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Draft Methodology for the 2022 Delaware River and Bay Water Quality Assessment

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Managing, Protecting and Improving the Water Resources of the Delaware River Basin since 1961

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Contents

1 Introduction

The Delaware River Basin Commission (DRBC) will assess waters of the mainstem Delaware River and Delaware Bay to determine whether the river is supporting the designated uses expressed in the Commission's Administrative Manual Part III, Water Quality Regulations (18 CFR Part 410). DRBC's Water Quality Regulations can be found at http://www.nj.gov/drbc/library/documents/WQregs.pdf

DRBC's assessment will be completed and submitted to the U.S. Environmental Protection Agency by April 1, 2022 under the title *2022 Delaware River and Bay Water Quality Assessment Report*.

This notice describes the proposed assessment methodology to be used by DRBC in performing its assessment for 2022. The purpose of this notice is to solicit comments and input from interested parties regarding the proposed assessment methodology. The Assessment Methodology proposed here is based on the methodology used in the 2020 report *with the following modifications*:

- In 2021, DRBC received water quality data from the tidal Schuylkill River from Bartram's Garden. This dataset included several parameters including dissolved oxygen, temperature, pH, turbidity, and bacteria (*E. coli)*. Dissolved oxygen, temperature, pH, and turbidity will be assessed using DRBC's methodology in the 2022 assessment. DRBC does not have criteria for *E. coli* so this parameter will be assessed using EPA criteria.

1.1 Coordination and Schedule

Because DRBC's role is to assess shared waters in the Basin, coordination with the Basin States is important. The Integrated Listing process includes a list of waters for which TMDLs must be prepared (i.e., 303(d) list). However, the regulatory responsibility for preparing a 303(d) list rests with the States.

In order to maximize agreement between the DRBC's 2022 Assessment and the Basin States' Integrated Lists, and to ensure that the Basin States have adequate time for their public noticing processes, it is DRBC's intent to provide a preliminary assessment to the States in advance of their administrative deadlines. To meet this task, the DRBC prepares the preliminary assessment and coordinates discussions with the Basin States during the year prior to the April 1 deadline. DRBC will provide a draft report to the states by February 28, 2022.

2 Assessment Methodology

The sections below describe specific details related to the 2022 assessment.

2.1 Data Window

For the 2022 assessment, DRBC will assess *readily available* data for a 5-year data window ending September 30, 2021.

Along with the notice of this methodology, DRBC will publish a notice in the Federal Register soliciting available data for inclusion in the 2022 assessment.

2.2 Assessment Units

Assessment units (AUs) are the spatial reaches within which data are grouped for assessment. Consistent with recent assessments, assessment units for most designated uses will consist of DRBC's Water Quality Management (WQM) Zones, as described in DRBC's Water Quality Regulations (http://www.nj.gov/drbc/library/documents/WQregs.pdf). WQM Zones include zones 1A, 1B, 1C, 1D, and 1E in the non-tidal river and Zones 2, 3, 4, and 5 in the tidal river, and Zone 6 in Delaware Bay. Zone C1-8 and intrastate streams (zones E, W1, W2, N1 and N2) are not assessed by DRBC, but rather are captured in the Integrated Reports of the Basin States. Figure 1 shows the assessment units for Delaware River and Bay, and Table 1 shows the river mile (miles from the mouth of the bay) limits for each assessment unit.

