2014 Delaware River and Bay Water Quality Assessment

DELAWARE RIVER BASIN COMMISSION

August 2014

Acknowledgements

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Introduction and Overview

The 2014 Delaware River and Bay Water Quality Assessment (2014 Assessment) reports the extent to which waters of the Delaware River and Bay are attaining designated uses in accordance with Delaware River Basin Commission's Water Quality Regulations (18 CFR 410, DRBC WQR) for the period October 1, 2008 through September 30, 2013. The designated water uses to be protected within the Delaware Basin are as follows:

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 (2001).

The assessment involves comparison of several key water quality parameters with applicable DRBC water quality criteria. DRBC regulations designate public water supply, agricultural, and industrial uses for the Delaware River. Since the public water supply use is assessed and protective of the other uses, agricultural and industrial uses are not assessed separately for this report. For each designated use in each assessment unit, a number of water quality parameters, relevant to the use, are compared to the existing, applicable water quality criteria.

Background

This assessment follows previous similar efforts performed beginning in 1996 and published under the DRBC Water Quality Assessment Reports/305(b) banner of the DRBC web site at: http://www.state.nj.us/drbc/quality/reports/quality/index.html

DRBC's water quality assessment report has been developed every even numbered year since its initiation. In the past several cycles, we referred to the report as an "Integrated List" water quality assessment report. This name referred to the reports developed by states for EPA which *integrated* the water quality assessment function, under section 305(b) of the Clean Water Act, together with the listing function, under section 303(d) of the Clean Water Act, into a single document. In the case of DRBC, this name was a mismatch. While DRBC does perform a water quality assessment function consistent with Section 305(b) of the Clean Water Act, only the states list water bodies not meeting standards, as per section 303(d). The DRBC does not list, but provides its assessment to the states for consideration in their listing determinations.

Pennsylvania, New Jersey, Delaware, and New York consider this assessment, in the context of their own EPA approved assessment and listing methodologies, to determine whether sections of the mainstem Delaware River should be listed on the state 303(d) list by a certain pollutant(s). Because their methodologies differ, listing decisions for shared waters are not automatically consistent.

Delaware River Basin

The Delaware River is the longest un-dammed river east of the Mississippi, extending from the confluence of its East and West branches at Hancock, N.Y. to the mouth of the Delaware Bay. The Delaware River is fed by 216 tributaries, the largest being the Schuylkill and Lehigh Rivers in Pennsylvania. In all, the basin contains approximately 13,500 square miles, draining parts of Pennsylvania (50.3 percent of the basin's total land area); New Jersey (23.3%); New York (18.5%); and Delaware (7.9%) (Figure 1).

Approximately 15 million people, or about 5% of the U.S. population, rely on the waters of the Delaware River Basin for drinking and industrial use, and the Delaware Bay is only a one to two hour drive away for about 20% of the people living in the United States. Yet the basin drains only four-tenths of one percent of the total continental U.S. land area. The population of the Delaware River Basin in 2010 stood at approximately 8.26 million people. Table 1 provides additional geographical statistics for the Delaware River Basin. The Delaware Bay and tidal reach of the Delaware River have been included in the National Estuary Program, a partnership initiative authorized by Section 320 of the Clean Water Act designed to protect estuarine systems of national significance.

Three reaches of the Delaware River have been included in the National Wild and Scenic Rivers System. One section extends 73 miles from the confluence of the river's East and West branches at Hancock, NY, downstream to Milrift, PA; the second is a 40-mile stretch from just south of Port Jervis, NY, downstream to the Delaware Water Gap near Stroudsburg, PA. The Lower Delaware Wild and Scenic Rivers Act, signed into law on November 1, 2000, adds approximately 65 miles of the Delaware and selected tributaries to the national system, linking the Delaware Water Gap and Washington Crossing, PA, just upstream of Trenton, N.J. Almost the entire non-tidal Delaware River (the portion north of the “fall line” at Trenton, NJ) is included in the National Wild and Scenic Rivers System. In addition, 35.4 miles of the Maurice River and its tributaries in New Jersey and approximately 190 miles of the White Clay Creek and its tributaries in Pennsylvania and Delaware have been included in the national system. Most recently, on December 22, 2006, President George W. Bush signed into law the Musconetcong Wild and Scenic Rivers Act, which designates 24.2 miles of the Musconetcong River (a tributary of the Delaware River located in New Jersey) as a component of the National Wild and Scenic Rivers System.

There are numerous economic benefits from the river. The Delaware River Port Complex (including docking facilities in Pennsylvania, New Jersey, and Delaware) is the largest freshwater port in the world. According to testimony submitted to a U.S. House of Representatives subcommittee in 2005, the port complex generates $19 billion in annual economic activity. It is one of only 14 strategic ports in the nation transporting military supplies and equipment by vessel to support our troops overseas. The Delaware River and Bay is home to the third largest petrochemical port as well as five of the largest east coast refineries. Nearly 42 million gallons of crude oil are moved on the Delaware River on a daily basis. There are approximately 3,000 deep draft vessel arrivals each year and it is the largest receiving port in the United States for Very Large Crude Carriers (tank ships greater than 125,000 deadweight tons). It is the largest North American port for steel, paper, and meat imports as well as the largest importer of cocoa beans and fruit on the east coast. Over 65% of Chilean and other South American fruits imported into

the United States arrive at terminal facilities in the tri-state port complex. Wilmington, Delaware is home to the largest U.S. banana importing port, handling over one million tons of this cargo annually from Central America. According to Rear Admiral Sally Brice-O'Hara, District Commander of the Fifth Coast Guard District, "The port is critical not only to the region, but also to the nation."

Figure 1: Delaware River Basin

In addition, Dr. Gerald Kauffman of the University of Delaware has estimated that the Delaware River Basin provides $25 billion annually in economic activity, including recreation, water quality, water supply, and hunting and fishing, $21 billion annually in ecosystem goods and services (natural capital), and $10 billion in annual wages.

Table 1: Approximate Geographical Statistics for the Delaware River Basin

Total Basin Land Area (mi^2)[a,b]	12,700
Population (2010)	8.26 million
Major River Basins (HUC 8)[c]	13
River Miles (Named)[a]	9,080
Border (Shared) River Miles[a]	339
Square Miles of Public Lakes and Reservoirs[c]	140
Square Miles of Estuary/Bay[c]	783
Square Miles of Wetlands[c]	480

[a]DRBC GIS files

[b]Total Basin area minus area of Estuary and Bay

[c]National Hydrographic Dataset

Delaware River Water Quality Assessment

Water Quality Standards

Water quality standards provide a description of water body uses to be protected, as well as water quality criteria necessary to protect those uses. DRBC's water quality standards program derives its authority from Section 3.2 of the Delaware River Basin Compact (1961) which directs the Commission to adopt "a comprehensive plan…for the immediate and long range development and uses of the water resources of the basin" and to adopt "a water resources program, based upon the comprehensive plan, which shall include a systematic presentation of the quantity and quality of water resources needs of the area…"; and Section 5.2 which allows the Commission to "assume jurisdiction to control future pollution and abate existing pollution in the waters of the basin, whenever it determines…that the effectuation of the comprehensive plan so requires."

Designated Uses

Water uses are paramount in determining stream quality criteria, which, in turn, are the basis for determining discharge effluent quality requirements. 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:

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

The Delaware River and Bay consists of a non-tidal and tidal Zone. Zones C1-8 and intrastate streams (Zones E, W1, W2, N1 and N2) are not assessed in this report as they are assessed in the Integrated Reports of the Basin States. The non-tidal main stem consists of five Water Quality Management (WQM) Zones: 1A, 1B, 1C, 1D, and 1E (Figure 2). These Zones form the boundaries for the DRBC's assessment units (AUs) in the non-tidal Zone. The Zones as defined by river mile (RM) are included in Table 2. The designated uses applicable to the non-tidal AUs include aquatic life, fish consumption, primary contact recreation, and drinking water (Table 3).

The tidal Delaware River consists of AU 2, 3, 4, and 5 (Figure 2) and extends from RM 133.4 to RM 48.2 (Table 2). Assessment unit 6 (Delaware Bay) includes multiple units that are defined in part by shellfish management areas issued by the states of Delaware and New Jersey (Figure 3). The uses designated in the estuary and bay are indicated in Table 3. Shellfish consumption only applies to WQM Zone 6.

Figure 2: Delaware River Water Quality Management Zones / Assessment Units

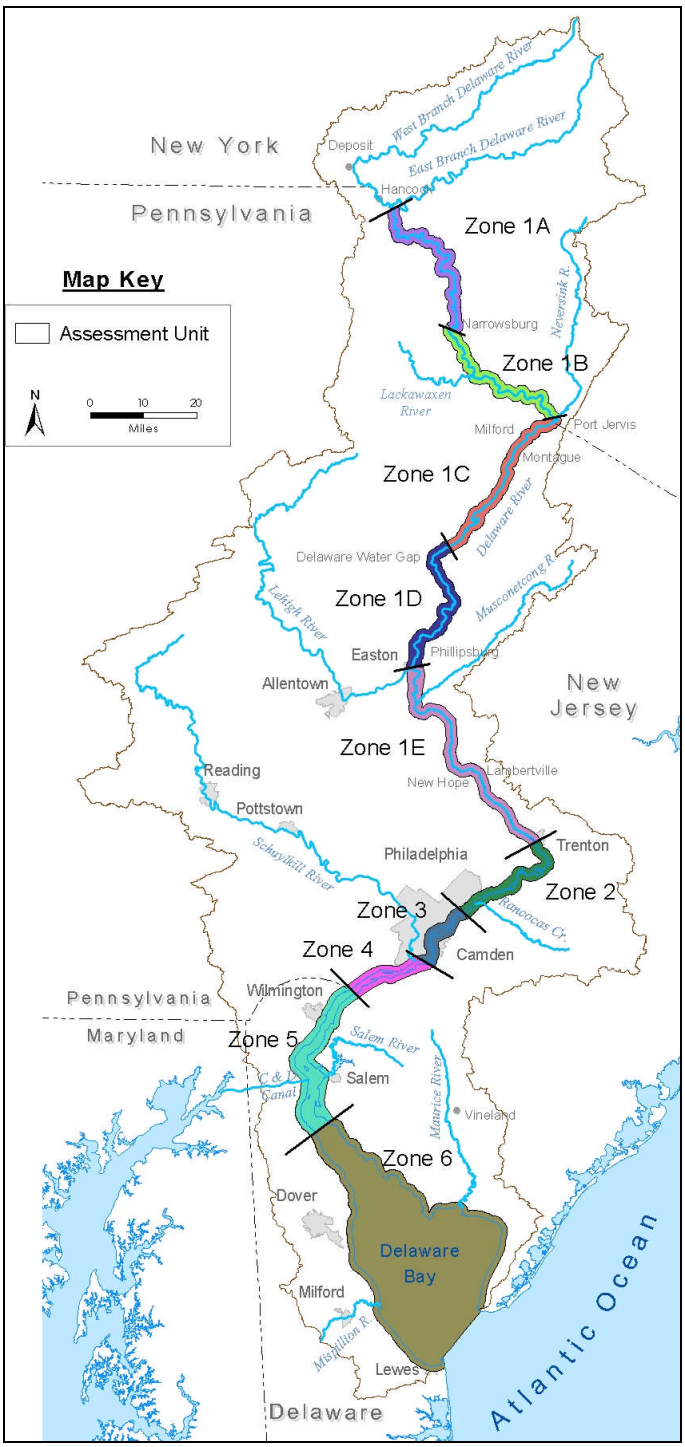


Table 2: Delaware River Water Quality Management (WQM) Zones

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

Figure 3: Zone 6 Shellfish Management Assessment Units

Table 3: Designated Uses by DRBC Water Quality Management Zones

Designated Water Use	Water Quality Management Zone									
	1A	**1B**	**1C**	**1D**	**1E**	**2**	**3**	**4**	**5**	**6**
Aquatic Life	X	X	X	X	X	X	X	X	X	X
Public Water Supply	X	X	X	X	X	X	X			
Recreation										
Primary & Secondary	X	X	X	X	X	X		X[A]	X	X
Secondary only							X[A]	X[A]		
Fish Consumption	X	X	X	X	X	X	X	X	X	X
Shellfish Consumption										X

[A] Primary recreation below RM 81.8; Secondary recreation above RM 81.8

Criteria

Sections 3.10, 3.20, and 3.30 of DRBC's Water Quality Regulations define the "Stream Quality Objectives." From this point on, the objectives will be referred to as "Water Quality Criteria" (WQC) for the tidal and non-tidal river. Criteria are Zone-based and define the water quality necessary to protect the designated uses in those Zones. For the water quality assessments, monitored data are compared against the Zone standards for determining use attainment.

Zones 1, 2 and 3 of the Delaware River are given the designated use of "public water supplies after reasonable treatment." It is the general policy of DRBC that all ground water of the Basin, as well as surface sources of drinking water, should be maintained to support drinking water (18 CFR Part 410, 3.10.3.B, 3.40.4). In Zones 2 and 3, there is additional definition of the permissible levels of specific toxicants in waters designated for both drinking water and fish consumption (due to the bioaccumulation of certain substances even at very low ambient levels).

Assessment Methods

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. DRBC published the Draft Methodology for the 2014 Delaware River and Bay Water Quality Assessment on its web site in September 2013, with subsequent notification

to advisory committee members including representatives from state and federal environmental protection agencies and participants. A notice with a link to the methodology was published in the Federal Register on October 25, 2013. Federal Register publication was delayed due to the federal government shutdown.

Assessment Units

As noted in the previous section, the non-tidal assessment units include WQM Zones 1A, 1B, 1C, 1D, and 1E (Figure 2). The designated uses assessed in Zones 1A through 1E include aquatic life, public water supply, primary recreation, and fish consumption (Table 3). WQM Zones 2, 3, 4, and 5 make up the tidal portion of the Delaware River Basin. Fish consumption, aquatic life, and recreation apply to all the tidal Zones. In the estuary, the public water supply use is only applicable to WQM Zones 2 and 3. The Delaware Bay consists of WQM Zone 6. The assessed designated uses for the Bay include aquatic life, primary recreation, fish consumption, and shellfish consumption.

Data Window

This assessment considers all readily available data collected in the 5-year period from October 1, 2008 through September 30, 2013.

Data Sets

This assessment considers all readily available data. To obtain the data, DRBC queried the EPA STORET database, the USGS NWIS database, the NOAA PORTS database, as well as internal DRBC databases. We also published a data solicitation in the Federal Register. The majority of the data considered is from the following monitoring programs and/or data sets:

- USGS continuous real time monitors via NWIS;
- USGS surface water monitoring programs via NWIS;
- DRBC / NPS Scenic Rivers Monitoring Program (SRMP);
- DRBC Biological Monitoring Program;
- DRBC Lower Delaware Monitoring Program;
- DRBC Boat Run monitoring program;
- DRBC Chronic Toxicity Monitoring;
- DRBC Special Copper Study in Zone 5;
- NOAA PORTS continuous data;
- PAWQN Monitoring program via STORET;
- NY Department of Environmental Conservation, Division of Water, via STORET;
- NJDEP Bureau of Freshwater and Biological Monitoring via STORET;
- Delaware Department Of Natural Resources And Environmental Control via STORET;
- NJDEP Bureau of Marine Water Monitoring via STORET;
- Philadelphia Water Department Monitoring programs.

Other data sets contained in STORET were considered as well, but represented a small subset of the overall available data.

Analytical Parameters supporting Designated Uses

Data Requirements

This section looks at the general approach for each designated use assessed relative to DRBC water quality criteria 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 data requirements, when the weight of evidence is compelling.

Listed below are cases where insufficient data (ID) are available and the uses cannot 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 as defined in Tables 4 through 9
b) Background level was not specified in DRBC WQR and cannot 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

Aquatic Life

Aquatic life is to be protected in all DRBC WQM Zones (Table 3). The assessment is based upon these water quality parameters: dissolved oxygen (DO), pH, turbidity, temperature, total dissolved solids (TDS), alkalinity, and in Zone 1, biological monitoring results (Table 4). In addition, toxic pollutants with acute and chronic criteria are used to support aquatic life in Zones 2 through 6, which correspond to the designated uses for each zone. Freshwater criteria apply in areas upstream of the Delaware Memorial Bridges (RM 68.75) and the more stringent of the freshwater or marine criteria apply below RM 68.75 to the end of Zone 5 (RM 48.23). Marine criteria apply in Zone 6.

