**Task 2B Report:**
**TAC Workshop Summary,**
**Recommended Water Quality Targets**
**and Templates for Reporting Monitoring Results**

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**Disclaimer**

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## I. TAC Workshop Summary

During its December 4, 2019, water quality monitoring workshop the PEP TAC identified the following recommendations which the group wishes to forward to the PEP Management Committee for its consideration:

- Adopt provisional targets for water clarity (Secchi disk depth), chlorophyll-*a*, and dissolved oxygen (DO) as proposed in the Suffolk County (2019) Subwatersheds Wastewater Plan (SWP):
  - Median Secchi disk depths should be 2m or greater during the April 1 through October 31 growing season;
  - Median chlorophyll-*a* concentrations should be no greater than 5.5ug/l during the April 1 through October 31 growing season; and
  - Dissolved oxygen concentrations should comply with New York State's acute (never less than 3 mg/l) and chronic (> 4.8 mg/l as daily average in 90% of samples) DO criteria.

- As an initial target for pathogens, adopt the existing threshold for fecal indicator bacteria (*Enterococcus*) that is used by Suffolk County to determine swimming beach closures. (*Enterococcus* counts at estuarine/marine swimming beaches should not exceed 104 colony forming units per 100 milliliter water sample [104 cfu/100ml]).

- Adopt three estuary segments (west, central and east; shown in Fig. 1 below) as reporting/ management units, based on chlorophyll-*a* concentrations and Secchi depths observed at Suffolk County Department of Health Services (SCDHS) monitoring stations in each segment.

- Use 'stoplight graphics' (green = target met; red = target not met) for public-facing documents, collating data by estuary segment. Update annually as soon as monitoring data are available from the previous year. Where possible, also include a yellow (intermediate) category in each stoplight graphic to reflect small-magnitude and/or short-duration failures to meet targets. Partial approaches for doing so with the Secchi depth, chlorophyll-*a* and *Enterococcus* targets are outlined below.

- Track and report water temperature, salinity, pH and HABs on an annual basis (adoption of numerical targets is not currently anticipated for these parameters).

- Finalize and adopt PEP water quality targets for pathogens, water clarity (Secchi depth), and chlorophyll-a and DO concentrations by late summer, in time for September 2020 PEP conference.

The TAC also identified the following issues to be addressed prior to the September conference:

- Determine whether the provisional targets (e.g., for Secchi depth and chl-*a* concentration) are appropriate for all three estuary segments, or if segment-specific targets may need to be developed.

- Identify feasible and cost-effective methods for monitoring diel variations in DO at multiple locations within the estuary. Deployable continuous monitoring instruments have become more affordable in recent years and may be an option. It may also be possible to use statistical

methods (such as regression analyses) to estimate daily minimum DO concentrations based on values observed at the SCDHS stations, which are measured during daylight hours, typically between mid-morning and mid-afternoon.

- Examine potential elements of an 'early warning system' (e.g., using hydrographic parameters such as salinity, DO, water temperature, pH), which could be used to alert decision-makers and the public to anticipated water quality issues such as fish kills and HABs.

- For HABs, use the maps prepared by Stony Brook University and TNC to track and report blooms in the estuary. Additional work will be needed to develop methods for reporting and tracking cyanobacterial HABs in freshwater bodies within the watershed.

- Issues related to shellfish bed closures and pathogen-related TMDLs will need to be resolved at the state and federal levels before PEP targets can be adopted for shellfish harvesting areas.

- Explore the development of a tiered reporting system, summarizing water quality conditions on a broad scale (e.g., for the three proposed estuary segments) and also identifying problem areas in individual sub-watersheds or embayments. The PEP Annual Workplan could potentially be used to address water quality issues in localized areas within each segment.

- Consider whether annual freshwater inflows ('hydrologic loads') to the estuary should be an element of tracking and reporting, and perhaps used to 'normalize' estimates of annual nutrient loads with respect to annual freshwater inflows.

- Consider additional indicators that may need to be tracked and reported, such as the spatial distribution of nuisance macroalgae blooms, suitability of water quality for spawning and development of diadromous fish, and tissue levels of mercury and other potential toxins in river otters and other wildlife.