Figure 1. Delaware River Water Quality Management Zones/Assessment Units

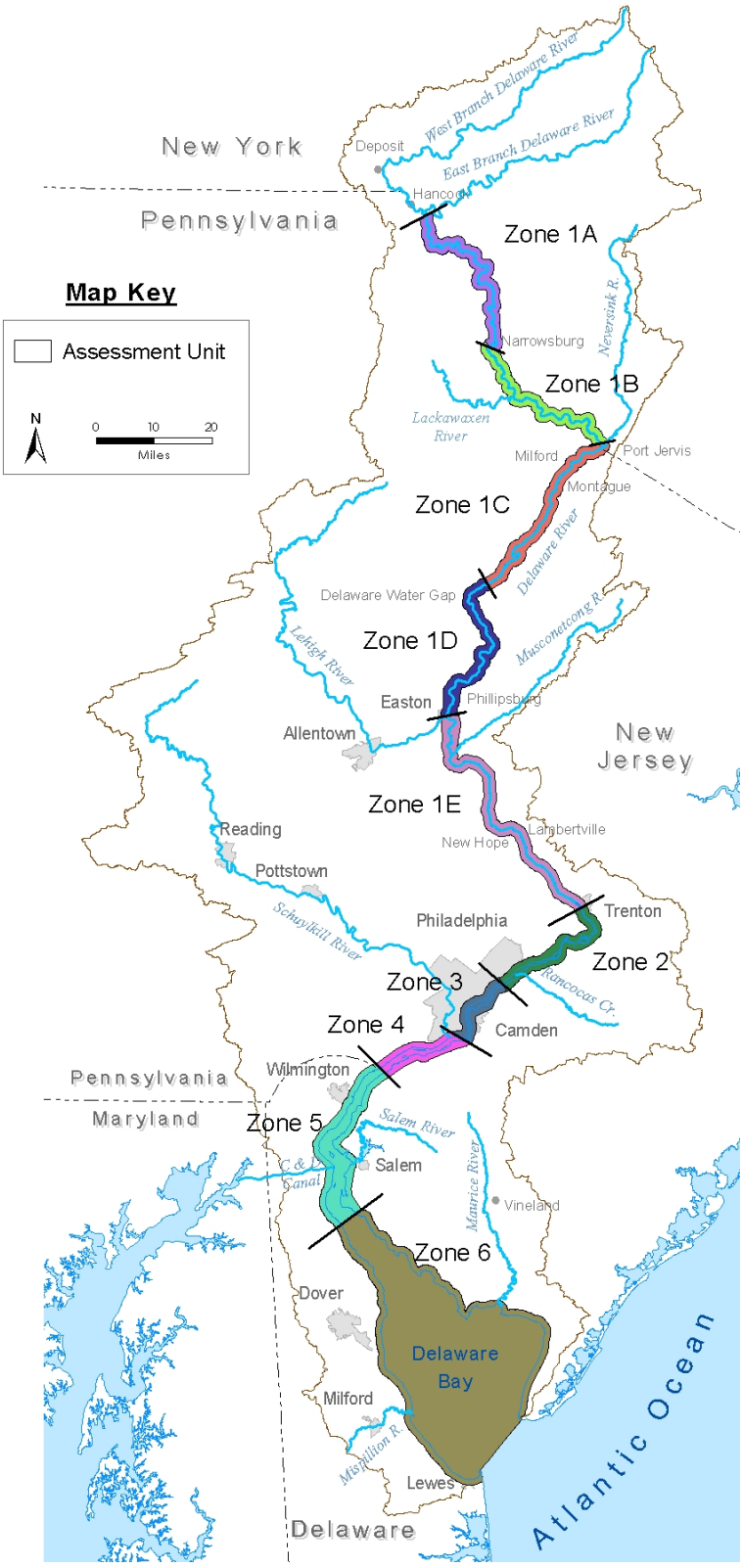

Table 1. Delaware River Water Quality Management (WQM) Zones

WQM zone	Location (as River Mile)
1A	330.7 – 289.9
1B	289.9 – 254.75
1C	254.75 – 217.0
1D	217.0 – 183.66
1E	183.66 – 133.4
2	133.4 – 108.4
3	108.4 – 95.0
4	95.0 – 78.8
5	78.8 – 48.2
6	48.2 – 0.0

It should be noted that Zone 4 includes standards for primary contact recreation up to River Mile 81.8, but secondary contact recreation only above River Mile 81.8. Similarly, Zone 5 is a transitional Zone between the estuary and the Bay. DRBC water quality regulations include different dissolved oxygen criteria for 3 sub-reaches within Zone 5. For Zone 5, the spatial location of measurements determines which DO criteria are applicable. However, Zones 4 and 5 are still treated as assessment units despite varied criteria within these zones.

Zone 6 encompasses numerous shellfish management subareas within the zone (Figure 2). Since a high degree of variability in the shellfish management areas is possible, and shellfish management areas are under the purview of the states, DRBC assesses individual shellfish management areas for the shellfish assessment, rather than Zone 6 as a whole.