Table 4: 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	For instantaneous minimums, less than 1 observation plus 1 confirmatory observation per AU fail the criteria. For 24-hour averages, less than one 24-hour average plus one confirmatory 24-hour average 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 observation plus 1 confirmatory observation 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 daily average plus 1 confirmatory daily average 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 observation plus 1 confirmatory observation 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
Turbidity	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Sections 3.20	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria	At least three samples in a 30-day period (AU 3) At least 20 samples

		and 3.30		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 observation plus 1 confirmatory observation 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 observation plus 1 confirmatory observation per AU fail the criteria	At least 20 samples per AU over the assessment period
Toxic Pollutants	2-6	Not to exceed criteria noted in DRBC Water Quality Regulations, Table 5	No more than one (1) exceedence in an AU over a three year window	Available data
	1	Not to exceed EPA recommended CCC criteria	No more than one (1) exceedence 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 sites per AU

Public Water Supply

The public water supply use is designated for WQM Zones 1A through 1E, 2, and 3. The parameters used for determining public water supply use support are:

1) TDS;
2) chlorides;
3) toxic substances (human health criteria for systemic toxicants and carcinogens in Zones 2 and 3 only);
4) hardness;
5) odor;
6) phenol;
7) sodium (Na); and
8) turbidity.

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. Data requirements are shown in Table 5.

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:

- boating,
- fishing,
- 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. Contact recreation data requirements are shown in Tables 6 (Primary Contact) and 7 (Secondary Contact).

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. 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: Public Water Supply 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 observation plus 1 confirmatory observation 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 observation plus 1 confirmatory observation 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 observation plus 1 confirmatory observation 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 observation plus 1 confirmatory observation 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 observation plus 1 confirmatory observation per AU fail the criteria	At least 20 samples per AU over the assessment period
Sodium (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 observation plus 1 confirmatory observation 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 observation plus 1 confirmatory observation 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) exceedence in an AU over a three year window	Available data
Carcinogens	2-3	Not to exceed criteria listed in DRBC Water Quality Regulations, Section 3.30, Table 6	No more than one (1) exceedence in an AU over a three year window	Available data
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 over the assessment period	Administrative closures for drinking water supply over the assessment period. Information from one or more drinking water intake facility per AU.

Table 6: 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 7: 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.

Fish Consumption

The fish consumption designated use applies to all DRBC WQM Zones. The assessment criterion is based primarily on the presence of the Basin states' fish consumption advisories in the mainstem Delaware River and Bay for the 2010 to 2011 assessment period. The presence of fish consumption advisories results in an assessment of "not supporting the designated use". Fish Consumption data requirements are shown in Table 8.

Table 8: 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' fish tissue data

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). 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. Shellfish Consumption data requirements are shown in Table 9.

Table 9: 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.

Assessment Results

The following sections provide the 2014 assessment results for the designated uses:

1. Aquatic Life;
2. Public Water Supply;
3. Contact Recreation;
4. Fish Consumption; and
5. Shellfish Consumption.

Meaningful assessment continues to be hampered by the requirement to indicate 1 exceedance plus 1 confirmatory exceedance as not meeting criteria and subsequently not supporting a designated use.

Aquatic Life

The Aquatic Life Assessment results are presented in Table 10 below. The composite aquatic life assessment for 2014 yields a result of "Not supporting" for all assessment units. It is important to note, however, that this result is largely driven by the requirement to categorize as not meeting criteria any assessment unit with 1 exceedance plus 1 confirmatory exceedance.

Table 10: Aquatic Life Designated Use Assessment Results

Zone (Assessment Unit)	DO	pH	Turbidity	Temperature	TDS	Alkalinity	Toxic Pollutants	Biological Assessment	2014 Composite	2012 Composite
1A	+	-[A]	-[A]	N/A[C]	+	N/A	-[F]	ID	NS[E]	NS[E]
1B	+	-[A]	-[A]	N/A[C]	+	N/A	-[F]	ID	NS[E]	NS[E]
1C	+	-[A]	+	N/A[C]	+	N/A	+[F]	ID	NS[E]	NS[E]
1D	+	-[A]	+	N/A[C]	+	N/A	-[F]	ID	NS[E]	NS[E]
1E	+	-	-[A]	N/A[C]	+	-[A]	+[F]	ID	NS	NS[E]
2	-[A]	-[A]	-[A]	-[A, B]	+	+	+	NC	NS[E]	NS[E]
3	+	+	-[A]	-[A, B]	+	+	+	NC	NS[E]	NS[E]
4	+	+	+	-[A, B]	N/A[D]	+	-	NC	NS	NS[E]
5	-[A]	+	-	-[A, B]	N/A	+	-	NC	NS	NS[E]
6	-[A]	-[A]	-[A]	+	N/A	+	-	NC	NS	NS[E]

Notes:

+ -- The Assessment Unit meets WQC

- -- The AU does not meet WQC

A – Rate of criteria exceedance is below the historical threshold of 10%.

B – Temperature criteria exceedance may be driven, in part, by meteorologic and atmospheric conditions. The proportion of temperature exceedance caused by controllable anthropogenic inputs is unknown at this time.

C – Temperature criteria in Zone 1A through 1E are expressed relative to ambient temperature, but ambient temperature is not defined. We interpret these criteria to be applicable to thermal mixing zones. Therefore, Zones 1A through 1E lack a surface water quality standard for temperature.

D – Criteria expressed relative to background, but background is undefined.

NC – No criteria developed.

E – Based primarily on fewer than 10% exceedances of criteria

F – The Assessment Unit meets (+) or does not meet (-) EPA's 2006 National Recommended Water Quality Criteria, where numerical criteria have not yet been adopted by the DRBC

ID – Insufficient data to make an assessment

NS – The assessment does not support the designated use

N/A – The parameter is not applicable in this assessment unit

Dissolved Oxygen

Dissolved oxygen (DO) refers to the concentration of oxygen gas incorporated in water. Oxygen enters water both by direct absorption from the atmosphere, which is enhanced by turbulence, and as a by-product of photosynthesis from algae and aquatic plants. Sufficient DO is essential to growth and reproduction of aerobic aquatic life. Oxygen levels in water bodies can be depressed by the discharge of oxygen-depleting materials (measured in aggregate as biochemical oxygen demand, BOD, from wastewater treatment facilities), from the decomposition of organic matter including algae generated during nutrient-induced blooms, and from the oxidation of ammonia and other nitrogen-based compounds.

Table 11 below shows the assessment results for DO for all Zones. All criteria were met in Zones 1E and Zone 4. In Zones 1A, 1C, and 1D, all instantaneous minima criteria were met. Since only daytime spot measurements were made in Zones 1A through 1D, attainment of the 24-hour mean criteria was presumed since all measurements were above (met) that criteria. All seasonal mean criteria were met in Zones 2 through 5. The majority of observations met minimum or 24-hour mean criteria in Zones 1B, 2, 3, and 5.

Table 11: DO Assessment Results

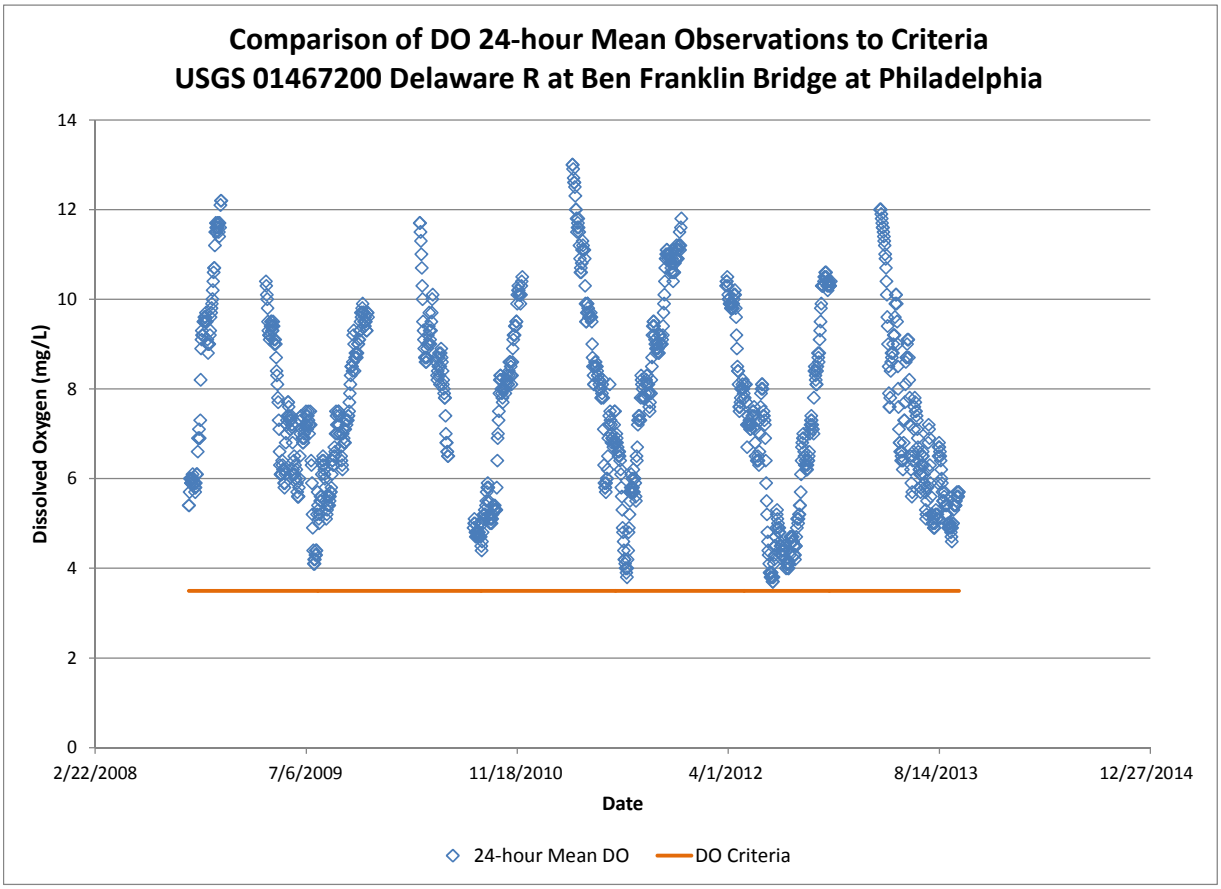
Zone	% Observations Meeting Daily Mean Criteria	% Meeting Seasonal Criteria	% Meeting Instantaneous Minimum Criteria	Primary Data Source(s)	Notes
1A	100%	N/A	100%	• National Park Service continuous monitor at Lordville	No continuous monitor data before July 2012
1B	100%	N/A	100%	• National Park Service continuous monitor at Barryville	No continuous monitor data before October 2012
1C	100% (presumed)	N/A	100%	• SRMP Monitoring • USGS NJ	Daytime spot measurements only
1D	100% (presumed)	N/A	100%	• SRMP / Lower Delaware Monitoring • USGS (PA & NJ) • PADEP	Daytime spot measurements only

Zone	% Observations Meeting Daily Mean Criteria	% Meeting Seasonal Criteria	% Meeting Instantaneous Minimum Criteria	Primary Data Source(s)	Notes
1E	100%	N/A	100%	• USGS 01463500 Delaware River at Trenton NJ	
2	98.3%	100%	N/A	• USGS 014670261 Delaware River nr Pennypack Woods, PA	No data before March 2011
3	100%	100%	N/A	• USGS 01467200 Delaware R at Ben Franklin Bridge at Philadelphia	
4	100%	100%	N/A	• USGS 01477050 Delaware River at Chester, PA	
5	96%	100%	N/A	• USGS 01482800 Delaware River at Reedy Island Jetty, DE	
6	90.5% (presumed)	N/A	98.4%	• DRBC Boat Run • Delaware Department Of Natural Resources And Environmental Control • NJDEP Bureau of Marine Water Monitoring	Daytime spot measurements only

Determining whether 24-hour criteria were met is most appropriately accomplished by comparing the daily mean DO from continuous monitors, which record data hourly or sub-hourly, and comparing these computed results to the criteria. Where only daytime spot measurements are available, we presumed that if the measured value is less than the 24-hour mean criterion, then the 24-hour mean is also likely to be below (not meet) the criterion. Zones 1A, 1B, 1C, 1D and 6 currently lack continuous water quality

meters, and were assessed using daytime spot measurements only. Figure 4 below shows a comparison of daily mean and seasonal mean DO observations at the USGS monitor at the Ben Franklin Bridge (Zone 3) to the 24-hour mean and seasonal criteria.

Figure 4: DO Observations Compared to Criteria



As shown in Table 11, the vast majority of the measurements meet criteria. The DO assessment in particular highlights the flaw associated with making a determination of not meeting criteria on the sole basis of one exceedance plus one confirmatory exceedance. Sparse, periodic exceedances may indeed negatively impact aquatic life, but more work is needed to determine the frequency and duration of exceedance that would cause this impact.

pH

The pH of surface waters has long been recognized as both a natural and human-induced constraint to the aquatic life of fresh and salt water bodies, both through direct effects of pH and through indirect effects on the solubility, concentration, and ionic state of other important chemicals (e.g., metals, ammonia). Among natural waters, both highly alkaline waters and highly acidic waters (like the NJ Pinelands) are known to severely restrict the species of plants and animals that can thrive in particular

lakes and streams. Likewise, human alteration of the pH regimen for a water body can alter both the quality of that water and the aquatic life inhabiting that system. Table 12 below shows the assessment results for pH for each Zone.

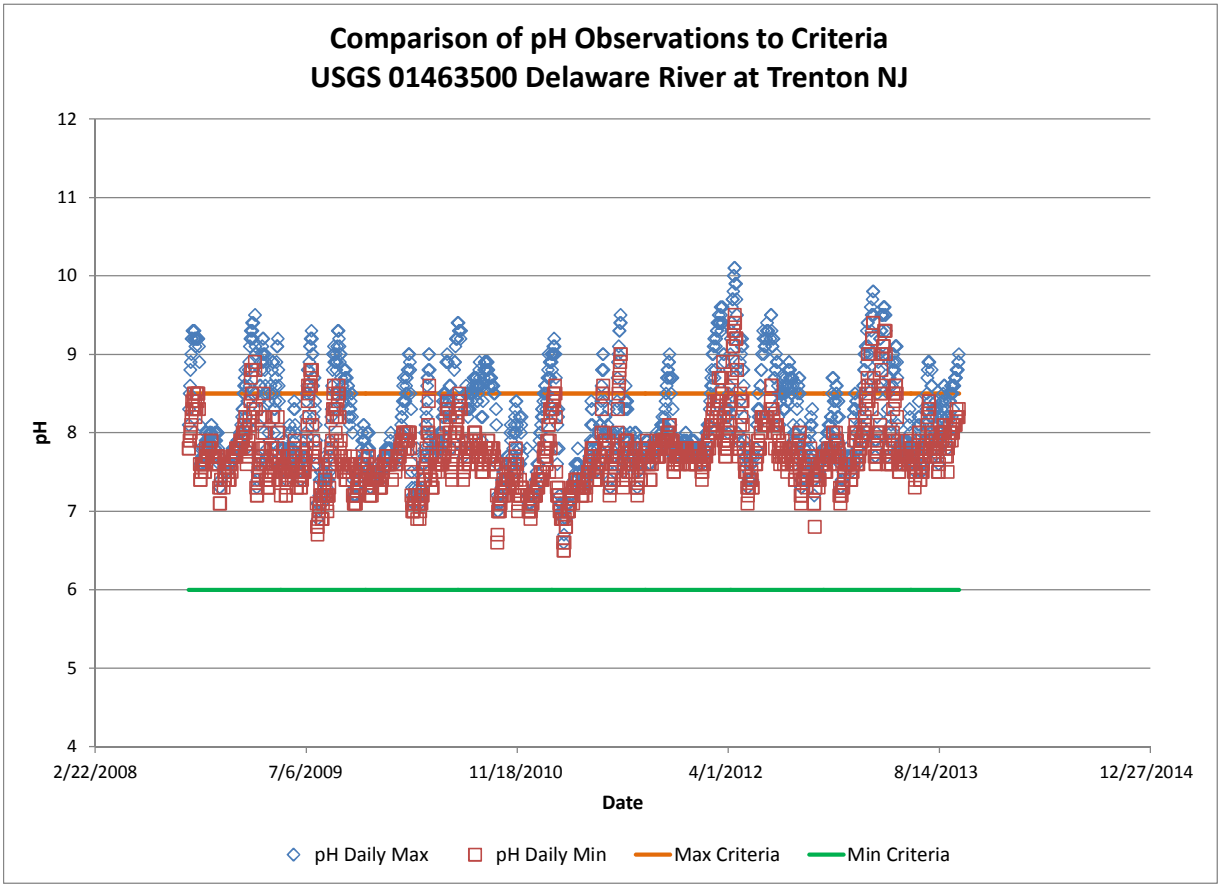
Table 12: pH Assessment Results

Zone	% Observations or Observations Days Meeting Criteria	Primary Data Source(s)	Notes
1A	91.97%	• National Park Service continuous monitor at Lordville	No data before July 2012
1B	96.25%	• National Park Service continuous monitor at Barryville	No data before September 2012
1C	95.77%	• SRMP Monitoring • USGS New Jersey	Daytime spot measurements only
1D	94.7%	• SRMP / Lower Delaware Monitoring • USGS PA • PADEP	Daytime spot measurements only
1E	72.8%	• USGS 01463500 Delaware River at Trenton NJ	
2	99.59%	• USGS 014670261 Delaware River nr Pennypack Woods, PA	No data before March 2011
3	100%	• USGS 01467200 Delaware R at Ben Franklin Bridge at Philadelphia	
4	100%	• USGS 01477050 Delaware River at Chester, PA	
5	100%	• USGS 01482800 Delaware River at Reedy Island Jetty, DE	
6	96.57%	• DRBC Boat Run • Delaware Department Of Natural Resources And Environmental Control	Daytime spot measurements only

As shown in Table 12, pH criteria were met in Zones 3, 4, and 5. pH criteria were mostly met, with the exception of Zone 1E, where daily pH maximum values routinely exceeded the maximum criterion of 8.5, as shown in Figure 5. In Zones 1C and 1D, pH assessment is hampered by the lack of continuous monitors. Like DO, pH has a diel cycle due to photosynthesis, with the lowest pH values expected in the early morning hours or pre-dawn, and the highest pH values expected in the mid to late afternoon. Monitoring programs that rely on spot measurements are far more likely to capture daytime high values, and miss pre-dawn low values.

