable; Ongoing Protection is Required	**Unacceptable; immediate restoration required**
HA-386 Harwich	Robbins			42.8	2017, 2018, 2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**
HA-525 Harwich	Sand Lake	Low	Acceptable; ongoing protection required	43.5	2017-2019, 2021	Acceptable; Ongoing Protection is Required	**Acceptable; ongoing protection required**

Table 6. Summary of 2019, 2020, 2021, and 2022 State of the Waters Grades for Public Water Supplies.

State of the Waters: Cape Cod: 2022 12/20/22
Summary of Public Water Supply Grades for 2019, 2020, 2021, and 2022

PUBLIC WATER SUPPLIES	**2019 Grades**		**2020 Grades**		**2021 Grades**		**2022**		
	No.	%	No.	%	No.	% of graded PWSs	No.	% of graded PWSs	Comments
Excellent	20	100%	20	100%	13	65%	16		10 had detectable PFAS6 but met the new PFAS6 MCL; 6 had no detectable PFAS6.
Good	NA		NA		6	30%	2		
Poor			0	0%	1	5%	2		
Total graded Public Water Supplies:	**20**		**20**		**20**	**100%**	**20**		

In the 2019 and 2020 reports, only two grade levels were possible: Excellent and Poor.
In the 2021 report, three grade levels were possible: Excellent, Good, and Poor. The change in grading reflects the wider range of results reported by public water suppliers in their 2020 Consumer Confidence Reports. The change in grading reflects the wider range of results reported by public water suppliers in their 2020 Consumer Confidence Reports.
In the 2022 report, the same three grading levels were used, but those PWSs that had detectable PFAS6 but met the new PFAS6 MCL were noted and marked with an asterisk on the map.

Table 7. 2022 Grades for Public Water Supplies. Grades were based on publicly available Consumer Confidence Reports and existing state and federal regulations for drinking water for 2020.

Public Water Supplies
Grades based on 2021 Consumer Confidence Reports and monitoring data

Public Water Supplier (PWS)	Final Grade	Reason for Grade
Barnstable COMM	**Excellent ***	All state and federal standards (MCLs) were met including the new PFAS6 MCL. * indicates PFAS6 was detected but levels met the MCL.
Barnstable Fire District	**Excellent ***	All state and federal standards (MCLs) were met including the new PFAS6 MCL. * indicates PFAS6 was detected but levels met the MCL.
Cotuit Water Department	**Excellent ***	All state and federal standards (MCLs) were met including the new PFAS6 MCL. * indicates PFAS6 was detected but levels met the MCL.
Hyannis Water System	**Excellent ***	All state and federal standards (MCLs) were met including the new PFAS6 MCL. * indicates PFAS6 was detected but levels met the MCL.
Bourne Water District	**Excellent ***	All state and federal standards (MCLs) were met including the new PFAS6 MCL. * indicates PFAS6 was detected but levels met the MCL.
Buzzards Bay Water District	**Good**	There were several violations of the Total Coliform MCL, but otherwise all state and federal standards (MCLs) were met including the new PFAS6 MCL.
North Sagamore Water District	**Excellent**	All state and federal standards (MCLs) were met including the new PFAS6 MCL.
Otis Air National Guard Base	**Poor ***	There were violations of two MCLs: Total Coliform and E. coli. The latter required four corrective actions including issuance of a boil-water order to protect consumers and public health. PFAS6 was detected in 2020 but met the MCL.
Town of Brewster Water Department	**Excellent**	All state and federal standards (MCLs) were met including the new PFAS6 MCL.
Town of Chatham DPW Water Division	**Excellent ***	All state and federal standards (MCLs) were met including the new PFAS6 MCL. * indicates PFAS6 was detected but levels met the MCL.
Town of Dennis Water District	**Excellent ***	All state and federal standards (MCLs) were met including the new PFAS6 MCL. * indicates PFAS6 was detected but levels met the MCL.
Town of Eastham Water Division	**Excellent**	All state and federal standards (MCLs) were met including the new PFAS6 MCL.
Town of Falmouth Water Department	**Excellent ***	All state and federal standards (MCLs) were met including the new PFAS6 MCL. * indicates PFAS6 was detected but levels met the MCL.
Town of Harwich Water Department	**Excellent**	All state and federal standards (MCLs) were met including the new PFAS6 MCL.
Mashpee Water District	**Excellent ***	All state and federal standards (MCLs) were met including the new PFAS6 MCL. * indicates PFAS6 was detected but levels met the MCL.
Town of Orleans Water Department	**Excellent**	All state and federal standards (MCLs) were met including the new PFAS6 MCL.
Town of Provincetown Water Department	**Excellent**	All state and federal standards (MCLs) were met including the new PFAS6 MCL.
Town of Sandwich Water District	**Excellent ***	All state and federal standards (MCLs) were met including the new PFAS6 MCL. * indicates PFAS6 was detected but levels met the MCL.
Town of Wellfleet Municipal Water System	**Good**	There were several violations of the Total Coliform MCL, but otherwise all state and federal standards (MCLs) were met including the new PFAS6 MCL.
Town of Yarmouth Water Department	**Poor**	There were violations of two MCLs: Enterococci and PFAS6.