Figure 2. Example Zone 6 Shellfish Management Assessment Units (2010)

2.3 Designated Uses and Data Requirements

Water uses are paramount in determining surface water quality standards. DRBC's Water Quality Standards require that all surface waters of the Basin be maintained in a safe and satisfactory condition for the following six (6) uses:

1) Agricultural, industrial and public water supplies after reasonable treatment, except where natural salinity precludes such uses;
2) Wildlife, fish and other aquatic life;
3) Recreation;
4) Navigation;
5) Controlled and regulated waste assimilation to the extent that such use is compatible with other uses; and
6) Such other uses as may be provided by the Commission's Comprehensive Plan.

Table 2 shows the designated uses assessed in each AU. The designated uses assessed in the non-tidal AUs (WQM zones: 1A, 1B, 1C, 1D, and 1E) include aquatic life, drinking water, primary recreation, and fish consumption.

Maintenance of resident fish and other aquatic life, and passage of anadromous fish, are designated uses for all WQM Zones. Propagation of fish is a designated use for all WQM Zones except Zones 3, 4 and the upper portion of Zone 5 (RM70.0 to 78.8).

The tidal Delaware River AUs (WQM Zones 2, 3, 4, and 5) are all designated for aquatic life and fish consumption. The drinking water use is designated in Zones 2 and 3 only. Primary contact recreation is designated for Zones 2 and 5, and Zone 4 below River Mile 81.8. Where primary contact recreation is not designated (Zone 3 and Zone 4 above River Mile 81.8), secondary contact recreation is designated. Secondary contact recreation is a designated use in all zones, however, where the primary contact use is designated, the standards are protective of both primary and secondary contact uses.

We assume that if the drinking water designated use is attained, agricultural and industrial uses are protected as well. We will assess agricultural and industrial uses separately, if the drinking water use is not attained.

The Delaware Bay AU (WQM Zone 6) is assessed for aquatic life, primary recreation, fish consumption, and shellfish.

Table 2. Designated Uses Applicable to Each AU (WQM Zone).

Designated Use	DRBC WQM Zone or AU									
	1A	1B	1C	1D	1E	2	3	4	5	6
Aquatic Life	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Drinking Water	✓	✓	✓	✓	✓	✓	✓			
Primary Recreation	✓	✓	✓	✓	✓	✓		✓	✓	✓
Secondary Recreation							✓	✓		
Fish Consumption	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Shellfish Consumption										✓

The remainder of this section looks at the general approach for each designated use assessed relative to DRBC water quality standards and other supporting evidence. The tables below also describe the parameter-specific data requirements. It should be noted, however, that assessments might also be made using less robust data than indicated by the objectives, when the weight of evidence is compelling.

Listed below are cases where insufficient data (ID) are available and the uses can not be assessed against DRBC criteria. Such data would fail to support the designated use, but the assessment may be identified as "ID" rather than "not supported" when the following conditions exist:

a) The number of samples per AU over an assessment period or season was below data requirements
b) Background level was not specified in DRBC WQR and can not reasonably be determined for a particular AU
c) The parameter was not monitored in an AU
d) The parameter was analyzed in a matrix other than surface water

2.3.1 Aquatic Life

Aquatic life is to be protected in all DRBC WQM zones. The assessment for aquatic life is based upon:

- dissolved oxygen (DO);
- pH;
- temperature;
- total dissolved solids (TDS);
- alkalinity;
- toxic chemicals; and
- biological monitoring.

Table 3 below shows the criteria, assessment method, and data objectives for the aquatic life use assessment.

DRBC's temperature criteria in Zones 1A through 1E are structured as allowable increases above ambient stream temperature, but ambient stream temperature is not defined. For this reason, DRBC did not assess against its temperature criteria in Zones 1A through 1E. In the 2012 assessment, we investigated multiple methods of estimating ambient stream temperature using data and models, to compare observed temperatures to the allowable increase. We determined these methods to be unworkable in the 2012 assessment and did not assess Zones 1A through 1E in years since.

