PART G: SPECIAL ASSESSMENTS

G.1 Conococheague Creek High pH Assessment

In the Draft 2018 Integrated Report that was released for public comment, this section detailed an intensive study of Conococheague Creek (Assessment Unit: MD-02140504-Multiple_segments_1) which proposed that local geological conditions (i.e. karst formations) caused the pH for this stream system to frequently go above the upper bound of Maryland's pH criteria (8.5). The Department intended to move this pH listing from category 5 to category 2 due to the impairment being caused by the natural geology of the area. However, upon further review and discussion, MDE has decided that additional follow-up monitoring and assessment is needed to further evaluate if the high pH levels were caused by the natural geology of the area or another factor. Therefore, MD-02140504-Multiple_segments_1 will remain on category 5 for high pH for the 2018 IR. This listing and the aforementioned study will be revisited in conjunction with the expected follow-up monitoring data. To see how this listing changed after the start of the public comment period please visit Part H of this report.

G.2 Water Quality Assessment for the Susquehanna River Downstream of Conowingo Dam (non-tidal, upstream from head of tide) – Assessment of Flow Alteration

G.2.1 Background

Lower Non-tidal Susquehanna River - *Changes from Natural Flow Regime*

The Lower Susquehanna has been hydrologically altered by various control structures (dams). The aquatic life and some beneficial uses will be different than those of a free-flowing (lotic) river system. The dam creates an impoundment or stillwater (lentic) ecosystem. Downstream of the dam, the river transitions back to a lotic system and eventually becomes tidal with gradually increasing salinities. The operation of the Conowingo Dam for hydropower creates unnatural hydrology. It is a system characterized by extreme "flashiness" due to the intermittent demand for hydropower. This is summarized succinctly by Genevieve Larouche (USFWS) in her testimony on May 5, 2014 before the Senate Environment and Public Works Subcommittee on Water and Wildlife:

"Currently at the Conowingo Dam, flow releases are lowest during the winter and spring months and highest in July and August. Daily maximum releases are equivalent to seasonal flood flows. There is no limit to the rate of rise or fall of water between minimum and maximum releases. These unnaturally rapid changes in water levels impact migratory fish by interrupting migratory cues, lengthening migration times, stranding fish, and reducing suitable habitat."

