Draft State of Delaware 2018 Combined Watershed Assessment Report (305(b)) and Determination for the Clean Water Act Section 303(d) List of Waters Needing TMDLs (The Integrated Report)

Delaware Department of Natural Resources and Environmental Control
Division of Watershed Stewardship
Watershed Assessment and Management Section
August, 2018
EXECUTIVE SUMMARY
The State of Delaware 2018 Combined Watershed Assessment Report (305(b)) and Determination for the Clean Water Act Section 303(d) List of Waters Needing TMDLs (the Integrated Report) provides a statewide assessment of surface water and ground water resources, highlights Delaware’s initiatives in water resources management and pollution control and provides a list of waters that need Total Maximum Daily Load regulations (TMDLs) to meet water quality standards. The document fulfills the reporting requirements set forth under Sections 305(b) and 303(d) of the Federal Clean water Act of 1977, as amended in 1981 and 1987. The document is organized largely in accordance with the federal Environmental Protection Agency’s (EPA) 2006 guidance document. In order to streamline the 2018 Integrated Report, many Departmental programs and other resources not specifically required in the report are briefly described and URLs for further information are supplied.

This Integrated Report summarizes statewide water quality assessments, provides an overview of major initiatives and concerns on a statewide basis, and lists waters needing TMDLs. Tables are provided which show the result of water quality analysis and designated use support findings for data from the period of January 2012 through December 2016 and the resulting Section 303(d) List of Waters Needing TMDLs from those assessments.

The 2018 303(d) List shows 65 revisions from earlier Lists. Those revisions are highlighted in “Change this cycle” column in the List. Under the Clean Water Act, “listing” a waterbody is an indication that the water body is not fully meeting its designated use, thus “impaired”, and needs further controls to support the designated use. Once listed, a TMDL regulation or alternative must be developed that will return the waterbody to supporting the designated use. Delisting a waterbody for a pollutant indicates that the previously listed waterbody now supports a designated use and thus “attains the use”. Segment/pollutant combinations allow the Department to track progress for individual pollutants in specified waterbodies. For example, one segment (which can be an entire waterbody or a section of larger waterbody) may be impacted by four fish tissue advisory pollutants, nutrients and bacteria. That segment would thus have six segment/pollutant combinations.

Four segments are newly listed for previously unlisted pollutants in their segments. Two of them are covered by TMDLs that are already in place and were listed in category 4a. Two of the new listings were for dieldrin as a result of fish tissue advisories and will be monitored for possible TMDL development in the future.

There were a total of thirty two delistings in this cycle. Twenty two of them were for nutrient, dissolved oxygen or bacteria impairments. Two delistings were for ammonia, one of which was the result of removing a point source discharger per a TMDL agreement. Delistings for chlordane, mercury and dioxins and furans were a result of lowered levels in fish tissues from those waters.

For the 2018 assessments, the Department incorporated the Fish Tissue Advisories that were issued by the Delaware Departments of Health and the Department of Natural Resources and Environmental Control on February 20th, 2018. As a result of the advisories, two
segment/pollutant combinations were delisted and one segment that was incorrectly delisted in 2016 was relisted for 2018.

The Department has been using a strategy called the Watershed Approach to Toxics Assessment and Restoration (WATER) to address toxic pollutant issues in the State. In March of 2018 the Department completed a report entitled “An Evaluation of Clean Water Act Section 303(d) Listings of Delaware Waters Affected by Fish Consumption Advisories” that is included in its entirety as an appendix to this report. The evaluation considered information gathered from the WATER and Fish Tissue Advisories programs to do detailed trends analyses of pollutants in fish tissue using data from the 1990s forward. Consistent with the Department’s 2016 Integrated Report, the Department made a series of recommendations for TMDL development in those waters. The evaluation recommended that six segments be delisted for some pollutants as those pollutants were no longer above the screening levels used for fish tissue advisories in those segments. Those segment pollutant combinations were changed to Category 1. Another recommendation was for seventeen segments to be placed into a new category of impairment known as Monitored Natural Recovery. That category is shown in this report as Category 5(MNR). In those waters, while the pollutant levels have not dipped below screening levels, they are expected to do so as shown in trend analyses of the available data. As suggested in the category name, the Department will continue to monitor fish in those waters and expects the contaminant level to decrease enough for future evaluations to recommend delisting those contaminants. The final recommended category in the Evaluation is to complete TMDLs in those waters where the above trend analyses shows that concentrations of those contaminants are not expected to reach acceptable levels in the near term without TMDL regulations. These five segments remain in Category 5, and the Department expects to complete them by 2022. See the table below for the recommendations table that is on page 6 in the complete Evaluation.
The Department has been working with US EPA to move Delaware’s 303(d) listing information into EPA’s Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS) database which will allow EPA and stakeholders to track the conditions of the Nation’s surface waters. As part of that effort, the Department has converted the list of impaired waters into a format more compatible with the ATTAINS database and geographical information systems (GIS). The new format is significantly longer than the older format, but much easier to use in those environments. The Department considers this new format a
transitional step to moving all 303(d) listing information to the ATTAINS system going forward. See the appendices for the new 303(d) listing format.

- PLACEHOLDER FOR GROUNDWATER SUMMARY
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PART A. INTRODUCTION
The State of Delaware 2018 Combined Watershed Assessment Report (305(b)) and Determination for the Clean Water Act Section 303(d) List of Waters Needing TMDLs (the Integrated Report) provides a statewide assessment of surface water and ground water resources, highlights Delaware’s initiatives in water resources management and pollution control and provides a list of waters that need Total Maximum Daily Load regulations (TMDLs) to meet water quality standards. The document fulfills the reporting requirements set forth under Sections 305(b) and 303(d) of the Federal Clean Water Act of 1977, as amended in 1981 and 1987. The document is organized largely in accordance with the federal Environmental Protection Agency’s (EPA) 2006 guidance document and subsequent updates.

This Integrated Report summarizes statewide water quality assessments, provides an overview of major initiatives and concerns on a statewide basis, and lists waters needing TMDLs. Tables are provided in the appendices which show the result of water quality analysis and designated use support findings for data from the period of January 2012 through December 2016 and the resulting TMDL List from those assessments.

In order to streamline the 2018 Integrated Report, many Departmental programs and other resources not specifically required in the report are briefly described and URLs for further information are supplied.
PART B. BACKGROUND

B1. Total Waters

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Population</td>
<td>961,939</td>
</tr>
<tr>
<td>State Surface Area</td>
<td>1981 square miles</td>
</tr>
<tr>
<td>Number of Basins</td>
<td>5</td>
</tr>
<tr>
<td>Number of Watersheds</td>
<td>45</td>
</tr>
<tr>
<td>Total Number of Stream and River Miles</td>
<td>2509</td>
</tr>
<tr>
<td>Number of Perennial River Miles</td>
<td>1778</td>
</tr>
<tr>
<td>Number of Intermittent Stream Miles</td>
<td>405</td>
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<tr>
<td>Number of Ditches and Canals</td>
<td>326</td>
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<tr>
<td>Number of Border Miles</td>
<td>87</td>
</tr>
<tr>
<td>Acres of Lakes/Reservoirs/Ponds</td>
<td>2954</td>
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<tr>
<td>Square Miles of Estuarine Waters</td>
<td>841</td>
</tr>
<tr>
<td>Number of Ocean Coastal Miles</td>
<td>25</td>
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<tr>
<td>Acres of Freshwater Wetlands</td>
<td>226,530</td>
</tr>
<tr>
<td>Acres of Tidal Wetlands</td>
<td>127,338</td>
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1. [http://www.census.gov/quickfacts/table/PST045215/10](http://www.census.gov/quickfacts/table/PST045215/10)
2. Values are being updated to reflect information in higher resolution mapping tools in cooperation with EPA and a contractor.
3. Surface area for Delaware River Zone 5 and Delaware Bay provided by the Delaware River Basin Commission (DRBC), 1994 -1995 305(b) Report. For purposes of this report, Delaware reports on the Inland Bays and DRBC reports on the Delaware River and Bay.
B2. Water Pollution Control Program

The Delaware Department of Natural Resources and Environmental Control (DNREC) has several programs related to water pollution control in its Watershed Assessment and Management Section. The Water Quality Standards program works with stakeholders and co-regulators to set the Designated Uses and Criteria for the State’s waters to protect them as required under the Clean Water Act (CWA), EPA regulations and Delaware Code. The most recent Triennial Review of Water Quality Standards was done in 2014. DNREC anticipates another Triennial Review will start in 2018. DNREC does Integrated Reporting to meet its CWA Section 305(b) and 303(d) requirements, as shown in this report. Integrated reports are due on April 1st of even numbered years. The Total Maximum Daily Load (TMDL) program is also part of the Watershed Assessment and Management Section. Waterbodies that don’t meet their designated uses due to pollutants, and thus part of the State’s 303(d) list of impaired waters, are required to have TMDLs to meet their criteria. The TMDL program has completed TMDLs for most of the watersheds in the State for excessive nutrients and bacteria. TMDLs and alternatives for other pollutants are being addressed by the Watershed Approach to Assessment and Restoration (WATAR) Program.