Through its interaction with the Water Quality Advisory Committee, DRBC identified Zones 1B through 1E as consistent with a warm water fishery. Zone 1A is a transitional zone influence for artificially lowered temperatures from reservoir releases. For this assessment, DRBC will assess Zones 1B through 1E against Pennsylvania and New Jersey ambient temperature criteria protective of warm water fisheries.

DRBC has adopted numeric toxics criteria in Zones 2 through 5. In addition, DRBC has a narrative standard requiring that:

> *"the waters shall be substantially free from … substances in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life"*

DRBC will assess data from zones 2 through 5 against its numeric criteria.

Where the DRBC has not adopted numeric toxics criteria (Zones 1A through 1E), DRBC narrative toxics standard will be implemented by an assessment methodology based on the most stringent of basin state standards in Zones 1A though 1E to ensure attainment and maintenance of downstream water quality standards and to facilitate consistent and efficient implementation and coordination of water quality-related management actions in shared interstate waters.

Stream quality objectives in the Delaware River are based on current EPA recommended national criteria and standards adopted by basin states. Criteria and standards to be used in the assessment of Zone 1 are New Jersey Surface Water Quality Standards, adopted January 18, 2011; Title 25, Chapter 93 Water Quality Standards of the Pennsylvania Code; NYDEC Part 703: Surface Water and Groundwater Quality Standards and Groundwater Limitations and USEPA National Recommended Water Quality Criteria.

In waters protected for public water supply, the most stringent ambient water quality criteria for human health for New York or Pennsylvania will be compared to surface water data in Zones 1A and 1B. The most stringent ambient water quality criteria for human health for Pennsylvania or New Jersey will be compared to surface water data in Zones 1C, 1D, and 1E.

For waters protected for use by fish and other aquatic life, the most stringent ambient water quality criteria will apply. Stream quality objectives for the protection of aquatic life for cadmium, chromium, copper, lead, nickel, silver and zinc shall be expressed as the dissolved form of the metal. Stream quality objectives for other metals shall be expressed as the concentration of the total recoverable form of the metal. For those stream quality objectives whose numerical value is related to hardness (cadmium, chromium III, copper, nickel silver and zinc), the actual criteria numeric value is computed with site-specific paired hardness measured concurrently with the toxic analytical parameter. When concurrent data is not available, median site-specific hardness measured at other times or at the nearest interstate control point (ICP) or boundary control point (BCP) may be used. ICPs are mainstem Delaware River monitoring points and BCPs are tributary monitoring points near their confluence with the mainstem. Where multiple sources of hardness data are available, the assessment will consider the weight of evidence for multiple derivations of the criteria.

For those stream quality objectives whose numerical value is related to pH (such as pentachlorophenol), site-specific paired pH measured concurrently with the toxic analytical parameter or median site-specific pH measured at other times or at the nearest interstate control point (ICP) or boundary control point (BCP) may be used.

Biological monitoring data will again be used for the aquatic life assessment, as was done for previous reports, using an interim methodology. The DRBC initiated biological monitoring of the Delaware River above the head-of-tide in 2001 using benthic macroinvertebrate collections. Through work with the Biological Advisory Subcommittee to the WQAC, the DRBC has developed an interim methodology (Silldorff and Limbeck 2009; see http://www.state.nj.us/drbc/library/documents/10IntegratedList/Bioassessment-draft-July2009rev.pdf) that uses benthic macroinvertebrate data as a direct assessment of the condition of the aquatic life use in the non-tidal Delaware River (Zones 1A to 1E). This interim methodology is based on a multi-metric index (termed Index of Biotic Integrity or IBI) that averages the standardized scores of 6 individual metrics (taxa richness, EPT richness, Shannon-Wiener diversity, biotic index, intolerant percent richness, and scraper richness). The multi-metric IBI scores can range from 0 up to 100, with higher values indicating improved aquatic life use condition. Under the current methodology, the DRBC has identified an IBI score of 75.6 units as the threshold between attainment (IBI>75.6) and non-attainment (IBI<75.6) for aquatic life use. Based on input from and discussion with the Biological Advisory Subcommittee, the DRBC will limit the application of this interim methodology in the 2022 Integrated Assessment to classification of non-tidal zones to only Categories 1, 2, and 3. For zones not meeting the attainment threshold using the methodology identified in Table 3, the biological assessment will classify the aquatic life as Category 3a, “Waters of Concern.”