Summary:

Excellent	16	Note: Of the 16 Excellent, 10 had detectable PFAS6 but met the PFAS6 MCL and 6 had no detectable PFAS6.
Good	2	
Poor	2	
Total:	**20**	

Table 8. 2022 Coastal Water Quality Scores and Grades for Town of Barnstable Stations. Data were provided by the town of Barnstable.

2022 SOTW Scores and Grades 9/29/22
Town of Barnstable

Station ID	Score	Status	Years of data	Years covered
BM1	77.4	Acceptable; Ongoing Protection is Required	5	2017-2021
BM2	81.8	Acceptable; Ongoing Protection is Required	5	2017-2021
BM3	88.3	Acceptable; Ongoing Protection is Required	5	2017-2021
BM10	64.9	Unacceptable; Immediate Restoration is Required	5	2017-2021
BM11	56.4	Unacceptable; Immediate Restoration is Required	5	2017-2021
BM12	69.3	Acceptable; Ongoing Protection is Required	5	2017-2021
BM13	48.6	Unacceptable; Immediate Restoration is Required	5	2017-2021
BC10	44.5	Unacceptable; Immediate Restoration is Required	5	2017-2021
BH1	41.1	Unacceptable; Immediate Restoration is Required	5	2017-2021
BH2	50.3	Unacceptable; Immediate Restoration is Required	5	2017-2021
BH3	49.8	Unacceptable; Immediate Restoration is Required	5	2017-2021
BH4	24.8	Unacceptable; Immediate Restoration is Required	5	2017-2021
BH7	50.4	Unacceptable; Immediate Restoration is Required	5	2017-2021
MC1	47.4	Unacceptable; Immediate Restoration is Required	5	2017-2021
MC2	47.1	Unacceptable; Immediate Restoration is Required	5	2017-2021
BC14	63.7	Unacceptable; Immediate Restoration is Required	5	2017-2021
BC15	62.2	Unacceptable; Immediate Restoration is Required	5	2017-2021
BY1	INSF	Insufficient years of data to score	4	2017, 2018, 2019, 2021
BY2	INSF	Insufficient years of data to score	4	2017, 2018, 2019, 2021
BY3	INSF	Insufficient years of data to score	4	2017, 2018, 2019, 2021
BM14	INSF	Insufficient years of data to score	4	2018, 2019, 2020, 2021
BC3	INSF	Insufficient years of data to score	4	2017, 2018, 2019, 2021
BC4	INSF	Insufficient years of data to score	4	2017, 2018, 2019, 2021
BC8	INSF	Insufficient years of data to score	4	2017, 2018, 2019, 2021
BC9	INSF	Insufficient years of data to score	4	2017, 2018, 2019, 2021
BCSS	INSF	Insufficient years of data to score	4	2017, 2018, 2019, 2021
BC1	INSF	Insufficient years of data to score	1	2021
BC11	INSF	Insufficient years of data to score	1	2021
BC12	INSF	Insufficient years of data to score	1	2021
BC13	INSF	Insufficient years of data to score	1	2021
BC2	INSF	Insufficient years of data to score	1	2021
BC5	INSF	Insufficient years of data to score	1	2021
BC6	INSF	Insufficient years of data to score	1	2021
BC7	INSF	Insufficient years of data to score	1	2021
BH5	INSF	Insufficient years of data to score	1	2021
BH6	INSF	Insufficient years of data to score	1	2021
BM15	INSF	Insufficient years of data to score	1	2021
BY4	INSF	Insufficient years of data to score	1	2021

Total number of stations scored: 17

Table 9. 2022 Water Quality Scores and Grades for Buzzards Bay (Falmouth and Bourne). Eutrophic Index scores for 2021 were downloaded from the Buzzards Bay Coalition's Bay Health website at https://www.savebuzzardsbay.org/bay-health/.