## II. Correction

As noted during the December 4 TAC meeting, information about the locations of SCDHS water quality monitoring stations (their distances down-estuary from the Peconic River dam) that was included in an earlier CoastWise Partners report (the November 5, 2019 Background report) was incorrect. That information has been corrected in the current report, in Figures 2 and 3 below and in the station summary table provided in Appendix A.

## III. Proposed management/reporting areas for the Peconic Estuary

Based on an evaluation of Secchi disk depths and chlorophyll-*a* concentrations reported by the SCDHS for the years 2009 through 2018, CoastWise Partners recommends that PEP consider using the three management zones shown in Fig. 1 as the basis for tracking and reporting large-scale water quality patterns within the estuary. These zones reflect the pronounced west-to-east (head-to-mouth) water quality gradients that are present in the system, presumably reflecting underlying gradients in nutrient loading and tidal flushing rates (e.g., Gobler 2007). The westernmost zone begins in the tidal reach of the Lower Peconic River and extends eastward to Nassau Point. The central zone extends eastward


**Figure 1. Proposed water quality management and reporting zones for the Peconic Estuary.**

from Nassau Point to the Greenport ferry terminal on the north prong, Ferry Road on Shelter Island, and the Sag Harbor Bridge on the south prong. The eastern zone extends eastward from those points through Gardiners Bay to Block Island Sound (Fig. 1).

The SWP (Suffolk County 2019) evaluates water quality conditions during the April – October growing seasons over the past 10 years to determine if its proposed targets are being met. Average Secchi depths and 90$^{th}$ percentile chlorophyll-*a* concentrations are used for that purpose. Applying that approach to the period 2009 – 2018, the chlorophyll-*a* and Secchi depth targets proposed in the 2019 SWP were almost always met in the eastern zone, frequently met in the central zone, and rarely or never met in the western zone (Figs. 2 and 3).

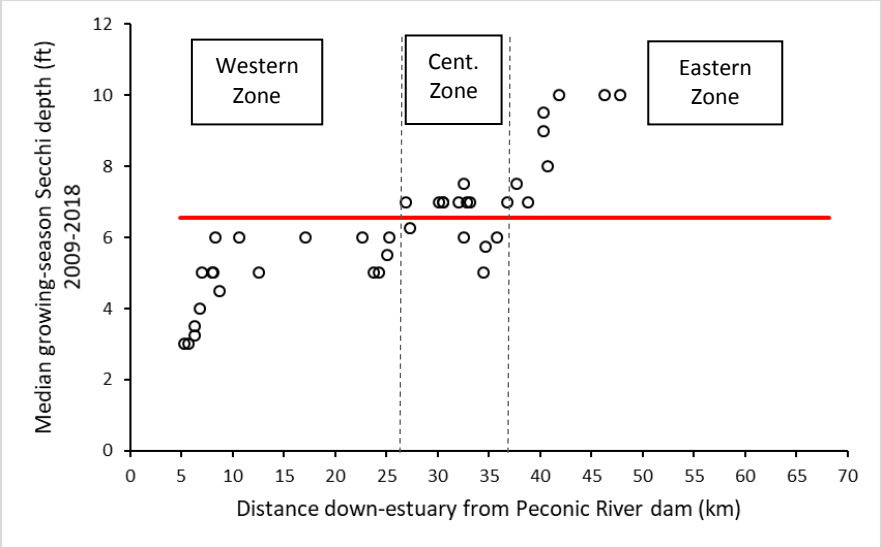


Fig. 2. Median growing season Secchi depth during the years 2009 – 2018 at SCDHS monitoring stations in the three proposed management/reporting zones. Red horizontal line represents 2019 SWP water quality target. (Data source: SCDHS)