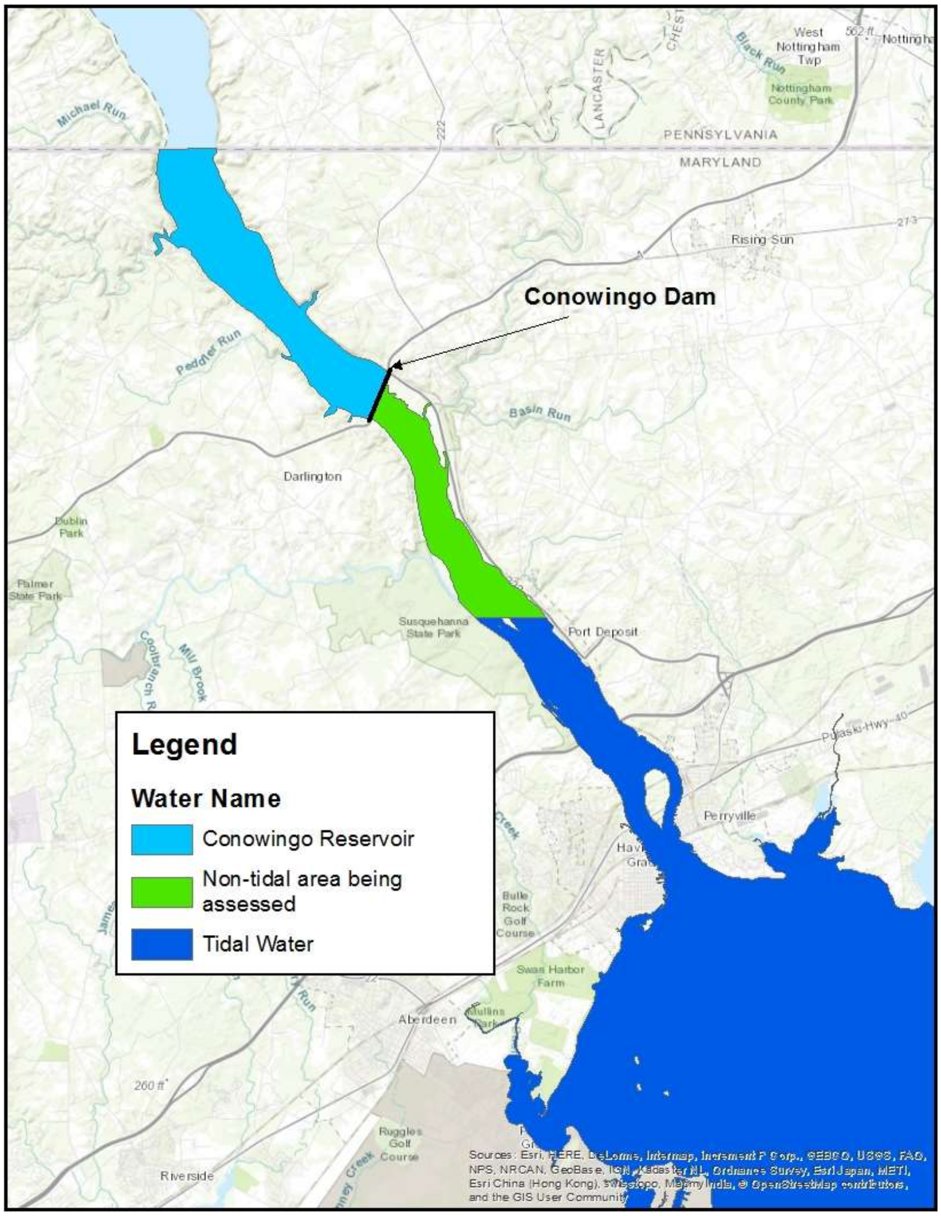

Figure 17: Map showing the portion of the Lower Susquehanna River included in this assessment.

To help further illustrate the extreme flow fluctuations due to the current operation of the dam, the Nature Conservancy (TNC), in its "Motion to Intervene" and comments filed with the Federal Energy Regulatory Commission (FERC) in the Conowingo Dam and Muddy Run Project dockets, summarizes the alteration to natural flows (based on upstream river gauge) under current and proposed project operations as follows:

- minimum flow releases (0 to 10,000 cfs) are less than the lowest recorded daily minimum flow for the months of December through June and are 60 to 100% lower than the historic monthly median flows from October through June;

- daily maximum generation releases (86,000 cfs) are equivalent to seasonal flood pulses during all months, with the exception of March and April, and are greater than the historic maximum daily flows during July and August;
- depending on the month, maximum generation flows are between 8 and 25 times greater than minimum flows;
- there is no limit to the rate of [water level] rise or fall between minimum [dam] releases and maximum generation releases so the river can fluctuate by as much as 86,000 cfs/hour, equating up to a 9 foot change in depth, or from typical dry conditions to flood conditions;
- the maximum hourly rise rate is 12 times or 1,200% greater than an upstream reference gage and the maximum hourly fall rate is 25 times or 2,542% greater than an upstream reference gage; and
- The frequency of flow fluctuations is 341% greater than an upstream reference gage.

Another useful illustration of the deviance from natural flows caused by current operations at Conowingo Dam can be seen by visual comparison of river discharge at two United States Geological Survey (USGS) gages during the same time period. Figure 18 below shows the river discharge for the week of August 13, 2017 through August 19, 2017 at USGS gage 01576000, located in Marietta, Pennsylvania. This gage, upstream of the Conowingo Dam, roughly approximates the natural flow fluctuations to be expected at Conowingo in the absence of flow controls. Meanwhile, Figure 19 shows the discharge, during this same time period, for USGS gage 01578310, located immediately downstream of the dam on the Susquehanna River at Conowingo, Maryland. As is readily apparent, the operations of the Conowingo Dam drastically alter the natural flow regime on the Susquehanna River at this location and for some distance downstream.