Buzzards Bay (Falmouth and Bourne only)
Buzzards Bay Coalition: Bay Health Index scores for Falmouth and Bourne (Cape Cod side)
Scores were compiled by APCC from reports posted on the BBC webpage: https://www.savebuzzardsbay.org/bay-health/
Status (grades) were assigned by APCC (>65 is Acceptable; <= 65 is Unacceptable)

Water body	BHI Score, 5-yr running average including 2021	APCC status
Back River	57	Unacceptable; requires immediate restoration
Buttermilk Bay	69	Acceptable; requires ongoing protection
Eel Pond, Bourne	40	Unacceptable; requires immediate restoration
Fiddlers Cove	61	Unacceptable; requires immediate restoration
Gunning Point Pond	30	Unacceptable; requires immediate restoration
Hen Cove (Red Brook Harbor)	57	Unacceptable; requires immediate restoration
Herring Brook	48	Unacceptable; requires immediate restoration
Little Buttermilk Bay	61	Unacceptable; requires immediate restoration
Little Sippewissett Marsh	63	Unacceptable; requires immediate restoration
Mashapaquit Creek	Not scored	
Megansett Harbor	83	Acceptable; requires ongoing protection
Phinneys Harbor	69	Acceptable; requires ongoing protection
Pocasset Harbor Inner	50	Unacceptable; requires immediate restoration
Pocasset Harbor Outer	76	Acceptable; requires ongoing protection
Pocasset River	51	Unacceptable; requires immediate restoration
Potters Hole Pond	Not scored	
Quissett Harbor Inner	89	Acceptable; requires ongoing protection
Quissett Harbor Outer	91	Acceptable; requires ongoing protection
Rands Harbor	39	Unacceptable; requires immediate restoration
Red Brook Harbor Inner	63	Unacceptable; requires immediate restoration
Red Brook Harbor Outer	76	Acceptable; requires ongoing protection
Squeteague Harbor	58	Unacceptable; requires immediate restoration
WFH Head	65	Unacceptable; requires immediate restoration
WFH Outer	74	Acceptable; requires ongoing protection
WFH Town Dock	66	Acceptable; requires ongoing protection
WFH Mid-Harbor	65	Unacceptable; requires immediate restoration
WFH Oyster Pond	32	Unacceptable; requires immediate restoration
WFH Snug Harbor	25	Unacceptable; requires immediate restoration
Wild Harbor Inner	57	Unacceptable; requires immediate restoration
Wild Harbor Outer	83	Acceptable; requires ongoing protection
Wild Harbor River	63	Unacceptable; requires immediate restoration
Total number:	29	

Table 10. 2022 Coastal Water Quality Scores and Grades for Three Bays, Barnstable. Data were provided by the Barnstable Clean Water Coalition.

Three Bays, Barnstable
Data provided by Barnstable Clean Water Coalition

2022 Scores and Grades

Name	Site Number	Score	APCC Status	No. Years	Years
Mill Pond	Site 1	30.8	Unacceptable; Immediate Restoration is Required	5	2017-2021
South Prince's Cove	Site 2	39.6	Unacceptable; Immediate Restoration is Required	5	2017-2021
North Prince's Cove	Site 3	38.3	Unacceptable; Immediate Restoration is Required	5	2017-2021
Warren's Cove	Site 4	34.9	Unacceptable; Immediate Restoration is Required	5	2017-2021
North N. Bay	Site 5	36.9	Unacceptable; Immediate Restoration is Required	5	2017-2021
South N. Bay	Site 6	51.3	Unacceptable; Immediate Restoration is Required	5	2017-2021
	Site 7	INSF			
	Site 8	INSF			
South West Bay	Site 9	70.2	Acceptable; Ongoing Protection is Required	5	2017-2021
	Site 10	58.6	Unacceptable; Immediate Restoration is Required	5	2017-2021
	Site 12	INSF			
South Cotuit Bay	Site 13	52.2	Unacceptable; Immediate Restoration is Required	5	2017-2021
	Site 14	INSF			
	Site 16	INSF			
Cotuit Sentinel	Site 18	49.6	Unacceptable; Immediate Restoration is Required	5	2017-2021
Old Mill	Site E	36.1	Unacceptable; Immediate Restoration is Required	5	2017-2021
	Site RM1	INSF			
	Site RM2	INSF			
	Site RM3	37.9	Unacceptable; Immediate Restoration is Required	5	2017-2021
	Site RM4	39.4	Unacceptable; Immediate Restoration is Required	5	2017-2021

Number of stations with scores and grades: 13

INSF - insufficient data to score

Table 11. 2022 Coastal Water Quality Scores and Grades for Cape Cod Stations. Data were provided by the Center for Coastal Studies.