The Drainage and Stormwater Section provides management and implementation of regulatory and non-regulatory programs to improve drainage, stormwater, water quality and dam safety.

The Surface Water Discharges Section regulates point and non-point sources of pollution to surface waters of the state. This section works with individuals, municipalities and industry to ensure that wastewater is properly treated, storm water is properly managed, and biosolids and residual wastes are beneficially reused. Delaware’s National Pollutant Discharge Elimination System (NPDES) permits are part of this Section’s programs.

The Nonpoint Source Program addresses nonpoint source pollution through educational programs, publications, and partnerships with other Delaware organizations. The Delaware NPS Program also administers a competitive grant made possible through Section 319 of the Clean Water Act, providing funding for projects designed to reduce NPS pollution.

The Ground Water Discharges Section (GWDS) is responsible for overseeing all aspects of the siting, design and installation of onsite wastewater treatment and disposal systems (aka septic systems). The section also issues waste transporter permits and licenses to percolation testers, designers, soil scientists, system contractors, liquid waste haulers and system inspectors.

The Ground-Water Protection Branch of the Water Supply Section is responsible for the ground-water protection program, source water assessment and protection program, and wellhead protection program. Hydrologists and environmental scientists of this branch provide technical expertise needed to protect the ground-water resources of Delaware. Responsibilities include regulatory review, resource assessment, database quality control, and public education.
The following table has web addresses for the programs mentioned above.

<table>
<thead>
<tr>
<th>Program</th>
<th>Web Address</th>
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<tbody>
<tr>
<td>305(b) Reports and 303(d) lists</td>
<td><a href="http://www.dnrec.delaware.gov/swc/wa/Pages/WatershedAssessment305band303dReports.aspx">http://www.dnrec.delaware.gov/swc/wa/Pages/WatershedAssessment305band303dReports.aspx</a></td>
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<td>Total Maximum Daily Loads</td>
<td><a href="http://www.dnrec.delaware.gov/swc/wa/Pages/WatershedAssessmentTMDLs.aspx">http://www.dnrec.delaware.gov/swc/wa/Pages/WatershedAssessmentTMDLs.aspx</a></td>
</tr>
<tr>
<td>Watershed Approach to Assessment and Restoration (WATAR)</td>
<td><a href="http://www.dnrec.delaware.gov/dwhs/SIRB/Pages/WATAR.aspx">http://www.dnrec.delaware.gov/dwhs/SIRB/Pages/WATAR.aspx</a></td>
</tr>
<tr>
<td>Drainage and Stormwater Section</td>
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</tr>
<tr>
<td>Nonpoint Source Program</td>
<td><a href="http://www.dnrec.delaware.gov/swc/district/Pages/NPS-Program.aspx">http://www.dnrec.delaware.gov/swc/district/Pages/NPS-Program.aspx</a></td>
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<td>Ground Water Discharges (septics)</td>
<td><a href="http://www.dnrec.delaware.gov/wr/Services/Pages/GroundWaterDischarges.aspx">http://www.dnrec.delaware.gov/wr/Services/Pages/GroundWaterDischarges.aspx</a></td>
</tr>
<tr>
<td>Surface Water Discharges</td>
<td><a href="http://www.dnrec.delaware.gov/wr/Services/Pages/SurfaceWaterDischarges.aspx">http://www.dnrec.delaware.gov/wr/Services/Pages/SurfaceWaterDischarges.aspx</a></td>
</tr>
<tr>
<td>Ground Water Protection Branch</td>
<td><a href="http://www.dnrec.delaware.gov/wr/Services/OtherServices/Pages/WaterSupplyGroundWaterProtectionProgram.aspx">http://www.dnrec.delaware.gov/wr/Services/OtherServices/Pages/WaterSupplyGroundWaterProtectionProgram.aspx</a></td>
</tr>
<tr>
<td>Municipal Separate Storm Sewer Systems (MS4s) Permits</td>
<td><a href="http://www.dnrec.delaware.gov/wr/Information/SWDInfo/Pages/MS4.aspx">http://www.dnrec.delaware.gov/wr/Information/SWDInfo/Pages/MS4.aspx</a></td>
</tr>
</tbody>
</table>

DNREC works closely with its partners in other Delaware agencies, other States and Federal agencies to address water issues that cross jurisdictional boundaries. For example, the Department works with the Delaware Department of Health and Social Services’ Division of Public Health to collect and analyze for toxins in fish and then coordinate fish consumption advisories statewide. The Department works with the Nutrient Management Commission to work with non-point sources of nutrients to manage and/or reduce nutrient inputs to Delaware’s waters. DNREC is also working closely with the Delaware Department of Transportation to develop and implement MS4 permits in New Castle County.

The Department is an active member of the Delaware River Basin Commission that works in the Delaware River and Delaware Bay to regulate both flow and water quality. Delaware is also working closely with partners and stakeholders from six states in the Chesapeake Bay watershed to implement the Chesapeake Bay Watershed Implementation Plan that will help restore the Chesapeake Bay’s water quality.
B3. Cost/Benefit Assessment

Under the Clean Water Act and the implementing regulations, States are required to submit estimates of the environmental, economic and social costs and benefits needed to achieve the objectives of the Clean Water Act. In cooperation with the Department, The University of Delaware Water Resources Center prepared a white paper entitled “Economic Benefits of Improved Water Quality in Delaware.” In the paper, the Center estimated the economic benefits of improved water quality to be $17.2 million dollars annually. The UD Water Resources Center has also concluded that Delaware watersheds and waterways support (1) over $6 billion in annual economic activity from water quality, flood control, water supply, fishing and wildlife viewing, recreation, agriculture, ports, forests, and parks, (2) ecosystem goods and services of $6.7 billion per year (2010 dollars) with a net present value (NPV) of $216.6 billion, (3) over 70,000 direct and indirect jobs with over $2 billion in wages, see http://www.wrc.udel.edu/research/watershed-economics/economic-benefits-and-jobs-provided-by-delaware-watersheds/. To date, cost estimates have not been compiled. Future iterations of the Integrated Report will expand the analysis of costs and benefits reported.
B4. Special State Concerns and Recommendations

The Department has been working on managing water quality issues for many years with stakeholders and other State and Federal agencies to address water quality issues statewide and in interstate waters. See Section B2 of this report for current activities in our water pollution control programs. The Department has been working with stakeholders on TMDLs that are being implemented with varying degrees of success. Toxics TMDLs for zinc have been implemented successfully in the Christina basin, bringing zinc levels into compliance with applicable water quality standards. Statewide trends analysis for nutrients shows that approximately half of the reporting stations considered are experiencing lower nutrient loads for nitrogen with fewer than ten percent of stations showing increasing trends. Continued TMDL implementation is still needed to continue those gains and achieve nutrient targets in Waters of the State.

The Department has been addressing remaining waterbodies needing TMDLs or alternatives for toxic pollutants in its WATAR program also described and linked to in Section B2 above. Tracking down pollution sources and using appropriate and cost effective approaches to remediate those sources is one keystone of the WATAR program. One such intervention at Mirror Lake in Dover was remarkably effective in reducing bioavailability of PCBs. The Department worked across Divisions, with other State and Federal agencies, and with academia to do the work at Mirror Lake. As a result, major reductions in PCBs in fish tissue in the fish in the lake were seen in less than a year. The Department believes working to expand the successes and lessons learned from the WATAR program will be important in reducing impacts from pollution statewide.

Climate change is an important issue long term in the State. The Department worked with a wide range of scientists and policy makers to create the Delaware Climate Change Impact Assessment that is online at: http://www.dnrec.delaware.gov/energy/Pages/The-Delaware-Climate-Impact-Assessment.aspx. One of the conclusions in the executive summary is that: “Delaware faces potential impacts from changes in temperature, precipitation, and sea level rise. State officials, local governments, residents, and businesses must prepare for changing climate conditions that will affect communities and economic sectors throughout Delaware.”

Water quality monitoring including fish tissue and other biological monitoring has been a keystone to understanding water quality issues statewide. The Department has invested heavily in monitoring data for many years. Scientists, citizens and policy makers rely on the continued availability of high quality data to track progress and make regulatory and policy decisions that affect a wide range of programs and interests. For example, the Department anticipates using site specific data from the WATAR program to set criteria in the water quality standards for toxic pollutants state wide in upcoming triennial reviews of water quality standards required under the Clean Water Act.
PART C. SURFACE WATER MONITORING AND ASSESSMENT

C1. Monitoring Program
The purpose of the Delaware’s Surface Water Quality Monitoring Program is to collect data on the chemical, physical and biological characteristics of Delaware's surface waters. The information that is collected under this program is used to:

- Describe general surface water quality conditions in the State;
- Identify long term trends in surface water quality;
- Determine the suitability of Delaware surface waters for water supply, recreation, fish and aquatic life, and other uses;
- Monitor achievement of Surface Water Quality Standards;
- Identify and prioritize high quality and degraded surface waters;
- Calculate annual nutrient loads and track progress toward achieving Total Maximum Daily Loads (TMDLs) targets; and
- Evaluate the overall success of Delaware's water quality management efforts.
- Inform decisions by other stakeholders and programs

Delaware maintains a General Assessment Monitoring Network (GAMN) of ~ 134 stations. Twenty two of the stations are monitored monthly and the remaining stations are monitored either six or twelve times per year. Each station is monitored for conventional parameters such as nutrients, bacteria, dissolved oxygen, pH, alkalinity, and hardness. Some stations are monitored for dissolved metals. The data from this monitoring is entered into EPA’s STORET database and used for this report and other uses by interested parties.