Table 3. Aquatic Life data Requirements and assessment criteria

Parameter	AU	Criteria	Assessment Method	Data Requirements
DO	All	Meet all Zone specific instantaneous minimum, minimum 24-hour average, spawning, and seasonal criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1% of the samples per AU fail the criteria.	For instantaneous minimums, at least 20 measurements over the assessment period. For 24-hour averages, at least 20 daily averages over the assessment period.
Temperature	1A-1E	Not to exceed Zone specific increases above ambient temperature	Estimate ambient temperature using data or models Less than 1% of the samples per AU fail the criteria, considered in conjunction with the ambient temperature variability or model standard error.	At least 20 samples per AU over the assessment period
	2-6	Not to exceed Zone specific maximum temperatures listed in DRBC Water Quality Regulations, Sections 3.30 and 4.30	Less than 1% of the samples per AU fail the criteria	At least 20 samples per AU over the assessment period
pH	All	Meet Zone specific pH criteria range listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1% of the samples per AU fail the criteria., unless evidence shows that pH violation are the result of natural conditions and biological communities are not impaired	At least 20 samples per AU over the assessment period
TDS	1A-1E, 2-4	Not to exceed Zone specific TDS criteria listed in the DRBC Water Quality Regulations, Sections 3.20, 3.30 and 4.20.2	Less than 1% of the samples per AU fail the criteria.	At least 20 samples per AU over the assessment period
Alkalinity	1E, 2-6	Meet Zone specific criteria range in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1% of the samples per AU fail the criteria.	At least 20 samples per AU over the assessment period
Toxic Pollutants	2-5	Not to exceed criteria noted in DRBC Water Quality Regulations, Table 5	No more than one (1) exceedance in an AU over a three year window	Available data
	1, 6	Not to exceed EPA recommended CCC criteria	No more than one (1) exceedance in an AU over a three year window	Available data
Biological Monitoring	1A – 1E	6-metric IBI not to fall below 75.6 unit threshold	No more than 30% of samples per AU below the threshold in the assessment period	At least 2 years of data with multiple (2 or more) sites per AU in each

2.3.2 Drinking Water

Drinking water use is designated for WQM zones 1A through 1E, 2, and 3. The parameters used for determining drinking water use support are:

- TDS;
- chlorides;
- toxic substances (human health criteria for systemic toxicants and carcinogens in Zones 2 and 3 only);
- hardness;
- odor;
- phenol;
- sodium (Na); and
- turbidity.

Drinking water data requirements and assessment criteria are shown in Table 4. Since this particular use relates to human health, the assessment also takes into account information on actual impacts to the use such as frequent or extended closures of drinking water facilities due to recurring or chronic water quality concerns.

Table 4. Drinking Water data requirements and assessment criteria

Parameter	AU	Criteria	Assessment Method	Data Requirements
TDS	1A-1E, 2-3	Not to exceed Zone specific TDS criteria listed in the DRBC Water Quality Regulations, Sections 3.20, 3.30 and 4.20.2	Less than 1% of the samples per AU fail the criteria.	At least 20 samples per AU over the assessment period
Hardness	2-3	Not to exceed Zone specific 30-day average criteria listed in DRBC Water Quality Regulations, Section 3.30.2 and 3.30.3	Less than 1% of the samples per AU fail the criteria.	At least three samples in a 30-day period At least 20 samples per AU over the assessment period
Chlorides	2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Section 3.30.2 and 3.30.3	Less than 1% of the samples per AU fail the criteria.	At least two samples in a 15-day period (AU 2) At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the assessment period
Odor	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1% of the samples per AU fail the criteria.	Available data
Phenols	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Section 3.20 and 3.30	Less than 1% of the samples per AU fail the criteria.	At least 20 samples per AU over the assessment period
Na	3 at or above RM 98	Not to exceed 30-day average criteria listed in DRBC Water Quality Regulations, Section 3.30.3	Less than 1% of the samples per AU fail the criteria.	At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the assessment period
Turbidity	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1% of the samples per AU fail the criteria.	At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the assessment period
Systemic Toxicants	2-3	Not to exceed criteria listed in DRBC Water Quality Regulations, Section 3.30, Table 7	No more than one (1) exceedance in an AU over a three year window	At least 10 samples per AU over the assessment period
Carcinogens	2-3	Not to exceed criteria listed in DRBC Water Quality Regulations, Section 3.30, Table 6	No more than one (1) exceedance in an AU over a three year window	At least 10 samples per AU over the assessment period
Drinking Water Closures	1A-1E, 2-3	No frequent or extended closures of drinking water facilities due to recurring or chronic water quality concerns	No closures affecting an AU over the assessment period	Administrative closures for drinking water supply over the assessment period