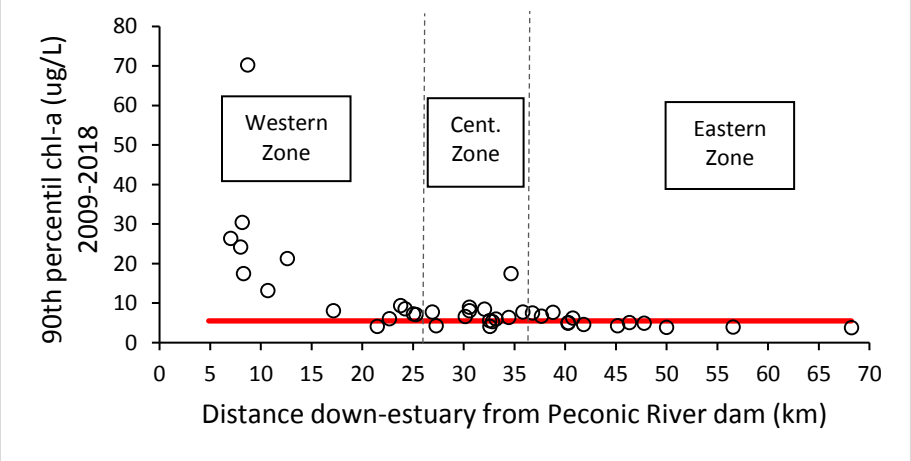


Fig. 2. 90$^{th}$ percentile growing season chlorophyll-*a* concentrations during the years 2009 – 2018 at SCDHS monitoring stations in the three proposed management/ reporting zones. Red horizontal line represents 2019 SWP water quality target. (Data source: SCDHS)

## IV. Proposed 'stoplight graphics' for tracking/reporting Secchi depths and chlorophyll-*a* concentrations

Graphics using the green/yellow/red 'stoplight' color scheme can be used to indicate spatial and temporal variations in water quality (e.g., TBEP 2019), with green table cells indicating places and times where targets are clearly met, red indicating places and times where targets are clearly not met, and yellow indicating intermediate or borderline situations. Examples for the three proposed reporting

zones in Peconic Estuary, using SCDHS Secchi depth and chlorophyll-*a* data from the years 1976 through 2018, are presented in Table 1. Growing season median values are shown for both parameters. Nonparametric (distribution-free) 95% confidence intervals were used to determine the green, yellow and red classifications. Median Secchi depth values whose lower 95% confidence limits exceeded the 6.5ft SWP target, and median chlorophyll-*a* values whose upper 95% confidence limits were below the 5.5 µg/L SWP target, were classified as meeting the target (=green). Median Secchi depth values whose upper 95% confidence limits were below the 6.5ft SWP target, and median chlorophyll-*a* values whose lower 95% confidence limits were above the 5.5 µg/L SWP target, were classified as failing to meet the target (=red). Median values whose upper and lower 95% confidence intervals bracketed a target were classified as intermediate or indeterminate (=yellow).

**Table 1. Stoplight graphic summarizing attainment of the proposed Secchi depth and chlorophyll-*a* targets in the three Peconic Estuary reporting zones for the years 1976 – 2018. Data source: SCDHS**

| Estuary Segment | YY | Median Chl=a (µg/L) | Median Secchi Depth (ft) |
|---|---|---|---|
| West | 1976 | 22.2 | 3.5 |
| West | 1977 | -- | 3.0 |
| West | 1978 | -- | 5.0 |
| West | 1979 | -- | 4.0 |
| West | 1980 | -- | -- |
| West | 1981 | -- | 5.0 |
| West | 1982 | -- | -- |
| West | 1983 | -- | -- |
| West | 1984 | -- | -- |
| West | 1985 | -- | 2.5 |
| West | 1986 | -- | 4.0 |
| West | 1987 | -- | 4.0 |
| West | 1988 | 12.6 | 3.5 |
| West | 1989 | 5.0 | 7.0 |
| West | 1990 | 4.2 | 5.0 |
| West | 1991 | 6.0 | 3.5 |
| West | 1992 | 4.0 | 4.0 |
| West | 1993 | 3.8 | 4.5 |
| West | 1994 | 3.5 | 5.5 |
| West | 1995 | 6.9 | 4.0 |
| West | 1996 | 7.4 | 5.5 |
| West | 1997 | 7.8 | 5.5 |
| West | 1998 | 3.8 | 5.5 |
| West | 1999 | 3.4 | 5.5 |
| West | 2000 | 3.2 | 5.0 |
| West | 2001 | 4.1 | 5.0 |
| West | 2002 | 3.8 | 5.5 |
| West | 2003 | 4.3 | 5.0 |
| West | 2004 | 4.4 | 5.0 |
| West | 2005 | 3.9 | 5.5 |
| West | 2006 | 4.8 | 6.0 |
| West | 2007 | 4.7 | 6.0 |
| West | 2008 | 4.8 | 5.5 |
| West | 2009 | 4.3 | 5.0 |
| West | 2010 | 9.0 | 5.0 |
| West | 2011 | 4.9 | 5.0 |
| West | 2012 | 3.9 | 5.0 |
| West | 2013 | 5.1 | 6.5 |
| West | 2014 | 3.2 | 6.0 |
| West | 2015 | 2.6 | 5.5 |
| West | 2016 | 3.6 | 4.5 |
| West | 2017 | 6.7 | 4.0 |
| West | 2018 | 5.4 | 5.0 |