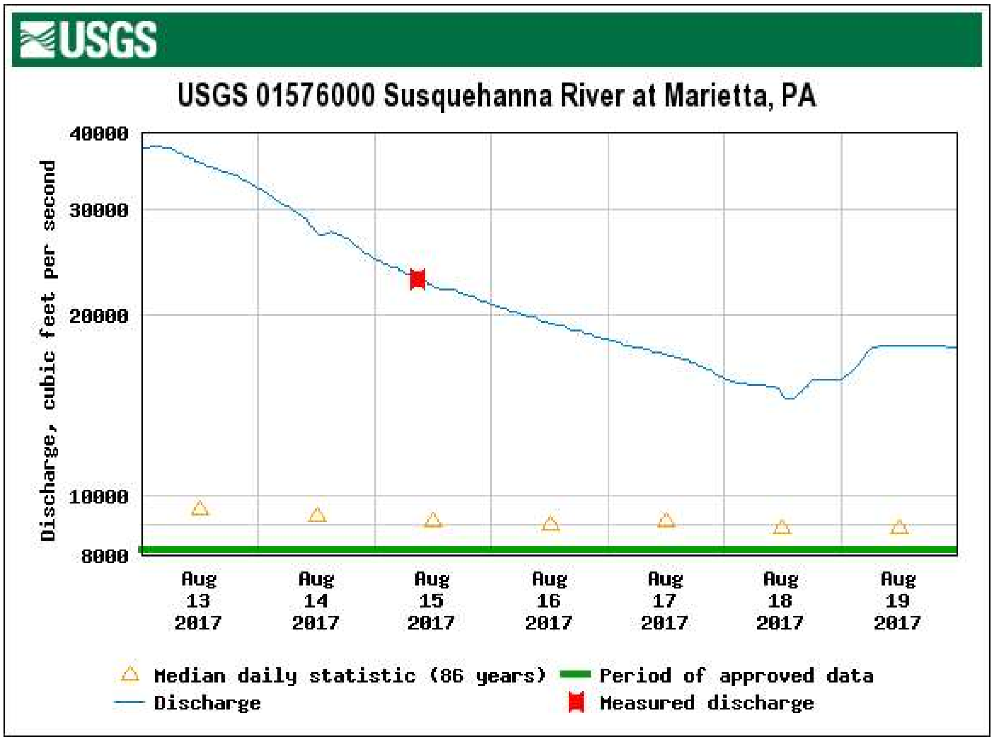

Figure 18: Graph of river discharge (cubic feet per second) at USGS gage 01576000 at Marietta, PA.

