CAPE COD
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# Regional Collection and Analysis of Cape Cod Water Resources Data to Inform Local Decision-Making

**FINAL REPORT - SNEP WATERSHED GRANT PROGRAM**

**GRANT #SNEPWG18-9-CCC**

CAPE COD COMMISSION
AUGUST 25, 2021

## CONTENTS




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Project Overview

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| Partner Organizations: | Association to Preserve Cape Cod<br>Center for Coastal Studies<br>Waquoit Bay National Estuarine Research Reserve<br>Woods Hole Oceanographic Institution |

# Project Report Narrative

## PROJECT RESULTS

### Project Goals

To identify and aggregate different sources of coastal water quality data into a single dataset, provide public access to quality-controlled data collected throughout the region, and utilize feedback from anticipated users of the data to tailor analysis capabilities and user interface functionality to the needs of the majority of end-users. Ultimately the project was designed to increase the accessibility and comparability of water quality data collected throughout the Cape Cod region, and to facilitate use of best available data by local decisionmakers.

### Background: Coastal Water Quality on Cape Cod

Cape Cod is a region surrounded by, and dependent on water. Its 53 coastal embayments, nearly 1,000 ponds, and sole source aquifer are all ecologically rich and extremely fragile. Human activity and land use – primarily nutrient pollution from septic systems – have significantly degraded estuarine and freshwater quality. Septic systems have historically been relied on for wastewater disposal because they can effectively infiltrate wastewater and remove pathogens in the sandy soils present nearly everywhere on Cape Cod. This approach has largely been protective of drinking water sources, but has significantly impacted coastal water quality because traditional septic systems do not effectively remove nitrogen under these conditions. Development on Cape Cod is generally low-density, due in part to the reliance on septic systems, which makes it difficult to manage wastewater treatment via centralized sewering in a cost-effective manner.

To address many of the wastewater management challenges towns throughout the region face, the Cape Cod Commission updated the Area Wide Water Quality Management Plan for Cape Cod (208 Plan) in 2015. The 208 Plan provides a framework of traditional and non-traditional strategies for estuarine and freshwater quality improvement, giving towns a variety of options in addition to centralized collection and treatment of wastewater for implementing nutrient reduction strategies. In areas without sufficient development density to support traditional sewering, new and alternative methods may be able to provide the required nutrient reductions at a lower cost. Performance of these alternative strategies is less certain, and implementation relies heavily on a data-based system of adaptive management.

### Cape Cod Water Quality Monitoring

Cape Cod has benefited from years of coastal water quality monitoring by a number of organizations, including University of Massachusetts Dartmouth's School for Marine Science and Technology (SMAST) and the towns of Barnstable County through the Massachusetts Estuaries Program (MEP), the Buzzards

Bay Coalition (BBC), Center for Coastal Studies (CCS), and Waquoit Bay National Estuarine Research Reserve (WBNERR). These organizations each maintain their own sampling programs and systems of water quality data storage, as documented in each program's respective Quality Assurance Project Plan (QAPP). In combination, this collection of programs has at some point monitored every coastal embayment on Cape Cod, as well as surrounding open water stations throughout Cape Cod Bay, Buzzards Bay, Nantucket / Vineyard Sound, and the Atlantic Ocean (Figure 1).

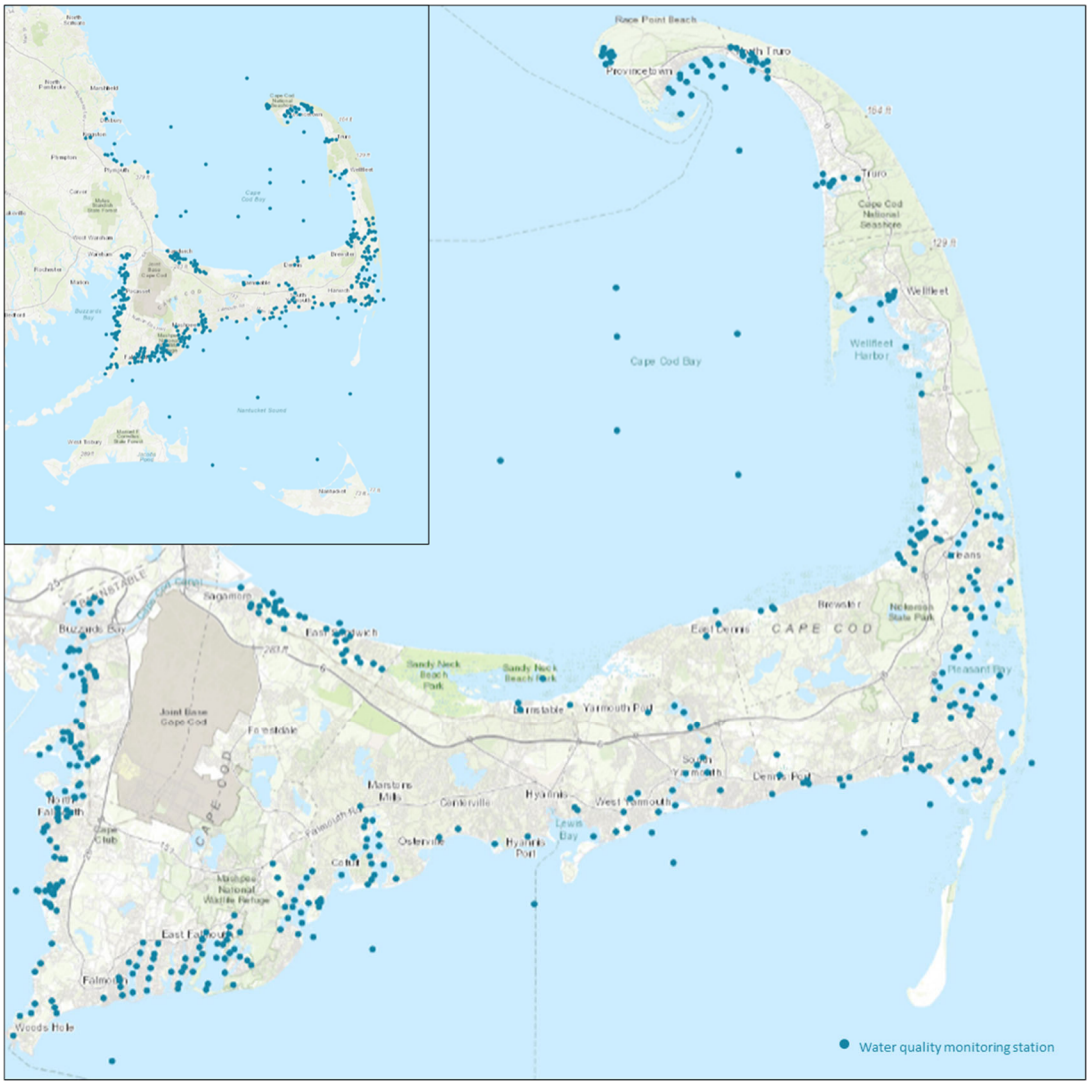


Figure 1: Locations of Cape Cod region water quality monitoring stations. Inset map is zoomed out to show additional monitoring stations in Cape Cod Bay and Nantucket Sound.

The emphasis on adaptive management incorporated into the 208 Plan's framework for innovative and alternative nitrogen reduction technologies relies upon ready access to monitoring data both to document technology performance, and to document water quality changes in the coastal embayments. Historically, data collected by these programs has been stored in a variety of separate and disconnected locations and formats. By bringing together data from all these organizations and monitoring programs, the Cape Cod Regional Water Quality Database (RWQDB) enables easier and more straightforward

access to all available monitoring data for use in municipal planning, and data analysis at the local, watershed, and regional scales.

## Building the Database - Data Integration

The project team worked with project partners, external collaborators, and towns on Cape Cod to identify sources of existing water quality data for Cape Cod's coastal embayments and the surrounding waters. The initial historical data set that resulted from these efforts is described below in Table 1.

| Monitoring Program | Sampling Events Imported | Sampling Stations | Embayments Sampled | Data Start | Data End |
|---|---|---|---|---|---|
| Buzzards Bay Coalition | 23,980 | 100 | 19 | 1992 | 2018 |
| Center for Coastal Studies | 11,996 | 100 | 39 | 2006 | 2019 |
| Massachusetts Estuaries Project | 11,332 | 369 | 42 | 2003 | 2018 |
| WBNERR Baywatchers | 5,303 | 10 | 1 | 1993 | 2017 |
| WBNERR SWMP | 2,567 | 4 | 1 | 2007 | 2017 |
| Overall | 53,424 | 529 | 64 | 1992 | 2018 |

Table 1: Historical data compiled by project team and collaborators and added to Regional Water Quality Database during initial import.