2022 SOTW Scores and Grades
Data provided by the Center for Coastal Studies

Not graded, for various reasons

Internal ID (CCS)	Stn #	Stn name	Location	Used or not	Score (5-yr average, 2017-2021)	2022 APCC Status	No. Years
1	1	5N	At edge of Provincetown Harbor	Use	99.1	Acceptable; Ongoing Protection is Required	5
11	10	Blackfish Creek	Wellfleet Harbor	Use	70.8	Acceptable; Ongoing Protection is Required	5
13	11	Boat Meadow	Boat Meadow River	Use	53.8	Unacceptable; Immediate Restoration is Required	5
15	15	Canal	Canal	Use	82.0	Acceptable; Ongoing Protection is Required	5
21	21	First Encounter	First Encounter	Use	45.8	Unacceptable; Immediate Restoration is Required	5
22	22	Great Island Channel	Wellfleet Harbor	Use	70.3	Acceptable; Ongoing Protection is Required	5
23	23	Holiday Inn	Provincetown Harbor	Use	59.0	Unacceptable; Immediate Restoration is Required	5
25	25	Inner Pamet Harbor	Pamet Harbor	Use	74.7	Acceptable; Ongoing Protection is Required	5
27	26	Inner Rock Harbor	Rock Harbor	Use	30.6	Unacceptable; Immediate Restoration is Required	5
28	27	Inner Sesuit Harbor	Sesuit Harbor	Use	79.8	Acceptable; Ongoing Protection is Required	5
29	28	Inner Wellfleet Harbor	Wellfleet Harbor	Use	52.1	Unacceptable; Immediate Restoration is Required	5
31	30	MacMillan	Provincetown Harbor	Use	91.9	Acceptable; Ongoing Protection is Required	5
41	39	Rock Harbor	Rock Harbor	Use	56.6	Unacceptable; Immediate Restoration is Required	5
44	42	Sunken Meadow	Wellfleet Harbor	Use	84.3	Acceptable; Ongoing Protection is Required	5
45	43	Wellfleet Harbor	Wellfleet Harbor	Use	59.2	Unacceptable; Immediate Restoration is Required	5
59	101	Boardwalk	Sandwich Harbor	Use (salt marsh)	87.9	Acceptable; Ongoing Protection is Required	5
60	102	Boat Meadow (Inner)	Boat Meadow River	Use	27.1	Unacceptable	5
63	105	Herring River	Wellfleet Harbor	Use	23.1	Unacceptable; Immediate Restoration is Required	5
65	107	Little Namskaket	Little Namskaket Creek	Use	61.1	Unacceptable; Immediate Restoration is Required	5
66	108	Namskaket	Namskaket Creek	Use	78.1	Acceptable; Ongoing Protection is Required	5
68	110	Paines	Paines Creek	Use	79.5	Acceptable; Ongoing Protection is Required	5
72	114	Scorton Creek	Scorton Creek	Use	84.4	Acceptable; Ongoing Protection is Required	5
73	115	Upper Namskaket	Namskaket Creek	Use	38.9	Unacceptable; Immediate Restoration is Required	5
75	117	Pamet River	Pamet River	Use	57.0	Unacceptable; Immediate Restoration is Required	5
77	119	Pilgrim Lake East	Provincetown Harbor	Use	76.7	Acceptable; Ongoing Protection is Required	5
80	123	Old Harbor Dewey	Sandwich Harbor	Not scored - salt marsh and too far inland			
81	124	Scorton Creek 6A	Scorton Harbor	Not scored - salt marsh and too far inland			
82	125	Scorton Creek Jones Lane	Scorton Harbor	Not scored - salt marsh and too far inland			
83	127	Duck Creek	Wellfleet Harbor	Not enough data; only 2017, 2018, 2019, and 2021 -no 2020			
84	128	Quivet Marsh	Quivett Creek	Use	34.7	Unacceptable; Immediate Restoration is Required	5
85	129	Cole Road Brook	Herring River, Eastham?	Use	64.9	Unacceptable; Immediate Restoration is Required	5
86	130	Sesuit Creek	Sesuit Harbor	Use	29.6	Unacceptable; Immediate Restoration is Required	5
87	131	Millway beach	Barnstable Harbor	Use	74.1	Acceptable; Ongoing Protection is Required	5
	134	Old Harbor PD	Sandwich Harbor	Not scored - salt marsh and too far inland			
		Upper Pamet River	Upper Pamet River (Post Office)	Not scored - too far upstream and fresh			
93	137	Little Namskaket Creek	Little Namskaket Creek	Use	19.3	Unacceptable; Immediate Restoration is Required	5
94	138	WH-5	Wellfleet Harbor	Use	65.7	Acceptable; Ongoing Protection is Required	5
144	141	Aunt Julias Landing	Bass River, downstream of Rte 6	Not scored - not enough data (only 2 yrs, 2020, 2021)			
	142	BRYC	Bass River, Yacht Club, downstream of 28	Not scored - not enough data (only 2021)			