In December 2013, the Commission adopted revised pH criteria applying to all zones of the Delaware River and Bay. That revised criteria requires that pH be between 6.5 and 8.5 inclusive, unless outside this range due to natural conditions. However, this criteria becomes effective 30 days following the last date of publication in the *Federal Register*, and was not in effect at the time that this assessment was prepared.

Figure 5: pH Observations Compared to Criteria



Turbidity

According to Standard Methods (2005), "Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms. Turbidity is an expression of the optical property that causes light to be scattered and

absorbed rather than transmitted with no change in direction or flux level through the sample." From an observational perspective, water with low turbidity appears clear, while higher turbidity waters are cloudy or muddy. Table 13 below shows the assessment results for each Zone relative to DRBC's turbidity criteria.

Table 13: Turbidity Assessment Results

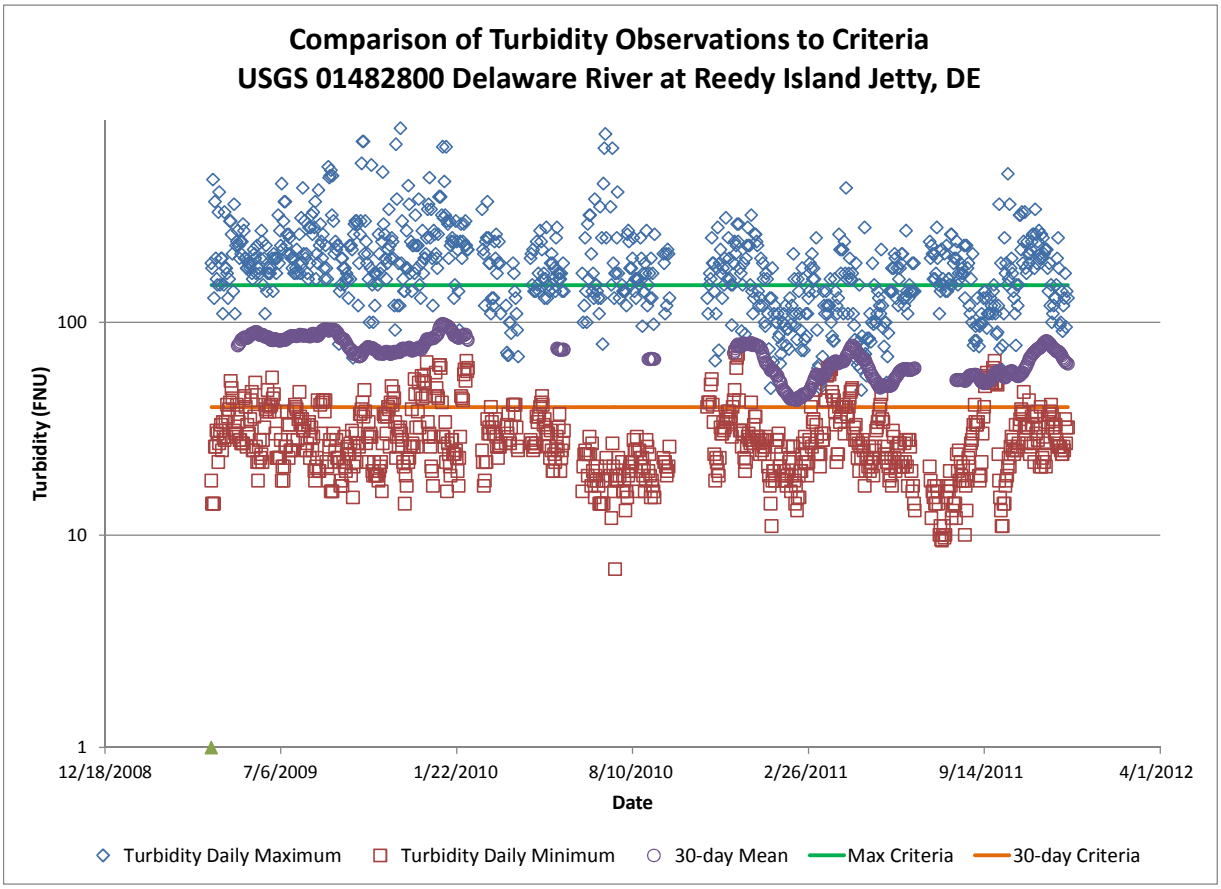
Zone	% Observation Meeting Max Criteria	% Meeting 30-day Average Criteria	Primary Data Source(s)	Notes
1A	98.52%	75.71%	• National Park Service continuous monitor at Lordville	No data before July 2012
1B	94.38%	32.45%	• National Park Service continuous monitor at Barryville	No data before September 2012
1C	100%	Insufficient Data to Assess	• SRMP Monitoring	Spot measurements only
1D	100%	Insufficient Data to Assess	• SRMP / Lower Delaware Monitoring	Daytime spot measurements only
1E	98.75%	99.57%	• USGS 01463500 Delaware River at Trenton NJ	
2	99.98%	100%	• USGS 014670261 Delaware River nr Pennypack Woods, PA	No data before March 2011
3	98.81%	100%	• USGS 01467200 Delaware R at Ben Franklin Bridge at Philadelphia	No data after December 2011
4	100%	Insufficient Data to Assess	• DRBC Boat Run	No Turbidity on USGS Monitor, spot measurements only
5	38.44%	0%	• USGS 01482800 Delaware River at Reedy Island Jetty, DE	Data from April 2009 to December 2011 only
6	96.01%	Insufficient Data to Assess	• DRBC Boat Run • Delaware Department Of Natural Resources And Environmental Control	Spot measurements only

In previous assessment cycles, only spot measurements were available for turbidity assessment in Zone 5. In April 2009, USGS added turbidity to the monitor at Reedy Island Jetty (01482800). In reviewing

these data, it became clear that turbidity in Zone 5 is largely not meeting criteria. In fact, no rolling 30-day mean during the data period met the 30-day mean criteria, and only 38% of observation days met the instantaneous maximum criteria. Figure 6 below shows the daily minimum and maximum observed turbidity at Reedy Island, as well as the computed daily mean and the rolling 30-day mean (where 30 days of uninterrupted data are available) compared to criteria. However, this mismatch between measured turbidity and criteria may indicate a problem with the criteria rather than a water pollution problem. Zone 5 of the estuary spans the well documented estuary turbidity maximum (ETM) for the Delaware. ETM's are naturally occurring features of most estuaries, and typically occur near the toe of the salt wedge. Again, however, it is unclear how anthropogenic drivers, such as vessel traffic and dredging impact the natural turbidity regime in the ETM, and what level of turbidity supports an aquatic life use.

As a result, we recommend additional coordination with physical oceanographers and estuarine ecologists to determine whether the existing turbidity criterion in Zone 5 is relevant and protective, or whether revision of the current criteria is warranted.

Figure 6: Turbidity Compared to Criteria in Zone 5



Temperature

Water temperature is an important factor for the health and survival of native fish and aquatic communities. Temperature can affect embryonic development; juvenile growth; adult migration; competition with non-native species; and the relative risk and severity of disease. Estuary Temperature Criteria are expressed in DRBC regulations by day of year in Zones 2, 3, and 4. In Zones 5 and 6, a single maximum water temperature is specified. Table 14 below shows that water temperature criteria were mostly met, with the greatest number of exceedances occurring in Zones 2 and 4.

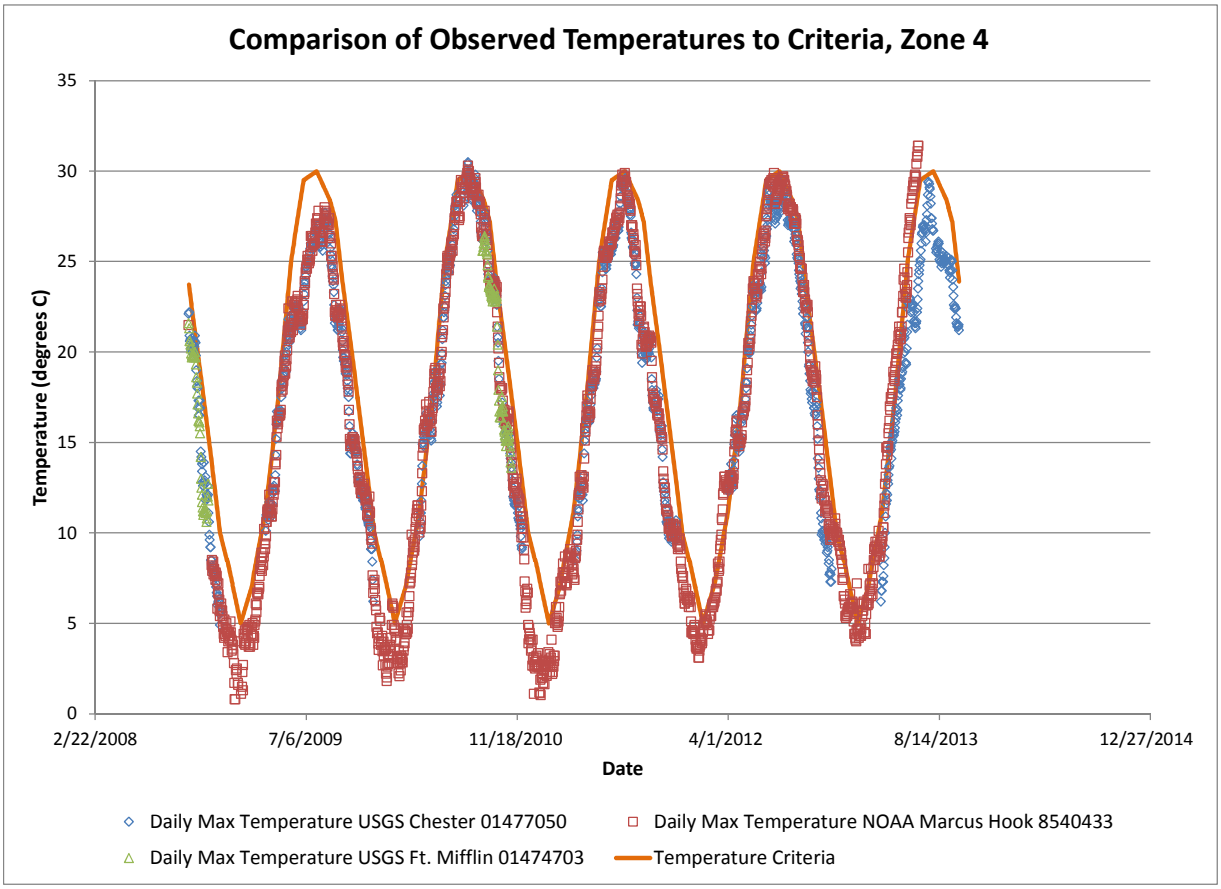
As noted in previous assessments, criteria in Zones 1A through 1E are clearly oriented toward determining compliance of thermal mixing zones for point discharges. Currently, DRBC has no ambient surface water temperature standards in Zones 1A through 1E. In previous assessments, we investigated approaches for assessing surface waters in the non-tidal river against the thermal mixing zone criteria. None of these approaches was workable. DRBC continues work on development of ambient temperature criteria in the non-tidal river, as well as clarifying language regarding the application of the existing criteria.

Table 14: Temperature Assessment Results

Zone	% Observation Days Meeting Criteria	Primary Data Source(s)	Notes
1A	Criteria applicable to Heat Dissipation Areas only for Zone 1 AU's		
1B			
1C			
1D			
1E			
2	93.93%	• Newbold (NOAA PORTS) • Burlington (NOAA PORTS) • Delran (USGS NWIS)	
3	96.02%	• Philadelphia (NOAA PORTS) • Ben Franklin Bridge (USGS NWIS) • Tacony Palmyra (NOAA PORTS)	
4	93.56%	• Marcus Hook (NOAA PORTS) • Chester (USGS NWIS) • Fort Mifflin (USGS NWIS)	
5	98.97%	• Reedy Island (USGS NWIS) • Reedy Point (NOAA PORTS)	
6	100%	• Brandywine Shoal (NOAA PORTS) • Lewes (NOAA PORTS) • Ship John Shoal (NOAA PORTS)	

Figure 7 below shows the comparison of water temperature observations in Zone 4 to the day-of-year temperature criteria. Note that observations in Zone 4 include continuous monitor data from USGS continuous monitors at Chester and Ft. Mifflin and a NOAA continuous monitor at Marcus Hook.

Figure 7: Water Temperature Observations Compared to Criteria in Zone 4



As also noted in previous assessments, atmospheric temperatures and meteorological conditions are strong drivers of water temperature. DRBC previously demonstrated that water temperatures are strongly linked to air temperatures, and that a notable increase in air temperatures is observable between the temperature gradient period (1961-1966) and the current period. At present, we lack the tools to determine which portion of the exceedance is attributable to potentially controllable anthropogenic thermal inputs, and which portion is due to meteorological drivers beyond our control.

Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) reflects the concentration of solids in a water sample capable of passing through a filter (typically 2 um) and dried. As an analytical parameter, TDS represents the collective mass of individual constituents, including cations, anions, and dissolved organic material. Studies have shown that high TDS concentrations negatively impact aquatic life and cause shifts in biological communities. In freshwater, TDS is frequently used as an indicator of the anthropogenic burden.

Table 15 below shows the TDS criteria in Zones 1A through 3 were met, with no Zone showing more than 1 exceedance. The TDS criteria in Zone 4 is expressed only as a percentage above background, and background in Zone 4 has not been defined. DRBC has no TDS criteria in Zones 5 and 6, presumably because TDS in marine waters is naturally high.

Table 15: TDS Assessment Results

Zone	% Observations Meeting Criteria	Primary Data Source(s)	Notes
1A	100%	• SRMP Monitoring • NY DECA • PADEP	
1B	99.59%	• SRMP Monitoring • NY DECA • PADEP	1 exceedance only, no confirmatory exceedance
1C	100%	• SRMP Monitoring	
1D	100%	• SRMP / Lower Delaware Monitoring	
1E	100%	• SRMP Monitoring • PADEP	
2	100%	• DRBC Boat Run	
3	100%	• DRBC Boat Run	
4	N/A		Criteria relative only to background, background not defined
5	No Criteria		
6			

Alkalinity

According to Standard Methods (2005), "alkalinity of a water is its acid-neutralizing capacity. It is the sum of all the titratable bases." As shown in Table 16 below, alkalinity criteria were met in all applicable zones except for 1E, where attainment of alkalinity criteria exceeded 96%.

