Michele Barden
U.S. Environmental Protection Agency – Region 1
5 Post Office Square, Suite 100 (06-1)
Boston, MA 02109-3912

Claire Golden
MassDEP - Surface Water Discharge Program
150 Presidential Way
Woburn, MA 01801

RE: Comments on MWRA Deer Island 2023 Draft Permit for Massachusetts Bay outfall

I am an oceanographer with many years of experience researching processes related to water quality in several coastal New England waterbodies including Massachusetts Bay. I worked as full-time staff at MWRA, where the environmental quality department and its contracted consultants run a high-quality monitoring program, for more than 8 years until early 2023. One of my roles there was to help analyze and interpret various Mass Bay datasets with respect to the monitoring goals. Although I wasn't involved in the 1990s and 2000s, I have become very familiar with the history of the monitoring program development and resulting 2000 permit; I am appreciative that EPA and MassDEP based them on good science, and that the Outfall Monitoring Science Advisory Panel has continued to give informed guidance through the years. My academic affiliation is the University of Rhode Island but the views expressed here are my own, as a scientist with knowledge of the Mass Bay ecosystem and MWRA monitoring programs, and as a Boston resident and MWRA ratepayer.

Background context relevant to below comments. As is reflected in the Fact Sheet and references it cites, the single most identifiable effect of the outfall on Mass Bay and its most serious potential cause of harm is nutrients in the effluent, particularly ammonium. The influence of effluent ammonium on the bay has been the subject of intense monitoring and analysis and is well understood. It results in water column concentrations increased above natural background levels persistently within about 5-10 km of the outfall, lesser increases that occur intermittently out to about 10-15 km away, and, rarely, more minor increases as far as 20-25 km away. Furthermore, it also is well understood that the only mechanism by which nutrients could potentially affect other aspects of the bay ecosystem is through their uptake by phytoplankton, and that studies seeking to identify modified phytoplankton conditions have found none. This includes phytoplankton species responsible for harmful algal blooms (HABs). The new permit should update the water column monitoring accordingly, in line with the recommendations from Hagy et al (2022) as cited in the Fact Sheet, for "reducing effort to monitor issues that have been resolved significantly via decades of monitoring" and to "focus on the most pertinent and prospective environmental concerns and their potential relationship to the discharge".

Requiring zooplankton monitoring by MWRA is not justified.

The water column monitoring spans hydrographic conditions, nutrients, phytoplankton, and zooplankton. Hydrography, nutrients, and phytoplankton are all closely relevant to potential effects of effluent and merit sustained bay monitoring—at least under the approach taken by the Draft Permit, which is cautious as noted by Hagy et al (2022) which the Fact Sheet cites as its supporting rationale.

In contrast, potential effects of effluent nutrients on zooplankton would have to result from impacts on phytoplankton. As noted in the Fact Sheet and documents it cites, such effects on phytoplankton are so far absent, and not anticipated to be likely even under the potential regime shifts raised by the Fact Sheet. While it is cautious to continue monitoring phytoplankton, continuing to monitor zooplankton is sufficiently beyond cautious to be unwarranted. Zooplankton are a trophic level further removed from potential influence of the outfall. Furthermore, in Mass Bay the relationship between zooplankton whales feed on and phytoplankton is not a tight coupling, in contrast to top-down systems strongly influenced by grazing, in part because the most important prey for some key zooplankton may not be phytoplankton.

Zooplankton are prey for endangered North Atlantic Right whales, and as such, monitoring and research to expand our understanding of them is important and necessary. However, the link between zooplankton and the MWRA outfall is too weak to reasonably justify continuation of MWRA zooplankton monitoring, until and unless more conclusive links between phytoplankton and effluent are documented.

Requiring Cape Cod Bay monitoring by MWRA is not justified.

The three Cape Cod Bay stations are so distant from the outfall, well beyond any intermittent minor influence of increased ammonium from the outfall, that they should be dropped from MWRA monitoring. In recent years there have been occurrences of hypoxia in Cape Cod Bay, but as noted by the Fact Sheet and documents it cites, extensive analysis has concluded that the factors responsible (e.g. regional trends for warming and shifts in wind patterns, unusual regional dinoflagellate blooms) do not include the outfall. This is consistent with knowledge of effluent ammonium dispersal in Mass Bay (as noted above) and the fact that dilution is very high by the time it reaches Cape Cod Bay, at least 37 km away.