	143	FOBR-1	Bass River, north of Rte 6	Not scored, too far upstream and may be fresh-brackish			
	144	Follins Pond	Bass River, north of Rte 6	Not scored - too far upstream			
	145	Kelleys Bay	Bass River, north of Rte 6	Not scored, too far upstream and may be fresh-brackish			
	149	Grand Cove	On Bass River between 28 and 6	Not scored - too far upstream			
97	202	Channel	Wellfleet Harbor	Use	39.0	Unacceptable; Immediate Restoration is Required	5
98	205	Transect 2	Wellfleet Harbor	Use	43.3	Unacceptable; Immediate Restoration is Required	5
99	212	DB-pipe	Wellfleet Harbor	Use	17.8	Unacceptable; Immediate Restoration is Required	5
101	302	Dyer Prince	Rock Harbor	Use if used last year (salt marsh)	37.6	Unacceptable; Immediate Restoration is Required	5
	303	RH-culvert	Rock Harbor, just W of Rte 6 and Cedar Pond	Not scored - too far upstream and may be fresh			
103	304	RH-bend	Rock Harbor	Use	35.3	Unacceptable; Immediate Restoration is Required	5
	306	RH-pipe	Rock Harbor	Not scored - too far upstream.			
105	500	B3	Bournes Pond	Use	44.9	Unacceptable; Immediate Restoration is Required	5
106	501	BC-14	Hall's Creek, Centerville River	Use	48.4	Unacceptable; Immediate Restoration is Required	5
107	502	BCT-1	Centerville-E, Centerville River	Use	30.5	Unacceptable; Immediate Restoration is Required	5
108	503	BCT-2	Centerville-W, Centerville River	Use	37.3	Unacceptable; Immediate Restoration is Required	5
109	504	BHY-3	Lewis Bay	Use	66.0	Acceptable; Ongoing Protection is Required	5
110	505	BR-7	Bass River	Use	54.1	Unacceptable; Immediate Restoration is Required	5
111	506	CM-10	Taylors Pond/Mill Creek, Chatham	Use	53.8	Unacceptable; Immediate Restoration is Required	5
112	507	CM-1A	Oyster Pond, Chatham-Stage Harbor	Use	75.2	Acceptable; Ongoing Protection is Required	5
113	508	CM-5A	Mitchel River, Chatham-Stage Harbor	Use	70.8	Acceptable; Ongoing Protection is Required	5
114	509	CM-8	Sulfur Spring, Chatham/Taylors Pond/Mill Creek, Chatham	Use	57.8	Unacceptable; Immediate Restoration is Required	5
115	510	Cotuit Bay	Three Bays	Use	70.3	Acceptable; Ongoing Protection is Required	5
118	518	FHx	Falmouth Inner Harbor	Use	43.0	Unacceptable; Immediate Restoration is Required	5
119	520	G4	Green Pond, Falmouth	Use	42.3	Unacceptable; Immediate Restoration is Required	5
120	521	GT-5	Great Pond, Falmouth	Use	44.0	Unacceptable; Immediate Restoration is Required	5
121	522	HAR-2	Saquatucket Harbor	Use	46.2	Unacceptable; Immediate Restoration is Required	5
122	523	HAR-3	Wychmere Harbor	Use	48.5	Unacceptable; Immediate Restoration is Required	5
123	524	HAR-4	Allen Harbor	Use	42.7	Unacceptable; Immediate Restoration is Required	5
	525	HAR-7	Herring River, Harwich	Not scored - insufficient data (2017, 2018, 2019, 2021) and too far upstream			
127	532	Narrows	Narrows in Three Bays	Use	55.9	Unacceptable; Immediate Restoration is Required	5
128	533	North Bay	Three Bays	Use	48.0	Unacceptable; Immediate Restoration is Required	5
129	534	OP-3	Oyster Pond, Falmouth	Use	63.4	Unacceptable; Immediate Restoration is Required	5
130	535	PBh	Popponessett Bay	Use	59.1	Unacceptable; Immediate Restoration is Required	5
131	536	PR-2	Parkers River	Use	45.2	Unacceptable; Immediate Restoration is Required	5
133	538	RM-2	Rushy Marsh-not an embayment	Use	39.0	Unacceptable; Immediate Restoration is Required	5
134	542	Stewarts Creek	Hyannis Harbor/Lewis Bay	Use	33.6	Unacceptable; Immediate Restoration is Required	5
135	543	SWP-2	Swan Pond River	Use	47.8	Unacceptable; Immediate Restoration is Required	5
136	551	Warrens Cove	Three Bays	Use	38.6	Unacceptable; Immediate Restoration is Required	5
138	553	West Bay	Three Bays	Use	77.1	Acceptable; Ongoing Protection is Required	5
143	568	LP-2	Little Pond, Falmouth	Use	35.5	Unacceptable; Immediate Restoration is Required	5

Table 12. 2022 Coastal Water Quality Scores and Grades for the Town of Chatham. Eutrophic Index scores were provided by the town of Chatham.