Table 16: Alkalinity Assessment Results

Zone	% Observations Meeting Criteria	Primary Data Source(s)	Notes
1A	No Criteria		
1B			
1C			
1D			
1E	96.38%	• SRMP / Lower Delaware Monitoring • USGS NJ	
2	100%	• DRBC Boat Run	
3	100%	• DRBC Boat Run	
4	100%	• DRBC Boat Run	
5	100%	• DRBC Boat Run	
6	100%	• DRBC Boat Run • DNREC	

Toxic Pollutants

The Delaware River Basin Commission (DRBC) stream quality objectives for human health and aquatic life in the tidal portion of Delaware Basin from the head of tide at Trenton, NJ to the mouth of the Delaware Bay (Zones 2 through 6) reflect current scientific information and harmonize DRBC criteria with basin states' criteria. DRBC criteria are used in the 2014 assessment for Zones 2 through 6. As described in Methodology for the 2014 Delaware River and Bay Water Quality Assessment Report, the DRBC compared observations in Zones 1A through 1E (where DRBC has not adopted numerical criteria) to USEPA National Recommended Water Quality Criterion as a method of implementing DRBC's narrative standard that the waters of the Basin shall not contain substances in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life.

Data Quantity and Quality

Water quality monitoring data from multiple organizations (DRBC, DNREC, NYSDEC, NJDEP, PADEP and USGS) were included in the 2014 assessment of toxics pollutants. This assessment includes data from DRBC enhanced studies of PAHs and pesticides in the Delaware Estuary (Zones 2 to 6) as well as non-tidal (Zone 1) and tidal (Zone 5) studies of metals. Toxic pollutants data reviewed were collected using EPA approved or equivalent methods. The level of monitoring varied by Zone with more monitoring for toxics reported in Zones 2 through 6 than in Zone 1. The level of monitoring also varied by toxic

pollutant with 1,220 data points reported for copper , 307 data points reported for aluminum, 231 data points reported for mercury in surface water and 94 data points reported for cadmium. Quality Assurance (QA) data was also reviewed as part of the assessment. DRBC toxics pollutants monitored during the timeframe of the assessment are listed in Appendix D.

Metals

Use of Freshwater or Marine Stream Quality Objectives

DRBC regulations include aquatic life toxics criteria for fresh and marine waters. As a policy, freshwater criteria will apply in all areas of the estuary upstream of the Delaware Memorial Bridges. In the main stem Delaware River below the Delaware Memorial Bridges and above Liston Point (RM 48.2, the downstream limit of Zone 5) and in tributaries up to the 5ppt isopleth at 7Q10, the more stringent of the freshwater or marine criteria will apply. Downstream from Liston Pt., the marine criteria are used.

- A supplemental assessment was done in 2014. Site-specific paired salinity measured between RM 69.7 and 48.2 concurrently with toxic analytical parameters confirmed that when exceedances of freshwater objectives occurred ambient conditions were < 5 ppt salinity and when exceedances of marine objectives occurred ambient conditions were ≥ 5 ppt salinity.

Dissolved Metals

For criteria expressed as the dissolved form of the metal, assessment of monitoring data is as follows:

1. In assessment Zones with dissolved metals data collected, direct comparison to DRBC dissolved criteria is the preferred assessment.
2. In assessment Zones with only total metals data collected (as noted in Appendix D), comparison of total metals data to estimated total metals criteria using conversion factors listed in "Revised Procedure for Converting Total Recoverable Water Quality Criteria for Metals to Dissolved Criteria" http://www.state.nj.us/drbc/library/documents/criteria-metals1995.pdf

Hardness Dependent Stream Quality Objectives

Some criteria require hardness values to compute the actual criteria numeric value. In these cases, toxics data from ambient water are compared to stream quality objectives using a median hardness value of 74 mg/l as $CaCO_3$ listed in DRBC Water Quality Regulations.

1. An additional comparison was conducted as part of the 2014 assessment where by exceedances of DRBC regulatory hardness dependent values were confirmed with site-specific paired hardness measured concurrently with toxic analytical parameters.

Whole Effluent Toxicity

Sampling in 2009 for **Whole Effluent Toxicity** (WET) in receiving waters indicated, based on the measured endpoints, that the samples from sites tested in the main-stem of the Delaware River and from the majority of tidal portions of tributaries tested were not chronically toxic to the tested species (Pimephales promelas, Americamysis bahia, Menidia beryllina, and Ceriodaphnia dubia in 7-day tests; Pseudokirchneriella subcapitata in a 96-hour test; and Hyalella azteca in a 10-day water-only test). The surveys identified tributaries that warrant further assessment for potential impairment from toxicity. For 1 of the 3 test species, in 2 separate years of sampling, 2 sites (Assunpink Creek and Red Lion Creek)

indicated chronic toxicity. Integrated Environmental Assessment and Management : Volume 7, Number 3, pp. 466–477.

Based on sampling in 2012, measured WET endpoints at eleven sites in the main stem of the Delaware River clearly did not indicate chronic toxicity to the tested species. However, three sites in main stem DRBC Water Quality Zone 5 warrant further assessment to confirm the existence and persistence of toxicity and to evaluate potential sources (chemical causes) of observed toxicity. (http://www.state.nj.us/drbc/quality/toxics/wet/).

Copper

Data showed multiple exceedances of DRBC acute and chronic marine stream quality objective for the protection of aquatic life for **copper** in Zones 5 and 6. Of 158 surface water samples tested for copper in Zone 5 during the assessment period, 8 exceeded the chronic marine criterion and 4 exceeded the acute marine criterion. Of 286 surface water samples tested for copper in Zone 6 during the assessment period, 27 exceeded the chronic marine criterion and 15 exceeded the acute marine criterion.

In previous assessment cycles, DRBC noted that copper assessment was hampered by several issues including sampling and analytical techniques. In 2011 and 2012, DRBC performed a special study utilizing clean metals sampling techniques and sensitive analytical methods to determine whether copper concentrations would continue to show exceedances under these more refined methods. In November 2011, and April, July, and August 2012, DRBC collected 68 samples in Zones 5 between RM 80.3 and RM 55. Of the 68 concentrations, 6 exceeded the marine chronic criteria. This special study confirmed that, even when clean metals techniques are employed, limited, episodic exceedances of copper criteria are observed.

Although the special study helped to address the ambiguity of sampling and analysis techniques, other considerations impacting the appropriate remedy for the copper exceedances remain, including the episodic nature of the exceedances, whether to revise current freshwater and marine criteria, and the influence of other water quality attributes that influence the partitioning and toxicity of copper. Coordination among basin states and agencies should continue to clarify a consensus course of action.

Future monitoring will continue to include additional synoptic sampling surveys targeted to copper and other metals with finer spatial and temporal scales.

Aluminum

Data showed multiple exceedances of **aluminum** acute and chronic freshwater objectives for the support of aquatic life in Zone 4. Of 35 surface water samples tested for copper in Zone 4 during the assessment period, 34 exceeded the chronic criterion and 8 exceeded the acute criterion at 21PA_WQX-WQN0182 near Marcus Hook, PA. No exceedances of aluminum were reported in Zones 2, 3, 5 and 6.

Exceedances in Zone 1

Data showed multiple exceedances for the following USEPA national recommended water quality criteria for the support of aquatic life:

1. EPA criterion for **aluminum** in Zones 1B and 1D. In Zone 1B, 7 out of 71 samples, exceeded acute criterion and 22 exceeded chronic criterion. In Zone 1D , 4 out of 79 samples exceeded acute criterion and 10 samples exceeded chronic criteria.
2. EPA criterion for **cadmium** in Zone 1B had 3 out of 31 samples exceed acute criterion and 30 samples exceed chronic criteria. In Zone 1A , 5 out of 10 samples exceeded chronic criterion.
3. EPA acute and chronic criteria for **dissolved mercury in water** for Zone 1B. Two out of 32 samples, exceeded acute criteria and 35 samples exceeded chronic criterion for protection of aquatic life while 12 samples exceeded human health criterion for fish and water ingestion.

Biological Assessment

Benthic macroinvertebrate data were not available for the October 1, 2008 through September 30, 2013 data window. As a result, a Biological Assessment could not be made for this round of the Water Quality Assessment Report. During the past two cycles(i.e., 2010, 2012), DRBC data have shown attainment of the interim biocriteria recommendations in Zones 1A, 1B, 1C, and 1D. However, during those periods, benthic macroinvertebrate scores in Zone 1E have typically not met the interim criteria. The evaluation of biological conditions in Zone 1E therefore needs further examination.

Public Water Supply

The public water supply designated use is assessed through evaluation of TDS, hardness, chlorides, odor, phenols, sodium, turbidity, systemic toxicants, carcinogens, and administrative drinking water closures. Table 17 below shows the Public Water Supply assessment results for the 2014 assessment. Additional detail on each evaluation is provided in the subsequent sections.

Table 17: Public Water Supply Designated Use Assessment Results

Zone (AU)	TDS	Hardness	Chlorides	Odor	Phenols	Sodium	Turbidity	Systemic Toxicants	Carcinogens	Drinking water closures	2014 Assessment	2012 Assessment
1A	+	N/A	N/A	ID	ID	N/A	-[A]	+	+	+	NS[B]	NS[B]
1B	+	N/A	N/A	ID	+	N/A	-[A]	+	+	+	NS[B]	NS[B]
1C	+	N/A	N/A	ID	ID	N/A	+	+	+	+	S	S
1D	+	N/A	N/A	ID	ID	N/A	+	+	+	+	S	NS[B]
1E	+	N/A	N/A	ID	ID	N/A	-[A]	+	+	+	NS[B]	NS[B]
2	+	+	+	ID	ID	N/A	-[A]	+	+	+	NS[B]	NS[B]
3	+	+	+	ID	ID	+	-[A]	+	+	+	NS[B]	S

Notes:
+ -- The Assessment unit meets WQC
- -- The Assessment unit does not meet WQC
A – Rate of criteria exceedance is below the historical threshold of 10%.
B – Based primarily on fewer than 10% exceedances of criteria
ID – Insufficient Data
N/A – Not applicable (no criteria in this assessment unit)
S – The use is supported in this Assessment Unit
NS – The use is not supported in this Assessment Unit

TDS

A description of TDS and assessment against the TDS criteria are presented under the Aquatic Life designated use in the previous section.

Hardness

Hardness is an integrated measure of divalent metallic cations. Measuring hardness in source water provides an indication of whether water softening will be desirable either in drinking water processing or in the finished drinking water at the point of use. Table 18 below shows that hardness criteria were met in all samples in Zones 2 and 3, where hardness criteria have been adopted.

Table 18: Hardness Assessment Results

Zone	% Observations Meeting Criteria	Primary Data Source(s)	Notes
1A	No Criteria		
1B			
1C			
1D			
1E			
2	100% (presumed)	• DRBC Boat Run	No individual observation exceeded criteria, therefore, attainment of 30-day mean criteria is presumed
3	100% (presumed)	• DRBC Boat Run	
4	Use not applicable in this Zone		
5			
6			

Chlorides

Chloride is one of the major inorganic ions in water and wastewater, and can impart a salty taste to drinking water at elevated concentrations. Chloride criteria are expressed as a 15-day mean in Zone 2 and a 30-day mean in Zone 3. Although sequential daily measurements are not made as part of routine surface water monitoring programs, no individual observation exceeded the numerical criteria (as shown in Table 19 below), therefore 100% attainment of the criteria is presumed.

Table 19: Chlorides Assessment Results

Zone	% Observations Meeting Criteria	Primary Data Source(s)	Notes
1A	No Criteria		
1B			
1C			
1D			
1E			
2	100% (presumed)	• DRBC Boat Run	No individual observation exceeded criteria, therefore, attainment of 15-day mean criteria is presumed
3	100% (presumed)	• DRBC Boat Run	No individual observation exceeded criteria, therefore, attainment of 30-day mean criteria is presumed
4	Use not applicable in this Zone		
5			
6			

Odor

No odor data was indicated in any of the data sets reviewed. Therefore, no assessment against odor criteria was made.

Two parameters with criteria to protect the taste and odor of ingested water and fish to be applied as human health stream quality objectives in all zones of the Delaware Estuary were monitored during the assessment period. Phenols were monitored and had no exceedances in Zones 1A, 1B and 4. Chlorobenzene was monitored and had no exceedances in Zones 1E, 2, 3, 4, 5, 6.

Phenols

Only one quantified measurement for Phenols was identified in the data set. This was collected in Zone 1B, and was below criteria.

Sodium

A criterion for sodium exists only in Zone 3. A review of all available data shows that all values were below the 30-day mean criterion of 100 mg/L. Although the spacing of the data did not support computing a 30-day mean, since all values were below 100 mg/L, attainment of this criterion is presumed.

Turbidity

A detailed discussion of the turbidity assessment is provided in the Aquatic Life section of this report.

Systemic Toxicants

Systemic toxicants affect the entire body or many organs rather than a specific site. For example, cyanide is a systemic toxicant that can affect every cell and organ in the body by interrupting oxygen exchange by cells. Stream quality objectives for systemic toxicants are established if a reference dose (RfD) exists in EPA's Integrated Risk Information System (IRIS). Public water supply use is supported in Zones 1, 2, and 3 (Table 17, with additional detail in Appendix C4).

Carcinogens

Carcinogens are substances that act directly in causing cancer. This may be due to the ability of the substance such as dioxins/furans to damage the genome or to disrupt cellular metabolic processes. Stream quality objectives for carcinogenic toxicants are established if a cancer potency factor (CPF) is available and the substance is classified as a carcinogen in EPA's Integrated Risk Information System (IRIS). Based on limited data on certain parameters, public water supply water use is supported in Zones 1, 2, and 3 (Table 17, with additional detail in Appendix C3)

Polycyclic aromatic hydrocarbons (PAHs)

In a DRBC pilot survey of PAHs analyzed by EPA Method 525.2 LL using low level analysis to achieve reporting levels of 0.25 to 5 ng/L, single date measurements of benz[a]anthracene concentration in surface water samples from two sites at 3.82 and 8.82 ng/L and benz[a]pyrene concentration from one site at 6.16 ng/L exceed the DRBC freshwater objective for human health fish and water ingestion of 3.8 ng/L. The limited data is insufficient to assess exceedance frequency of greater than once per three years for PAHs.

Using the Relative Potency Factor (RPF) approach for assessing carcinogenic risk from PAH mixtures by summing PAH concentrations for anthracene, benz[a]anthracene , benzo[b]fluoranthene, benzo[k]fluoranthene and pyrene adjusted by relative potency factors (RPF), a potential risk is indicated at sites sampled in Zones 2, 3 and 4 from PAH mixtures in surface water. DRBC water quality assessment methodology does not currently include assessment for PAH mixtures. Coordination among basin states and agencies should continue to ensure the use of the most appropriate assessment methodologies for PAHs.

Maximum Contaminant Levels

Maximum contaminant levels to be applied as human health stream quality objectives in Zones 2 and 3 were not exceeded.

Emerging Contaminants

Emerging contaminants are unregulated substances that have entered the environment through human activities. Current regulatory approaches are inadequate to address these contaminants and the increasing public concern over their environmental and human health implications. Emerging contaminants have historically not been routinely monitored therefore limited information is available on past trends. A pilot survey of emerging contaminants in the main stem of the tidal Delaware River ambient waters in 2007, 2008 and 2009 detected pharmaceuticals, personal care products, perfluorinated compounds, hormones, sterols, nonyl phenols and polybrominated diphenyl ethers at levels comparable to similar compounds and concentrations measured in occurrence studies of ambient water in other urban areas (DRBC Draft Report February 2012. Contaminants of Emerging Concern in the Tidal Delaware River: Pilot Monitoring Survey 2007 – 2009). Assessment priorities in the tidal River include further characterization of persistent and bioaccumulative perfluorinated compounds and a more comprehensive evaluation of potential ecological effects from pharmaceuticals in the estuary. Benchmark values for environmental safety are needed and in some cases water quality criteria may need to be derived for some emerging contaminants to facilitate future water quality assessment.

Drinking Water Closures

For the Assessment Period (Oct 2008 – Sept 2013), there were no administrative closures to drinking water intakes as a result of water quality issues or violations.