The dataset was then surveyed to determine formatting, sampling locations, water quality parameters, additional metadata fields, and quality control records used by each monitoring program. The project team evaluated a variety of options for structuring the RWQDB to streamline importing of data without requiring the monitoring programs to change their data format, accommodate all of the water quality parameters already being measured, provide functionality for storage and retrieval of metadata (e.g. analytical methods, data quality, additional sampling observations), offer expansion potential to include additional water quality data (e.g. data from freshwater ponds, bacterial or biological sampling, etc.) as part of future efforts, and connect to an interactive web-based user interface.

The project team looked at the potential to update the Cape Cod Commission's previously existing Microsoft SQL database and at several commercial database solutions, weighing the specific capabilities and strengths of each solution against the needs of the project. Ultimately the project team chose to utilize Water Information Systems by KISTERS (WISKI), based on its ability to satisfy the criteria listed in the previous paragraph. The data structure within WISKI and the KISTERS Water Quality Module (KiWQM) in particular, was designed for filtering and viewing data by time-period, sampling location, monitoring program, data quality, and measurement parameter; at individual sampling locations, and for all stations within a coastal embayment. Both of those spatial scales are of particular interest for examining and analyzing coastal water quality on Cape Cod.

To facilitate data import, a comma separated value (CSV) import procedure was developed within WISKI for each unique data format, which creates a map from each column in the raw data sheets to the appropriate location in the database. The CSV import process allowed information about sampling events (e.g. date/time, sample station, sample depth, etc.), field measurements, individual sample results, sample result quality flags, and additional program-specific observations to be imported in an automated fashion.

Project partners and collaborators provided historical data for the initial import process that encompassed five monitoring programs, 529 sampling locations, and over 55,000 unique sampling events. Data collection extended as far back as 1992 and the initial dataset included samples collected through early 2019. The location of sampling stations and total geographic extent of the RWQDB are shown in Figure 1. During the initial data import, primary and extended data validation were performed and any flagged sample values were checked with the appropriate monitoring program. Ultimately over 53,000 or 96% of the total sampling events contained in the initial body of data were imported successfully.

As data sharing continues and expands, the same procedures will ensure a uniform level of quality and comparability for future imports, including any database expansions to include additional monitoring programs, measurement parameters, or data types. There is, however, still a need for continued effort to improve data sharing. Despite the substantial amount of historic data that was imported during this project, data gaps still exist where field data have been collected but have not been shared or made available. While the integration of data from several monitoring programs in the RWQDB can overcome some of these data limitations, the capabilities of the database and associated analysis tools depend directly on volume and quality of the data shared and incorporated into it.

## Database Quality Assurance and Quality Control

The WISKI database structure establishes explicit relationships between monitoring programs, sampling locations, analysis methods and parameters. These relationships allow for basic and extended data validation to be applied automatically during the data import process. Basic data validation will flag and restrict import for any entries with incorrect formatting (e.g., text in a numeric field, invalid characters, impossible sample result values, etc.); for sample locations or parameters that are not established in the system or associated with a current monitoring program. Extended data validation additionally flags any values that are accepted for import where a value already exists in the database and requires the database administrator to specify for each value whether to accept or reject the proposed change. Both layers of data validation guard against unintended changes to database values that could result from incorrect sample labeling, typographic errors, value transposition, and other common data issues. Values that fail import are logged to allow the database administrator to confer with appropriate project partner(s) to determine the source of the errors.

One of the challenges associated with the RWQDB, and any regional database that brings together several distinct monitoring programs, is reconciling different QA/QC procedures to create a single data quality scheme for the aggregated data. In this project, each monitoring organization applies its own

QA/QC procedures to data as outlined in their respective program QAPP, prior to sharing data with the RWQDB. The data quality scheme used to integrate multiple QA/QC processes and data flagging protocols was developed through discussions with representatives from State and Federal regulatory agencies and was ultimately reviewed and approved by the end-user group. Further detail including plans for future QA/QC enhancements is provided in the *Quality Assurance Project Plan for Analysis of Cape Cod Water Resources Data*. In brief, data without any qualifications or flags resulting from the monitoring organization QA/QC procedures are categorized as "good," data with certain flags that may call its accuracy into question. Data where the raw data source cannot be confirmed are categorized as "fair," and any data confirmed as erroneous is classified as "bad" data. Since many data providers filter out "bad" data before sharing with the RWQDB, the Project Team elected to not make "bad" data available for display via the Data Portal, but to make it available in raw data exports if desired by users.

It was anticipated that both data integration and QA/QC would be ongoing tasks throughout the life of the RWQDB. The project team has undertaken multiple rounds of these activities during the project period when importing newly received data, adding new data formats, and reconciliation of data redundancies or inconsistencies that emerged only during detailed analysis within a single watershed. It is anticipated that as the data portal is more widely used, the end-users who are most familiar with local sampling stations and trends in water quality will serve as an additional layer of quality control by informing the database team of any inconsistencies that were not identified by automated QA/QC procedures.

## Water Quality Data Analysis Toolbox

A major goal of the RWQDB was to produce an application responsive to the specific needs of the users and types of analysis most useful to them. The project partners utilized a unique end-user engagement process that took place throughout the entire project to seek input and feedback. This diverse group was assembled by considering the potential users that collect water quality data, use the data to make management decisions, track water quality for regulatory purposes, or include water quality data in their research, public education and outreach efforts. The end-user group was comprised of town representatives from the Cape Cod Water Protection Collaborative, local and regional non-profit organizations, representatives from the state (Massachusetts Department of Environmental Protection) and federal level (Environmental Protection Agency, National Park Service), and others. The process and specific topics where the end-user group provided input are described in further detail in the Volunteer and Community Involvement section.

For purposes related to time, budget, and to limit dropdown options in the user interface to a reasonable number, the end-user group was asked to select 8-10 of the available water quality parameters that were most critical to their individual work. End-users ultimately selected water temperature, salinity, dissolved oxygen, nitrate, total dissolved nitrogen, total nitrogen, total phosphorus, Chlorophyll a, and pH. pH was eliminated from the user interface by the development team because it is not currently measured at a large majority of sampling locations; however, some additional nitrogen species not reported by all programs (particulate organic nitrogen, dissolved inorganic nitrogen, dissolved organic nitrogen) were added to the user interface where the ability of the database to

perform automatic calculations allowed them to be calculated from other directly measured parameters.

The end-user group then established criteria to guide the project team's development of the Water Quality Analysis Toolbox. Through a collaborative prioritization process, the functionality requests for the user interface were distilled down to the following general needs:

- The ability to view water quality sampling locations and sampling results from the database in an easy to navigate web interface
- Options for filtering the data display by specifying certain geographic and time scales
- Processing capability to allow a user to define a region and time range of interest, and to perform time series analyses to determine whether a water quality parameter is changing over time in a statistically significant manner.

The project team, guided by the end-user group's performance criteria, developed a Python script to provide Data Portal users with time-series analysis on request, and results displayed in a format that is easy to digest and understand. The end-user group expressed a clear desire to be able to view and analyze data for a single sampling location, and to be able to perform the same analyses when looking at all stations within a single coastal embayment. Regional water quality monitoring is dynamic by nature, with actions such as establishing new monitoring stations or changing monitoring schedules potentially introducing spatio-temporal bias into long-term trend analyses evaluated at the embayment scale. Minimizing the potential for spatio-temporal bias during the calculation of embayment-wide trends required development of a method for filtering out monitoring stations that due to the timing or frequency of measurements could skew trend results. A set of suitability criteria were developed by the project team, vetted by the end-user group, and used to remove stations with insufficient data density from embayment-wide analyses. Based on project team experience with marine water quality data and from end-user feedback, five years of data was selected as the minimum requirement to calculate a trend using the toolbox. Correspondingly, a sampling station would be included in a long-term embayment trend as long as the station was sampled each year during the first 25% and final 25% of the period specified for trend analysis, from at least 50% of the years within the specified analysis period, and with a minimum of five years of data available.

To determine whether a selected water quality parameter is changing over time in a statistically significant manner, users first have the opportunity to filter data using dropdown menus in the Data Portal. Data can be filtered by start and end year, month(s) of data collection, and monitoring program(s) collecting the data. Additionally, individual monitoring stations can be toggled on and off at the embayment scale to add or remove them from trend analysis. Trends are then quantified over the selected time period using annual averages of the filtered data that meets the suitability criteria detailed above. Trends are calculated as the slope of the linear regression of the annual averages, and qualified by the confidence in the trend which is determined by the statistical significance of the result. The toolbox's trend output (Figure 2) was designed with end-user feedback to provide results in a clear and easy to understand format.

Greater detail regarding the use of data sources by the Data Analysis Toolbox, methods employed to reduce potential bias in the analyses, data quality objectives, and reconciliation of results with user requirements is available in the *Quality Assurance Project Plan for Analysis of Cape Cod Water Resources*, which is described further in the Compliance section.