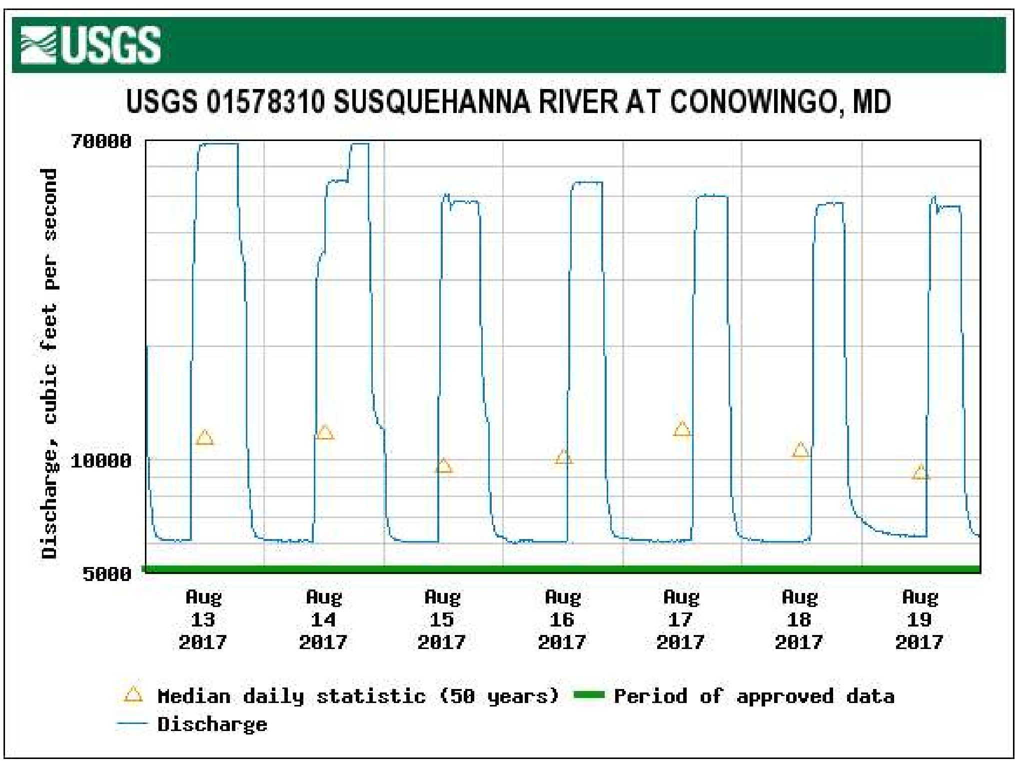

Figure 19: Graph of river discharge (cubic feet per second) at USGS gage 01578310, located immediately downstream of the Conowingo Dam at Conowingo, MD.

The following photos also provide a visual comparison of the water levels found in the Susquehanna River below the dam during peak energy generation (first figure) and during off-peak energy generation (second figure).

Figure 20: Picture depicting the water level downstream of the Conowingo Dam during peak (i.e. high flow) energy generation (Richards and Seigel 2009).

Figure 21: Picture depicting the water level downstream of the Conowingo Dam during low energy (i.e. low flow) generation (Richards and Seigel 2009).

G.2.2 Environmental and Biological Impacts of Flow Alteration

G.2.2.1 Fish Migration

Migratory Cues

Dam operations interrupt migratory cues and lengthen migratory times. "Based on telemetry data from *RSP 3.5*, it took migrating American shad an average of 11 days between first entering the tailrace and successfully entering the fish lift." (Normandeau Associates, Inc. / Gomez and Sullivan Engineers, P.C. RSP 3.5) Delay in migration creates stress to the fish and can be detrimental to the spawning success of diadromous fish. Delay in migration, both upstream and downstream, has been shown to negatively impact total fecundity on spawning fish. Dams with hydropower operations can delay migration and impose bioenergetic costs that are detrimental to the spawning and survival of diadromous fish (Castro-Santos and Letcher 2010).

Fish Passage

According to the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) Migratory Fish Management and Restoration Plan for the Susquehanna River Basin (2010), "adult numbers have decreased most likely due to a variety of factors including: poor efficiency of fish passage measures and facilities; low hatchery production in recent years; low numbers of spawning fish accessing quality habitat: poor young-of-year recruitment upstream of Conowingo Dam; ocean and Chesapeake Bay mortality; turbine mortality and predation." A variety of migratory species are affected by the dam operations and a variety of management strategies have been implemented over the years. To that end, the aforementioned plan developed by SRAFRC provides specific goals for American shad and river herring. Restoration goals for the American eel and other migratory species are forthcoming.