Contact Recreation

The DRBC water quality regulations sub-divide Zone 4 for bacteria criteria. The upper portion of Zone 4, above River Mile 81.8, is designated as secondary contact recreation only, while the lower portion of Zone 4, below River Mile 81.8, is designated for both primary and secondary contact recreation. Primary contact recreation is supported in all applicable Zones, except Zone 4 below RM 81.8, where there is insufficient data. Secondary contact recreation is supported in Zones 3 and 4. The geometric mean of Enterococcus data shows a violation of the standard in Zone 2 during 2011. Although Enterococcus geometric means were once again below criteria in 2012 and 2013, water quality in Zone 2 was not supporting the primary contact recreation use for the assessment period. As shown in Table 20, primary and secondary contact uses were supported in all other Zones, except for the lower portion of Zone 4, where insufficient data were available.

Table 20: Primary and Secondary Contact Recreation Assessment Results

AU	Fecal Coliform		Enterococcus		2014 Assessment	2012 Assessment
	Primary	Secondary	Primary	Secondary		
1A	+	+	N/A	N/A	S	S
1B	+	+	N/A	N/A	S	S
1C	+	+	N/A	N/A	S	S
1D	+	+	N/A	N/A	S	S
1E	+	+	N/A	N/A	S	S
2	+	+	-	+	NS	S
3	N/A	+	N/A	+	S	S
4 (> RM 81.8)	N/A	+	N/A	+	S	S
4 (< RM 81.8)	ID	ID	ID	ID	ID	ID
5	+	+	+	+	S	S
6	+	+	+	+	S	S

Notes:
+ -- The Assessment Unit meets WQC
- -- The Assessment Unit does not meet WQC
ID – Insufficient Data
N/A – Not applicable (no criteria in this assessment unit)
S – The use is supported in this Assessment Unit
NS – The use is not supported in this Assessment Unit

Fish Consumption

The fish consumption designated use applies to all DRBC WQM Zones. The assessment criterion is based primarily on the presence of the Basin states' fish consumption advisories in the mainstem Delaware River and Bay for the 2010 to 2011 assessment period. The presence of fish consumption advisories results in an assessment of "not supporting the designated use".
The following fish advisories reports were used:

State	Fish Consumption Advisory Link
Delaware	http://www.dnrec.delaware.gov/fw/Fisheries/Pages/Advisories.aspx
New Jersey	http://www.state.nj.us/dep/dsr/fishadvisories/2013-final-fish-advisories.pdf
Pennsylvania	http://fishandboat.com/fishpub/summary/sumconsumption.pdf
New York	http://www.health.ny.gov/environmental/outdoors/fish/health_advisories/regional

Table 21 below provides a summary of the consumption advisories issued by the states. For each assessment unit, between 2 and 8 advisories were issued. There is no assessment unit without an advisory, so the use is not supported in any zone.

It is important to note that the table below provides a summary of consumption advisories only to determine the presence or absence of advisories. In most cases, the actual advisories issued by the respective states are much more detailed. Users should consult the advisories directly for health information regarding consumption of caught fish. Actual State issued advisories *may* differ from Table 22 in several ways, including:

1. Different advisories may be issued for specific subpopulations;
2. Different advisories may be issued for subsections of the water quality management zones;
3. Specific recommendations may be provided for preparation of fish to reduce exposure to contaminants;
4. Species with no restrictions may not be listed in Table 22, as these do not contribute to the total count of advisories for assessing achievement of criteria. However, anglers should be aware of species with no recommended restrictions on consumption.

Polychlorinated Biphenyls (PCBs)

The violation of criteria indicated by the presence of fish consumption advisories is further supported by the presence of measureable PCB concentrations in the water column in excess of the surface water quality standard. Twenty-two main stem channel sites in the tidal Estuary were sampled in September 2012 for PCBs, and analyzed using EPA method 1668 Rev A. Sampling stations were located from Biles Channel near Trenton NJ, to the ocean boundary between Cape May and Lewis. Whole water samples were analyzed for all 209 PCB congeners. Total PCB concentrations range from approximately 200 pg/L, at the ocean boundary, to a maximum of 9,600 pg/L in Zone 5, and decreasing to approximately 3,000 pg/L in Zone 2. All PCB concentrations exceed the former and current PCB water quality criteria for the protection of human health from carcinogenic effects at 16 pg/L.

EPA approved a total maximum daily load (TMDL) for PCBs for Zones 2 through 5 in December 2003, and a second PCB TMDL for Zone 6 in December 2006.

Table 21: Fish Consumption Advisory Summary

Fish Species	Contaminant	Fish Consumption Advisory – General Population									
		1A	1B	1C	1D	1E	2	3	4	5	6
DELAWARE											
All Finfish	PCBs, Dioxins, Mercury, Chlorinated Pesticides									State line to C&D Canal 1/year	
Weakfish (all sizes), Bluefish (q14 in)	PCBs										C&D Canal to mouth of bay 1/month
White Perch, American Eel, Channel Catfish, White Catfish, Bluefish (>14 in)	PCBs										C&D Canal to mouth of bay 1/year
Striped Bass	PCBs, Mercury										C&D Canal to mouth of bay 2/year
NEW JERSEY											
Smallmouth Bass	Not listed			1/week	1/week	1/week					
White Sucker	Not listed			1/month	1/week	1/week					
Largemouth Bass	Not listed					No restrictions	1/month	1/month	1/month		
Walleye	Not listed			1/week	No restrictions						
American Eel	Not listed			1/month	1/month	1/month	1/year	1/year	1/year		1/year
Channel Catfish	Not listed			No restrictions	No restrictions	4/year	1/year	1/year	1/year		1/year
White Catfish	Not listed				1/week		1/month	1/month	1/month		1/year
Striped Bass	Not listed					4/year	4/year	4/year	4/year		1/year

White Perch	Not listed						4/year	4/year	4/year		1/year
All Finfish	Not listed									1/year (state line to C&D canal)	
Bluefish - larger than 24 inches or 6 lbs.	Not listed										Do Not Eat
Bluefish - smaller than 24 inches or 6 lbs.	Not listed										1/year
Striped Bass, White Perch, American Eel, Channel Catfish, White Catfish	Not listed										1/year
Weakfish	Not listed										1/week
NEW YORK											
No advisories for the mainstem Delaware River, although advisories are listed for Cannonsville Reservoir											
PENNSYLVANIA											
Smallmouth Bass	Mercury	1/month	1/month	1/month	1/month	1/month					
Rock Bass	Mercury	2/month	2/month	2/month	2/month	2/month					
American Eel	Mercury	2/month	2/month	2/month	2/month	2/month					
	PCBs						Do Not Eat	Do Not Eat	Do Not Eat		
Carp	PCBs						Do Not Eat	Do Not Eat	Do Not Eat		
White Perch, Channel Catfish, Flathead Catfish	PCBs						1/month	1/month	1/month		
Striped Bass (20 to 26 inches)	PCBs						1/week	1/week	1/week		
Striped Bass (Over 28 inches)	PCBs						1/month	1/month	1/month		
Advisories in Place?		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Shellfish Consumption

Shellfish consumption, as a DRBC designated use, only applies to DRBC WQM Zone 6. The state of Delaware classifies its designated shellfish waters within Delaware Bay as falling into the following two categories:

- Approved
- Prohibited

New Jersey classifies shellfish waters as falling into the following categories:

- Unrestricted
- Special Restricted
- Seasonal (Nov to Apr)
- Prohibited

Figure 8 indicates the current DE and NJ classifications for shellfish in zone 6. Table 22 lists the current DE and NJ classifications and the 2014 Assessment results, with the 2012 Assessment results given for comparison (*note: 2014 and 2012 designations are identical)*.

For the current 2014 assessment, approved harvesting areas were considered to be supporting (S) the use. Prohibited waters were considered to be not supporting (NS) the use. AUs classified as special restricted and seasonally restricted are considered to be supported, but with special conditions (SS). Note, however, that the states of DE and NJ do not list all prohibited or provisionally approved waters as impaired waters, as not all restrictions on shellfish harvesting are due to water quality issues (see the respective state Integrated Assessment reports for further information).

In total for the 2014 assessment, 637 mi^2 are in full support (90% of zone 6), 33 mi^2 are supporting with special conditions (5%), and 40 mi^2 are not supporting the shellfish consumption use (5%).

Figure 8: Shellfish Consumption Classifications designated by New Jersey and Delaware for the Delaware Bay (DRBC WQM zone 6)

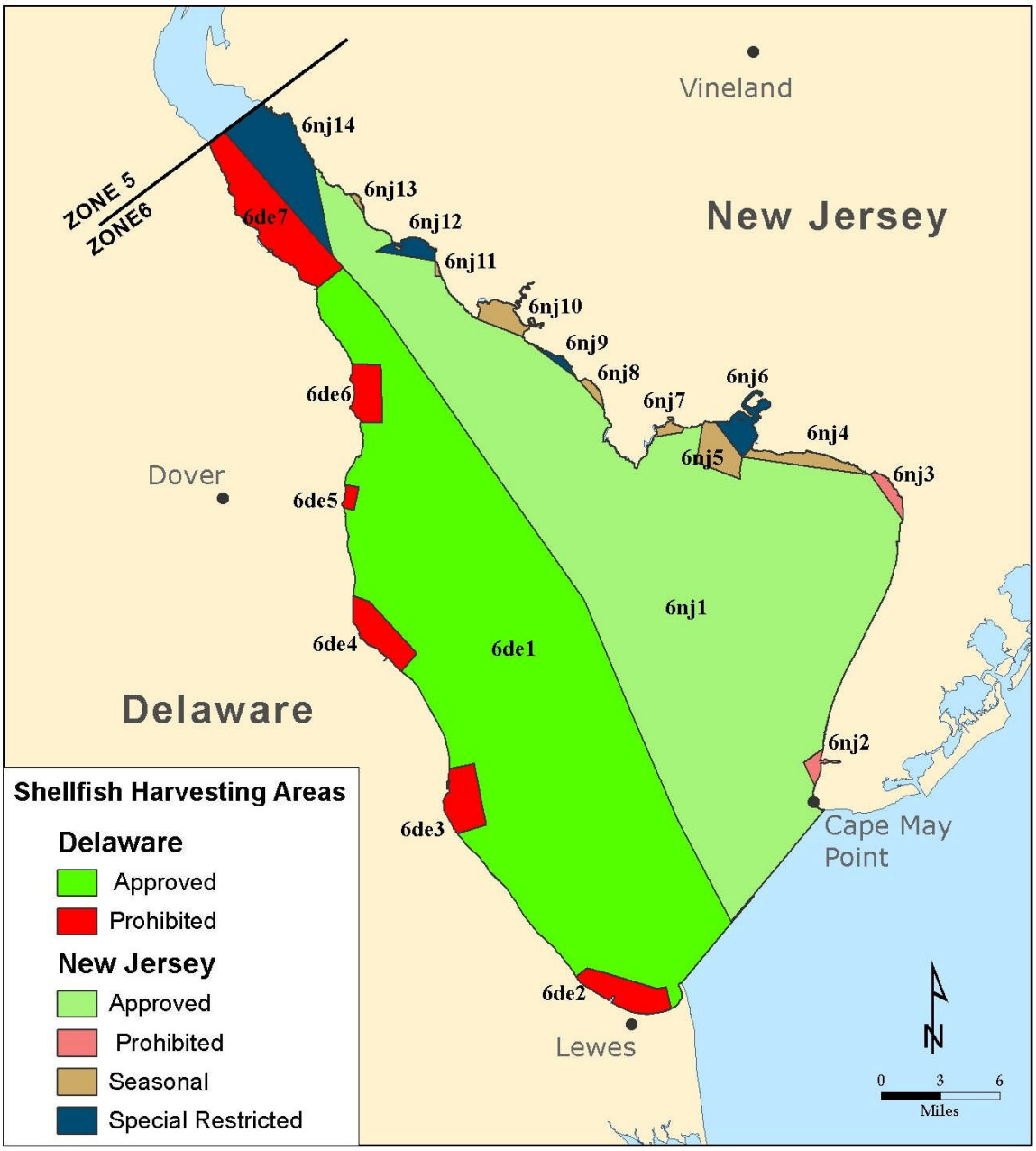


Table 22: Shellfish Consumption Designated Use Assessment Result

State	Sub-Assessment Unit within Zone 6	Area (mi^2)	DE / NJ Shellfish Classification	2014 Assessment	2012 Assessment
Delaware	6de1	306	Approved	S	S
	6de2	6	Prohibited	**NS**	**NS**
	6de3	5	Prohibited	**NS**	**NS**
	6de4	5	Prohibited	**NS**	**NS**
	6de5	1	Prohibited	**NS**	**NS**
	6de6	4	Prohibited	**NS**	**NS**
	6de7	17	Prohibited	**NS**	**NS**
New Jersey	6nj1	331	Approved	S	S
	6nj2	1	Prohibited	**NS**	**NS**
	6nj3	1	Prohibited	**NS**	**NS**
	6nj4	3	Seasonal (Nov-Apr)	SS	SS
	6nj5	4	Seasonal (Nov-Apr)	SS	SS
	6nj6	3	Special Restricted	SS	SS
	6nj7	1	Seasonal (Nov-Apr)	SS	SS
	6nj8	1	Seasonal (Nov-Apr)	SS	SS
	6nj9	1	Special Restricted	SS	SS
	6nj10	3	Seasonal (Nov-Apr)	SS	SS
	6nj11	0.2	Seasonal (Nov-Apr)	SS	SS
	6nj12	2	Special Restricted	SS	SS
	6nj13	0.2	Seasonal (Nov-Apr)	SS	SS
	6nj14	15	Special Restricted	SS	SS

S = “Supports”: The assessment unit supports the designated use

SS = “Supports – Special”: The assessment unit supports the designated use, but with special conditions

NS = “Not Supporting”: The assessment unit does not support the designated use

ID = “Insufficient Data”: Insufficient or unreliable data is present

Assessment Summary

Table 23 below shows the summary of assessments for Aquatic Life, Public Water Supply, Recreation, and Fish Consumption. Meaningful assessment continues to be hampered by the requirement to indicate one exceedance plus one confirmatory exceedance as not meeting criteria and subsequently not supporting a designated use. Turbidity exceedances not associated with high flow events during this assessment cycle resulted in Not Supporting indications for public water supply for several zones which were indicated as Supporting in the previous assessment.

Assessment of Shellfish applies only to Zone 6 and utilizes shellfish-specific assessment units. The Shellfish assessment summary is provided in Table 22 in the previous section.

Table 23: Summary of the 2014 Assessment

Zone (AU)	Aquatic Life		Drinking Water		Recreation		Fish Consumption	
	2014	2012	2014	2012	2014	2012	2014	2012
1A	NS[A]	NS[A]	NS[A]	NS[A]	S	S	NS	NS
1B	NS[A]	NS[A]	NS[A]	NS[A]	S	S	NS	NS
1C	NS[A]	NS[A]	S	S	S	S	NS	NS
1D	NS[A]	NS[A]	S	NS[A]	S	S	NS	NS
1E	NS	NS[A]	NS[A]	NS[A]	S	S	NS	NS
2	NS[A]	NS[A]	NS[A]	NS[A]	NS	S	NS	NS
3	NS[A]	NS[A]	NS[A]	S	S	S	NS	NS
4	NS	NS[A]	N/A	N/A	S	ID/S	NS	NS
5	NS	NS[A]	N/A	N/A	S	S	NS	NS
6	NS	NS[A]	N/A	N/A	S	S	NS	NS

Notes:
A – Based primarily on fewer than 10% exceedances of criteria
ID – Insufficient Data
N/A – Not applicable (no criteria in this assessment unit)
S – The use is supported in this Assessment Unit
NS – The use is not supported in this Assessment Unit

Recommendations for Future Action

Based on the results of this assessment cycle, we recommend additional effort prior to the next cycle to help address the following issues:

- Current guidance from EPA indicates that the proportion of allowable exceedances of conventional criteria must be adopted as part of criteria in order to be considered during assessment. Where the conventional criteria do not already include this information, EPA has indicated that assessors must indicate an assessment unit as having not met criteria when one exceedance plus one confirmatory exceedance are found. However, this approach is logically flawed and not supportable because it fails to recognize inherent measurement and analytical uncertainty, and imposes a wholly different standard than that which was in place at the time the criteria were developed. Prior to the next assessment cycle, DRBC should develop and adopt in Article 4, criteria implementation tables to assist in future assessment cycles.
- Renewed attention must be focused on developing ambient temperature criteria for the non-tidal Delaware River. For multiple assessment cycles, DRBC has highlighted the lack of applicable criteria. As part of the 2010 assessment, DRBC attempted to develop workable assessment methods that would provide some indication of the appropriateness of the temperature regime without criteria, but these efforts were unsuccessful.
- DRBC and its partner organizations must craft a specific plan to better define the linkage between atmospheric and meteorological drivers, in order to estimate the proportion of temperature exceedances attributable to potentially controllable anthropogenic activities.
- Good progress has been achieved on reducing the number of un-assessable parameters and zones with the establishment of permanent continuous water quality monitors in Zones 1A and 1B, through the National Park Service, and in Zone 2, through the USGS and Philadelphia Water Department. However, Zones 1C, 1D, and 6 remain without the benefit of continuous water quality monitors. DRBC and its partner organizations need to accelerate the pace of establishing continuous water quality monitoring programs where still needed.
- In previous assessment cycles, DRBC recommended the use of enhanced analytical methods and modified collection procedures to refine our understanding of apparent copper exceedances. Since 2012, DRBC has employed those refined methods, and demonstrated multiple exceedances of DRBC acute and chronic marine stream quality objective for **copper** in Zones 5. DRBC and its partner organizations must develop a consensus on appropriate management approaches toward achieving surface water quality standards for copper in Zones 5 and 6.
- Using sensitive analysis, single date measurements of benz[a]anthracene concentration in surface water samples from two sites and benz[a]pyrene concentration from one site exceeded the DRBC freshwater objective for human health fish and water ingestion. The limited data is insufficient to assess exceedance frequency of greater than once per three years for PAHs. In addition, DRBC water quality assessment methodology does not currently include assessment for PAH mixtures. Coordination among basin states and agencies should continue to ensure the use of the most appropriate assessment methodologies for PAHs.
- Data showed multiple exceedances of **aluminum** acute and chronic objectives for the support of aquatic life in Zone 4. at 21PA_WQX-WQN0182 near Marcus Hook, PA. No exceedances of aluminum were reported in Zones 2, 3, 5 and 6. Exceedances of aluminum criteria in Zone 4 warrant further attention.