Working outside the capabilities of the built-in analysis tools, staff from WHOI have also undertaken two regional analyses of the historic data set. The first examines connections between trends in total nitrogen and chlorophyll *a* throughout the different coastal waters surrounding Cape Cod, as well as regional progress towards embayment total nitrogen targets. The second study utilized reflectance data from satellite imagery to examine seasonal patterns in chlorophyll *a* and assess whether the characteristics of phytoplankton blooms are changing over time. Both sets of analyses are being prepared as scientific publications, and are also anticipated to form the basis for a higher-level regional analysis document to be made available via the Data Portal's resources page. Preliminary example figures from these analyses are included in Supporting Materials.

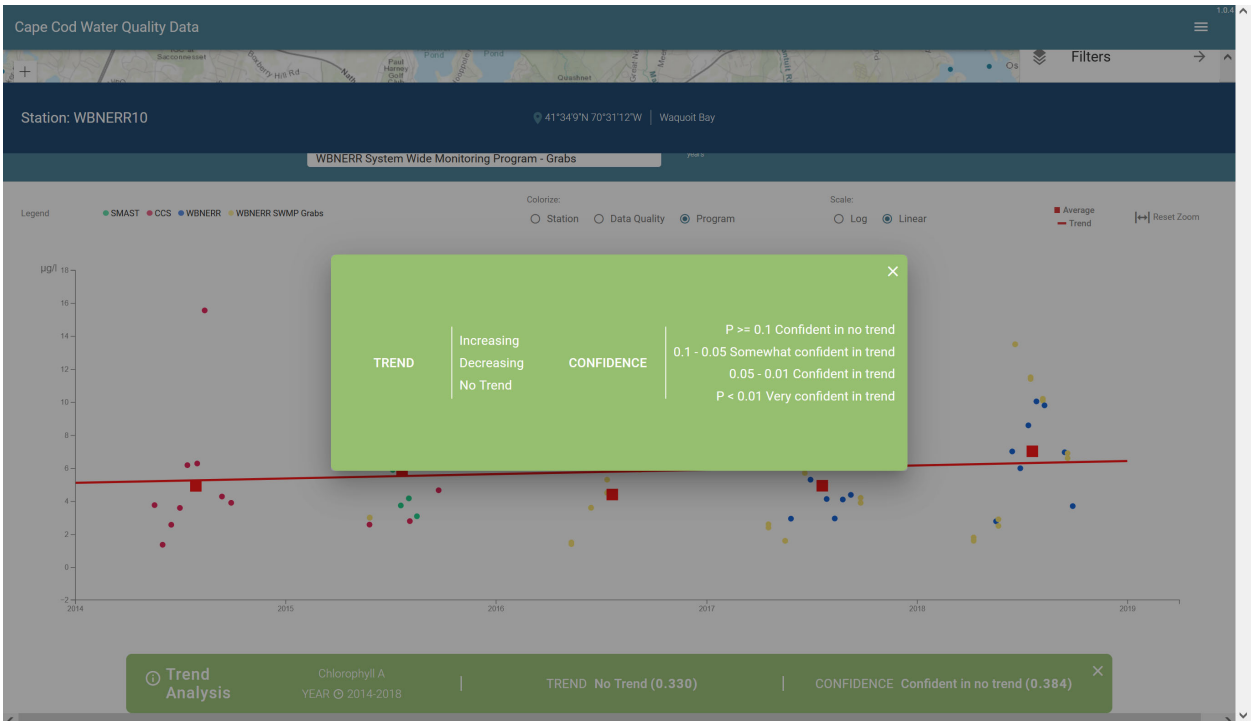


Figure 2: Trend analysis results dialog and informational popup with additional explanation.

## Water Quality Data Portal

While the Data Analysis Toolbox was simultaneously being developed, the project team worked to produce an initial design for the user interface, refining the appearance and user experience with input from the end-user group. Following review of numerous existing web-based water quality user interfaces, the project team used Microsoft PowerPoint to create an initial set of static mock-ups to illustrate how the user interface might look and how users could interact with its different elements. Where possible, the end-user group was presented with multiple options for how to display information,

and how the display could be changed by toggling map layers on and off or by filtering out certain categories of data to aid in data exploration or fit a user's specific area of analysis (Figure 3). The project team utilized direct feedback from the end-user group when designing the final layout, type and format of information displays, and the interactive features used to navigate and access different functionality within the Water Quality Data Portal. Among other elements, end-users provided direct input on the design of the Map View (Figure 3), single station Data View (Figure 4), embayment Data View (Figure 5), and the trend analysis calculations performed at each of those spatial scales.

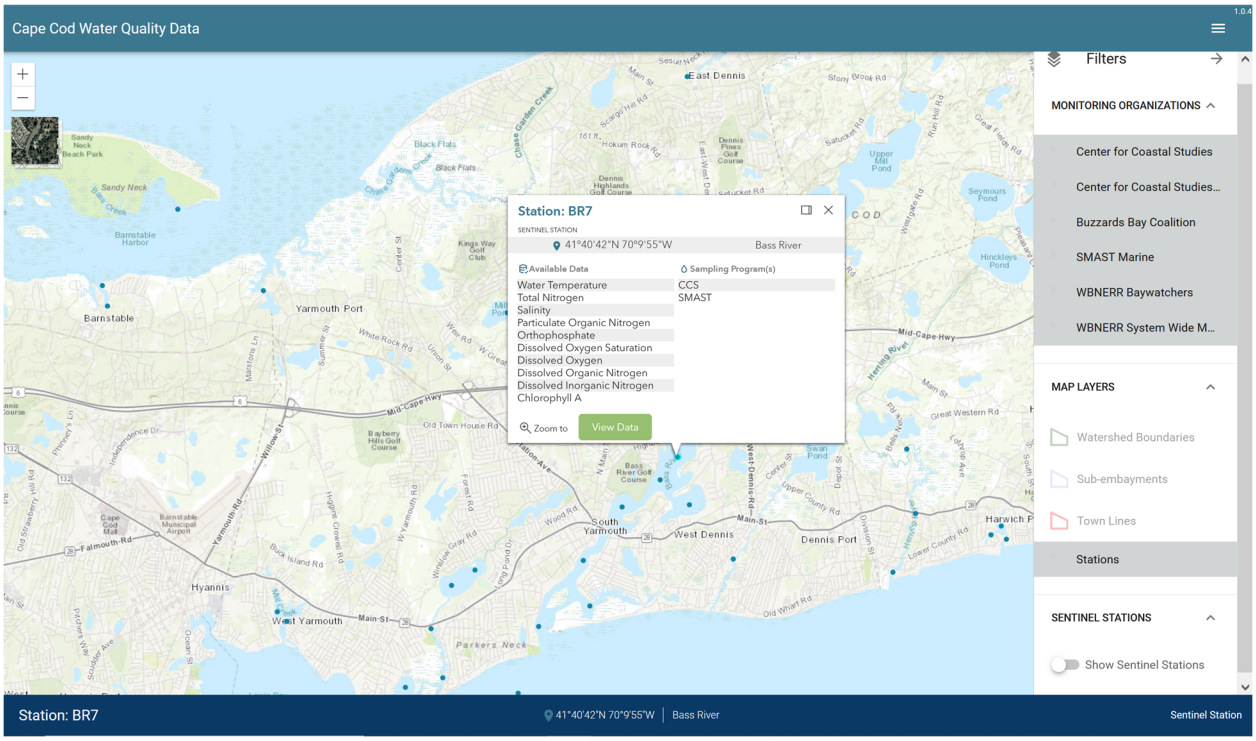


Figure 3: Map view showing informational station popup and layer selection.

Once the final static designs for the Data Portal were completed, the project team worked with Timmons Group (Richmond, VA) to convert those mock-ups into a fully functional web-based application. The web application needed to provide live access to the data housed in the RWQDB, allow users to explore the data via an interactive map-based interface, and perform analyses consistent with the needs of the end-users defined through the Collaborative Process. A substantial portion of the web development effort was dedicated to establishing links between the web application and the data displayed in the Map View and station popups; and to the WISKI database for the actual water quality measurements displayed in the Data View. To maintain the responsiveness of the application, the information displayed in Map View by the station popup about active monitoring programs, sentinel station status, available water quality parameters, and station location is served from an ESRI REST service. As this information is not expected to change frequently, storing it in the REST service avoids having to query the database repeatedly while users interact with the Map View. This information is also used to populate the dropdown menus in the Explore the Data ribbon. The REST service is updated whenever a large data import is completed, changes are made to the database, or new data types are incorporated into the database.


Figure 4: Single station data view showing trend analysis results.

Anticipating that new water quality measurements will be continually added to the database, linking the web application directly to the WISKI database was a critical component of the development process to ensure that the most up to date data within the database is available through the Data Portal. Calls to retrieve data from the WISKI server were created using the built-in Application Programming Interface (API). Since retrieving water quality results from the WISKI database is the most time-consuming function of the data portal, the process is set up to retrieve all water quality data when a user selects a station or embayment and enters Data View, and to store the data in the web browser's cache. This arrangement may require the user to wait initially while data is retrieved, but then allows for filtering and trend analysis to be conducted with near instantaneous updates to the Data View.