More information about Delaware’s Water Quality monitoring is available online at: http://www.dnrec.delaware.gov/swc/wa/Pages/WaterQualityMonitoring.aspx
In addition to uploading data to STORET, the Department also works in co-operation with the University of Delaware to share available water quality data in a more user friendly format in the Delaware Water Quality Portal at this URL: http://demac.udel.edu/waterquality/.
C2. Assessment Methodology

General Provisions

Data Considered:
All readily available data and information for the period of January 1, 2012 through December 31, 2016 will be considered for the assessment of most designated uses. Given that adequate water quality data may not be available in all cases, determinations of use attainment will be made with an abundance of caution.

Data Quality and Quantity
Data from the Department of Natural Resources and Environmental Control’s (DNREC’s) Environmental Laboratory Section (ELS) will be considered for use if it is collected and analyzed in accordance with the DNREC ELS Quality Assurance Project Plan. For data from sources other than the DNREC ELS, the Department will consider the quality controls used in collection and analysis to determine if it will be appropriate for use in this assessment. Data will be considered readily available if it is in an electronic format that can be imported into or exported from a modern spreadsheet or database program like Microsoft Excel or Access. Data that is only available on paper will be considered on a case by case basis given the limited resources available to the Department to convert such data to the more usable electronic format. The Department routinely currently collects water quality samples at more than 130 stations throughout the State. That data makes up the bulk of the data available for use in 305(b) assessments. The Department considers data from the most recent five-year period, thus, at each station, there are usually data from 20 sampling dates or more. Some stations are in place for a more limited time period and have smaller data sets. Other readily available data and reports are requested in advance of each assessment from parties outside of the Department and used when they are made available. In addition to electronic mail requests from specific organizations, a notice will be published in the Delaware State News and the News Journal.

For the 2018 assessment, the Department will consider data and information received on or before March 2018 from the following sources:

- Reports of ambient water quality data including State ambient water quality monitoring programs, citizen volunteer monitoring programs, complaint investigations, and other readily available data sources (e.g., EPA’s Storage and Retrieval System (STORET), the United States Geological Survey, and research reports), and data and information provided by the public;
- Reports prepared to satisfy Clean Water Act (CWA) Sections 305(b), 303(d) and 314 and any updates;
- Fish and shellfish advisories
- Restrictions on water sports or recreational contact

Coordination with Delaware River Basin Commission (DRBC) and Chesapeake Bay Program Assessments
The DRBC prepares 305(b) assessment reports every two years for the Delaware River and Delaware Bay. Delaware will incorporate the most recent use attainment determinations made by DRBC for the shared waters of the Delaware River and Delaware Bay into its 2016 303(d) list.
Delaware expects to work cooperatively with the DRBC, member states and stakeholders to develop and implement TMDLs in waters of the Delaware River and Bay that the DRBC determines to be impaired.

The Chesapeake Bay Program (CBP) is doing assessments for waters in the Chesapeake Bay and nearby waters that drain into the bay in co-operation with Maryland, Virginia, Washington D.C. and Delaware. Delaware will incorporate the most recent use attainment determinations for waters of the state that use criteria developed by the CBP for waters that drain to the Chesapeake Bay.

**Use of Environmental Protection Agency Integrated Assessment Guidance**

US EPA has guidance online for preparation of Integrated Reports at the following URL: https://www.epa.gov/tmdl/integrated-reporting-guidance

The core recommendation of the guidance is to categorize all waters of the state according to the following five categories:

**Category 1:** All designated uses are met;

**Category 2:** Some of the designated uses are met but there is insufficient data to determine if remaining designated uses are met;

**Category 3:** Insufficient data to determine whether any designated uses are met. Either no data is available or some data is available, but it is insufficient to make a determination;

**Category 4:** Water is impaired or threatened but a TMDL is not needed;

- 4A: All TMDLs for this segment have been completed and EPA approved. Class 4A waters have all necessary TMDLs approved, but one or more impairments exist, despite the approved TMDLs.
- 4B: Other required control measures are expected to result in the attainment of WQSs in a reasonable period of time
- 4C: The impairment or threat is not caused by a pollutant

**Category 5:** Water is impaired or threatened and a TMDL is needed for at least one pollutant or stressor

For the 2018 and forward 303(d) lists, the Department has created a sub-category of Category 5 waters based on recommendations in a March 2018 report prepared by the Department titled “An Evaluation of Clean Water Act Section 303(d) listings of Delaware Waters Affected by Fish Consumption Advisories”, a copy of which is included in the appendices to this report. That evaluation recommends that for some waters where trends indicate a downward slope in fish tissue contaminant concentrations that should be below fish tissue target levels within five to ten years without implementing a TMDL a subcategory of impaired waters be created. That subcategory is 5(MNR) in which MNR stands for “Monitored Natural Recovery”. As implied by the name, the Department plans to continue monitoring fish tissue in those waterbodies in accordance with the Fish Tissue Advisory program protocols until such time as the contaminants in the fish are no longer above levels of concern and beyond. When the data supports removing
the fish tissue advisories, the Department will consider that information for delisting decisions with stakeholder input. For more information about the Fish Tissue Advisory process see section C6 of this report. The Department also plans to pursue remediation efforts in affected watersheds in accordance with the WATAR program and process as discussed in other sections of this report and online at http://www.dnrec.delaware.gov/dwhs/SIRB/Pages/WATAR.aspx. If trends analyses at later dates show that trends in 5(MNR) waters are not in fact trending downward, or reaching their target levels, the Department will reclassify those waters as Category 5 and TMDLs for those pollutants will be developed.

The Department has been working with US EPA to move Delaware’s 303(d) listing information into EPA’s Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS) database which will allow EPA and stakeholders to track the conditions of the Nation’s surface waters. As part of that effort, the Department has converted the list of impaired waters into a format more compatible with the ATTAINS database and geographical information systems (GIS). The new format is significantly longer than the older format, but much easier to use in those environments. The Department considers this new format a transitional step to moving all 303(d) listing information to the ATTAINS system going forward. Future Integrated Reports are expected to be compiled largely within the ATTAINS system and reports for stakeholders will be prepared as needed for the public comment period.

The Department assesses data for a number of parameters in each segment that sufficient data is readily available for, and then assigns them the codes listed above for each parameter and segment combination. This gives the Department more information about specific parameters of concern and allows more detailed tracking of those concerns over time. Each of Delaware’s monitored waterbody segments will be assigned to the appropriate category for each designated use and then ‘rolled up’ into a final categorization for the segment.

**Dissolved Oxygen (DO) Aquatic Life Use Support (ALUS)**

The following types of DO data are potentially available for analysis:

- Field measurements taken by personnel using handheld DO probes; and
- Continuous monitoring data collected using multiparameter monitoring systems that are typically deployed for several days, weeks, or months. In order to get a more accurate picture of dissolved oxygen dynamics and other water quality parameters, the Department continues to increase its use of continuous monitoring systems.

To determine ALUS with regard to Dissolved Oxygen (DO), the following methodology will be used to compare measured DO concentrations to two different standards, the minimum at all times and daily average concentrations. Average DO concentrations are considered to be met if the 10th percentile of available data is above the applicable criteria of 5.0 mg/l for marine waters and 5.5 mg/l for fresh waters. The statewide minimum DO concentration for surface waters is 4.0 mg/l at any time. Stations are judged to be in compliance with this criterion if the minimum is not violated by more than 1% of continuous monitoring data and no more than two field samples are below the minimum. Dissolved oxygen criteria in the Murderkill River are different from the Statewide averages for the period of May 16 to September 30th and the data from that period is considered in the same way as the rest of the State against the lower criteria.
Assessments of Average DO Criteria Attainment:
If sampling events occurred on at least ten different days during the assessment period for each station, attainment of the DO average criteria will be assessed using the method that follows. Stations with fewer than ten different sampling days will be considered to have insufficient data and be placed in Category 3 for this assessment cycle. Stations where monitoring has been discontinued that have data from fewer than 10 days will not be considered for further evaluation.

For purposes of DO compliance with the daily average criteria in a segment, continuous monitoring data, if available, will be averaged on a daily basis for each station. If no continuous data is available, then the field measurements (as available) will be considered to be representative of the daily average for that day. Any type of sample (continuous or field measurement) will be considered to be representative for that station at the time of collection. Once the daily average for each station (station daily average, SDA) has been determined, the SDAs for each station will be pooled and the upper confidence limit (UCL) of the nonparametric 10th percentile confidence interval will be determined using methods described in Section 3.7 of Helsel and Hirsch. That UCL will be compared to the applicable standard. If the UCL is above the applicable average criteria for all stations in a segment, the segment will be considered to be fully supporting (Category 1) for the DO average portion of ALUS. If the UCL from any station in a segment is below the applicable average, the segment will be considered not fully supportive of the aquatic life use (Category 5).