References

Fikslin, TJ, GJ Cavallo, AR MacGillivray, N Suk, D Haltmeier. 2013. An Assessment of Metals in Estuarine Water using Clean Hand Techniques, PDE Science Symposium. January 2013.

Cavallo, GJ, TJ Fikslin, N Suk. 2013. Clean Hands Metals Sampling Techniques, PDE Science Symposium. January 2013.

MacGillivray, AR, DE Russell, SS Brown, TJ Fikslin, R Greene, RA Hoke, C Nally and L O'Donnell. 2011. Monitoring the Tidal Delaware River for Ambient Toxicity. Integr. Environ. Assess. Manag.: 7(3)466-477.

Appendix A: Descriptions of DRBC Monitoring Programs

The surface water quality monitoring program utilized by the DRBC consists of the following programs:

- The upper and middle non-tidal portions of the River (RM 330.7 to 209.5) are monitored through the *Scenic Rivers Monitoring Program*, a joint NPS and DRBC effort;
- The lower non-tidal portions (RM 209.5 to 133.4) are monitored through the *Lower Delaware Monitoring Program;*
- The Estuary, or tidal portion of the Delaware River (RM 133.4 to the mouth of the Delaware Bay), is monitored through the *Delaware River Boat Run Monitoring Program*, a joint effort between the DNREC and DRBC; and
- DRBC Ambient Water Monitoring of the Delaware River for Chronic Toxicity, which is included as an additional study under the Boat Run Monitoring Program.
- The *Biological Monitoring Program* collects macroinvertebrate samples throughout the non-tidal River (RM 300.7 to 133.4) for assessment of Aquatic Life Use

In addition, data obtained from other agencies' monitoring efforts are used to supplement data obtained through the DRBC sampling efforts. The other data sources include:

- DNREC Dioxins and Furans in Fish from the Delaware River Study,
- Pennsylvania Department of Environmental Protection (PADEP) Water Quality Network (WQN),
- New Jersey Department of Environmental Protection (NJDEP) Ambient Surface Water Monitoring Network (from STORET),
- New York State Department of Environmental Conservation (NYSDEC) Ambient Water Quality Monitoring Program (from STORET),
- United States Geological Survey (USGS) National Water Information System (NWIS),
- DRBC/USGS Cooperative Monitoring Program (continuous monitors),
- National Oceanic Atmospheric Administration (NOAA) Physical Oceanographic Real-Time System (PORTS) data, and
- EPA National Coastal Assessment Programs.

The DRBC water quality monitoring programs and the DNREC dioxin and furan study are described below. For information on quality objectives and criteria and sample design, refer to the following DRBC Quality Assurance Project Plans (QAPPs):

- Scenic Rivers Monitoring Program QAPP, Revision 1 (2006)
- Ambient Water Monitoring of the Delaware River for Chronic Toxicity QAPP, June 13, 2006
- Lower Delaware Water Quality Monitoring Program QAPP (2004)
- Delaware River Boat Run Monitoring Program QAPP (2004)
- Delaware River Biomonitoring Program QAPP (2007)

Scenic Rivers Monitoring Program (SRMP)

In 1984, the SRMP began monitoring approximately a 121-mile reach of the Delaware River, from RM 330.7 to RM 209.5, which contains two portions of the National Wild and Scenic Rivers System and numerous high quality tributaries that drain portions of New York, New Jersey, and Pennsylvania. The DRBC and NPS collect water quality measurements for the following purposes:

1. To convert reach-wide EWQ targets to ICP and/or BCP targets;
2. To support water quality models for SPW implementation; and
3. To gather sufficient water quality information to implement DRBC SPW regulations using a site-specific statistical approach to define and assess possible changes to existing water quality.

There are 47 sampling locations; however, for the 2010 Assessment, only data from Interstate Control Points (ICP) along the main stem Delaware River are utilized. Tributary boundary sites are not used.

Lower Delaware Monitoring Program (LDMP)

In 1999, DRBC began monitoring to characterize the existing water quality of the Lower Non-tidal Delaware River, the reach extending from Trenton, NJ, (RM 134) to the Delaware Water Gap (RM 210). This monitoring network was established because little data existed to characterize water quality in this reach, portions of which have been included in the National Wild and Scenic Rivers System. In 2004, DRBC completed a five-year effort to define existing water quality and to develop a water quality management strategy that protects and improves the water quality of the Lower Delaware region. Based on LDMP monitoring results, the Lower Delaware was declared by DRBC in 2005 as "Significant Resource Waters."

Program objectives include:

- Establishing EWQ for future comparison;
- Assessing attainment of water quality standards;
- Setting geographic and water quality priorities to maintain or improve EWQ; and
- Long-term monitoring so that DRBC can consistently perform its 305b assessment, evaluate trends, prioritize agency management activities, and assess effectiveness of strategy implementation.

Sampling is conducted at 9 Delaware River ICP sites and 15 tributary sites. Only the results for the ICP sites are used in the assessment.

Estuary Boat Run Program (Boat Run)

The Boat Run consists of monitoring of the tidal portion of the Delaware River from the head of tide at Trenton, NJ, (RM 133.4) to the mouth of the Delaware Bay, delineated as a line from Cape May, NJ, to Lewes, DE. The goals of the program are to provide accurate, precise, and defensible estimates of the surface water quality of the Delaware Estuary and to allow assessment of water quality standards compliance.

Sampling occurs 8 to 12 times per year at up to 22 locations, depending on funding. The samples are analyzed for routine and bacterial parameters, nutrients, heavy metals, sodium and biotic ligand model parameters, chlorophyll-a, dissolved silica, productivity, and volatile organics.

Delaware River Chronic Toxicity Study

The Toxic Advisory Committee (TAC) for the DRBC recommended and the DRBC Commissioners asked the DRBC staff to study and characterize the nature and extent of ambient chronic toxicity in the Delaware Estuary (Zone 2 through 5). As part of that ongoing effect, ambient toxicity surveys were conducted in 2009 and 2012 The surveys used ambient water to measure potential chronic toxicity in the tidal Delaware River (RM 50 to RM 131). The objective was to assess if chronic lethal or sublethal toxicity, as measured in laboratory experiments, was present in river water samples. Ambient toxicity at sixteen fixed stations in the main-stem of the tidal Delaware River with salinities from 0 to 15 parts per thousand (ppt) was assessed using six species: *Pimephales promelas*, *Americamysis bahia,* and *Menidia beryllina* in 7-day tests*; Ceriodaphnia dubia* in a test conducted for a maximum of 8-days; *Pseudokirchneriella subcapitata* in a 96-hour test*;* and *Hyalella azteca* in a 10-day water-only test. Survival, growth, and when possible, reproduction were measured in the toxicity tests. Sampling in two different years indicated, based on the measured endpoints, that the ambient samples from the mainstem of the Delaware River were not chronically toxic to the tested species. The sampling was not designed to characterize any potential near-field toxicity issues immediately surrounding point source discharges or contaminated sites. The surveys did identify tributaries that warrant further assessment for potential impairment from chronic lethal or sublethal toxicity.

Biological Monitoring Program

DRBC's biological monitoring of the non-tidal Delaware River (RM 330.7 to 133.4) began in 2001 using benthic macroinvertebrates as the monitoring endpoint. For many years, DRBC has assessed the Aquatic Life Use of the non-tidal river using physical and chemical parameters. The biological monitoring program seeks to complement this physical/chemical monitoring with measurements of the diversity and health of the aquatic life community itself.

The initial years of data collection were designed to characterize the spatial and temporal variation in invertebrate communities at 25 fixed monitoring stations within riffle habitats (see Appedix A-1 for station locations; see Biomonitoring QAPP and Silldorff and Limbeck 2009 for details of the monitoring design). Using these initial data, DRBC has worked with the Biological Advisory Subcommittee to the WQAC in the analysis of the data and in the development of an interim assessment methodology based on these macroinvertebrate collections. Data from macroinvertebrate collections during 2007 and 2008

were then interpreted relative to the newly developed interim assessment methodology for the 2014Integrated Assessment.

Appendix B: Other DRBC Water Pollution Control Programs

DRBC's water pollution control program is carried out through a series of interdependent steps and provides a rational approach to protecting and restoring water quality in the basin. The waters of the Basin are protected for designated uses with water quality criteria (WQC) that specify what levels of individual parameters are appropriate, based upon a review of the current scientific understanding about the needs of those uses. DRBC's monitoring programs provide a mechanism to evaluate how those WQC are being met, and assessment of those monitored data provide the link to how well the designated uses are being protected. The identified impairment of interstate waters in the Basin leads to the development of total maximum daily loads (TMDLs), issuing of permits and other mechanisms to reduce loading of pollutants in order to improve water quality to levels that meet the criteria. In addition, DRBC has other layers of protection (i.e., Special Protection Waters) that aim to maintain existing water quality where it is better than the water quality criteria. The following are examples of how the Commission takes a multi-faceted approach to water quality regulation.

Special Protection Waters

Currently, portions of the Delaware River are designated by DRBC as "Special Protection Waters" (SPW) and have associated with them a variety of specific pollution prevention and reduction requirements driven by a "no measurable change" policy toward water quality. Designated reaches of SPW fall into two categories:

(1) Outstanding Basin Waters

- The Upper Delaware Scenic and Recreational River from Hancock, NY, to Milrift, NY (Delaware River between RM 330.7 and 258.4)
- Portions of intrastate tributaries located within the established boundary of the Upper Delaware Scenic and Recreational River Corridor
- The Middle Delaware Scenic and Recreational River from Milrift, NY, to the Delaware Water Gap (Delaware River between RM 250.1 and 209.5)
- Portions of tributaries located within the established boundaries of the Delaware Water Gap National Recreation Area

(2) Significant Resource Waters

- The Delaware River from Milrift, NY, to Milford, PA (RM 258.4 to 250.1)
- The Delaware River from the Delaware Water Gap to Trenton, NJ (RM 209.5 to 133.4).

SPW regulations take a watershed approach to antidegradation of water quality. The regulations apply to the drainage area of the designated waters. Policies provide an up-front approach to reducing or eliminating new pollutant loadings, through requirements made in the docket (permit) review process, for the purpose of maintaining "Existing Water Quality" (EWQ) in designated waters. This is accomplished, in part, by looking at the cumulative impacts of point and non-point sources as they may affect the designated waters, either through direct discharge or through tributary loading. EWQ is

defined in the regulations by numerical tables (DRBC WQR 2008). Numerical values for SPW EWQ are defined as (a) an annual or seasonal mean of the available water quality data, (b) two-tailed upper and lower 95 percent confidence limits around the mean, and (c) the 10^{th} and 90^{th} percentiles of the dataset from which the mean was calculated.

Estuary CBOD Allocations

The Commission determined that the 1964 carbonaceous biochemical oxygen demand ($CBOD_{20}$) of the effluent load to Zones 2, 3, 4, and 5 exceeded the waste assimilative capacity of those Zones to meet the stream quality objectives based upon numerical modeling study conducted in the late 1960s. In accordance with the regulations, the assimilative capacity of each Delaware Estuary Zone minus a reserve was originally allocated in 1968 among the individual dischargers based upon the concept of uniform reduction of raw waste in a Zone (Zones 2, 3, 4, and 5). Since 1968, the wasteload allocations for individual dischargers have been updated and documented by the Commission.

Pollutant Minimization Plans

In 2005, DRBC established requirements for the development of Pollutant Minimization Plans (PMP) for polychlorinated biphenyls (PCBs). These plans are currently being required for selected point and non-point discharges of PCBs in the Delaware Estuary. The goal of this program is to work toward meeting water quality standards and to eliminate fish consumption advisories due to PCBs. Because of the limited ability of dischargers to reduce their PCB loadings quickly enough to fully comply in the short term with the numeric limits that are based on water quality standards, this non-numeric approach allows the Commission to require dischargers to take actions in reducing PCB loadings to the Estuary. Pollutant Minimization Plans require biennial PCB sampling and submission of an annual report summarizing PCB loading reduction efforts. The Commission in cooperation with the states of New Jersey, Delaware and Pennsylvania has established a workgroup to include supplementary monitoring requirements via NPDES permits in order to better evaluate these efforts. Additionally, dischargers who were not initially required to develop a PMP have been required as part of their NPDES renewal or at the direction of the Commission to develop a PMP, perform monitoring and submit annual reports. The DRBC also has the authority to require PMPs for contaminated sites to further reduce non-point sources of PCB loadings to the Estuary.

More detailed descriptions of PCB efforts are provided at the DRBC web site, including the PCB Model Calibration Report (http://www.state.nj.us/drbc/library/documents/PCBhomolog_model-rpt0511.pdf), and extensive information on the PMP program (http://www.state.nj.us/drbc/programs/quality/pmp.html).

Point Source Control Program

DRBC uses a variety of programs to regulate point source pollutant loadings that would impact the Delaware River. These consist of docket review, pollutant allocations (including Pollutant Minimization Plans, PMPs), SPW regulations, and basin-wide minimum treatment standards and interstate cooperative agreements.

Section 3.8 of the compact states that “No project having substantial effect on the water resources of the Basin shall hereafter be undertaken by any person, corporation or governmental authority unless it

shall have been first submitted to and approved by the Commission". Projects are reviewed for potential impacts to the waters of the basin and for consistency with the Comprehensive Plan (http://www.nj.gov/drbc/library/documents/comprehensive_plan.pdf), which consists of the statements of policies and programs that the commission determines are necessary to govern the proper development and use of the Delaware River Basin (DRBC Rules of Practice and Procedure, 2002: http://www.nj.gov/drbc/library/documents/admin_manual.pdf).

In addition, it is the policy of the Commission that there be no measurable change in existing water quality except towards natural conditions in Special Protection Waters (SPW). The DRBC implements both point source and non-point source controls through its SPW regulations. All new or expanding wastewater treatment projects must demonstrate that the new or incremental increase in the facility's load will not cause a measurable change in existing water quality at the relevant water quality control point for several parameters.

Article 4 of DRBC's Water Quality Regulations (http://www.nj.gov/drbc/library/documents/WQregs.pdf) identifies basin-wide minimum treatment standards for wastewater discharges. These include:

- Removal of total suspended solids;
- Minimum secondary treatment for biodegradable wastes;
- BOD treatment requirements;
- Disinfection requirements;
- Color standards; Dissolved substance standards;
- pH standards;
- Ammonia standards;
- Temperature standards

DRBC maintains cooperative agreements with all four Basin states, which provide that all NPDES permits for projects that lie within the Basin must comply with DRBC standards as well as state standards.