Town of Chatham eutrophic index scores

Score	APCC Status
>65 to 100	Acceptable; Ongoing Protection is Required
65 or below	Unacceptable; Immediate Restoration is Required

Station	Name	2013	2014	2015	2016	2017	2018	2019	2020	2021	5-yr moving average 2017-2021	APCC Status 2022 SOTW
CM-1	Oyster Pond	58.3	60.3	48.8	47.0	63.2	57.07506	49.71217	53.06278	53.1	**55.2**	**Unacceptable; Immediate Restoration is Required**
CM-1A	Oyster Pond-Outer	57.8	82.5	88.3	72.0	75.5	82.42328	67.26109	56.66007	66.3	**69.6**	**Acceptable; Ongoing Protection is Required**
CM-3	Outer Stage Harbor	62.8	72.4	80.7	78.4	72.2	79.33436	79.56609	76.81368	79.1	**77.4**	**Acceptable; Ongoing Protection is Required**
CM-4	Inner Stage Harbor	66.9	78.2	62.4	74.3	73.0	79.74545	74.27565	83.10271	93	**80.6**	**Acceptable; Ongoing Protection is Required**
CM-5	Mill Pond - Inner	67.3	75.6	68.1	62.1	71.3	57.43058	58.9441	67.80395	70.7	**65.2**	**Acceptable; Ongoing Protection is Required**
CM-5A	Mill Pond - Outer	64.6	72.9	75.4	56.6	72.9	66.98716	66.42496	70.94906	78.2	**71.1**	**Acceptable; Ongoing Protection is Required**
CM-7	Nantucket Sound	84.9	87.6	84.3	84.1	89.2	99.05357	96.96243	98.87876	97.5	**96.3**	**Acceptable; Ongoing Protection is Required**
CM-8	Upper Bucks Creek	34.4	31.4	34	35.9	29.1	45.27693	34.34314	42.67508	25.9	**35.5**	**Unacceptable; Immediate Restoration is Required**
CM-10	Taylors Pond	23.5	36	30.4	49.0	49.0	36.61291	29.76065	46.4974	46	**41.6**	**Unacceptable; Immediate Restoration is Required**
CM-12	Lower Cockle Cove (	20	20.8	23.2	21.9	23.0	25.75912	25.41312	21.27039	35.5	**26.2**	**Unacceptable; Immediate Restoration is Required**
CM-13	Outer Ryder's Cove	38.9	59.1	72.5	63.5	76.7	73.14289	84.5918	79.69629	78.2	**78.5**	**Acceptable; Ongoing Protection is Required**
PBA-1	Chatham Harbor	84.7	66.3	76.8	87.2	80.5	90.89925	80.07376	86.52474	70.3	**81.7**	**Acceptable; Ongoing Protection is Required**
PBA-3	Inner Ryder's Cove	49.6	64.4	54.3	45.6	63.1	46.92544	32.57202	42.39104	52.3	**47.5**	**Unacceptable; Immediate Restoration is Required**
PBA-4	Crows Pond	64.4	71.2	60.7	61.5	85.4	89.93319	76.5363	81.66402	79.1	**82.5**	**Acceptable; Ongoing Protection is Required**
PBA-5	Muddy Creek	28.4	53	40.4	31.8	64.1	54.02112	65.76486	63.42619	58.1	**61.1**	**Unacceptable; Immediate Restoration is Required**
PBA-5A	Muddy Creek - Uppe	6.8	9	28.6	10.0	46.8	15.72246	12.31192	8.254175	33.7	**23.4**	**Unacceptable; Immediate Restoration is Required**

Green = station is also in Pleasant Bay Alliance data

Table 13. 2022 Coastal Water Quality Scores and Grades for the Town of Harwich. Data were provided by the town of Harwich.