An unexpected benefit of the design for the embayment level Data View is the ability to run a trend analysis on multiple stations within an embayment or sub-embayment. This functionality was requested by the end-user group, but because sub-embayments are not currently coded into the WISKI data hierarchy the Project Team anticipated having to develop a custom solution in the future to facilitate this sort of analysis. The interactive legend (Figure 5) allows users to click on a legend entry and toggle that category of data on or off in the Data View. By choosing to colorize data points by station and then excluding stations not desired for analysis, users can calculate trends for multiple stations within an embayment. This method requires some detailed knowledge about the area of interest (namely an understanding of precisely which station names correspond to the sub-embayment or geographic area), but ultimately provides an additional level of analysis capability requested by the end-users.


Figure 5: Embayment data view with interactive legend (outlined in red). Stations colored gray in the legend have been clicked to remove from the data view and will not be included in trend analysis.

The web development process also involved conversion of the Python based Water Quality Data Analysis Toolbox script to javascript. Bringing the mathematical procedures into javascript allows all calculation steps used for trend analyses to be performed within a user's web browser, using the data that is retrieved and cached when a user selects a station or embayment. This arrangement allows users to change data filters after running a trend analysis and to see updated trend results with nearly instantaneous response.

Throughout the design process, the team went to great lengths to make the Water Quality Data Portal intuitive and user friendly. Understanding that the tool will be publicly available, the project team prepared a white paper that describes how to navigate and interact with the portal, and outlines the basic functionality and purpose of the various Data Portal elements. The *Cape Cod Water Quality Portal Methodology* is available from the "Resources" tab in the Data Portal and is also included in the Supporting Materials.

# COMPLIANCE

## Quality Assurance Project Plans

To improve the consistency and comparability of future data collection, and analysis / display of data through the Water Quality Data Portal, Quality Assurance Project Plans (QAPPs) were prepared as part of several project tasks.

The *Quality Assurance Project Plan for Waquoit Bay National Estuarine Research Reserve Water Quality Monitoring Programs* (WBNERR QAPP) was prepared by WBNERR staff and signed by EPA in June 2019. It addresses the program management, data generation, assessment and oversight, and data validation for the Reserve's ongoing water quality monitoring. Having a signed QAPP will enable usage of future water quality data collected by WBNERR programs for regulatory purposes and will add greater uniformity to future data added to the data portal as all monitoring programs currently sharing data now have approved QAPPs.

The *Quality Assurance Project Plan for Regional Collection and Analysis of Cape Cod Water Resources* (Analysis QAPP) was prepared by Cape Cod Commission and Woods Hole Oceanographic Institution staff as part of the proposed data processing toolbox and was signed by EPA in January 2020. The Analysis QAPP defines the data sources and QA/QC procedures applied to source data, details for analysis of trends in historical water quality data, and the analysis methodology and criteria for data suitability associated with the data processing toolbox.

The *Quality Assurance Project Plan for Cape Cod Ponds Monitoring Program* (Ponds QAPP) was prepared through a collaborative effort between staff from the Cape Cod Commission, APCC, and CCS. This QAPP was submitted to EPA for initial comments in April 2021, and following revision is now awaiting EPA approval. The Ponds QAPP covers the program structure, preparation and training, data collection, QA/QC checks, data handling and review, and data dissemination for a regional pond monitoring program on Cape Cod. This approved QAPP will improve the consistency of freshwater data collected from Cape Cod's ponds and lakes and stored in the RWQDB. It will offer existing pond monitoring groups access to training resources, an avenue to have their data used for regulatory purposes, and a more formalized structure for future pond monitoring data to be incorporated into the RWQDB.

# PROJECT PARTNERS

## Association to Preserve Cape Cod

APCC staff provided project guidance and maintained coordination with State of the Waters tasks throughout the project by attending project team and end-user group meetings. As part of the data integration task, in 2019 APCC contacted 19 towns, agencies, and organizations to request additional water quality data; receiving 14 responses. A follow up effort in 2020 received 7 additional responses and approximately 40 marine and freshwater monitoring data sets. As part of its Cape Cod State of the Waters effort, APCC analyzed marine, fresh water, and drinking water quality data from throughout the Cape Cod region. These results and analyses were compiled into the 2019 and 2020 editions of the State of the Waters Report, an annual assessment of water quality on Cape Cod. Notably, APCC added the results of cyanobacteria monitoring to its water quality grading for freshwater ponds in 2020. Outreach efforts related to the reports included building the State of the Waters website, presentations to various groups throughout the region, and posts to its blog and social media accounts. More detail on specific outreach efforts is available in the Outreach and Communications section. APCC staff also

collaborated with Cape Cod Commission staff to prepare the Ponds QAPP detailed in the Compliance section.

### Center for Coastal Studies

CCS staff provided water quality monitoring data for inclusion in the RWQDB, provided project guidance through project team and end-user group meetings, and assisted with the preparation of the Ponds QAPP.

### Waquoit Bay National Estuarine Research Reserve

As a partner on the grant, WBNERR continued to collect water quality monitoring data in Waquoit Bay under the Baywatchers volunteer monitoring program and System Wide Monitoring Program for inclusion in the RWQDB. These activities included preparation of the WBNERR QAPP, which covers both the Baywatchers and the SWMP programs, and deployment of two additional water quality data sondes. WBNERR continues to maintain the data sonde network as part of the National Estuarine Research Reserve system. WBNERR staff also led the planning and facilitation of the collaborative process through six end-user group meetings and two pilot watershed project meetings. For each of the end-user group meetings, at least one internal planning meeting occurred. WBNERR staff also provided guidance throughout the entire project by attending project team and end-user group meetings, and coordinating directly with other project partners.

### Woods Hole Oceanographic Institution

WHOI staff were integrally involved in the development of data QA/QC procedures and co-developed the Analysis QAPP with Cape Cod Commission staff. WHOI staff led development of the data processing toolbox, including the prototype data dashboard, and used initial versions of the analysis scripts to troubleshoot mathematical operations in the final web application. Throughout development of the user interface, WHOI staff worked directly with Cape Cod Commission and Timmons Group staff to add data analysis capabilities to the web application, and to verify and troubleshoot various data connections and analysis functions. Regional analysis of the historical water quality data set is ongoing with two manuscripts currently in preparation. WHOI staff presented at project team meetings, end-user group meetings, and meetings of the Cape Cod Water Protection Collaborative.

## VOLUNTEER AND COMMUNITY INVOLVEMENT

The collaborative end-user process, and the pilot watershed project were designed with the express purpose of involving community and regional stakeholders. Engagement with end-users was the project element most directly impacted by the COVID-19 pandemic, as only the first two end-user meetings could be convened and facilitated in-person as envisioned in the project proposal. The Project Team was able to adapt the collaborative end-user process to a remote format, and subsequently held six meetings of the end-user group remotely via Zoom, with live polling and virtual whiteboard exercises used to encourage structured input from the group on specific questions and topics. Navigating this

transition did introduce some delays to the end-user engagement process, but ultimately the group was able to provide input and feedback in all subject areas originally anticipated by the Project Team.

Similarly, engagement of the Pilot Watershed stakeholder group was similarly prevented from meeting in-person. While the digital format in some cases made scheduling logistics easier, by the end of the project it seemed that stakeholders and team members were all affected by some degree of remote meeting fatigue.

## Collaborative End-User Process

A key component of the RWQDB project was the convening of an end-user group and recurring meetings with that group to guide the development of the database, analysis tools, and user interface. The end-user group was intended to represent a variety of potential users of water quality data, including representatives from town governments and the Cape Cod Water Protection Collaborative, local and regional non-profit organizations, representatives from the state (Massachusetts Department of Environmental Protection) and federal level (Environmental Protection Agency, National Park Service), and others. Collectively, this group represents those that collect the water quality data, use the data to make management decisions, track water quality for regulatory purposes, or include water quality data in their public education and outreach efforts. Over the course of the three-year project, six meetings were held with the end user group.

In meeting 1 (July 2019), the project team provided an introduction to the RWQDB project, better defined the connection to, and distinctions between the database project and APCC's State of the Waters Report and summarized the goals and purposes of the end user driven collaborative model. At meeting 2 (October 2019), the project team gathered input from end users to refine which of the available water quality monitoring parameters were of highest priority, as well as which spatial and temporal scales for trend analysis would be most relevant for water quality decision-making in the region. The project team spent the next several months developing the Analysis Toolbox, a prototype data dashboard, and example layouts for how the different elements of the final data portal might look. At meeting 3 (April 2020), end-users were able to review initial mock-ups showing a potential map interface with several options for interacting with sampling stations and other viewable map elements. End-users provided feedback on the function and appearance of the interface's Map View, and got an initial look at how data might be displayed for a single monitoring station. Meeting 3 was also the first meeting conducted in an entirely virtual environment due to the COVID-19 pandemic, which generally necessitated somewhat shorter and more focused meetings to maintain participant engagement and productivity, as well as some ingenuity to foster active participation in a virtual meeting format.