| Estuary Segment | YY | Median Chl=a (µg/L) | Median Secchi Depth (ft) |
|---|---|---|---|
| Central | 1976 | -- | -- |
| Central | 1977 | -- | -- |
| Central | 1978 | -- | -- |
| Central | 1979 | -- | -- |
| Central | 1980 | -- | -- |
| Central | 1981 | -- | -- |
| Central | 1982 | -- | -- |
| Central | 1983 | -- | -- |
| Central | 1984 | -- | -- |
| Central | 1985 | -- | -- |
| Central | 1986 | -- | 5.0 |
| Central | 1987 | -- | 3.5 |
| Central | 1988 | 12.0 | 4.5 |
| Central | 1989 | 4.6 | 7.0 |
| Central | 1990 | 3.5 | 7.0 |
| Central | 1991 | 8.6 | 3.3 |
| Central | 1992 | 3.2 | 5.5 |
| Central | 1993 | 3.0 | 6.5 |
| Central | 1994 | 2.7 | 7.5 |
| Central | 1995 | 4.8 | 5.5 |
| Central | 1996 | 3.9 | 7.5 |
| Central | 1997 | 4.1 | 7.0 |
| Central | 1998 | 2.6 | 7.0 |
| Central | 1999 | 2.2 | 7.5 |
| Central | 2000 | 1.6 | 7.0 |
| Central | 2001 | 2.4 | 7.0 |
| Central | 2002 | 3.1 | 7.0 |
| Central | 2003 | 2.3 | 9.0 |
| Central | 2004 | 2.5 | 7.5 |
| Central | 2005 | 1.9 | 7.5 |
| Central | 2006 | 2.9 | 8.0 |
| Central | 2007 | 3.8 | 7.0 |
| Central | 2008 | 2.9 | 7.0 |
| Central | 2009 | 2.5 | 7.3 |
| Central | 2010 | 4.5 | 6.5 |
| Central | 2011 | 2.8 | 7.0 |
| Central | 2012 | 2.7 | 6.0 |
| Central | 2013 | 3.1 | 7.5 |
| Central | 2014 | 2.3 | 7.0 |
| Central | 2015 | 1.9 | 6.5 |
| Central | 2016 | 2.4 | 6.0 |
| Central | 2017 | 3.3 | 6.0 |
| Central | 2018 | 2.3 | 6.0 |

| Estuary Segment | YY | Median Chl=a (µg/L) | Median Secchi Depth (Fft) |
|---|---|---|---|
| East | 1976 | -- | -- |
| East | 1977 | -- | -- |
| East | 1978 | -- | -- |
| East | 1979 | -- | -- |
| East | 1980 | -- | -- |
| East | 1981 | -- | -- |
| East | 1982 | -- | -- |
| East | 1983 | -- | -- |
| East | 1984 | -- | -- |
| East | 1985 | -- | -- |
| East | 1986 | -- | 6.5 |
| East | 1987 | -- | 5.0 |
| East | 1988 | 7.5 | 6.0 |
| East | 1989 | 4.5 | 8.0 |
| East | 1990 | 3.0 | 8.5 |
| East | 1991 | 5.0 | 6.0 |
| East | 1992 | 2.5 | 7.5 |
| East | 1993 | 2.8 | 7.5 |
| East | 1994 | 2.4 | 8.5 |
| East | 1995 | 2.9 | 7.0 |
| East | 1996 | 3.0 | 8.5 |
| East | 1997 | 3.2 | 9.5 |
| East | 1998 | 2.1 | -- |
| East | 1999 | 1.6 | 8.0 |
| East | 2000 | 1.2 | 8.0 |
| East | 2001 | 1.9 | 8.0 |
| East | 2002 | 2.5 | 8.0 |
| East | 2003 | 2.4 | 8.0 |
| East | 2004 | 2.8 | 8.0 |
| East | 2005 | 1.5 | 8.0 |
| East | 2006 | 2.7 | 8.5 |
| East | 2007 | 3.3 | 8.5 |
| East | 2008 | 2.4 | -- |
| East | 2009 | 2.2 | 9.0 |
| East | 2010 | 2.8 | 9.0 |
| East | 2011 | 2.4 | 8.0 |
| East | 2012 | 2.1 | 7.0 |
| East | 2013 | 2.4 | 9.0 |
| East | 2014 | 1.9 | 8.0 |
| East | 2015 | 1.5 | 9.0 |
| East | 2016 | 2.2 | 7.5 |
| East | 2017 | 2.1 | 8.0 |
| East | 2018 | 2.9 | 7.5 |