Formally stated, the following hypotheses will be tested:

- $H_0$: at the 90% Confidence level, $X_{10} \geq \text{Standard}$
- $H_1$: at the 90% Confidence level, $X_{10} < \text{Standard}$

Where $X_{10}$ = Non parametric estimate of the 10th percentile of available data.

Assessments of Minimum DO Criteria Attainment:
Attainment of the minimum DO criteria will be assessed based on all available data (note that ten samples in 5 years are not needed for the comparison to the minimum). For stations for which no continuous DO monitoring data are available, two or more SDAs in five years below the applicable minimum will be sufficient evidence to show that the aquatic life use is not supported (Category 5).

For stations with continuous monitoring data, available continuous monitoring data will be pooled on an annual basis for each station. The UCL of the first percentile of the data will be calculated and compared to the minimum criteria in the same manner as the average comparison above for each year of the applicable five previous years. One or more years in which the upper confidence limit of the first percentile is below the minimum will be sufficient to determine that aquatic life use is not fully supported in the segment (Category 5). See the flow chart below for a graphical depiction of the dissolved oxygen assessment process.
Nutrient Enrichment Assessment

From a state-wide perspective, nutrient overenrichment is one of the leading causes of water quality impairment in Delaware. While nutrients are essential to the health of aquatic ecosystems, excessive nutrient loadings to surface waters can lead to an undesirable proliferation of aquatic weeds and algae, which in turn can result in oxygen depletion and associated impacts to fish and macroinvertebrate populations. Excessive aquatic plant growth can also preclude or seriously curtail water dependent activities such as fishing and boating when plant densities become so great that uses are not physically possible.

For tidal portions of the Indian River, Rehoboth Bay and Little Assawoman Bay watersheds, the water quality criterion for dissolved inorganic nitrogen is a seasonal average of 0.14 mg/l as N, and for dissolved inorganic phosphorus a seasonal average of 0.01 mg/l. For those stations where sampling events occurred on at least ten different days during the assessment period, the available data for the months of March to October from each station will be averaged and confidence intervals on the averages will be determined. The lower confidence limit on the averages will be compared to the above values to assess attainment of desired nutrient levels in these waters. Stations with fewer than ten different sampling days will be considered to have insufficient data and be placed in Category 3 for this assessment cycle. Segments with one or more stations whose lower confidence limit on their seasonal average is above the criteria will be considered to be not fully supporting the aquatic life use (Category 5).

For the remaining waters of the State, the Department has been developing and implementing nutrient and dissolved oxygen TMDLs using target values for total nitrogen of 2-3 mg/l and total phosphorus levels of 0.1 to 0.2 mg/l. These target values were developed in order to implement the narrative provisions in the Surface Water Quality Standards. For those stations with sampling events on at least ten different days during the five-year assessment period the data will be averaged and lower confidence limits on the averages will be calculated and compared to the maximum values above. Stations whose lower confidence limit on the 5 year average total nitrogen or total phosphorus levels are above those levels will be considered to be not fully supporting the aquatic life use (Category 5). Active stations with fewer than ten different sampling days will be considered to have insufficient data and be placed in Category 3 for this assessment cycle. Segments with one or more stations whose lower confidence limit on their average nutrient concentrations are above the target values will be considered to be not fully supporting the aquatic life use (Category 5).

The following conditions will also result in segments being listed in Category 5:

1. There were documented cases of nuisance algal blooms or excessive macrophyte growth. These cases violate Section 4.1.1.3 of Delaware’s Standards which require waters of the State to be free from substances that may result in a dominance of nuisance species;
2. Detailed, site-specific monitoring studies indicated a strong linkage between nutrient levels and indicators of eutrophication such as high chlorophyll-a concentrations, extreme daily variation in dissolved oxygen levels, and high sediment oxygen demand; or
3. For ERES waters, a long-term trend analysis indicates a statistically significant increase in nutrient levels over time. Such increases are inconsistent with the short-term goal of “holding the line” on water quality in ERES waters. Such increases are also inconsistent
with the long-term goal of restoring those waters, to the extent feasible, to their natural state.

Assessments of Total Suspended Solids in the Tidal Inland Bays Watershed
For tidal portions of the Indian River, Rehoboth Bay and Little Assawoman Bay watersheds, the water quality criterion for total suspended solids (TSS) is a seasonal average of 20mg/l from March 1 to October 31. For those stations where sampling events occurred on at least ten different days during the assessment period, the available data for the months of March to October from each station will be averaged and confidence intervals on the averages will be determined. The lower confidence limit on the averages will be compared to the above values to assess attainment of desired TSS levels in these waters. Active stations with fewer than ten different sampling days will be considered to have insufficient data and be placed in Category 3 for this assessment cycle. Segments with one or more stations whose lower confidence limit on their seasonal average is above the criteria will be considered to be not fully supporting the aquatic life use (Category 5).

Primary Contact Recreation Use Assessments
Generally, total enterococcus bacteria water quality samples are collected several times each year at each monitoring station. In addition, for all guarded beaches and many unguarded beaches, samples are collected much more frequently from mid-May through mid-September as part of beach monitoring activities pursuant to the Beaches Environmental Assessment and Coastal Health (BEACH) Act. Assessment of the above two situations for primary contact recreation use support will be as follows.

For segments with no beach monitoring, if sampling events occurred on at least ten different days during the assessment period, the geometric mean of the available enterococcus (colonies/100 ml) data for each station will be compared to the geometric mean values shown in the table below. Stations with fewer than ten different sampling days will be considered to have insufficient data (Category 3) to make a determination if the geometric mean criterion is met. For segments with no beach monitoring, one or more station geometric means above the values in the table will be considered to not be in support of the Primary Contact Recreation designated use (Category 5).

<table>
<thead>
<tr>
<th>Water Type</th>
<th>Geometric Mean (Enterococcus colonies/100 ml) Criteria for Primary Contact Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>100</td>
</tr>
<tr>
<td>Marine</td>
<td>35</td>
</tr>
</tbody>
</table>

Segments with beaches that are closed as a result of poor bacterial water quality data two or more times in a single calendar year will be considered not to support the primary contact designated use (Category 5).
Temperature Assessments

Delaware surface water quality criteria indicate that, in freshwaters, no human induced increase of the daily maximum temperature above 86°F (30.0 °C) shall be allowed and in marine waters the maximum human induced temperature is 87 °F (30.6 °C). Stations for which two or more sampling events are above the criteria and whose segments receive thermal discharges will be deemed not in support of the aquatic life use. For the 2018 cycle, the Department delisted five small segments that had no point source heat discharges.

Assessment of Harvestable Shellfish Waters Use Support

Delaware is a member of the Interstate Shellfish Sanitation Conference (ISSC), the administrative body of the National Shellfish Sanitation Program (NSSP). Delaware’s Shellfish Sanitation Regulations are administered as per ISSC / NSSP standards and practices. Section 3.2.1.3 of said Regulations specifies data collection / closure criteria for Delaware shellfish waters, which include parameters constituting administrative closure of shellfish waters. Parameters that would trigger administrative closures in compliance with ISSC/NSSP standards may include theoretical pollution loading, sanitary shoreline survey information, and numerical total coliform data. All Delaware shellfish waters designated as other-than-Approved, which may include Prohibited, Seasonally Approved, Conditionally Approved, or restricted, are so designated on the basis of administrative decisions. Specifically, these criteria include: 1) theoretical pollution loading, which is determined to be the potential for intermittent pollution discharges, making detection of said theoretical releases non-detectable via conventional sampling methodology; 2) sanitary shoreline survey findings which indicate potential for theoretical pollution loading, also non-detectable via conventional sampling methodology; and 3) may include dilution of theoretical virus discharges from point sources; however, not corresponding to increases in total coliform levels. In order to comply with ISSC / NSSP requirements, Delaware samples all shellfish waters not administratively closed for other reasons for total coliform bacteria. Delaware’s Shellfish Program is assessed under the auspices of the U.S. Food and Drug Administration, as per ISSC/NSSP standards and practices, and submits bacteriological water quality data to the U.S. Food and Drug Administration to demonstrate compliance.

To assess the harvestable shellfish designated use, the Department will consider the data and reports to FDA for waters that are not administratively closed. Waters that have been administratively closed for shellfish harvesting as a result of total coliform exceedances during the assessment period will be assessed as category-5.

Listing Criteria for Waters with Fish Consumption Advisories

For purposes of developing Delaware’s Integrated 305(b) Report and 303(d) List, the issuance of a “no consumption” or “limited consumption” fish advisory will be interpreted as a violation of Section 4.5.9.2.3 and Section 4.1.1.3 of Delaware’s Surface Water Quality Standards. Those two narrative provisions provide, respectively, that:

1) waters of the State shall be maintained to prevent adverse toxic effects on human health resulting from ingestion of chemically contaminated aquatic organisms; and

2) waters of the State shall be free from pollutants that may endanger public health.

Any segment for which fish consumption advisories are in place as of the publishing of the Integrated Report will be placed in Category 5 for each of the chemicals of concern included in
each advisory. In the event that fish consumption advisories have been lifted, or any chemical of concern has been removed from an advisory, any requirements to develop a TMDL for that chemical in that segment will be removed if the fish tissue data was originally the sole cause for placement of the segment on the 303(d) list. In waters impaired by toxic pollutants, with both fish consumption advisories and water column data, both fish tissue and water column data will be assessed independently against the applicable criteria.