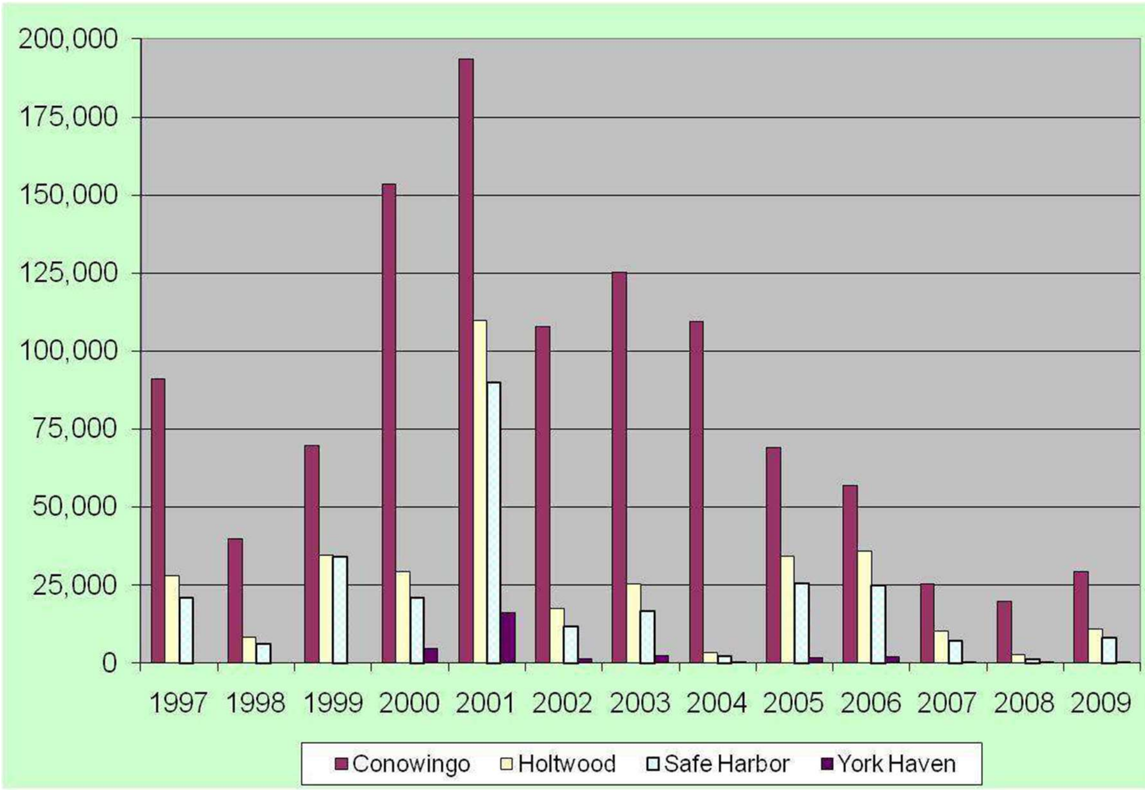

Figure 22: American Shad passage at Susquehanna River dams (SRAFRC).

G.2.2.2 Fish Stranding

Hydropower operations result in fish stranding and mortality as a direct result of rapid dewatering of the downstream varial zone. Current minimum flows range from 3,000 - 10,000 cubic feet per second (cfs) and peaking flows are regularly as high as 86,000 cfs. In the course of an hour, water depths may vary by as much as 9 ft. According to a study during the 2011 spawning migration, an estimated 1,400 American shad (about 6 % that passed that year) and more than 500 river herring were stranded as a result of hydropower operations. According to TNC analysis, they conclude that an estimated 420,000 fish may have been stranded over the course of the year. The times of highest stranding potential occur in spring and summer. (TNC)

G.2.2.3 Map Turtle Impacts

During peak generation flows, endangered map turtles are adversely impacted by the inundation of basking habitat which is critical to adult reproductive growth. Peaking flows have reduced basking activity by an estimated 50% and impairs short and long term map turtle movements. (Richards and Seigel 2009)

G.2.2.4 General Impacts to Substrate

The Conowingo Dam traps a large portion of coarse sediments above the dam, effectively starving the downstream waters of habitat-forming bottom gravel and sediments. According to the TNC, lack of sediment along with peaking extreme high flows results a loss of available habitat for organisms that require these habitats including mussels, SAV, EAV, etc. (TNC) Additionally, since excess sediment is stored upstream of the dam, high flow scouring events have the potential to deliver large pulses of sediment (and associated nutrients) downstream that can have significant negative impacts to biological resources.

G.2.2.5 Macroinvertebrates

Below the Conowingo Dam, the macroinvertebrate community is characterized as hydrologically impaired (TNC) and is dominated by taxa tolerant of poor habitat. (Normandeau Associates, Inc. / Gomez and Sullivan Engineers, P.C. RSP 3.18);

G.2.2.6 Mussels

Dam operations has a negative impact on composition and abundance of freshwater mussels due to high-flow shear stress during peak generation, lack of coarse-grain bedload, and unsuitable conditions for host-fish to provide recruitment/transport. Currently, a freshwater mussel population downstream of the dam is not viable. (TNC) In addition, Normandeau Associates, Inc./Gomez and Sullivan Engineers RSP 3.19 documents observations downstream of the dam as "The patchy distribution of mussels in the study reach is likely influenced by a combination of factors, including zones of unsuitable flow conditions related to the dam and associated hydropower operations as well as zones of naturally unsuitable flow conditions and substrate." Additionally this study states that catch per unit effort (CPUE) increased with distance downstream, indicating improving habitat conditions increases with distance from the dam.