Nonpoint Source Control Program

DRBC regulates non-point pollution as part of the anti-degradation requirements of SPW. Under DRBC SPW regulations, the service areas of all new or expanding wastewater discharge or water withdrawal project sponsors located in the drainage areas of SPW must submit for approval a Non-point Source Pollution Control Plan with their application. The plan must control the new or increased non-point source loads generated within the portion of the project sponsor's service area that is also located within the drainage area of SPW. The plans must document the Best Management Practices to be applied to the project site and/or service area. Non-point source pollution from runoff of developed areas in SPW may not be subject to antidegradation constraints if they are associated with an existing, non-expanding facility, such as a wastewater treatment plant that is not expanding its service area.

Non-point sources of PCBs may also be regulated, on a project-specific basis, by PMPs that the DRBC has begun requiring assistance in reducing PCB loadings into the Delaware River.

Coordination with Other Agencies

The nature of DRBC's water quality management activities relies on interstate coordination and cooperation. For instance, the agency maintains agreements with all four Basin states regarding permit review. Additionally, all new or amended DRBC regulations are ruled on by the Commission, which has representation by the four states and federal government. The Scenic Rivers Monitoring Program (SRMP) and Estuary Boat Run also rely on cooperation between DRBC and other agencies. The SRMP is a partnership between DRBC and the National Park Service (NPS), while the Boat Run is a partnership between DRBC and the Delaware Department of Natural Resources and Environmental Conservation (DNREC).

Integrated Resource Plans

In 1998, DRBC amended its Southeastern Pennsylvania Ground Water Protected Area Regulations to include watershed-based ground water withdrawal limits for sub-basins that lie entirely or partially within the protected area. As required by the Regulations, those withdrawal limits may be revised by the Commission to be more protective of streams designated by the State of Pennsylvania as either "high quality" or "exceptional value," or "wild," "scenic," or "pastoral," or to correspond to more stringent requirements in "integrated resource plans" adopted and implemented by all municipalities in the sub-basin. Integrated Resource Plans (IRPs) must assess water resources and existing uses of water; estimate future water demands and resource requirements; evaluate supply-side and demand-side alternatives to meet water withdrawal needs; assess options for wastewater discharge to subsurface formations and streams; consider storm water and floodplain management; assess the capacity of the sub-basin to meet present and future demands for withdrawal and non-withdrawal uses such as instream flows; identify potential conflicts and problems; incorporate public participation; and outline plans and programs including land use ordinances to resolve conflicts and meet needs. The development of IRPs helps focus and coordinate planning tools to consider the multiple uses of water resources and the interrelationships of water quality and quantity to meet various needs.

Integrated Resource Management

In 2001, DRBC began a multi-stakeholder process to develop a "forward-looking" Water Resources Plan for the Delaware River Basin (Basin Plan). In September 2004, the Governors of the Basin States and representatives of six federal agencies, signed a resolution showing their support for the Basin Plan. The Basin Plan is a unified framework of desired outcomes, goals, objectives, and milestones for protecting, preserving, and enhancing water resources. The central theme of the Basin Plan is a watershed-based approach to the achievement of integrated resource management. The Basin Plan sets a direction for water resource policy and management through 2030 and calls for the active involvement of a broad range of governmental and non-governmental entities in addition to DRBC.

Among the concepts included in the Basin Plan are the integration of water resources considerations into land use planning and management, the development of analytical tools to evaluate water resources impacts of municipal land use plans, the implementation of TMDLs to meet water quality standards for the protection of designated uses, and the use of regulatory and non-regulatory approaches to maintaining and improving water quality where it is better than criteria.

Appendix C: Toxic Pollutants Water Quality Assessment Details

Table C1: Human Health Objectives (Toxics MCLs) Assessment Results

Parameter	Maximum Contaminant Level (µg/l)	2014 Assessment/Zones monitored
Metals		
Arsenic	10	No exceedance Zones 1C,1D, 1E and 2
Barium	2000	No exceedance Zones 1C and 1E
Beryllium	4	No exceedance Zones 1Cand 1E
Chromium (trivalent)	100	NE (as total) Zones 1C,1D,1E,2,3
Copper	1300	No exceedance Zones 1A, 1B,1E, 2,3
Lead	15	One exceedance Zone 1B (no impairment) NE Zones 1A, 1E, 2and 3
Selenium	50	NE Zones 1C,1D,1E
Pesticides/PCBs		
alpha-BHC	0.2	NM
beta-BHC	0.2	NM
gamma - BHC (Lindane)	2	One exceedance Zone 1D (no impairment) NE Zone 2,3 (2012 low DL study)
2,4-Dichloro-phenoxyacetic acid (2,4-D)	70	NM

Parameter	Maximum Contaminant Level (µg/l)	2014 Assessment/Zones monitored
Methoxychlor	40	NE Zone 1E / NE Zones 2,3 (2012 low DL study)
Toxaphene	3	NE Zone 1E
Dioxin (2,3,7,8-TCDD)	0.00003	NM
2,4,5 Trichloro-phenoxypropionic acid (2,4,5-TP-Silvex)	50	NM
Volatile Organic Compounds (VOCs)		
Benzene	5	NE Zones 1E, 2,3,4,5,6
Carbon Tetrachloride	5	NE Zones 2,3,4,5,6
1,2-Dichloroethane	5	NE Zones 1E, 2,3,4,5,6
1,1-Dichloroethylene	7	NE Zones 1E, 2,3,4,5,6
[1,2 - trans – Dichloroethene] 1,2 - trans - Dichloroethylene	100	NE Zones 1E
Dichloromethane (methylene chloride)	5	NE Zones 1B, 2,3,4,5,6
Tetrachloroethylene (PCE)	5	NE Zones 1B,1E, 2,3,4,5,6
Toluene	1000	NE Zones 1B,1E, 2,3
Total Trihalomethanes	80	NE Zones 1E
1,1,1-Trichloroethane	200	NE Zones 1E, 2,3,4,5,6
1,1,2-Trichloroethane	5	NE Zones 1E, 2,3,4,5,6
Trichloroethylene	5	NE Zones 1B,1E, 2,3,4,5,6

Parameter	Maximum Contaminant Level (µg/l)	2014 Assessment/Zones monitored
Vinyl Chloride	2	NE Zones 1B,1,1E, 2,3,4,5,6
Polycyclic Aromatic Hydrocarbons (PAHs)		
Benzo(a)Pyrene	0.2	NM
Other Compounds		
Asbestos	7 million fibers/L	NM
Bis(2-Ethylhexyl) Phthalate	6	NM
Fluoride	4,000	NE Zones 1B,11E,2
Nitrate	10,000	NE Zones 1A,1B,1C,1D,1E,2,3,4,5,6
Pentachlorophenol	1	NM

Table C2: Aquatic Life Objectives Assessment Results

Parameter	Freshwater Objectives (µg/l)		2014	Marine Objectives (µg/l)		2014
	Acute	Chronic		Acute	Chronic	
	Metals					
Aluminum[a,b]	750	87	E acute Zones 1B, 1D, 4 E chronic Zones 1A, 1B, 1D, 1E, 4	NA	NA	NM
Arsenic (trivalent)[c]	340	150	NE Zones 1A, 1B, 1E and 6	69	36	NM
Cadmium[c]	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	E acute Zone1B / chronic Zones 1A, 1B / NE Zones 1C, 1E, 5	40	8.8	NM
Chromium (trivalent)[c]	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	NE estimated from total chromium Zones 1C,1E	NA	NA	NM
Chromium (hexavalent)[c]	16	11	NE Zones 1E,2,3,4,5 (NE estimated from chromium 1C,1E)	1,100	50	NE Zones 5,6
Copper[c,g]	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	NE Zones 1A, 1B,1E,2,3,4,5	4.8	3.1	E acute Zones 5,6
Lead[c]	38	5.4	NE Zones 1A, 1B 1E, 2,3,4,5	210	8.1	NE Zone 5,6

Parameter	Freshwater Objectives (µg/l)		2014	Marine Objectives (µg/l)		2014
	Acute	Chronic		Acute	Chronic	
Mercury [c]	1.4	0.77	E acute and chronic Zones 1B / NE Zone 1A,1C, 1E, 2,3,4,5	1.8	0.94	NE Zone 5,6
Nickel [c]	0.846*EXP(0.846* LN(hardness)+2.255)	0.846*EXP(0.846* LN(hardness)+0.0584)	NE all Zones (estimated from total in 1B and 1C)	64	22	NE Zones 5 to 6
Selenium [a]	20	5.0	NE Zones 1A, 1B,1C,1E NM other Zones	290	71	NM
Silver [c]	0.85*EXP(1.72* LN(hardness)-6.59)	NA	NE Zones 1A, 1B, 1C, 1E NM other Zones	1.9	NA	NM
Zinc [c]	0.95*EXP(0.8473* LN(hardness)+0.884)	0.95*EXP(0.8473* LN(hardness)+0.884)	NE All Zones (estimated from total in 1B and 1C)	90	81	NE Zones 5 to 6
	Pesticides/PCBs					
Aldrin	3	NA	NE Zone 1E / NE Zones 2,3,4,5 (2012 low DL study)	1.3	NA	NE Zones 5,6 (2012 low DL study)

Parameter	Freshwater Objectives (µg/l)		2014	Marine Objectives (µg/l)		2014
	Acute	Chronic		Acute	Chronic	
gamma - BHC (Lindane)	0.95	NA	NE Zone 1E / NE Zones 2,3,4,5 (2012 low DL study)	1.3	NA	NE Zones 5,6 (2012 low DL study)
Chlordane	2.4	0.0043	NE Zone 1E / NE Zones 2,3,4,5 (2012 low DL study)	0.16	NA	NE Zones 5,6 (2012 low DL study)
Chlorpyrifos (Dursban)	0.083	0.041	NE Zone 1E NE Zones 2,3,4,5 (2012 low DL study)	0.09	0.004	NE Zones 5,6 (2012 low DL study)
DDT and metabolites (DDE & DDD) [d]	1.1	0.001	NE Zones 1E	0.011	0.0056	NM
Dieldrin	0.24	0.056	NE Zones 2,3,4,5 (2012 low DL study)	0.13	0.001	NE Zones 5,6 (2012 low DL study)
Endosulfan [e]	0.22	0.056	NE Zone 1E, / NE Zones 2,3,4,5 (2012 low DL study)	0.71	0.0019	NE/ Zones 5,6 (2012 low DL study)

Parameter	Freshwater Objectives (µg/l)		2014	Marine Objectives (µg/l)		2014
	Acute	Chronic		Acute	Chronic	
Endrin	0.086	0.036	NE Zone1E	0.034	0.0087	NM
Heptachlor	0.52	0.0038	NE Zone 1E NE Zones 2,3,4,5 (2012 low DL study)	0.037	0.0023	Zones 5,6 (2012 low DL study)
Heptachlor Epoxide	0.52	0.0038	NE Zone 1E / NE Zones 2,3,4,5 (2012 low DL study)	0.053	0.0036	Zones 5,6 (2012 low DL study)
Parathion	0.065	0.013	NE Zone 1E / NE Zones 2,3,4,5 (2012 low DL study)	0.053	0.0036	Zones 5,6 (2012 low DL study)
PCBs (Total)	1.0	0.014	ongoing TMDL	NA	NA	TMDL
Toxaphene	0.73	0.0002	NM	5.0	0.03	NM
	Other Compounds					
Cyanide (free)	22	5.2	NM	1	1	NM
Pentachlorophenol	$e^{(1.005*pH-4.83)}$	$e^{(1.005*pH-5.29)}$	NM	13	7.9	NM
	Indicator Parameters					
Whole Effluent Toxicity	0.3 Toxic Units $_{acute}$	1.0 Toxic Units $_{chronic}$	NE[f]	0.3 TU_a	1.0 TU_c	NE[f]

[a] Total recoverable criterion

[b] Aluminum criteria listed should be restricted to waters with pH between 6.5 and 9.0.

[c] Dissolved Criterion

[d] This criterion applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value.

[e] This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

Criteria for cadmium, chromium(trivalent), copper, nickel, silver and zinc are hardness dependent and are expressed as the dissolved form (see Section 3.10.3.C.2. for form of metal).

Multiple exceedances of EPA criteria for cadmium in Zone 1B at a single site (RM 254).

[f] Sampling in 2009 indicated, based on the measured endpoints, that the samples from sites tested in the main-stem of the Delaware River and from the majority of its tributaries were not chronically toxic to the tested species (Pimephales promelas, Americamysis bahia, Menidia beryllina, and Ceriodaphnia dubia in 7-d tests;

Pseudokirchneriella subcapitata in a 96-h test; and Hyalella azteca in a 10-d water-only test). The surveys identified tributaries that warrant further assessment for potential impairment from toxicity. For 1 of the 3 test species, in 2 separate years of sampling, 2 sites (Assunpink Creek and Red Lion Creek) indicated chronic toxicity in both screening tests and confirmatory tests. Integrated Environmental Assessment and Management : Volume 7, Number 3, pp. 466–477. Based on sampling in 2012, measured endpoints at eleven sites in the main stem of the Delaware River clearly did not indicate chronic toxicity to the tested species. However, three sites in main stem DRBC Water Quality Zone 5 warrant further assessment to confirm the existence and persistence of toxicity and to evaluate potential sources (chemical causes) of observed toxicity (http://www.state.nj.us/drbc/quality/toxics/wet/).

[g] Copper concentrations continue to be near water quality criteria in the Delaware Estuary with several apparent exceedances of the acute and chronic marine criteria in Zones 5 and 6. The apparent exceedances are low in both frequency and magnitude. Assessment is complicated by factors such as field sampling and analytical issues with contamination, the applicability of DRBC's freshwater or marine criteria, a need to assess revisions to the current

freshwater and marine criteria, and the influence of other water quality attributes that influence the partitioning and toxicity of copper. Therefore, copper levels in the Delaware Estuary should be considered of concern warranting additional monitoring and assessment. Suggested studies include additional synoptic sampling surveys targeted to copper and other metals with finer spatial and temporal scales, as well as, further assessment including the evaluation of water quality models such as the Biotic Ligand Model to assess the frequency of criteria exceedances and the factors contributing to those exceedances. Coordination among basin states and agencies should continue to ensure the use of the most appropriate methods and procedures for the conduct of monitoring studies in the Basin, and the harmonization of water quality criteria and assessment methodologies.