For the 2018 assessments, the Department incorporated the Fish Tissue Advisories that were issued by the Delaware Departments of Health and the Department of Natural Resources and Environmental Control on February 20th, 2018. As a result of the advisories, two segment/pollutant combinations were delisted and one segment that was incorrectly delisted in 2016 was relisted for 2018.

Ammonia assessments
In fresh waters, ammonia’s toxicity is known to be controlled by both the temperature and pH of the water. Delaware’s ammonia criteria are based on the presence or absence of early life stages of fish and specify that the criterion should not be exceeded more than one time in a three-year period. The applicable criterion is calculated for each sampling event.

For stations whose average salinity during the assessment period is below 5 ppt, total ammonia as nitrogen, temperature and pH data will be used to compare the total ammonia data to the criterion calculated according to the following formulas:

When fish early life stages are present:

\[
\text{Criterion} = \frac{0.0577}{1 + 10^{7.688-pH}} + \frac{2.487}{1 + 10^{pH-7.688}} \times \min (2.85, 1.45 \times 10^{0.028 \times (25-T)})
\]

When fish early life stages are absent:

\[
\text{Criterion} = \frac{0.0577}{1 + 10^{7.688-pH}} + \frac{2.487}{1 + 10^{pH-7.688}} \times [1.45 \times 10^{0.028 \times (25-MAX(T,7))}]
\]

If two or more sampling events from the same station result in exceedances of the calculated criteria within three years, the station will be deemed not supported for aquatic life use support based on ammonia toxicity.

Assessments of Aquatic Life Use Support Using Site-Specific Data That Results from Environmental Assessments and Other Programs
In the normal course of business, the Department requests, receives and evaluates water quality data for various environmental programs. Similar data may also come from other parties (e.g., State, Federal, or local agencies). The Department will use those site-specific studies to compare water quality data to the applicable water quality standard(s) and make assessment and listing decisions for the affected segments. If the data show no water quality criteria are exceeded and no uses are impaired, no further listing action will be taken. If the data are ambiguous or
inconclusive, the segment will be listed in Category 3. If water quality criteria are exceeded or uses are impaired as a result of a contaminated site, and the owners of the site are making substantial progress (as determined by the Department) toward correcting the pollution problem, the segment will be listed in Category 4 if an enforceable regulatory mechanism has been identified and implemented. If it appears that there is a water quality problem related to a contaminated site, and that substantial progress is not likely in the near future, the segment will be listed in Category 5.

Assessments of Biology and Habitat
The Department is working with the EPA to address prior listings for Biology and Habitat. As new stressor analyses and other data and information become available, appropriate measures will be taken to address these listings. Where no specific pollutant can be determined, the Department will delist those segments (move to category 4b or 4c as needed) and address water quality issues through restoration and other efforts as funding is available. If specific pollutants can be determined, TMDLs or other actions will be taken to address those pollutants.

Setting Priorities for Water Quality Limited Segments Still Needing TMDLs
The Department has set priorities for upcoming TMDLs in waters that remain in Category 5 or 5(MNR) according to the following protocol. Waters where TMDL development is not expected for five or more years are assigned to the “Low” priority group. For 2018 that includes waters listed for Habitat or Biology TMDL development. It also includes waters in Category 5(MNR) where waters are expected to be attaining for toxics in fish tissues within five to ten years as discussed above. As discussed above, the Department will change the priority of 5(MNR) waters if, for some reason, data shows that attainment of the use is not expected in a short period of time. The Department is working with EPA Region 3 to develop stressor analysis tools to try to resolve longstanding listings for Habit or Biology. Finally, there are some Delaware waters that are part of the DRBC waters and for which the DRBC and EPA will be taking the lead for TMDL development. Those are also listed as Low priority.

For waters the Department expects to develop TMDLs in more than 2 years, but less than 5 or more, the Department shows those as “Medium” priority. In those waters, plans are underway to collect data and other information to develop appropriate TMDLs. At this time, there are several waters in the Medium category and the Department expects to complete those TMDLs by 2022.

If the Department expects to develop TMDLs in the next two years or less, those waters are shown as “High” priority. For the 2018 cycle, there are no High Priority waters. The Department expects the waters in Medium category above to move to the High priority category in the 2020 Integrated Report cycle.

Rationale Used to Designate a Lower Category for Segments Previously Designated for TMDL Development
The Department may move segments from prior 303(d) Lists (equivalent to Category 5) to another category based on any of the following factors, and will document the reasons for doing so on a case-by-case basis. Once a TMDL has been promulgated and approved by the EPA, it is in place until it has been rescinded by the Department following applicable Departmental procedures.
- The assessment and interpretation of more recent or more accurate data demonstrate that the applicable WQS(s) is being met. (Move to category 1)
- The results of more sophisticated water quality modeling demonstrate that the applicable WQS(s) is being met. (Move to category 1)
- Demonstration that flaws in the original analysis of data and information led to the water being incorrectly listed. (Move to category 1)
- The development of a new listing methodology, consistent with State WQSs and federal listing requirements, and a reassessment of the data that led to the prior listing, concluding that WQSs are now attained. (Move to appropriate category)
- A demonstration pursuant to 40 CFR 130.7(b)(1)(ii) that there are effluent limitations required by State or local authorities that are more stringent than technology-based effluent limitations required by the CWA and that these more stringent effluent limitations will result in the attainment of WQSs for the pollutant causing the impairment. (Move to category 4A or 4B until data and analysis support move to Category 1)
- A demonstration pursuant to 40 CFR 130.7(b)(1)(iii) that there are other pollution control requirements required by State, local, or federal authority that will result in attainment of WQSs for a specific pollutant(s) within a reasonable time. (Move to category 4A or 4B until data and analysis support move to Category 1)
- Documentation that the State included on a previous Section 303(d) List an impaired water that was not required to be listed by EPA regulations; e.g., waters where there is no pollutant associated with the impairment. (Move to category 1 or 4C as appropriate)
- Approval or establishment by EPA of a TMDL since the last Section 303(d) List. (Move to category 4A or 4B until data and analysis support move to Category 1)

Other factors may also be used to change categories on a case by case basis, subject to EPA approval and appropriate stakeholder involvement.
Flow Charts for Designated Use Attainment
Assessment of Aquatic Life Use Support Using Average Dissolved Oxygen Criteria

Continuous Monitoring Data

Field Data

Calculate Daily Average at each station

Are there 10 or more days of Data for this Station?

Find upper limit of confidence interval of 10th Percentile of SDAs for Station

Is upper limit above Average Criterion at all stations?

Segment Supports ALUS DO Average Criteria; go to Minimum DO Flow Chart

Insufficient Data to Determine DO Average ALUS, Go to DO Minimum

No

Yes

Yes

No

Segment does not support Aquatic Life Use

Are the re 10 or more days of Data for this Station?

No

Yes

Assessment of Aquatic Life Use Support Using Average Dissolved Oxygen Criteria

Continuous Monitoring Data

Field Data

Calculate Daily Average at each station

Are there 10 or more days of Data for this Station?

Find upper limit of confidence interval of 10th Percentile of SDAs for Station

Is upper limit above Average Criterion at all stations?

Segment Supports ALUS DO Average Criteria; go to Minimum DO Flow Chart

Insufficient Data to Determine DO Average ALUS, Go to DO Minimum

No

Yes
Assessment of Aquatic Life Use Support Using Minimum Dissolved Oxygen Criteria

Are there two or more SDAs below the applicable minimum?

- Yes → Segment does not support Aquatic Life Use
- No → Is there continuous monitoring data available at this station?
  - No → Segment does not support Aquatic Life Use
  - Yes → Calculate upper limit of the 1st percentile confidence interval for each year of available continuous monitoring readings at each station in segment
    → Is upper limit above the minimum criteria for all stations in a segment?
      - Yes → Segment minimum DO supports Aquatic Life Use
      - No → Segment does not support Aquatic Life Use
    → Station Supports aquatic life with regard to minimum DO
Assessment of Primary Contact Use Support in Segments that do not have Beach Monitoring Programs

Is there data for 10 or more sampling days?

Yes

Calculate Geometric mean of Enterococcus data in the segment

No

Insufficient Data to Determine Primary Contact Use Support

Is the Geometric mean above the criteria?

Yes

Primary Contact use is Fully Supported

No

Primary Contact use is Not Supported
Assessment of Primary Contact Use Support in Segments with Beach Monitoring Programs

Determine annual count of beach closures in the segment due to Enterococcus data

Has there been more than 1 beach closure in the segment in any calendar year?