At meeting 3, there was a lively debate regarding how data quality and the QAPP status of monitoring data related to its acceptability for different uses and by different stakeholders. A follow up meeting was convened in May 2020 with a smaller group including staff representatives from the Massachusetts Department of Environmental Protection and US Environmental Protection Agency to specifically address data quality, QAPPs, acceptable usage for different types of data, and how best to incorporate data quality and QAPP status into the first version of the Data Portal. Those discussions concluded that

the only data in the portal currently considered non-QAPP is pre-2019 data from WBNERR, data that were collected as part of the National Estuarine Research Reserve System Wide Monitoring Program (SWMP) using SWMP protocols. These data are largely expected to be considered equivalent to having an approved QAPP once a formal process for that determination is established. As additional sources of data are incorporated into the Commission's Water Quality Data Portal, having a process in place for determining QAPP status will become more critical. The Cape Cod Commission, MassDEP, and US EPA will continue to develop a data use framework for inclusion as part of future versions of the RWQDP.

Continuing to round out refinement of the Data Portal, meeting 4 (June 2020) examined the view when an entire embayment's data is being explored and delved deeper into the details of the data filtering that happens during calculation of embayment-wide trends. The results of the previous meeting with state and federal regulators were discussed with the end-user group within the context of how data quality and QAPP status are displayed and can be interacted with through the Data Portal. Meeting 5 (June 2020) was a brief and targeted discussion of different options for data filtering when calculating an embayment trend. A major focus of this meeting, and many others as well, was the fact that excluding certain data points from analysis based on set criteria can minimize potential bias but can also limit the applicability of the built-in analysis functions in areas of limited data. Continued interaction and feedback from the end-user group was critical to finding the right balance between these two often competing interests.

After taking into account all of the discussion, debate, and feedback from the first five end-user group meetings, the project team focused on translating the static mockups into a fully functional web application that met as many of the end-user group needs as possible. The sixth end-user group meeting (April 2021) revealed the Water Quality Data Portal (https://waterquality.capecodcommission.org) to the group, allowed users to test drive the application themselves, and collected their initial impressions after briefly working with the Data Portal on their own. Two "office hours" sessions were offered in April 2021 to answer questions or address issues encountered once users had more time to test the functionality and capabilities of the Data Portal.

How the feedback gathered from the end-user group was incorporated into project output is detailed above in the Water Quality Data Analysis Toolbox and Water Quality Data Portal sections. To summarize, the end-users guided project development on the following topics, with feedback incorporated by the project team and presented back to the end-users in an iterative fashion:

- Which water quality parameters were of interest for local decision-making and should be included in the interactive user interface
- How to accurately represent the quality of data points from multiple monitoring programs within a single data quality scheme
- Which spatial and temporal scales were most critical for viewing water quality data, and for performing trend analyses
- What type(s) of data analysis would be most helpful if automated as part of the user interface

- Appearance, feel and functionality of the user interface
- Development of criteria for selecting a watershed in which to pilot the Water Quality Data Portal

## Waquoit Bay Pilot Watershed Project

To directly explore how the Data Portal could be used to evaluate the impacts of water quality management activities, a single watershed was selected for evaluation as a pilot project. The project team composed a list of candidate criteria to be used to choose between possible pilot watersheds. A meeting of the end-user group was convened to examine several candidate watersheds, evaluate them using a standard set of criteria, and select a single pilot watershed for closer examination.

Following the end-user group's evaluation and targeted outreach to potential watershed stakeholders, Waquoit Bay was selected for the pilot watershed analysis and one virtual meeting was held with the Waquoit Bay stakeholder group. The stakeholder group included representatives from various departments and committees within the Towns of Mashpee and Falmouth, such as the wastewater / water quality committees, select boards, and natural resource departments; as well as consultants to both towns and representatives from WBNERR. Based on input from that stakeholder group, the project team used the Water Quality Data Portal to examine whether changes in water quality trends could be observed in the vicinity of town managed oyster and quahog propagation activities based on existing data in the Portal, and whether town dredging activities resulted in any changes to local water quality.

The project team examined the location of the respective shellfish aquaculture and dredging activities, and determined nearby water quality monitoring stations in the database. The years and types of monitoring data collected were compared with the dates of implementation actions, and analyses were identified to try to examine whether the dredging or aquaculture activities corresponded with changes in salinity (dredging), nitrogen (dredging / aquaculture), or chlorophyll *a* (dredging / aquaculture) trends. Both the timing and location of projects led to challenges in analysis, as many of the stations closest to these activities only had one year of data. This precluded calculation of trends, since a minimum of five years of data is required for trend analysis.

The pilot watershed project highlighted some challenges with the database and underlying data, namely that it draws primarily from multiple sampling programs designed to gather large-scale regional water quality data. This type of data is not necessarily well suited for assessing small-scale localized impacts, though it can be used for that purpose when existing monitoring stations are well located, and the data from them is shared for inclusion in the database. What the current Water Quality Database is well suited to provide however, is larger context for small-scale observations. It allows for easy comparison of water quality data and trends from one station to another, from one station to an entire embayment, and from a station or embayment to nearby open ocean sampling stations. In addition, the intuitive map interface allows for identification of gaps in monitoring coverage, which will hopefully lead to strategic placement of new monitoring efforts, and subsequent inclusion of that data in the database.

More detail can be found in the Waquoit Bay pilot watershed analysis, which is included in Supporting Materials.

## OUTREACH AND COMMUNICATIONS

The major outcome of this grant and associated project is a tool designed to improve our understanding of how water quality is changing throughout the Cape Cod region, and to provide better information and access to information for water quality decisionmakers. The ultimate impact of the tool for the region will depend highly on the level of usage it sees once released. Tool design and capabilities undoubtedly play a large role, and the collaborative end-user process was envisioned to address those considerations. Equally important however, are how many decisionmakers are aware of the tool and feel the data and outputs from the tool are credible. To these ends, the project team has provided continual updates to various groups, along with targeted outreach efforts throughout the entire project.

APCC prepared Cape Cod State of the Waters reports for 2019 and 2020, which are available at https://capecodwaters.org/. APCC issued informational releases in advance of each report's publication via newsletters, social media, the State of the Waters website and its blog (https://capecodwaters.org/blog/). APCC most recently published the 2020 State of the Waters: Cape Cod report at their annual meeting in September 2020, followed by issuance of a press release and media packet, in addition to distribution via appropriate e-newsletters and directly to municipal and state agencies and organizations. APCC staff presented the State of the Waters Report to the Barnstable County Coastal Resources subcommittee, and to the Compact of Cape Cod Conservation Trusts.

Cape Cod Commission staff along with various project partners provided regular updates to the Cape Cod Water Protection Collaborative, which included presentations at one meeting in 2018, five meetings in 2019, and four meetings in 2020. Cape Cod Commission staff participated in a SNEP Watershed Grants session at the 2018 Restore America's Estuaries conference and presented with WHOI staff as part of the 2020 conference's "Insights and restoration policy applications derived from long-term monitoring of estuarine water quality" session. Cape Cod Commission staff submitted an abstract in December 2020 and are scheduled to present at the session titled "Come Together, Right Now, Over Watersheds..." at the 2021 Water Environment Federation Conference.

Locally, the Commission has shared information on the project in its 2018 Year in Review and highlighted how SNEP funding enabled the project as part of the presentation on Cape Cod 208 Plan Update implementation at the 2019 OneCape Summit. A breakout session highlighting the Water Quality Data Portal is scheduled for August 23rd as part of the 2021 OneCape Summit. Project information is also summarized on the Cape Cod Commission's website at https://capecodcommission.org/our-work/cape-cod-water-quality-data-portal, where users can connect to the Data Portal itself and learn about how the effort connects to other Cape Cod Commission initiatives.

In addition, Cape Cod Commission staff support the SNEP program in several capacities including the Monitoring Subcommittee, Ecosystem Services Subcommittee, and SNEP Expert Panel. Where relevant, Cape Cod Commission staff have discussed the Data Portal project, experiences, and lessons learned.

WBNERR staff engaged in direct outreach through the end-user process, which included soliciting members for the group, facilitating the meetings and discussions, and also coordinating activities and assignments for project team and end-user group members between meetings. As a result of the COVID-19 pandemic, some outreach efforts were revised to ensure that the database, resources, and decision-support tools were shared, and that support remained available to integrate them into local decision-making. WBNERR also prepared the outreach materials for the webinar and OneCape breakout session included in Supporting Materials.