## V. Proposed 'stoplight graphic' for tracking/reporting *Enterococcus* levels at swimming beaches

As noted on the Suffolk County website (https://www.suffolkcountyny.gov/Departments/Health-Services/Environmental-Quality/Ecology/Beach-Monitoring-Program), water quality at swimming beaches can be adversely affected by episodic sources such as stormwater runoff, wastewater discharges from boats or land-based septic systems, and fecal material from pets and wildlife. In order to provide information on the potential presence of pathogens public in swimming areas that may be impacted by such contamination, the Suffolk County Department of Health Services (SCDHS) conducts a comprehensive bathing beach water quality monitoring program from May through September each year. Sampling is performed by SCDHS staff, with analyses conducted by the Department's accredited Public and Environmental Health Laboratory (PEHL).

As with the example above, information from this monitoring program can also be summarized in 'stoplight' form, to allow the frequency of *Enterococcus*-based beach closures to be summarized and tracked. An example of this approach is shown in Table 2, for the years 2010 through 2018. Numbers in the table cells represent the number of *Enterococcus*-related beach closures (due to exceedances of the 104 cfu/100 ml criterion) that occurred in a given year. Years with zero closures are shown as green, those with one closure are shown as yellow, and those with more than one closure are shown as red. In this data set the Founders Landing beach stands out as experiencing a substantially larger number of closures than the other locations sampled.

**Table 2. Frequencies of *Enterococcus*-related Peconic Estuary beach closures for the years 2010 through 2018. (Data source: SCDHS)**

| Beach Name | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Subtotals |
|---|---|---|---|---|---|---|---|---|---|---|
| Alberts Landing Beach | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Camp Blue Bay Beach | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Camp Quinipet Beach | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 5 |
| Clearwater Beach | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Cornell Cooperative Extension Marine Center Beach | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Crescent Beach - Shelter Island | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Culloden Shores Beach | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Devon Yacht Club Beach | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| East Lake Drive Beach | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fifth Street Park Beach | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 1 | 5 |
| Fleets Neck Beach | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Foster Memorial Beach | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Founders Landing Beach | 2 | 1 | 1 | 1 | 0 | 0 | 1 | 3 | 1 | 10 |
| Goose Creek Beach | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Havens Beach | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Maidstone Beach | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Meschutt Beach | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 3 |
| Nassau Point Causeway Beach | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 |
| New Suffolk Beach | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Norman E. Klipp Park Beach | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 |
| Perlman Music Camp Beach | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| Pridwin Hotel Beach | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 |
| Shelter Island Heights Beach Club Beach | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| Silver Sands Motel Beach | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 4 |
| South Jamesport Beach | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 4 |
| Southampton Peconic Beach & Tennis Club Beach | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Veteran's Memorial Park Beach | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 4 |
| Wades Beach | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

## VI. Next Steps

The issues identified by the TAC at its December 4, 2019, meeting will require additional consideration and evaluation prior to the finalization of targets. As noted above, these evaluations and decisions by the TAC are due to be completed before the planned September 2020, PEP conference. The TAC should assign timelines and responsible parties to each of the issues identified as requiring additional consideration as a first and critical step in order to meet the September 2020 due date.