NA = not available; NE = no exceedances greater than once per three years; E = exceedances

NM = not monitored

DL>C = detection limit is greater than DRBC criteria

Table C3: Human Health Objectives (Carcinogens) Assessment Result

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014 assessment	MARINE OBJECTIVES (µg/l)	2014 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Metals					
Arsenic	*	NA	NE Zones 1A, 1B,1C, 1E and 6	NA	NM
Pesticides/PCBs					
Aldrin	0.000049	0.000050	NE Zone 1E NE Zones 2,3,4,5 (2012 low DL study)	0.000050	NE Zones 5,6 (2012 low DL study)
alpha – BHC	0.0026	0.0049	NM	0.0049	NM
beta – BHC	0.0091	0.017	NM	0.017	NM
Chlordane	0.00080	0.00081	NE Zone 1E	0.00081	NM
DDD	0.00031	0.00031	NM	0.00031	NM
DDE	0.00022	0.00022	NM	0.00022	NM
DDT	0.00022	0.00022	NM	0.00022	NM
Dieldrin	0.000052	0.000054	NE Zones 1C, 1D,1E NE Zones 2,3,4,5 (2012 low DL study	0.000054	NE Zones 5,6 (2012 low DL study)

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014 assessment	MARINE OBJECTIVES (µg/l)	2014 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Heptachlor	0.000079	0.000079	NE Zone 1E NE Zones 2,3,4,5 (2012 low DL study	0.000079	NE Zones 5,6 (2012 low DL study)
Heptachlor Epoxide	0.000039	0.000039	NE Zone 1E NE Zones 2,3,4,5 (2012 low DL study (no impairment - single detection at RM 88 and RM 105	0.000039	NE Zones 5,6 (2012 low DL study)
PCBs (Total)	0.0000444	0.0000448	Not assessed ongoing TMDL	0.0000079	ongoing TMDL
Toxaphene	0.00028	0.00028	DL>C	0.00028	NM
Volatile Organic Compounds (VOCs)					
Acrylonitrile	0.051	0.25	DL>C	0.25	NM
Benzene	0.61	14	NE Zones 1E,	14	NE Zones

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014 assessment	MARINE OBJECTIVES (µg/l)	2014 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
			2,3,4,5		5,6
Benzidine	0.000086	0.00020	NM	0.00020	NM
Bromoform(tribromomethane)	4.3	140	NE Zones 1E, 2,3,4,5	140	NE Zones 5,6
Bromodichloromethane	0.55	17	NM	17	NM
Carbon Tetrachloride	0.23	1.6	NE Zones 1E, 2,3,4,5	1.6	NE Zones 5,6
Chlorodibromomethane	0.40	13	NE Zones 1B,,1E, 2,3,4,5,6	13	NE Zones 5,6
Chloroform	5.7	470	NE Zones 1B, 1E,2,3,4,5	470	NE Zones 5,6
3,3 - Dichlorobenzidine	0.021	0.028	NM	0.028	NM
1,2 - Dichloroethane	0.38	37	NE Zones 1B,,1E, 2,3,4,5	37	NE Zones 5,6
1,2 - Dichloropropane	0.50	15	NM	15	NM
1,3 - Dichloropropene	0.34	21	NM	21	NM
Dichloromethane (Methylene chloride)	*	590	NE Zones 1B,1E, 2,3,4,5	590	NE Zones 5,6

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014 assessment	MARINE OBJECTIVES (µg/l)	2014 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Tetrachloroethylene	0.69	3.3	NE Zones 1B, 1E, 2,3,4,5	3.3	NE Zones 5,6
1,1,2,2 - Tetrachloroethane	0.17	4.0	NM	4.0	NM
1,1,2 - Trichloroethane	0.59	16	NE Zones 1E, 2,3,4,5,	16	NE Zones 5,6
Trichloroethylene	2.5	30	NE Zones 1B,1E, 2,3,4,5 (no impairment single exceedance in Zone 1B)	30	NE Zones 5,6
Vinyl Chloride	0.025	2.4	NE Zones 1B, 1E, 2,3,4,5	2.4	NE Zones 5,6
Polycyclic Aromatic Hydrocarbons (PAHs)[a]					
Benz[a]anthracene	0.0038	0.18	Single E Zones 2,3 (no impairment-2012 low DL screen survey) NE Zones 4,5	0.18	NE Zones 5,6
Benzo[b]fluoranthene	0.038	0.18	NE Zones	0.18	NE Zones

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014 assessment	MARINE OBJECTIVES (µg/l)	2014 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
			2,3,4,5		5,6
Benzo[k]fluoranthene	0.38	1.8	NE Zones 2,3,4,5	1.8	NE Zones 5,6
Benzo[a]pyrene	0.0038	0.018	Single E Zone 3 (no impairment-2012 low DL screen survey) NE Zones 4,5	0.018	NE Zones 5,6
Chrysene	3.8	18	NE Zones 2,3,4,5	18	NE Zones 5,6
Dibenz[a,h]anthracene	0.0038	0.018	NE Zones 2,3,4,5	0.018	NE Zones 5,6
Indeno[1,2,3-cd]pyrene	0.038	0.18	NE Zones 2,3,4,5	0.18	NE Zones 5,6
Other Compounds					
Bis (2-chloroethyl) ether	0.03	0.53	NM	0.53	NM
Bis (2-ethylhexyl) phthalate	1.2	2.2	NM	2.2	NM
2,4 - Dinitrotoluene	0.11	3.4	NM	3.4	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014 assessment	MARINE OBJECTIVES (µg/l)	2014 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
1,2 - Diphenylhydrazine	0.036	0.2	NM	0.2	NM
Hexachlorobenzene	0.00028	0.00029	NE Zones 2,3,4,5 (2012 low DL study)	0.00029	NE Zones 5,6 (2012 low DL study)
Hexachlorobutadiene	0.44	18	NE Zones 1C,1D,1E	18	NM
Hexachloroethane	1.4	3.3	NE Zones 1C,1D,1E	3.3	NM
Isophorone	35	960	NM	960	NM
N-Nitrosodi-N-butylamine	0.0063	14	NM	14	NM
N-Nitrosodi-N-methylamine	0.00069	3.0	NM	3.0	NM
N-Nitrosodiethylamine	0.0008	1.24	NM	1.24	NM
N-Nitrosodi-N-phenylamine	3.3	6	NM	6	NM
N-Nitrosodi-N-propylamine	0.0050	0.51	NM	0.51	NM
N-Nitrosopyrrolidine	0.016	34	NM	34	NM
Pentachlorophenol	0.27	3.0	NM	3.0	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014 assessment	MARINE OBJECTIVES (µg/l)	2014 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Dioxin (2,3,7,8 – TCDD)	0.000000005	0.0000000051	NM	0.0000000051	NM
2,4,6 - Trichlorophenol	1.4	2.4	NM	2.4	NM

* The MCL for this compound applies in Zones 2 and 3 and is listed in Table 3. NA = not available

[a] Using the Relative Potency Factor (RPF) approach for assessing carcinogenic risk from PAH mixtures by summing PAH concentrations for anthracene, benz[a]anthracene , benzo[b]fluoranthene, benzo[k]fluoranthene and pyrene adjusted by relative potency factors (RPF) indicates a potential risk at sites sampled in Zones 2, 3 and 4 from PAH mixtures in surface water. DRBC water quality assessment methodology does not currently include PAH mixtures. Coordination among basin states and agencies should continue to ensure the use of the most appropriate assessment methodologies for PAHs.

Table C4: Human Health Objectives (Systemic Toxicants) Assessment Results

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014	MARINE OBJECTIVES (µg/l)	2014
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
	Metals				
Antimony	5.6	640	NM	640	NM
Arsenic	*	NA	NE Zones 1A, 1B,1C, 1E and 6	NA	NM
Beryllium	*	420	NE Zones 1C,1E	420	NM
Cadmium	3.4	16	NE Zones 1A, 1B, 1C,and 1E	16	NM
Chromium (trivalent)	*	380,000	NE as total Zone 1E	380,000	NM
Chromium (hexavalent)	92	NA	NE Zones 1E,2,3,4,5	NA	NE Zones 5,6
Chromium (total)	NA	750	NE Zone 1E	750	NM
Mercury	0.050	0.051	E Zone 1B / NE Zones 1A,1C,, 1E 2,3,4,5	0.051	NE
Methylmercury [a]	0.3 mg/kg fish tissue	0.3 mg/kg fish tissue	NE Zones 2,3,4, 5	0.3 mg/kg fish tissue	NE/Zone 5 , 6
Nickel	500	1,700	NE all Zones	1,700	NE Zones 5,6
Selenium	170	4,200	NE Zones 1A 1B,1C,1E	4,200	NM
Silver	170	40,000	NE Zones 1A, 1B,1C,1E	40,000	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014	MARINE OBJECTIVES (µg/l)	2014
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Thallium	0.24	0.47	NM	0.47	NM
Zinc	7,400	26,000	NE All Zones	26,000	NE Zones 5,6
	Pesticides/PCBs				
Aldrin	0.025	0.025	NE Zones 1D, 1E / NE Zones 2,3,4,5 (2012 low DL study)	0.025	NE/Zones 5,6 (2012 low DL study)
gamma - BHC (Lindane)	0.98	1.8	NE Zones 1E NE Zones 2,3,4,5 (2012 low DL study)	1.8	NM NE Zones 5,6 (2012 low DL study)
Chlordane	0.14	0.14	NE Zones 1E	0.14	NM
DDT and Metabolites (DDD and DDE)	0.037	0.037	NM	0.037	NM
Dieldrin	0.041	0.043	NE Zones 1E / NE Zones 2,3,4,5 (2012 low DL study)	0.043	NE Zones 5,6 (2012 low DL study)
alpha -Endosulfan	62	89	NE Zones 1C, 1E	89	NM
beta- Endosulfan	62	89	NM	89	NM
Endosulfan Sulfate	62	89	NE Zones 1C,1E	89	NM
Endrin	0.059	0.060	NE Zones 1E	0.060	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014	MARINE OBJECTIVES (µg/l)	2014
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Endrin Aldehyde	0.29	0.30	NM	0.30	NM
Heptachlor	0.18	0.18	NE Zones 1E	0.18	NM
Heptachlor Epoxide	0.0046	0.0046	NE Zones 1E	0.0046	NM
Total PCBs	0.00839	0.00849	ongoing TMDL	0.00149	ongoing TMDL
	Volatile Organic Compounds (VOCs)				
Acrolein	6.1	9.3	NM	9.3	NM
Benzene	*	3,100	NE Zones 1C,1D,1E, 2,3,4,5	3,100	NE Zones 5,6
Bromoform (tribromomethane)	650	9,600	NE Zones 1E, 2,3,4,5	9,600	NE Zones 5,6
Bromodichloromethane	680	NA	NM	NA	NM
Dibromochloromethane	680	21,000	NM	21,000	NM
Carbon Tetrachloride	*	150	NE Zones 1E, 2,3,4,5	150	NE Zones 5,6
Chloroform	68	2,100	NE Zones 1B 1E, 2,3,4,5	2,100	NE Zones 5,6
Chlorobenzene	130	1,600	NE Zones 1E, 2,3,4,5	1,600	NE Zones 5,6
1,1 - Dichloroethylene	*	7,100	NE Zones 1C,1D,1E, 2,3,4,5	7,100	NE Zones 5,6
1,2 - trans - Dichloroethylene	140	10,000	NM	10,000	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014	MARINE OBJECTIVES (µg/l)	2014
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
1,3 - Dichloropropene	1,000	63,000	NM	63,000	NM
Ethylbenzene	530	2,100	NE Zones 1E, 2,3,45	2,100	NE Zones 5,6
Methyl Bromide	47	1,500	NE Zones 2,3,45	1,500	NE Zones 5,6
Methylene Chloride	*	260,000	NE Zones 1B, 1E ,2,3,4,5	260,000	NE Zones 5,6
1,1,2 – Trichloroethane	*	3,600	NE Zones 1C,1D,1E, 2,3,4,5,	3,600	NE Zones 5,6
Tetrachloroethylene	*	1,300	NE Zones 1B,1E, 2,3,4,5	1,300	NE Zones 5,6
Toluene	1,300	15,000	NE Zones 1E, 2,3,4,5	15,000	NE Zones 5,6
	Polycyclic Aromatic Hydrocarbons (PAHs)				
Anthracene	8,300	40,000	NM	40,000	NM
Fluoranthene	130	140	NM	140	NM
Fluorene	1,100	5,300	NE Zones 2,3,4,5 (2012 low DL study)	5,300	NE Zones 5,6 (2012 low DL study)
Pyrene	830	4,000	NM	4,000	NM
	Other Compounds				

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014	MARINE OBJECTIVES (µg/l)	2014
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Acenaphthene	670	990	NM	990	NM
Benzidine	59	140	NM	140	NM
Bis (2-chloroisopropyl) ether	1,400	65,000	NM	65,000	NM
Bis (2-ethylhexyl) phthalate	*	620	NM	620	NM
Butylbenzyl phthalate	1,500	1,900	NM	1,900	NM
2 - Chloronaphthalene	1,000	1,600	NM	1,600	NM
2 - Chlorophenol	81	150	NM	150	NM
Cyanide	140	140	NE Zone 4	140	NM
Dibutyl Phthalate	2,000	4,500	NM	4,500	NM
1,2 - Dichlorobenzene	420	1,300	NM	1,300	NM
1,3 - Dichlorobenzene	420	1,300	NM	1,300	NM
1,4 - Dichlorobenzene	63	190	NM	190	NM
2,4 - Dichlorophenol	77	290	NM	290	NM
Diethyl Phthalate	17,000	44,000	NM	44,000	NM
Dimethyl Phthalate	270,000	1,100,000	NM	1,100,000	NM
2,4 - Dimethylphenol	380	850	NM	850	NM
2,4 - Dinitrophenol	69	5,300	NM	5,300	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014	MARINE OBJECTIVES (µg/l)	2014
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
2,4 - Dinitrotoluene	68	2,100	NM	2,100	NM
Hexachlorobenzene	0.35	0.36	NE Zones 2,3,4,5 (2012 low DL study	0.36	NE Zones 5,6 (2012 low DL study)
Hexachlorocyclopentadiene	40	1,100	NE Zones 2,3,4,5 (2012 low DL study)	1,100	NE Zone 5,6 (2012 low DL study)
Hexachloroethane	20	46	NE Zones1E	46	NM
Isophorone	6,700	180,000	NM	180,000	NM
2-Methyl-4,6-dinitrophenol	13	280	NM	280	NM
Nitrobenzene	17	690	NM	690	NM
Pentachlorobenzene	1.4	1.5	NM	1.5	NM
Pentachlorophenol	*	11,000	NM	11,000	NM
Phenol	10,000	860,000	NE Zones 1A, 1B, 4	860,000	NM
1,2,4,5-Tetrachlorobenzene	0.97	1.1	NM	1.1	NM
1,2,4 - Trichlorobenzene	35	70	NE Zones 1E	70	NM
2,4,5-Trichlorophenol	1,800	3,600	NM	3,600	NM
Vinyl Chloride	*	10,000	NE Zones	10,000	NE Zones 5,6

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2014	MARINE OBJECTIVES (µg/l)	2014
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
			1B,1C,1D,1E, 2,3,4,5		

* The MCL for this compound applies in Zones 2 and 3 and is listed in Table 3.

NA = not available

For this assessment cycle, where DRBC has not adopted numeric toxics criteria (Zones 1A through 1E), the DRBC narrative toxics standard is implemented by comparing measured toxics concentrations to USEPA's most recent National Recommended Water Quality Criteria for each parameter where an appropriate Criteria Maximum Concentration (CMC) and Criterion Continuous Concentration (CCC) are listed. EPA's most recent recommended criteria can be found at http://www.epa.gov/waterscience/criteria/wqctable/#cmc.

Some criteria require hardness values to compute the actual criteria numeric value. In these cases, multiple sources of hardness information may be used. Where multiple sources of hardness data are available, the assessment will consider the weight of evidence for multiple derivations of the criteria. Sources of hardness data could include:

- Site-specific paired hardness measured concurrently with toxic analytical parameter;
- Median site-specific hardness measured at other times;
- Hardness values listed in DRBC Water Quality Regulations.

For criteria expressed as the dissolved form of the metal, assessment of monitoring data is as follows:

- In assessment Zones with dissolved metals data collected, direct comparison to DRBC dissolved criteria;
- In assessment Zones with only total metals data collected (as noted in Table 5), comparison of total metals data to estimated total metals criteria using conversion factors listed in "Revised Procedure for Converting Total Recoverable Water Quality Criteria for Metals to Dissolved Criteria" http://www.nj.gov/drbc/library/documents/criteria-metals1995.pdf.

[a]The DRBC methylmercury criterion is fish tissue residue based as is the recommended USEPA's most recent National Recommended Water Quality Criterion . No exceedances were observed in the fish species monitored by the DRBC in tidal and non-tidal waters (channel catfish, white perch, smallmouth bass and white sucker). Concentrations of mercury as wet weight in fish species sampled do not exceed a residue based water quality criteria of 300 ppb methylmercury in 2012 data or in 2011 data assuming methyl mercury is ≤ 80% total mercury measured in the fish tissue. In order to include available data for other aquatic biota in the water quality assessment, DRBC staff is soliciting data on methyl mercury in biota sampled from the Delaware River especially large fish that have a high potential for bioaccumulation of methyl mercury.

Appendix D: Taste and Odor Water Quality Assessment Details

Table D1: Taste and Odor as Human Health Objectives Assessment Results

PARAMETER	STREAM QUALITY OBJECTIVE (µg/l)	2014 asssessment
Phenol	300	NE Zones 1B, 4
2 - Chlorophenol	0.1	NM
2,4 - Dichlorophenol	0.3	NM
2,4 - Dimethylphenol	400	NM
4 - Chloro - 3 - methylphenol	3.0 mg/l	NM
Pentachlorophenol	30	NM
Acenaphthene	20	NM
Chlorobenzene	20	NE Zones 1E, 2,3,
Hexachlorocyclopentadiene	1.0	NM
Nitrobenzene	30	NM

Appendix E: Public Participation Procedures

The table below highlights specific dates in the public participation and coordination process associated with this Assessment Report.

Table F1: Public Participation Milestones

Date	**Action**
September 2013	Draft Assessment Methodology published on DRBC's web site with subsequent notification of the Water Quality Advisory Committee (WQAC) and Monitoring Advisory Committee (MAC) and their routine participants.
October 25, 2013	Publication of a notice in the Federal Register regarding publication of the draft assessment methodology, including link to the Methodology on the DRBC web site. Federal Register publication was delayed due to the Federal government shutdown.
December 31, 2013	Comments on Methodology due to DRBC.
April 1, 2014	Assessment Report e-mailed to USEPA, Region 3.