Yes

No

Primary Contact use is Fully Supported

Primary Contact use is Not Supported
C3. Assessment Results

Appendix One: Station Roll ups shows the results of the data analyzed for each station evaluated for this report. Appendix Two: Segment Roll Ups shows the Assessments for each segment for this listing cycle. Appendix Three: An Evaluation of Clean Water Act Section 303(d) Listings of Delaware Waters Affected by Fish Consumption Advisories shows the report by that same title in its entirety. Appendix Four: Integrated Report Database shows the entire database as of 2018. Appendix Five: Changes to the Listing Statuses for This Cycle shows the subset of the entire Database that were changed for this cycle. Appendix Six: The Final Determination for the State of Delaware 2018 Clean Water Act Section 303(d) List of Waters Needing TMDLs shows only the waters in Category 5 or 5(MNR) as required by the CWA. Appendix Seven: Volunteer Water Quality Monitoring Data shows results from volunteer monitoring results in the Inland Bays watershed, and the Nanticoke River Watershed. Appendix Eight is the Public Participation Section

The 2018 303(d) List shows 65 revisions from earlier Lists. Those revisions are highlighted in “Change this cycle” column in the List. Four segments are newly listed for previously unlisted pollutants in their segments. Two of them are covered by TMDLs that are already in place and were listed in category 4a. Two of the new listings were for dieldrin as a result of fish tissue advisories and will be monitored for possible TMDL development in the future.

There were a total of thirty two delistings in this cycle. Twenty two of them were for nutrient, dissolved oxygen or bacteria impairments. Two delistings were for ammonia, one of which was the result of removing a point source discharger per a TMDL agreement. Delistings for chlordane, mercury and dioxins and furans were a result of lowered levels in fish tissues from those waters.

For the 2018 assessments, the Department incorporated the Fish Tissue Advisories that were issued by the Delaware Departments of Health and the Department of Natural Resources and Environmental Control on February 20th, 2018. As a result of the advisories, two segment/pollutant combinations were delisted and one segment that was incorrectly delisted in 2016 was relisted for 2018.

The Department has been using a strategy called the Watershed Approach to Toxics Assessment and Restoration (WATAR) to address toxic pollutant issues in the State. In March of 2018 the Department completed a report entitled “An Evaluation of Clean Water Act Section 303(d) Listings of Delaware Waters Affected by Fish Consumption Advisories” that is included in its entirety as an appendix to this report. The evaluation considered information gathered from the WATAR and Fish Tissue Advisories programs to do detailed trends analyses of pollutants in fish tissue using data from the 1990s forward. Consistent with the Department’s 2016 Integrated Report, the Department made a series of recommendations for TMDL development in those
waters. The evaluation recommended that six segments be delisted for some pollutants as those pollutants were no longer above the screening levels used for fish tissue advisories in those segments. Those segment pollutant combinations were changed to Category 1. Another recommendation was for seventeen segments to be placed into a new category of impairment known as Monitored Natural Recovery. That category is shown in this report as Category 5(MNR). In those waters, while the pollutant levels have not dipped below screening levels, they are expected to do so as shown in trend analyses of the available data. As suggested in the category name, the Department will continue to monitor fish in those waters and expects the contaminant level to decrease enough for future evaluations to recommend delisting those contaminants. The final recommended category in the Evaluation is to complete TMDLs in those waters where the above trend analyses shows that concentrations of those contaminants are not expected to reach acceptable levels in the near term without TMDL regulations. These five segments remain in Category 5, and the Department expects to complete the non DRBC waters by 2022. See the table below for the recommendations table that is on page 6 in the complete Evaluation.
### Excerpted table of Recommended Actions for Selected Segments/Contaminant Pairs Listed on Delaware’s 2016 Clean Water Act Section List Based on Fish Consumption Advisories

<table>
<thead>
<tr>
<th>Waterbody ID</th>
<th>Watershed Name</th>
<th>Segment</th>
<th>Pollutant</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE300-001-01</td>
<td>Shellpot Creek</td>
<td>Lower Shellpot Creek</td>
<td>Chlordane</td>
<td>Delist</td>
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<tr>
<td>DE040-002</td>
<td>Brandywine Creek</td>
<td>Upper Brandywine</td>
<td>D and F TEQs</td>
<td>MNR</td>
</tr>
<tr>
<td>DE 260-001</td>
<td>Red Clay Creek</td>
<td>Mainstem</td>
<td>D and F TEQs</td>
<td>TMDL</td>
</tr>
<tr>
<td>DE120-001</td>
<td>Christina River</td>
<td>Lower Christina River</td>
<td>Dieldrin</td>
<td>MNR</td>
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<tr>
<td>DE120-004-01</td>
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<td>Lower Christina Creek</td>
<td>Dieldrin</td>
<td>MNR</td>
</tr>
<tr>
<td>N/A</td>
<td>Delaware River</td>
<td>DRBC Zone 5</td>
<td>D and F TEQs</td>
<td>TMDL</td>
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<tr>
<td>N/A</td>
<td>Delaware River</td>
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<td>Dieldrin</td>
<td>TMDL</td>
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<tr>
<td>DE020-001</td>
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<td>Lower Army Creek</td>
<td>D and F TEQs</td>
<td>MNR</td>
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<td>DE090-001</td>
<td>Chesapeake &amp; Delaware Canal</td>
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<td>DE010-001-03</td>
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<td>DE290-001-01</td>
<td>Saint Jones River</td>
<td>Lower Saint Jones</td>
<td>D and F TEQs</td>
<td>MNR</td>
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<tr>
<td>DE290-001-01</td>
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<td>D and F TEQs</td>
<td>TMDL</td>
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<td>DE290-L02</td>
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<td>Silver Lake</td>
<td>Mercury</td>
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<td>Waples Pond and Reynolds Pond</td>
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<td>N/A</td>
<td>Delaware Bay</td>
<td>DRBC Zone 6</td>
<td>Mercury</td>
<td>MNR</td>
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</tbody>
</table>
C4. Wetlands Program

The Goals, Objectives and Products of the Delaware Department of Natural Resources and Environmental Control’s Wetland Monitoring and Assessment Program

Program Goals
The goal of DNREC's Wetland Monitoring and Assessment Program (WMAP) is to assess the condition, or health, of wetlands and the functions and ecosystem benefits that wetlands provide. This information is used to inform the citizens of Delaware and to improve existing education, restoration, protection, and land use planning efforts. The 2015 Delaware Wetland Management Plan will guide future efforts of the WMAP in the areas of protocol development, wetland monitoring and assessment activities, research, and application of information.

We work closely with other states through the Environmental Protection Agency's Mid-Atlantic Wetlands Program to establish and conduct research methods and share information.

Objectives:
- Develop scientifically valid wetland assessment methods.
- Assess the current condition of wetlands by watershed and identify major stressors that are impacting wetlands.
- Perform research to improve our understanding of wetland functions, the impact of stressors, and the ecosystem services provided by wetlands to humans and the environment.
- Evaluate the performance of wetland restoration and other compensatory wetland mitigation in replacing wetland acreage and function.
- Educate other state agencies, conservation partners, and the general public to improve efforts to protect and restore wetlands.
- Integrate monitoring and assessment data into watershed restoration plans and other conservation strategies.
- Meet requirements of the Clean Water Act.

Productivity
- Development of Delaware’s nationally-recognized Monitoring and Assessment Protocols
- Developed a collaborative Delaware Wetland Management Plan
- Completed non-tidal wetland condition reports for the Nanticoke, Inland Bays, Murderkill, St. Jones, and Broadkill watersheds
- Completed wetland condition reports for the Nanticoke, Inland Bays, Murderkill, St. Jones, Broadkill and Mispillion watersheds
- Collaborative development of a Restoration Plan for the Nanticoke Watershed

Links to more information about Delaware’s wetlands including Wetland Health Reports, the 2015 Delaware Wetland Management Plan, a review of Delaware’s Wetland program and many
other resources are online at:
C5. Trends Analysis for Surface Waters

Trend Analysis for Nitrogen and Phosphorus

Trend analysis for nitrite+nitrate, total nitrogen, and total phosphorus has been performed to assess water quality changes in Delaware Surface Waters and to track progresses made toward achieving the nutrients target loads established for various watersheds in Delaware as the result of the Total Maximum Daily Load (TMDL) Program. For this analysis, flow-normalized concentrations and loads, and their changes over a 10-year period (2008-2017), have been estimated using an R statistical package called “Exploration and Graphics for RivEr Trends (EGRET)”, (Hirsch and DeCicco, 2015). This statistical package uses a multiple regression method called “Weighted Regressions on Time, Discharge, and Season (WRTDS)”, (Hirsch and others, 2010). As the name indicates, WRTDS method estimates daily concentration by establishing a regression relationship between concentration, stream flow, and time of the year (season). “Flow-normalized” concentration refers to concentration during normal flow condition. Using flow-normalized concentration would eliminate the impact of flow variations on nutrient concentrations and loads and would allow investigating water quality changes that are occurring as the result of management actions. The WRTDS method has been widely used by many agencies for conducting trend analysis. For example, the United States Geological Survey (USGS) is relying on this method to assess water quality changes in non-tidal tributaries of the entire Chesapeake Bay Watershed.

To perform trend analysis for Delaware surface waters based on WRTDS method, daily mean stream flow and nutrients concentration for the 11 monitoring sites in Delaware that are collocated with a USGS stream gauging stations (C1 sites) were retrieved from the USGS website (https://maps.waterdata.usgs.gov/mapper/index.html) and from the Environmental Protection Agency’s modernized STORET website (https://www.waterqualitydata.us/). Figure 1 below shows the location of the C1 monitoring sites used for this analysis and Table 1 provides information about the location of these 11 monitoring sites and the collocated USGS stream gaging station as well as the drainage area above the stream gaging station.