The methods that PEP selects for measuring and reporting levels of attainment of its water quality targets will need to be based on statistical considerations. Environmental monitoring data rarely follow the symmetric, bell-shaped 'normal' distribution that underlies the most frequently-used statistical procedures. Field measurements of many water quality parameters, such as chlorophyll-*a*, nutrient and potential toxin concentrations, are typically skewed rather than symmetric. They frequently contain 'outliers' (values that are substantially larger than the bulk of the data), and often appear to follow a lognormal, gamma or other 'non-normal' distribution (e.g., Gilbert 1987). In addition, monitoring data are often 'censored' due to the presence of nutrient or chemical concentrations that are less than laboratory detection limits ('left censoring') or to values that are known to be greater than the measured values ('right censoring')(e.g., Millard 2013). Right censoring is common in Secchi depth data from shallow-water areas, where the disk is often visible to the bay bottom. In such cases the Secchi depth is known to be larger than the observed value, but its true value is unknown (e.g., Carstensen 2010).

Right-censoring occurs frequently in the SCDHS Secchi depth data, particularly at shallow-water stations. The median Secchi depths and 95% confidence limits used to generate Table 1 and Figure 2 were therefore calculated using the Kaplan-Meier method (Barker 2009), which was developed for analysis of right-censored data and provides nonparametric (distribution-free) maximum likelihood parameter estimates (Allison 1995). Other analytical options are also available (e.g., Carstensen 2010), and could be explored by the TAC.

Left-censoring is not an issue with the SCDHS chlorophyll-*a* data used to produce Table 1 and Figure 3, but the data sets for each year and estuary section contain numerous outliers, are highly skewed and are clearly non-normal. This does not affect calculations of median values, but nonparametric, distribution-free methods were used to calculate 95% confidence limits for the annual medians to evaluate target attainment and non-attainment for Table 1.

The provisional Secchi depth and chlorophyll-*a* targets discussed above are based on median values (rather than means or other potential choices such as $80^{th}$ or $90^{th}$ percentiles), in recognition of the statistical robustness of medians when applied to skewed, censored and otherwise 'non-normal' data. In some situations, however, other estimators may have advantages that outweigh these desirable characteristics and could be evaluated during the target selection process. For example, median values are appropriate for estimating 'average' water conditions that occur throughout the growing season of a given year. But for living resources that respond strongly to shorter-term phenomena, such as episodic phytoplankton blooms that may affect chlorophyll-*a* concentrations, Secchi depths and other water quality parameters for only a portion of the growing season, other estimators may prove to be more helpful for tracking water quality conditions that are most relevant to them.

In addition to these statistical concerns the TAC may also wish to consider several resource management issues, either during the process of finalizing the initial water quality targets or in future years when the performance and usefulness of the selected targets can be assessed. Potential issues here include:

- The possible need for different water clarity targets to support restoration of former vs. protecting existing eelgrass beds, and for maintaining eelgrass beds in waters experiencing varying levels of temperature stress and/or eutrophication. Numerous studies (reviewed by Kenworthy et al. 2014) have shown that eelgrass beds growing in more eutrophic conditions, for example, can have water clarity and light requirements that are substantially higher than those in less eutrophic sites.

- In addition to the three proposed water quality management and reporting zones shown in Figure 1, it may also be helpful to develop water quality targets, and monitoring and assessment strategies, for the smaller embayments within each zone. A citizen science program could potentially be developed to provide water quality samples and other information from the embayments, which may be difficult to include in the existing SCDHS monitoring program due to cost constraints.

- The effects of global climate change on water temperature, dissolved oxygen and pH levels in the estuary, and their potential impacts on living resources such as native fish, shellfish and aquatic plants. As the climate continues to change, monitoring strategies will need to adapt and adaptive management practices will become increasingly necessary for resource management programs (e.g., https://www.epa.gov/arc-x/climate-adaptation-and-estuaries).

## VII. References


Allison, P.D. 1995. Survival Analysis Using SAS: A Practical Guide. SAS Institute, Cary, NC. 292 pp.

Barker, C. 2009. The mean, median and confidence intervals of the Kaplan-Meier survival estimate: Computations and applications. American Statistician 63:78-80.