## NEXT STEPS AND CHALLENGES

Although work on the Water Quality Data Portal under the SNEP Watershed Grant has concluded, continued updates, maintenance, and enhancements to the database and web interface are anticipated for the foreseeable future. The Cape Cod Commission has committed to maintaining the operation of the water quality database in WISKI, and adding to the web application as part of future projects. The database team is beginning to import data newly received from project partners, and through APCC's outreach efforts to collect data from local towns, non-profits, and environmental groups. The team also maintains a list of features that were requested by the end-user group but could not be incorporated into the first version of the Data Portal. These features include:

- Display of Total Nitrogen threshold concentrations (where applicable) in the data viewer at sentinel stations
- Ability to download a custom data export based on the user selected data filters
- Options to export data and trend analysis graphics to different image formats
- Incorporation of high-resolution continuous monitoring data using sensors from WBNERR monitoring programs and others as available

Other broader requests are being considered as part of future efforts. These include:

- A similar data portal for viewing and analyzing freshwater pond data (including cyanobacteria monitoring results)
- Integration of other data sources and types (e.g. tide or meteorological data)
- A map viewer that allows users to explore sampling coverage by individual monitoring parameters – to better assess data gaps.
- Development of a routine to export data from the RWQDB to the Water Quality Exchange for inclusion in EPA's Water Quality Portal.

# Project Budget Report

## SUMMARY BUDGET TABLE

| Budget Category | Total Budgeted Grant Funds | Total Budgeted Match | Total Budgeted Grant & Match | Actual Grant Funds Expended | Actual Match Funds Expended | Actual Expended Grant & Match |
|---|---|---|---|---|---|---|
| Personnel | 177,069 | 48,653 | 225,721 | 177,068 | 116,271 | 293,339 |
| Fringe | 66,970 | 14,041 | 81,011 | 68,172 | 33,211 | 101,383 |
| Travel | 1,729 | 1,020 | 2,748 | 1,729 | - | 1,729 |
| Equipment | 13,000 | - | 13,000 | 13,111 | - | 13,111 |
| Supplies | 458 | 413 | 870 | 200 | - | 200 |
| Contractual | 71,149 | 62,322 | 133,471 | 68,876 | 60,610 | 129,486 |
| **Total Direct** | **$ 330,375** | **$ 126,447** | **$ 456,822** | **$ 329,156** | **$ 210,092** | **$ 539,248** |
| Indirect Cost | $ 69,623 | $ 42,699 | $ 112,322 | $ 67,545 | $ 48,250 | $ 115,795 |
| **TOTAL** | **$ 399,998** | **$ 169,146** | **$ 569,144** | **$ 396,701** | **$ 258,341** | **$ 655,042** |

## DETAILED PROJECT BUDGET TABLE

**Detailed Budget Table**

September 1, 2018 - June 30, 2021

| SNEP Watershed Grant - Final Financial Report | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Cost Item or Category** | **Budgeted Grant Funds** | **Grant Funds Expended Cumulative** | **Grant Funds Balance** | **Budgeted Non-Federal Match** | **Match Funds Expended Cumulative** | **Match Funds Balance** | **Match Source** | **Total Budgeted Grant & Match** | **Expended Grant & Match** |
| **Personnel** | | | | | | | | | |
| Erin Perry, CCC | 11,812.71 | 4,078.78 | 7,733.93 | 3,937.57 | 1,501.76 | 2,435.81 | CCC | 15,750.28 | 5,580.54 |
| Tim Pasakarnis, CCC | 10,043.99 | 23,914.52 | (13,870.53) | 3,348.00 | 8,844.46 | (5,496.46) | CCC | 13,391.99 | 32,758.98 |
| Phil Detjens, CCC | 6,934.20 | 13,632.92 | (6,698.72) | 2,311.40 | 6,629.23 | (4,317.83) | CCC | 9,245.60 | 20,262.15 |
| Mario Carloni, CCC | 10,150.14 | - | 10,150.14 | 3,383.38 | - | 3,383.38 | | 13,533.52 | - |
| Jo Ann Muramoto, APCC | 12,048.80 | 25,343.50 | (13,294.70) | 6,000.00 | 15,052.00 | (9,052.00) | APCC - MET | 18,048.80 | 40,395.50 |
| Don Keeran, APCC | 15,400.00 | 5,019.50 | 10,380.50 | 5,421.60 | 17,117.30 | (11,695.70) | APCC - MET | 20,821.60 | 22,136.80 |
| Kristin Andres, APCC | 13,540.00 | 8,773.00 | 4,767.00 | 5,020.00 | 27,292.00 | (22,272.00) | APCC - MET | 18,560.00 | 36,065.00 |
| Kevin Johnson, APCC | 10,800.00 | 12,660.75 | (1,860.75) | 3,328.00 | 20,583.75 | (17,255.75) | APCC - MET | 14,128.00 | 33,244.50 |
| Jordanne Feldman, APCC | 7,520.00 | 7,536.00 | (16.00) | - | 160.00 | (160.00) | APCC - MET | 7,520.00 | 7,696.00 |
| Rebecca Miller, APCC | 1,000.00 | 976.00 | 24.00 | - | 4,376.00 | (4,376.00) | APCC - MET | | 5,352.00 |
| Amy Costa, CCS | 11,072.00 | 11,075.00 | (3.00) | 2,422.00 | 2,419.00 | 3.00 | CCS | 13,494.00 | 13,494.00 |
| Outreach Asst., WBRF | 10,770.00 | 9,237.50 | 1,532.50 | - | - | - | | 10,770.00 | 9,237.50 |
| WQ Monitoring Asst., WBRF | 4,145.00 | 4,145.00 | - | - | - | - | | 4,145.00 | 4,145.00 |
| Waquoit Bay Volunteers, WBI | - | - | - | 13,480.74 | 12,295.62 | 1,185.12 | WBRF | 13,480.74 | 12,295.62 |
| Jennie Rheuban, WHOI | 51,832.00 | 50,675.78 | 1,156.22 | - | - | - | | 51,832.00 | 50,675.78 |
| **Total Personnel** | **177,068.74** | **177,068.25** | **0.49** | **48,652.69** | **116,271.11** | **(67,618.42)** | | **225,721.43** | **293,339.36** |
| **Fringe** | | | | | | | | | |
| Fringe, CCC | 25,841.27 | 28,429.16 | (2,587.89) | 8,613.76 | 11,591.21 | (2,977.45) | CCC | 34,455.03 | 40,020.37 |
| Fringe, APCC | 15,077.20 | 15,077.20 | - | 4,942.40 | 21,145.29 | (16,202.89) | APCC - MET | 20,019.60 | 36,222.49 |
| Fringe, CCS | 2,214.40 | 2,220.00 | (5.60) | 484.40 | 474.00 | 10.40 | CCS | 2,698.80 | 2,694.00 |
| Fringe, WBNERR | - | - | - | - | - | - | | - | - |
| Fringe, WHOI | 23,837.54 | 22,445.72 | 1,391.82 | - | - | - | | 23,837.54 | 22,445.72 |
| **Total Fringe** | **66,970.31** | **68,172.08** | **(1,201.77)** | **14,040.56** | **33,210.50** | **(19,169.94)** | | **81,010.87** | **101,382.58** |
| **Travel** | | | | | | | | | |
| In-state travel (APCC) | 17.98 | 17.98 | - | 359.70 | - | 359.70 | | 377.68 | 17.98 |
| In-state travel (CCC) | 39.44 | 39.44 | - | - | - | - | | 39.44 | 39.44 |
| Out-of-state (RAE Summit 201 | 1,671.27 | 1,671.27 | - | - | - | - | | 1,671.27 | 1,671.27 |
| Out-of-state (RAE Summit 201 | - | - | - | 660.00 | - | 660.00 | | 660.00 | - |
| Out-of-state travel (WHOI - S. Doney) | - | - | - | - | - | - | | - | - |
| **Total Travel** | **1,728.69** | **1,728.69** | **-** | **1,019.70** | **-** | **1,019.70** | | **2,748.39** | **1,728.69** |
| **Equipment** | | | | | | | | | |
| WQ Monitoring Equipment | 13,000.00 | 13,110.89 | (110.89) | - | - | - | | 13,000.00 | 13,110.89 |
| **Total Equipment** | **13,000.00** | **13,110.89** | **(110.89)** | **-** | **-** | **-** | | **13,000.00** | **13,110.89** |