Town of Harwich

Site Name	Site #	Score	APCC Status	No. Years	Years	Notes
SAQUATUCKET HARBOR	HAR2	30.3	**Unacceptable; Immediate Restoration is Required**	5	2016-2019, 2021	No 2020 data due to COVID
WYCHMERE OUTER HARBOR	HAR2A	47.7	**Unacceptable; Immediate Restoration is Required**	5	2016-2019, 2021	No 2020 data due to COVID
WYCHMERE HARBOR	HAR3	38.0	**Unacceptable; Immediate Restoration is Required**	5	2016-2019, 2021	No 2020 data due to COVID
ALLENS HARBOR MARINA	HAR4	35.8	**Unacceptable; Immediate Restoration is Required**	5	2016-2019, 2021	No 2020 data due to COVID
ALLEN HULSE PT	HAR4A	36.6	**Unacceptable; Immediate Restoration is Required**	5	2016-2019, 2021	No 2020 data due to COVID
ALLENS HARBOR CREEK	HAR5	41.5	**Unacceptable; Immediate Restoration is Required**	5	2016-2019, 2021	Scored as salt marsh. No 2020 data due to COVID
HERRING RIVER 6	HAR6	49.3	**Unacceptable; Immediate Restoration is Required**	5	2016-2019, 2021	No 2020 dataOmitted last year - include this year
HERRING RIVER 7 - 28 BRIDGE	HAR7	51.2	**Unacceptable; Immediate Restoration is Required**	5	2016-2019, 2021	Scored as salt marsh. No 2020 data due to COVID
HERRING RIVER 9 - NORTH RD	HAR9	31.3	**Unacceptable; Immediate Restoration is Required**	5	2016-2019, 2021	Scored as salt marsh. No 2020 data due to COVID

Table 14. 2022 Coastal Water Quality Scores and Grades for Towns of Eastham and Orleans. Data were provided by the towns of Eastham and Orleans.

Towns: Orleans and Eastham

Station ID	Score	2022 APCC Status	No. Years	Years	Comments
WMO15	36.9	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	From Orleans data set
WMO19	36.7	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	From Orleans data set
WMO22	40.3	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	From Orleans data set
WMO25	41.7	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	From Orleans data set
WMO26	61.4	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	From Orleans data set
WMO27	57.6	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	From Orleans data set
WMO28	58.4	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	From Eastham data set
WMO29	65.6	**Acceptable; Ongoing Protection is Required**	5	2017-2021	From Eastham data set
WMO30	82.0	**Acceptable; Ongoing Protection is Required**	5	2017-2021	From Orleans data set
WMO31	66.9	**Acceptable; Ongoing Protection is Required**	5	2017-2021	From Orleans data set
WMO32	87.8	**Acceptable; Ongoing Protection is Required**	5	2017-2021	From Orleans data set
WMO33	61.6	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	From Orleans data set
WMO34	34.6	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	From Orleans data set
WMO35	56.5	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	From Orleans data set
WMO36	67.7	**Acceptable; Ongoing Protection is Required**	5	2017-2021	From Eastham data set
WMO37	66.5	**Acceptable; Ongoing Protection is Required**	5	2017-2021	From Eastham data set
WMO38	40.1	**Unacceptable; Immediate Restoration is Required**	5	2017-2021	
WMO39	ND				No data for 2021

Table 15. 2022 Coastal Water Quality Scores and Grades for Pleasant Bay. Eutrophic Index scores were provided by the Pleasant Bay Alliance.

Pleasant Bay
Eutrophic Index scores received from Pleasant Bay Alliance member (Town of Chatham, Natural Resources Director)