The results of trend analysis for the 11 C1 monitoring sites are grouped and graphically presented in Figures 2 and 3 for nitrite+ nitrate. In these Figures, the annual mean concentrations are shown as black dots and flow-normalized concentrations are shown as green line and reflect how the nitrite+nitrate concentration has changed over time (trend). The time span for trend analysis for a site is dependent on the data period used for the analysis and may be different from one site to the other. Table 2 shows the time period that data was used for the analysis for each monitoring site as well as concentration change (trend) over a 10-year period from 2008 through 2017. Negative values in the table indicate lowering concentrations (improving trend) and positive values indicate increasing concentrations (worsening condition). From Table 2 it can be seen that 9 sites have improving trend and 2 sites (Nanticoke River site and Marshyhope Creek site) have worsening trend with regard to nitrite+nitrate.

Figures 4 and 5 show the results of trend analysis for total nitrogen (TN) and Table 3 summaries these results. This table shows that similar to results for nitrite+nitrate, total nitrogen is improving at 9 sites and are worsening at 2 sites (Nanticoke River and Marshyhope Creek).
Figures 6 and 7 show the results of trend analysis for Total Phosphorus (TP) at the 11 C1 sites and Table 4 summarizes the results. The Table shows TP concentration is improving at 5 sites and worsening at 6 sites.

Figure 1. The 11 C1 Monitoring Sites used for WRTDS Trend Analysis
Table 1. The Monitoring Sites and Their Co-located USGS Stream Gage Site

<table>
<thead>
<tr>
<th>Monitoring Site STORET ID</th>
<th>Location</th>
<th>USGS Stream Gage ID</th>
<th>USGS Stream Gage Name</th>
<th>Drainage Area above the gage (mi²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>103031</td>
<td>Red Clay Creek at Lancaster Pike (Rt. 48)</td>
<td>1480000</td>
<td>RED CLAY CREEK AT WOODDALE, DE</td>
<td>47.0</td>
</tr>
<tr>
<td>104021</td>
<td>Brandywine River at New Bridge Rd. (Rd. 279)</td>
<td>1481500</td>
<td>BRANDYWINE CREEK AT WILMINGTON, DE</td>
<td>314.0</td>
</tr>
<tr>
<td>105151</td>
<td>White Clay Creek at Delaware Park Blvd.</td>
<td>1479000</td>
<td>WHITE CLAY CREEK NEAR NEWARK, DE</td>
<td>89.1</td>
</tr>
<tr>
<td>106141</td>
<td>Christina River at Sunset Lake Rd. (Rt. 72)</td>
<td>1478000</td>
<td>CHRISTINA RIVER AT COOCHS BRIDGE, DE</td>
<td>20.5</td>
</tr>
<tr>
<td>109251</td>
<td>Appoquinimink River’s tributary, Deep Creek Branch at Summit Bridge Rd. (Rt. 71)</td>
<td>1483155</td>
<td>SILVER LAKE TRIBUTARY AT MIDDLETOWN, DE</td>
<td>1.7</td>
</tr>
<tr>
<td>110011</td>
<td>Blackbird Creek at Blackbird Station Rd. (Rd. 463)</td>
<td>1483200</td>
<td>BLACKBIRD CREEK AT BLACKBIRD, DE</td>
<td>4.1</td>
</tr>
<tr>
<td>205191</td>
<td>St. Jones River at Silver Lake at Spillway (Dover City Park)</td>
<td>1483700</td>
<td>ST JONES RIVER AT DOVER, DE</td>
<td>31.9</td>
</tr>
<tr>
<td>302034</td>
<td>Marshyhope Creek at Fishers Bridge Rd. (Rd. 308)</td>
<td>1488500</td>
<td>MARSHYHOPE CREEK NEAR ADAMsville, DE</td>
<td>46.8</td>
</tr>
<tr>
<td>304191</td>
<td>Nanticoke River at Rifle Range Rd. (Rd. 545)</td>
<td>1487000</td>
<td>NANTICOKE RIVER NEAR BRIDGEville, DE</td>
<td>75.4</td>
</tr>
<tr>
<td>308071</td>
<td>Indian River at Millsboro Pond outlet at John Williams Hwy. (Rt. 24)</td>
<td>1484525</td>
<td>MILLSBORO POND OUTLET AT MILLSBORO, DE</td>
<td>61.7</td>
</tr>
<tr>
<td>310121</td>
<td>Little Assawoman Bay, Beaver Dam Ditch at Beaver Dam Rd. (Rd. 368)</td>
<td>1484695</td>
<td>BEAVERDAM DITCH NEAR MILLVILLE, DE</td>
<td>2.2</td>
</tr>
</tbody>
</table>
Figure 2. Annual mean Concentration (black dots) and Flow-Normalized Concentrations (green line) for Nitrite+Nitrate Nitrogen
Figure 3. Annual mean Concentration (black dots) and Flow-Normalized Concentrations (green line) for Nitrite+Nitrate Nitrogen
Table 2. Data period used for trend analysis of Nitrite + Nitrate and the results

<table>
<thead>
<tr>
<th>Monitoring Site ID</th>
<th>Site Description</th>
<th>Data used start year</th>
<th>Data used end year</th>
<th>Concentration change from 2008-2017 (mg/l)</th>
<th>Improving/Worsening Trend</th>
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</thead>
<tbody>
<tr>
<td>103031</td>
<td>Red Clay Creek at Lancaster Pike (Rt. 48)</td>
<td>1999</td>
<td>2017</td>
<td>-0.48</td>
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<tr>
<td>104021</td>
<td>Brandywine Creek at New Bridge Rd. (Rd. 279)</td>
<td>1999</td>
<td>2017</td>
<td>-0.58</td>
<td>Improving</td>
</tr>
<tr>
<td>105151</td>
<td>White Clay Creek at Delaware Park Blvd.</td>
<td>1999</td>
<td>2017</td>
<td>-0.43</td>
<td>Improving</td>
</tr>
<tr>
<td>106141</td>
<td>Christina River at Sunset Lake Rd. (Rt. 72)</td>
<td>1999</td>
<td>2017</td>
<td>-0.42</td>
<td>Improving</td>
</tr>
<tr>
<td>109251</td>
<td>Appoquinimink River trib, Deep Creek Br at Summit Bridge Rd. (Rt. 71)</td>
<td>2008</td>
<td>2017</td>
<td>-1.10</td>
<td>Improving</td>
</tr>
<tr>
<td>110011</td>
<td>Blackbird Creek at Blackbird Station Rd. (Rd. 463)</td>
<td>2002</td>
<td>2017</td>
<td>-0.23</td>
<td>Improving</td>
</tr>
<tr>
<td>205191</td>
<td>St. Jones River, Silver Lake at Spillway (Dover City Park)</td>
<td>1999</td>
<td>2017</td>
<td>-0.18</td>
<td>Improving</td>
</tr>
<tr>
<td>302034</td>
<td>Marshyhope Creek at Fishers Bridge Rd. (Rd. 308)</td>
<td>1998</td>
<td>2017</td>
<td>0.30</td>
<td>Worsening</td>
</tr>
<tr>
<td>304191</td>
<td>Nanticoke River at Rifle Range Rd. (Rd. 545)</td>
<td>1989</td>
<td>2017</td>
<td>0.09</td>
<td>Worsening</td>
</tr>
<tr>
<td>308071</td>
<td>Indian River, Millsboro Pond outlet at John Williams Hwy. (Rt. 24)</td>
<td>1998</td>
<td>2017</td>
<td>-0.47</td>
<td>Improving</td>
</tr>
<tr>
<td>310121</td>
<td>Little Assawoman Bay, Beaver Dam Ditch at Beaver Dam Rd. (Rd. 368)</td>
<td>1999</td>
<td>2017</td>
<td>-1.60</td>
<td>Improving</td>
</tr>
</tbody>
</table>
Figure 4. Annual mean Concentration (black dots) and Flow-Normalized Concentrations (green line) for Total Nitrogen (TN)
Figure 5. Annual mean Concentration (black dots) and Flow-Normalized Concentrations (green line) for Total Nitrogen (TN)
Table 3. Data period used for trend analysis of Total Nitrogen (TN) and the results