**Detailed Budget Table**

September 1, 2018 - June 30, 2021

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Supplies** | | | | | | | | | |
| Software (APCC) | 457.80 | 200.00 | 257.80 | 165.00 | - | 165.00 | | 622.80 | 200.00 |
| Workshop Supplies (APCC) | - | - | - | 247.50 | - | 247.50 | | 247.50 | - |
| Workshop Supplies (WBNERF | - | - | - | - | - | - | | - | - |
| **Total Supplies** | **457.80** | **200.00** | **257.80** | **412.50** | **-** | **412.50** | | **870.30** | **200.00** |
| **Contractual** | | | | | | | | | |
| QAQC Database (CCC) | 20,000.00 | 20,000.00 | - | 10,000.00 | - | 10,000.00 | | 30,000.00 | 20,000.00 |
| Technical Assistance (CCC) | 26,567.01 | 26,567.00 | 0.01 | 23,383.00 | 23,378.00 | 5.00 | CCC | 49,950.01 | 49,945.00 |
| OneCape Conferences (Venues | 10,000.00 | 10,000.00 | - | 10,000.00 | 15,955.00 | (5,955.00) | CCC | 20,000.00 | 25,955.00 |
| Workshop & Coastal Conference expenses (Venues & AV equipment; WBNERR) | - | - | - | - | - | - | | - | - |
| Web Design (APCC) | 14,582.02 | 12,309.20 | 2,272.82 | 6,600.00 | 9,675.00 | (3,075.00) | APCC | 21,182.02 | 21,984.20 |
| Dr. Scott Doney | - | - | - | 12,339.00 | 11,602.00 | 737.00 | WHOI | 12,339.00 | 11,602.00 |
| **Total Contractual** | **71,149.03** | **68,876.20** | **2,272.83** | **62,322.00** | **60,610.00** | **1,712.00** | | **133,471.03** | **129,486.20** |
| **TOTAL DIRECT** | **$ 330,374.57** | **$ 329,156.11** | **$ 1,218.46** | **$ 126,447.45** | **$ 210,091.61** | **$ (83,644.16)** | | **$ 456,822.02** | **$ 539,247.72** |
| CCC Indirect Cost (applied to | 26,038.87 | 28,400.70 | (2,361.83) | 11,292.61 | 11,515.73 | (223.12) | CCC | 37,331.48 | 39,916.43 |
| APCC Indirect Cost | 9,044.38 | 8,791.31 | 253.07 | 3,274.42 | 11,540.14 | (8,265.72) | APCC-MET | 12,318.80 | 20,331.45 |
| CCS Indirect Cost (NICRA) | 4,428.80 | 4,420.00 | 8.80 | 3,717.80 | 2,754.00 | 963.80 | CCS | 8,146.60 | 7,174.00 |
| WBNERR Indirect Cost | 3,289.47 | 1,338.25 | 1,951.22 | 1,348.07 | 1,229.56 | 118.51 | WBRF | 4,637.55 | 2,567.81 |
| WHOI Indirect Cost (NICRA) | 26,822.00 | 24,594.81 | 2,227.19 | 23,066.00 | 21,210.09 | 1,855.91 | WHOI | 49,888.00 | 45,804.90 |
| **Total Indirect Cost** | **$ 69,623.43** | **$ 67,545.07** | **$ 2,078.36** | **$ 42,698.90** | **$ 48,249.52** | **$ (5,550.62)** | | **$ 112,322.43** | **$ 115,794.59** |
| **TOTAL (Total Direct+Indire** | **$ 399,998.00** | **$ 396,701.18** | **$ 3,296.82** | **$ 169,146.35** | **$ 258,341.13** | **$ (89,194.78)** | | **$ 569,144.45** | **$ 655,042.31** |

## BUDGET NARRATIVE

The original SNEP grant agreement for "Regional Collection and Analysis of Cape Cod Water Resources Data", project #SNEPWG18-9-CCC, awarded the Cape Cod Commission $399,998 to complete the project. The Cape Cod Commission and its partners committed $169,146 in match contributions (42% of the grant amount). Actual cost of the completed project is $655,042: $396,701 expended from SNEP grant and $258,341 contributed as match (65% of the grant amount).

### PERSONNEL

The Cape Cod Commission and its partners, Association to Preserve Cape Cod (APCC), Center for Coastal Studies (CCS), Waquoit Bay Reserve Foundation (WBNERR), and Woods Hole Oceanographic Institution (WHOI) were able to complete their grant tasks within the budgeted personnel cost of $177,068 (grant only). There were a few personnel changes during the performance period of the grant that affected how the personnel costs were expended. Erin Perry, originally Special Projects Coordinator with the Cape Cod Commission and project manager for the SNEP grant, took on the role of the Cape Cod Commission's Deputy Director, and subsequently had to transfer the SNEP Watershed Grant project management to Tim Pasakarnis, Water Resources Analyst. Mario Carloni, Geospatial Analyst, left Cape Cod Commission in January of 2020. Mario Carloni was assigned a task of programming the interface for the new water quality monitoring database. His departure triggered a budget amendment to transfer funds from the personnel category to contractual to allow the completion of this task by a consultant. Waquoit Bay Reserve Foundation was unable to fill the position of the Outreach Assistant during the COVID-19 pandemic and decided to reduce its personnel expenses to allow for a purchase of a second water quality sonde (please see detailed description of budget amendments #1 and #2 below).

Cape Cod Commission, APCC, and CCS all met their in-kind match commitments. It is worth noting that APCC contributed over $84,500 in staff time related to work on the "State of the Waters" website and related water quality data. This match contribution was funded by a state grant from the Massachusetts Environmental Trust through APCC. Waquoit Bay Reserve Foundation committed to $13,480 in-kind match and contributed a match of $12,295 provided by the Waquoit BayWatchers volunteers. The monitoring program at WBNERR had to be suspended due to COVID-19 for several months during 2020 and 2021 sampling seasons which resulted in lower contribution of volunteer time. Total in-kind match contributed to this project is $116,271 and exceeds the budgeted in-kind match of $48,653 by $67,618.

### FRINGES

Cape Cod Commission and its partners expended $68,172 from the SNEP grant in fringe cost. The budgeted fringe amount was $66,970. Cape Cod Commission's fringe expenses were budgeted based on the FY17 fringe rate of 66.37%. Cape Cod Commission's fringe rate increased to 70.15% in fiscal year 2018 and then decreased to 68.22% in fiscal year 2019. The Cape Cod Commission applies the most

recent audited fringe rate to staff salaries and this rate increase caused the fringe expenses to exceed the budgeted amount by $1,202.

The match commitment in the fringe line was $14,041. The Cape Cod Commission and its partners contributed $33,210 to the grant match in fringe expenses because of the higher than initially estimated in-kind contribution of personnel costs.

**TRAVEL**

The original grant budget included $10,868 in travel expenses. $5,340 was allocated to out-of-state travel for two Cape Cod Commission staff members and one APCC staff member to Restore America's Estuaries National Summit in Long Beach, California in December 2018. Only Erin Perry was able to attend this event and was reimbursed $1,671. Out-of-state expenses in the amount of $4,798 were allocated in the WHOI's original budget for Dr. Scott Doney's potential travel from Virginia to Massachusetts for in-person meetings. As the COVID-19 pandemic progressed and all in-person meetings were suspended, the travel budget was amended, and funds moved to other budget categories (see below for details of budget amendments #1 and #2).

**EQUIPMENT**

The original grant budget included $6,500 for purchase of a water quality sonde for the Waquoit Bay National Estuarine Research Reserve. The new sonde was purchased in January of 2019. It was later decided that a second sonde would strengthen their water quality data collection program. Personnel funds were transferred to the equipment line for the purchase of the second water quality sonde (see amendment #2) and the additional EXO2 Sonde was purchased in January 2021 for $6,611. A total of $13,111 was expended from SNEP grant funds in the equipment category.

**SUPPLIES**

Supplies were budgeted mainly for workshop supplies for grant partners: APCC ($502.50) and WBNERR ($1,500). APCC had also requested grant funds for ArcGIS software required for its State of the Waters website ($335). Since in-person workshops could not be held due to the COVID-19 pandemic, there were no supply expenses incurred and billed to the grant. APCC submitted ArcGIS software renewal invoices for $200. APCC committed to a match of $412.50 in the supplies category and did not provide this cash match since there were no actual expenses incurred.

**CONTRACTUAL**

Contractual funds were originally budgeted for the following expenses:

- QAQC Database ($20,000 in grant funds)
- QAPP Development ($7,500 in match funds)
- OneCape Conference ($10,000 in grant funds, $10,000 in match funds)
- Workshop & Coastal Conference expenses ($6,000 in grant funds)
- Website Design ($13,400 in grant funds, $6,600 in match funds)
- TMDL Solutions (SMAST lab consultant; $3,500 in grant funds)
- Dr. Scott Doney's consulting services ($12,339 in match funds)

Contractual expenses listed above totaled $89,339: $52,900 in grant funds and $36,439 in matching funds. After budget amendments #1 and #2 (see details below), this contractual category was increased to $133,471 ($71,149 in grant funds and $62,322 in match). Actual contractual expenses totaled $129,486 ($68,876 in grant funds and $60,610 in match) and were expended as follows:

QAQC Database:

A contractual expense of $20,000 was incurred by the Cape Cod Commission for the purchase of WISKI water quality information systems database licenses. The total cost of the WISKI database platform, including implementation, training, support, and maintenance expenses was $46,392.10 and the difference was paid with Cape Cod Commission funds (not applied to the match).

QAPP Development:

Quality Assurance Project Plans were developed by the collaborative efforts of all partners. APCC's staff time in excess of grant funding was applied to in-kind match. There was no need to hire a consultant to complete this task.