G.2.3 Assessment and Rationale

EPA provides guidance to states on various tools for assessing and listing waters on the Integrated Report (combined 303(d) List and 305(b) Report). In addition to assessing numeric physical, chemical and biological criteria, a state may want to assess its narrative criteria. These narrative statements in their water quality standards also provide for the protection of designated uses. However, narrative criteria are stated broadly so that impairments caused by pollutants and pollution for which the state does not have numeric criteria may be characterized, with the ultimate goal of implementing practices that will allow for use attainment or attainment of the highest attainable conditions in those waterbodies. When a state determines that an impairment is caused by pollution and not a pollutant, the state may choose to include a waterbody in Category 4C on their Integrated Report. USEPA's 2015 guidance states:

"Category 4C - If States have data and/or information that a water is impaired due to pollution not caused by a pollutant (e.g., aquatic life use is not supported due to hydrologic alteration or habitat alteration), those causes should be identified and that water should be assigned to Category 4C. Examples of hydrologic alteration include: a perennial water is dry; no longer has flow; has low flow; has stand-alone pools; has extreme high flows; or has other significant alteration of the frequency, magnitude, duration or rate-of-change of natural flows in a water; or a water is characterized by entrenchment, bank destabilization, or channelization. Where circumstances such as unnatural low flow, no flow or stand-alone pools prevent sampling, it may be appropriate to place that water in Category 4C for impairment due to pollution not caused by a pollutant. In order to simplify and clarify the identification of waters impaired by pollution not caused by a pollutant, States may create further sub-categories to distinguish such waters. While TMDLs are not required for waterbody impairments assigned to Category 4C, States can employ a variety of watershed restoration tools and approaches to address the source(s) of the impairment." (underlining added here for emphasis)

Based on the hydrological data alone, the flow in the lower Susquehanna River is clearly and significantly altered by the nature of peaking hydroelectric operations. This hydrologic alteration, as well as the presence of the Conowingo Dam itself, impact biological resources (i.e. impair the aquatic life and wildlife designated use) in a variety of ways as is summarized above. Therefore, the Department is placing the non-tidal Susquehanna River, from the Conowingo Dam downstream to the head-of-tide, in Category 4c due to pollution caused by flow alteration - changes in depth and flow velocity.

Table 40: This table summarizes the new impairment listing for the portion of the Susquehanna River downstream from Conowingo Dam down to the head-of-tide.

Water Body	Designated_Use	Cause	Listing_Category
Susquehanna River (basin code 02120201)	Aquatic Life and Wildlife	Flow Alteration - Changes in depth and flow velocity	4c – impaired, impairment caused by pollution (not a pollutant)