Carstensen, J. 2010. Censored data regression: Statistical methods for analyzing Secchi transparency in shallow systems. Limnology and Oceanography: Methods 8:376-385.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Company, N.Y. 320 pp.

Gobler, C. 2007. Water quality in Long Island's estuaries: South Shore Estuary Reserve, Peconic Estuary and Long Island Sound. pp. 21-26 *in:* New York Seagrass Meeting, May 22, 2007. Meeting Proceedings and Priority Recommendations.
https://seagrant.sunysb.edu/Images/Uploads/PDFs/SeagrassMeeting07-Proceedings.pdf

Kenworthy, W.J., et al. 2014. Dependence of eelgrass (*Zostera marina*) light requirements on sediment organic matter in Massachusetts coastal bays: Implications for remediation and restoration. *Mar. Pollut. Bull.* 83:446-57.

Millard, S.P. 2013. EnvStats: An R Package for Environmental Statistics. Springer, N.Y. DOI: 10.1007/978-1-4614-8456-1.

Suffolk County Department of Health Services (SCDHS). 2019. Draft Subwatersheds Wastewater Plan. Prepared by CDM Smith, June 2019. https://reclaimourwater.info/TheSubwatershedsWastewaterPlan.aspx

Tampa Bay Estuary Program (TBEP). 2019. Tampa Bay water quality assessment for 2018. TBEP, St. Petersburg, FL. https://www.tbeptech.org/TBEP_TECH_PUBS/2019/TBEP_01_19_2018_Decision_Matrix_Update_FINAL.pdf.