Station	Name	2013	2014	2015	2016	2017	2018	2019	2020	2021	5-yr moving average 2017-2021	APCC Status 2022 SOTW
PBA-3	Inner Ryder's Cove	49.8	64.4	54.2	45.6	63.1	46.9	32.6	42.4	52.3	**47.5**	**Unacceptable; Immediate Restoration is Required**
PBA-4	Crows Pond	64.6	71.2	60.6	61.5	85.4	89.9	76.5	81.7	79.1	**82.5**	**Acceptable; Ongoing Protection is Required**
PBA-5	Muddy Creek	28.4	52.9	40.3	31.8	64.1	54.0	65.8	63.4	58.1	**61.1**	**Unacceptable; Immediate Restoration is Required**
PBA-5A	Muddy Creek - Upper	6.8	9.1	28.6	10	77.9	15.7	12.3	8.3	33.7	**29.6**	**Unacceptable; Immediate Restoration is Required**
PBA-6	Big Bay - SW	71.6	77.3	81.6	65.6	88.1	87.6	94.6	86.9	87.6	**88.9**	**Acceptable; Ongoing Protection is Required**
PBA-8	Big Bay - NE	53.2	78.9	66.3	73.9	86.1	79.4	84.6	78.5	67.5	**79.2**	**Acceptable; Ongoing Protection is Required**
PBA-9	Round Cove	46.1	40.9	42.9	41	57.2	34.5	56.1	29.6	44.6	**44.4**	**Unacceptable; Immediate Restoration is Required**
PBA-10	Quanset Pond	44.7	52.3	58.6	44.5	66.6	53.7	50.9	67.7	70.7	**61.9**	**Unacceptable; Immediate Restoration is Required**
PBA-11	Paw Wah Pond	25.2	37.3	43.3	40	54.5	30.8	28.6	56.2	60.1	**46.1**	**Unacceptable; Immediate Restoration is Required**
PBA-12	Namequoit Point - South	67.3	63.8	71	65.6	70.5	58.4	63.6	66.9	70.3	**65.9**	**Acceptable; Ongoing Protection is Required**
PBA-13	Namequoit Point - North	51.5	61.1	67.1	64.1	71.4	64.8	54.5	57.2	61.7	**61.9**	**Unacceptable; Immediate Restoration is Required**
PBA-14	Areys Pond	31.9	34.9	25	19.9	43.6	18.0	10.8	7.3	12.9	**18.5**	**Unacceptable; Immediate Restoration is Required**
PBA-15	Kescayo Gansett Pond	51.2	44.8	48.6	27.2	49.5	21.7	15.1	23.1	21.8	**26.2**	**Unacceptable; Immediate Restoration is Required**
PBA-16	Pochet-mouth	30.7	41.3	27.1	11.7	34.0	12.9	14.5	13.8	15.4	**18.1**	**Unacceptable; Immediate Restoration is Required**
PBA-19	Strong Island - NE	95	59.2	70.1	75.1	81.2	84.0	84.0	84.0	80.9	**82.8**	**Acceptable; Ongoing Protection is Required**
PBA-20	Nickerson's Neck	79.6	60.5	84.2	77.9	91.8	85.6	85.6	85.6	75.2	**84.8**	**Acceptable; Ongoing Protection is Required**
PBA-21	Little Pleasant Bay	69.3	74.6	69.7	72.3	79.2	80.1	80.1	80.1	76.0	**79.1**	**Acceptable; Ongoing Protection is Required**
WMO-3	Pochet-mouth	57.4	51.3	56.7	54.3	61.5	54.9	54.9	54.9	50.2	**55.3**	**Unacceptable; Immediate Restoration is Required**
WMO-5	Pochet-Upper	26.9	27.6	24.6	23.2	26.7	12.8	7.3	16.8	33.2	**19.4**	**Unacceptable; Immediate Restoration is Required**
WMO-6	Namequoit River-Upper	40.6	42.5	53.9	23.3	50.3	22.8	27.9	15.8	28.4	**29.0**	**Unacceptable; Immediate Restoration is Required**
WMO-8	Lower River	54.9	45.3	48.5	43.7	60.4	43.8	17.1	44.6	44.9	**42.1**	**Unacceptable; Immediate Restoration is Required**
WMO-10	Meetinghouse-Rattles dock	44.7	53.4	55.3	30.6	55.8	47.3	32.2	30.9	36.6	**40.6**	**Unacceptable; Immediate Restoration is Required**
WMO-12	Little Quanset Pond	35.1	37.8	47.1	35.3	48.1	53.1	50.9	42.7	37.7	**46.5**	**Unacceptable; Immediate Restoration is Required**
CM-13	Outer Ryder's Cove	38.9	59.1	72.4	63.5	76.7	73.2	84.6	79.7	78.2	**78.5**	**Acceptable; Ongoing Protection is Required**

Table 16. 2022 Coastal Water Quality Scores and Grades for Waquoit Bay. Data were provided by the Waquoit Bay National Estuarine Research Reserve (WBNERR). Data for 2021 were not available so data used in last year's report were reviewed and reused.

Waquoit Bay, 2016-2020

Site Name	Site #	Score	APCC Status	No. Years	Years
Seapit River	Site 1	44.25	**Unacceptable; Immediate Restoration is Required**	5	2016-2020
North Basin-WB*	Site 2	53.07	**Unacceptable; Immediate Restoration is Required**	5	2016-2020
Hamblin Pond	Site 3	49.58	**Unacceptable; Immediate Restoration is Required**	5	2016-2020
Jehu Pond	Site 4	44.18	**Unacceptable; Immediate Restoration is Required**	5	2016-2020
Quashnet River	Site 5	35.35	**Unacceptable; Immediate Restoration is Required**	5	2016-2020
Menauhant	Site 6	72.43	**Acceptable; Ongoing Protection is Required**	5	2016-2020
Childs River	Site 7	21.75	**Unacceptable; Immediate Restoration is Required**	5	2016-2020
Eel River	Site 8	47.83	**Unacceptable; Immediate Restoration is Required**	5	2016-2020
South Basin-WB*	Site 9	75.04	**Acceptable; Ongoing Protection is Required**	5	2016-2020
	Site 10	59.70	**Unacceptable; Immediate Restoration is Required**	5	2016-2020