Monitoring and understanding hypoxia in Cape Cod Bay is of course a high priority in general, but the link to the MWRA outfall influence is too weak to reasonably justify continuation of MWRA monitoring there. The only document considered by the Fact Sheet that indicates Cape Cod Bay monitoring by MWRA should continue is Hagy et al (2022), which does not provide supporting information for its assertion specific to the relationship between outfall influences and Cape Cod Bay.

Harmful algal bloom monitoring required of MWRA by the permit needs to (1) be oriented around a specific monitoring question focused on the potential role of effluent nutrients; and (2) improve its effectiveness through use of more modern technologies to the fullest extent justified.

HABs are a serious concern and carry potential threats to public health through shellfish consumption. They merit oceanographic research and rapid response monitoring.

However, the Fact Sheet and documents it cites make clear that the potential relationship between HABs and the outfall is unproven and largely speculative. The Draft Permit requirement for MWRA to continue the existing HAB component of its water column monitoring, and expand its rapid response sampling for additional HAB species, is a very cautious approach.

HAB monitoring and research are specialized and expensive endeavors. In addition to the public at large, the main beneficiaries are the shellfishing industry, related public health agencies, and scientific researchers. The scope and expense of the HAB monitoring in the Draft Permit is large, and it does not

include a sufficient focus on potential links to the outfall to justify it being funded wholly by MWRA ratepayers.

The HAB monitoring required by the Draft Permit consists mainly of weekly Rapid Response vessel-based surveys, during years when they bloom to an extent that they are observed during routine surveys above certain levels and/or their toxins are observed in shellfish above certain levels. The weekly surveys are necessary to achieve field sampling of nutrients and certain HAB species (*Alexandrium*, *Pseudo-nitzschia*) more frequently than occurs during routine monitoring surveys, which are each 3-5 weeks. While this weekly monitoring will improve tracking of HABs, and is of general interest, it is not designed with emphasis on improving understanding of the role of outfall nutrients on HABs.

As an example of this last point, there are extensive data from more than two decades of Rapid Response vessel-based surveys for *Alexandrium*, which have occurred in roughly half of the years. These data have improved our general understanding of bloom characteristics and variability. But they have not enabled advances toward better understanding of the potential role of effluent nutrients. This is evident from the statements in the Draft Permit and the documents it cites, which highlight a persistent lack of knowledge on the possible linkage between HABs and the outfall.

The Draft Permit and Fact Sheet do not provide a clear monitoring question that needs to be answered by the continued and expanded HAB monitoring. Such a question needs to be formulated, must be focused on potential effluent nutrient effects, and should be noted in the new permit so that there is an end game for the monitoring. At present it appears that the continued and expanded HAB monitoring in the Draft Permit is targeted on general understanding of HAB occurrence and variability, but not on links between effluent nutrients and HABs, and insufficient guidance is provided on the desired outcome or end goal.

A better approach would be for the new permit to require MWRA to carry out a Special Study to:

1. More definitively probe the existing phytoplankton monitoring datasets for potential relationships between effluent nitrogen and phytoplankton community structure, including HAB species.

2. Research available technologies and methods for HAB monitoring and do cost-benefit analyses comparing them to the Rapid Response survey approach of the Draft Permit with emphasis on cost-effectiveness and ability to identify potential roles of effluent nutrients.

MWRA has proven effective with Special Studies in the past, including through engagement of outside consultants in the process, and there is considerable oceanographic expertise available to them in Massachusetts and nearby states.

Examples of technologies for #2 include phytoplankton imaging systems, automated water sample collection devices, *in situ* ammonium sensors, autonomous surface vessels as sampling platforms, and many others. The potential advantages of equipping the A01 mooring (operated by NERACOOS) and the 44013 Boston Buoy (operated by NDBC) with HAB-relevant sensors, through suitable partnerships with these operators, should also be prioritized.

The Special Study should culminate in a report summarizing scientific understanding of links between effluent and phytoplankton, with guidance to define a monitoring question focused on the role of effluent ammonium, and recommendations to improve on the HAB monitoring approach described by

the Draft Permit through application of updated technology if justified in light of the cost-benefit analysis.

Note that the results of the technologies and methods part of the Special Study should be informative to improve not only the HAB component of the monitoring but also all the other components of the water column monitoring; in fact, if there is no Special Study focused on HABs there should be one focused on technologies and methods to improve the rest of the water column monitoring. In need of particular attention is that the 3-5 week gaps between the routine vessel-based surveys, as noted in the Fact Sheet, severely limit the understanding of oceanographic variability and events in bay conditions that occur during them. This makes continuous time series measurements extremely valuable. The Draft Permit requirement for MWRA to sustain its continuous sampling on the A01 mooring helps in this regard (though the Draft Permit should be clearer as to what parameters it requires for this sampling, and what depths each parameter should be sampled at). Additional timeseries sampling would bring many advantages to the monitoring, including possibly cost-effectiveness, and should be thoroughly explored.