OneCape Conference:

The Cape Cod Commission held its OneCape Summit on July 29 & 30, 2019 in Harwich. Contractual expenses for the audio-visual services at the conference were applied to the grant in the amount of $10,000. The remaining $955 for the AV services and $15,000 conference venue deposit were paid by the Cape Cod Commission and applied to the match.

Workshop & Costal Conference expenses:

The Coastal Conference and all in-person workshops were cancelled as of March 2020 because of the COVID-19 pandemic. Funds budgeted in this category were transferred to technical assistance related to data portal development (please see budget amendment #2 for details).

Website Design:

APCC incurred a total of $21,984 in contractual expenses related to the State of the Waters website design (https://capecodwaters.org) and website related work during the grant period. APCC worked with the following consultants on the website design: Shawn Goulet, ColeWebDev, and Katie Glodzik, and billed $12,309 of their expenses to the grant (amended grant budget: $14,582) and contributed $9,675 as cash match to the project.

TMDL Solutions:

This contractual expense was removed from the budget and funds reassigned to technical assistance related to data portal development with budget amendment #1 (please see details below).

Dr. Scott Doney:

Jennie Rheuban from WHOI worked with Dr. Scott Doney from the University of Virginia, Department of Environmental Sciences, on strategies for data analysis and incorporating remote sensing information

into an analysis of water quality data. Dr. Doney has contributed $11,602 as part of the contractual match to the project during the year 2020 (budgeted match: $12,339).

Technical Assistance – Water Quality Data Portal Development:

This contractual category was added to the budget with amendment #1 and later increased with budget amendment #2 to total of $49,950 ($26,567 in grant funds, $23,383 in match funds). In October 2020, the Cape Cod Commission issued a Request for Quotations for a consultant to develop an open-sourced web-based portal for the water quality data. Timmons Group was selected and contracted as the consultant for the project. The total consultant fee for the project was $49,945. $26,567 of the SNEP grant funds were expended for the consultant fee and the remaining $23,378 was provided by the Cape Cod Commission as a match.

**INDIRECT COST**

Total indirect cost was budgeted at $112,322 ($69,623 in grant funds and $42,699 in match funds). Total expended indirect cost was $115,795 ($67,545 in grant funds and $48,250 in match funds). Budget amendments did not change the original indirect cost budget. Indirect costs were calculated and applied, in accordance with 2 CFR 200, as follows:

Cape Cod Commission's indirect cost was budgeted based on the FY17 indirect cost rate of 71.90% and applied to direct labor only. Cape Cod Commission's FY18 indirect cost rate changed to 70.15% and FY19 rate (the most recent audited rate) to 66.09%. Cape Cod Commission exceeded the indirect cost budgeted in the grant funds ($26,039) by $2,362 because of the increased personnel budget (see amendment #2). Since other partners did not bill out their indirect cost categories, total indirect cost expended from the grant is $2,078 under the budgeted amount of $69,623.

APCC and Waquoit Bay Reserve Foundation do not have Negotiated Indirect Cost Rate agreements and have applied 10% de minimus rate to their Modified Total Direct Costs throughout the grant period. APCC charged $8,791 ($9,044 budgeted) and WBRF charged $1,338 ($3,289 budgeted) in indirect cost to the SNEP grant.

The CCS negotiated indirect cost rate of 50.31% was applied to the CCS Modified Total Direct Costs for a total of $7,174. $4,420 of the indirect cost was applied to the grant and indirect cost over the 25% of the subaward amount were applied to the match ($2,754).

WHOI's indirect cost budget of $49,888 was calculated based on their NICRA for the calendar year 2018: 62% negotiated indirect cost rate was applied to their MTDC. Indirect cost billed to the grant was reduced to 25% of the subaward amount ($26,822) and the difference was budgeted as a match ($23,066). WHOI has submitted their NICRA for each of the grant years and applied the indirect cost rate in accordance with their NICRA. The actual indirect cost amount charged to the grant was $24,595 and the actual indirect cost contributed by WHOI as a match was $21,210.

**BUDGET AMENDMENT #1 – SEPTEMBER 2019**

The first budget amendment was requested by the Cape Cod Commission in September 2019. The amendment adjusted the grant budget of APCC and the Cape Cod Commission. It also reallocated the funds budgeted originally for UMass Dartmouth SMAST ($16,429.41 of the RAE SNEP request funds). Included in the amendment #1 were the following budget changes:

- Jordanne Feldman was added to APPC staff working on the project (an APCC intern supporting the development of the State of the Waters project and report cards); $7,520 has been allocated to Jordanne's salary by reducing the number of hours of other APCC staff.
- Cape Cod Commission increased salary line/number of hours assigned to Tim Pasakarnis, Water Resources Analyst, by reallocating the Cape Cod Commission out-of-state travel expenses and a portion of the SMAST salaries.
- Cape Cod Commission fringes were increased accordingly to reflect the increased personnel costs (66.36% fringe rate applied to Cape Cod Commission salaries) by reallocating its out-of-state travel expenses and a portion of SMAST's fringe costs.
- APCC reduced its out-of-state and in-state travel lines to $600 each and reallocated the reduced funds ($870.30) to increase its software budget.
- The Cape Cod Commission reduced its out-of-state travel line by $2,328.73 and reallocated $328.73 to in-state travel and the remaining $2,000 to personnel and fringes lines (see above). The original grant budget included out-of-state costs for two Cape Cod Commission staff members to attend the 2018 RAE Summit in Long Beach, CA. Only Erin Perry was able to attend the summit as Jennifer Clinton fell ill just before the scheduled trip.
- The Cape Cod Commission allocated $10,000 from the SMAST original budget (from personnel, fringes, and contractual categories) to technical assistance to support development of the web-based water quality data portal.

This budget amendment did not change the total direct cost amount ($330,375) or total indirect cost amount ($69,624) of the awarded grant. The total amendment amount was $28,466.93 and was below the 10% threshold for budget amendments requiring prior approval. Cape Cod Commission staff informed Tom Ardito, SNEP Watershed Grants Director, about the budget amendment and received his informal approval by email on September 12, 2019.

**BUDGET AMENDMENT #2 – NOVEMBER 2020**

The Cape Cod Commission requested a second amendment to the SNEP grant budget due to the impacts of COVID-19 in November of 2020. The original grant budget allowed for expenses related to in-person meetings and public outreach events. Those meetings and events have been conducted virtually since March 2020 and the remaining funds were reallocated to other tasks of the project as follows:

- APCC added Rebecca Miller to the project (an APCC intern supporting the development of the State of the Waters project and report cards). $1,000 has been moved from APCC's software expenses to personnel for Rebecca's salary. APCC's fringe line was increased by $250 to allow for fringe expenses associated with the added personnel costs (25% of $1,000). $250 has been moved from APCC's software expenses.

- WBNERR's salary line for the Outreach Assistant was reduced by $10,480 (moved to equipment and contractual lines).
- The Cape Cod Commission, APCC, and WHOI eliminated its out-of-state and in-state travel expenses as all project meetings were held online. APCC allocated $1,182.02 remaining in travel expenses to the web design expenses under the contractual line. The Cape Cod Commission and WHOI allocated their remaining travel expenses to technical assistance related to the data portal development under contractual expenses ($289.29 from the Cape Cod Commission in-state travel line and $4,798 from the WHOI out-of-state line).
- WBNERR increased the equipment line by $6,500 to allow for the purchase of a second water quality sonde.
- APCC reduced its software budget by $1,250 in order to allow for the additional personnel and fringe expenses.
- $1,500 from WBNERR's workshop supplies category was allocated to technical assistance related to the data portal development under the contractual line.
- $10,567.01 ($3,979.72 from personnel, $289.29 from Cape Cod Commission travel, $4,798.00 from WHOI travel, and $1,500.00 from supplies) was allocated to technical assistance related to development of the water quality data portal. WBNERR's Workshop and Coastal Conference expenses of $6,000 were also allocated towards the development of the data portal. Please note that this amount was not included in the budget amendment total since it was budgeted in the contractual line.
- APCC increased its web design budget by $1,182.02 (from travel lines) to the new total of $14,582.02.

The budget amendment #2 did not change the total direct cost amount ($330,375) or total indirect cost amount ($69,624). The total amendment amount was $18,499.03. Cape Cod Commission staff informed Tom Ardito, SNEP Watershed Grants Director, about the budget amendment and received his approval by email on November 30, 2020.

# Supporting Materials

Supporting materials can be viewed electronically at the following link:
https://barnstablecounty.sharepoint.com/:f:/g/dept/commission/team/projects/EkR28zTzdXJBmFecF98TJ1cBE07Ngb9fL7FoROiTIdrGnA?e=xTkWe3

# Certification

The undersigned verifies that the description of activities and expenditures in this final report are accurate to the best of my knowledge; and that the activities were conducted in agreement with the grant contract. I also understand that matching fund levels established in the grant contract must be met.

Grantee Signature: 

Name: Erin Perry

Title: Deputy Director

Date: 8/25/2021

Organization: Cape Cod Commission