2.3.3 Contact Recreation

In the DRBC Water Quality Regulations, the "Recreation" designated use includes all water-contact sports, and thus corresponds to “primary contact” recreation. Some waters, however, are designated as "Recreation - secondary contact" which restricts activities to where the probability of significant contact or water ingestion is minimal, encompassing but not limited to:

1. boating,
2. fishing,
3. those other activities involving limited contact with surface waters incident to shoreline recreation.

Criteria protective of the primary contact designated use are also protective of secondary contact uses. Criteria protective of secondary contact uses are not protective of primary contact uses.

Primary

Primary contact recreation applies to zones 1A-1E, 2, 4 below RM 81.8, and 5 and 6. The parameter used for determining primary contact recreation in zones 1A-1E is fecal coliform. In addition to fecal coliform, enterococcus bacteria is used to assess primary contact recreation in the tidal zones 2, 4, 5, and 6. Zone 4 is only assessed against primary contact standards below RM 81.8. The criteria are based on a geometric mean, with samples taken at a certain frequency and location as to permit valid interpretation.

Secondary

DRBC WQM zones 3 and 4 above RM 81.8 are restricted to secondary contact recreation. Fecal coliform and enterococcus bacteria are used to assess secondary contact recreation (Table 6). Zone 4 is assessed against secondary contact standards above RM 81.8. The criteria are based on a geometric mean, with samples taken at a certain frequency and location as to permit valid interpretation.

Table 5. Primary Contact Recreation data requirements and assessment criteria

Parameter	AU[A]	Criteria	Assessment Method	Data Requirements
Fecal coliform	1A-1E,2,4 (below RM 81.8),5,6	Not to exceed Zone specific Fecal coliform criteria listed in the DRBC Water Quality Regulations, Sections 3.20 and 3.30	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year
Enterococcus	2,4 (below RM 81.8)	Not to exceed Zone and sub-Zone specific Enterococcus criteria listed in the DRBC Water Quality Regulations, Section 3.30	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year
	5,6	Not to exceed Zone and sub-Zone specific Enterococcus criteria listed in the DRBC Water Quality Regulations, Section 3.30	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year

[A]WQM zone 4 is assessed for the parameters below RM 81.8.

Table 6. Secondary Contact Recreation data requirements and assessment criteria

Parameter	AU[A]	Criteria	Assessment Method	Data Requirements
Fecal coliform	3,4 (above RM 81.8)	Not a single geometric mean to exceed 770 / 100 ml	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year
Enterococcus	3,4 (above RM 81.8)	Not a single geometric mean to exceed 88 / 100 ml	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year

[A]WQM zone 4 is assessed for the parameters above RM 81.8.

2.3.4 Fish Consumption

Fish consumption designated use applies to all DRBC WQM zones. An assessment of "not supporting" the designated use is primarily based upon the presence of one or more consumption advisories in the main stem Delaware River and/or Estuary issued by a Basin State. For the purposes of this assessment, advisories related to the general population only are used, rather than advisories for more sensitive subpopulations. However, DRBC will review targeted consumption advisories for sensitive sub-populations in the absence of consumption advisories for the general population. The states' fish advisory reports current to the assessment period are used in the fish consumption assessment.

Monitoring data, if available, may also be used to support listed fish consumption advisories.