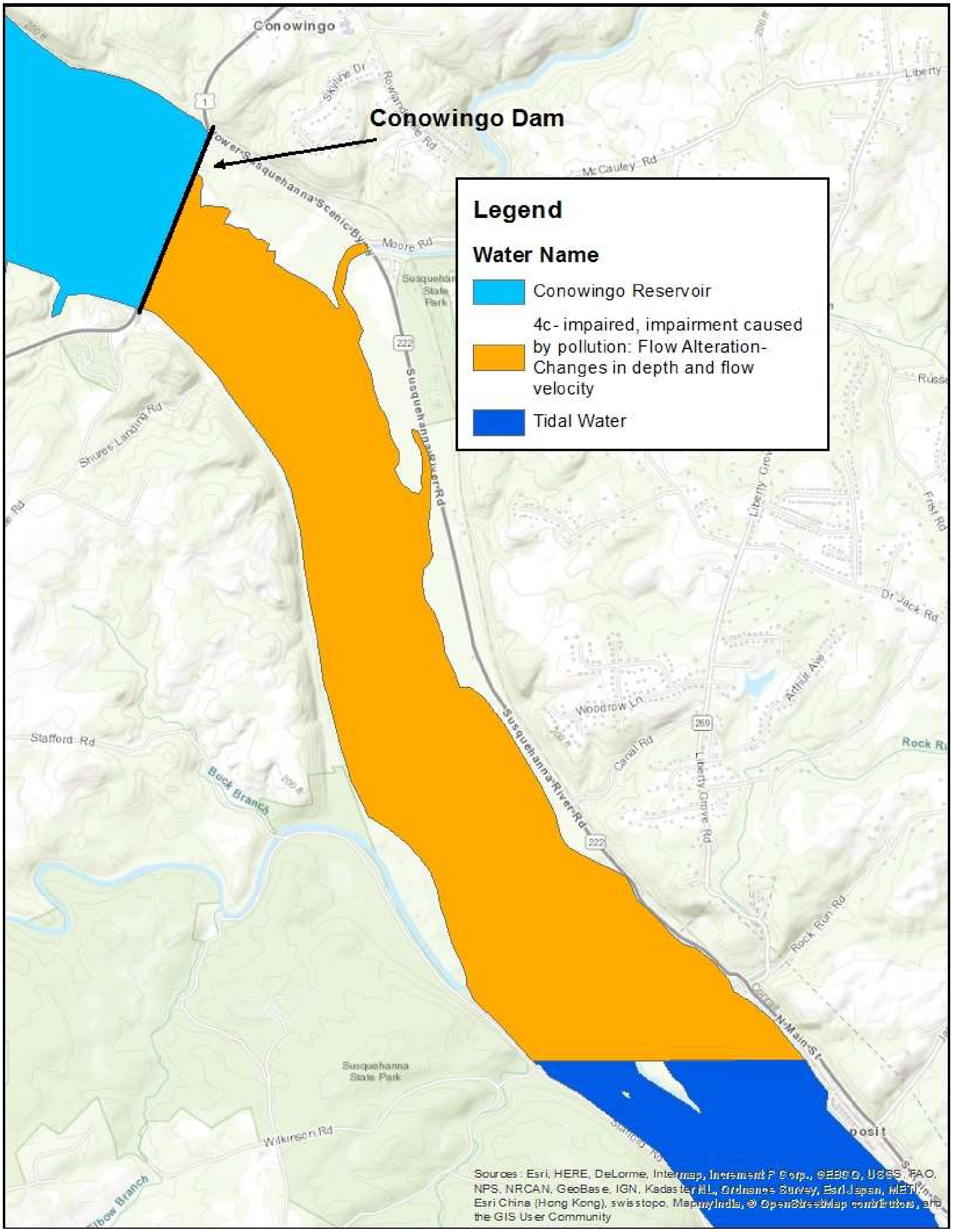

Figure 23: Map showing the geographic extent of the impairment listing for flow alteration – changes in depth and flow velocity in the Lower Susquehanna River mainstem.

References Specific to the Lower Susquehanna River Flow Alteration Assessment

Castro-Santos, T. and B.H. Letcher. 2010. Modeling migratory energetics of Connecticut River American shad (Alosa sapidissima): implications for the conservation of an iteroparous anadromous fish. *Canadian Journal of Fisheries and Aquatic Sciences* 67:806-830.

Genevieve LaRouche, Field Office Supervisor, Chesapeake Bay Field Office, U.S. Fish and Wildlife Service, U.S. Department of the Interior – Testimony Before the Senate Environment and Public Works Subcommittee on Water and Wildlife, May 5, 2014 Office of Congressional and Legislative Affairs / Hearings and Testimony / Hearings and Testimony of the 113th Congress / Conowingo Dam - 5.5.14 https://www.doi.gov/ocl/hearings/113/conowingodam_050514.

The Nature Conservancy - Motion to Intervene and NREA Comments; Exelon, Conowingo (P-405-106) and Muddy Run Projects (P-2355-018) York Haven, York Haven Project (P-1888-030) "*Alternatives for Environmental Analysis, and Preliminary Terms and Conditions*".

Normandeau Associates, Inc. / Gomez and Sullivan Engineers, P.C. August 2012 - Analysis of the 2010 American Shad Radio Telemetry Animations RSP 3.5; Conowingo Hydrolelectric Project; FERC PROJECT NUMBER 405.

Normandeau Associates, Inc. / Gomez and Sullivan Engineers, P.C. August 2012 – Final Study Report Characterization of Downstream Aquatic Communities RSP 3.18; Conowingo Hydrolelectric Project; FERC PROJECT NUMBER 405.

Normandeau Associates, Inc. / Gomez and Sullivan Engineers, P.C. August 2012 –Freshwater Mussel Characterization Study Below Conowingo Dam RSP 3.19; Conowingo Hydrolelectric Project; FERC PROJECT NUMBER 405.

Richards, T.M. and R. A. Seigel 2009. Habitat use of Northern Map Turtles (Graptemys geographica) in an altered system, the Susquehanna River, Maryland (USA) – Poster Presentation at 2009 Ecological Society of America Conference.

Susquehanna River Anadromous Fish Restoration Cooperative. 2010; Migratory Fish Management and Restoration Plan for the Susquehanna River Basin.