<table>
<thead>
<tr>
<th>Monitoring Site ID</th>
<th>Site Description</th>
<th>Data used start year</th>
<th>Data used end year</th>
<th>Concentration change from 2008-2017 (mg/l)</th>
<th>Improving/Worsening Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>103031</td>
<td>Red Clay Creek at Lancaster Pike (Rt. 48)</td>
<td>1999</td>
<td>2017</td>
<td>-0.43</td>
<td>Improving</td>
</tr>
<tr>
<td>104021</td>
<td>Brandywine Creek at New Bridge Rd. (Rd. 279)</td>
<td>1999</td>
<td>2017</td>
<td>-0.53</td>
<td>Improving</td>
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<tr>
<td>105151</td>
<td>White Clay Creek at Delaware Park Blvd.</td>
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<td>2017</td>
<td>-0.50</td>
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</tr>
<tr>
<td>106141</td>
<td>Christina River at Sunset Lake Rd. (Rt. 72)</td>
<td>1999</td>
<td>2017</td>
<td>-0.47</td>
<td>Improving</td>
</tr>
<tr>
<td>109251</td>
<td>Appoquinimink River trib, Deep Creek Br at Summit Bridge Rd. (Rt. 71)</td>
<td>2008</td>
<td>2017</td>
<td>-0.87</td>
<td>Improving</td>
</tr>
<tr>
<td>110011</td>
<td>Blackbird Creek at Blackbird Station Rd. (Rd. 463)</td>
<td>2002</td>
<td>2017</td>
<td>-0.43</td>
<td>Improving</td>
</tr>
<tr>
<td>205191</td>
<td>St. Jones River, Silver Lake at Spillway (Dover City Park)</td>
<td>1999</td>
<td>2017</td>
<td>-0.26</td>
<td>Improving</td>
</tr>
<tr>
<td>302034</td>
<td>Marshyhope Creek at Fishers Bridge Rd. (Rd. 308)</td>
<td>1998</td>
<td>2017</td>
<td>0.42</td>
<td>Worsening</td>
</tr>
<tr>
<td>304191</td>
<td>Nanticoke River at Rifle Range Rd. (Rd. 545)</td>
<td>1989</td>
<td>2017</td>
<td>0.23</td>
<td>Worsening</td>
</tr>
<tr>
<td>308071</td>
<td>Indian River, Millsboro Pond outlet at John Williams Hwy. (Rt. 24)</td>
<td>1998</td>
<td>2017</td>
<td>-0.45</td>
<td>Improving</td>
</tr>
<tr>
<td>310121</td>
<td>Little Assawoman Bay, Beaver Dam Ditch at Beaver Dam Rd. (Rd. 368)</td>
<td>1999</td>
<td>2017</td>
<td>-1.50</td>
<td>Improving</td>
</tr>
</tbody>
</table>
Figure 6. Annual mean Concentration (black dots) and Flow-Normalized Concentrations (green line) for Total Phosphorus (TP)
Figure 7. Annual mean Concentration (black dots) and Flow-Normalized Concentrations (green line) for Total Phosphorus (TP)
Table 4 Data period used for trend analysis of Total Phosphorus (TP) and the results

<table>
<thead>
<tr>
<th>Monitoring Site ID</th>
<th>Site Description</th>
<th>Data used start year</th>
<th>Data used end year</th>
<th>Concentration change from 2008-2017 (mg/l)</th>
<th>Improving/Worsening Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>103031</td>
<td>Red Clay Creek at Lancaster Pike (Rt. 48)</td>
<td>1999</td>
<td>2017</td>
<td>-0.0270</td>
<td>Improving</td>
</tr>
<tr>
<td>104021</td>
<td>Brandywine Creek at New Bridge Rd. (Rd. 279)</td>
<td>1999</td>
<td>2017</td>
<td>0.0004</td>
<td>Worsening</td>
</tr>
<tr>
<td>105151</td>
<td>White Clay Creek at Delaware Park Blvd.</td>
<td>1999</td>
<td>2017</td>
<td>-0.0057</td>
<td>Improving</td>
</tr>
<tr>
<td>106141</td>
<td>Christina River at Sunset Lake Rd. (Rt. 72)</td>
<td>1999</td>
<td>2017</td>
<td>0.0059</td>
<td>Worsening</td>
</tr>
<tr>
<td>109251</td>
<td>Appoquinimink River trib, Deep Creek Br at Summit Bridge Rd. (Rt. 71)</td>
<td>2008</td>
<td>2017</td>
<td>0.0082</td>
<td>Worsening</td>
</tr>
<tr>
<td>110011</td>
<td>Blackbird Creek at Blackbird Station Rd. (Rd. 463)</td>
<td>2002</td>
<td>2017</td>
<td>-0.0077</td>
<td>Improving</td>
</tr>
<tr>
<td>205191</td>
<td>St. Jones River, Silver Lake at Spillway (Dover City Park)</td>
<td>1999</td>
<td>2017</td>
<td>-0.0096</td>
<td>Improving</td>
</tr>
<tr>
<td>302034</td>
<td>Marshyhope Creek at Fishers Bridge Rd. (Rd. 308)</td>
<td>1998</td>
<td>2017</td>
<td>0.0500</td>
<td>Worsening</td>
</tr>
<tr>
<td>304191</td>
<td>Nanticoke River at Rifle Range Rd. (Rd. 545)</td>
<td>1989</td>
<td>2017</td>
<td>-0.0058</td>
<td>Improving</td>
</tr>
<tr>
<td>308071</td>
<td>Indian River, Millsboro Pond outlet at John Williams Hwy. (Rt. 24)</td>
<td>1998</td>
<td>2017</td>
<td>0.0080</td>
<td>Worsening</td>
</tr>
<tr>
<td>310121</td>
<td>Little Assawoman Bay, Beaver Dam Ditch at Beaver Dam Rd. (Rd. 368)</td>
<td>1999</td>
<td>2017</td>
<td>0.0620</td>
<td>Worsening</td>
</tr>
</tbody>
</table>
C6. Public Health Issues
The Department addresses public health issues through various programs related to drinking water supplies, beach use and fish/shellfish advisories.

Delaware Source Water Protection Program
The Source Water Assessment and Protection Program (SWAPP) was created by Congress as part of the Safe Drinking Water Act Amendments of 1996. The goal of the SWAPP is to better protect public drinking water resources by providing local and state governments, and the public more information about those resources. The susceptibility of each source of public drinking water to various types of contamination will be determined and published. Congress has provided funding through the U.S. EPA to the states to support their efforts in conducting these assessments.

The Delaware Department of Natural Resources and Environmental Control (DNREC) has the lead role in the development and implementation of the Delaware SWAPP. The Delaware Division of Public Health and the Water Resources Agency, Institute for Public Administration at the University of Delaware, closely supports its work. A SWAPP Citizen and Technical Advisory Committee (CTAC) was formed at the start of this program in 1998 and continuing to assist in developing and implementing Delaware’s SWAPP and ensures public involvement.

<table>
<thead>
<tr>
<th>Program</th>
<th>Web Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delaware Source Water Protection Program (DNREC)</td>
<td><a href="http://delawaresourcewater.org/">http://delawaresourcewater.org/</a></td>
</tr>
</tbody>
</table>

Delaware’s Recreational Beach Monitoring Program
DNREC’s Recreational Water Program protects the health of swimmers in a number of ways:

- Shoreline surveys are conducted adjacent to guarded recreational beaches to identify all actual and potential sources of pollution.
- Water samples are collected at least weekly at all guarded beaches during the swimming season (mid May through September).
- Water samples are analyzed to determine the levels of Enterococci bacteria in recreational waters. Enterococcus is one of several indicator organisms that signal the presence of potentially harmful bacteria and viruses.
- Signs have been posted at popular public access points around Rehoboth Bay, Indian River Bay, and Little Assawoman Bay to warn potential swimmers of the risks associated with swimming in poor quality waters.
- The Department recommends swimming only at guarded beaches where water samples are collected.
There is a permanent caution regarding swimming in the Inland Bays. The Inland Bays suffer from nutrient and bacterial pollution that come from failing septic systems, fertilizers, and other sources. Water is slow to flush out of these bay, Indian River Bay, Rehoboth Bay and Little Assawoman Bay, so pollutants linger. Up to date information about swimming advisories is available online at http://apps.dnrec.state.de.us/recwater/ or by phone on the 24-hour "Beach Hotline" at 1-800-922-WAVE (9283).

Fish Consumption Advisories

Fishing is an important activity in Delaware's inland and coastal waters. Among the benefits provided by fishing are quality recreational opportunities, direct and indirect input to the local economy, food for recreational anglers and food for the commercial marketplace. Fish are a good source of readily digestible protein, they are low in fat and sodium, and the unique type of fats found in fish are believed to provide cardiovascular benefits. Despite the general benefits of fishing and fish consumption, there has been a growing concern regarding the presence of chemical toxins in the flesh of finfish and shellfish taken from Delaware waters and the associated health risk to anglers and their families who consume their catch. The existence of chemicals in the edible portion of some fish has resulted in the public advisories (see Section C2 above). These advisories are as a result of joint action taken by the Department of Natural Resources and Environmental Control and the Department of Health and Social Service's (DHSS) Division of Public Health. Information about the latest advisories that are in effect is online at: http://www.dnrec.delaware.gov/fw/Fisheries/Pages/Advisories.aspx
PART D. GROUND WATER MONITORING AND ASSESSMENT
Place holder Text
PART E. PUBLIC PARTICIPATION

The Department kept the public informed of the process and progress of this Integrated Report using its website, an email list of interested parties and public notices placed in local newspapers.
Appendix One: Station Roll Ups
Appendix Two: Segment Roll Ups
Appendix Three: An Evaluation of Clean Water Act Section 303(d) Listings of Delaware Waters Affected by Fish Consumption Advisories
Appendix Four: Integrated Report Database
Appendix Five: Changes to the Integrated Report for this Listing Cycle
Appendix Six: The Final Determination for the State of Delaware 2018 Clean Water Act
Section 303(d) List of Waters Needing TMDLs
Appendix 7: Volunteer Water Quality Monitoring Data
Appendix Eight: Public Participation