The Mass Bay bacteria monitoring program should consist only of the "adverse" surveys component, with the routine monthly ("conditional") surveys discontinued.

Based on the extensive dataset for bacteria in Mass Bay, the monitoring of bacteria in effluent at the treatment plant is fully protective except potentially under unusual plant operating conditions or plant upset beyond the scale of those experienced during prior monitoring. The potential environmental impacts of such upsets are addressed by the adverse surveys, as triggered based on plant conditions, so continuing them will protect public health.

In contrast, the routine monthly surveys in Mass Bay should be ended. As shown by documents the Fact Sheet cites, nearly all results from the routine surveys have 90% or higher proportion of non-detects. Continuing to collect these data would not be informative nor useful. This is especially true because effluent will continue to be sampled for bacteria routinely at the treatment plant, with adverse surveys triggered and executed as appropriate.

Also: In the Draft Permit, the second sentence of item #3 on page 8 states "For reporting an average based on a mix of values detected and not detected, assign a value of "0" to all non-detects for that reporting period and report the average of all the results." While this approach is expedient, and has been used in past analyses, it is contrary to best practices for statistical methods (e.g., Helsel et al., 2020). The permit should either (a) provide justification for this requirement, despite that it does not follow best practices, or (b) instead require use of statistical methods appropriate for analysis of datasets with censored values (e.g., Helsel et al., 2020).

In the Draft Permit the elimination of several components of the MWRA Mass Bay monitoring programs—including the Contingency Plan, the benthic/sediment monitoring, the fish and shellfish monitoring, and the water quality modeling—is strongly supported by the scientific results from 30+ years of completed monitoring.

Contingency Plan. The Contingency Plan (CP) was valuable and useful during the first several years of operations of the Mass Bay outfall and served its intended purpose. However, after several years it was clear that the outfall operated as planned, without causing harmful changes. Since then, the CP has been ineffective because its thresholds were defined to detects changes relative to the 1990s baseline period,

and not necessarily changes that are harmful. This means that in recent years some of its thresholds have been exceeded due to climate change, unrelated to the outfall; for example, oxygen declines due to regional changes have caused CP exceedances over the past few years. The 30 years of baseline and post-diversion monitoring mean that we now understand much more about the bay, and potential outfall effects, such that requiring MWRA to continue to carry out the CP threshold checks and associated reporting would have effectively no benefit (and be an unjustified expense).

Benthic/sediment monitoring; Fish and shellfish monitoring. The monitoring questions these programs were designed to address have been thoroughly answered. MWRA has documented this in detail, in the reports cited by the Fact Sheet. For at least the most recent 5 years this monitoring has provided limited information useful to further address the questions. The programs were successful but they do not merit continuation and would not be an effective use of resources; this will remain true even under the influence of the potentially emerging regime changes the Fact Sheet cites as rationale for continued water column monitoring.

Water quality modeling. The investigations done using the Bays Eutrophication Model, in the late 1990s prior to the permit and as required by the permit since 2000, have served their purpose and led to improved understanding of potential effects of the outfall on Massachusetts Bay water quality. However, our current knowledge of processes by which the outfall influences bay conditions is quite mature. The recent update to the BEM showed that state-of-the-art modern modeling methods lead to results that confirm findings from earlier modeling. This includes scenario simulations that explicitly evaluate water quality with and without inputs from wastewater effluent. (Hagy et al 2022 commented that the recently updated model was not applied to such scenarios, but this is because they prepared their report a short time earlier than when MWRA published results of these particular simulations.) The benefits of modeling, as a complement to the observational monitoring program, have reached or passed a point of diminishing returns. Discontinuing the modeling requirement is justified, and will help MWRA to succeed more effectively with other goals.

Daniel L. Codiga, PhD

November 28, 2023

References cited

Hagy, J., Gleason, T., Oczkowski, A., Tatters, A., and Wan, Y., 2022. Technical Memorandum: Review of MWRA Water Quality Monitoring Results to Address Potential for Harmful Effects of the Deer Island Discharge on Threatened and Endangered Species in Massachusetts Bay. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-22/063.

Helsel, D.R., Hirsch, R.M., Ryberg, K.R., Archfield, S.A., and Gilroy, E.J., 2020. Statistical Methods in Water Resources: U.S. Geological Survey Techniques and Methods, book 4, chapter A3, 458 p.