**APPENDIX A**

**Information on SCDHS/Peconic Estuary Program stations**

| Station Number | Station Name | Distance from Peconic River dam (km) | Mean Depth (ft) 2009 - 2018 | First Year Sampled | Median Growing Season Secchi depth (ft) 2009-2018 | N_OBS Secchi 2009 - 2018 | Secchi VOB % 2009 - 2018 | 90th percentile Growing Season [Chla] ug/L 2009 - 2018 |
|---|---|---|---|---|---|---|---|---|
| 60101 | East Creek (South Jamesport) | 12.6 | 6.2 | 1994 | 5.0 | 73 | 16% | 21.3 |
| 60102 | Cutchogue Harbor | 23.8 | 11.5 | 1994 | 5.0 | 69 | 1% | 9.4 |
| 60103 | East Creek (Cutchogue) | 24.2 | 6.9 | 1994 | 5.0 | 68 | 25% | 8.6 |
| 60104 | North Sea Harbor | 25.3 | 10.2 | 1994 | 6.0 | 68 | 12% | 7.1 |
| 60105 | Hog Neck Bay North | 27.3 | 19.1 | 1994 | 6.3 | 40 | 0% | 4.3 |
| 60106 | Goose Creek | 30.2 | 8.3 | 1994 | 7.0 | 67 | 36% | 6.6 |
| 60107 | Town Creek | 30.6 | 9.7 | 1994 | 7.0 | 66 | 26% | 9.0 |
| 60109 | Mill Creek (Hashamomuck Pond) | 32.6 | 7.7 | 1994 | 6.0 | 71 | 28% | 4.1 |
| 60111 | Greenport Harbor | 37.7 | 26.7 | 1994 | 7.5 | 64 | 0% | 6.7 |
| 60113 | Little Peconic Bay | 25.1 | 33.8 | 1985 | 5.5 | 96 | 0% | 7.3 |
| 60114 | Paradise Point | 32.6 | 71.9 | 1985 | 7.5 | 99 | 0% | 5.6 |
| 60115 | Orient Harbor | 40.7 | 22.7 | 1985 | 8.0 | 97 | 0% | 6.2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 60116 | Gardiner's Bay West | 41.8 | 14.1 | 1986 | 10.0 | 93 | 24% | 4.6 |
| 60118 | Northwest Harbor | 40.3 | 23.6 | 1986 | 9.5 | 95 | 4% | 5.1 |
| 60119 | West Neck Bay | 34.7 | 12.0 | 1987 | 5.8 | 84 | 6% | 17.5 |
| 60121 | Noyack Bay | 33.2 | 24.2 | 1987 | 7.0 | 97 | 0% | 6.0 |
| 60122 | Coecles Harbor | 38.8 | 7.9 | 1992 | 7.0 | 75 | 39% | 7.7 |
| 60124 | West Neck Harbor | 34.5 | 10.5 | 1994 | 5.0 | 74 | 11% | 6.4 |
| 60126 | Sag Harbor | 36.8 | 11.3 | 1994 | 7.0 | 71 | 15% | 7.5 |
| 60127 | Sag Harbor Cove | 35.8 | 7.2 | 1994 | 6.0 | 70 | 34% | 7.8 |
| 60130 | Great Peconic Bay | 17.2 | 21.3 | 1976 | 6.0 | 93 | 0% | 8.1 |
| 60131 | Northwest Creek | 40.3 | 9.9 | 1994 | 9.0 | 51 | 49% | 4.9 |
| 60132 | Three Mile Harbor | 46.3 | 12.5 | 1994 | 10.0 | 46 | 30% | 5.1 |
| 60133 | Acabonac Harbor | 50.0 | 6.9 | 1994 | -- | 48 | 83% | 3.9 |
| 60134 | Napeague Harbor | 56.6 | 7.7 | 1994 | -- | 44 | 89% | 4.0 |
| 60135 | Lake Montauk | 68.2 | 8.9 | 1994 | -- | 46 | 76% | 3.8 |
| 60137 | Gardiner's Bay Central | 47.8 | 32.3 | 1996 | 10.0 | 30 | 0% | 4.9 |
| 60148 | Bullhead Bay | 22.7 | 4.5 | 1998 | 6.0 | 67 | 70% | 6.1 |
| 60170 | Flanders Bay | 10.7 | 9.0 | 1976 | 6.0 | 126 | 11% | 13.2 |
| 60210 | Reeves Bay | 8.3 | 6.8 | 1976 | 6.0 | 73 | 38% | 17.5 |
| 60220 | Meetinghouse Creek | 8.7 | 8.9 | 1976 | 4.5 | 104 | 5% | 70.3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 60230 | Terrys Creek | 8.2 | 8.1 | 1976 | 5.0 | 41 | 17% | 30.4 |
| 60240 | Peconic River Mouth | 8.0 | 7.2 | 1976 | 5.0 | 134 | 10% | 24.2 |
| 60250 | Sawmill Creek | 7.0 | 5.1 | 1976 | 5.0 | 40 | 48% | 26.4 |
| 60260 | Peconic River (no Chla data 2009-2018) | 6.9 | 7.8 | 1976 | 4.0 | 33 | 3% | -- |
| 60265 | Peconic River (no Chla data 2009-2018) | 6.3 | 8.0 | 2015 | 3.5 | 33 | 0% | -- |
| 60266 | Peconic River (no Chla data 2009-2018) | 6.3 | 7.8 | 2015 | 3.3 | 14 | 0% | -- |
| 60270 | Peconic River (no Chla data 2009-2018) | 5.7 | 9.3 | 1976 | 3.0 | 33 | 0% | -- |
| 60275 | Peconic River (no Chla data 2009-2018) | 5.3 | 9.2 | 2015 | 3.0 | 33 | 0% | -- |
| 60290 | Cold Spring Pond | 21.5 | 6.3 | 2002 | | 53 | 77% | 4.1 |
| 60300 | Wooley Pond | 26.9 | 8.5 | 2002 | 7.0 | 52 | 33% | 7.8 |
| 60310 | Noyack Creek | 30.6 | 8.9 | 2002 | 7.0 | 50 | 36% | 8.1 |
| 60320 | Mill Creek | 32.1 | 8.2 | 2002 | 7.0 | 54 | 35% | 8.5 |
| 60330 | Hallocks Bay | 45.2 | 6.9 | 2001 | -- | 53 | 74% | 4.3 |
| 60340 | Hashamomuck Pond 1 | 32.8 | 7.6 | 2001 | 7.0 | 51 | 43% | 5.3 |

SIGN-IN SHEET:
PEP TAC Meeting
Maxine S. Postal Auditorium
300 Center Drive
Riverhead, NY 11901
December 4, 2019
10:00 AM

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| Mary Ann Eddy | Sag Harbor - Harbor Committee | | |
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