Table 7. Fish Consumption Data requirements and assessment criteria

Parameter	AU	Criteria	Assessment Method	Data Requirements
Fish Consumption Advisory	1A-1E, 2-6	Not a single fish advisory listed for an AU	Count of the number of fish consumption advisories per AU listed over the assessment period	NY, NJ, DE, and PA fish consumption advisories for the general population based upon the Basin states' water quality or fish tissue data

2.3.5 Shellfish Consumption

Shellfish consumption designated use only applies to DRBC WQM zone 6 (RM 48.2 to the mouth of the Delaware Bay). New Jersey and Delaware assess this use in their coastal waters, using procedures developed by the FDA National Shellfish Sanitation Program (NSSP) (http://www.fda.gov/food/guidanceregulation/federalstatefoodprograms/ucm2006754.htm). Both states use total coliform (as most probable number) as the assessment tool and compare it against federal shellfish standards.

In both states, waters classified for shellfishing may be opened for that use all year round. In some cases, the AU is opened seasonally (typically in winter). In other cases, harvesting may be prohibited due to administrative closures based upon proximity to sewer outfalls. In still other cases, waters may be open to harvesting, but with special treatment of the shellfish, such as transplantation to cleaner waters for a period of time prior to the harvesting. Finally, some waters are closed to shellfish harvesting due to existing water quality concerns.

Table 8. Shellfish Consumption data requirements and assessment criteria

Parameter	AU[A]	Criterion	Assessment Method	Data Requirements
Shellfish Consumption Classifications	6	No prohibitions and/or year-round closures in an AU. Shellfish waters with special conditions and temporal windows are assessed as supporting but with conditions	Determine the number of shellfish harvesting prohibitions, year-round closures, and limiting conditions per AU listed over the assessment period	DE and NJ shellfish consumption and harvesting advisories, prohibitions, closures, and limiting conditions per AU over the assessment period

[A] WQM zone 6 is subdivided into multiple units based on Shellfish Management Directives.

2.4 Assessment Summary

Beginning with the 2010 Assessment, DRBC ended the practice of placing assessment units into a single final Assessment Category. Since assessment units may support certain designated uses, and fail to support other designated uses, assigning a final assessment category was deemed to be confusing.

In addition, DRBC does not list assessment units on a 303(d). Instead, we provide information to states to support their listing decisions, but state assessment methodologies differ from each other. Given the different state assessment methodologies, it would be impossible to DRBC to devise one methodology which would allow a unified final assessment category agreed upon by all states.

Alternatively, as was done in the 2020 Assessment, DRBC will include a summary of the individual assessments for each designated use.

2.5 Threatened Waters

Consistent with EPA's "Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act - July 29, 2005" DRBC will review data trends, where appropriate, to assess whether impairments in future listing cycles are likely.

References:

Commonwealth of Pennsylvania. Jan, 2017. Water Quality Standards of the Pennsylvania Code. Title 25, Chapter 93. https://www.pacode.com/secure/data/025/chapter93/025_0093.pdf

Delaware River Basin Commission. 2010. Administrative Manual – Part III Water Quality Regulations. DRBC, West Trenton, New Jersey.

EPA's *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act* - July 29, 2005.

National Shellfish Sanitation Program (NSSP). 2015. Guide for the Control of Molluscan Fish.https://www.fda.gov/food/guidanceregulation/federalstatefoodprograms/ucm2006754.htm

New York Department of Environmental Conservation. 2008. Part 703: Surface Water and Groundwater Quality Standards and Groundwater Limitations. https://govt.westlaw.com/nycrr/Browse/Home/NewYork/NewYorkCodesRulesandRegulations?guid=I070d30d0b5a111dda0a4e17826ebc834&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)

NJ Department of Environmental Protection. January 18, 2011. Surface Water Quality Standards. http://www.nj.gov/dep/rules/rules/njac7_9b.pdf

Silldorff, E.L. and R.L. Limbeck. 2009. "Interim Methodology for Bioassessment of the Delaware River for the DRBC 2010 Integrated Assessment". Delaware River Basin Commission draft report to the Biological Advisory Subcommittee; revision date 24-July-2009. 26 pp.

U.S. Environmental Protection Agency. 2017. National Recommended Water Quality Criteria. https://www.epa.gov/wqc/national-recommended-water-quality-criteria